

National Spatial Data Infrastructure

Final Draft -- FGDC Digital Cartographic Standard for Geologic Map Symbolization

Geologic Data Subcommittee
Federal Geographic Data Committee

May 2006

Prepared by the U.S. Geological Survey for the Federal Geographic Data Committee

Recommended reference:
Federal Geographic Data Committee [prepared for the Federal Geographic Data Committee by the U.S. Geological Survey], 2006, FGDC Digital cartographic standard for geologic map symbolization: Reston, Va., Federal Geographic Data Committee, ??? p., 2 plates.

Federal Geographic Data Committee
Department of Agriculture • Department of Commerce • Department of Defense • Department of Energy
Department of Housing and Urban Development • Department of the Interior • Department of State
Department of Transportation • Environmental Protection Agency
Federal Emergency Management Agency • Library of Congress
National Aeronautics and Space Administration • National Archives and Records Administration
Tennessee Valley Authority

46 Federal Geographic Data Committee

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48 Established by Office of Management and Budget Circular A-16, the Federal Geographic Data Committee
49 (FGDC) promotes the coordinated development, use, sharing, and dissemination of geographic data.

50
51 The FGDC is composed of representatives from the Departments of Agriculture, Commerce, Defense, Energy,
52 Housing and Urban Development, the Interior, State, and Transportation; the Environmental Protection Agency;
53 the Federal Emergency Management Agency; the Library of Congress; the National Aeronautics and Space
54 Administration; the National Archives and Records Administration; and the Tennessee Valley Authority.
55 Additional Federal agencies participate on FGDC subcommittees and working groups. The Department of the
56 Interior chairs the committee.

57
58 FGDC subcommittees work on issues related to data categories coordinated under the circular. Subcommittees
59 establish and implement standards for data content, quality, and transfer; encourage the exchange of information
60 and the transfer of data; and organize the collection of geographic data to reduce duplication of effort. Working
61 groups are established for issues that transcend data categories.

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307 **1. INTRODUCTION**

308 **1.1 OBJECTIVE**

309 This document provides a single national standard for the digital cartographic representation of geologic map
310 features. This standard is intended to support the Nation's producers and users of geologic map information by
311 providing line symbols, point symbols, and colors and patterns that can be used to portray the various features
312 on geologic maps. The objective of this standard is to aid in the production of geologic maps and related
313 products, as well as to help provide geologic maps and products that are more consistent in both their
314 appearance and their underlying database content.

315 A geologic map is a cartographic product that expresses information about the geology of a particular area. The
316 map uses graphical elements such as line symbols, point symbols, and colored or patterned areas to portray
317 complex geological information such as the composition, age, genesis, and extent of an area's geologic
318 materials, as well as the geometry, orientation, and character of the geologic structures that have deformed
319 them. Geologic maps generally are intended for use by both the geoscience professional and the general public;
320 however, designing and preparing a geologic map that will inform such a diverse audience can be a daunting
321 task because of the complexity of both the mapping concepts and the geologic information. This standard
322 attempts to facilitate map comprehension by providing clear and familiar symbology, thereby ensuring that the
323 lines, points, and areas on the map convey the same meaning to all information producers and users. This
324 standard also endeavors to clarify some of the concepts of geologic mapping, as well as to standardize some of
325 the terminology used to describe the various features on a geologic map.

326 The imperative for the clear communication of geologic map information to such a diverse audience was
327 outlined early in the history of the U.S. Geological Survey (USGS) by then-Director John Wesley Powell, who
328 stated that "the maps are designed not so much for the specialist as for the people, who justly look to the official
329 geologist for a classification, nomenclature, and system of convention so simple and expressive as to render his
330 work immediately available alike to the theoretic physicist or astronomer, the practical engineer or miner, and
331 the skilled agriculturist or artisan" (Powell, 1888, p. 229). The consistent, unambiguous expression of geologic
332 map information is even more critical now because such information increasingly is compiled, stored,
333 manipulated, and exchanged in digital files and geospatial databases. In the digital files, the cartographic
334 representation of each feature on a geologic map must have a unique and explicit meaning, and it also must be
335 compatible with the feature's attributes in the geologic map database. To that end, the preparers of this standard
336 reviewed existing formal and informal USGS geologic map symbolization standards and adapted them for
337 implementation with modern digital mapmaking systems and geospatial databases.

338 Although this standard is herein formalized, it is not intended to be used inflexibly or in a manner that will
339 unduly restrict a geologist's ability to communicate the observations and interpretations gained from geologic
340 mapping. On the contrary, this standard recognizes that, in certain situations, an existing symbol or its usage

341 might need to be modified to fit a particular geologic situation or setting. Likewise, this standard recognizes that
342 a new symbol or set of symbols may need to be created to more fully express local geologic conditions or to
343 keep pace with evolving geologic mapping concepts and practices. Accordingly, such new or modified symbols,
344 if found to be of wide applicability, will be incorporated into this standard through planned, periodic revisions.

345 **1.2 SCOPE**

346 This standard contains descriptions, examples, cartographic specifications, and notes on usage for a wide
347 variety of symbols that may be used on typical, general-purpose geologic maps and related products such as
348 cross sections. However, the standard also can be used for different kinds of special-purpose or derivative map
349 products and databases that may be focused on a specific geoscience topic (for example, slope stability) or class
350 of features (for example, a fault map). The standard is scale-independent, meaning that the symbols are
351 appropriate for use with geologic mapping compiled or published at any scale. It is designed for use by anyone
352 who either produces or uses geologic map information, whether in analog or digital form.

353 **1.3 APPLICABILITY**

354 This document establishes standards that are applicable to all geologic map information (in other words,
355 geologic maps and databases) published by the Federal Government and its Federally funded contractors and
356 collaborators. Non-Federal agencies and private firms that produce geologic map information also are urged to
357 adopt the standard.

358 The standard applies to all forms of geologic map publications, whether they are released as (1) hard-copy
359 products, in either offset-print or plot-on-demand format, or (2) digital products, either as files for spatial
360 analysis in Geographic Information Systems (GIS), as Portable Document Format (PDF) files in online
361 publications, or as browse-graphic files for display on the World Wide Web. In particular, the standard applies
362 to all geologic map products archived within the National Geologic Map Database (NGMDB), which is
363 administered by the USGS: geologic map products submitted to and incorporated within the NGMDB will
364 conform to this standard.

365 **1.4 RELATED STANDARDS**

366 The USGS traditionally has established nationally applicable cartographic standards for the production of
367 geologic map information, both explicitly, through various formal and informal standards documents (see
368 Section 2.1 below, entitled "Relation to Previous U.S. Geological Survey Standards"), and implicitly, through
369 the cartographic content of its publications. This standard supersedes any existing USGS formal or informal
370 cartographic standards for geologic maps.

371 During preparation of this standard, its relation to other standards or standards-development activities was
372 assessed, and no significant conflicts were found. For example, the International Organization for
373 Standardization (ISO) Standard 710, Parts 1–4, describes a general schema for graphical display of a selected

374 set of geologic map symbols. Although similar to some that are included in this standard, they were found to
375 have limited applicability. In addition, similar standards have been developed in other agencies of the Federal
376 Government, including the U.S. Forest Service (in the geology component of their Terra database), the U.S.
377 Army Corps of Engineers (in the geology component of their Spatial Data Standard for Facilities, Infrastructure,
378 and the Environment [SDSFIE]), and the U.S. Bureau of Reclamation (in their Engineering Geology Office
379 Manual). These were found to be somewhat specialized and limited in their coverage of geologic map features.
380 Conversely, this standard provides comprehensive coverage of symbology for a broad range of geologic map
381 features.

382 **1.5 STANDARDS DEVELOPMENT PROCEDURES**

383 This standards document represents only the latest milestone in a long history of geologic map standards
384 development in the United States, which, within the USGS, began prior to 1881. As then-Director John Wesley
385 Powell noted in 1888, in reference to geologic map standards under development at that time within the USGS,
386 "While it is not professed that this [cartographic] system is final, or even unobjectionable, it represents the
387 present state of knowledge and opinion" (Powell, 1888, p. 230). Although the present standards document
388 draws heavily on previously established formal and informal cartographic standards of the USGS, it has
389 undergone substantial revisions that reflect current geologic mapping practices and modern digital mapmaking
390 methods. Accordingly, the standards-development procedures outlined in this section will address only the most
391 recent development history of this standard (for a more complete historical background, see Section 2.1 below,
392 entitled "Relation to Previous U.S. Geological Survey Standards").

393 This standards document was developed by members of the USGS Geologic Discipline's Western Publications
394 Group and the National Geologic Map Database (NGMDB), with guidance and contributions from members of
395 the Map Symbol Standards Committee (see below; see also, Section 2.3, entitled "Preparers of This Standard").
396 In addition, this standards document has benefited from the broad, modern-day perspective gained from the
397 many thoughtful responses from reviewers of the Federal Geographic Data Committee's (FGDC) Public Review
398 Draft of the standard (Federal Geographic Data Committee, 2000; see also, U.S. Geological Survey, 2000). The
399 preparers of this standard gratefully acknowledge all current and prior participants and appreciate their
400 invaluable contributions to the development of both this standards document and all preceding works.

401 In 1995, a proposed cartographic standard for geologic map information was informally released by the USGS
402 as the "Cartographic and Digital Standard for Geologic Map Information" (U.S. Geological Survey, 1995a,
403 1995b). In 1996, this proposed standard was formally reviewed by geologists and cartographers from the USGS,
404 as well as from the Association of American State Geologists (AASG), which represents the State geological
405 surveys, and from the FGDC's Geologic Data Subcommittee, which is composed of representatives from
406 Federal agencies that produce or use geologic map information. That review (Soller, 1996) indicated the need
407 for some revision to the proposed standard prior to its consideration by the FGDC for formal adoption as a
408 Federal standard.

409 In 1996, plans were outlined to create a revised and updated Federal standard, and an early standards-
410 development group was formed (see Section 2.3 below, entitled "Preparers of This Standard"). A proposal to
411 develop the revised standard was submitted by the FGDC's Geologic Data Subcommittee (see
412 http://ncgmp.usgs.gov/fgdc_gds/mapsymbprop.html), and the FGDC accepted that proposal in 1997. Later that
413 year, the standards-development group produced a preliminary version of the draft standard, which was
414 circulated among selected USGS and State geological survey personnel for review. Comments were
415 incorporated and, in 1999, the revised draft standard was submitted (as the "Working Draft") to the FGDC's
416 Geologic Data Subcommittee for consideration. Upon review and subsequent approval by the Subcommittee,
417 the Working Draft was submitted to the FGDC Standards Working Group, which, in 2000, approved the
418 document for public review as the "Public Review Draft" (see below), pending adoption of minor changes.

419 The Public Review Draft of this standard was finalized and then published in April 2000 (Federal Geographic
420 Data Committee, 2000; see also, U.S. Geological Survey, 2000). In May 2000, the public was invited to review
421 the draft standard and to provide comments and suggestions for revision (see
422 http://ncgmp.usgs.gov/fgdc_gds/mapsymb/mapsymbpubrev.html). At the end of the 120-day public review
423 period (May 19 through September 15, 2000), all comments and suggestions to the Public Review Draft were
424 compiled, and a plan was developed to address the comments and make the necessary changes. Under this plan,
425 a standing Map Symbol Standards Committee was formed to assist in the resolution of the public's review
426 comments and suggestions, as well as in the long-term maintenance of the standard. Committee members were
427 drawn from the geologic mapping community in the State geological surveys, academia, and the USGS (see
428 Section 2.3 below, entitled "Preparers of This Standard").

429 Revisions to the standards document began in 2001. The revised standard was approved by the Map Symbol
430 Standards Committee, then by the FGDC Geologic Data Subcommittee, and then it was submitted to the FGDC
431 Standards Working Group for formal approval in 2005.

432 This standard will be managed as a "living" standard—that is, it will be maintained and revised as needed to
433 reflect new mapping concepts or evolving usage conventions. The initial release of this FGDC-approved
434 standard is available as an offset-printed document, supplemented by electronic (CD-ROM) and online (PDF)
435 versions. However, all future updates to this standard will be released online in PDF format only. To help
436 maintain an up-to-date hard-copy version of the standards document, this initial offset-printed release has been
437 designed in a "loose-leaf" format. Subsequent updates to this standards document may be downloaded as PDF
438 files and then printed out and inserted where appropriate into a loose-leaf binder. These online updates will be
439 the authoritative reference.

440 Because this standard is intended for use with digital applications, a PostScript implementation of the Public
441 Review Draft was informally released as a USGS Open-File Report (U.S. Geological Survey, 2000). This early
442 PostScript implementation enabled reviewers to directly apply the standard to geologic maps and illustrations
443 prepared in desktop illustration and (or) publishing software. The PostScript implementation has been updated

444 to reflect changes found in the now-approved standard and has been released as a USGS Techniques and
445 Methods report (U.S. Geological Survey, 2006). Additionally, preliminary work on an ArcGIS implementation
446 may be completed in the future and released as a USGS report. Information regarding these implementation
447 efforts will be posted on FGDC's Geologic Data Subcommittee website (http://ncgmp.usgs.gov/fgdc_gds/).

448 Questions and comments about, or suggested additions to, this standard may be submitted by e-mail to
449 mapsymbol@flagmail.wr.usgs.gov or mailed to Geologic Map Symbol Standard, c/o David R. Soller, National
450 Geologic Map Database, U.S. Geological Survey, 926A National Center, Reston, Virginia, 20192.

451 **1.6 MAINTENANCE AUTHORITY**

452 On behalf of the FGDC, the USGS will maintain this Federal standard. The responsibility for coordinating
453 Federal geologic mapping information is stipulated by Office of Management and Budget Circular A-16 (see
454 <http://www.whitehouse.gov/omb/circulars/a016/a016.html>). The Geologic Mapping Act of 1992 (see
455 <http://ncgmp.usgs.gov/info/ngmact.html> and subsequent reauthorizations) stipulates a requirement for standards
456 development under the auspices of the National Geologic Map Database (NGMDB). Under this authority, the
457 NGMDB will function on behalf of the USGS as coordinator of this maintenance activity (see
458 <http://ngmdb.usgs.gov/info/standards/general.html>). Maintenance will be conducted in cooperation primarily
459 with the AASG, which is the USGS's partner in the Geologic Mapping Act. The NGMDB will continue to rely
460 on the Map Symbol Standards Committee to assist in its maintenance efforts. The Committee membership
461 comes from the NGMDB, the USGS scientific staff and Publications Groups, the AASG, and the academic
462 community (see Section 2.3 below, entitled "Preparers of This Standard"). The Committee will, as needed,
463 review comments and suggestions for revisions, additions, and deletions to the standard.

464 **2. BACKGROUND**

465 **2.1 RELATION TO PREVIOUS U.S. GEOLOGICAL SURVEY STANDARDS**

466 Soon after the USGS was established in 1879, USGS geologists began to map and assess the Nation's lands,
467 including many areas previously unexplored by Europeans. A new publication series, the Geologic Atlas (or
468 "Folio") series, was created to publish many of these maps. Beginning prior to 1881, the USGS, then under the
469 direction of John Wesley Powell, began to identify geologic and cartographic standards and conventions
470 necessary to uniformly portray the geology in this series: "In providing for the publication of this large body of
471 material, it seemed wise to adopt a common system of general nomenclature, a uniform color scheme for
472 geographic geology, a system of conventional characters for diagrams, and a form for geologic and topographic
473 charts and atlases" (Powell, 1882a, p. XL; see also, Powell, 1882b, for an elaboration on the proposed
474 standards). Following a 1889 Conference on Map Publication, these standards were articulated in more detail
475 and then were published (Powell, 1890).

476 The standards that were adopted by the USGS in the 1880s served as a strong foundation for the Nation's

477 geological science. Paramount to systematized geologic mapping was the adoption of a standard rock
478 stratigraphic nomenclature, a naming convention for geologic formations, and the subdivisions of geologic time.
479 Another significant contribution was the adoption of a standardized color scheme for displaying geologic map
480 units. This scheme used pure, single-ink colors, usually a different one for each geologic time period; to achieve
481 this, a practical and informative system of overprint patterns also was developed, which served to differentiate
482 the various mapped units within a single time period. Although this single-ink color scheme did not persist
483 intact in the twentieth century because of the emergence of more modern printing technologies (for example,
484 the combining of CMYK—cyan, magenta, yellow, and black—inks to produce a greater variety of colors),
485 many of the overprint patterns that were developed then are still in use today.

486 In the following decades, as the geological sciences advanced, the concepts of geologic processes and historical
487 geology became more complex, and new insights and refinements required more map symbols and precise
488 scientific cartographic methods to convey details of geology. In 1920, the USGS published a manual on the
489 preparation of illustrations (Ridgway, 1920). By that time, the need for standardization had become urgent:
490 "More than 200 symbols have been used on maps to express 25 different kinds of data, a fact indicating at once
491 a notable lack of uniformity and a need of standardization" (Ridgway, 1920, p. 20). The manual addressed
492 various issues associated with geologic cartography, including standard symbology for geologic maps and cross
493 sections (for example, geologic line and point symbols, water wells, oil and gas wells, coal seams, mine
494 workings, and topographic and other base-category information) and stratigraphic columns (for example,
495 lithologic patterns).

496 After 1920, and throughout much of the twentieth century, the maintenance of USGS standards for geologic
497 map symbolization and cartography was an internal and somewhat informal process enacted through official
498 USGS policy. For example, USGS Chief Geologist W.H. Bradley (written commun., 1956) adopted
499 recommendations and a list of symbols from the Map Symbol Committee (E.N. Goddard, Chairman), and
500 USGS Chief Geologist D.L. Peck (written commun., 1978) adopted recommendations from the committee for
501 Standards for General Purpose Geologic Maps (J.C. Reed, Chairman).

502 In the mid-1970s, the USGS outlined the technical specifications for geologic symbology in its informal
503 "Technical Cartographic Standards" volume (U.S. Geological Survey, ca. 1975). This informal standard, which
504 was maintained until the mid-1980s, was available to USGS cartographers and editors as a set of green,
505 loose-leaf notebooks that allowed pages to be replaced as the standard evolved. The technical specifications at
506 that time were devised to serve the needs of cartographers who prepared maps for offset-print publication using
507 hand-placed type, hand-scribed linework, and peelcoat color-separation techniques. This informal standard
508 served the USGS well, but it was not available to other producers or users of geologic maps, nor was it formally
509 recognized as a standard by the Nation's geoscience community. However, the cartographic details of this
510 standard were clearly displayed on USGS geologic maps. And so, drawing from the cartographic content of
511 USGS maps, others have published manuals on geologic map standards that have (unofficially) incorporated

512 parts of this informal standard: for example, the American Geological Institute's "AGI Data Sheets for Geology
513 in the Field, Laboratory, and Office" (Dietrich and others, 1982 [2nd ed.]; Dutro and others, 1989 [3rd ed.])
514 includes many symbols commonly shown on USGS geologic maps (see also, "Suggestions to Authors of the
515 Reports of the United States Geological Survey" [7th ed.]; Hansen, 1991).

516 Beginning about the mid-1980s, digital-cartographic and GIS (Geographic Information System) technologies
517 rapidly evolved and became more widely available. The gradual adoption of digitally based mapmaking
518 methods made clear the need to develop new cartographic standards that would satisfy the requirements of the
519 latest technologies for the preparation of digital files, whether they are to be used for geospatial databases, for
520 plot-on-demand or online map publications, or for the production of negatives for offset printing of maps.

521 In response to this steady increase in digital mapmaking and the accompanying concern about preparing
522 consistent, high-quality, digitally produced geologic maps and geologic map databases, the USGS informally
523 released in 1995 a proposed standard entitled "Cartographic and Digital Standard for Geologic Map
524 Information" (U.S. Geological Survey, 1995a). As noted above, subsequent review of that document by the
525 USGS, the AASG, and the FGDC's Geologic Data Subcommittee (Soller, 1996) indicated the need for some
526 revision prior to its consideration by the FGDC for formal adoption as a Federal standard, which led to the
527 development of this standard (see discussion in Section 1.5 above, entitled "Standards Development
528 Procedures").

529 **2.2 CHANGES FROM PREVIOUS STANDARDS**

530 In this new standard (contained in [normative] appendix A), descriptions, examples, cartographic specifications,
531 and notes on usage are provided for a wide variety of symbols that may be used on typical digital geologic maps
532 or related products such as cross sections. In the preparation of this standard, every effort was made to retain the
533 original symbols and their specifications from the 1995 USGS proposed standard (U.S. Geological Survey,
534 1995a); however, many updates have been incorporated into this new version. The number of symbols has
535 increased significantly, from about 800 to over 2300. Symbols are more logically grouped; some sections have
536 been combined with others, and a few new sections have been added.

537 Many symbols, particularly lines, have been redesigned slightly so that they would more successfully translate
538 to digital applications. For instance, in the old "Technical Cartographic Standards" volume (U.S. Geological
539 Survey, ca. 1975), as well as in the 1995 USGS proposed standard (U.S. Geological Survey, 1995a), the
540 lineweight for contacts was specified as .005 inches (.125 millimeters). However, experience has shown that
541 .005-inch lines do not always plot well when digitally output by high-resolution imagesetters. Therefore, the
542 minimum lineweight for contacts, as well as for most other stroked-line symbol elements, has been increased to
543 .006 inches (.15 millimeters) in this new standard. In addition, the dash and gap lengths for many line symbols
544 have been adjusted so that their dash-gap templates can be more easily defined electronically.

545 A chart showing a wide range of CMYK colors ("CMYK Color Chart") has been included; an offset-print

546 version of this chart has been in use at the USGS for many years, and the variety of colors has proved to be
547 sufficient for portraying complex geology shown on most maps, regardless of the output medium. In addition, a
548 chart that shows commonly used geologic patterns ("Pattern Chart") has been added; the patterns themselves are
549 similar to what was in the old "Technical Cartographic Standards" volume (U.S. Geological Survey, ca. 1975),
550 as well as in the 1995 USGS proposed standard (U.S. Geological Survey, 1995a), but most have undergone
551 lineweight changes to facilitate digital output at high resolutions. The old pattern numbers have been revised
552 and the patterns are now organized into seven geologically relevant series. A few new patterns have been added,
553 and some have been eliminated. In addition, each pattern in the Pattern Chart, as well as each color in the
554 CMYK Color Chart, has associated with it a generic lookup-table number that, if desired, may be used to access
555 the pattern (or color) from within digital applications.

556 Also included in this new standard is a diagram showing suggested ranges of map-unit colors for stratigraphic
557 ages of sedimentary and metamorphic rocks, as well as for volcanic and plutonic rocks. In addition, a new
558 geologic age symbol font ("FGDC-GeoAge") has been added. Three new sections that address map marginalia
559 have been included: (1) quadrangle location maps for each of the 50 states (and District of Columbia, Guam,
560 Puerto Rico, and U.S. Virgin Islands), as well as a map of the 48 conterminous states (so that quadrangle
561 locations covering more than one state can be shown); (2) a variety of bar scales, as well as calculation tables
562 that show how to convert between inches, miles, and kilometers; and (3) a series of mean declination arrows,
563 showing magnetic north both east and west of true north.

564 A few new informational sections have been added to the introductory material in this standard. The section
565 entitled "Guidelines for Map Color and Pattern Selection" provides useful information on color selection and
566 the use of patterns. The section entitled "Guidelines for Map Labeling" provides recommendations on
567 placement of text on a map.

568 The most significant update to this standard is the addition of two important sections to the introductory
569 material. The section entitled "Geologic Mapping Concepts and Definitions" provides basic information about
570 some of the fundamental concepts of geologic mapping, as well as defines and categorizes the various types of
571 geologic map features. The section entitled "Scientific Confidence and Locational Accuracy of Geologic
572 Features" clarifies the concepts of, and establishes new terminology for, the levels of scientific confidence and
573 locational accuracy of geologic map features.

574 In response to reviewer's comments (Soller, 1996), much of the first part of the 1995 USGS proposed standard
575 has been abandoned because it was either not pertinent to this standard (for example, the sections on geologic
576 map content, metadata, and geocoding) or not widely applicable to the full range of mapping situations (for
577 example, the specification of a "1.0 mm accuracy standard"). In addition, no attempt has been made in this new
578 standard to provide detailed definitions for the geologic features represented by the various symbols. For such
579 information, please refer to one of a number of reference books available; an excellent source is the American
580 Geological Institute's Glossary of Geology (Bates and Jackson, 1987 [3rd ed.]; Jackson, 1997 [4th ed.]).

581 **2.3 PREPARERS OF THIS STANDARD**

582 Principal contributors¹ to the preparation of this FGDC Digital Cartographic Standard for Geologic Map
583 Symbolization include the following individuals:

584 David R. Soller (USGS; Chief, National Geologic Map Database)—Coordinator, author, and editor, FGDC
585 Digital Cartographic Standard for Geologic Map Symbolization; coordinator, Map Symbol Standards
586 Committee.

587 Taryn A. Lindquist (USGS; Digital Map Specialist and Geologic Map Editor, Western Publications
588 Group)—Editor, author, and compiler, FGDC Digital Cartographic Standard for Geologic Map
589 Symbolization; designer, line symbols and point symbols, FGDC Digital Cartographic Standard for
590 Geologic Map Symbolization.

591 Map Symbol Standards Committee: Thomas Berg (State Geologist, Ohio); Jay Parrish (State Geologist,
592 Pennsylvania); Mark Jirsa (Minnesota Geological Survey); Robert Hatcher (University of Tennessee,
593 Knoxville); Steven Reynolds (Arizona State University); and Byron Stone, Jack Reed, Jonathan Matti,
594 Taryn Lindquist, and David Soller (all USGS)—Referees and reviewers of public comments and
595 subsequent revisions, Public Review Draft (Jonathan Matti is especially noted for his guidance on issues of
596 scientific confidence and locational accuracy).

597 Sara Boore (USGS; Publication Graphics Specialist, Western Publications Group)—Book designer, FGDC
598 Digital Cartographic Standard for Geologic Map Symbolization; designer, point symbols, line symbols,
599 color charts, and patterns, FGDC Digital Cartographic Standard for Geologic Map Symbolization.

600 F. Craig Brunstein (USGS; Geologic Map Editor, Central Publications Group)—Technical reviewer,
601 Working Draft.

602 Alessandro J. Donatich (USGS; Geologic Map Editor, Central Publications Group)—Technical reviewer,
603 Working Draft.

604 Carolyn Donlin (USGS; Online Publications Specialist and Geologic Map Editor, Western Publications
605 Group)—Preparer, online publication of Public Review Draft (PostScript implementation).

606 Michael F. Diggles (USGS; CD-ROM Publications Specialist and Online Publications Specialist, Western
607 Publications Group)—Preparer, CD-ROM publications of PostScript implementations; preparer, online
608 publication of FGDC-approved standard (PostScript implementation).

609 Kevin Ghequiere (USGS; Cartographer, Western Publications Group)—Designer, patterns, FGDC Digital

¹ Unless otherwise noted, persons listed as contributors to the "FGDC Digital Cartographic Standard for Geologic Map Symbolization" participated in the preparation of the following versions of the standard: the Working Draft; the Public Review Draft (Federal Geographic Data Committee, 2000) and its PostScript implementation (U.S. Geological Survey, 2000); and the now FGDC-approved standard (this document) and its PostScript implementation (U.S. Geological Survey, 2006).

- 610 Cartographic Standard for Geologic Map Symbolization.
- 611 Richard D. Koch (USGS; Digital Map Specialist, Western Publications Group)—Designer, geologic age
612 symbol font, FGDC Digital Cartographic Standard for Geologic Map Symbolization.
- 613 Diane E. Lane (USGS; Geologic Map Editor, Central Publications Group)—Technical reviewer, Working
614 Draft.
- 615 Susan E. Mayfield (USGS; Publication Graphics Specialist, Western Publications Group)—Designer, color
616 charts and patterns, FGDC Digital Cartographic Standard for Geologic Map Symbolization.
- 617 Kathryn Nimz (USGS; Digital Map Specialist, Western Publications Group)—Designer, patterns, FGDC
618 Digital Cartographic Standard for Geologic Map Symbolization.
- 619 Glenn Schumacher (USGS; Publication Graphics Specialist, Western Publications Group)—Designer, bar
620 scales, mean declination arrows, and quadrangle location maps, FGDC Digital Cartographic Standard for
621 Geologic Map Symbolization.
- 622 Stephen L. Scott (USGS; Publication Graphics Specialist, Western Publications Group)—Designer, point
623 symbols and line symbols, FGDC Digital Cartographic Standard for Geologic Map Symbolization.
- 624 Will Stettner (USGS; Cartographer, Eastern Publications Group)—Technical reviewer, Working Draft.
- 625 José F. Vigil (USGS; Motion Graphics Specialist, Western Publications Group)—Designer, geologic age
626 symbol font, FGDC Digital Cartographic Standard for Geologic Map Symbolization.
- 627 Jan L. Zigler (USGS; Geologic Map Editor, Western Publications Group)—Technical reviewer, Working
628 Draft.

629 **3.1.1 GEOLOGIC MAPPING CONCEPTS AND DEFINITIONS**

630 **3.1.1.1 GEOLOGIC MAPS**

631 A *geologic map* is a cartographic product that portrays information about the geologic character of a specific
632 geographic area. It is a two-dimensional representation of real-world, three-dimensional geologic features. To
633 achieve this, a geologic map uses graphical elements to express detailed information about the different kinds of
634 earth materials, the boundaries that separate them, and the geologic structures that have subsequently deformed
635 them. For example, a typical general-purpose geologic map may consist of *lines* that trace contacts, faults, and
636 folds; *points* that locate bedding attitudes, minor fold orientations, and sample localities; *areas* that represent
637 geologic units, landslides, and areas of alteration; and *labels* that identify geologic map units, sample-locality
638 numbers, and fault names. Thus, an appropriately symbolized and labeled geologic map can portray
639 comprehensive information about the composition, age, and genesis of the geologic materials and the nature of
640 their boundaries, as well as the character and three-dimensional geometry of the geologic structures that have
641 deformed them. In addition, such geologic map information usually is drawn onto a base map that also uses

642 graphical elements to represent the topography, drainage, and cultural features of an area, and so a geologic map
643 also can depict the spatial relation of the various geologic features to the physical landscape. Other things that
644 may be shown on a geologic map include information about the geomorphology, pedology, paleontology, rock
645 alteration and mineralization, geophysics, geochemistry, or geochronology of an area.

646 **3.2 GEOLOGIC MAP DATABASES**

647 A *geologic map database* is a digitally compiled collection of spatial (geographically referenced) and
648 descriptive geologic information about a specific geographic area. The information in the geologic map
649 database consists of (1) the geographic location and the orientation, length, shape, and (or) area (in other words,
650 the geometry) of each geologic feature or object (for example, an outcrop or a fault), and (2) many different
651 types of descriptive geologic information about each feature or object.

652 A geologic map database also may contain extensive amounts of additional qualitative and quantitative geologic
653 information. For example, a geologic map database may include geochemical analyses, radiometric ages, soil-
654 horizon information, and geophysical contours, as well as information on the weathering of surface exposures
655 of geologic features, the subsurface geometry of geologic map units, and the glacial landforms or other types of
656 geomorphic features.

657 Fundamental data elements of a geologic map database are *lines* (for example, contacts and faults), *points* (for
658 example, bedding attitudes and fossil localities), and *areas* or *polygons* (for example, map-unit areas and zones
659 of alteration). In addition, each feature or object in the geologic map database has several associated *feature*
660 *attributes*. The most basic feature attributes may simply identify the feature (for example, "thrust fault" or
661 "overturned anticline") and express its scientific confidence and locational accuracy (for example, "identity
662 certain" or "location inferred"). Other feature attributes may consist of detailed descriptions of each feature (for
663 example, the lithologic characteristics of a map unit, the dip of a mapped fault, or the identification and age
664 determination of a fossil specimen).

665 When a geologic map is generated as a cartographic product from a geologic map database, each geologic
666 feature is represented by a specific *geologic map symbol*. The attributes in the database provide the information
667 needed to symbolize each feature. In addition, *annotation* is added to the geologic map wherever necessary to
668 identify the various features (for example, map-unit labels and fault names) and to provide essential quantitative
669 information (for example, dip values and fossil-locality numbers).

670 **3.3 GEOLOGIC MAP UNITS**

671 A *geologic map unit* is a cartographic representation of a volume of geologic materials that share enough
672 characteristics (for example, the composition, areal extent, age, and (or) genesis) to be considered a single entity
673 (a single geologic unit). On a typical geologic map, most geologic units are represented by polygons that are
674 filled with colors and (or) patterns. Geologic units can also be represented by lines (for example, dikes) or
675 points (for example, blueschist blocks).

676 The *formation*, whether formal or informal, is the lithostratigraphic unit most commonly depicted on a geologic
677 map. A formation can be subdivided into lower rank stratigraphic units (for example, members, tongues, lentils,
678 or beds) or assembled with other formations to make up more generalized, higher rank stratigraphic units (for
679 example, groups or supergroups), depending on the scale of the map or the focus of the geologist (see guidelines
680 for the recognition and naming of geologic units by the North American Commission on Stratigraphic
681 Nomenclature, 1983).

682 **3.3.1 Geologic Time, the Ages of Rock Units, and Geologic Age Symbols**

683 The USGS has published a scheme for the major divisions of *geologic time*, the age estimates of the boundaries,
684 and the specialized *geologic age symbols* to be used on geologic maps (Hansen, 1991). This particular scheme
685 was formally adopted after a 1980 meeting of the Geologic Names Committee of the USGS (Hansen, 1991). In
686 addition, several other schemes of geologic time boundaries have been published (see, for example, Berggren
687 and others, 1995; Gradstein and Ogg, 1996; Haq and van Eysinga, 1998; Harland and others, 1982, 1989;
688 International Union of Geological Sciences, 1998; Palmer, 1983; Palmer and Geissman, 1999; Snelling, 1985),
689 each of which is based on different assumptions, techniques, and (or) data. Any formally published age scheme
690 may be used for a particular map, as long as which scheme was used is specified on the map and in the geologic
691 map database.

692 **3.3.2 Map-Unit Labels**

693 A *map-unit label* is an alphanumeric symbol that identifies the geologic map unit on the map. The map-unit
694 symbol is an abbreviated acronym that usually is made up of, in the following order, (1) either capital letters or
695 geologic age symbols indicating the age of the geologic unit (see Appendix A, Section 32), and (2) lower case
696 letters denoting the name or the lithologic characteristics of the geologic unit. In some cases, numerical
697 subscripts are added to designate different subunits (for example, members or individual lava flows) within a
698 geologic unit.

699 Map-unit labels are added to the geologic map wherever necessary to clearly identify the various geologic map
700 units. In addition, map-unit labels are included among the feature attributes in the geologic map database,
701 thereby designating each mapped area as belonging to a particular geologic map unit.

702 **3.4 PLANAR GEOLOGIC FEATURES**

703 A *planar geologic feature* is a two-dimensional geologic surface, which may be either a real-world, physical
704 surface (for example, a contact between two geologic units) or a hypothetical surface (for example, an axial
705 surface of a fold). The geometry of the geologic surface may be flat, curved, or crenulated, and its orientation
706 may be horizontal, inclined, vertical, or overturned.

707 The intersection of a planar geologic feature with the ground surface forms a real or perceived (projected) linear
708 trace. When these linear traces are mapped in the field and then plotted as lines on a base map, they become the

709 most basic and fundamental elements of a typical geologic map: they may delineate simple map-unit areas, or
710 they may define complex patterns of structural deformation. The various types of linear traces are portrayed on
711 a geologic map by unique line symbols (Appendix A), each of which has a different width, pattern,
712 ornamentation, or color; thus, a particular line symbol conveys specific information about the character and (or)
713 geometry of each planar geologic feature.

714 **3.4.1.1 Contacts**

715 A *contact* is a planar surface that bounds a geologic unit (except where that bounding surface is a fault; see
716 discussion below in Section 3.4.3, entitled "Faults"). A contact is intrinsic to the genesis of each geologic unit;
717 that is, the contact delineates the stratigraphic position where, owing to changing environmental conditions or
718 other genetic factors at the time of origin, the properties and characteristics of one geologic unit change, either
719 abruptly or gradually, to those of another geologic unit.

720 Discussion of contacts in this standard primarily pertains to those that have been mapped in the field (for
721 example, contacts that bound formations, members, beds, lava flows, or intrusions). Contacts can also exist
722 between higher rank units, although these contacts typically are not mapped in the field; instead, they are
723 concepts that may arise later when lower rank stratigraphic units are combined into higher rank stratigraphic
724 units (see discussion of lithostratigraphic boundaries by the North American Commission on Stratigraphic
725 Nomenclature, 1983, p. 856–58).

726 Contacts can be classified as one of a number of types, depending on the nature or origin of the contact and the
727 geologic units that it separates. Examples of such contact types include the following: sedimentary
728 (conformable; unconformable, etc.); alluvial; landslide; residual; igneous (intrusive, extrusive, pyroclastic);
729 metamorphic; and high-strain (cataclastic, mylonitic, tectonic). If available, supplemental information about a
730 contact's type is added as a feature attribute to the geologic map database; however, specialized line symbols
731 usually are not used to represent these various contact types. In general, unless otherwise stated on the geologic
732 map or in the geologic map database, contacts should be considered generic; that is, they have no particular type
733 or identity.

734 The geologic age of a contact also may be specified as a feature attribute in the geologic map database, but
735 rarely is this characteristic symbolized on the geologic map; if desired, such information can be communicated
736 by the addition of geologic point data or annotation placed along the trace of the contact. In addition, specific
737 information collected about a contact's local surface exposure, orientation or character can be added as geologic
738 point data and annotation placed along the trace of the contact where the observation was made.

739 **3.4.1.1.1 Discrete versus Gradational Contacts**

740 In the field, a contact between two geologic units is a transition zone whose width can range from very narrow
741 to very broad. Examples of transition zones include the following:

- 742 • a single surface, as sharply delineated as a knife-edge, between two lithologically distinct geologic units;
- 743 • a single surface that zigzags between two intertonguing geologic units;
- 744 • a narrow zone, a few centimeters to a few decimeters wide, in which the lithologic character changes from
745 one geologic unit to another;
- 746 • a diffuse zone, a few meters to many meters wide, in which the lithologic character of one geologic unit gives
747 way gradually to that of another geologic unit.

748 Despite the differences inherent in each of these examples, contacts generally can be classified as either one of
749 two types of transition zones: *discrete* or *gradational*. A precise definition of the width of a discrete versus a
750 gradational contact, however, is difficult because of (1) different scales of mapping (for example, a contact that
751 is gradational at a scale of 1:24,000 would probably be considered discrete at a scale of 1:100,000); (2) differing
752 interpretations that can arise between geologists whose mapping primarily focuses on either sedimentary,
753 igneous, or metamorphic rocks (for example, contact relations that are considered gradational by a geologist
754 who maps sedimentary rocks may be viewed as discrete by a geologist who maps plutonic rocks); and (3)
755 differences in individual biases that may arise from different geologic-mapping traditions in geologically
756 dissimilar parts of the Nation. Because of these and other factors, this standard makes no attempt to delimit the
757 precise width of a discrete or a gradational contact. Nevertheless, this standard provides the following general
758 definitions:

759 A *discrete* contact is a map-unit boundary that is individually distinct; that is, the transition between geologic
760 units is abrupt enough to be recognized and delineated easily on the map. A discrete contact may be a sharp,
761 knife-edged surface, or it may be transitional across a zone as wide as a meter or more, depending on the scale
762 of the map.

763 A *gradational* contact is a map-unit boundary that is diffuse; that is, the transition between geologic units is
764 gradual enough that it cannot be recognized or delineated easily on the map. A gradational contact is so diffuse
765 across the transition zone (the width of which will vary at different map scales) that delineation of its exact
766 position can be difficult.

767 The discrete versus gradational character of a contact is specified as a feature attribute in the geologic map
768 database. In addition, if the map scale allows, gradational contacts can be represented on the geologic map by a
769 specialized line symbol (see Appendix A, Section 1). Unless otherwise stated on the map or in the geologic map
770 database, however, a generic contact (that is, one not represented by a specialized line symbol) should be
771 considered discrete at the scale of the map.

772 **3.4.2 Key Beds**

773 A *key bed* is an easily identifiable stratigraphic marker bed within a geologic unit. Although a key bed is a
774 three-dimensional volume rather than a two-dimensional surface, commonly it is too thin to depict as a map-

775 unit area at most map scales, and so it usually is classified as a planar geologic feature.

776 Key beds are identified on the basis of their lithologic character and, in most cases, their relation to the
777 surrounding rock materials. Examples of various types of key beds include the following:

- 778 • a coal bed;
- 779 • a fossiliferous horizon;
- 780 • a cross-cutting dike;
- 781 • a clay bed in a dominantly coarse-grained sedimentary sequence;
- 782 • a gravel bed in a dominantly fine-grained sedimentary sequence;
- 783 • a marine sedimentary bed in a dominantly nonmarine sedimentary sequence;
- 784 • a nonmarine sedimentary bed in a dominantly marine sedimentary sequence;
- 785 • a sandstone bed in a dominantly carbonate sedimentary sequence;
- 786 • a limestone bed in a dominantly dolomitic sedimentary sequence;
- 787 • a volcanic-ash bed or flow in a dominantly nonvolcanic sequence.

788 The type of key bed can be specified as a feature attribute in the geologic map database. In addition, some types
789 of key beds are portrayed on the geologic map by specialized line symbols (see Appendix A, Section 1). In
790 some cases, if the map scale allows, key beds are represented by colored or patterned areas. Map-unit labels are
791 added to the geologic map to identify the various types of key beds shown on the map. In addition, map-unit
792 labels are included among the feature attributes in the geologic map database to identify each key bed.

793 **3.4.3 Faults**

794 A *fault* is a planar surface of rupture along which geologic units have been fractured and then displaced. Faults
795 can be geometrically complex structures that juxtapose map units over great distances, or they can be simple
796 fracture planes along which the amount of offset is very small.

797 Discussion of faults in this standard primarily pertains to those that have been mapped in the field. Faults also
798 can be required conceptually when lower rank stratigraphic units are grouped into higher rank units or
799 tectonostratigraphic terranes, although these faults may not have been observed in the field.

800 Faults can be classified as one of a number of types, depending on the nature of their geometry and (or) sense of
801 offset. Examples of fault types include the following: normal (low-angle, listric); reverse; thrust; overturned
802 thrust; vertical; strike-slip (right-lateral, left-lateral); oblique-slip; detachment; or some combination of the
803 above. Information about a fault's type is specified as a feature attribute in the geologic map database. When the
804 map scale allows, such information also is represented on the geologic map by a specialized line symbol and
805 (or) line-symbol decoration. A particularly robust set of specialized line symbols and line-symbol decorations

806 has evolved to represent the various fault types (see Appendix A, Section 2). In general, unless otherwise stated
807 on the map or in the geologic map database, faults that lack such specialized symbology should be considered
808 generic; that is, their geometry or sense of offset either is not known or has not been specified.

809 The age of a fault also can be specified as a feature attribute in the geologic map database, but rarely is this
810 characteristic symbolized on the geologic map; if desired, such information can be communicated through the
811 addition of geologic point data or annotation placed along the trace of the fault. In addition, specific information
812 collected about a fault's local orientation can be added as geologic point data and annotation placed along the
813 trace of the fault where the observation was made.

814 Some faults are relatively minor structures whose traces are mapped within single geologic units until the faults
815 can no longer be observed or they no longer exist. More commonly, faults are mapped as larger, thoroughgoing
816 structures that can produce a significant amount of offset between one or more geologic units, so that the
817 rupture surfaces form new map-unit boundaries. In addition, faulting sometimes can take place at the
818 stratigraphic position where a contact would normally exist between two stratigraphically coherent geologic
819 units. But because faulting is not a process intrinsic to a geologic units' genesis (in these cases, faulting has
820 occurred through already-formed geologic units), these bounding surfaces do not meet the criteria to be called
821 contacts (see discussion above in Section 3.4.1, entitled "Contacts"). Therefore, although they may form
822 boundaries between geologic units, such structures are classified as "faults," not "fault contacts" or "faulted
823 contacts."

824 **3.4.3.1 Discrete Faults versus Fault Zones**

825 In the field, a fault forms a zone of offset whose width can range from very narrow to very broad. Examples of
826 such zones of offset include the following:

- 827 • a single offset-fracture surface, as sharply delineated as a knife-edge;
- 828 • a narrow zone of offset, a few centimeters to a few decimeters wide;
- 829 • a diffuse zone, a few meters to many meters or as much as a kilometer or more wide, within which offset has
830 been distributed among a few or many shear planes.

831 Despite the differences inherent in each of these examples, faults generally can be described in either one of two
832 ways: as a *discrete fault* or as a *fault zone*. A precise definition of the width of a discrete fault versus a fault
833 zone, however, is difficult for a number of reasons (see related discussion above in Section 3.4.1.1, entitled
834 "Discrete versus Gradational Contacts"), and this standard makes no attempt to do so. Nevertheless, this
835 standard provides the following general definitions:

836 A *discrete fault* is a zone of offset that is individually distinct; that is, the zone is narrow enough to be
837 recognized and delineated easily on the map. A discrete fault may be a sharp, knife-edged surface of offset, or it
838 may be a zone of offset as wide as a meter or more, depending on the scale of the map.

839 A *fault zone* (also called a *shear zone*) is a diffuse zone within which offset has been distributed among a few or
840 many shear planes, commonly resulting in a zone of crushed and sheared or ductily deformed rock. In some
841 cases, a fault zone can be mapped as an area bounded by discrete fault planes.

842 The character of a fault (discrete fault versus fault zone) is specified as a feature attribute in the geologic map
843 database. In addition, a fault zone can be portrayed either by a specialized line symbol or, if the map scale
844 allows, by a colored or patterned area (see Appendix A, Section 2). Unless otherwise stated on the map or in the
845 geologic map database, a generic fault (that is, one not portrayed as an area or by a specialized line symbol)
846 should be considered discrete at the scale of the map.

847 **3.4.4** **Folds**

848 In its simplest sense, a *fold* is a geologic structure that results when a flat-lying or otherwise undeformed
849 geologic surface is warped and deformed into an undulating geologic surface. In reality, many fold structures
850 further deform bodies of rock that may already be highly deformed and (or) metamorphosed. Thus, folds may
851 form simple, symmetric structures, or they may form complex, multidimensional and multigenerational fold
852 systems.

853 The *fold axis* or *hinge line* of a fold is a hypothetical line that traces the locus of maximum curvature of the fold
854 structure. The *axial surface* or *axial plane* of a fold is a hypothetical planar surface that connects the fold axes
855 or hinge lines of folded strata.

856 Folds can be classified as one of a number of fold types, depending on the geometry of the fold's axial surface
857 and the geometry and the relative ages of the folded strata. Examples of fold types include the following:
858 anticline, syncline, monocline; antiform, synform; symmetrical, asymmetrical, overturned, inverted, isoclinal,
859 recumbent, and plunging.

860 Information about a fold's type is specified as a feature attribute in the geologic map database. In addition, such
861 information is portrayed on the geologic map by specialized line symbols and line-symbol decorations (see
862 Appendix A, Section 5). On a geologic map, a fold is mapped as a line where the trace of its axial surface
863 intersects the ground surface. In some cases, the trace of a fold's *crest line* (highest point on a fold's crest) or
864 *trough line* (lowest point in a fold's trough) can also be mapped.

865 The age of a fold also can be specified as a feature attribute in the geologic map database, but rarely is this
866 characteristic symbolized on the geologic map; if desired, such information can be communicated through the
867 addition of geologic point data or annotation placed along the trace of the fold. In addition, specific data
868 collected about a fold's local orientation can be added as geologic point data and annotation placed along the
869 trace of the fold where the observation was made.

870 **3.5** **LINEAR GEOLOGIC FEATURES**

871 A *linear geologic feature* is a one-dimensional geologic or geomorphic line, which may be either a real-world,

872 physical line (for example, a fault-scarp lineament or an outcrop-scale lineation) or a hypothetical line (for
873 example, a hinge line of a fold or a paleocurrent direction). The geometry of the line may be straight, curved, or
874 crenulated, and its orientation may be horizontal, inclined, or vertical.

875 The orientations of linear geologic features are mapped in the field and then plotted as lines on a base map.
876 Information about the various types of linear geologic features is specified as a feature attribute in the geologic
877 map database. In addition, such information is represented on a geologic map by a unique line symbol
878 (Appendix A), each of which has a different width, pattern, ornamentation, or color; thus, a particular line
879 symbol conveys specific information about the character and (or) geometry of each linear geologic feature.

880 **3.6.1.1 GEOLOGIC POINT FEATURES**

881 A *geologic point feature* consists of geologic or geomorphic information that has been collected at a particular
882 point of observation in the field (except when that point feature is a line-symbol decoration; see discussion
883 below in Section 3.6.3.2, entitled "Line-Symbol Decorations"). In some field situations, more than one
884 observation can be taken at a single locality.

885 Geologic point data may pertain to a planar feature (for example, the orientation of bedded strata), a linear
886 feature (for example, the plunge of a fold axis), or a single locality (for example, a fossil locality). Geologic
887 point data also can be added as line-symbol decorations (for example, anticline arrows) that provide
888 supplemental information about a particular part of a line on a geologic map.

889 Geologic point data are recorded in the field and then plotted as points on a base map. Information about the
890 various types of geologic point data is specified as a feature attribute in the geologic map database. In addition,
891 such information usually is represented on a geologic map by specialized point symbols and associated
892 annotation (Appendix A).

893 **3.6.1.1.1 Planar-Feature Geologic Point Data**

894 *Planar-feature geologic point data* consist of quantitative information about the character and the orientation of
895 a geologic surface, which may be a physical surface (for example, a fault plane or bedded strata) or a
896 hypothetical surface (for example, an axial surface of a fold or a plane of foliation). The geologic surface may
897 be horizontal, inclined, vertical, or overturned.

898 Two measurements, the *strike* and the *dip*, define the orientation of a geologic surface in three-dimensional
899 space:

- 900 • the *strike* of a surface is the azimuthal direction of a hypothetical line formed by the intersection of the
901 surface with an imaginary horizontal surface, as measured in the direction that the observer is facing when
902 the surface dips down to the right (this method of directional measurement follows the *right-hand rule*
903 convention);
- 904 • the *dip* of a surface is the angle of departure of that surface downward from horizontal, as measured

905 perpendicular to the line of strike.

906 Information about the type of observation, as well as the values of strike and dip, is specified as feature
907 attributes in the geologic map database. Such information also is represented on the geologic map by
908 specialized point symbols and associated annotation: the strike value and the direction of dip are implicit in the
909 orientation of the point symbol; the dip value is added as annotation.

910 **3.6.1.1 Point Symbols for Planar Features, and Their Placement Relative to Point of Observation**

911 The point symbols for inclined or overturned planar features typically are made up of two parts: a long shaft
912 oriented in the strike direction, and a short tick (or ornamentation such as a triangle) pointing in the downdip
913 direction. The point symbol is placed on the map so that the intersection of its long shaft and short tick (or
914 ornamentation) is at the point of observation. When data have been collected about the local orientation of a
915 planar feature that has been represented on the map by a line symbol (for example, the dip of a contact or a
916 fault), the point symbol is placed directly on the line symbol at the point of observation.

917 The point symbols for vertical planar features are similar to those for inclined surfaces, except that two short
918 ticks (or ornamentations), not one, point away from the long shaft. The point symbol is placed on the map so
919 that the intersection of its long shaft and short ticks (or ornamentations) is at the point of observation.

920 The point symbols for horizontal planar features, which display no directional information, are simply placed on
921 the map at the point of observation.

922 **3.6.1.2 Specialized Planar-Feature Point Symbols for Multiple Observations at One Locality**

923 In situations where more than one observation has been taken at a single locality, point symbols for planar
924 features can be combined with other point symbols at the point of observation. In these cases, specialized point
925 symbols may be used to avoid the overprinting of information. These specialized point symbols have the short
926 ticks (or ornamentations such as triangles) moved down near the end of the long shafts; the symbols are joined
927 at their endpoints (opposite the ticks or ornamentations) at the point of observation.

928 **3.6.2 Linear-Feature Geologic Point Data**

929 *Linear-feature geologic point data* consist of quantitative information about the orientation of a geologic or
930 geomorphic linear feature, which may be a physical line (for example, a fault-plane groove or slickenline) or a
931 hypothetical line (for example, the intersection of two surfaces of deformation). The geologic or geomorphic
932 linear feature may be horizontal, inclined, or vertical.

933 Two measurements, the *bearing* and the *plunge*, define the orientation of a geologic or geomorphic line in
934 three-dimensional space:

- 935 • the *bearing* of a line is the azimuthal direction of the trend of that line, as measured in its direction of plunge;
- 936 • the *plunge* of a line is the angle of departure of that line downward from horizontal.

937 Information about the type of observation, as well as the values of bearing and plunge, is specified as attributes
938 in the geologic map database. Such information also is represented on the geologic map by specialized point
939 symbols and associated annotation: the bearing value and the direction of plunge are implicit in the orientation
940 of the point symbol; the plunge value is added as annotation.

941 **3.6.2.1 Point Symbols for Linear Features, and Their Placement Relative to Point of Observation**

942 The point symbols for inclined linear features typically are made up of two parts: a shaft oriented in the bearing
943 direction, and an arrowhead pointing in the plunge direction. The symbol is placed on the map so that the end of
944 its shaft opposite the arrowhead is at the point of observation. When data have been collected about the local
945 orientation of a linear feature that has been represented on the map by a line symbol (for example, a lineation on
946 a fault), the point symbol is placed directly on the line symbol at the point of observation.

947 The point symbols for horizontal linear features are similar to those for inclined linear features, except that
948 arrowheads are at both ends of the long shaft. The symbol is placed on the map so that the middle of its shaft is
949 at the point of observation.

950 The point symbols for vertical linear features, which display no directional information, are simply placed on
951 the map at the point of observation.

952 In situations where more than one observation has been taken at a single locality, point symbols for linear
953 features can be combined with other point symbols at the point of observation. When a single linear-feature
954 observation and a single planar-feature observation are taken at a single locality, the symbols are combined so
955 that the end of the arrow that represents the linear feature is placed at the intersection of the planar-feature point
956 symbol's long shaft and short tick (or ornamentation). When more than two such observations are taken at a
957 single locality, the point symbols for linear features are joined at their endpoints with the specialized point
958 symbols for planar features (see Section 3.6.1.2 above, entitled "Specialized Planar-Feature Point Symbols for
959 Multiple Observations at One Locality") at the point of observation.

960 **3.6.3 Informational Geologic Point Data**

961 *Informational geologic point data* consist of geologic information that is supplemental to a typical geologic map
962 or its features. Informational geologic point data are divided into two types: *locality-information point data*, and
963 *line-symbol decorations*.

964 **3.6.3.1 Locality-Information Point Data**

965 *Locality-information point data* record information collected at a particular locality (for example, fossil
966 localities or sample localities). The type of data collected at the locality is specified as a feature attribute in the
967 geologic map database. In addition, such information commonly is represented on the geologic map by a
968 specialized point symbol placed at the point of observation. Sample numbers or other identifying labels are
969 added as annotation near the point symbols.

970 **3.6.3.2 Line-Symbol Decorations**

971 *Line-symbol decorations* are specialized point symbols that convey qualitative information about the character
972 of a particular line or line segment (for example, anticline arrows or ball-and-bar symbols). The type of line-
973 symbol decoration is specified as a feature attribute in the geologic map database. Line-symbol decorations are
974 not placed at a specific point of observation because they do not represent information collected at a particular
975 locality; instead, they should be placed at a strategic location (or locations) along the trace of a line symbol in
976 order to clearly communicate information about the nature of that line.

977 **4. SCIENTIFIC CONFIDENCE AND LOCATIONAL ACCURACY OF GEOLOGIC**
978 **FEATURES**

979 Another important concept in geologic mapping is a geologist's level of confidence in the interpretation of
980 features observed in the field. Many factors can adversely affect a geologist's level of confidence when
981 mapping, and field situations often arise in which the interpretation of a feature may be in question, as indicated
982 by the following examples:

- 983 • a planar feature is well-exposed in outcrop, but it is not easily identifiable as either a contact or a fault;
- 984 • a contact is clearly exposed in a roadcut, but its trace cannot be followed away from that roadcut;
- 985 • a fault's trace is obscured by vegetation, and so both its location and its sense of offset cannot be definitively
986 determined;
- 987 • a fault's trace is completely concealed beneath valley fill.

988 As these examples show, uncertainties can exist in either the scientific interpretation or the mapped location of a
989 feature (or in both). Therefore, not only is it important to communicate to the map user the level of confidence
990 in each geologic map feature, but also which type of uncertainty (scientific and (or) locational) may be
991 associated with that feature.

992 Traditionally, a system of solid, dashed, dotted, or queried line symbol styles (see, for example, Ridgway, 1920,
993 plate 2) has been used on geologic maps to show levels of locational accuracy of planar and linear geologic
994 features observed in the field. This convention followed USGS Director Powell's 1888 policy, which stipulated
995 that "fault lines (particularly when they are formation boundaries) shall be indicated when actually traced by
996 somewhat heavy full lines in black; and when not actually traced, by similar broken lines" (Powell, 1890, p. 76).
997 More guidance was provided in 1956 by USGS Chief Geologist W.H. Bradley, who, in a memorandum to
998 USGS personnel regarding geologic map standards, stated, "The accuracy of location of faults and contacts
999 should be shown by appropriate symbols ... Solid lines should be used to indicate accurate locations of features
1000 that are geologically identifiable within the plottable limits of the map ... Features that are only approximately
1001 located should be shown by long dashed lines; those that are indefinite or inferred, by short dashed lines; and
1002 those that are concealed, by dotted lines" (W.H. Bradley, written commun., 1956). To further encourage the use

1003 of such symbology, Bradley added, "The use of many dashed contacts or faults on a map is not to be construed
1004 as a detraction from the quality of the map, and for many maps, it may be undesirable or impossible to achieve
1005 sufficiently accurate locations to permit use of solid lines. The quality of the map is not impaired so long as the
1006 reader can interpret the accuracy of location" (W.H. Bradley, written commun., 1956).

1007 In conjunction with these traditional line symbol styles, geologists at various times have used terms such as
1008 "known," "probable," "certain," "uncertain," "accurately located," "approximately located," "inferred,"
1009 "projected," "concealed," and "queried" to express the levels of confidence of planar and linear geologic
1010 features. However, these terms and their associated line symbol styles have not been used consistently from
1011 region to region or from map to map. Also, it has not been always clear whether they reflect uncertainty in a
1012 feature's scientific interpretation, its mapped location, or both.

1013 To facilitate the communication of geologic map information, this standard clarifies the concepts of, and
1014 establishes the attributes for, the levels of scientific confidence and locational accuracy of geologic map
1015 features. In addition, to facilitate the cartographic representation of geologic map information, this standard
1016 establishes new terminology that expresses both these concepts.

1017 **4.1 SCIENTIFIC CONFIDENCE**

1018 *Scientific confidence* expresses a geologist's level of certainty regarding the nature, origin, geometry, identity,
1019 and even the existence of a geologic feature. The characteristics of the geologic materials and structures, the
1020 number of outcrops, and the availability of subsurface or geophysical data directly affect the level of scientific
1021 confidence in any area. Experience and resources available to a geologist also affect scientific confidence.
1022 These fundamental characteristics of geologic features can be grouped into two distinct but related concepts,
1023 *identity* and *existence*.

1024 **4.1.1 Identity**

1025 *Identity* expresses whether or not the observations and data support the stated nature, origin, or geometry of a
1026 mapped geologic feature (for example, a contact versus a fault, or a normal fault versus a thrust fault). The
1027 concept of identity is communicated in the following two ways:

- 1028 • in the geologic map database, the attribute describing the confidence in a feature's identity is specified as
1029 either *certain* or *questionable*;
- 1030 • on the geologic map, the confidence in a feature's identity is communicated in the symbol explanation and
1031 (or) the map unit description (see Section 4.1.3 below, entitled "Levels of Scientific Confidence") and also,
1032 for some types of geologic map features, conveyed cartographically (see Section 4.1.4 below, entitled
1033 "Cartographic Representation of Scientific Confidence").

1034 **4.1.2 Existence**

1035 *Existence* expresses whether or not the observations and data support the continuity or existence of a concealed

1036 or an otherwise unseen geologic feature (for example, a postulated fault or a subsurface fault). The concept of
1037 existence is communicated in the following two ways:

- 1038 • in the geologic map database, the attribute describing the confidence in a feature's existence is specified as
1039 either *certain* or *questionable*;
- 1040 • on the geologic map, the confidence in a feature's existence is communicated in the symbol explanation and
1041 (or) the map unit description (see Section 4.1.3 below, entitled "Levels of Scientific Confidence") and also,
1042 for some types of geologic map features, conveyed cartographically (see Section 4.1.4 below, entitled
1043 "Cartographic Representation of Scientific Confidence").

1044 **4.1.3 Levels of Scientific Confidence**

1045 A geologic map must communicate to the map user the level of scientific confidence associated with each
1046 mapped feature (both its identity and its existence). In a geologic map database, this information is contained in
1047 two attribute fields, identity (*certain, questionable*), and existence (*certain, questionable*). To facilitate the
1048 communication of the two concepts of identity and existence on a geologic map, this standard sets forth the
1049 following new terminology, which expresses clearly yet concisely the levels of scientific confidence of geologic
1050 features (see Figure 1 for the relation of this new terminology to historically used terminology):

1051 "*Identity and existence certain*" Both the identity and the existence of a feature can be determined using
1052 relevant observations and scientific judgment; therefore, one can be
1053 reasonably confident in the scientific credibility of this interpretation.
1054 These criteria are met, for example, when a geologist reasons, "*I am
1055 certain that the planar feature I see in this outcrop is a fault.*" This is the
1056 default condition for all geologic map features unless otherwise stated on
1057 the geologic map or in the geologic map database.

1058 "*Identity or existence questionable*" Either the identity or the existence of a feature cannot be determined using
1059 relevant observations and scientific judgment; therefore, one cannot be
1060 reasonably confident in the scientific credibility of this interpretation.
1061 These criteria are met, for example, when a geologist reasons, "*I can see
1062 some kind of planar feature in this outcrop, but I cannot be certain if it is a
1063 contact or a fault,*" or, "*My interpretation requires that a thrust fault be
1064 present to account for incongruities in the stratigraphy of these rocks, but I
1065 can't be certain because I haven't yet seen one here.*"

1066 This new terminology is intended to be used when choosing a particular style of symbol to represent a feature
1067 on a geologic map (fig. 2), as well as when describing that feature in the symbol explanation and (or) the map
1068 unit description. If a feature is symbolized or described as "identity or existence questionable," the map user
1069 should consult the geologic map database for more complete information.

1070

Symbol style ¹	Examples of historically used terminology	Newly revised FGDC standard terminology	Scientific confidence		Locational confidence	
			Identity ...	Existence ...	Location (in field) ...	Position (on map) ...
_____	certain; known; accurately located	identity and existence certain, location accurate ²	certain	certain	observable	within zone of confidence ⁶
_____?	[not available for newly defined symbol]	identity or existence questionable, location accurate	may be questionable	may be questionable	observable	within zone of confidence
_____	approximately located	identity and existence certain, location approximate ³	certain	certain	observable	may not be within zone of confidence
_____?	approximately located, queried	identity or existence questionable, location approximate	may be questionable	may be questionable	observable	may not be within zone of confidence
_____	inferred; probable; projected	identity and existence certain, location inferred ⁴	certain	certain	inferred (between outcrops or beneath rubble or vegetation)	may not be within zone of confidence
_____?	inferred, queried	identity or existence questionable, location inferred	may be questionable	may be questionable	inferred (between outcrops or beneath rubble or vegetation)	may not be within zone of confidence
_____	concealed; projected	identity and existence certain, location concealed ⁵	certain	certain	concealed (beneath overlying map unit, ice, or water)	may not be within zone of confidence
_____?	concealed, queried	identity or existence questionable, location concealed	may be questionable	may be questionable	concealed (beneath overlying map unit, ice, or water)	may not be within zone of confidence

¹ Queries are added to symbols to indicate that a feature's scientific confidence (that is, either its identity or its existence) may be in question.
² The term "location accurate" is used when a feature is observable, and its plotted position on the map is within the zone of confidence.
³ The term "location approximate" is used when a feature is observable, but its plotted position on the map may not be within the zone of confidence.
⁴ The term "location inferred" is used when a feature's location must be inferred between outcrops or beneath rubble or vegetation, and so its plotted position on the map may not be within the zone of confidence.
⁵ The term "location concealed" is used when a feature is concealed beneath an overlying map unit, ice, or water, and so its plotted position on the map may not be within the zone of confidence.
⁶ The zone of confidence for a particular map or mapped area is specified by the mapping geologists and their agencies.

Figure 1. Diagram showing relation of new FGDC standard terminology to historically used terminology and to traditional line symbol styles.

1071

1072

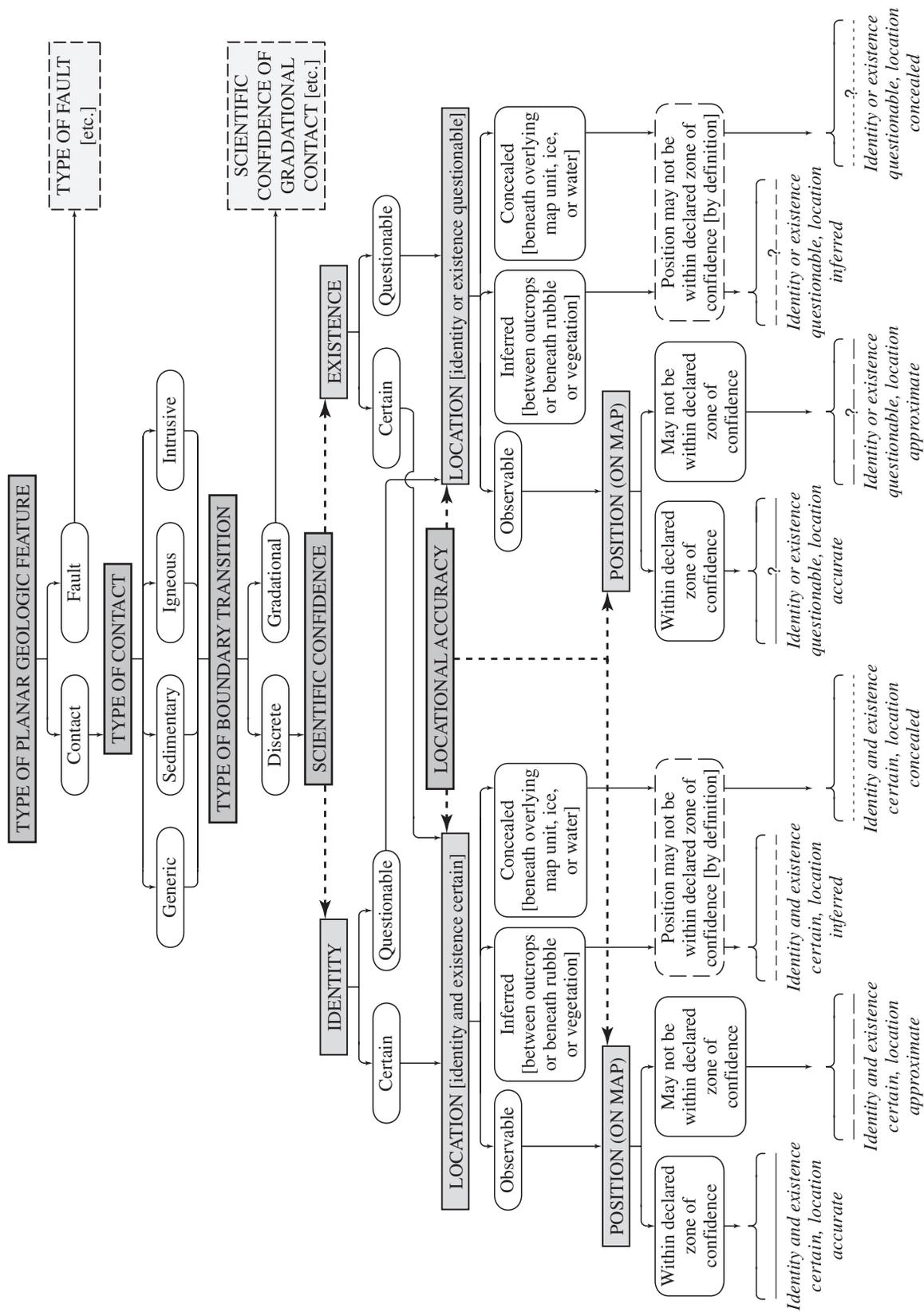


Figure 2. Flowchart showing example of logical steps that might be used to determine appropriate line symbol styles and associated terminology (in italics).

1073

1074 **4.1.4 Cartographic Representation of Scientific Confidence**

1075 For most types of geologic map features, queries are used to communicate the lack of scientific confidence in a
1076 feature. A queried line symbol indicates that either the identity or the existence of a planar or linear feature may
1077 be in question (figs. 1,2; see also, Appendix A); the map user should consult the geologic map database for
1078 more complete information. In contrast, a line symbol without a query most likely indicates that both the
1079 identity and the existence of a planar or linear feature are certain, unless otherwise stated in the geologic map
1080 database.

1081 For geologic point data, queries are not added to point symbols to indicate that the scientific confidence of a
1082 feature may be in question. However, a limited amount of specialized symbology has evolved to express the
1083 scientific confidence of certain types of geologic point information; for example, to indicate that the direction of
1084 stratigraphic top is known, a small ball may be added to bedding and foliation symbols (see Appendix A,
1085 Sections 6 and 8, respectively). In addition, queries may be added to dip or plunge values, both on the geologic
1086 map and in the geologic map database, if those measurements are questionable.

1087 A queried map-unit label indicates that either the identity or existence of the geologic map unit may be in
1088 question.

1089 **4.2 Locational Accuracy**

1090 *Locational accuracy* is based on the relation between a mapped feature's location in the field and its position on
1091 the base map. Information about the locational accuracy of mapped features is important to all disciplines, even
1092 those in which mapped features commonly are directly observable and can be positioned with a significant
1093 degree of accuracy (for example, roads or utilities). It is especially critical in the natural sciences, however,
1094 because many mapped features are either interpretive or not directly observable.

1095 The process of locating a feature in the field and then positioning it on a base map is complex, and the
1096 locational accuracy of a mapped feature is not easily described or quantified. To evaluate the locational
1097 accuracy of a mapped feature, a geologist must consider the following three factors:

- 1098 • the nature of the feature and its degree of exposure (for example, a contact may be gradational or sharp, and
1099 either poorly exposed or well-exposed);
- 1100 • the quality of the base map (for example, whether the cultural or topographic features on the base map are
1101 positioned accurately, according to the geologist's observations);
- 1102 • the confidence in accurately positioning the feature relative to the base-map information.

1103 Together, these factors determine a geologist's confidence in the locational accuracy of the features on the map.
1104 Locational accuracy is expressed by two distinct but related concepts, *locatability* and *positioning*.

1105

1106 **4.2.1 Locatability**

1107 *Locatability* expresses whether or not a geologist can clearly observe a feature *in the field*, as indicated by the
1108 following examples:

- 1109 • a planar or linear feature is observable in several outcrops along its trace;
- 1110 • a planar or linear feature is observable in only a few outcrops along its trace, but its physical characteristics
1111 permit locating it between outcrops by indirect methods;
- 1112 • a planar or linear feature is not defined by a distinctive physical trace and so is not observable beneath either
1113 vegetation, a thin veneer of unmapped geologic material (colluvium, eolian deposits, or residual soil), or
1114 man-made features, therefore its location must be inferred by indirect means;
- 1115 • a planar or linear feature is not observable because it is concealed by an overlying geologic map unit,
1116 although it may be observable nearby (for example, a thrust fault is visible on both sides of a glacial valley,
1117 but its location within the valley is concealed by ice), and so its location must be projected beneath the
1118 overlying map unit.

1119 As the above examples show, uncertainty in a feature's locatability can arise in a number of geologic situations.
1120 The concept of locatability is communicated in the following two ways:

- 1121 • in the geologic map database, the attribute describing the confidence in a feature's locatability is specified as
1122 either *observable*, *inferred*, or *concealed*;
- 1123 • on the geologic map, the confidence in a feature's locatability is communicated in the symbol explanation and
1124 (or) the map unit description (see Section 4.2.3 below, entitled "Levels of Locational Accuracy") and also,
1125 for some types of geologic map features, conveyed cartographically (see Section 4.2.4 below, entitled
1126 "Cartographic Representation of Locational Accuracy").

1127 **4.2.2 Positioning**

1128 *Positioning* expresses the degree of confidence with which a feature is plotted *on the base map*. Commonly, a
1129 feature can be accurately plotted on the map because the base-map information is accurate, detailed, and
1130 distinctive. However, in some field situations, a feature cannot be confidently plotted on the base map, as
1131 indicated by the following examples:

- 1132 • a feature is observable, but its position on the map cannot be plotted accurately because topographic contours,
1133 drainage lines, or cultural information on the base map is insufficiently detailed for the feature to be
1134 confidently located relative to the various base-map features (for example, a contact is observable in
1135 outcrop, but its location in relatively featureless terrain prevents its position from being plotted accurately on
1136 the base map);
- 1137 • a feature is observable, and its geographic coordinates can be determined in the field by using either a Global

1138 Positioning System (GPS) device or in the laboratory by using a georeferenced aerial photographic
1139 stereopair; however, the geographic relation between these coordinates and the topographic or cultural
1140 setting shown on the base map is not compatible (for example, a feature was mapped on a hillside, but the
1141 GPS-derived coordinates, when plotted on the base map, place its position in a valley bottom).

1142 In such situations, either a feature can be plotted relative to the indistinct or incompatible base-map features, or
1143 the locations of topographic contours or other base-map features can be adjusted (the latter approach is not
1144 encouraged unless it is done systematically and is well-documented). In either case, the inherent uncertainty in a
1145 feature's positioning must be communicated to the map user, both on the geologic map and in the geologic map
1146 database (see discussion in Section 4.2.2.1 below, entitled "Specifying Positional Accuracy with the Zone of
1147 Confidence").

1148 In the USGS, stringent policies for the accuracy with which an observable feature can be positioned on the base
1149 map have been put forth in the past. For example, Chief Geologist W.H. Bradley's 1956 memorandum to the
1150 staff advocated a geologic map accuracy standard based on the United States National Map Accuracy Standards
1151 (NMAPS) for topographic and other types of base maps. The geologic map adaptation of the NMAPS stipulated
1152 that "features that ... can be located from exposures or other evidence [should be positioned] within 1/25 inch
1153 [on the map] of their true map position" (W.H. Bradley, written commun., 1956; see also, U.S. Geological
1154 Survey, 1995a, Part 1, p. 1.0-4). These earlier efforts to quantify the positional accuracy of geologic features
1155 were not widely adopted by the geoscience community, likely in part because of (1) the difficulty in translating
1156 to geologic mapping a concept designed for topographic and other types of base maps, (2) the impracticality of
1157 requiring that all geologic map information meet the same accuracy criteria uniformly across the Nation, in all
1158 types of geologic and topographic settings, and (3) the need to convert ground distance to publication-scale
1159 cartographic units before evaluating if a feature is plotted accurately on a base map.

1160 In contrast, this standard advocates a more flexible and conceptually simpler approach in which the accuracy
1161 criteria can be defined for each project so that the specified positional accuracy takes into account the character
1162 of the geologic setting and other factors (see below). In addition, if the geologic map adaptation of the NMAPS
1163 (1/25 inch on the map) has been used when mapping, this value can be specified (1/25 inch on the map must
1164 first be converted to ground units).

1165 **4.2.2.1 Specifying Positional Accuracy with the Zone of Confidence**

1166 When a feature is drawn or digitized onto a base map, a geologist commonly has some sense of confidence
1167 regarding whether or not the feature is positioned accurately, depending on the quality of the base map and the
1168 ability to position features on that base map. This positioning confidence can be characterized as the likelihood
1169 that the feature actually occurs within a certain, roughly defined distance from where it is positioned on the base
1170 map. This hypothetical distance, which extends outward from a feature's position on the map, is herein defined
1171 as the *zone of confidence*, and its numerical value quantifies a feature's positional accuracy as follows:

1172

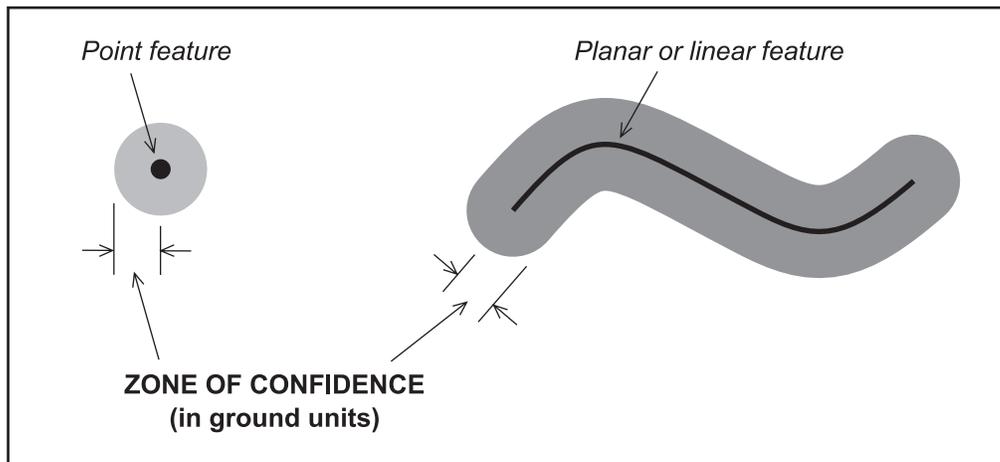


Figure 3. Figure showing examples of the zone of confidence for planar, linear, and point features. The region within which a *point* feature can be considered to be accurately positioned (on a base map) is a circle (light-shaded area above) around the point, and the value of the zone of confidence is the radius of that circle, in ground units. For a *planar* or *linear* feature, the region is a buffer zone (dark-shaded area above) surrounding the line, and the value of the zone of confidence is the distance from the line to the edge of the buffer zone, in ground units.

1173

1174 • for planar and linear geologic features, the *zone of confidence* borders the feature along both sides, forming
1175 what is described in GIS terminology as a buffer zone, and its numerical value is specified as the
1176 approximate distance in ground units (feet or meters) from the feature to the edge of the buffer zone (fig. 3);

1177 • for geologic point features, the *zone of confidence* is concentric around the feature, forming a circle, and its
1178 numerical value is the approximate radius of that circle (fig. 3).

1179 For any geologic map or mapped area, the numerical value of the zone of confidence will depend on a number
1180 of factors: the area's geology, landscape terrain, vegetation cover, and (or) cultural features; the scale of
1181 mapping; the quality and nature of the base map used; and (or) a particular project's allotted field-mapping time
1182 or other logistical constraints. Because this standard recognizes that the factors affecting the value of the zone of
1183 confidence will vary from region to region (and from map to map), and because different agencies have
1184 differing mapping needs and mandates, a single, universally applicable value for the zone of confidence is not
1185 herein established. Instead, this standard advocates that the responsibility for setting the value of the zone of
1186 confidence for a particular geologic map or mapped area lies with each geoscience organization and each
1187 mapping geologist.

1188 In the geologic map database, the attributes describing positioning confidence, which are expressed in terms of
1189 the zone of confidence, are as follows:

1190 • a numerical value for the zone of confidence is specified (for example, 5 meters);

1191 • a feature's positioning is specified as being either "*within zone of confidence*" or "*may not be within zone of*
1192 *confidence*" (note that this standard does not stipulate that a feature whose positioning is specified as "may
1193 not be within zone of confidence" must *necessarily* be located outside the zone of confidence, but simply
1194 that it *may* be).

1195 On the geologic map, positioning confidence is communicated in the symbol explanation and (or) the map unit
1196 description (see Section 4.2.3 below, entitled "Levels of Locational Accuracy") and also, for some types of
1197 geologic map features, conveyed cartographically (see Section 4.2.4 below, entitled "Cartographic
1198 Representation of Locational Accuracy"). In addition, the numerical value of the zone of confidence is
1199 indicated, either in a general statement (if one value applies to the entire mapped area) or shown in an index
1200 map (if different values apply to different mapped areas; see Section 4.2.2.2 below, entitled "Accommodating
1201 Different Values of the Zone of Confidence"). Likewise, if the geologic map adaptation of the NMAS (1/25
1202 inch on the map, converted to ground units) has been used during field mapping as a measure of positioning
1203 confidence, or if a zone of confidence was not used during field mapping or map compilation, this also is
1204 indicated.

1205 **4.2.2.2** *Accommodating Different Values of the Zone of Confidence*

1206 For many geologic maps or mapped areas, especially those that are defined by latitude and longitude (for
1207 example, quadrangle maps) or political boundaries (for example, state or county maps), one map may contain
1208 areas of vastly contrasting geology, topography, vegetation cover, and (or) societal infrastructure, and so
1209 different positional accuracy criteria can exist within a single map. For example, a geologic map may include
1210 both a mountain range underlain by well-bedded sedimentary rocks and a broad alluvial valley underlain by
1211 mostly surficial deposits. In the mountains, clear distinction among the sedimentary rocks, as well as their high
1212 relief, may provide a geologist with a significantly higher sense of confidence in the position of contacts than in
1213 the adjacent valley, where few topographic landmarks or contours exist and where contacts may be gradational
1214 and obscured by vegetation and soil cover. In geologic settings as diverse as these, the levels of confidence in
1215 positional accuracy will be different, and so a geologist has the following two choices:

- 1216 • express the differences in positioning confidence solely by differences in symbology (for example, specify
1217 one zone of confidence value for both areas, which might result in mostly solid-line contacts in the
1218 mountains and mostly dashed- or dotted-line contacts in the valley);
- 1219 • express the differences in positioning confidence by specifying different values of the zone of confidence for
1220 each area (for example, specify the zone of confidence value as 5 meters in the mountains and 15 meters in
1221 the valley).

1222 The choice might depend on the magnitude of the difference between the areas, or on the geologist's level of
1223 confidence in the positional accuracy of features across the map area.

1224 Map compilations represent another example where different positional accuracy criteria can exist within a

1225 single map. A map compilation is made up of several source maps or mapped areas, each of which may have
1226 had a different value specified for the zone of confidence (or perhaps no value had been specified). These
1227 variations in the specified value of the zone of confidence should be preserved in the map compilation as well.

1228 In situations in which the numerical values of the zone of confidence are different for different areas across the
1229 geologic map, the differences must be communicated to the map user. In the geologic map database, variations
1230 in the value of the zone of confidence can be readily accommodated because each feature is assigned (as an
1231 attribute in the database) the value of the zone of confidence that has been specified for a particular area. On the
1232 geologic map, areas that have different values of the zone of confidence should be shown in an index map.

1233 **4.2.3 Levels of Locational Accuracy**

1234 A geologic map must communicate to the map user the level of locational accuracy associated with each
1235 mapped feature (both its locatability in the field and its positioning on the base map). In the geologic map
1236 database, this information is contained in the following three attribute fields: (1) locatability (*observable,*
1237 *inferred, concealed*); (2) positioning (*within zone of confidence, may not be within zone of confidence*); and (3)
1238 the numerical value of the zone of confidence (for example, *5 meters*).

1239 To facilitate the communication of the two concepts of locatability and positioning on a geologic map, this
1240 standard sets forth the following revised terminology, which expresses clearly yet concisely the levels of
1241 locational accuracy of geologic features (see Figure 1 for the relation of this revised terminology to historically
1242 used terminology):

1243 "*Location accurate*" A feature is observable, and its plotted position on the map is within the declared zone
1244 of confidence. These criteria are met, for example, when a geologist reasons, "*I can*
1245 *clearly see this contact in outcrop, and I can accurately plot its position on the map.*"
1246 This is the default condition for all geologic map features unless otherwise stated on
1247 the geologic map or in the geologic map database.

1248 "*Location approximate*" A feature is observable, but its plotted position on the map may not be within the
1249 declared zone of confidence. These criteria are met, for example, when a geologist
1250 reasons, "*I can see this contact in outcrop, but I can't tell exactly where it is located*
1251 *because I am surrounded by trees,*" or, "*I can see this contact in outcrop, but the poor*
1252 *quality of my base map prohibits me from accurately plotting its position,*" or, "*I can*
1253 *see that the width of the gradational contact between these two map units exceeds my*
1254 *value of the zone of confidence, and so, although my base map is of high quality, my*
1255 *confidence in the accuracy of its plotted position is not high.*"

1256 "*Location inferred*" A feature is not directly observable between outcrops or beneath rubble or vegetation,
1257 so its location must be inferred by indirect means; by definition, its plotted position on
1258 the map may not be within the declared zone of confidence. These criteria are met, for

1259 example, when a geologist reasons, "*I can see by the change in debris materials*
1260 *visible around these gopher holes that a contact runs through here, but I can't locate*
1261 *it very precisely.*"

1262 "*Location concealed*" A feature is not observable because it is completely concealed beneath an overlying
1263 map unit or body of water or ice (although it may be observable nearby); by
1264 definition, its plotted position on the map may not be within the declared zone of
1265 confidence. These criteria are met, for example, when a geologist reasons, "*I can see*
1266 *that a contact is present on both sides of this lake, but I can't tell where it is located*
1267 *beneath the water.*"

1268 This revised terminology is intended to be used when choosing a particular style of symbol to represent a
1269 feature on a geologic map (fig. 2), as well as when describing that feature in the symbol explanation and (or) the
1270 map unit description.

1271 **4.2.4 Cartographic Representation of Locational Accuracy**

1272 A system of solid, dashed, dotted, and queried line symbols has long been used on geologic maps to convey the
1273 uncertainty of planar and linear geologic features (fig. 1), but it has not always been clear whether these line
1274 symbol styles reflect uncertainty in a feature's scientific interpretation, its mapped location, or both. This
1275 standard clarifies the use of these line symbols (figs. 1,2) by applying its revised terminology for locational
1276 accuracy (see Section 4.2.3 above, entitled "Levels of Locational Accuracy") to the following line symbol
1277 styles²:

- 1278 • a solid, continuous line symbol indicates that the location of a feature is accurate; that is, its location in the
1279 field either is readily observable in outcrop or is revealed by the characteristic geomorphic expression of its
1280 trace, without extensive cover of thin overlying surficial deposits, and is verifiable by shallow excavations;
1281 in addition, it can be accurately plotted because base-map information is accurate, detailed, and distinctive,
1282 and so its position on the base map is within the declared zone of confidence.
- 1283 • a long-dashed line symbol indicates that the location of a feature is approximate; that is, its location in the
1284 field either is readily observable in outcrop or is revealed by the characteristic geomorphic expression of its
1285 trace, without extensive cover of thin overlying surficial deposits, and is verifiable by shallow excavations;
1286 however, it cannot be accurately plotted because base-map information is inaccurate, indistinct, or
1287 incompatible with the location of the geologic feature, and so its position on the base map may not be within
1288 the declared zone of confidence.
- 1289 • a short-dashed line symbol indicates that the location of a feature is inferred; that is, its location in the field
1290 generally is obscured by overlying (unmapped) surficial deposits, debris materials, or vegetation that may

² Note that this standard restricts the use of queries to represent the lack of scientific confidence only (see discussion in Section 4.1.4 above, entitled "Cartographic Representation of Scientific Confidence").

1291 cover exposures and the geomorphic expression of its trace, and has therefore been projected between few
1292 outcrops; by definition, its position on the base map may not be within the declared zone of confidence.

1293 • a dotted³ line symbol indicates that the location of a feature is concealed; that is, its location in the field is
1294 covered by an overlying, mapped geologic unit, ice, or water; by definition, its position on the base map may
1295 not be within the declared zone of confidence.

1296 These types of line symbol styles (solid, long-dashed, short-dashed, and dotted) are intended to be used to
1297 convey the various levels of locational accuracy of planar and most types of linear geologic features.

1298 The locational accuracy of a geologic map unit is not expressed by a specialized symbol but, instead, by the
1299 style of line symbols representing the planar features (contacts and faults) that bound it.

1300 In most cases, specialized point symbols are not used to indicate that the locational accuracy of a geologic point
1301 feature may be in question. One exception is the specialized symbols that are used to portray bedding attitudes
1302 that have been determined using aerial photographs (see Appendix A, Section 6); however, these symbols also
1303 may be used to indicate that the scientific confidence (the measurement of dip) is in question, and so, when
1304 these types of symbols are used on a geologic map, the map user should consult the geologic map database for
1305 more complete information.

1306 **5.1.1 GUIDELINES FOR MAP COLOR AND PATTERN SELECTION**

1307 The goal in color design is to enhance the legibility of the map, as well as to lend meaning to the data presented
1308 by helping to focus attention on a particular map feature or group of features. Colors and patterns should not,
1309 however, be so visually dominant as to distract from the purpose of the map. A well-balanced color design can
1310 greatly improve the presentation of scientific information.

1311 **5.1.1.1 FACTORS THAT INFLUENCE COLOR AND PATTERN SELECTION**

1312 **5.1.1.1.1 Purpose of Map**

1313 Color is used differently on different types of maps. For example, on geologic maps, color is primarily
1314 determined by age and type of rock, although other rules may apply for terrane maps or maps that portray only a
1315 limited range of ages or types of rocks. In addition, some map units, because of their geologic or economic
1316 importance, may need to be emphasized by selected colors.

1317 Geophysical maps use several color schemes, depending on the purpose of the data being shown; usually a
1318 range of colors from dark to light is used. One such scheme is a graduated set of hues of similar value (for
1319 example, purple and magenta to orange and red). Another is a rainbow of hues in which the values alternate
1320 between full color and lightly screened color.

³ In reality, dotted line symbols that are thinner than a certain lineweight are difficult to produce with some software applications; therefore, this standard substitutes a very-short-dashed line symbol as the cartographic standard (see Figures 1,2; see also, Appendix A).

1321 On slope-stability maps, the brightest colors are used on areas of highest instability. Similarly, on volcanic- or
1322 earthquake-hazard maps, areas of greatest hazard usually are shown in red, whereas areas of lowest hazard are
1323 shown in yellow or green.

1324 Data on hydrologic maps are frequently shown in two or three colors. On maps showing depth to water table,
1325 color ranges from light blue at the shallowest depths to dark blue at the greatest depths. On maps showing
1326 dissolved-solids concentrations, color ranges from dark blue where concentration is lowest to dark red where
1327 concentration is highest.

1328 **5.1.2 Age and Type of Rock**

1329 Whenever possible, colors for ages and rock types on geologic maps should follow the scheme presented in the
1330 diagram showing "Suggested Ranges of Map-Unit Colors for Volcanic and Plutonic Rocks and for Stratigraphic
1331 Ages of Sedimentary and Metamorphic Rocks" (see Appendix A, Section 33). However, it may not always be
1332 feasible to show map units in the suggested color; in these cases, other characteristics should be emphasized
1333 with color.

1334 On surficial maps, for example, it may be desirable to show all glacial deposits in one color, landslide deposits
1335 in another, lacustrine deposits in another, and alluvial deposits in yet another. On terrane maps, color may be
1336 used to show lithotectonic relations between various groups of rocks.

1337 On maps that are mostly one age group, it is best to distinguish sedimentary rocks from volcanic rocks (usually
1338 shown in reds or other bright colors) and plutonic rocks (usually shown in pinks). On maps that are mostly one
1339 type of rock, differentiation between different rock sequences can be shown through the use of different colors.

1340 On maps that cover a broad range of ages and rock types, relations between rocks within one age group can be
1341 shown by using similar colors, whereas relations between the same type of rock in different age groups can be
1342 shown by using patterns (for example, all volcanic rocks may have the same "v" pattern). Patterns should be
1343 used sparingly, however, as their use can create an overly busy appearance; use them only when the complexity
1344 of the map requires the diversity achieved by the use of patterns.

1345 Although it is preferable to follow the aforementioned guidelines, some rock types defy such guidelines because
1346 they traditionally have been shown in a particular color. For example, serpentinite and other ultramafic rocks
1347 characteristically are shown in purple; limestone usually is shown in bright blue; and glacial till often is shown
1348 in light green.

1349 **5.1.3 Size of Map-Unit Areas**

1350 In general, small map-unit areas should be shown in darker colors and large areas should be shown in lighter
1351 colors. An exception to this may be in situations when numerous small bands of map units are shown; in this
1352 case it may be best to alternate light and dark colors. In the case of map units that consist of both large and
1353 small areas, add labels and leaders to the smaller map units to avoid confusion. For guidelines and

1354 recommendations on the placement of map-unit labels and leaders, see Section 6 below, entitled "Guidelines for
1355 Map Labeling."

1356 Because it is more difficult to clearly distinguish color in small areas, it is very important to choose as unique a
1357 color as possible for map units that are present only in small areas. The minimum size of map-unit area that can
1358 show color is about two square millimeters; anything smaller will need to be labeled. In addition, exercise
1359 caution when using patterns in small areas because small areas may fail to show enough of the pattern to
1360 adequately identify a map unit; about one square centimeter is the minimum size to clearly show patterns. If
1361 there can be any ambiguity in a map-unit area's identification, it is safest to add a label and leader.

1362 **5.1.4 Contrast**

1363 Adequate contrast enhances readability. A key factor is not so much the difference in hue, such as blue or green,
1364 but the difference in intensity. Contrast should not, however, be so great as to be glaring, but it should be
1365 significant enough for easy legibility. Map units that need to be emphasized should be assigned colors that stand
1366 out and contrast well with the colors of less important units. In addition, greater contrast is required for small
1367 areas, whereas a more subtle contrast is sufficient for larger areas.

1368 **5.2 SPECIFYING COLOR FOR MAP-UNIT AREAS**

1369 To maintain control of color output, color on maps and illustrations should always be specified using process-
1370 color (CMYK, cyan/magenta/yellow/black) inks, regardless of the intended output medium. If another non-ink
1371 color scheme such as RGB (red/green/blue) or HSV (hue/saturation/value) is used, then the output device (be it
1372 printer, plotter, or imagesetter) will automatically convert the non-CMYK values to CMYK during output, and
1373 unwanted color shifts often will take place. To aid in the selection of color fill for map units, a chart showing a
1374 wide variety of CMYK colors ("CMYK Color Chart") has been included herein.

1375 Color values must be high enough to provide adequate contrast but not so great that they prevent the map-unit
1376 labels, structure symbols, and topographic base from showing clearly. Except in small areas, magenta and cyan
1377 should be used in intensities of 50% or less. A greater intensity of cyan might obscure drainage features
1378 (commonly shown in cyan), and a greater intensity of magenta might obscure magenta fold axes and dikes.

1379 As a general rule, use a combination of CMYK color values that, when added together, totals 100 or less (for
1380 example, 30% cyan/40% magenta/20% yellow; $30+40+20 = 90$), especially in larger areas.

1381 To maintain enough contrast between two colors, keep at least a 20% difference between the values of one of
1382 the CMYK colors (for example, 30% cyan/8% magenta/20% yellow and 30% cyan/8% magenta/40% yellow).

1383 Avoid using 8% yellow because it is too light and cannot easily be distinguished from white. In addition, it may
1384 be wise to avoid using 13% or 20% cyan, as these colors may look like a body of water.

1385 On maps that are to be offset printed, it may be best to use a solid (100%) single-ink color such as cyan,
1386 magenta, or yellow in very small map-unit areas to avoid misregistration problems. For example, 100% cyan

1387 may be used to show small limestone blocks in melange, or 100% magenta may be used to show thin rhyolite
1388 intrusions.

1389 **5.3 USE OF PATTERNS**

1390 Patterns can be printed either in black, in color, or as a dropout. Ideally, patterns should be used sparingly and
1391 only when necessary for clarification, as they can add unnecessary complexity to a map. To select appropriate
1392 patterns for a map, both the type of rock and the size and (or) orientation of map-unit areas must be considered.
1393 To aid in the selection of patterns for map units, a chart showing a wide variety of geologic patterns ("Pattern
1394 Chart") has been included herein.

1395 Although some flexibility exists in the use of patterns, some patterns are traditionally and exclusively used for
1396 certain rock types: for example, "+" patterns are used for plutonic rocks, and irregular "v" patterns represent
1397 volcanic rocks. For map units that are present only in small areas, a tight, random pattern will fit more of the
1398 pattern elements into a particular area. Exercise caution, however, when choosing metamorphic patterns that
1399 display a strong directionality, as their use may imply a general orientation of metamorphic fabric that in reality
1400 is much more varied than the pattern may indicate.

1401 **5.3.1 Overprint Patterns**

1402 Color overprint patterns are usually specified in either cyan or magenta, but sometimes a spot color such as red
1403 is used. For offset printing, it is best to specify only one color for overprint patterns, as using more than one
1404 color can cause misregistration problems. Color overprint patterns can be screened to reduce their intensity.

1405 Black overprint patterns are less effective than color in most situations, as they can conceal base-map
1406 information or interfere with type or structure symbols. Thus, it may be best to restrict the use of 100% black
1407 patterns to small, uncluttered areas; if a map-unit label is needed, it can be placed outside the area and leadered
1408 in. Black patterns also can be screened to reduce their intensity.

1409 **5.3.2 Dropout Patterns**

1410 Dropout patterns cause to be transparent one or more of the CMYK colors that combine to make a map-unit
1411 color, thus allowing the remaining color(s) to show through. Their use can be especially effective on a map that
1412 has a large amount of labeling or many structure symbols.

1413 For offset printing, only one color should be dropped out, as dropping out more than one will lead to
1414 misregistration problems; in general, the most dominant color (the one with the highest value) other than yellow
1415 should be the one dropped out. For output to a single-pass inkjet plotter, a dropout pattern may be applied to all
1416 of the CMYK colors that make up a map-unit color; the dropout pattern would then show as white. Be aware,
1417 however, that doing so may cause that map unit to stand out more than is desired.

1418

1419 **5.4.1 SPECIFYING COLOR FOR LINE AND POINT SYMBOLS**

1420 Color commonly is specified for many line and point symbols because it highlights these features. Whenever
1421 possible, color for line and point symbols should be specified as either 100% cyan or 100% magenta, two of the
1422 standard four process-color (CMYK, cyan/magenta/yellow/black) inks that are used for offset printing and in
1423 most inkjet plotters (other non-ink color schemes such as RGB or HSV should be avoided so that unwanted
1424 color shifts during output are prevented). However, in some cases it may not be practical or preferable to
1425 specify cyan or magenta; for example, mineral resource assessment areas traditionally have been outlined in
1426 red.

1427 Although it is possible to make a non-process color such as red from two or more process-color inks, this should
1428 be avoided if the map is to be offset printed because of the difficulties in registering large, CMYK-separated
1429 negatives. For maps that are to be offset printed, a Pantone color (single-ink spot color) should be specified.
1430 Each Pantone color is imaged onto a separate piece of film, thereby avoiding misregistration problems caused
1431 when a color is converted to CMYK and then is color separated onto more than one piece of film.

1432 **6.1 GUIDELINES FOR MAP LABELING**

1433 Map-unit labels are the most common labels on geologic maps. Other labels may include base-map information,
1434 feature names, and data items such as dip values, gold concentrations, well depths, radiometric ages, and sample
1435 locality numbers.

1436 Before the advent of digital technologies for mapmaking, labels were either drawn by hand or applied using
1437 stick-up type. Nowadays, using digital mapmaking techniques, labels (and leaders) can be automatically plotted
1438 from information in a database; however, this often results in labels overprinting other map features, requiring
1439 them to be interactively repositioned or deleted. Regardless of the method employed, effective label placement
1440 is an important factor in producing a useful map.

1441 **6.1.1 STRATEGIES FOR MAP LABELING**

1442 Enough features on the map should be labeled so that the reader can identify all of the various map elements; no
1443 unlabeled map feature should leave the reader guessing. Labels (and leaders) should not, however, create an
1444 overly "busy" or cluttered appearance, which makes recognition of map patterns and shapes and map-element
1445 distribution difficult to discern. For a map to be easily read, labels and leaders should be placed where they are
1446 clear and legible, taking care to avoid overprinting of linework, symbols, or other labels. In addition, they
1447 should not obscure base-map features that are mentioned in the text or that may be useful in locating places on
1448 the map.

1449 Commonly, color or pattern can be used to identify an unlabeled map-unit area if a nearby area of the same map
1450 unit is labeled. Therefore, the color and pattern selection is critical when deciding whether or not to label a
1451 particular map-unit area, and so it is important to complete the color and pattern design of the map before

1452 attempting to place and move map-unit labels, especially for complex maps or those that have many map units.

1453 There are no precise rules for which and how many of the map-unit areas on a map should be labeled, but the
1454 following are some general guidelines. If a map unit has a unique and clearly distinguishable color or pattern, it
1455 is not necessary to label every area of that map unit. Color and pattern can carry the identification of a group of
1456 areas of the same unit as long as some of them are labeled. Use judgment when deciding whether the color for
1457 that map unit is distinctive enough and (or) whether a particular unlabeled map-unit area can be visually or
1458 logically associated with any nearby labeled areas of the same unit. In small map-unit areas, however, even the
1459 most distinctive color or pattern may be difficult to discern. If there might be any doubt, add a label and leader.

1460 At least one area of every map unit within a "normal field of view" should be labeled. This field of view is the
1461 area in focus when the map is viewed at a comfortable, readable distance. In uncluttered areas of the map or in
1462 areas of relatively simple geology, this field of view might have a radius of about two or three inches; in
1463 geologically complex or cluttered areas, however, it may be much smaller. The reader should not need to search
1464 across the map trying to find a labeled map-unit area that has a color that matches an unlabeled map-unit area.

1465 In addition, maps that are to be downloaded from the Web will be sent to a plotter of unknown type, and there is
1466 no guarantee that colors that appear distinct when plotted on your plotter will also be distinguishable when
1467 plotted on other plotters. The more map-unit areas that are labeled, the less chance of ambiguity and confusion.

1468 **6.2 FONT SELECTION**

1469 For most type on a map (for example, unit labels, dip values, and fault names), a sans-serif font such as
1470 Helvetica (or FGDC-GeoAge; see Appendix A, Section 32) should be used. Other sans-serif fonts such as
1471 Univers or Arial also may be used, but consider that not all fonts will plot correctly on all output devices. Also
1472 consider that combining FGDC-GeoAge with Univers or Arial will result in odd-looking character strings
1473 because the character size and kerning (spacing of letters) of FGDC-GeoAge is based on that of Helvetica;
1474 therefore, using Helvetica with FGDC-GeoAge is recommended. For base-map information, use a combination
1475 of sans-serif (for example, Helvetica or Univers) and serif (for example, Times or Times New Roman) fonts;
1476 the general rule is to follow the styles used on a published topographic map sheet.

1477 When placing labels digitally, it is important to use the same font that will be used for final publication because
1478 the size and kerning of characters are different for different fonts, even those having the same point size. If
1479 labels are placed carefully in tight areas using one font, but then another font is used for final publication, the
1480 labels may overprint linework or other features because the new font may have longer character heights and
1481 string lengths. Therefore, for best results, choose fonts early in a project, and then stay with that choice
1482 throughout the project. In addition, the use of PostScript fonts may result in more consistent final output for
1483 both print and digital publications.

1484

1485 **6.3 TYPE SIZE AND STYLE**

1486 The ideal size for map-unit labels is 8 pt, although labels as small as 6 pt may be substituted in places where
1487 space is tight. Fractional font sizes may be used if needed, and different sizes can be mixed on the same map. If
1488 unit labels contain subscripts or superscripts, the minimum unit-label size should be 7 pt; then the size for the
1489 subscript or superscript character would be 5 pt, two point sizes smaller.

1490 Other sizes and styles are used to label different features. In general, use 8 pt type (all caps) for names of faults
1491 and major structures, for sample locality numbers and radiometric ages, and for fault (U/D, A/T) and contact
1492 (Y/O) ornamentation. Use 6 pt italic type for dip or plunge values. Use 12 pt italic type for cross-section labels.
1493 For labels of larger features, type size and (or) kerning (letter spacing) may be increased to improve legibility.

1494 **6.4 LABEL PLACEMENT**

1495 Labels for linear map features should be aligned along those features. Other labels should have a logical or
1496 comfortable orientation relative to the map. In rare cases it might be desirable to have labels run parallel to lines
1497 of latitude, but in general they should be oriented horizontally.

1498 Map-unit labels and dip values should always be oriented horizontally. They should not overprint other map
1499 elements such as linework, point symbols, or any other dip values and labels, nor should they obscure base-map
1500 features that are referenced in text or are needed to orient the map in the field. Single labels can be used to
1501 identify more than one map-unit area; use multiple leaders where necessary.

1502 Map-unit labels should not be placed in dark-colored map-unit areas or in densely patterned areas, both of
1503 which would make the labels hard to read; instead, move labels outside such areas and add leaders. If a label
1504 must be placed in a dark-colored or densely patterned map-unit area, it may be necessary to mask out the color
1505 or pattern around the label to help make it more legible.

1506 **6.5 LEADER PLACEMENT**

1507 Leaders should be drawn as straight lines, not bent or curved. They should cross map-unit area boundaries at as
1508 high an angle as possible, and they should not stop at the boundary but should extend well into the map-unit
1509 area. Leaders should not cross through other map-unit areas to reach a particular map unit unless absolutely
1510 necessary. Multiple leaders emanating from a single label should not be joined at their "label" ends.

1511 **7. TECHNICAL SPECIFICATIONS USED IN THE PREPARATION OF THIS**
1512 **STANDARD**

1513 This new standard (contained in Appendix A) consists of geologic line and point symbols, geologic map-unit
1514 colors and patterns, a geologic age symbol font, and related map marginalia. This section provides some
1515 technical discussion regarding preparation of the standard and its implementations.

1516

1517 7.1 UNITS FOR LINEWEIGHTS, LENGTHS, AND DISTANCES

1518 In previous standards, lineweights were specified in thousandths-of-an-inch, which corresponded to the widths
1519 of the engraving tools used to scribe the linework. Most lengths and distances also were given in inches. In this
1520 standard, the cartographic specifications are given in millimeters, in accordance with the Federal standard for
1521 metrification.

1522 The old thousandths-of-an-inch specifications have been converted to millimeters (Table 1), and then most have
1523 been rounded to the nearest .05 mm or .025 mm, for ease of use. Whenever possible, cartographic specifications
1524 for lengths and distances have been given in whole- or half-integer values. However, when preparing the
1525 symbols in this standard document, as well as in its PostScript implementation, lineweights, lengths, and
1526 distances were specified in points, and the exact conversion values (from inches to points; see Table 1) were
1527 retained.

1528 As an example of the unit-conversion process, consider the symbol for faults, which in previous standards had a
1529 lineweight of .015" specified. This original lineweight was converted to millimeters (.015" = .381 mm; Table 1)
1530 and then rounded to .375 mm, which is the value given as the cartographic specification in this standard (see p.
1531 A-2-1, Appendix A). However, when preparing the fault symbol for inclusion in this standard document (and
1532 in its PostScript implementation), the exact .015" lineweight was retained and directly converted to points
1533 (.015" = 1.08 pt; Table 1), and so the symbol lineweight was defined electronically as 1.08 pt.

1534 Complications from unit conversion can arise not just when designing line symbols but also when creating point
1535 symbols and patterns, as most symbols are made of stroked lines. When creating symbols for a particular
1536 application, the user should choose the unit of measure most easily used in an application and then use the
1537 conversion table (Table 1) to convert to those units.

1538 7.2 TYPE SPECIFICATIONS

1539 Most type in this standard is specified as either Helvetica (sans-serif) or Times (serif), two fonts that are
1540 commonly used and widely available (see Table 2 for abbreviations for type faces used in this standard); type
1541 sizes are given in points. Other fonts such as Univers, Arial, or Times New Roman may be substituted, but
1542 consider that they may not be installed on all common output devices and thus may not plot correctly.

1543 Geologic age characters have been specified as FGDC-GeoAge, a specialized sans-serif font designed by the
1544 U.S. Geological Survey (see Appendix A, Section 32). The character size and kerning (spacing of letters) of
1545 FGDC-GeoAge is based on that of Helvetica; therefore, using Helvetica with FGDC-GeoAge is recommended.

1546 7.3 COLOR SPECIFICATIONS FOR LINE AND POINT SYMBOLS

1547 Color has been specified as the cartographic standard for many line and point symbols in this standard, either
1548 because of adherence to a long-established color convention or because using color for features such as folds
1549 and dikes may help them to stand out better from other full-black linework such as contacts and faults. In most

1550 cases, another color or black may be substituted if the color specified as the standard would not be visible when
1551 printed over an underlying map-unit color.

1552 Whenever possible, color has been specified as either cyan or magenta, two of the four process-color (CMYK,
1553 cyan/magenta/yellow/black) inks that are used both in inkjet plotters and for offset printing. However, in some
1554 cases it was not practical or preferable to specify cyan or magenta as the standard; for example, mineral
1555 resource assessment areas traditionally have been outlined in red (see p. A-19-1, Appendix A).

1556 Although it is possible to make a non-process color such as red from two or more process-color inks, this should
1557 be avoided if the map is to be offset printed because of the difficulties in registering large, CMYK-separated
1558 negatives. Thus, in some cases a spot color (a single-ink, non-CMYK color) has been specified as the
1559 cartographic standard.

1560 As a simple, general way of specifying spot colors, generic color names (for example, "red" and "green") have
1561 been used in this standard. Specifying color as these generic color names, however, may not be appropriate for
1562 use with certain output media. Therefore, the user must choose a method of specifying color that is appropriate
1563 for a particular output device; Table 3 shows suggestions for conversions of spot colors to other color models.

1564 For maps that are to be offset printed, a Pantone color (single-ink spot color) should be specified (Table 3).
1565 Each Pantone color is imaged onto a separate piece of film, thereby avoiding misregistration problems caused
1566 when a color is converted to CMYK and then is color separated onto more than one piece of film. For output to
1567 an inkjet plotter, however, specifying a spot color as one of the generic color names is satisfactory because,
1568 during the plotter's RIP⁴ of the file, the color will automatically be converted to the proper amounts of CMYK
1569 inks that will combine to make the CMYK equivalent of that color. Misregistration is not a problem with single-
1570 pass inkjet-plotter output.

1571 If simple, graphical map elements are to be published as part of a web page on the World Wide Web, it may be
1572 best to choose colors from a "Web-safe" color palette⁵ to avoid unwanted dithering on monitors that display
1573 only 256 colors (Weinman, 1996). As an aid in doing so, an attempt was made to provide "Web-safe" color
1574 equivalents of the Pantone spot colors used in this standard (Table 3). These "Web-safe" color equivalents are
1575 made up of the RGB (red/green/blue) values that are as close as possible to the directly converted RGB-
1576 equivalent colors (Table 3). Note, however, that it was impossible to exactly reproduce the directly converted
1577 RGB-equivalent colors because, to make "Web-safe" colors, there are only six possible RGB values (000, 051,
1578 102, 153, 204, and 255) from which to choose.

⁴ RIP = raster-image processing, a process that runs on all plotters, printers, and imagesetters and converts data (in either raster or vector format) to printer dots to produce an image.

⁵ Industry opinions on using "Web-safe" colors (8-bit, 216 colors) are changing, owing to the large number of monitors now in use that can display more than 256 colors; Chris MacGregor (*in* Dennis, 1999) stated that using non-"Web-safe" colors may be acceptable to use in detailed areas, although she still recommends using "Web-safe" colors in large areas.

1579 **7.4 COLOR SPECIFICATIONS FOR MAP-UNIT AREAS**

1580 To aid in the selection of color fill for geologic map units, a chart showing a wide variety of CMYK colors
1581 ("CMYK Color Chart") has been included in this standard. The CMYK Color Chart was designed in Adobe
1582 Illustrator 8.0.1 to closely replicate the colors on the offset-printed color chart entitled "Printing Colors and
1583 Screens in Use by the U.S. Geological Survey for Geologic and Hydrologic Maps" [yellow/magenta/cyan
1584 version], which has been in use for many years at the USGS. The new color chart contains the same colors that
1585 were in the original offset-printed USGS chart; however, the old color codes indicating the YMC
1586 (yellow/magenta/cyan) values have been updated to show CMYK (cyan/magenta/yellow, with K=0) values, to
1587 conform to industry standards. In addition, each color in the CMYK Color Chart has associated with it a generic
1588 lookup-table number that, if desired, may be used to access the color from within digital applications.

1589 In addition, a diagram showing "Suggested Ranges of Map-Unit Colors for Volcanic and Plutonic Rocks and
1590 for Stratigraphic Ages of Sedimentary and Metamorphic Rocks" (see Appendix A, Section 33) has been
1591 included in this standard. This diagram was designed in Adobe Illustrator 8.0.1 to reproduce a similar diagram
1592 in the old USGS Technical Cartographic Standards volume (U.S. Geological Survey, ca. 1975). In this new
1593 version, however, the range of colors was modified slightly, a few new colors were added, and the old color
1594 codes were updated to show CMYK (cyan/magenta/yellow, with K=0) values.

1595 **7.5 PATTERN SPECIFICATIONS**

1596 The old USGS Technical Cartographic Standards volume (U.S. Geological Survey, ca. 1975) contained no
1597 cartographic specifications (lineweights, dot sizes, or size and spacing of pattern elements) for its patterns. The
1598 volume dates back to a time when maps were conventionally prepared using hand-scribed linework and
1599 peelcoats. In those days, patterns were preprinted onto large sheets of film, which were photomechanically
1600 combined with the various peelcoats to make the CMYK negatives.

1601 For this standard, the patterns (see "Pattern Chart") were recreated by scanning the old pattern sheets and then
1602 tracing the pattern elements in Adobe Illustrator 8.0.1. For most patterns, black, cyan, and magenta versions, as
1603 well as dropout versions, were created. Yellow versions were not created because yellow patterns are not visible
1604 over color fill. Also, red and (or) brown versions were created if red or brown patterns were specified as the
1605 cartographic standard for a particular feature. Glacial and hydrologic patterns were created only in cyan and
1606 black, as it is unlikely that magenta or other colors would be used for these types of patterns.

1607 To facilitate digital output, lineweights and dot sizes were in many cases increased. A few pattern tiles were
1608 scaled to accommodate the increased lineweights, and some of the lined patterns were dropped because an
1609 increased lineweight would fill in the pattern and because an increase in scale would cause the pattern to be too
1610 similar to other patterns. The lineweights and dot sizes for the color and dropout versions were increased even
1611 more than for the black versions, to help them show more clearly on maps.

1612 All patterns were renumbered, and suffixes indicating color were added so that all versions of the same pattern

1613 are referenced by the same number. In addition, each pattern in the Pattern Chart has associated with it a generic
1614 lookup-table number that, if desired, may be used to access the pattern from within digital applications.

1615 **7.6 GEOLOGIC AGE SYMBOL FONT**

1616 A digital font named FGDC-GeoAge (see Appendix A, Section 32) has been created, in which 16 special
1617 geologic age characters have been substituted into positions of normal keyboard characters. These characters
1618 can be typed either directly or with the Shift key; no Option, Control, or Alt keys are needed to type these
1619 characters (they are all in lower-order ASCII positions that have character ID numbers below 128), allowing the
1620 same character positioning to work on different computer platforms without interfering with special control key
1621 sequences.

1622 **8. ACKNOWLEDGMENTS**

1623 This standard owes its existence mostly to the well-established history and traditions of geologic map
1624 cartography by the USGS. In particular, the editors and compilers of this standard wish to thank the many
1625 cartographers, editors, and geologists who contributed to the informal USGS "Technical Cartographic
1626 Standards" volume (U.S. Geological Survey, ca. 1975), as well as Mitchell Reynolds, James Queen, Richard
1627 Taylor, and others who were responsible for preparing the earlier (1995) USGS proposed standard (U.S.
1628 Geological Survey, 1995a,b), from which this standard has evolved. We especially wish to thank the many
1629 members of the USGS Geologic Discipline's Western Publications Group who have made substantial
1630 contributions to the design and preparation of this standard (see Section 2.3 above, entitled "Preparers of this
1631 Standard").

1632 We also thank the numerous geologists, cartographers, graphics specialists, GIS specialists, editors, and others
1633 who provided invaluable comments and suggestions for revisions to this standard during their review(s) of the
1634 previous versions of this standard: the 1995 USGS proposed standard (see Soller, 1996); the preliminary, beta
1635 version of this standard; the Working Draft of this standard; and, most importantly, the Public Review Draft of
1636 this standard. In addition, we gratefully acknowledge the intellectual contributions of members of the standing
1637 Map Symbol Standards Committee (see section 2.3 above, entitled "Preparers of This Standard"), and especially
1638 Jonathan Matti (USGS) for his guidance on issues of scientific and locational confidence. Finally, we thank
1639 Jack Reed, Ron Wahl, Will Stettner, and Nancy Stamm (all USGS) for providing insight and access to USGS
1640 historical documents and standard cartographic practices.

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APPENDIX A. GEOLOGIC MAP SYMBOLS, COLORS, AND PATTERNS

This [normative] appendix contains the geologic map symbols and their descriptions, their cartographic specifications, and notes on their usage. Also included are the CMYK Color Chart and the Pattern Chart (enclosed in sleeve on inside back cover), which contain colors and patterns for use on geologic maps.

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PREFACE TO APPENDIX A

In this preface to Appendix A, we include some general guidelines for using the "FGDC Digital Cartographic Standard for Geologic Map Symbolization," as well as some basic information on the newly implemented standard for the scientific confidence and the locational accuracy of geologic features. For more specific information, please refer to the following sections in the accompanying introductory text: "Geologic Mapping Concepts and Definitions" (Section 3); "Scientific Confidence and Locational Accuracy of Geologic Features" (Section 4); "Guidelines for Map Color and Pattern Selection" (Section 5); "Guidelines for Map Labeling" (Section 6); and "Technical Specifications Used in the Preparation of this Standard" (Section 7).

ABOUT THIS VERSION OF THE STANDARD

This now formally approved version of the standard incorporates revisions that reflect reviewers' responses to the "Public Review Draft — Digital Cartographic Standard for Geologic Map Symbolization" (Federal Geographic Data Committee, 2000). We thank all the reviewers for their contributions, and we are pleased that most of the comments and suggestions could be accommodated (see http://ngmdb.usgs.gov/fgdc_gds/geolsymstd/prdresponse.html). Note, however, that we were able to fully address suggestions for the inclusion of new symbols only if examples of the proposed symbol additions were provided.

We intend this standard to be a "living standard" — that is, we recognize that an existing symbol's usage may need to be modified, or a new symbol or set of symbols created, to more fully express local geologic conditions or to keep pace with evolving geologic mapping concepts and practices. Accordingly, such new or modified symbols, if found to be of wide applicability, will be incorporated into this standard through planned, periodic revisions. You are invited to submit comments and suggestions for updates or other improvements to this standard by email to mapsymbol@flagmail.wr.usgs.gov.

In response to reviewers' comments, we tested various cartographic specifications for dashed and ornamented line symbols in several different software packages (Adobe Illustrator v.8.0.1, ArcInfo v.7x, and ArcGIS v.8x) to ensure that symbols would render correctly and consistently. As a result, we found it necessary to modify the cartographic specifications (dash/gap lengths and ornament spacings) of many line symbols in this standard from the specifications found in previous versions of the standard.

HOW TO USE THIS STANDARD

The contents of this standard are not intended to be used inflexibly or in a manner that will limit one's ability to communicate the observations and interpretations gained from geologic mapping. On the contrary, we recognize that, in certain situations, a symbol or its usage might need to be modified in order to better represent a particular feature on a geologic map or cross section.

To that end, we emphasize that this standard allows the use of any symbol that doesn't conflict with others in the standard, provided that it is clearly explained on the map and in the database. In addition, modifying the size, color, and (or) lineweight of an existing symbol to suit the needs of a particular map or output device also is permitted, provided that the modified symbol's appearance is not too similar to another symbol on the map. Be aware, however, that reducing lineweights below .125 mm (.005 inch) may cause symbols to plot incorrectly if output at higher resolutions (1800 dpi or higher). For more information, please refer to Section 7 ("Technical Specifications Used in the Preparation of this Standard") in the accompanying introductory text.

To facilitate the use of this standard, we include in this preface tables showing conversion values from inches to points to millimeters (Table 1), abbreviations used (Table 2), and spot color specifications and their equivalent colors in other color models (Table 3). We also offer the following illustrations of a few key terms and concepts used when preparing this standard:

LINE SYMBOLS	POINT SYMBOLS	TYPE EXAMPLES	
<p>Right-Hand Rule:</p>	<p>Point of Observation (at center of cyan circle):</p>	<p>Sans-Serif Font:</p> <p>Trv Qls HAYWARD FAULT</p>	<p>Serif Font:</p> <p>Triassic volcanic rocks <i>Columbia River</i></p>

THE NEWLY IMPLEMENTED STANDARD FOR THE SCIENTIFIC CONFIDENCE AND LOCALATIONAL ACCURACY OF GEOLOGIC MAP FEATURES

In response to reviewers' comments, we have implemented a new standard (concepts and terminology) for the scientific confidence and the locational accuracy of geologic map features (note that, at this time, we have applied these new concepts only to line features). Scientific confidence expresses a geologist's level of certainty about the identity or perhaps even the existence of a feature. Locational accuracy is based on the relation between a feature's location in the field and its position on the base map. For a more detailed discussion of these concepts and their associated terminology, please refer to Section 4, "Scientific Confidence and Locational Accuracy of Geologic Features," in the accompanying introductory text.

FEATURE ATTRIBUTES FOR SCIENTIFIC CONFIDENCE AND LOCALATIONAL ACCURACY

The following is a list of the feature attributes (in italics) that are used to express these concepts:

Scientific Confidence:

- Identity — '*certain*' or '*questionable*'
- Existence — '*certain*' or '*questionable*'

Locational Accuracy:

- Locatability — '*observable*,' '*inferred*' (between outcrops or beneath rubble or vegetation), or '*concealed*' (beneath overlying map unit, ice, or water)
- Zone of Confidence — [*value, in ground units*]; [*unit of measurement*]
- Positioning Confidence — '*within zone of confidence*' or '*may not be within zone of confidence*'

LEVELS OF SCIENTIFIC CONFIDENCE AND LOCATIONAL ACCURACY

Discrete levels of scientific confidence and locational accuracy have been developed to use as a terminology that can clearly yet concisely communicate the identity, existence, locatability, and positioning of geologic map features. These levels are directly derived from, or are closely associated with, the feature attributes (for more information, see Figures 1 and 2 in the accompanying introductory text). The following diagram shows how the various levels of scientific confidence and locational accuracy relate to the feature attributes; it also shows examples (in italics) of geologic situations to which the levels may be applied.

SCIENTIFIC CONFIDENCE		
Feature Attributes for Scientific Confidence		Levels of Scientific Confidence
Identity: • certain • questionable	Existence: • certain • questionable	Identity and existence certain (<i>"I am certain that the planar feature I see in this outcrop is a fault"</i>) Identity or existence questionable (<i>"I can see some kind of planar feature in this outcrop, but I cannot be certain if it is a contact or a fault"</i>)
LOCATIONAL ACCURACY		
Feature Attributes for Locational Accuracy		Levels of Locational Accuracy
Locatability: • observable • inferred • concealed	Zone of Confidence: • [value, in ground units] • [unit of measurement] Positioning Confidence: • within zone of confidence • may not be within zone of confidence	Location accurate (<i>"I can clearly see this contact in outcrop, and I can accurately plot its position on the map"</i>) Location approximate (<i>"I can see this contact in outcrop, but I can't tell exactly where it is located because I am surrounded by trees"</i>) Location inferred (<i>"I can see by the change in debris materials visible around these gopher holes that a contact runs through here, but I can't locate it precisely"</i>) Location concealed (<i>"I can see that a contact is present on both sides of this lake, but I can't tell where it is located beneath the water"</i>)

The levels of scientific confidence and locational accuracy have been used to identify and describe the line symbols in this standard. The following example is extracted from Appendix A (see p. A-1-1).

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
Contact—Identity and existence certain, location accurate	—————	Contact—Identity and existence certain, location inferred	- - - - -
Contact—Identity or existence questionable, location accurate	———?———	Contact—Identity or existence questionable, location inferred	- - - - ? - - - -
Contact—Identity and existence certain, location approximate	- - - - -	Contact—Identity and existence certain, location concealed
Contact—Identity or existence questionable, location approximate	- - - ? - - -	Contact—Identity or existence questionable, location concealed?.....

In the symbol explanation on a published map, the levels of scientific confidence and locational accuracy also are used to identify and describe the various types and styles of line symbols that appear on the map; however, not every style of a particular line symbol needs to be listed individually in the explanation, as the following two examples show.

<p>————— Contact—Solid where location is accurate; long-dashed where location is approximate; short-dashed where location is inferred; dotted where location is concealed. Queries added where identity or existence may be questionable</p> <p>————— Fault—Solid where location is accurate; long-dashed where location is approximate; short-dashed where location is inferred; dotted where location is concealed. Queries added where identity or existence may be questionable</p> <p>▼▼ Thrust fault—Solid where location is accurate; long-dashed where location is approximate; short-dashed where location is inferred; dotted where location is concealed. Queries added where identity or existence may be questionable. Sawteeth on upper plate</p> <p>Folds—Solid where location is accurate; long-dashed where location is approximate; dotted where location is concealed. Queries added where identity or existence may be questionable. Showing direction of plunge where appropriate</p> <p> Anticline</p> <p> Syncline</p>	<p>SYMBOL EXPLANATION</p> <p>[For all line symbols: lines are solid where location is accurate; long-dashed where location is approximate; short-dashed where location is inferred; dotted where location is concealed. Queries added where identity or existence may be questionable]</p> <p>————— Contact</p> <p>————— Fault</p> <p>▼▼ Thrust fault—Sawteeth on upper plate</p> <p>Folds—Showing direction of plunge where appropriate</p> <p> Anticline</p> <p> Syncline</p>
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Table 1. Chart showing conversion values from inches (in) to points (pts) to millimeters (mm).

in	pts	mm	in	pts	mm	in	pts	mm	in	pts	mm
0.001	0.072	0.025	0.051	3.672	1.295	0.101	7.272	2.565	0.151	10.872	3.835
0.002	0.144	0.051	0.052	3.744	1.321	0.102	7.344	2.591	0.152	10.944	3.861
0.003	0.216	0.076	0.053	3.816	1.346	0.103	7.416	2.616	0.153	11.016	3.886
0.004	0.288	0.102	0.054	3.888	1.372	0.104	7.488	2.642	0.154	11.088	3.912
0.005	0.360	0.127	0.055	3.960	1.397	0.105	7.560	2.667	0.155	11.160	3.937
0.006	0.432	0.152	0.056	4.032	1.422	0.106	7.632	2.692	0.156	11.232	3.962
0.007	0.504	0.178	0.057	4.104	1.448	0.107	7.704	2.718	0.157	11.304	3.988
0.008	0.576	0.203	0.058	4.176	1.473	0.108	7.776	2.743	0.158	11.376	4.013
0.009	0.648	0.229	0.059	4.248	1.499	0.109	7.848	2.769	0.159	11.448	4.039
0.010	0.720	0.254	0.060	4.320	1.524	0.110	7.920	2.794	0.160	11.520	4.064
0.011	0.792	0.279	0.061	4.392	1.549	0.111	7.992	2.819	0.161	11.592	4.089
0.012	0.864	0.305	0.062	4.464	1.575	0.112	8.064	2.845	0.162	11.664	4.115
0.013	0.936	0.330	0.063	4.536	1.600	0.113	8.136	2.870	0.163	11.736	4.140
0.014	1.008	0.356	0.064	4.608	1.626	0.114	8.208	2.896	0.164	11.808	4.166
0.015	1.080	0.381	0.065	4.680	1.651	0.115	8.280	2.921	0.165	11.880	4.191
0.016	1.152	0.406	0.066	4.752	1.676	0.116	8.352	2.946	0.166	11.952	4.216
0.017	1.224	0.432	0.067	4.824	1.702	0.117	8.424	2.972	0.167	12.024	4.242
0.018	1.296	0.457	0.068	4.896	1.727	0.118	8.496	2.997	0.168	12.096	4.267
0.019	1.368	0.483	0.069	4.968	1.753	0.119	8.568	3.023	0.169	12.168	4.293
0.020	1.440	0.508	0.070	5.040	1.778	0.120	8.640	3.048	0.170	12.240	4.318
0.021	1.512	0.533	0.071	5.112	1.803	0.121	8.712	3.073	0.171	12.312	4.343
0.022	1.584	0.559	0.072	5.184	1.829	0.122	8.784	3.099	0.172	12.384	4.369
0.023	1.656	0.584	0.073	5.256	1.854	0.123	8.856	3.124	0.173	12.456	4.394
0.024	1.728	0.610	0.074	5.328	1.880	0.124	8.928	3.150	0.174	12.528	4.420
0.025	1.800	0.635	0.075	5.400	1.905	0.125	9.000	3.175	0.175	12.600	4.445
0.026	1.872	0.660	0.076	5.472	1.930	0.126	9.072	3.200	0.176	12.672	4.470
0.027	1.944	0.686	0.077	5.544	1.956	0.127	9.144	3.226	0.177	12.744	4.496
0.028	2.016	0.711	0.078	5.616	1.981	0.128	9.216	3.251	0.178	12.816	4.521
0.029	2.088	0.737	0.079	5.688	2.007	0.129	9.288	3.277	0.179	12.888	4.547
0.030	2.160	0.762	0.080	5.760	2.032	0.130	9.360	3.302	0.180	12.960	4.572
0.031	2.232	0.787	0.081	5.832	2.057	0.131	9.432	3.327	0.181	13.032	4.597
0.032	2.304	0.813	0.082	5.904	2.083	0.132	9.504	3.353	0.182	13.104	4.623
0.033	2.376	0.838	0.083	5.976	2.108	0.133	9.576	3.378	0.183	13.176	4.648
0.034	2.448	0.864	0.084	6.048	2.134	0.134	9.648	3.404	0.184	13.248	4.674
0.035	2.520	0.889	0.085	6.120	2.159	0.135	9.720	3.429	0.185	13.320	4.699
0.036	2.592	0.914	0.086	6.192	2.184	0.136	9.792	3.454	0.186	13.392	4.724
0.037	2.664	0.940	0.087	6.264	2.210	0.137	9.864	3.480	0.187	13.464	4.750
0.038	2.736	0.965	0.088	6.336	2.235	0.138	9.936	3.505	0.188	13.536	4.775
0.039	2.808	0.991	0.089	6.408	2.261	0.139	10.008	3.531	0.189	13.608	4.801
0.040	2.880	1.016	0.090	6.480	2.286	0.140	10.080	3.556	0.190	13.680	4.826
0.041	2.952	1.041	0.091	6.552	2.311	0.141	10.152	3.581	0.191	13.752	4.851
0.042	3.024	1.067	0.092	6.624	2.337	0.142	10.224	3.607	0.192	13.824	4.877
0.043	3.096	1.092	0.093	6.696	2.362	0.143	10.296	3.632	0.193	13.896	4.902
0.044	3.168	1.118	0.094	6.768	2.388	0.144	10.368	3.658	0.194	13.968	4.928
0.045	3.240	1.143	0.095	6.840	2.413	0.145	10.440	3.683	0.195	14.040	4.953
0.046	3.312	1.168	0.096	6.912	2.438	0.146	10.512	3.708	0.196	14.112	4.978
0.047	3.384	1.194	0.097	6.984	2.464	0.147	10.584	3.734	0.197	14.184	5.004
0.048	3.456	1.219	0.098	7.056	2.489	0.148	10.656	3.759	0.198	14.256	5.029
0.049	3.528	1.245	0.099	7.128	2.515	0.149	10.728	3.785	0.199	14.328	5.055
0.050	3.600	1.270	0.100	7.200	2.540	0.150	10.800	3.810	0.200	14.400	5.080

Table 2. Abbreviations used in this standard.

Abbreviation	Meaning	Example of usage
B	brown [ink]	422-B (pattern)
C	cyan [ink]	132-C (pattern)
CMYK	cyan/magenta/yellow/black	CMYK color model
DO	dropout [pattern]	204-DO (pattern)
FG-8	FGDC-GeoAge [font], 8 pt type	Ƨg (unit label containing geologic age character)
H-8 ¹	Helvetica [font], 8 pt type	GOLDEN FAULT (name of fault)
HB-8 ¹	Helvetica Bold [font], 8 pt type	? (query indicating "identity or existence questionable" fault)
HI-6 ¹	Helvetica Italic [font], 6 pt type	40 (dip value)
HSV	hue/saturation/value	HSV color model
K	black [ink]	134-K (pattern)
M	magenta [ink]	313-M (pattern)
R	red [ink]	405-R (pattern)
RGB	red/green/blue	RGB color model
TBI-12 ²	Times Bold Italic [font], 12 pt type	A—A' (cross section labels)
TI-8 ²	Times Italic [font], 8 pt type	Bass Lake (name of lake)
Y	yellow [ink]	CMYK color model

¹ Although Helvetica has been specified, any sans-serif font (such as Univers or Arial) may be used. Note, however, that if other fonts are used, their appearance will not match that of FGDC-GeoAge, whose character size and spacing is based on Helvetica.

² Although Times has been specified, any serif font (such as Times New Roman or Souvenir) may be used.

Table 3. Spot color specifications used in this standard, and their equivalent colors in other color models.

[Abbreviations: C, cyan; M, magenta; Y, yellow; K, black (standard process-color inks combined during offset printing). CMYK, cyan/magenta/yellow/black color model. R, red; G, green; B, blue (primary colors transmitted by computer monitors and televisions). RGB, red/green/blue color model.]

Spot color ¹	Pantone color ²	Directly converted CMYK color ³	Color on CMYK Color Chart ⁴	Directly converted RGB color ⁵	"Web-safe" RGB color ⁶
red	485 U	0/100/91/0	0/100/100	254/0/12	255/0/0
50% red	485 U (screened 50%)	0/50/45.5/0	0/50/40	251/128/104	255/102/102
green	354 U	91/0/83/0	100/0/100	24/150/76	51/153/102
50% green	354 U (screened 50%)	45.5/0/41.5/0	40/0/40	139/207/144	153/204/153
violet	253 U	47/91/0/0	50/100/0	136/22/135	153/0/153
purple	2735 U	100/94/0/0	100/100/0	18/12/128	0/0/153
brown	470 U	0/56/94/34	30/70/100	168/74/9	153/51/0
orange	1585 U	0/56/87/0	0/60/100	254/112/24	255/102/0

¹ Generic name of spot color, as specified in this standard (note that cyan, magenta, yellow, and black are process-color inks, not spot colors, and so they have not been included in this table).

² Suggested Pantone color for offset printing on uncoated paper.

³ Color value after direct conversion of suggested Pantone color to CMYK (C/M/Y/K) by Adobe Illustrator 8.0.1.

⁴ Closest color on CMYK Color Chart (in pocket) to directly converted CMYK color value.

⁵ Color value after direct conversion of suggested Pantone color to RGB (R/G/B) by Adobe Illustrator 8.0.1.

⁶ Closest "web-safe" color (see discussion in Section 7.3, entitled "Color Specifications for Line and Point Symbols," in the introductory text) to directly converted RGB color value.

1—CONTACTS, KEY BEDS, AND DIKES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
1.1—Contacts				
1.1.1	Contact—Identity and existence certain, location accurate	—————	<i>lineweight .15 mm</i> 	
1.1.2	Contact—Identity or existence questionable, location accurate	—————?		
1.1.3	Contact—Identity and existence certain, location approximate	-----		
1.1.4	Contact—Identity or existence questionable, location approximate	-----?		
1.1.5	Contact—Identity and existence certain, location inferred	-----		
1.1.6	Contact—Identity or existence questionable, location inferred	-----?		
1.1.7	Contact—Identity and existence certain, location concealed	-----		
1.1.8	Contact—Identity or existence questionable, location concealed	-----?		
1.1.9	Internal contact—Identity and existence certain, location accurate	—————	<i>lineweight .15 mm</i> 	Use to delineate individual debris flows, landslide blocks, alluvial fans, etc., within the same geologic map unit.
1.1.10	Internal contact—Identity or existence questionable, location accurate	—————?		
1.1.11	Internal contact—Identity and existence certain, location approximate	-----		
1.1.12	Internal contact—Identity or existence questionable, location approximate	-----?		
1.1.13	Internal contact—Identity and existence certain, location inferred	-----		
1.1.14	Internal contact—Identity or existence questionable, location inferred	-----?		
1.1.15	Internal contact—Identity and existence certain, location concealed	-----		
1.1.16	Internal contact—Identity or existence questionable, location concealed	-----?		
1.1.17	Gradational contact—Identity and existence certain, location accurate		<i>hachure lineweight .15 mm</i> 	Use to indicate a gradual or continuous lithologic change from one geologic map unit to another.
1.1.18	Gradational contact—Identity or existence questionable, location accurate	?		
1.1.19	Gradational contact—Identity and existence certain, location approximate			
1.1.20	Gradational contact—Identity or existence questionable, location approximate	?		
1.1.21	Gradational contact—Identity and existence certain, location inferred			
1.1.22	Gradational contact—Identity or existence questionable, location inferred	?		
1.1.23	Gradational contact—Identity and existence certain, location concealed			
1.1.24	Gradational contact—Identity or existence questionable, location concealed	?		

1—CONTACTS, KEY BEDS, AND DIKES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
1.1—Contacts (continued)				
1.1.25	Unconformable contact—Identity and existence certain, location accurate			May be used to show paraconformities or disconformities. Not intended for use to show angular unconformities or nonconformities. Boundary of geologic map unit is center line (solid or dashed), not "sine-wave"-style line.
1.1.26	Unconformable contact—Identity or existence questionable, location accurate			
1.1.27	Unconformable contact—Identity and existence certain, location approximate			
1.1.28	Unconformable contact—Identity or existence questionable, location approximate			
1.1.29	Unconformable contact—Identity and existence certain, location inferred			
1.1.30	Unconformable contact—Identity or existence questionable, location inferred			
1.1.31	Unconformable contact—Identity and existence certain, location concealed			
1.1.32	Unconformable contact—Identity or existence questionable, location concealed			
1.1.33	Incised-scarp sedimentary contact—Identity and existence certain, location accurate. Hachures point downscarp			Use to show where a younger surficial geologic unit has been deposited on an erosional scarp that has been incised into an older surficial geologic unit.
1.1.34	Incised-scarp sedimentary contact—Identity or existence questionable, location accurate. Hachures point downscarp			
1.1.35	Incised-scarp sedimentary contact—Identity and existence certain, location approximate. Hachures point downscarp			
1.1.36	Incised-scarp sedimentary contact—Identity or existence questionable, location approximate. Hachures point downscarp			

*For more information, see general guidelines on pages A-i to A-v.

1—CONTACTS, KEY BEDS, AND DIKES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
1.2—Key beds				
1.2.1	Key bed—Identity and existence certain, location accurate		<i>lineweight .2 mm</i> 	Use to show key beds that are too narrow to map as an area at map scale. Add name of geologic map unit if more than one type of key bed is shown on map (see Section 1.4). May also be shown in color.
1.2.2	Key bed—Identity or existence questionable, location accurate			
1.2.3	Key bed—Identity and existence certain, location approximate			
1.2.4	Key bed—Identity or existence questionable, location approximate			
1.2.5	Key bed—Identity and existence certain, location inferred			
1.2.6	Key bed—Identity or existence questionable, location inferred			
1.2.7	Key bed—Identity and existence certain, location concealed			
1.2.8	Key bed—Identity or existence questionable, location concealed			
1.2.9	Clay bed—Identity and existence certain, location accurate		<i>lineweight .3 mm</i> <i>color 100% green</i> 	Use to show clay beds that are too narrow to map as an area at map scale. Add name if more than one type is shown on map (see Section 1.4). May also be shown in black or other colors.
1.2.10	Clay bed—Identity or existence questionable, location accurate			
1.2.11	Clay bed—Identity and existence certain, location approximate			
1.2.12	Clay bed—Identity or existence questionable, location approximate			
1.2.13	Clay bed—Identity and existence certain, location inferred			
1.2.14	Clay bed—Identity or existence questionable, location inferred			
1.2.15	Clay bed—Identity and existence certain, location concealed			
1.2.16	Clay bed—Identity or existence questionable, location concealed			
1.2.17	Bed of economically important commodity—Identity and existence certain, location accurate		<i>lineweight .3 mm</i> 	Use to show such economically important beds as gypsum, salt, bentonite, phosphate, or limestone that are too narrow to map as an area at map scale. Do not use to show coal beds (see Section 1.2, ref. nos. 1.2.25-40). Add name of commodity if more than one type is shown on map (see Section 1.4). May also be shown in color.
1.2.18	Bed of economically important commodity—Identity or existence questionable, location accurate			
1.2.19	Bed of economically important commodity—Identity and existence certain, location approximate			
1.2.20	Bed of economically important commodity—Identity or existence questionable, location approximate			
1.2.21	Bed of economically important commodity—Identity and existence certain, location inferred			
1.2.22	Bed of economically important commodity—Identity or existence questionable, location inferred			
1.2.23	Bed of economically important commodity—Identity and existence certain, location concealed			
1.2.24	Bed of economically important commodity—Identity or existence questionable, location concealed			

1—CONTACTS, KEY BEDS, AND DIKES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
1.2—Key beds (continued)				
1.2.25	Coal bed—Identity and existence certain, location accurate		lineweight .3 mm color 100% red HB-8 (100% red)	Use to show coal beds that are too narrow to map as an area at map scale. Add name if more than one type is shown on map (see Section 1.4). May also be shown in black or other colors.
1.2.26	Coal bed—Identity or existence questionable, location accurate			
1.2.27	Coal bed—Identity and existence certain, location approximate		3.5 mm 	
1.2.28	Coal bed—Identity or existence questionable, location approximate			
1.2.29	Coal bed—Identity and existence certain, location inferred		1.5 mm 	
1.2.30	Coal bed—Identity or existence questionable, location inferred			
1.2.31	Coal bed—Identity and existence certain, location concealed		.5 mm 	
1.2.32	Coal bed—Identity or existence questionable, location concealed			
1.2.33	Clinkered coal bed—Identity and existence certain, location accurate			Use to show clinkered coal beds that are too narrow to map as an area at map scale. Tops of V's follow trace of bed; V's point downward stratigraphically. Add name if more than one type is shown on map (see Section 1.4). May also be shown in black or other colors.
1.2.34	Clinkered coal bed—Identity or existence questionable, location accurate		lineweight .2 mm color 100% red	
1.2.35	Clinkered coal bed—Identity and existence certain, location approximate		.375 mm 	
1.2.36	Clinkered coal bed—Identity or existence questionable, location approximate			
1.2.37	Clinkered coal bed—Identity and existence certain, location inferred			
1.2.38	Clinkered coal bed—Identity or existence questionable, location inferred			
1.2.39	Clinkered coal bed—Identity and existence certain, location concealed			
1.2.40	Clinkered coal bed—Identity or existence questionable, location concealed			
1.2.41	Area of clinkered coal bed		contact [lineweight .15 mm] pattern 317-R	Add name if more than one type is shown on map (see Section 1.4).
1.2.42	Outcrop area of key bed or bed of economically important commodity (1st option)		scratch boundary [lineweight 0.0] 100% black	Outcrop areas may either overprint other geologic map units or be used as stand-alone geologic map units. Each type of outcrop area may also be shown in other values of black or in other colors; add name(s) if more than one type is shown on map (see Section 1.4).
1.2.43	Outcrop area of key bed or bed of economically important commodity (2nd option)		scratch boundary [lineweight 0.0] 30% black	
1.2.44	Outcrop area of clay bed		scratch boundary [lineweight 0.0] 100% green	
1.2.45	Outcrop area of coal bed		scratch boundary [lineweight 0.0] 100% red	

*For more information, see general guidelines on pages A-i to A-v.

1—CONTACTS, KEY BEDS, AND DIKES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
1.3—Dikes				
1.3.1	Dike (1st option)—Identity and existence certain, location accurate		color 100% red lineweight .25 mm	Use when dike is too narrow to show as an area at map scale. Add map-unit labels to dikes if needed (see Section 1.4); use a queried label if identity of dike is questionable. May also be shown in black or other colors.
1.3.2	Dike (1st option)—Identity and existence certain, location approximate		3.5 mm lineweight .75 mm	
1.3.3	Dike (2nd option)—Identity and existence certain, location accurate		color 100% red lineweight .25 mm 2.0 mm 1.25 mm	
1.3.4	Dike (2nd option)—Identity and existence certain, location approximate		3.5 mm lineweight .75 mm	
1.3.5	Dike (3rd option)—Identity and existence certain, location accurate		color 100% red lineweight .25 mm 90° 4.25 mm 1.0 mm	
1.3.6	Dike (3rd option)—Identity and existence certain, location approximate		3.5 mm lineweight .75 mm	
1.3.7	Dike (4th option)—Identity and existence certain, location accurate		color 100% red lineweight .25 mm dot diameter 1.125 mm 4.25 mm	
1.3.8	Dike (4th option)—Identity and existence certain, location approximate		3.5 mm lineweight .75 mm	
1.3.9	Dike (5th option)—Identity and existence certain, location accurate		color 100% red lineweight .25 mm circle diameter 1.175 mm 4.25 mm	
1.3.10	Dike (5th option)—Identity and existence certain, location approximate		3.5 mm lineweight .75 mm	
1.3.11	Dike (6th option)—Identity and existence certain, location accurate		color 100% red lineweight .25 mm 1.125 mm 4.25 mm	
1.3.12	Dike (6th option)—Identity and existence certain, location approximate		3.5 mm lineweight .75 mm	
1.3.13	Dike of variable thickness		50% red contact [lineweight .15 mm]	
1.3.14	Dike intruding fault (1st option)		fault [lineweight .375 mm]	
1.3.15	Dike intruding fault (2nd option)		contact [lineweight .15 mm]	

*For more information, see general guidelines on pages A-i to A-v.

1—CONTACTS, KEY BEDS, AND DIKES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
1.4—Line-symbol decorations and notations for contacts, key beds, and dikes				
1.4.1	Inclined contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity (1st option)—Showing dip value and direction		tick length 1.75 mm; line weight .15 mm 35 ← H-6	Line-symbol decorations may be added to any type or style of contact, as well as to any type or style of key bed or dike (use proper line-weights, etc., to show clay beds, coal beds, dikes, etc.). Place tick, arrow, or other line-symbol decoration where observation was made. Add arrowhead or '90' to ticks showing dip if necessary for clarity.
1.4.2	Inclined contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity (2nd option)—Showing dip value and direction		tick length 1.375 mm; line weight .15 mm 15 ← H-6 30°	
1.4.3	Vertical or near-vertical contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity (1st option)		tick length 2.5 mm; line weight .15 mm	
1.4.4	Vertical or near-vertical contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity (2nd option)		90 ← H-6	
1.4.5	Overtaken contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity (1st option)—Showing dip value and direction		tick length 1.75 mm; line weight .15 mm 85 ← H-6 .625 mm radius	
1.4.6	Overtaken contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity (2nd option)—Showing dip value and direction		tick length 1.375 mm; line weight .15 mm 75 ← H-6 .625 mm radius 30°	
1.4.7	Lineation on surface of contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity—Showing bearing and plunge		6.0 mm 65 ← H-6 line weight .175 mm 25° 1.5 mm	
1.4.8	Lineation on surface of inclined contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity—Tick shows contact dip value and direction; arrow shows bearing and plunge of lineation		tick length 1.75 mm; line weight .15 mm H-6 → 25 35	
1.4.9	Contact—Showing relative age of intrusive or extrusive units where known: Y, younger; O, older		H-7 → Y H-7 → O	
1.4.10	Contact—Showing location where contact is particularly well exposed in field		1/20° 1.75 mm .75 mm	
1.4.11	Key bed, clay bed, coal bed, bed of economically important commodity, or dike—Showing thickness and location where measured		1.5 ← H-6	Use proper line-weights, etc., to show clay beds, coal beds, dikes, etc.
1.4.12	Key bed—Showing name		ds ← H-8	
1.4.13	Clay bed—Showing name		sc ← H-8 (100% black)	
1.4.14	Bed of economically important commodity—Showing name		gyp ← H-8	
1.4.15	Coal bed—Showing name		lg ← H-8 (100% black)	
1.4.16	Clinkered coal bed—Showing name		m ← H-8 (100% black)	
1.4.17	Area of clinkered coal bed—Showing name		bg ← H-8 (100% black)	
1.4.18	Dike—Showing name		Km ← H-8 leader line weight .175 mm	Although only "dike (2nd option)" is shown labeled here, map-unit labels may be added to any type of dike symbol. Use a queried map-unit label if identity of dike is questionable.
1.4.19	Dike of variable thickness—Showing name		KJd ← H-8 leader line weight .175 mm	
1.4.20	Dike intruding fault (1st option)—Showing name		Km ← H-8 leader line weight .175 mm	
1.4.21	Dike intruding fault (2nd option)—Showing name		H-8 → Td leader line weight .175 mm	

*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.1—Faults (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)				
2.1.1	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence certain, location accurate	—————	lineweight .375 mm 	Use generic, nonspecific (non-ornamented) fault symbols when orientation or sense of slip is not known or not specified; use also on small-scale maps to show regional fault patterns. If orientation or sense of slip is known and if scale allows, use more specific types of ornamented fault symbols to indicate fault geometry and (or) relative motion.
2.1.2	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence questionable, location accurate	—————?		
2.1.3	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence certain, location approximate	-----	3.5 mm 	
2.1.4	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence questionable, location approximate	-----?		
2.1.5	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence certain, location inferred	- - - - -	1.5 mm 	
2.1.6	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence questionable, location inferred	- - - - -?		
2.1.7	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence certain, location concealed5 mm 	
2.1.8	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence questionable, location concealed?		

*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*	
2.2—Normal faults					
2.2.1	Normal fault—Identity and existence certain, location accurate. Ball and bar on downthrown block		tick length 1.0 mm; lineweight .175 mm 	Ball and bar symbols are placed along a fault to indicate its overall fault type (normal fault). Ball and bar symbols may also be placed along other types of faults at specific localities where observations of normal (or apparent normal) offset have been made (see Section 2.11).	
2.2.2	Normal fault—Identity or existence questionable, location accurate. Ball and bar on downthrown block				
2.2.3	Normal fault—Identity and existence certain, location approximate. Ball and bar on downthrown block			Ball and bar symbols may be combined with paired arrows to show oblique offset (see Sections 2.7, 2.11). In cross section, use paired arrows to show relative motion of normal faults (see Section 2.11).	
2.2.4	Normal fault—Identity or existence questionable, location approximate. Ball and bar on downthrown block				
2.2.5	Normal fault—Identity and existence certain, location inferred. Ball and bar on downthrown block				
2.2.6	Normal fault—Identity or existence questionable, location inferred. Ball and bar on downthrown block				
2.2.7	Normal fault—Identity and existence certain, location concealed. Ball and bar on downthrown block				
2.2.8	Normal fault—Identity or existence questionable, location concealed. Ball and bar on downthrown block				
2.2.9	Low-angle normal fault—Identity and existence certain, location accurate. Half-circles on downthrown block		lineweight .375 mm 		Half-circles indicate overall fault type (low-angle normal fault); they are not placed at specific localities where observations have been made.
2.2.10	Low-angle normal fault—Identity or existence questionable, location accurate. Half-circles on downthrown block				
2.2.11	Low-angle normal fault—Identity and existence certain, location approximate. Half-circles on downthrown block			In cross section, use paired arrows to show relative motion of low-angle normal faults (see Section 2.11).	
2.2.12	Low-angle normal fault—Identity or existence questionable, location approximate. Half-circles on downthrown block				
2.2.13	Low-angle normal fault—Identity and existence certain, location inferred. Half-circles on downthrown block				
2.2.14	Low-angle normal fault—Identity or existence questionable, location inferred. Half-circles on downthrown block				
2.2.15	Low-angle normal fault—Identity and existence certain, location concealed. Half-circles on downthrown block				
2.2.16	Low-angle normal fault—Identity or existence questionable, location concealed. Half-circles on downthrown block				

*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.3—Low-angle faults (unknown or unspecified sense of slip)				
2.3.1	Low-angle fault (unknown or unspecified sense of slip)—Identity and existence certain, location accurate. Half-circles on upper plate			Use to show faults that exhibit low-angle geometry but for which relative motion cannot be (or has not been) specified. Half-circles indicate overall fault type (low-angle fault, unknown or unspecified sense of slip); they are not placed at specific localities where observations have been made.
2.3.2	Low-angle fault (unknown or unspecified sense of slip)—Identity or existence questionable, location accurate. Half-circles on upper plate			
2.3.3	Low-angle fault (unknown or unspecified sense of slip)—Identity and existence certain, location approximate. Half-circles on upper plate			
2.3.4	Low-angle fault (unknown or unspecified sense of slip)—Identity or existence questionable, location approximate. Half-circles on upper plate			
2.3.5	Low-angle fault (unknown or unspecified sense of slip)—Identity and existence certain, location inferred. Half-circles on upper plate			
2.3.6	Low-angle fault (unknown or unspecified sense of slip)—Identity or existence questionable, location inferred. Half-circles on upper plate			
2.3.7	Low-angle fault (unknown or unspecified sense of slip)—Identity and existence certain, location concealed. Half-circles on upper plate			
2.3.8	Low-angle fault (unknown or unspecified sense of slip)—Identity or existence questionable, location concealed. Half-circles on upper plate			
2.4—Reverse faults				
2.4.1	Reverse fault—Identity and existence certain, location accurate. Rectangles on upthrown block			Rectangles indicate overall fault type (reverse fault); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of reverse faults (see Section 2.11).
2.4.2	Reverse fault—Identity or existence questionable, location accurate. Rectangles on upthrown block			
2.4.3	Reverse fault—Identity and existence certain, location approximate. Rectangles on upthrown block			
2.4.4	Reverse fault—Identity or existence questionable, location approximate. Rectangles on upthrown block			
2.4.5	Reverse fault—Identity and existence certain, location inferred. Rectangles on upthrown block			
2.4.6	Reverse fault—Identity or existence questionable, location inferred. Rectangles on upthrown block			
2.4.7	Reverse fault—Identity and existence certain, location concealed. Rectangles on upthrown block			
2.4.8	Reverse fault—Identity or existence questionable, location concealed. Rectangles on upthrown block			

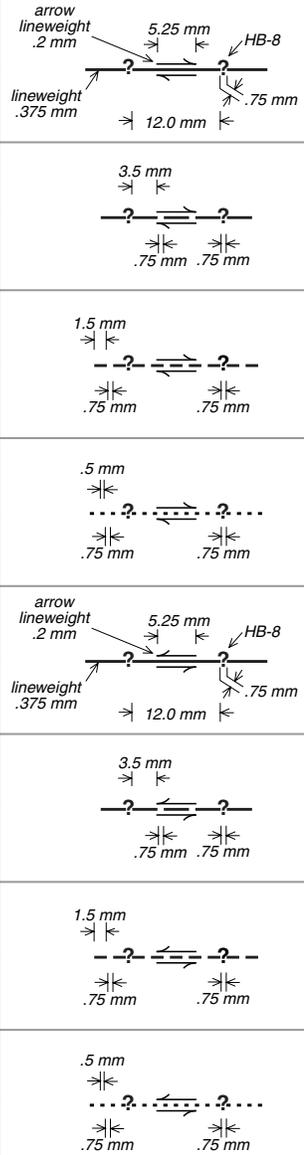
*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*	
2.5—Rotational or scissor faults					
2.5.1	Rotational or scissor fault, reverse-slip offset— Identity and existence certain, location accurate. Rectangles on upthrown block		<i>lineweight .375 mm</i> 	Rectangles indicate overall fault type (rotational or scissor fault, reverse-slip offset); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of rotational or scissor faults (see Section 2.11).	
2.5.2	Rotational or scissor fault, reverse-slip offset— Identity or existence questionable, location accurate. Rectangles on upthrown block				
2.5.3	Rotational or scissor fault, reverse-slip offset— Identity and existence certain, location approximate. Rectangles on upthrown block		3.5 mm 		
2.5.4	Rotational or scissor fault, reverse-slip offset— Identity or existence questionable, location approximate. Rectangles on upthrown block				
2.5.5	Rotational or scissor fault, reverse-slip offset— Identity and existence certain, location inferred. Rectangles on upthrown block		1.5 mm 2.5 mm 		
2.5.6	Rotational or scissor fault, reverse-slip offset— Identity or existence questionable, location inferred. Rectangles on upthrown block				
2.5.7	Rotational or scissor fault, reverse-slip offset— Identity and existence certain, location concealed. Rectangles on upthrown block		.5 mm 2.5 mm 		
2.5.8	Rotational or scissor fault, reverse-slip offset— Identity or existence questionable, location concealed. Rectangles on upthrown block				
2.5.9	Rotational or scissor fault, normal-slip offset— Identity and existence certain, location accurate. Rectangles on downthrown block		<i>lineweight .375 mm</i> 		Rectangles indicate overall fault type (rotational or scissor fault, normal-slip offset); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of rotational or scissor faults (see Section 2.11).
2.5.10	Rotational or scissor fault, normal-slip offset— Identity or existence questionable, location accurate. Rectangles on downthrown block				
2.5.11	Rotational or scissor fault, normal-slip offset— Identity and existence certain, location approximate. Rectangles on downthrown block		3.5 mm 		
2.5.12	Rotational or scissor fault, normal-slip offset— Identity or existence questionable, location approximate. Rectangles on downthrown block				
2.5.13	Rotational or scissor fault, normal-slip offset— Identity and existence certain, location inferred. Rectangles on downthrown block		1.5 mm 2.5 mm 		
2.5.14	Rotational or scissor fault, normal-slip offset— Identity or existence questionable, location inferred. Rectangles on downthrown block				
2.5.15	Rotational or scissor fault, normal-slip offset— Identity and existence certain, location concealed. Rectangles on downthrown block		.5 mm 2.5 mm 		
2.5.16	Rotational or scissor fault, normal-slip offset— Identity or existence questionable, location concealed. Rectangles on downthrown block				

*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.6—Strike-slip faults				
2.6.1	Strike-slip fault, right-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion			<p>Paired arrows are placed along a fault to indicate its overall type (strike-slip fault) and its relative motion.</p> <p>Paired arrows may also be placed along other types of faults at specific localities where observations of strike-slip (or apparent strike-slip) offset have been made (see Section 2.11).</p> <p>Paired arrows may be combined with ball and bar symbols to show oblique offset (see Sections 2.7, 2.11).</p> <p>In cross section, use either A/T or +/- notation to show relative motion of strike-slip faults (see Section 2.11).</p>
2.6.2	Strike-slip fault, right-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion			
2.6.3	Strike-slip fault, right-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion			
2.6.4	Strike-slip fault, right-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion			
2.6.5	Strike-slip fault, right-lateral offset—Identity and existence certain, location inferred. Arrows show relative motion			
2.6.6	Strike-slip fault, right-lateral offset—Identity or existence questionable, location inferred. Arrows show relative motion			
2.6.7	Strike-slip fault, right-lateral offset—Identity and existence certain, location concealed. Arrows show relative motion			
2.6.8	Strike-slip fault, right-lateral offset—Identity or existence questionable, location concealed. Arrows show relative motion			
2.6.9	Strike-slip fault, left-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion			
2.6.10	Strike-slip fault, left-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion			
2.6.11	Strike-slip fault, left-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion			
2.6.12	Strike-slip fault, left-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion			
2.6.13	Strike-slip fault, left-lateral offset—Identity and existence certain, location inferred. Arrows show relative motion			
2.6.14	Strike-slip fault, left-lateral offset—Identity or existence questionable, location inferred. Arrows show relative motion			
2.6.15	Strike-slip fault, left-lateral offset—Identity and existence certain, location concealed. Arrows show relative motion			
2.6.16	Strike-slip fault, left-lateral offset—Identity or existence questionable, location concealed. Arrows show relative motion			

*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.7—Oblique-slip faults				
2.7.1	Oblique-slip fault, right-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion; ball and bar on downthrown block			Sets of paired arrows and ball and bar symbols are placed along a fault to indicate its overall type (oblique-slip fault) and its relative motion. Sets of paired arrows and ball and bar symbols may also be placed along other types of faults at specific localities where observations of oblique-slip (or apparent oblique-slip) offset have been made (see Section 2.11). In cross section, use paired arrows with either A/T or +/- notation to show relative motion of oblique-slip faults (see Section 2.11).
2.7.2	Oblique-slip fault, right-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion; ball and bar on downthrown block			
2.7.3	Oblique-slip fault, right-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion; ball and bar on downthrown block			
2.7.4	Oblique-slip fault, right-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion; ball and bar on downthrown block			
2.7.5	Oblique-slip fault, right-lateral offset—Identity and existence certain, location inferred. Arrows show relative motion; ball and bar on downthrown block			
2.7.6	Oblique-slip fault, right-lateral offset—Identity or existence questionable, location inferred. Arrows show relative motion; ball and bar on downthrown block			
2.7.7	Oblique-slip fault, right-lateral offset—Identity and existence certain, location concealed. Arrows show relative motion; ball and bar on downthrown block			
2.7.8	Oblique-slip fault, right-lateral offset—Identity or existence questionable, location concealed. Arrows show relative motion; ball and bar on downthrown block			
2.7.9	Oblique-slip fault, left-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion; ball and bar on downthrown block			
2.7.10	Oblique-slip fault, left-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion; ball and bar on downthrown block			
2.7.11	Oblique-slip fault, left-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion; ball and bar on downthrown block			
2.7.12	Oblique-slip fault, left-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion; ball and bar on downthrown block			
2.7.13	Oblique-slip fault, left-lateral offset—Identity and existence certain, location inferred. Arrows show relative motion; ball and bar on downthrown block			
2.7.14	Oblique-slip fault, left-lateral offset—Identity or existence questionable, location inferred. Arrows show relative motion; ball and bar on downthrown block			
2.7.15	Oblique-slip fault, left-lateral offset—Identity and existence certain, location concealed. Arrows show relative motion; ball and bar on downthrown block			
2.7.16	Oblique-slip fault, left-lateral offset—Identity or existence questionable, location concealed. Arrows show relative motion; ball and bar on downthrown block			

*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.8—Thrust faults				
2.8.1	Thrust fault (1st option)—Identity and existence certain, location accurate. Sawteeth on upper (tectonically higher) plate			<p>Sawteeth indicate overall fault type (thrust fault); they are not placed at specific localities where observations have been made.</p> <p>In cross section, use paired arrows to show relative motion of thrust faults (see Section 2.11).</p> <p>If desired, "2nd option" and "3rd option" symbols may be used to show other types or generations of thrust faults.</p>
2.8.2	Thrust fault (1st option)—Identity or existence questionable, location accurate. Sawteeth on upper (tectonically higher) plate			
2.8.3	Thrust fault (1st option)—Identity and existence certain, location approximate. Sawteeth on upper (tectonically higher) plate			
2.8.4	Thrust fault (1st option)—Identity or existence questionable, location approximate. Sawteeth on upper (tectonically higher) plate			
2.8.5	Thrust fault (1st option)—Identity and existence certain, location inferred. Sawteeth on upper (tectonically higher) plate			
2.8.6	Thrust fault (1st option)—Identity or existence questionable, location inferred. Sawteeth on upper (tectonically higher) plate			
2.8.7	Thrust fault (1st option)—Identity and existence certain, location concealed. Sawteeth on upper (tectonically higher) plate			
2.8.8	Thrust fault (1st option)—Identity or existence questionable, location concealed. Sawteeth on upper (tectonically higher) plate			
2.8.9	Thrust fault (2nd option)—Identity and existence certain, location accurate. Sawteeth on upper (tectonically higher) plate			
2.8.10	Thrust fault (2nd option)—Identity or existence questionable, location accurate. Sawteeth on upper (tectonically higher) plate			
2.8.11	Thrust fault (2nd option)—Identity and existence certain, location approximate. Sawteeth on upper (tectonically higher) plate			
2.8.12	Thrust fault (2nd option)—Identity or existence questionable, location approximate. Sawteeth on upper (tectonically higher) plate			
2.8.13	Thrust fault (2nd option)—Identity and existence certain, location inferred. Sawteeth on upper (tectonically higher) plate			
2.8.14	Thrust fault (2nd option)—Identity or existence questionable, location inferred. Sawteeth on upper (tectonically higher) plate			
2.8.15	Thrust fault (2nd option)—Identity and existence certain, location concealed. Sawteeth on upper (tectonically higher) plate			
2.8.16	Thrust fault (2nd option)—Identity or existence questionable, location concealed. Sawteeth on upper (tectonically higher) plate			
2.8.17	Thrust fault (3rd option)—Identity and existence certain, location accurate. Sawteeth on upper (tectonically higher) plate			
2.8.18	Thrust fault (3rd option)—Identity or existence questionable, location accurate. Sawteeth on upper (tectonically higher) plate			
2.8.19	Thrust fault (3rd option)—Identity and existence certain, location approximate. Sawteeth on upper (tectonically higher) plate			
2.8.20	Thrust fault (3rd option)—Identity or existence questionable, location approximate. Sawteeth on upper (tectonically higher) plate			
2.8.21	Thrust fault (3rd option)—Identity and existence certain, location inferred. Sawteeth on upper (tectonically higher) plate			
2.8.22	Thrust fault (3rd option)—Identity or existence questionable, location inferred. Sawteeth on upper (tectonically higher) plate			
2.8.23	Thrust fault (3rd option)—Identity and existence certain, location concealed. Sawteeth on upper (tectonically higher) plate			
2.8.24	Thrust fault (3rd option)—Identity or existence questionable, location concealed. Sawteeth on upper (tectonically higher) plate			

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.9—Overturned thrust faults				
2.9.1	Overturned thrust fault (1st option)—Identity and existence certain, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			Bars and sawteeth indicate overall fault type (overturned thrust fault); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of overturned thrust faults (see Section 2.11). If desired, "2nd option" and "3rd option" symbols may be used to show other types or generations of overturned thrust faults.
2.9.2	Overturned thrust fault (1st option)—Identity or existence questionable, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.3	Overturned thrust fault (1st option)—Identity and existence certain, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.4	Overturned thrust fault (1st option)—Identity or existence questionable, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.5	Overturned thrust fault (1st option)—Identity and existence certain, location inferred. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.6	Overturned thrust fault (1st option)—Identity or existence questionable, location inferred. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.7	Overturned thrust fault (1st option)—Identity and existence certain, location concealed. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.8	Overturned thrust fault (1st option)—Identity or existence questionable, location concealed. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.9	Overturned thrust fault (2nd option)—Identity and existence certain, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.10	Overturned thrust fault (2nd option)—Identity or existence questionable, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.11	Overturned thrust fault (2nd option)—Identity and existence certain, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.12	Overturned thrust fault (2nd option)—Identity or existence questionable, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.13	Overturned thrust fault (2nd option)—Identity and existence certain, location inferred. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.14	Overturned thrust fault (2nd option)—Identity or existence questionable, location inferred. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.15	Overturned thrust fault (2nd option)—Identity and existence certain, location concealed. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.16	Overturned thrust fault (2nd option)—Identity or existence questionable, location concealed. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.17	Overturned thrust fault (3rd option)—Identity and existence certain, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.18	Overturned thrust fault (3rd option)—Identity or existence questionable, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.19	Overturned thrust fault (3rd option)—Identity and existence certain, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.20	Overturned thrust fault (3rd option)—Identity or existence questionable, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.21	Overturned thrust fault (3rd option)—Identity and existence certain, location inferred. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.22	Overturned thrust fault (3rd option)—Identity or existence questionable, location inferred. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.23	Overturned thrust fault (3rd option)—Identity and existence certain, location concealed. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			
2.9.24	Overturned thrust fault (3rd option)—Identity or existence questionable, location concealed. Bars on tectonically higher plate (footwall); sawteeth in direction of dip			

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.10—Detachment faults (sense of slip unspecified)				
2.10.1	Detachment fault (sense of slip unspecified) (1st option)—Identity and existence certain, location accurate. Hachures on upper plate			May be used to show either normal (extensional) or thrust (compressional) offset. Hachures indicate overall fault type (detachment fault); they are not placed at specific localities where observations have been made.
2.10.2	Detachment fault (sense of slip unspecified) (1st option)—Identity or existence questionable, location accurate. Hachures on upper plate			
2.10.3	Detachment fault (sense of slip unspecified) (1st option)—Identity and existence certain, location approximate. Hachures on upper plate			In cross section, use paired arrows to show relative motion of detachment faults (see Section 2.11).
2.10.4	Detachment fault (sense of slip unspecified) (1st option)—Identity or existence questionable, location approximate. Hachures on upper plate			
2.10.5	Detachment fault (sense of slip unspecified) (1st option)—Identity and existence certain, location inferred. Hachures on upper plate			If desired, "2nd option" and "3rd option" symbols may be used to show other types or generations of detachment faults.
2.10.6	Detachment fault (sense of slip unspecified) (1st option)—Identity or existence questionable, location inferred. Hachures on upper plate			
2.10.7	Detachment fault (sense of slip unspecified) (1st option)—Identity and existence certain, location concealed. Hachures on upper plate			
2.10.8	Detachment fault (sense of slip unspecified) (1st option)—Identity or existence questionable, location concealed. Hachures on upper plate			
2.10.9	Detachment fault (sense of slip unspecified) (2nd option)—Identity and existence certain, location accurate. Boxes on upper plate			May be used to show either normal (extensional) or thrust (compressional) offset. Boxes indicate overall fault type (detachment fault); they are not placed at specific localities where observations have been made.
2.10.10	Detachment fault (sense of slip unspecified) (2nd option)—Identity or existence questionable, location accurate. Boxes on upper plate			
2.10.11	Detachment fault (sense of slip unspecified) (2nd option)—Identity and existence certain, location approximate. Boxes on upper plate			In cross section, use paired arrows to show relative motion of detachment faults (see Section 2.11).
2.10.12	Detachment fault (sense of slip unspecified) (2nd option)—Identity or existence questionable, location approximate. Boxes on upper plate			
2.10.13	Detachment fault (sense of slip unspecified) (2nd option)—Identity and existence certain, location inferred. Boxes on upper plate			If desired, "2nd option" and "3rd option" symbols may be used to show other types or generations of detachment faults.
2.10.14	Detachment fault (sense of slip unspecified) (2nd option)—Identity or existence questionable, location inferred. Boxes on upper plate			
2.10.15	Detachment fault (sense of slip unspecified) (2nd option)—Identity and existence certain, location concealed. Boxes on upper plate			
2.10.16	Detachment fault (sense of slip unspecified) (2nd option)—Identity or existence questionable, location concealed. Boxes on upper plate			
2.10.17	Detachment fault (sense of slip unspecified) (3rd option)—Identity and existence certain, location accurate. Boxes on upper plate			
2.10.18	Detachment fault (sense of slip unspecified) (3rd option)—Identity or existence questionable, location accurate. Boxes on upper plate			
2.10.19	Detachment fault (sense of slip unspecified) (3rd option)—Identity and existence certain, location approximate. Boxes on upper plate			
2.10.20	Detachment fault (sense of slip unspecified) (3rd option)—Identity or existence questionable, location approximate. Boxes on upper plate			
2.10.21	Detachment fault (sense of slip unspecified) (3rd option)—Identity and existence certain, location inferred. Boxes on upper plate			
2.10.22	Detachment fault (sense of slip unspecified) (3rd option)—Identity or existence questionable, location inferred. Boxes on upper plate			
2.10.23	Detachment fault (sense of slip unspecified) (3rd option)—Identity and existence certain, location concealed. Boxes on upper plate			
2.10.24	Detachment fault (sense of slip unspecified) (3rd option)—Identity or existence questionable, location concealed. Boxes on upper plate			

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*	
2.10—Detachment faults (sense of slip unspecified) (continued)					
2.10.25	Master detachment fault (sense of slip unspecified) —Identity and existence certain, location accurate. Hachures on upper plate			May be used to show either normal (extensional) or thrust (compressional) offset. Hachures indicate overall fault type (master detachment fault); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of master detachment faults (see Section 2.11).	
2.10.26	Master detachment fault (sense of slip unspecified) —Identity or existence questionable, location accurate. Hachures on upper plate				
2.10.27	Master detachment fault (sense of slip unspecified) —Identity and existence certain, location approximate. Hachures on upper plate				
2.10.28	Master detachment fault (sense of slip unspecified) —Identity or existence questionable, location approximate. Hachures on upper plate				
2.10.29	Master detachment fault (sense of slip unspecified) —Identity and existence certain, location inferred. Hachures on upper plate				
2.10.30	Master detachment fault (sense of slip unspecified) —Identity or existence questionable, location inferred. Hachures on upper plate				
2.10.31	Master detachment fault (sense of slip unspecified) —Identity and existence certain, location concealed. Hachures on upper plate				
2.10.32	Master detachment fault (sense of slip unspecified) —Identity or existence questionable, location concealed. Hachures on upper plate				
2.10.33	Listric fault at head of detachment fault (sense of slip unspecified)—Identity and existence certain, location accurate. Ticks on upper plate				May be used to show either normal (extensional) or thrust (compressional) offset. Ticks indicate overall fault type (listric fault at head of detachment fault); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of listric faults at head of detachment faults (see Section 2.11).
2.10.34	Listric fault at head of detachment fault (sense of slip unspecified)—Identity or existence questionable, location accurate. Ticks on upper plate				
2.10.35	Listric fault at head of detachment fault (sense of slip unspecified)—Identity and existence certain, location approximate. Ticks on upper plate				
2.10.36	Listric fault at head of detachment fault (sense of slip unspecified)—Identity or existence questionable, location approximate. Ticks on upper plate				
2.10.37	Listric fault at head of detachment fault (sense of slip unspecified)—Identity and existence certain, location inferred. Ticks on upper plate				
2.10.38	Listric fault at head of detachment fault (sense of slip unspecified)—Identity or existence questionable, location inferred. Ticks on upper plate				
2.10.39	Listric fault at head of detachment fault (sense of slip unspecified)—Identity and existence certain, location concealed. Ticks on upper plate				
2.10.40	Listric fault at head of detachment fault (sense of slip unspecified)—Identity or existence questionable, location concealed. Ticks on upper plate				

*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.11—Line-symbol decorations and notations for faults				
2.11.1	Fault showing local normal offset (1st option)—Ball and bar on downthrown block		tick length 1.0 mm; lineweight .175 mm ← .875 mm diameter lineweight .375 mm	Place line-symbol decorations where observations have been made. Line-symbol decorations may be added to any type or style of fault to show local relative motion or geomorphic relations. Line-symbol decorations may also be added to faults in places where local geomorphic features may indicate an apparent offset but where true sense of displacement is unknown.
2.11.2	Fault showing local normal offset (2nd option)—U, upthrown block; D, downthrown block			
2.11.3	Fault showing local reverse offset—Showing dip value and direction. U, upthrown block; D, downthrown block			
2.11.4	Fault showing local right-lateral strike-slip offset—Arrows show relative motion			
2.11.5	Fault showing local left-lateral strike-slip offset—Arrows show relative motion			
2.11.6	Fault showing local right-lateral oblique-slip offset—Arrows show relative motion; ball and bar on downthrown block			
2.11.7	Fault showing local left-lateral oblique-slip offset—Arrows show relative motion; ball and bar on downthrown block			
2.11.8	Inclined fault (1st option)—Showing dip value and direction		tick length 1.75 mm; lineweight .225 mm ← HI-6	Place tick, arrow, or other line-symbol decoration where observation was made. Add arrowhead or '90' to ticks showing dip if necessary for clarity.
2.11.9	Inclined fault (2nd option)—Showing dip value and direction		tick length 1.375 mm; lineweight .225 mm ← .875 mm 30°	
2.11.10	Vertical or near-vertical fault (1st option)		tick length 2.5 mm; lineweight .225 mm	
2.11.11	Vertical or near-vertical fault (2nd option)		90 ← HI-6	
2.11.12	Lineation on fault surface—Showing bearing and plunge		6.0 mm ← HI-6 lineweight .225 mm 25°	
2.11.13	Lineation on inclined fault surface—Tick shows fault dip value and direction; arrow shows bearing and plunge of lineation		tick length 1.75 mm; lineweight .225 mm HI-6 → 25°	
2.11.14	Fault—Showing amount of local displacement		68 ← H-6	
2.11.15	Fault—Showing name	<u>GOLDEN FAULT</u>	<u>GOLDEN FAULT</u> ← H-8	
2.11.16	Normal fault (in cross section)—Arrows show relative motion			
2.11.17	Thrust fault or reverse fault (in cross section)—Arrows show relative motion			
2.11.18	Detachment fault, movement of upper plate to left (in cross section)—Arrows show relative motion			
2.11.19	Detachment fault, movement of upper plate to right (in cross section)—Arrows show relative motion			
2.11.20	Strike-slip fault (in cross section) (1st option)—A, away from observer; T, toward observer		H-7 → A T ← H-7	May be combined with paired arrows to show oblique-slip offset.
2.11.21	Strike-slip fault (in cross section) (2nd option)—minus, away from observer; plus, toward observer		lineweights .2 mm circle diameters 1.75 mm; crossbar lengths 1.75 mm	
2.11.22	Normal fault (on small-scale maps or figures)—Tick on downthrown side		tick length .8 mm; lineweight .25 mm	Usually reserved for use on page-size illustrations or on maps at scales of 1:1,000,000 or smaller.
2.11.23	Reverse fault (on small-scale maps or figures)—R on upthrown block		← H-6 (rotate parallel to fault)	
2.11.24	Thrust fault (on small-scale maps or figures)—T on upper (tectonically higher) plate		← H-6 (rotate parallel to fault)	

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.12—Fault scarps				
2.12.1	Scarp on fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence certain, location accurate. Hachures point downscarp			
2.12.2	Scarp on fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence questionable, location accurate. Hachures point downscarp			
2.12.3	Scarp on fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence certain, location approximate. Hachures point downscarp			
2.12.4	Scarp on fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence questionable, location approximate. Hachures point downscarp			
2.12.5	Scarp on normal fault—Identity and existence certain, location accurate. Ball and bar on downthrown block. Hachures point downscarp			
2.12.6	Scarp on normal fault—Identity or existence questionable, location accurate. Ball and bar on downthrown block. Hachures point downscarp			
2.12.7	Scarp on normal fault—Identity and existence certain, location approximate. Ball and bar on downthrown block. Hachures point downscarp			
2.12.8	Scarp on normal fault—Identity or existence questionable, location approximate. Ball and bar on downthrown block. Hachures point downscarp			
2.12.9	Scarp on low-angle normal fault—Identity and existence certain, location accurate. Half-circles on downthrown block. Hachures point downscarp			
2.12.10	Scarp on low-angle normal fault—Identity or existence questionable, location accurate. Half-circles on downthrown block. Hachures point downscarp			
2.12.11	Scarp on low-angle normal fault—Identity and existence certain, location approximate. Half-circles on downthrown block. Hachures point downscarp			
2.12.12	Scarp on low-angle normal fault—Identity or existence questionable, location approximate. Half-circles on downthrown block. Hachures point downscarp			
2.12.13	Scarp on low-angle fault (unknown or unspecified sense of slip)—Identity and existence certain, location accurate. Half-circles on upper plate. Hachures point downscarp			
2.12.14	Scarp on low-angle fault (unknown or unspecified sense of slip)—Identity or existence questionable, location accurate. Half-circles on upper plate. Hachures point downscarp			
2.12.15	Scarp on low-angle fault (unknown or unspecified sense of slip)—Identity and existence certain, location approximate. Half-circles on upper plate. Hachures point downscarp			
2.12.16	Scarp on low-angle fault (unknown or unspecified sense of slip)—Identity or existence questionable, location approximate. Half-circles on upper plate. Hachures point downscarp			
2.12.17	Scarp on reverse fault—Identity and existence certain, location accurate. Rectangles on upthrown block. Hachures point downscarp			
2.12.18	Scarp on reverse fault—Identity or existence questionable, location accurate. Rectangles on upthrown block. Hachures point downscarp			
2.12.19	Scarp on reverse fault—Identity and existence certain, location approximate. Rectangles on upthrown block. Hachures point downscarp			
2.12.20	Scarp on reverse fault—Identity or existence questionable, location approximate. Rectangles on upthrown block. Hachures point downscarp			

*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.12—Fault scarps (continued)				
2.12.21	Scarp on rotational or scissor fault, reverse-slip offset—Identity and existence certain, location accurate. Rectangles on upthrown block. Hachures point downscarp			
2.12.22	Scarp on rotational or scissor fault, reverse-slip offset—Identity or existence questionable, location accurate. Rectangles on upthrown block. Hachures point downscarp			
2.12.23	Scarp on rotational or scissor fault, reverse-slip offset—Identity and existence certain, location approximate. Rectangles on upthrown block. Hachures point downscarp			
2.12.24	Scarp on rotational or scissor fault, reverse-slip offset—Identity or existence questionable, location approximate. Rectangles on upthrown block. Hachures point downscarp			
2.12.25	Scarp on rotational or scissor fault, normal-slip offset—Identity and existence certain, location accurate. Rectangles on upthrown block. Hachures point downscarp			
2.12.26	Scarp on rotational or scissor fault, normal-slip offset—Identity or existence questionable, location accurate. Rectangles on upthrown block. Hachures point downscarp			
2.12.27	Scarp on rotational or scissor fault, normal-slip offset—Identity and existence certain, location approximate. Rectangles on upthrown block. Hachures point downscarp			
2.12.28	Scarp on rotational or scissor fault, normal-slip offset—Identity or existence questionable, location approximate. Rectangles on upthrown block. Hachures point downscarp			
2.12.29	Scarp on strike-slip fault, right-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion. Hachures point downscarp			
2.12.30	Scarp on strike-slip fault, right-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion. Hachures point downscarp			
2.12.31	Scarp on strike-slip fault, right-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion. Hachures point downscarp			
2.12.32	Scarp on strike-slip fault, right-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion. Hachures point downscarp			
2.12.33	Scarp on strike-slip fault, left-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion. Hachures point downscarp			
2.12.34	Scarp on strike-slip fault, left-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion. Hachures point downscarp			
2.12.35	Scarp on strike-slip fault, left-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion. Hachures point downscarp			
2.12.36	Scarp on strike-slip fault, left-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion. Hachures point downscarp			
2.12.37	Scarp on oblique-slip fault, right-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.38	Scarp on oblique-slip fault, right-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.39	Scarp on oblique-slip fault, right-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.40	Scarp on oblique-slip fault, right-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.41	Scarp on oblique-slip fault, left-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.42	Scarp on oblique-slip fault, left-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.43	Scarp on oblique-slip fault, left-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.44	Scarp on oblique-slip fault, left-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.12—Fault scarps (continued)				
2.12.45	Scarp on thrust fault (1st option)—Identity and existence certain, location accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.46	Scarp on thrust fault (1st option)—Identity or existence questionable, location accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.47	Scarp on thrust fault (1st option)—Identity and existence certain, location approximate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.48	Scarp on thrust fault (1st option)—Identity or existence questionable, location approximate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.49	Scarp on thrust fault (2nd option)—Identity and existence certain, location accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.50	Scarp on thrust fault (2nd option)—Identity or existence questionable, location accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.51	Scarp on thrust fault (2nd option)—Identity and existence certain, location approximate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.52	Scarp on thrust fault (2nd option)—Identity or existence questionable, location approximate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.53	Scarp on thrust fault (3rd option)—Identity and existence certain, location accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.54	Scarp on thrust fault (3rd option)—Identity or existence questionable, location accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.55	Scarp on thrust fault (3rd option)—Identity and existence certain, location approximate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.56	Scarp on thrust fault (3rd option)—Identity or existence questionable, location approximate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.57	Scarp on overturned thrust fault (1st option)—Identity and existence certain, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.58	Scarp on overturned thrust fault (1st option)—Identity or existence questionable, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.59	Scarp on overturned thrust fault (1st option)—Identity and existence certain, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.60	Scarp on overturned thrust fault (1st option)—Identity or existence questionable, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.61	Scarp on overturned thrust fault (2nd option)—Identity and existence certain, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.62	Scarp on overturned thrust fault (2nd option)—Identity or existence questionable, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.63	Scarp on overturned thrust fault (2nd option)—Identity and existence certain, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.64	Scarp on overturned thrust fault (2nd option)—Identity or existence questionable, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.65	Scarp on overturned thrust fault (3rd option)—Identity and existence certain, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.66	Scarp on overturned thrust fault (3rd option)—Identity or existence questionable, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.67	Scarp on overturned thrust fault (3rd option)—Identity and existence certain, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.68	Scarp on overturned thrust fault (3rd option)—Identity or existence questionable, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.12—Fault scarps (continued)				
2.12.69	Scarp on detachment fault (sense of slip unspecified) (1st option)—Identity and existence certain, location accurate. Long-hachure pairs on upper plate. Shorter, widely spaced hachures point downscarp		hachure height 1.0 mm; lineweight .175 mm HB-8 2.0 mm	
2.12.70	Scarp on detachment fault (sense of slip unspecified) (1st option)—Identity or existence questionable, location accurate. Long-hachure pairs on upper plate. Shorter, widely spaced hachures point downscarp		lineweight .375 mm .75 mm 12.0 mm 1.25 mm hachure height 1.25 mm; lineweight .25 mm	
2.12.71	Scarp on detachment fault (sense of slip unspecified) (1st option)—Identity and existence certain, location approximate. Long-hachure pairs on upper plate. Shorter, widely spaced hachures point downscarp		3.5 mm	
2.12.72	Scarp on detachment fault (sense of slip unspecified) (1st option)—Identity or existence questionable, location approximate. Long-hachure pairs on upper plate. Shorter, widely spaced hachures point downscarp		.75 mm .75 mm	
2.12.73	Scarp on detachment fault (sense of slip unspecified) (2nd option)—Identity and existence certain, location accurate. Boxes on upper plate. Hachures point downscarp		hachure height 1.0 mm; lineweight .175 mm HB-8 2.0 mm	
2.12.74	Scarp on detachment fault (sense of slip unspecified) (2nd option)—Identity or existence questionable, location accurate. Boxes on upper plate. Hachures point downscarp		lineweight .375 mm .75 mm 12.0 mm 1.25 mm box height 1.25 mm; lineweight .25 mm	
2.12.75	Scarp on detachment fault (sense of slip unspecified) (2nd option)—Identity and existence certain, location approximate. Boxes on upper plate. Hachures point downscarp		3.5 mm	
2.12.76	Scarp on detachment fault (sense of slip unspecified) (2nd option)—Identity or existence questionable, location approximate. Boxes on upper plate. Hachures point downscarp		.75 mm .75 mm	
2.12.77	Scarp on detachment fault (sense of slip unspecified) (3rd option)—Identity and existence certain, location accurate. Boxes on upper plate. Hachures point downscarp		hachure height 1.0 mm; lineweight .175 mm HB-8 1.25 mm 2.0 mm	
2.12.78	Scarp on detachment fault (sense of slip unspecified) (3rd option)—Identity or existence questionable, location accurate. Boxes on upper plate. Hachures point downscarp		lineweight .375 mm .75 mm 12.0 mm .625 mm 1.25 mm box height 1.25 mm; lineweight .25 mm	
2.12.79	Scarp on detachment fault (sense of slip unspecified) (3rd option)—Identity and existence certain, location approximate. Boxes on upper plate. Hachures point downscarp		3.5 mm	
2.12.80	Scarp on detachment fault (sense of slip unspecified) (3rd option)—Identity or existence questionable, location approximate. Boxes on upper plate. Hachures point downscarp		.75 mm .75 mm	
2.12.81	Scarp on master detachment fault (sense of slip unspecified)—Identity and existence certain, location accurate. Long-hachure triplets on upper plate. Shorter, widely spaced hachures point downscarp		hachure height 1.0 mm; lineweight .175 mm HB-8 1.25 mm 2.0 mm	
2.12.82	Scarp on master detachment fault (sense of slip unspecified)—Identity or existence questionable, location accurate. Long-hachure triplets on upper plate. Shorter, widely spaced hachures point downscarp		lineweight .375 mm .75 mm 12.0 mm .625 mm 1.25 mm hachure height 1.25 mm; lineweight .25 mm	
2.12.83	Scarp on master detachment fault (sense of slip unspecified)—Identity and existence certain, location approximate. Long-hachure triplets on upper plate. Shorter, widely spaced hachures point downscarp		3.5 mm	
2.12.84	Scarp on master detachment fault (sense of slip unspecified)—Identity or existence questionable, location approximate. Long-hachure triplets on upper plate. Shorter, widely spaced hachures point downscarp		.75 mm .75 mm	
2.12.85	Scarp on listric fault at head of detachment fault (sense of slip unspecified)—Identity and existence certain, location accurate. Single (longer) ticks on upper plate. Shorter, widely spaced hachures point downscarp		lineweight .375 mm HB-8 2.0 mm	
2.12.86	Scarp on listric fault at head of detachment fault (sense of slip unspecified)—Identity or existence questionable, location accurate. Single (longer) ticks on upper plate. Shorter, widely spaced hachures point downscarp		hachure height 1.0 mm; lineweight .175 mm .75 mm 12.0 mm tick height 1.25 mm; lineweight .25 mm	
2.12.87	Scarp on listric fault at head of detachment fault (sense of slip unspecified)—Identity and existence certain, location approximate. Single (longer) ticks on upper plate. Shorter, widely spaced hachures point downscarp		3.5 mm	
2.12.88	Scarp on listric fault at head of detachment fault (sense of slip unspecified)—Identity or existence questionable, location approximate. Single (longer) ticks on upper plate. Shorter, widely spaced hachures point downscarp		.75 mm .75 mm	

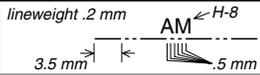
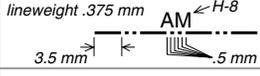
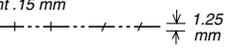
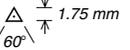
*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.13—Quaternary faulting				
2.13.1	Fault showing displacement during historic time (includes areas of known fault creep)		fault [linewidth .375 mm] linewidth 1.25 mm; color 100% red	Although only shown here on "identity and existence certain, location accurate," generic faults, color may be added to any type or style of fault to highlight where geomorphic evidence indicates displacement during Quaternary time.
2.13.2	Fault showing displacement during Holocene time		fault [linewidth .375 mm] linewidth 1.25 mm; color 100% orange	
2.13.3	Fault showing displacement during late Quaternary time		fault [linewidth .375 mm] linewidth 1.25 mm; color 100% green	
2.13.4	Fault showing displacement during Quaternary time (undifferentiated)		fault [linewidth .375 mm] linewidth 1.25 mm; color 100% violet	
2.14—Shear zones; mylonite zones; fault-breccia zones				
2.14.1	Ductile shear zone or mylonite zone—May or may not be associated with mappable faults		all linewidths .2 mm	Orient S-shaped symbols to indicate linear trend of zone; spacing may be varied to show intensity of shear. Width of zones may vary. Patterns may either overprint other map units or be used as stand-alone map units (if zones have well-defined boundaries).
2.14.2	Zone of sheared rock within fault		pattern 405-K (at ~45° to fault trend)	
2.14.3	Fault-breccia zone or zone of broken rock within fault		pattern 401-K	
2.14.4	Fault-breccia zone or zone of broken rock around fault		pattern 401-K	
2.15—Small, minor faults				
2.15.1	Small, minor inclined fault—Showing strike and dip		HI-6 35 1.425 m tick linewidth .2 mm linewidth .375 mm	Use to show small, minor faults that are observed in outcrop but that cannot be traced away from that outcrop.
2.15.2	Small, minor vertical or near-vertical fault—Showing strike		2.5 mm linewidth .375 mm	
2.15.3	Small, minor shear fault—Showing dip. Arrow shows direction of relative horizontal displacement		85 arrow linewidth .2 mm	

*For more information, see general guidelines on pages A-i to A-v.

3—BOUNDARIES LOCATED BY GEOPHYSICAL SURVEYS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
3.1—Boundaries located by geophysical methods				
3.1.1	Boundary located by aeromagnetic survey	— · · · · · AM · · · · ·	lineweight .2 mm 	Use for boundaries that have been defined by measured contrasts in rock properties but that may not be definitively identifiable as either a contact or a fault by survey methods. May be shown in red or other colors.
3.1.2	Boundary located by ground magnetic survey	— · · · · · M · · · · ·	— · · · · · M · · · · ·	
3.1.3	Boundary located by gravity survey	— · · · · · G · · · · ·	— · · · · · G · · · · ·	
3.1.4	Boundary located by radiometric survey	— · · · · · RM · · · · ·	— · · · · · RM · · · · ·	
3.1.5	Boundary located by seismic reflection survey	— · · · · · S · · · · ·	— · · · · · S · · · · ·	
3.1.6	Boundary located by induced polarization survey	— · · · · · IP · · · · ·	— · · · · · IP · · · · ·	
3.1.7	Boundary located by electromagnetic survey	— · · · · · EM · · · · ·	— · · · · · EM · · · · ·	
3.1.8	Boundary located by resistivity survey	— · · · · · R · · · · ·	— · · · · · R · · · · ·	
3.1.9	Boundary located by magnetotelluric survey	— · · · · · MT · · · · ·	— · · · · · MT · · · · ·	
3.2—Faults located by geophysical methods				
3.2.1	Fault located by aeromagnetic survey	— · · · · · AM · · · · ·	lineweight .375 mm 	Use for boundaries that have been defined by measured contrasts in rock properties and that also can be identified as faults by geophysical survey or by other evidence that contributes to survey. May be shown in red or other colors.
3.2.2	Fault located by ground magnetic survey	— · · · · · M · · · · ·	— · · · · · M · · · · ·	
3.2.3	Fault located by gravity survey	— · · · · · G · · · · ·	— · · · · · G · · · · ·	
3.2.4	Fault located by radiometric survey	— · · · · · RM · · · · ·	— · · · · · RM · · · · ·	
3.2.5	Fault located by seismic reflection survey	— · · · · · S · · · · ·	— · · · · · S · · · · ·	
3.2.6	Fault located by induced polarization survey	— · · · · · IP · · · · ·	— · · · · · IP · · · · ·	
3.2.7	Fault located by electromagnetic survey	— · · · · · EM · · · · ·	— · · · · · EM · · · · ·	
3.2.8	Fault located by resistivity survey	— · · · · · R · · · · ·	— · · · · · R · · · · ·	
3.2.9	Fault located by magnetotelluric survey	— · · · · · MT · · · · ·	— · · · · · MT · · · · ·	
3.3—Geophysical survey lines and stations				
3.3.1	Geophysical data collection line—Accurately located	— — — — —	lineweight .15 mm dash length 3.75 mm; spacing 3.75 mm	May be shown in red or other colors.
3.3.2	Geophysical data collection line—Located by aerial survey	— — — — —	lineweight .15 mm dash length 7.5 mm; spacing 7.5 mm	
3.3.3	Cross ticks showing location and orientation of data collection lines crossing geophysical boundary	+ + + + +	tick lineweight .15 mm 	
3.3.4	Horizontal control point	△	dot diameter .3 mm lineweight .2 mm 	
3.3.5	Survey station	+	lineweight .2 mm 	

*For more information, see general guidelines on pages A-i to A-v.

4—LINEAMENTS AND JOINTS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
4.1—Lineaments				
4.1.1	Lineament		lineweight .375 mm 	Use to show linear features that have been determined from aerial photographs or remotely sensed imagery but not identified on the ground.
4.1.2	Lineament—Showing name	<u>OLYMPIC-WALLOWA</u>	<u>OLYMPIC-WALLOWA</u> ← H-7	
4.2—Joints				
4.2.1	Joint—Identity and existence certain, location accurate		lineweight .3 mm	Use to show regional joint patterns or single joints that are mappable beyond outcrop. May also be shown in red or other colors.
4.2.2	Joint—Identity and existence certain, location approximate		2.0 mm 	
4.2.3	Inclined joint (1st option)—Showing dip value and direction		tick length 1.75 mm; lineweight .2 mm 	Place tick where observation was made. Add arrowhead or '90' to tick if necessary for clarity.
4.2.4	Inclined joint (2nd option)—Showing dip value and direction		tick length 1.375 mm; lineweight .2 mm 	
4.2.5	Vertical or subvertical joint (1st option)		tick length 2.5 mm; lineweight .2 mm	
4.2.6	Vertical or subvertical joint (2nd option)		90 ← HI-6	
4.3—Small, minor joints				
4.3.1	Small, minor horizontal joint (1st option)		lineweight .2 mm 	Use to show small, minor joints that are observed in outcrop but that cannot be traced away from that outcrop. For symbols representing a single observation at one locality, point of observation is the mid-point of the strike line. For multiple observations at one locality, joint symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding). May also be shown in red or other colors.
4.3.2	Small, minor inclined joint (1st option)—Showing strike and dip		1.125 mm 	
4.3.3	Small, minor vertical or near-vertical joint (1st option)—Showing strike		1.125 mm 	
4.3.4	Small, minor inclined (dip direction to right) joint, for multiple observations at one locality (1st option)—Showing strike and dip		5.5 mm 	
4.3.5	Small, minor inclined (dip direction to left) joint, for multiple observations at one locality (1st option)—Showing strike and dip			
4.3.6	Small, minor vertical or near-vertical joint, for multiple observations at one locality (1st option)—Showing strike		5.5 mm 	
4.3.7	Small, minor horizontal joint (2nd option)		all lineweights .2 mm 	
4.3.8	Small, minor inclined joint (2nd option)—Showing strike and dip		1.125 mm 	
4.3.9	Small, minor vertical or near-vertical joint (2nd option)—Showing strike		1.125 mm 	
4.3.10	Small, minor inclined (dip direction to right) joint, for multiple observations at one locality (2nd option)—Showing strike and dip		5.5 mm 	
4.3.11	Small, minor inclined (dip direction to left) joint, for multiple observations at one locality (2nd option)—Showing strike and dip			
4.3.12	Small, minor vertical or near-vertical joint, for multiple observations at one locality (2nd option)—Showing strike		5.5 mm 	

*For more information, see general guidelines on pages A-1 to A-v.

5—FOLDS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.1—Anticlines				
5.1.1	Anticline (1st option)—Identity and existence certain, location accurate		arrow linewidth .2 mm color 100% magenta 40° HB-8 5.5 mm 12.0 mm 1.475 mm .75 mm linewidth .25 mm	Place fold trace where axial surface intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (anticline); do not place at specific locality where observation was made.
5.1.2	Anticline (1st option)—Identity or existence questionable, location accurate			
5.1.3	Anticline (1st option)—Identity and existence certain, location approximate		3.5 mm .75 mm .75 mm	Arrowheads may be added to show direction of plunge (see Section 5.10). Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type.
5.1.4	Anticline (1st option)—Identity or existence questionable, location approximate			
5.1.5	Anticline (1st option)—Identity and existence certain, location inferred		1.5 mm .75 mm .75 mm	May also be shown in black or other colors.
5.1.6	Anticline (1st option)—Identity or existence questionable, location inferred			
5.1.7	Anticline (1st option)—Identity and existence certain, location concealed		.5 mm .75 mm .75 mm	
5.1.8	Anticline (1st option)—Identity or existence questionable, location concealed			
5.1.9	Anticline (2nd option)—Identity and existence certain, location accurate		arrow linewidth .2 mm color 100% magenta 40° HB-8 5.5 mm 12.0 mm 1.475 mm .75 mm linewidth .25 mm	
5.1.10	Anticline (2nd option)—Identity or existence questionable, location accurate			
5.1.11	Anticline (2nd option)—Identity and existence certain, location approximate		3.5 mm .75 mm .75 mm	
5.1.12	Anticline (2nd option)—Identity or existence questionable, location approximate			
5.1.13	Anticline (2nd option)—Identity and existence certain, location inferred		1.5 mm .75 mm .75 mm	
5.1.14	Anticline (2nd option)—Identity or existence questionable, location inferred			
5.1.15	Anticline (2nd option)—Identity and existence certain, location concealed		.5 mm .75 mm .75 mm	
5.1.16	Anticline (2nd option)—Identity or existence questionable, location concealed			

*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.2—Antiforms				
5.2.1	Antiform (1st option)—Identity and existence certain, location accurate		arrow linewidth .2 mm color 100% magenta 60° HB-8 5.5 mm 12.0 mm 1.475 mm .75 mm linewidth .25 mm	Place fold trace where axial surface of antiform intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (antiform); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.2.2	Antiform (1st option)—Identity or existence questionable, location accurate			
5.2.3	Antiform (1st option)—Identity and existence certain, location approximate		3.5 mm .75 mm .75 mm	
5.2.4	Antiform (1st option)—Identity or existence questionable, location approximate			
5.2.5	Antiform (1st option)—Identity and existence certain, location inferred		1.5 mm .75 mm .75 mm	
5.2.6	Antiform (1st option)—Identity or existence questionable, location inferred			
5.2.7	Antiform (1st option)—Identity and existence certain, location concealed		.5 mm .75 mm .75 mm	
5.2.8	Antiform (1st option)—Identity or existence questionable, location concealed			
5.2.9	Antiform (2nd option)—Identity and existence certain, location accurate		arrow linewidth .2 mm color 100% magenta 60° HB-8 5.5 mm 12.0 mm 1.475 mm .75 mm linewidth .25 mm	
5.2.10	Antiform (2nd option)—Identity or existence questionable, location accurate			
5.2.11	Antiform (2nd option)—Identity and existence certain, location approximate		3.5 mm .75 mm .75 mm	
5.2.12	Antiform (2nd option)—Identity or existence questionable, location approximate			
5.2.13	Antiform (2nd option)—Identity and existence certain, location inferred		1.5 mm .75 mm .75 mm	
5.2.14	Antiform (2nd option)—Identity or existence questionable, location inferred			
5.2.15	Antiform (2nd option)—Identity and existence certain, location concealed		.5 mm .75 mm .75 mm	
5.2.16	Antiform (2nd option)—Identity or existence questionable, location concealed			

*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.3—Asymmetric, overturned, and inverted anticlines				
5.3.1	Asymmetric anticline (1st option)—Identity and existence certain, location accurate. Beds are upright; shorter arrow on steeper limb			<p>Place fold trace where axial surface of asymmetric anticline intersects the ground surface.</p> <p>Place arrows at places along fold trace to indicate overall fold type (asymmetric anticline); do not place at specific locality where observation was made.</p> <p>Arrowheads may be added to show direction of plunge (see Section 5.10).</p> <p>Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type.</p> <p>May also be shown in black or other colors.</p>
5.3.2	Asymmetric anticline (1st option)—Identity or existence questionable, location accurate. Beds are upright; shorter arrow on steeper limb			
5.3.3	Asymmetric anticline (1st option)—Identity and existence certain, location approximate. Beds are upright; shorter arrow on steeper limb			
5.3.4	Asymmetric anticline (1st option)—Identity or existence questionable, location approximate. Beds are upright; shorter arrow on steeper limb			
5.3.5	Asymmetric anticline (1st option)—Identity and existence certain, location inferred. Beds are upright; shorter arrow on steeper limb			
5.3.6	Asymmetric anticline (1st option)—Identity or existence questionable, location inferred. Beds are upright; shorter arrow on steeper limb			
5.3.7	Asymmetric anticline (1st option)—Identity and existence certain, location concealed. Beds are upright; shorter arrow on steeper limb			
5.3.8	Asymmetric anticline (1st option)—Identity or existence questionable, location concealed. Beds are upright; shorter arrow on steeper limb			
5.3.9	Asymmetric anticline (2nd option)—Identity and existence certain, location accurate. Beds are upright; shorter arrow on steeper limb			
5.3.10	Asymmetric anticline (2nd option)—Identity or existence questionable, location accurate. Beds are upright; shorter arrow on steeper limb			
5.3.11	Asymmetric anticline (2nd option)—Identity and existence certain, location approximate. Beds are upright; shorter arrow on steeper limb			
5.3.12	Asymmetric anticline (2nd option)—Identity or existence questionable, location approximate. Beds are upright; shorter arrow on steeper limb			
5.3.13	Asymmetric anticline (2nd option)—Identity and existence certain, location inferred. Beds are upright; shorter arrow on steeper limb			
5.3.14	Asymmetric anticline (2nd option)—Identity or existence questionable, location inferred. Beds are upright; shorter arrow on steeper limb			
5.3.15	Asymmetric anticline (2nd option)—Identity and existence certain, location concealed. Beds are upright; shorter arrow on steeper limb			
5.3.16	Asymmetric anticline (2nd option)—Identity or existence questionable, location concealed. Beds are upright; shorter arrow on steeper limb			
5.3.17	Overturned anticline (1st option)—Identity and existence certain, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.18	Overturned anticline (1st option)—Identity or existence questionable, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.19	Overturned anticline (1st option)—Identity and existence certain, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.20	Overturned anticline (1st option)—Identity or existence questionable, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.21	Overturned anticline (1st option)—Identity and existence certain, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.22	Overturned anticline (1st option)—Identity or existence questionable, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.23	Overturned anticline (1st option)—Identity and existence certain, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.24	Overturned anticline (1st option)—Identity or existence questionable, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs			

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*	
5.3—Asymmetric, overturned, and inverted anticlines (continued)					
5.3.25	Overturned anticline (2nd option)—Identity and existence certain, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs			Place fold trace where axial surface of overturned anticline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (overturned anticline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.	
5.3.26	Overturned anticline (2nd option)—Identity or existence questionable, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs				
5.3.27	Overturned anticline (2nd option)—Identity and existence certain, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs				
5.3.28	Overturned anticline (2nd option)—Identity or existence questionable, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs				
5.3.29	Overturned anticline (2nd option)—Identity and existence certain, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs				
5.3.30	Overturned anticline (2nd option)—Identity or existence questionable, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs				
5.3.31	Overturned anticline (2nd option)—Identity and existence certain, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs				
5.3.32	Overturned anticline (2nd option)—Identity or existence questionable, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs				
5.3.33	Inverted anticline (1st option)—Identity and existence certain, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs				Place fold trace where axial surface of inverted anticline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (inverted anticline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.3.34	Inverted anticline (1st option)—Identity or existence questionable, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.35	Inverted anticline (1st option)—Identity and existence certain, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.36	Inverted anticline (1st option)—Identity or existence questionable, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.37	Inverted anticline (1st option)—Identity and existence certain, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.38	Inverted anticline (1st option)—Identity or existence questionable, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.39	Inverted anticline (1st option)—Identity and existence certain, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.40	Inverted anticline (1st option)—Identity or existence questionable, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.41	Inverted anticline (2nd option)—Identity and existence certain, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.42	Inverted anticline (2nd option)—Identity or existence questionable, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.43	Inverted anticline (2nd option)—Identity and existence certain, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.44	Inverted anticline (2nd option)—Identity or existence questionable, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.45	Inverted anticline (2nd option)—Identity and existence certain, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.46	Inverted anticline (2nd option)—Identity or existence questionable, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.47	Inverted anticline (2nd option)—Identity and existence certain, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs				
5.3.48	Inverted anticline (2nd option)—Identity or existence questionable, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs				

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*	
5.4—Antiformal sheath folds					
5.4.1	Antiformal sheath fold (1st option)—Identity and existence certain, location accurate		color 100% magenta arrow linewidth .2 mm linewidth .25 mm 1.5 mm HB-8 50° 1.475 mm 12.0 mm .75 mm 1.25 mm radius	Place fold trace where axial surface of antiformal sheath fold intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (antiformal sheath fold); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.	
5.4.2	Antiformal sheath fold (1st option)—Identity or existence questionable, location accurate				
5.4.3	Antiformal sheath fold (1st option)—Identity and existence certain, location approximate		3.5 mm .75 mm .75 mm		
5.4.4	Antiformal sheath fold (1st option)—Identity or existence questionable, location approximate				
5.4.5	Antiformal sheath fold (1st option)—Identity and existence certain, location inferred		1.5 mm .75 mm .75 mm		
5.4.6	Antiformal sheath fold (1st option)—Identity or existence questionable, location inferred				
5.4.7	Antiformal sheath fold (1st option)—Identity and existence certain, location concealed		.5 mm .75 mm .75 mm		
5.4.8	Antiformal sheath fold (1st option)—Identity or existence questionable, location concealed				
5.4.9	Antiformal sheath fold (2nd option)—Identity and existence certain, location accurate		color 100% magenta arrow linewidth .2 mm linewidth .25 mm 1.5 mm HB-8 50° 1.475 mm 12.0 mm .75 mm 1.25 mm radius		
5.4.10	Antiformal sheath fold (2nd option)—Identity or existence questionable, location accurate				
5.4.11	Antiformal sheath fold (2nd option)—Identity and existence certain, location approximate		3.5 mm .75 mm .75 mm		
5.4.12	Antiformal sheath fold (2nd option)—Identity or existence questionable, location approximate				
5.4.13	Antiformal sheath fold (2nd option)—Identity and existence certain, location inferred		1.5 mm .75 mm .75 mm		
5.4.14	Antiformal sheath fold (2nd option)—Identity or existence questionable, location inferred				
5.4.15	Antiformal sheath fold (2nd option)—Identity and existence certain, location concealed		.5 mm .75 mm .75 mm		
5.4.16	Antiformal sheath fold (2nd option)—Identity or existence questionable, location concealed				

*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.5—Synclines				
5.5.1	Syncline (1st option)—Identity and existence certain, location accurate			Place fold trace where axial surface of syncline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (syncline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.5.2	Syncline (1st option)—Identity or existence questionable, location accurate			
5.5.3	Syncline (1st option)—Identity and existence certain, location approximate			
5.5.4	Syncline (1st option)—Identity or existence questionable, location approximate			
5.5.5	Syncline (1st option)—Identity and existence certain, location inferred			
5.5.6	Syncline (1st option)—Identity or existence questionable, location inferred			
5.5.7	Syncline (1st option)—Identity and existence certain, location concealed			
5.5.8	Syncline (1st option)—Identity or existence questionable, location concealed			
5.5.9	Syncline (2nd option)—Identity and existence certain, location accurate			
5.5.10	Syncline (2nd option)—Identity or existence questionable, location accurate			
5.5.11	Syncline (2nd option)—Identity and existence certain, location approximate			
5.5.12	Syncline (2nd option)—Identity or existence questionable, location approximate			
5.5.13	Syncline (2nd option)—Identity and existence certain, location inferred			
5.5.14	Syncline (2nd option)—Identity or existence questionable, location inferred			
5.5.15	Syncline (2nd option)—Identity and existence certain, location concealed			
5.5.16	Syncline (2nd option)—Identity or existence questionable, location concealed			

*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.6—Synforms				
5.6.1	Synform (1st option)—Identity and existence certain, location accurate		arrow linewidth .2 mm color 100% magenta	Place fold trace where axial surface of synform intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (synform); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.6.2	Synform (1st option)—Identity or existence questionable, location accurate		linewidth .25 mm 2.725 mm 12.0 mm 1.475 mm	
5.6.3	Synform (1st option)—Identity and existence certain, location approximate		3.5 mm	
5.6.4	Synform (1st option)—Identity or existence questionable, location approximate		.75 mm .75 mm	
5.6.5	Synform (1st option)—Identity and existence certain, location inferred		1.5 mm	
5.6.6	Synform (1st option)—Identity or existence questionable, location inferred		.75 mm .75 mm	
5.6.7	Synform (1st option)—Identity and existence certain, location concealed		.5 mm	
5.6.8	Synform (1st option)—Identity or existence questionable, location concealed		.75 mm .75 mm	
5.6.9	Synform (2nd option)—Identity and existence certain, location accurate		arrow linewidth .2 mm color 100% magenta	
5.6.10	Synform (2nd option)—Identity or existence questionable, location accurate		linewidth .25 mm 2.725 mm 12.0 mm 1.475 mm	
5.6.11	Synform (2nd option)—Identity and existence certain, location approximate		3.5 mm	
5.6.12	Synform (2nd option)—Identity or existence questionable, location approximate		.75 mm .75 mm	
5.6.13	Synform (2nd option)—Identity and existence certain, location inferred		1.5 mm	
5.6.14	Synform (2nd option)—Identity or existence questionable, location inferred		.75 mm .75 mm	
5.6.15	Synform (2nd option)—Identity and existence certain, location concealed		.5 mm	
5.6.16	Synform (2nd option)—Identity or existence questionable, location concealed		.75 mm .75 mm	

*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.7—Asymmetric, overturned, and inverted synclines				
5.7.1	Asymmetric syncline (1st option)—Identity and existence certain, location accurate. Beds are upright; shorter arrow on steeper limb			Place fold trace where axial surface of asymmetric syncline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (asymmetric syncline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.2	Asymmetric syncline (1st option)—Identity or existence questionable, location accurate. Beds are upright; shorter arrow on steeper limb			
5.7.3	Asymmetric syncline (1st option)—Identity and existence certain, location approximate. Beds are upright; shorter arrow on steeper limb			
5.7.4	Asymmetric syncline (1st option)—Identity or existence questionable, location approximate. Beds are upright; shorter arrow on steeper limb			
5.7.5	Asymmetric syncline (1st option)—Identity and existence certain, location inferred. Beds are upright; shorter arrow on steeper limb			
5.7.6	Asymmetric syncline (1st option)—Identity or existence questionable, location inferred. Beds are upright; shorter arrow on steeper limb			
5.7.7	Asymmetric syncline (1st option)—Identity and existence certain, location concealed. Beds are upright; shorter arrow on steeper limb			
5.7.8	Asymmetric syncline (1st option)—Identity or existence questionable, location concealed. Beds are upright; shorter arrow on steeper limb			
5.7.9	Asymmetric syncline (2nd option)—Identity and existence certain, location accurate. Beds are upright; shorter arrow on steeper limb			
5.7.10	Asymmetric syncline (2nd option)—Identity or existence questionable, location accurate. Beds are upright; shorter arrow on steeper limb			
5.7.11	Asymmetric syncline (2nd option)—Identity and existence certain, location approximate. Beds are upright; shorter arrow on steeper limb			
5.7.12	Asymmetric syncline (2nd option)—Identity or existence questionable, location approximate. Beds are upright; shorter arrow on steeper limb			
5.7.13	Asymmetric syncline (2nd option)—Identity and existence certain, location inferred. Beds are upright; shorter arrow on steeper limb			
5.7.14	Asymmetric syncline (2nd option)—Identity or existence questionable, location inferred. Beds are upright; shorter arrow on steeper limb			
5.7.15	Asymmetric syncline (2nd option)—Identity and existence certain, location concealed. Beds are upright; shorter arrow on steeper limb			
5.7.16	Asymmetric syncline (2nd option)—Identity or existence questionable, location concealed. Beds are upright; shorter arrow on steeper limb			
5.7.17	Overturned syncline (1st option)—Identity and existence certain, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs			Place fold trace where axial surface of overturned syncline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (overturned syncline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.18	Overturned syncline (1st option)—Identity or existence questionable, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.19	Overturned syncline (1st option)—Identity and existence certain, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.20	Overturned syncline (1st option)—Identity or existence questionable, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.21	Overturned syncline (1st option)—Identity and existence certain, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.22	Overturned syncline (1st option)—Identity or existence questionable, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.23	Overturned syncline (1st option)—Identity and existence certain, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.24	Overturned syncline (1st option)—Identity or existence questionable, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs			

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.7—Asymmetric, overturned, and inverted synclines (continued)				
5.7.25	Overturned syncline (2nd option)—Identity and existence certain, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs		<p>2.275 mm line weight .25 mm 40° color 100% magenta 1.475 mm HB-8 .75 mm arrow line weight .2 mm 12.0 mm 1.0 mm radius</p>	Place fold trace where axial surface of overturned syncline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (overturned syncline); do not place at specific locality where observation was made.
5.7.26	Overturned syncline (2nd option)—Identity or existence questionable, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.27	Overturned syncline (2nd option)—Identity and existence certain, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs		<p>3.5 mm</p>	Arrowheads may be added to show direction of plunge (see Section 5.10). Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.28	Overturned syncline (2nd option)—Identity or existence questionable, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs		<p>.75 mm .75 mm</p>	
5.7.29	Overturned syncline (2nd option)—Identity and existence certain, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs		<p>1.5 mm</p>	Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.30	Overturned syncline (2nd option)—Identity or existence questionable, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs		<p>.75 mm .75 mm</p>	
5.7.31	Overturned syncline (2nd option)—Identity and existence certain, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs		<p>.5 mm</p>	May also be shown in black or other colors.
5.7.32	Overturned syncline (2nd option)—Identity or existence questionable, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs		<p>.75 mm .75 mm</p>	
5.7.33	Inverted syncline (1st option)—Identity and existence certain, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>.875 mm radius line weight .25 mm 40° color 100% magenta 1.475 mm HB-8 .75 mm arrow line weight .2 mm 12.0 mm 2.25 mm</p>	Place fold trace where axial surface of inverted syncline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (inverted syncline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.34	Inverted syncline (1st option)—Identity or existence questionable, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.35	Inverted syncline (1st option)—Identity and existence certain, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>3.5 mm</p>	Arrowheads may be added to show direction of plunge (see Section 5.10). Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.36	Inverted syncline (1st option)—Identity or existence questionable, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>.75 mm .75 mm</p>	
5.7.37	Inverted syncline (1st option)—Identity and existence certain, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>1.5 mm</p>	Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.38	Inverted syncline (1st option)—Identity or existence questionable, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>.75 mm .75 mm</p>	
5.7.39	Inverted syncline (1st option)—Identity and existence certain, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>.5 mm</p>	May also be shown in black or other colors.
5.7.40	Inverted syncline (1st option)—Identity or existence questionable, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>.75 mm .75 mm</p>	
5.7.41	Inverted syncline (2nd option)—Identity and existence certain, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>.875 mm radius line weight .25 mm 40° color 100% magenta 1.475 mm HB-8 .75 mm arrow line weight .2 mm 12.0 mm 2.25 mm</p>	Place fold trace where axial surface of inverted syncline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (inverted syncline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.42	Inverted syncline (2nd option)—Identity or existence questionable, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.43	Inverted syncline (2nd option)—Identity and existence certain, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>3.5 mm</p>	Arrowheads may be added to show direction of plunge (see Section 5.10). Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.44	Inverted syncline (2nd option)—Identity or existence questionable, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>.75 mm .75 mm</p>	
5.7.45	Inverted syncline (2nd option)—Identity and existence certain, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>1.5 mm</p>	Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.46	Inverted syncline (2nd option)—Identity or existence questionable, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>.75 mm .75 mm</p>	
5.7.47	Inverted syncline (2nd option)—Identity and existence certain, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>.5 mm</p>	May also be shown in black or other colors.
5.7.48	Inverted syncline (2nd option)—Identity or existence questionable, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs		<p>.75 mm .75 mm</p>	

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.8—Synformal sheath folds				
5.8.1	Synformal sheath fold (1st option)—Identity and existence certain, location accurate		color 100% magenta arrow linewidth .2 mm 1.475 mm HB-8 50° 1.5 mm .75 mm 12.0 mm 1.25 mm radius linewidth .25 mm	Place fold trace where axial surface of synformal sheath fold intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (synformal sheath fold); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.8.2	Synformal sheath fold (1st option)—Identity or existence questionable, location accurate			
5.8.3	Synformal sheath fold (1st option)—Identity and existence certain, location approximate		3.5 mm .75 mm .75 mm	
5.8.4	Synformal sheath fold (1st option)—Identity or existence questionable, location approximate		.75 mm .75 mm	
5.8.5	Synformal sheath fold (1st option)—Identity and existence certain, location inferred		1.5 mm .75 mm .75 mm	
5.8.6	Synformal sheath fold (1st option)—Identity or existence questionable, location inferred		.75 mm .75 mm	
5.8.7	Synformal sheath fold (1st option)—Identity and existence certain, location concealed		.5 mm .75 mm .75 mm	
5.8.8	Synformal sheath fold (1st option)—Identity or existence questionable, location concealed		.75 mm .75 mm	
5.8.9	Synformal sheath fold (2nd option)—Identity and existence certain, location accurate		color 100% magenta arrow linewidth .2 mm 1.475 mm HB-8 50° 1.5 mm .75 mm 12.0 mm 1.25 mm radius linewidth .25 mm	
5.8.10	Synformal sheath fold (2nd option)—Identity or existence questionable, location accurate			
5.8.11	Synformal sheath fold (2nd option)—Identity and existence certain, location approximate		3.5 mm .75 mm .75 mm	
5.8.12	Synformal sheath fold (2nd option)—Identity or existence questionable, location approximate		.75 mm .75 mm	
5.8.13	Synformal sheath fold (2nd option)—Identity and existence certain, location inferred		1.5 mm .75 mm .75 mm	
5.8.14	Synformal sheath fold (2nd option)—Identity or existence questionable, location inferred		.75 mm .75 mm	
5.8.15	Synformal sheath fold (2nd option)—Identity and existence certain, location concealed		.5 mm .75 mm .75 mm	
5.8.16	Synformal sheath fold (2nd option)—Identity or existence questionable, location concealed		.75 mm .75 mm	

*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.9—Monoclines				
5.9.1	Monocline (1st option)—Identity and existence certain, location accurate. Arrow shows direction of dip			Use to show monocline whose anticlinal and synclinal bends are too close together at map scale to show as separate fold traces.
5.9.2	Monocline (1st option)—Identity or existence questionable, location accurate. Arrow shows direction of dip			
5.9.3	Monocline (1st option)—Identity and existence certain, location approximate. Arrow shows direction of dip			Place fold trace where dip of surface connecting anticlinal and synclinal bends is at its maximum angle.
5.9.4	Monocline (1st option)—Identity or existence questionable, location approximate. Arrow shows direction of dip			
5.9.5	Monocline (1st option)—Identity and existence certain, location inferred. Arrow shows direction of dip			Place arrow at places along fold trace to indicate overall fold type (monocline); do not place at specific locality where observation was made.
5.9.6	Monocline (1st option)—Identity or existence questionable, location inferred. Arrow shows direction of dip			
5.9.7	Monocline (1st option)—Identity and existence certain, location concealed. Arrow shows direction of dip			Arrowheads may be added to show direction of plunge (see Section 5.10).
5.9.8	Monocline (1st option)—Identity or existence questionable, location concealed. Arrow shows direction of dip			
5.9.9	Monocline (2nd option)—Identity and existence certain, location accurate. Arrow shows direction of dip			Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.9.10	Monocline (2nd option)—Identity or existence questionable, location accurate. Arrow shows direction of dip			
5.9.11	Monocline (2nd option)—Identity and existence certain, location approximate. Arrow shows direction of dip			
5.9.12	Monocline (2nd option)—Identity or existence questionable, location approximate. Arrow shows direction of dip			
5.9.13	Monocline (2nd option)—Identity and existence certain, location inferred. Arrow shows direction of dip			
5.9.14	Monocline (2nd option)—Identity or existence questionable, location inferred. Arrow shows direction of dip			
5.9.15	Monocline (2nd option)—Identity and existence certain, location concealed. Arrow shows direction of dip			
5.9.16	Monocline (2nd option)—Identity or existence questionable, location concealed. Arrow shows direction of dip			
5.9.17	Monocline, anticlinal bend (1st option)—Identity and existence certain, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			Place fold trace where axial surface of anticlinal bend of monocline intersects the ground surface.
5.9.18	Monocline, anticlinal bend (1st option)—Identity or existence questionable, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.19	Monocline, anticlinal bend (1st option)—Identity and existence certain, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			Place arrows at places along fold trace to indicate overall fold type (anticlinal bend of monocline); do not place at specific locality where observation was made.
5.9.20	Monocline, anticlinal bend (1st option)—Identity or existence questionable, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.21	Monocline, anticlinal bend (1st option)—Identity and existence certain, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			Arrowheads may be added to show direction of plunge (see Section 5.10).
5.9.22	Monocline, anticlinal bend (1st option)—Identity or existence questionable, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.23	Monocline, anticlinal bend (1st option)—Identity and existence certain, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.9.24	Monocline, anticlinal bend (1st option)—Identity or existence questionable, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.9—Monoclines (continued)				
5.9.25	Monocline, anticlinal bend (2nd option)—Identity and existence certain, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			Place fold trace where axial surface of anticlinal bend of monocline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (anticlinal bend of monocline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.9.26	Monocline, anticlinal bend (2nd option)—Identity or existence questionable, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.27	Monocline, anticlinal bend (2nd option)—Identity and existence certain, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.28	Monocline, anticlinal bend (2nd option)—Identity or existence questionable, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.29	Monocline, anticlinal bend (2nd option)—Identity and existence certain, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.30	Monocline, anticlinal bend (2nd option)—Identity or existence questionable, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.31	Monocline, anticlinal bend (2nd option)—Identity and existence certain, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.32	Monocline, anticlinal bend (2nd option)—Identity or existence questionable, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.33	Monocline, synclinal bend (1st option)—Identity and existence certain, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			Place fold trace where axial surface of synclinal bend of monocline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (synclinal bend of monocline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.9.34	Monocline, synclinal bend (1st option)—Identity or existence questionable, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.35	Monocline, synclinal bend (1st option)—Identity and existence certain, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.36	Monocline, synclinal bend (1st option)—Identity or existence questionable, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.37	Monocline, synclinal bend (1st option)—Identity and existence certain, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.38	Monocline, synclinal bend (1st option)—Identity or existence questionable, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.39	Monocline, synclinal bend (1st option)—Identity and existence certain, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.40	Monocline, synclinal bend (1st option)—Identity or existence questionable, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.41	Monocline, synclinal bend (2nd option)—Identity and existence certain, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.42	Monocline, synclinal bend (2nd option)—Identity or existence questionable, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.43	Monocline, synclinal bend (2nd option)—Identity and existence certain, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.44	Monocline, synclinal bend (2nd option)—Identity or existence questionable, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.45	Monocline, synclinal bend (2nd option)—Identity and existence certain, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.46	Monocline, synclinal bend (2nd option)—Identity or existence questionable, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.47	Monocline, synclinal bend (2nd option)—Identity and existence certain, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.48	Monocline, synclinal bend (2nd option)—Identity or existence questionable, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.10—Line-symbol decorations and notations for folds				
5.10.1	Fold having inclined axial surface (1st option)—Tick shows dip value and direction		HI-6 (100% black)	Although only shown here on anticlines, line-symbol decorations and notations may be added to any type or style of fold. Add arrowhead or '90' to ticks showing dip if necessary for clarity. Place where observation was made.
5.10.2	Fold having inclined axial surface (2nd option)—Tick shows dip value and direction		HI-6 (100% black)	
5.10.3	Fold having vertical or near-vertical axial surface (1st option)			
5.10.4	Fold having vertical or near-vertical axial surface (2nd option)		HI-6 (100% black)	
5.10.5	Plunging anticline—Large arrowhead shows direction of plunge			Although only shown here on anticlines and synclines, line-symbol decorations and notations may be added to any type or style of fold. Place arrowhead(s) showing plunge at end(s) of, or along, any type or style of fold to indicate general plunge direction(s); do not add plunge angle.
5.10.6	Doubly plunging anticline			
5.10.7	Plunging syncline—Large arrowhead shows direction of plunge			
5.10.8	Doubly plunging syncline			
5.10.9	Fold having near-vertical fold limbs—Half-circle shows direction of closure			Although only shown here on anticlines and synclines, line-symbol decorations and notations may be added to any type or style of fold.
5.10.10	Crest line (CL) of fold where it diverges from axial surface of anticline		H-7	
5.10.11	Trough line (TL) of fold where it diverges from axial surface of syncline		H-7	
5.10.12	Fold—Showing name			Letter size or spacing may be increased on longer fold segments.

*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.11—Small, minor folds				
5.11.1	Small, minor fold, horizontal axial surface		color 100% magenta circle diameter 3.0 mm; linewidth .2 mm crossbar linewidth .25 mm	Use when beds are too tightly folded to show traces of individual folds or when small, minor folds are observed in outcrop but cannot be traced away from that outcrop. Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.11.2	Small, minor dome		color 100% magenta 5.5 mm 40° linewidth .2 mm 1.475 mm	
5.11.3	Small, minor basin		color 100% magenta 5.5 mm 40° linewidth .2 mm 1.475 mm	
5.11.4	Small, minor anticline, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta 2.75 mm 40° arrow linewidth .2 mm 6.0 mm 1.475 mm linewidth .25 mm	
5.11.5	Small, minor anticline, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black) 35 tick length 1.75 mm; linewidth .2 mm; color 100% magenta 9.0 mm	
5.11.6	Small, minor anticline, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta 2.75 mm 40° arrow linewidth .2 mm 6.0 mm 1.475 mm linewidth .25 mm	
5.11.7	Small, minor anticline, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black) 35 tick length 1.75 mm; linewidth .2 mm; color 100% magenta 9.0 mm	
5.11.8	Small, minor antiform, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta 2.75 mm 60° arrow linewidth .2 mm 6.0 mm 1.475 mm linewidth .25 mm	
5.11.9	Small, minor antiform, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black) 35 tick length 1.75 mm; linewidth .2 mm; color 100% magenta 9.0 mm	
5.11.10	Small, minor antiform, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta 2.75 mm 60° arrow linewidth .2 mm 6.0 mm 1.475 mm linewidth .25 mm	
5.11.11	Small, minor antiform, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black) 35 tick length 1.75 mm; linewidth .2 mm; color 100% magenta 9.0 mm	
5.11.12	Small, minor asymmetric anticline, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta 2.25 mm 40° arrow linewidth .2 mm 6.0 mm 1.475 mm 3.5 mm linewidth .25 mm	
5.11.13	Small, minor asymmetric anticline, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black) 35 tick length 1.75 mm; linewidth .2 mm; color 100% magenta 9.0 mm	
5.11.14	Small, minor asymmetric anticline, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta 2.25 mm 40° arrow linewidth .2 mm 6.0 mm 1.475 mm 3.5 mm linewidth .25 mm	
5.11.15	Small, minor asymmetric anticline, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black) 35 tick length 1.75 mm; linewidth .2 mm; color 100% magenta 9.0 mm	
5.11.16	Small, minor overturned anticline, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta 2.275 mm 40° arrow linewidth .2 mm 1.0 mm radius 6.0 mm 1.475 mm linewidth .25 mm	
5.11.17	Small, minor overturned anticline, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black) 35 tick length 1.75 mm; linewidth .2 mm; color 100% magenta 9.0 mm	
5.11.18	Small, minor overturned anticline, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta 2.275 mm 40° arrow linewidth .2 mm 1.0 mm radius 6.0 mm 1.475 mm linewidth .25 mm	
5.11.19	Small, minor overturned anticline, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black) 35 tick length 1.75 mm; linewidth .2 mm; color 100% magenta 9.0 mm	
5.11.20	Small, minor inverted anticline, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta .875 mm radius 40° arrow linewidth .2 mm 6.0 mm 1.475 mm 2.25 mm linewidth .25 mm	
5.11.21	Small, minor inverted anticline, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black) 35 tick length 1.75 mm; linewidth .2 mm; color 100% magenta 9.0 mm	
5.11.22	Small, minor inverted anticline, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta .875 mm radius 40° arrow linewidth .2 mm 6.0 mm 1.475 mm 2.25 mm linewidth .25 mm	
5.11.23	Small, minor inverted anticline, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black) 35 tick length 1.75 mm; linewidth .2 mm; color 100% magenta 9.0 mm	

*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.11—Small, minor folds (continued)				
5.11.24	Small, minor syncline, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta 2.75 mm 6.0 mm 2.75 mm arrow 40° arrow linewidth .2 mm 1.475 mm linewidth .25 mm	Use when beds are too tightly folded to show traces of individual folds or when small, minor folds are observed in outcrop but cannot be traced away from that outcrop. Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.11.25	Small, minor syncline, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black) 35 9.0 mm tick length 1.75 mm; linewidth .2 mm; color 100% magenta	
5.11.26	Small, minor syncline, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta 2.75 mm 6.0 mm 2.75 mm arrow 40° arrow linewidth .2 mm 1.475 mm linewidth .25 mm	
5.11.27	Small, minor syncline, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black) 35 9.0 mm tick length 1.75 mm; linewidth .2 mm; color 100% magenta	
5.11.28	Small, minor synform, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta 2.75 mm 6.0 mm 2.75 mm arrow 60° arrow linewidth .2 mm 1.475 mm linewidth .25 mm	
5.11.29	Small, minor synform, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black) 35 9.0 mm tick length 1.75 mm; linewidth .2 mm; color 100% magenta	
5.11.30	Small, minor synform, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta 2.75 mm 6.0 mm 2.75 mm arrow 60° arrow linewidth .2 mm 1.475 mm linewidth .25 mm	
5.11.31	Small, minor synform, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black) 35 9.0 mm tick length 1.75 mm; linewidth .2 mm; color 100% magenta	
5.11.32	Small, minor asymmetric syncline, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta 2.25 mm 6.0 mm 3.5 mm arrow 40° arrow linewidth .2 mm 1.475 mm linewidth .25 mm	
5.11.33	Small, minor asymmetric syncline, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black) 35 9.0 mm tick length 1.75 mm; linewidth .2 mm; color 100% magenta	
5.11.34	Small, minor asymmetric syncline, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta 2.25 mm 6.0 mm 3.5 mm arrow 40° arrow linewidth .2 mm 1.475 mm linewidth .25 mm	
5.11.35	Small, minor asymmetric syncline, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black) 35 9.0 mm tick length 1.75 mm; linewidth .2 mm; color 100% magenta	
5.11.36	Small, minor overturned syncline, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta 2.275 mm 1.0 mm radius 6.0 mm arrow 40° arrow linewidth .2 mm 1.475 mm linewidth .25 mm	
5.11.37	Small, minor overturned syncline, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black) 35 9.0 mm tick length 1.75 mm; linewidth .2 mm; color 100% magenta	
5.11.38	Small, minor overturned syncline, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta 2.275 mm 1.0 mm radius 6.0 mm arrow 40° arrow linewidth .2 mm 1.475 mm linewidth .25 mm	
5.11.39	Small, minor overturned syncline, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black) 35 9.0 mm tick length 1.75 mm; linewidth .2 mm; color 100% magenta	
5.11.40	Small, minor inverted syncline, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta .875 mm radius 6.0 mm 2.25 mm arrow 40° arrow linewidth .2 mm 1.475 mm linewidth .25 mm	
5.11.41	Small, minor inverted syncline, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black) 35 9.0 mm tick length 1.75 mm; linewidth .2 mm; color 100% magenta	
5.11.42	Small, minor inverted syncline, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta .875 mm radius 6.0 mm 2.25 mm arrow 40° arrow linewidth .2 mm 1.475 mm linewidth .25 mm	
5.11.43	Small, minor inverted syncline, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black) 35 9.0 mm tick length 1.75 mm; linewidth .2 mm; color 100% magenta	

*For more information, see general guidelines on pages A-i to A-v.

6—BEDDING

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
6.1	Horizontal bedding		all lineweights .2 mm circle diameter 2.5 mm	Inclined (upright) and overturned bedding symbols are used when the top direction of beds is known to a reasonable degree of certainty.
6.2	Inclined bedding—Showing strike and dip		1.0 mm 40 HI-6 5.0 mm all lineweights .2 mm	On maps where determination of top direction is "known" at some places and "unknown" at others, such symbols also may be used to indicate where top direction is "unknown" (compare with ref. nos. 6.13-24). Symbols may be used without a dip value to indicate the generalized strike and direction of dip of beds.
6.3	Vertical bedding—Showing strike		2.0 mm	For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line.
6.4	Overturned bedding—Showing strike and dip		1.0 mm 65 HI-6 .625 mm radius	For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
6.5	Bedding overturned more than 180 degrees—Showing strike and dip		.7 mm 20 HI-6 .375 mm radius	
6.6	Inclined (dip direction to right) bedding, for multiple observations at one locality—Showing strike and dip		5.5 mm 40 HI-6 1.0 mm 1.325 mm	
6.7	Inclined (dip direction to left) bedding, for multiple observations at one locality—Showing strike and dip		40	
6.8	Vertical bedding, for multiple observations at one locality—Showing strike		2.0 mm	
6.9	Overturned (dip direction to right) bedding, for multiple observations at one locality—Showing strike and dip		.625 mm radius 65 HI-6 1.0 mm	
6.10	Overturned (dip direction to left) bedding, for multiple observations at one locality—Showing strike and dip		65	
6.11	Bedding overturned more than 180 degrees (dip direction to right), for multiple observations at one locality—Showing strike and dip		.7 mm 20 HI-6 .375 mm radius	
6.12	Bedding overturned more than 180 degrees (dip direction to left), for multiple observations at one locality—Showing strike and dip		20	
6.13	Inclined bedding, where top direction of beds is known from local features—Showing strike and dip		1.0 mm 30 HI-6 5.0 mm all lineweights .2 mm dot diameter .75 mm	Symbols that have a ball may be used to indicate a greater level of certainty in the determination of top direction.
6.14	Vertical bedding, where top direction of beds is known from local features—Showing strike. Ball shows top direction		2.0 mm	
6.15	Overturned bedding, where top direction of beds is known from local features—Showing strike and dip		1.0 mm 85 HI-6 .625 mm radius	On maps where determination of top direction is "known" at some places and "unknown" at others, symbols that have a ball also may be used to indicate where top direction is "known" (compare with ref. nos. 6.1-12).
6.16	Bedding overturned more than 180 degrees, where top direction of beds is known from local features—Showing strike and dip		.7 mm 10 HI-6 .375 mm radius	
6.17	Inclined (dip direction to right) bedding, where top direction of beds is known from local features, for multiple observations at one locality—Showing strike and dip		5.5 mm 30 HI-6 1.0 mm 1.325 mm	
6.18	Inclined (dip direction to left) bedding, where top direction of beds is known from local features, for multiple observations at one locality—Showing strike and dip		30	
6.19	Vertical (top direction to right) bedding, where top direction of beds is known from local features, for multiple observations at one locality—Showing strike. Ball shows top direction		2.0 mm	
6.20	Vertical (top direction to left) bedding, where top direction of beds is known from local features, for multiple observations at one locality—Showing strike. Ball shows top direction			
6.21	Overturned (dip direction to right) bedding, where top direction of beds is known from local features, for multiple observations at one locality—Showing strike and dip		.625 mm radius 85 HI-6 1.0 mm 1.7 mm	
6.22	Overturned (dip direction to left) bedding, where top direction of beds is known from local features, for multiple observations at one locality—Showing strike and dip		85	
6.23	Bedding overturned more than 180 degrees (dip direction to right), where top direction of beds is known from local features, for multiple observations at one locality—Showing strike and dip		.7 mm 10 HI-6 .375 mm radius 1.325 mm	
6.24	Bedding overturned more than 180 degrees (dip direction to left), where top direction of beds is known from local features, for multiple observations at one locality—Showing strike and dip		10	

*For more information, see general guidelines on pages A-1 to A-v.

6—BEDDING (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*	
6.25	Inclined crenulated, warped, undulatory, or contorted bedding—Showing approximate strike and dip			Symbols may be used without a dip value to indicate the generalized strike and direction of dip of beds.	
6.26	Vertical or near-vertical crenulated, warped, undulatory, or contorted bedding—Showing approximate strike				
6.27	Inclined graded bedding—Showing strike and dip				
6.28	Vertical or near-vertical graded bedding—Showing strike				
6.29	Overtuned graded bedding—Showing strike and dip				
6.30	Inclined bedding in crossbedded rocks—Showing approximate strike and dip				
6.31	Vertical or near-vertical bedding in crossbedded rocks—Showing approximate strike				
6.32	Overtuned bedding in crossbedded rocks—Showing approximate strike and dip				
6.33	Approximate orientation of inclined bedding—Showing approximate strike and dip				Use when the measurement of strike and (or) dip value is approximate but the location of observation is accurate. Symbols that have a ball may be used to indicate a greater level of certainty in the determination of top direction. On maps where determination of top direction is "known" at some places and "unknown" at others, symbols that have a ball also may be used to indicate where top direction is "known".
6.34	Approximate orientation of vertical or near-vertical bedding—Showing approximate strike				
6.35	Approximate orientation of overturned bedding—Showing approximate strike and dip				
6.36	Approximate orientation of inclined bedding, where top direction of beds is known from local features—Showing approximate strike and dip				
6.37	Approximate orientation of vertical or near-vertical bedding, where top direction of beds is known from local features—Showing approximate strike. Ball shows top direction				
6.38	Approximate orientation of overturned bedding, where top direction of beds is known from local features—Showing approximate strike and dip				
6.39	Horizontal bedding, as determined remotely or from aerial photographs				
6.40	Gently inclined (between 0° and 30°) bedding, as determined remotely or from aerial photographs—Showing approximate strike and direction of dip				
6.41	Moderately inclined (between 30° and 60°) bedding, as determined remotely or from aerial photographs				
6.42	Steeply inclined (between 60° and 90°) bedding, as determined remotely or from aerial photographs—Showing approximate strike and direction of dip				
6.43	Vertical or near-vertical bedding, as determined remotely or from aerial photographs—Showing approximate strike				
6.44	Gently overturned (between 0° and 30°) bedding, as determined remotely or from aerial photographs				
6.45	Moderately overturned (between 30° and 60°) bedding, as determined remotely or from aerial photographs				
6.46	Steeply overturned (between 60° and 90°) bedding, as determined remotely or from aerial photographs				

*For more information, see general guidelines on pages A-1 to A-9.

7—CLEAVAGE

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
7.1	Horizontal cleavage (generic or type unspecified)		all lineweights .2 mm 	For symbols representing a single observation at one locality, point of observation is the mid-point of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
7.2	Inclined cleavage (generic or type unspecified)—Showing strike and dip		HI-6 	
7.3	Vertical cleavage (generic or type unspecified)—Showing strike			
7.4	Inclined (dip direction to right) cleavage (generic or type unspecified), for multiple observations at one locality—Showing strike and dip		HI-6 	
7.5	Inclined (dip direction to left) cleavage (generic or type unspecified), for multiple observations at one locality—Showing strike and dip			
7.6	Vertical cleavage (generic or type unspecified), for multiple observations at one locality—Showing strike			
7.7	Horizontal continuous, slaty cleavage		all lineweights .2 mm 	
7.8	Inclined continuous, slaty cleavage—Showing strike and dip		HI-6 	
7.9	Vertical continuous, slaty cleavage—Showing strike			
7.10	Inclined (dip direction to right) continuous, slaty cleavage, for multiple observations at one locality—Showing strike and dip		HI-6 	
7.11	Inclined (dip direction to left) continuous, slaty cleavage, for multiple observations at one locality—Showing strike and dip			
7.12	Vertical continuous slaty, cleavage, for multiple observations at one locality—Showing strike			
7.13	Horizontal disjunctive, spaced cleavage		all lineweights .2 mm 	
7.14	Inclined disjunctive, spaced cleavage—Showing strike and dip		HI-6 	
7.15	Vertical disjunctive, spaced cleavage—Showing strike			
7.16	Inclined (dip direction to right) disjunctive, spaced cleavage, for multiple observations at one locality—Showing strike and dip		HI-6 	
7.17	Inclined (dip direction to left) disjunctive, spaced cleavage, for multiple observations at one locality—Showing strike and dip			
7.18	Vertical disjunctive, spaced cleavage, for multiple observations at one locality—Showing strike			
7.19	Horizontal disjunctive, symmetric crenulation cleavage		all lineweights .2 mm 	
7.20	Inclined disjunctive, symmetric crenulation cleavage—Showing strike and dip		HI-6 	
7.21	Vertical or near-vertical disjunctive, symmetric crenulation cleavage—Showing strike			
7.22	Inclined (dip direction to right) disjunctive, symmetric crenulation cleavage, for multiple observations at one locality—Showing strike and dip		HI-6 	
7.23	Inclined (dip direction to left) disjunctive, symmetric crenulation cleavage, for multiple observations at one locality—Showing strike and dip			
7.24	Vertical or near-vertical disjunctive, symmetric crenulation cleavage, for multiple observations at one locality—Showing strike			

*For more information, see general guidelines on pages A-i to A-v.

7—CLEAVAGE (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
7.25	Horizontal disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation cleavage		all lineweights .2 mm 4.0 mm 4.0 mm draft as shown long dash length 1.0 mm; short dash .5 mm; spacing .5 mm	For symbols representing a single observation at one locality, point of observation is the mid-point of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
7.26	Inclined disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation cleavage—Showing strike and dip		HI-6 1.0 mm 4.0 mm 5.0 mm draft as shown	
7.27	Vertical or near-vertical disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation cleavage—Showing strike		 1.5 mm	
7.28	Inclined (dip direction to right) disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation cleavage, for multiple observations at one locality—Showing strike and dip		HI-6 1.0 mm 5.5 mm 4.0 mm draft as shown	
7.29	Inclined (dip direction to left) disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation cleavage, for multiple observations at one locality—Showing strike and dip		 4.0 mm	
7.30	Vertical or near-vertical disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation cleavage, for multiple observations at one locality—Showing strike		 1.5 mm	
7.31	Horizontal disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation cleavage		all lineweights .2 mm 4.0 mm 4.0 mm draft as shown long dash length 1.0 mm; short dash .5 mm; spacing .5 mm	
7.32	Inclined disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation cleavage—Showing strike and dip		HI-6 1.0 mm 4.5 mm 5.0 mm draft as shown	
7.33	Vertical or near-vertical disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation cleavage—Showing strike		 1.5 mm	
7.34	Inclined (dip direction to right) disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation cleavage, for multiple observations at one locality—Showing strike and dip		HI-6 1.0 mm 5.5 mm 4.5 mm draft as shown	
7.35	Inclined (dip direction to left) disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation cleavage, for multiple observations at one locality—Showing strike and dip		 4.5 mm	
7.36	Vertical or near-vertical disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation cleavage, for multiple observations at one locality—Showing strike		 1.5 mm	

*For more information, see general guidelines on pages A-i to A-v.

8—FOLIATION

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
8.1—Generic foliation (origin not known or not specified)				
8.1.1	Horizontal generic (origin not known or not specified) foliation		all lineweights .2 mm 90° 1.5 mm circle diameter 2.5 mm	For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.1.2	Inclined generic (origin not known or not specified) foliation—Showing strike and dip		1.0 mm 90° 55 HI-6 5.0 mm all lineweights .2 mm	
8.1.3	Vertical generic (origin not known or not specified) foliation—Showing strike		2.0 mm	
8.1.4	Inclined (dip direction to right) generic (origin not known or not specified) foliation, for multiple observations at one locality—Showing strike and dip		5.5 mm 55 HI-6 1.0 mm 90°	
8.1.5	Inclined (dip direction to left) generic (origin not known or not specified) foliation, for multiple observations at one locality—Showing strike and dip		55	
8.1.6	Vertical generic (origin not known or not specified) foliation or foliation, for multiple observations at one locality—Showing strike		2.0 mm	
8.2—Primary foliation or layering (in igneous rocks)				
8.2.1	Massive igneous rock		dot diameter .35 mm 2.0 mm 90°	May be used at locality where foliation and lineation are absent.
8.2.2	Horizontal flow banding, lamination, layering, or foliation in igneous rock		all lineweights .2 mm 60° circle diameter 2.5 mm	For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.2.3	Inclined flow banding, lamination, layering, or foliation in igneous rock—Showing strike and dip		1.0 mm 60° 10 HI-6 5.0 mm all lineweights .2 mm	
8.2.4	Vertical flow banding, lamination, layering, or foliation in igneous rock—Showing strike		2.0 mm	For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.2.5	Inclined (dip direction to right) flow banding, lamination, layering, or foliation in igneous rock, for multiple observations at one locality—Showing strike and dip		5.5 mm 10 HI-6 1.0 mm 60°	
8.2.6	Inclined (dip direction to left) flow banding, lamination, layering, or foliation in igneous rock, for multiple observations at one locality—Showing strike and dip		10	For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.2.7	Vertical flow banding, lamination, layering, or foliation in igneous rock, for multiple observations at one locality—Showing strike		2.0 mm	
8.2.8	Inclined crinkled or deformed flow banding, lamination, layering, or foliation in igneous rock—Showing approximate strike and dip		1.0 mm 60° 20 HI-6 all lineweights .2 mm 5.0 mm 375 mm .75 mm radius	For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.2.9	Vertical or near-vertical crinkled or deformed flow banding, lamination, layering, or foliation in igneous rock—Showing approximate strike		2.0 mm	
8.2.10	Horizontal cumulate foliation		all lineweights .2 mm circle diameter 2.5 mm 5.5 mm	Inclined (upright) and overturned cumulate foliation symbols are used when the top direction of layers is known to a reasonable degree of certainty.
8.2.11	Inclined cumulate foliation—Showing strike and dip		all lineweights .2 mm 1.0 mm 45 HI-6 5.5 mm	Symbols that have a ball may be used to indicate a greater level of certainty in the determination of top direction.
8.2.12	Vertical cumulate foliation—Showing strike		2.5 mm	
8.2.13	Overturned cumulate foliation—Showing strike and dip		1.0 mm 70 HI-6 .625 mm radius	On maps where determination of top direction is "known" at some places and "unknown" at others, symbols that have a ball also may be used to indicate where top direction is "known".
8.2.14	Inclined cumulate foliation, where top direction of layers is known from local features—Showing strike and dip		all lineweights .2 mm .5 mm 30 HI-6 1.0 mm 5.0 mm dot diameter .75 mm	
8.2.15	Vertical cumulate foliation, where top direction of layers is known from local features—Showing strike		2.5 mm	On maps where determination of top direction is "known" at some places and "unknown" at others, symbols that have a ball also may be used to indicate where top direction is "known".
8.2.16	Overturned cumulate foliation, where top direction of layers is known from local features—Showing strike and dip		1.0 mm 80 HI-6 .625 mm radius	

*For more information, see general guidelines on pages A-i to A-v.

8—FOLIATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
8.2—Primary foliation or layering (in igneous rocks) (continued)				
8.2.17	Inclined crinkled or deformed cumulate foliation—Showing approximate strike and dip			For symbols representing a single observation at one locality, point of observation is the mid-point of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.2.18	Vertical or near-vertical crinkled or deformed cumulate foliation—Showing approximate strike			
8.2.19	Horizontal eutaxitic foliation			
8.2.20	Inclined eutaxitic foliation—Showing strike and dip			
8.2.21	Vertical or near-vertical eutaxitic foliation—Showing strike			
8.2.22	Inclined (dip direction to right) eutaxitic foliation, for multiple observations at one locality—Showing strike and dip			
8.2.23	Inclined (dip direction to left) eutaxitic foliation, for multiple observations at one locality—Showing strike and dip			
8.2.24	Vertical or near-vertical eutaxitic foliation, for multiple observations at one locality—Showing strike			
8.2.25	Inclined crinkled or deformed eutaxitic foliation—Showing approximate strike and dip			
8.2.26	Vertical or near-vertical crinkled or deformed eutaxitic foliation—Showing approximate strike			

*For more information, see general guidelines on pages A-i to A-v.

8—FOLIATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
8.3—Secondary foliation (caused by metamorphism or tectonism)				
8.3.1	Horizontal metamorphic or tectonic foliation		circle diameter 2.5 mm line weight .2 mm 60°	For symbols representing a single observation at one locality, point of observation is the mid-point of the strike line.
8.3.2	Inclined metamorphic or tectonic foliation—Showing strike and dip		1.0 mm 35° HI-6 5.0 mm line weight .2 mm	
8.3.3	Vertical metamorphic or tectonic foliation—Showing strike		2.0 mm	For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.3.4	Inclined (dip direction to right) metamorphic or tectonic foliation, for multiple observations at one locality—Showing strike and dip		5.5 mm 35° HI-6 1.0 mm 60°	
8.3.5	Inclined (dip direction to left) metamorphic or tectonic foliation, for multiple observations at one locality—Showing strike and dip		35°	Inclined (upright) and overturned foliation symbols are used when the top direction of bedding is known to a reasonable degree of certainty.
8.3.6	Vertical metamorphic or tectonic foliation, for multiple observations at one locality—Showing strike		2.0 mm	
8.3.7	Horizontal metamorphic or tectonic foliation parallel to bedding		circle diameter 2.5 mm all line weights .2 mm	Symbols that have a ball may be used to indicate a greater level of certainty in the determination of top direction.
8.3.8	Inclined metamorphic or tectonic foliation parallel to bedding—Showing strike and dip		1.0 mm 10° HI-6 1.0 mm 5.0 mm all line weights .2 mm	
8.3.9	Vertical metamorphic or tectonic foliation parallel to bedding—Showing strike		4.0 mm 2.0 mm	On maps where determination of top direction is "known" at some places and "unknown" at others, symbols that have a ball also may be used to indicate where top direction is "known".
8.3.10	Inclined metamorphic or tectonic foliation parallel to overturned bedding—Showing strike and dip		75° HI-6 .625 mm radius	
8.3.11	Inclined metamorphic or tectonic foliation parallel to upright bedding, where top direction of beds is known from local features—Showing strike and dip		1.0 mm 15° HI-6 1.0 mm 5.0 mm dot diameter .75 mm all line weights .2 mm	
8.3.12	Vertical metamorphic or tectonic foliation parallel to bedding, where top direction of beds is known from local features—Showing strike. Ball shows top direction		4.0 mm 2.0 mm	
8.3.13	Inclined metamorphic or tectonic foliation parallel to overturned bedding, where top direction of beds is known from local features—Showing strike and dip		85° HI-6 .625 mm radius	
8.3.14	Inclined crinkled or deformed metamorphic or tectonic foliation—Showing approximate strike and dip		30° HI-6 1.0 mm 375 mm 5.0 mm line weight .2 mm .75 mm radius	
8.3.15	Vertical or near-vertical crinkled or deformed metamorphic or tectonic foliation—Showing approximate strike		2.0 mm	
8.3.16	Horizontal continuous, penetrative foliation		1.0 mm 60° circle diameter 2.5 mm 5 mm all line weights .2 mm 4.25 mm	For symbols representing a single observation at one locality, point of observation is the mid-point of the strike line.
8.3.17	Inclined continuous, penetrative foliation—Showing strike and dip		1.0 mm 25° HI-6 1.0 mm 5.0 mm all line weights .2 mm	
8.3.18	Vertical continuous, penetrative foliation—Showing strike		2.0 mm	For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.3.19	Inclined (dip direction to right) continuous, penetrative foliation, for multiple observations at one locality—Showing strike and dip		5.5 mm 25° HI-6 1.0 mm 5 mm 1.0 mm 60°	
8.3.20	Inclined (dip direction to left) continuous, penetrative foliation, for multiple observations at one locality—Showing strike and dip		25°	
8.3.21	Vertical continuous, penetrative foliation, for multiple observations at one locality—Showing strike		2.0 mm	

*For more information, see general guidelines on pages A-1 to A-v.

8—FOLIATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
8.3—Secondary foliation (caused by metamorphism or tectonism) (continued)				
8.3.22	Horizontal disjunctive, spaced foliation		circle diameter 2.5 mm all lineweights .2 mm 60° 1.0 mm 3.6 mm	For symbols representing a single observation at one locality, point of observation is the mid-point of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.3.23	Inclined disjunctive, spaced foliation—Showing strike and dip		HI-6 60° 1.0 mm 5.0 mm 1.0 mm	
8.3.24	Vertical disjunctive, spaced foliation—Showing strike		2.0 mm	
8.3.25	Inclined (dip direction to right) disjunctive, spaced foliation, for multiple observations at one locality—Showing strike and dip		5.5 mm 30° 1.0 mm 1.0 mm 60°	
8.3.26	Inclined (dip direction to left) disjunctive, spaced foliation—Showing strike and dip		30°	
8.3.27	Vertical disjunctive, spaced foliation, for multiple observations at one locality—Showing strike		2.0 mm	
8.3.28	Horizontal disjunctive, symmetric crenulation foliation		circle diameter 2.5 mm draft as shown 60° all lineweights .2 mm	
8.3.29	Inclined disjunctive, symmetric crenulation foliation—Showing strike and dip		draft as shown 60° HI-6 1.0 mm 5.0 mm 1.0 mm	
8.3.30	Vertical or near-vertical disjunctive, symmetric crenulation foliation—Showing strike		2.0 mm	
8.3.31	Inclined (dip direction to right) disjunctive, symmetric crenulation foliation, for multiple observations at one locality—Showing strike and dip		5.5 mm 35° 1.0 mm 1.0 mm 60° draft as shown	
8.3.32	Inclined (dip direction to left) disjunctive, symmetric crenulation foliation, for multiple observations at one locality—Showing strike and dip		35°	
8.3.33	Vertical or near-vertical disjunctive, symmetric crenulation foliation, for multiple observations at one locality—Showing strike		2.0 mm	
8.3.34	Horizontal disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation foliation		circle diameter 2.5 mm draft as shown 60° all lineweights .2 mm	
8.3.35	Inclined disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation foliation—Showing strike and dip		HI-6 60° 1.0 mm 5.0 mm 1.0 mm draft as shown	
8.3.36	Vertical or near-vertical disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation foliation—Showing strike		2.0 mm	
8.3.37	Inclined (dip direction to right) disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation foliation, for multiple observations at one locality—Showing strike and dip		5.5 mm 40° 1.0 mm 1.0 mm 60° draft as shown	
8.3.38	Inclined (dip direction to left) disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation foliation, for multiple observations at one locality—Showing strike and dip		40°	
8.3.39	Vertical or near-vertical disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation foliation, for multiple observations at one locality—Showing strike		2.0 mm	
8.3.40	Horizontal disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation foliation		circle diameter 2.5 mm draft as shown 60° all lineweights .2 mm	
8.3.41	Inclined disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation foliation—Showing strike and dip		HI-6 60° 1.0 mm 5.0 mm 1.0 mm draft as shown	
8.3.42	Vertical or near-vertical disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation foliation—Showing strike		2.0 mm	
8.3.43	Inclined (dip direction to right) disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation foliation, for multiple observations at one locality—Showing strike and dip		5.5 mm 45° 1.0 mm 1.0 mm 60° draft as shown	
8.3.44	Inclined (dip direction to left) disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation foliation, for multiple observations at one locality—Showing strike and dip		45°	
8.3.45	Vertical or near-vertical disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation foliation, for multiple observations at one locality—Showing strike		2.0 mm	

8—FOLIATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
8.3—Secondary foliation (caused by metamorphism or tectonism) (continued)				
8.3.46	Horizontal gneissic layering		circle diameter 2.5 mm all lineweights .2 mm	For symbols representing a single observation at one locality, point of observation is the mid-point of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.3.47	Inclined gneissic layering—Showing strike and dip		circle diameter 2.5 mm all lineweights .2 mm HI-6 60° 1.0 mm 5.0 mm 1.0 mm	
8.3.48	Vertical or near-vertical gneissic layering—Showing strike		2.0 mm	
8.3.49	Inclined (dip direction to right) gneissic layering, for multiple observations at one locality—Showing strike and dip		5.5 mm 50 HI-6 1.0 mm 60° 1.0 mm	
8.3.50	Inclined (dip direction to left) gneissic layering, for multiple observations at one locality—Showing strike and dip		50	
8.3.51	Vertical or near-vertical gneissic layering, for multiple observations at one locality—Showing strike		2.0 mm	
8.3.52	Horizontal undulatory gneissic layering		circle diameter 2.5 mm all lineweights .2 mm 1.0 mm 1.5 mm radius 5.0 mm 3.75 mm	
8.3.53	Inclined undulatory gneissic layering—Showing strike and dip		HI-6 60° 1.0 mm 55 1.5 mm radius 1.0 mm 3.75 mm 5.0 mm all lineweights .2 mm	
8.3.54	Vertical or near-vertical undulatory gneissic layering—Showing strike		2.0 mm	
8.3.55	Horizontal mylonitic foliation		circle diameter 2.5 mm all lineweights .2 mm 1.5 mm 1.475 mm	
8.3.56	Inclined mylonitic foliation—Showing strike and dip		HI-6 60° 1.0 mm 1.5 mm 1.475 mm 5.0 mm	
8.3.57	Vertical or near-vertical mylonitic foliation—Showing strike		2.0 mm	
8.3.58	Inclined (dip direction to right) mylonitic foliation, for multiple observations at one locality—Showing strike and dip		5.5 mm 60 HI-6 1.5 mm 60° 1.0 mm	
8.3.59	Inclined (dip direction to left) mylonitic foliation, for multiple observations at one locality—Showing strike and dip		60	
8.3.60	Vertical or near-vertical mylonitic foliation, for multiple observations at one locality—Showing strike		2.0 mm	

*For more information, see general guidelines on pages A-i to A-v.

9—LINEATION

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
9.1	Approximate plunge direction of inclined generic (origin or type not known or not specified) lineation or linear structure (1st option)		lineweight .2 mm 	Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular lineation. Lineation symbols may be used separately or combined with other symbols. For lineation symbols representing a single observation at one locality, the point of observation is at one of the following two places: for inclined lineations, at the "tail" end (opposite the arrow-head); for horizontal lineations, at the "tail" end (opposite the arrow-head); for a single lineation symbol combined with a single planar-feature (for example, bedding or foliation) symbol, join the "tail" end of the lineation arrow to the midpoint of the strike line of the planar-feature symbol; the junction point is at the point of observation. For multiple observations at one locality, join all symbols at their "tail" ends (opposite the arrowheads or other ornamentations); the junction point is at the point of observation.
9.2	Approximate plunge direction of inclined generic (origin or type not known or not specified) lineation or linear structure (2nd option)		all lineweights .2 mm 	
9.3	Inclined generic (origin or type not known or not specified) lineation or linear structure (1st option)—Showing bearing and plunge			
9.4	Inclined generic (origin or type not known or not specified) lineation or linear structure (2nd option)—Showing bearing and plunge			
9.5	Horizontal generic (origin or type not known or not specified) lineation or linear structure (1st option)—Showing bearing		lineweight .2 mm 	
9.6	Horizontal generic (origin or type not known or not specified) lineation or linear structure (2nd option)—Showing bearing		all lineweights .2 mm 	
9.7	Vertical or near-vertical generic (origin or type not known or not specified) lineation or linear structure (1st option)		all lineweights .2 mm 	
9.8	Vertical or near-vertical generic (origin or type not known or not specified) lineation or linear structure (2nd option)			
9.9	Inclined parting lineation in sedimentary materials (1st option)—Showing bearing and plunge		all lineweights .2 mm 	
9.10	Inclined parting lineation in sedimentary materials (2nd option)—Showing bearing and plunge			
9.11	Horizontal parting lineation in sedimentary materials (1st option)—Showing bearing		all lineweights .2 mm 	
9.12	Horizontal parting lineation in sedimentary materials (2nd option)—Showing bearing			
9.13	Inclined sole mark, tool mark, scour mark, flute mark, groove, or channel in sedimentary materials (1st option)—Showing bearing and plunge		2.0 mm lineweight .2 mm 	
9.14	Inclined sole mark, tool mark, scour mark, flute mark, groove, or channel in sedimentary materials (2nd option)—Showing bearing and plunge		all lineweights .2 mm 	
9.15	Horizontal sole mark, tool mark, scour mark, flute mark, groove, or channel in sedimentary materials (1st option)—Showing bearing		2.0 mm lineweight .2 mm 	
9.16	Horizontal sole mark, tool mark, scour mark, flute mark, groove, or channel in sedimentary materials (2nd option)—Showing bearing		all lineweights .2 mm 	
9.17	Inclined slickenline, groove, or striation on fault surface (1st option)—Showing bearing and plunge		lineweight .2 mm 	
9.18	Inclined slickenline, groove, or striation on fault surface (2nd option)—Showing bearing and plunge		all lineweights .2 mm 	
9.19	Horizontal slickenline, groove, or striation on fault surface (1st option)—Showing bearing		lineweight .2 mm 	
9.20	Horizontal slickenline, groove, or striation on fault surface (2nd option)—Showing bearing		all lineweights .2 mm 	
9.21	Inclined surface groove or striation (origin not known or not specified) (1st option)—Showing bearing and plunge		all lineweights .2 mm 	
9.22	Inclined surface groove or striation (origin not known or not specified) (2nd option)—Showing bearing and plunge			
9.23	Horizontal surface groove or striation (origin not known or not specified) (1st option)—Showing bearing		all lineweights .2 mm 	
9.24	Horizontal surface groove or striation (origin not known or not specified) (2nd option)—Showing bearing			

*For more information, see general guidelines on pages A-i to A-v.

9—LINEATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
9.25	Inclined aligned-object lineation (1st option)—Showing bearing and plunge		dot diameter 1.0 mm 	Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular lineation.
9.26	Inclined aligned-object lineation (2nd option)—Showing bearing and plunge		all lineweights .2 mm 	
9.27	Horizontal aligned-object lineation (1st option)—Showing bearing		dot diameter 1.0 mm 	Lineation symbols may be used separately or combined with other symbols.
9.28	Horizontal aligned-object lineation (2nd option)—Showing bearing		all lineweights .2 mm 	
9.29	Inclined aligned-clast or aligned-grain lineation (in sedimentary materials) (1st option)—Showing bearing and plunge		2.425 mm 	For lineation symbols representing a single observation at one locality, the point of observation is at one of the following two places: for inclined lineations, at the "tail" end (opposite the arrow-head); for horizontal lineations, at the midpoint of the bearing line.
9.30	Inclined aligned-clast or aligned-grain lineation (in sedimentary materials) (2nd option)—Showing bearing and plunge		all lineweights .2 mm 	
9.31	Horizontal aligned-clast or aligned-grain lineation (in sedimentary materials) (1st option)—Showing bearing		2.425 mm 	For a single lineation symbol combined with a single planar-feature (for example, bedding or foliation) symbol, join the "tail" end of the lineation arrow to the midpoint of the strike line of the planar-feature symbol; the junction point is at the point of observation.
9.32	Horizontal aligned-clast or aligned-grain lineation (in sedimentary materials) (2nd option)—Showing bearing		all lineweights .2 mm 	
9.33	Inclined aligned-inclusion lineation (in igneous rocks) (1st option)—Showing bearing and plunge		circle diameter 1.0 mm 	For multiple observations at one locality, join all symbols at their "tail" ends (opposite the arrowheads or other ornamentations); the junction point is at the point of observation.
9.34	Inclined aligned-inclusion lineation (in igneous rocks) (2nd option)—Showing bearing and plunge		all lineweights .2 mm 	
9.35	Horizontal aligned-inclusion lineation (in igneous rocks) (1st option)—Showing bearing		circle diameter 1.0 mm 	
9.36	Horizontal aligned-inclusion lineation (in igneous rocks) (2nd option)—Showing bearing		all lineweights .2 mm 	
9.37	Inclined aligned-mineral lineation (1st option)—Showing bearing and plunge		1.0 mm 	
9.38	Inclined aligned-mineral lineation (2nd option)—Showing bearing and plunge		all lineweights .2 mm 	
9.39	Horizontal aligned-mineral lineation (1st option)—Showing bearing		1.0 mm 	
9.40	Horizontal aligned-mineral lineation (2nd option)—Showing bearing		all lineweights .2 mm 	
9.41	Inclined aligned mineral-aggregate lineation (1st option)—Showing bearing and plunge		.75 mm 	
9.42	Inclined aligned mineral-aggregate lineation (2nd option)—Showing bearing and plunge		all lineweights .2 mm 	
9.43	Horizontal aligned mineral-aggregate lineation (1st option)—Showing bearing		.75 mm 	
9.44	Horizontal aligned mineral-aggregate lineation (2nd option)—Showing bearing		all lineweights .2 mm 	
9.45	Inclined aligned deformed-mineral lineation (1st option)—Showing bearing and plunge		2.75 mm 	
9.46	Inclined aligned deformed-mineral lineation (2nd option)—Showing bearing and plunge		all lineweights .2 mm 	
9.47	Horizontal aligned deformed-mineral lineation (1st option)—Showing bearing		2.75 mm 	
9.48	Horizontal aligned deformed-mineral lineation (2nd option)—Showing bearing		all lineweights .2 mm 	

*For more information, see general guidelines on pages A-i to A-v.

9—LINEATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
9.49	Inclined aligned stretched-object lineation (1st option)—Showing bearing and plunge			Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular lineation. Lineation symbols may be used separately or combined with other symbols. For lineation symbols representing a single observation at one locality, the point of observation is at one of the following two places: for inclined lineations, at the "tail" end (opposite the arrow-head); for horizontal lineations, at the midpoint of the bearing line. For a single lineation symbol combined with a single planar-feature (for example, bedding or foliation) symbol, join the "tail" end of the lineation arrow to the midpoint of the strike line of the planar-feature symbol; the junction point is at the point of observation. For multiple observations at one locality, join all symbols at their "tail" ends (opposite the arrowheads or other ornamentations); the junction point is at the point of observation.
9.50	Inclined aligned stretched-object lineation (2nd option)—Showing bearing and plunge			
9.51	Horizontal aligned stretched-object lineation (1st option)—Showing bearing			
9.52	Horizontal aligned stretched-object lineation (2nd option)—Showing bearing			
9.53	Inclined aligned stretched-pebble lineation (1st option)—Showing bearing and plunge			
9.54	Inclined aligned stretched-pebble lineation (2nd option)—Showing bearing and plunge			
9.55	Horizontal aligned stretched-pebble lineation (1st option)—Showing bearing			
9.56	Horizontal aligned stretched-pebble lineation (2nd option)—Showing bearing			
9.57	Inclined aligned stretched-oid lineation (1st option)—Showing bearing and plunge			
9.58	Inclined aligned stretched-oid lineation (2nd option)—Showing bearing and plunge			
9.59	Horizontal aligned stretched-oid lineation (1st option)—Showing bearing			
9.60	Horizontal aligned stretched-oid lineation (2nd option)—Showing bearing			
9.61	Inclined rodding (1st option)—Showing bearing and plunge			
9.62	Inclined rodding (2nd option)—Showing bearing and plunge			
9.63	Horizontal rodding (1st option)—Showing bearing			
9.64	Horizontal rodding (2nd option)—Showing bearing			
9.65	Inclined mullions (1st option)—Showing bearing and plunge			
9.66	Inclined mullions (2nd option)—Showing bearing and plunge			
9.67	Horizontal mullions (1st option)—Showing bearing			
9.68	Horizontal mullions (2nd option)—Showing bearing			
9.69	Inclined boudins (1st option)—Showing bearing and plunge			
9.70	Inclined boudins (2nd option)—Showing bearing and plunge			
9.71	Horizontal boudins (1st option)—Showing bearing			
9.72	Horizontal boudins (2nd option)—Showing bearing			

*For more information, see general guidelines on pages A-i to A-v.

9—LINEATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
9.73	Inclined pencil structure (1st option)—Showing bearing and plunge		all lineweights .2 mm 	Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular lineation. Lineation symbols may be used separately or combined with other symbols. For lineation symbols representing a single observation at one locality, the point of observation is at one of the following two places: for inclined lineations, at the "tail" end (opposite the arrow-head); for horizontal lineations, at the midpoint of the bearing line. For a single lineation symbol combined with a single planar-feature (for example, bedding or foliation) symbol, join the "tail" end of the lineation arrow to the midpoint of the strike line of the planar-feature symbol; the junction point is at the point of observation. For multiple observations at one locality, join all symbols at their "tail" ends (opposite the arrowheads or other ornamentations); the junction point is at the point of observation.
9.74	Inclined pencil structure (2nd option)—Showing bearing and plunge			
9.75	Horizontal pencil structure (1st option)—Showing bearing		all lineweights .2 mm 	
9.76	Horizontal pencil structure (2nd option)—Showing bearing			
9.77	Inclined lineation at intersection of bedding and cleavage (1st option)—Showing bearing and plunge		all lineweights .2 mm 	
9.78	Inclined lineation at intersection of bedding and cleavage (2nd option)—Showing bearing and plunge			
9.79	Horizontal lineation at intersection of bedding and cleavage (1st option)—Showing bearing		all lineweights .2 mm 	
9.80	Horizontal lineation at intersection of bedding and cleavage (2nd option)—Showing bearing			
9.81	Inclined lineation at intersection of two cleavages (1st option)—Showing bearing and plunge		all lineweights .2 mm 	
9.82	Inclined lineation at intersection of two cleavages (2nd option)—Showing bearing and plunge			
9.83	Horizontal lineation at intersection of two cleavages (1st option)—Showing bearing		all lineweights .2 mm 	
9.84	Horizontal lineation at intersection of two cleavages (2nd option)—Showing bearing			
9.85	Inclined lineation at intersection of two fractures or joints (1st option)—Showing bearing and plunge		all lineweights .2 mm 	
9.86	Inclined lineation at intersection of two fractures or joints (2nd option)—Showing bearing and plunge			
9.87	Horizontal lineation at intersection of two fractures or joints (1st option)—Showing bearing		all lineweights .2 mm 	
9.88	Horizontal lineation at intersection of two fractures or joints (2nd option)—Showing bearing			
9.89	Inclined lineation at intersection of two foliations (1st option)—Showing bearing and plunge		all lineweights .2 mm 	
9.90	Inclined lineation at intersection of two foliations (2nd option)—Showing bearing and plunge			
9.91	Horizontal lineation at intersection of two foliations (1st option)—Showing bearing		all lineweights .2 mm 	
9.92	Horizontal lineation at intersection of two foliations (2nd option)—Showing bearing			
9.93	Inclined lineation at intersection of two surfaces (origin or type unspecified) (1st option)—Showing bearing and plunge		all lineweights .2 mm 	
9.94	Inclined lineation at intersection of two surfaces (origin or type unspecified) (2nd option)—Showing bearing and plunge			
9.95	Horizontal lineation at intersection of two surfaces (origin or type unspecified) (1st option)—Showing bearing		all lineweights .2 mm 	
9.96	Horizontal lineation at intersection of two surfaces (origin or type unspecified) (2nd option)—Showing bearing			

*For more information, see general guidelines on pages A-i to A-v.

9—LINEATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
9.97	Inclined fold hinge of generic (type or orientation unspecified) small, minor fold (1st option)—Showing bearing and plunge		dot diameter .5 mm color 100% magenta 2.75 mm 6.0 mm HI-6 (100% black) 20 25° 1.25 mm line weight .2 mm	Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular lineation. Lineation symbols may be used separately or combined with other symbols. For lineation symbols representing a single observation at one locality, the point of observation is at one of the following two places: for inclined lineations, at the "tail" end (opposite the arrow-head); for horizontal lineations, at the midpoint of the bearing line. For a single lineation symbol combined with a single planar-feature (for example, bedding or foliation) symbol, join the "tail" end of the lineation arrow to the midpoint of the strike line of the planar-feature symbol; the junction point is at the point of observation. For multiple observations at one locality, join all symbols at their "tail" ends (opposite the arrowheads or other ornamentations); the junction point is at the point of observation. May also be shown in black or other colors.
9.98	Inclined fold hinge of generic (type or orientation unspecified) small, minor fold (2nd option)—Showing bearing and plunge		all line weights .2 mm	
9.99	Horizontal fold hinge of generic (type or orientation unspecified) small, minor fold (1st option)—Showing bearing		dot diameter .5 mm 2.75 mm 6.0 mm 25° 1.25 mm line weight .2 mm color 100% magenta	
9.100	Horizontal fold hinge of generic (type or orientation unspecified) small, minor fold (2nd option)—Showing bearing		all line weights .2 mm	
9.101	Inclined fold hinge of small, minor penecontemporaneous soft-sediment fold (1st option)—Showing bearing and plunge		3.0 mm color 100% magenta 20 draft as shown	
9.102	Inclined fold hinge of small, minor penecontemporaneous soft-sediment fold (2nd option)—Showing bearing and plunge			
9.103	Horizontal fold hinge of small, minor penecontemporaneous soft-sediment fold (1st option)—Showing bearing		3.0 mm color 100% magenta draft as shown	
9.104	Horizontal fold hinge of small, minor penecontemporaneous soft-sediment fold (2nd option)—Showing bearing			
9.105	Inclined fold hinge of small, minor anticline (1st option)—Showing bearing and plunge		3.5 mm color 100% magenta 20 draft as shown	
9.106	Inclined fold hinge of small, minor anticline (2nd option)—Showing bearing and plunge			
9.107	Horizontal fold hinge of small, minor anticline (1st option)—Showing bearing. Ball on topographically higher side of fold		3.5 mm dot diameter .5 mm draft as shown 4 mm all line weights .2 mm color 100% magenta	
9.108	Horizontal fold hinge of small, minor anticline (2nd option)—Showing bearing. Ball on topographically higher side of fold			
9.109	Inclined fold hinge of small, minor antiform (1st option)—Showing bearing and plunge		3.3 mm color 100% magenta 20 draft as shown	
9.110	Inclined fold hinge of small, minor antiform (2nd option)—Showing bearing and plunge			
9.111	Horizontal fold hinge of small, minor antiform (1st option)—Showing bearing. Ball on topographically higher side of fold		3.5 mm dot diameter .5 mm draft as shown 4 mm all line weights .2 mm color 100% magenta	
9.112	Horizontal fold hinge of small, minor antiform (2nd option)—Showing bearing. Ball on topographically higher side of fold			
9.113	Inclined fold hinge of small, minor syncline (1st option)—Showing bearing and plunge		2.45 mm color 100% magenta 20 draft as shown	
9.114	Inclined fold hinge of small, minor syncline (2nd option)—Showing bearing and plunge			
9.115	Horizontal fold hinge of small, minor syncline (1st option)—Showing bearing. Ball on topographically higher side of fold		2.45 mm dot diameter .5 mm draft as shown 1.3 mm all line weights .2 mm color 100% magenta	
9.116	Horizontal fold hinge of small, minor syncline (2nd option)—Showing bearing. Ball on topographically higher side of fold			
9.117	Inclined fold hinge of small, minor synform (1st option)—Showing bearing and plunge		3.3 mm color 100% magenta 20 draft as shown	
9.118	Inclined fold hinge of small, minor synform (2nd option)—Showing bearing and plunge			
9.119	Horizontal fold hinge of small, minor synform (1st option)—Showing bearing. Ball on topographically higher side of fold		3.3 mm dot diameter .5 mm draft as shown 8 mm all line weights .2 mm color 100% magenta	
9.120	Horizontal fold hinge of small, minor synform (2nd option)—Showing bearing. Ball on topographically higher side of fold			

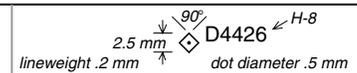
*For more information, see general guidelines on pages A-i to A-v.

9—LINEATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
9.121	Inclined symmetric minor fold hinge (1st option)— Showing bearing and plunge		color 100% magenta HI-6 (100% black) draft as shown 6.0 mm 25° 2.75 mm 1.25 mm all lineweights .2 mm	Open-armed ("2nd option") symbols may be used to show a second generation or another instance of a particular lineation. Lineation symbols may be used separately or combined with other symbols. For lineation symbols representing a single observation at one locality, the point of observation is at one of the following two places: for inclined lineations, at the "tail" end (opposite the arrow-head); for horizontal lineations, at the midpoint of the bearing line. For a single lineation symbol combined with a single planar-feature (for example, bedding or foliation) symbol, join the "tail" end of the lineation arrow to the midpoint of the strike line of the planar-feature symbol; the junction point is at the point of observation. For multiple observations at one locality, join all symbols at their "tail" ends (opposite the arrowheads or other ornamentations); the junction point is at the point of observation. May also be shown in black or other colors.
9.122	Inclined symmetric minor fold hinge (2nd option)— Showing bearing and plunge			
9.123	Horizontal symmetric minor fold hinge (1st option)— Showing bearing		color 100% magenta HI-6 (100% black) draft as shown 6.0 mm 25° 1.25 mm 2.5 mm all lineweights .2 mm	
9.124	Horizontal symmetric minor fold hinge (2nd option)— Showing bearing			
9.125	Inclined asymmetric (S-shaped, counterclockwise sense of shear) minor fold hinge (1st option)— Showing bearing and plunge		color 100% magenta HI-6 (100% black) draft as shown 3.0 mm all lineweights .2 mm	
9.126	Inclined asymmetric (S-shaped, counterclockwise sense of shear) minor fold hinge (2nd option)— Showing bearing and plunge			
9.127	Horizontal asymmetric (S-shaped, counterclockwise sense of shear) minor fold hinge (1st option)— Showing bearing		color 100% magenta HI-6 (100% black) draft as shown 3.0 mm all lineweights .2 mm	
9.128	Horizontal asymmetric (S-shaped, counterclockwise sense of shear) minor fold hinge (2nd option)— Showing bearing			
9.129	Inclined asymmetric (Z-shaped, clockwise sense of shear) minor fold hinge (1st option)— Showing bearing and plunge		color 100% magenta HI-6 (100% black) draft as shown 3.0 mm all lineweights .2 mm	
9.130	Inclined asymmetric (Z-shaped, clockwise sense of shear) minor fold hinge (2nd option)— Showing bearing and plunge			
9.131	Horizontal asymmetric (Z-shaped, clockwise sense of shear) minor fold hinge (1st option)— Showing bearing		color 100% magenta HI-6 (100% black) draft as shown 3.0 mm all lineweights .2 mm	
9.132	Horizontal asymmetric (Z-shaped, clockwise sense of shear) minor fold hinge (2nd option)— Showing bearing			
9.133	Inclined crenulation lineation (1st option)— Showing bearing and plunge		color 100% magenta HI-6 (100% black) draft as shown 3.0 mm all lineweights .2 mm	
9.134	Inclined crenulation lineation (2nd option)— Showing bearing and plunge			
9.135	Horizontal crenulation lineation (1st option)— Showing bearing		color 100% magenta HI-6 (100% black) draft as shown 3.0 mm all lineweights .2 mm	
9.136	Horizontal crenulation lineation (2nd option)— Showing bearing			
9.137	Inclined asymmetric (S-shaped, counterclockwise sense of shear) kink-band crenulation lineation (1st option)— Showing bearing and plunge		color 100% magenta HI-6 (100% black) draft as shown 3.0 mm all lineweights .2 mm	
9.138	Inclined asymmetric (S-shaped, counterclockwise sense of shear) kink-band crenulation lineation (2nd option)— Showing bearing and plunge			
9.139	Horizontal asymmetric (S-shaped, counterclockwise sense of shear) kink-band crenulation lineation (1st option)— Showing bearing		color 100% magenta HI-6 (100% black) draft as shown 3.0 mm all lineweights .2 mm	
9.140	Horizontal asymmetric (S-shaped, counterclockwise sense of shear) kink-band crenulation lineation (2nd option)— Showing bearing			
9.141	Inclined asymmetric (Z-shaped, clockwise sense of shear) kink-band crenulation lineation (1st option)— Showing bearing and plunge		color 100% magenta HI-6 (100% black) draft as shown 3.0 mm all lineweights .2 mm	
9.142	Inclined asymmetric (Z-shaped, clockwise sense of shear) kink-band crenulation lineation (2nd option)— Showing bearing and plunge			
9.143	Horizontal asymmetric (Z-shaped, clockwise sense of shear) kink-band crenulation lineation (1st option)— Showing bearing		color 100% magenta HI-6 (100% black) draft as shown 3.0 mm all lineweights .2 mm	
9.144	Horizontal asymmetric (Z-shaped, clockwise sense of shear) kink-band crenulation lineation (2nd option)— Showing bearing			

*For more information, see general guidelines on pages A-i to A-v.

10—PALEONTOLOGICAL FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
10.1—Fossil locality				
10.1.1	Fossil locality—Showing collection number	 D4426	 lineweight .2 mm 2.5 mm 90° H-8 dot diameter .5 mm	May be shown in red or other colors.

REF NO	DESCRIPTION	SYMBOL	REF NO	DESCRIPTION	SYMBOL	REF NO	DESCRIPTION	SYMBOL
10.2—Fossil symbols			10.2—Fossil symbols (continued)			10.2—Fossil symbols (continued)		
10.2.1	Macrofossils		10.2.23	Gastropods		10.2.45	Microfossils	
10.2.2	Invertebrates		10.2.24	Pelecypods		10.2.46	Conodonts	
10.2.3	Annelids		10.2.25	Sponges		10.2.47	Diatoms	
10.2.4	Arthropods		10.2.26	Vertebrates		10.2.48	Foraminifera	
10.2.5	Arachnids		10.2.27	Amphibians		10.2.49	Larger foraminifera, or fusulinids	
10.2.6	Crustaceans		10.2.28	Fish		10.2.50	Smaller, benthonic foraminifera	
10.2.7	Insects		10.2.29	Mammals		10.2.51	Smaller, planktonic foraminifera	
10.2.8	Trilobites		10.2.30	Reptiles		10.2.52	Nannofossils	
10.2.9	Brachiopods		10.2.31	Plants		10.2.53	Ostracodes	
10.2.10	Bryozoans		10.2.32	Leaves		10.2.54	Palynomorphs	
10.2.11	Cnidarians		10.2.33	Roots		10.2.55	Acritarchs	
10.2.12	Corals		10.2.34	Wood		10.2.56	Chitinozoans	
10.2.13	Stromatoporoids		10.2.35	Algae		10.2.57	Dinoflagellates	
10.2.14	Echinoderms		10.2.36	Conifers		10.2.58	Pollen and (or) spores	
10.2.15	Crinoids		10.2.37	Ferns		10.2.59	Radiolarians	
10.2.16	Echinoids		10.2.38	Flowering plants		10.2.60	Silicoflagellates	
10.2.17	Graptolites		10.2.39	Stromatolites		10.2.61	Spicules	
10.2.18	Mollusks		10.2.40	Fungi		CARTOGRAPHIC SPECIFICATIONS*		
10.2.19	Cephalopods		10.2.41	Trace fossils		all lineweights .125 mm draft as shown size may vary	 fill color 100% white	 fill color 100% black
10.2.20	Ammonoids		10.2.42	Burrows		NOTES ON USAGE*		
10.2.21	Belemnoids		10.2.43	Coprolites		Fossil symbols are usually reserved for use on stratigraphic columns, sections, or charts. Cartographic specifications (shown for two examples above) pertain to all fossil symbols.		
10.2.22	Nautiloids		10.2.44	Tracks		Fossil symbols may be reduced in size, and line-weights reduced accordingly; however, note that lineweights below .125 mm may not plot correctly if output at higher resolutions (1800 dpi or higher). May also be shown in other colors.		

11—GEOPHYSICAL AND STRUCTURE CONTOURS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
11.1	Geophysical contour (index)—Accurately located		lineweight .325 mm line and text color 100% red	On most maps, every fourth or fifth contour should be an index contour.
11.2	Geophysical contour (index)—Showing datum (in parentheses): SL, sea level			Only index contours are labeled. Negative values must be preceded by a minus (-) sign.
11.3	Geophysical contour (index)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm 5.0 mm 1.0 mm	Add hachures to indicate closed areas of low values or if it is unclear that contour values are decreasing (hachures point into areas of low value).
11.4	Geophysical contour (index)—Approximately located where data are incomplete		 .5 mm 4.5 mm	May be shown in black or other colors.
11.5	Geophysical contour (index)—Approximately located where data are incomplete. Hachures point into closed areas of lower values		hachure lineweight .2 mm 5.0 mm 1.0 mm	
11.6	Geophysical contour (intermediate)—Accurately located		lineweight .2 mm line color 100% red	
11.7	Geophysical contour (intermediate)—Accurately located. Hachures point into closed areas of lower values		all lineweights .2 mm 5.0 mm 1.0 mm	
11.8	Geophysical contour (intermediate)—Approximately located where data are incomplete		 .5 mm 4.5 mm	
11.9	Geophysical contour (intermediate)—Approximately located where data are incomplete. Hachures point into closed areas of lower values		 5.0 mm 1.0 mm	
11.10	Geophysical data collection locality		2.0 mm line color 100% red 90° lineweight .25 mm	May be shown in black or other colors.
11.11	Geophysical data collection locality—Showing value where known		752 line and text color 100% red HI-7	
11.12	Maximum or minimum intensity value within closed high or closed low		lineweights .15 mm 2.0 mm 30° HI-7 line and text color 100% red	
11.13	Structure contour, 1st surface (index)—Accurately located		lineweight .4 mm line and text color 100% red HI-9	On most maps, every fourth or fifth contour should be an index contour.
11.14	Structure contour, 1st surface (index)—Showing datum (in parentheses): SL, sea level			Only index contours are labeled. Negative values must be preceded by a minus (-) sign.
11.15	Structure contour, 1st surface (index)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm 5.5 mm 1.0 mm	Add hachures to indicate closed areas of low values or if it is unclear that contour values are decreasing (hachures point into areas of low value).
11.16	Structure contour, 1st surface (index)—Approximately located where control is poor		 .5 mm 5.0 mm	May be shown in black or other colors.
11.17	Structure contour, 1st surface (index)—Approximately located where control is poor. Hachures point into closed areas of lower values		 5.5 mm 1.0 mm	
11.18	Structure contour, 1st surface (intermediate)—Accurately located		lineweight .275 mm 	
11.19	Structure contour, 1st surface (intermediate)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm 5.5 mm 1.0 mm	
11.20	Structure contour, 1st surface (intermediate)—Approximately located where control is poor		 .5 mm 5.0 mm	
11.21	Structure contour, 1st surface (intermediate)—Approximately located where control is poor. Hachures point into closed areas of lower values		 5.5 mm 1.0 mm	
11.22	Outcrop point as structural control point (1st surface)		line and text color 100% red 90° HI-7 lineweight .275 mm	May be shown in black or other colors.

*For more information, see general guidelines on pages A-i to A-v.

11—GEOPHYSICAL AND STRUCTURE CONTOURS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
11.23	Structure contour, 2nd surface (index)—Accurately located		lineweight .4 mm line and text color 100% violet	On most maps, every fourth or fifth contour should be an index contour.
11.24	Structure contour, 2nd surface (index)—Showing datum (in parentheses): SL, sea level			Only index contours are labeled. Negative values must be preceded by a minus (-) sign.
11.25	Structure contour, 2nd surface (index)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm 	Add hachures to indicate closed areas of low values or if it is unclear that contour values are decreasing (hachures point into areas of low value).
11.26	Structure contour, 2nd surface (index)—Approximately located where control is poor			May be shown in black or other colors.
11.27	Structure contour, 2nd surface (index)—Approximately located where control is poor. Hachures point into closed areas of lower values			
11.28	Structure contour, 2nd surface (intermediate)—Accurately located		lineweight .275 mm 	
11.29	Structure contour, 2nd surface (intermediate)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm 	
11.30	Structure contour, 2nd surface (intermediate)—Approximately located where control is poor			
11.31	Structure contour, 2nd surface (intermediate)—Approximately located where control is poor. Hachures point into closed areas of lower values			
11.32	Outcrop point as structural control point (2nd surface)		line and text color 100% violet lineweight .275 mm 2.0 mm	May be shown in black or other colors.
11.33	Structure contour, 3rd surface (index)—Accurately located		lineweight .4 mm line and text color 100% green	On most maps, every fourth or fifth contour should be an index contour.
11.34	Structure contour, 3rd surface (index)—Showing datum (in parentheses): SL, sea level			Only index contours are labeled. Negative values must be preceded by a minus (-) sign.
11.35	Structure contour, 3rd surface (index)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm 	Add hachures to indicate closed areas of low values or if it is unclear that contour values are decreasing (hachures point into areas of low value).
11.36	Structure contour, 3rd surface (index)—Approximately located where control is poor			May be shown in black or other colors.
11.37	Structure contour, 3rd surface (index)—Approximately located where control is poor. Hachures point into closed areas of lower values			
11.38	Structure contour, 3rd surface (intermediate)—Accurately located		lineweight .275 mm 	
11.39	Structure contour, 3rd surface (intermediate)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm 	
11.40	Structure contour, 3rd surface (intermediate)—Approximately located where control is poor			
11.41	Structure contour, 3rd surface (intermediate)—Approximately located where control is poor. Hachures point into closed areas of lower values			
11.42	Outcrop point as structural control point (3rd surface)		line and text color 100% green lineweight .275 mm 2.0 mm	May be shown in black or other colors.

*For more information, see general guidelines on pages A-i to A-v.

12—FLUVIAL AND ALLUVIAL FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
12.1	Fluvial terrace scarp—Identity and existence certain, location accurate. Hachures point downscarp		<p>all lineweights .2 mm</p> <p>12.0 mm</p> <p>color 100% cyan</p>	May also be shown in black or other colors.
12.2	Fluvial terrace scarp—Identity or existence questionable, location accurate. Hachures point downscarp			
12.3	Fluvial terrace scarp—Identity and existence certain, location approximate. Hachures point downscarp		<p>3.5 mm</p> <p>.75 mm .75 mm</p>	
12.4	Fluvial terrace scarp—Identity or existence questionable, location approximate. Hachures point downscarp			
12.5	Fluvial transport direction		<p>lineweight .2 mm</p> <p>color 100% cyan</p>	
12.6	Sediment transport direction determined from imbrication		<p>circle diameters .75 mm</p> <p>color 100% cyan</p> <p>all lineweights .2 mm</p>	
12.7	Sediment transport direction determined from crossbeds		<p>color 100% cyan</p> <p>all lineweights .2 mm</p>	
12.8	Sediment transport direction determined from flute casts		<p>color 100% cyan</p> <p>all lineweights .2 mm</p>	

*For more information, see general guidelines on pages A-i to A-v.

13—GLACIAL AND GLACIOFLUVIAL FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
13.1	Crevasse on glacier		lineweights .2 mm color 100% cyan lengths may vary	
13.2	Ice-flow direction		lineweight .25 mm color 100% cyan length may vary 60° 1.5 mm	
13.3	Glacial-lake spillway—Arrow shows direction of flow		color 100% cyan 1.25 mm lineweight .2 mm length may vary 25° 60° 2.0 mm	
13.4	Glacial-lake spillway—Showing elevation. Arrow shows direction of flow		785' HI-6 (100% black)	
13.5	Inferred glacial-lake spillway—Arrow shows direction of flow		all lineweights .2 mm	
13.6	Inferred glacial-lake spillway—Showing estimated elevation. Arrow shows direction of flow		785'	
13.7	Glacial meltwater stream—Barbs show direction of flow		all lineweights .2 mm 7.5 mm color 100% cyan spacing may vary 3.0 mm 2.25 mm ≤ 20°	
13.8	Cutbanks of glacial meltwater stream channel (mapped to scale)—Hachures point into channel		spacing may vary all lineweights .25 mm 1.125 mm color 100% cyan 3.0 mm	
13.9	Flow direction of glacial meltwater in stream channel		color 100% cyan all lineweights .2 mm stem lengths may vary 2.0 mm ≤ 25°	
13.10	Crest line of moraine, sense of symmetry unspecified (1st option)		color 100% cyan lineweight .2 mm circle diameter .75 mm; spacing .625 mm	
13.11	Crest line of moraine, sense of symmetry unspecified (2nd option)		color 100% cyan dot diameter .825 mm; spacing .625 mm	
13.12	Crest line of symmetrical moraine		color 100% cyan 3.0 mm .5 mm all lineweights .2 mm circle diameter .675 mm; hachure height 1.5 mm	
13.13	Crest line of asymmetrical moraine—Ticks point down steeper slope		hachure height .75 mm	
13.14	Ridges on moraine		color 100% cyan lineweight .25 mm lengths and spacing may vary	
13.15	Scarp at top of ice-contact slope—Hachures point downscarp		.5 mm 1.375 mm 12° color 100% cyan	
13.16	Ice-contact slope		pattern 521-C in 50% cyan	
13.17	Esker or ice-channel deposit, transport direction unknown		1.25 mm .375 mm .625 mm color 100% cyan lineweight .2 mm 70°	
13.18	Esker or ice-channel deposit, transport direction known (1st option)—Chevrons point in direction of transport		color 100% cyan 70° 1.25 mm lineweight .2 mm 1.0 mm	
13.19	Esker or ice-channel deposit, transport direction known (2nd option)—Chevrons point in direction of transport		color 100% cyan 70° 5.0 mm 1.25 mm lineweight .375 mm lineweight .2 mm	
13.20	Drumlin—Showing bearing and direction of flow		2.25 mm 1.25 mm 1.25 mm all lineweights .2 mm color 100% cyan 25° 1.875 mm 6.0 mm	Point of observation is at the midpoint of the bearing line.
13.21	Drumlin, flow direction unknown (1st option)—Showing bearing		1.875 mm 6.0 mm	May also be shown in black or other colors.
13.22	Drumlin, flow direction unknown (2nd option)—Showing bearing		1.75 mm 1.0 mm lineweight .2 mm color 100% cyan 3.5 mm	
13.23	Drumlin (length mapped to scale)—Showing bearing and direction of flow		color 100% cyan 1.25 mm draw length to scale 1.25 mm all lineweights .2 mm 25°	Use when map scale is large enough to show actual length of drumlin.
13.24	Drumlin (length mapped to scale), flow direction unknown—Showing bearing		draw length to scale	May also be shown in black or other colors.

*For more information, see general guidelines on pages A-i to A-v.

13—GLACIAL AND GLACIOFLUVIAL FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
13.25	Kettle		color 100% cyan 	May also be shown in black or other colors.
13.26	Hummocky topography (1st option)			
13.27	Hummocky topography (2nd option)			
13.28	Hummocky topography (3rd option)			
13.29	Younger glacial striation or groove—Showing general bearing and direction of flow		line weight .2 mm 	Point of observation is at the midpoint of the bearing line.
13.30	Younger glacial striation or groove—Showing measured bearing and direction of flow. Dot indicates location of observation point			May also be shown in black or other colors.
13.31	Older glacial striation or groove—Showing general bearing and direction of flow			
13.32	Older glacial striation or groove—Showing measured bearing and direction of flow. Open circle indicates location of observation point			
13.33	Younger glacial striation or groove, flow direction unknown—Showing general bearing		line weight .2 mm 	
13.34	Younger glacial striation or groove, flow direction unknown—Showing measured bearing. Dot indicates location of observation point			
13.35	Older glacial striation or groove, flow direction unknown—Showing general bearing		all line weights .2 mm 	
13.36	Older glacial striation or groove, flow direction unknown—Showing measured bearing. Open circle indicates location of observation point		all line weights .2 mm 	
13.37	Younger glacial striation or groove (length mapped to scale)—Arrow shows direction of flow		line weight .2 mm 	Use when map scale is large enough to show actual length of striation or groove.
13.38	Younger glacial striation or groove (length mapped to scale), flow direction unknown			May also be shown in black or other colors.
13.39	Older glacial striation or groove (length mapped to scale)—Arrow shows direction of flow		line weight .2 mm 	
13.40	Older glacial striation or groove (length mapped to scale), flow direction unknown			
13.41	Cirque headwall—Hachures point into cirque		line weight .2 mm 	
13.42	Arête or headwall of adjoining cirques		line weight .2 mm 	May also be shown in black or other colors.
13.43	Margin of glacially scoured basin—Identity and existence certain, location accurate. Hachures point into basin		all line weights .225 mm 	
13.44	Margin of glacially scoured basin—Identity or existence questionable, location accurate. Hachures point into basin			
13.45	Margin of glacially scoured basin—Identity and existence certain, location approximate. Hachures point into basin			
13.46	Margin of glacially scoured basin—Identity or existence questionable, location approximate. Hachures point into basin			
13.47	Margin of glacially scoured basin—Identity and existence certain, location concealed. Hachures point into basin			
13.48	Margin of glacially scoured basin—Identity or existence questionable, location concealed. Hachures point into basin			

*For more information, see general guidelines on pages A-i to A-v.

13—GLACIAL AND GLACIOFLUVIAL FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
13.49	Glacial limit or terminus—Identity and existence certain, location accurate		lineweight .45 mm color 100% cyan	May also be shown in black or other colors.
13.50	Glacial limit or terminus—Identity or existence questionable, location accurate			
13.51	Glacial limit or terminus—Identity and existence certain, location approximate			
13.52	Glacial limit or terminus—Identity or existence questionable, location approximate			
13.53	Glacial limit or terminus—Identity and existence certain, location inferred			
13.54	Glacial limit or terminus—Identity or existence questionable, location inferred			
13.55	Glacial limit or terminus—Identity and existence certain, location concealed			
13.56	Glacial limit or terminus—Identity or existence questionable, location concealed			
13.57	Glacial limit or terminus—Showing name of glaciation (BL, Bull Lake)			
13.58	Limit of significant glacial advance—Identity and existence certain, location accurate. Hachures on side of advancing ice		lineweight .3 mm color 100% cyan	
13.59	Limit of significant glacial advance—Identity or existence questionable, location accurate. Hachures on side of advancing ice			
13.60	Limit of significant glacial advance—Identity and existence certain, location approximate. Hachures on side of advancing ice			
13.61	Limit of significant glacial advance—Identity or existence questionable, location approximate. Hachures on side of advancing ice			
13.62	Limit of significant glacial advance—Identity and existence certain, location concealed. Hachures on side of advancing ice			
13.63	Limit of significant glacial advance—Identity or existence questionable, location concealed. Hachures on side of advancing ice			
13.64	Retreatal position of stagnant ice margin—Identity and existence certain, location accurate		lineweight .3 mm color 100% cyan	
13.65	Retreatal position of stagnant ice margin—Identity or existence questionable, location accurate			
13.66	Retreatal position of stagnant ice margin—Identity and existence certain, location approximate			
13.67	Retreatal position of stagnant ice margin—Identity or existence questionable, location approximate			
13.68	Retreatal position of stagnant ice margin—Identity and existence certain, location inferred			
13.69	Retreatal position of stagnant ice margin—Identity or existence questionable, location inferred			
13.70	Retreatal position of stagnant ice margin—Identity and existence certain, location concealed			
13.71	Retreatal position of stagnant ice margin—Identity or existence questionable, location concealed			
13.72	Retreatal position of stagnant ice margin—Showing name of depositional unit			

*For more information, see general guidelines on pages A-1 to A-v.

14—PERIGLACIAL FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
14.1	Pingo		all lineweights .2 mm 60° .875 mm color 100% cyan dot diameter .325 mm circle diameter 1.5 mm	May also be shown in black or other colors.
14.2	Periglacial patterned ground			
14.3	Polygonal patterned ground			
14.4	Sorted circles		diameter .9 mm color 100% cyan lineweight .2 mm	
14.5	Stone stripe, fine debris		circle diameter .9 mm; spacing .45 mm	
14.6	Stone stripe, coarse debris		circle lineweight .2 mm color 100% cyan dot diameter .5 mm; spacing 1.25 mm	
14.7	Solifluction lobes			
14.8	Ice-wedge polygon		2.25 mm color 100% cyan	
14.9	Ice-wedge polygons			
14.10	Felsenmeer			
14.11	Thermokarst depression		color 100% cyan all lineweights .2 mm hachure height 1.0 mm; spacing 1.75 mm	

*For more information, see general guidelines on pages A-i to A-v.

15—LACUSTRINE AND MARINE FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
15.1	Beach		color 100% cyan dot diameter .75 mm; spacing .75 mm	May also be shown in black or other colors.
15.2	Beach ridges		color 100% cyan lineweight .2 mm length and spacing may vary	
15.3	Marine-abrasion platform (1st option)		pattern 201-C (at 45°)	
15.4	Marine-abrasion platform (2nd option)		pattern 522-C	
15.5	Aggradational shoreline—Identity and existence certain, location accurate. Triangles point offshore		color 100% cyan lineweight .2 mm H-8	
15.6	Aggradational shoreline—Identity or existence questionable, location accurate. Triangles point offshore		1.5 mm 12.0 mm 2.0 mm 22° .75 mm	
15.7	Aggradational shoreline—Identity and existence certain, location approximate. Triangles point offshore		3.5 mm	
15.8	Aggradational shoreline—Identity or existence questionable, location approximate. Triangles point offshore		.75 mm .75 mm	
15.9	Erosional shoreline—Identity and existence certain, location accurate. Triangles point onshore		color 100% cyan lineweight .2 mm H-8	
15.10	Erosional shoreline—Identity or existence questionable, location accurate. Triangles point onshore		1.5 mm 12.0 mm 2.0 mm 22° .75 mm	
15.11	Erosional shoreline—Identity and existence certain, location approximate. Triangles point onshore		3.5 mm	
15.12	Erosional shoreline—Identity or existence questionable, location approximate. Triangles point onshore		.75 mm .75 mm	
15.13	Former shoreline or marine limit—Identity and existence certain, location accurate		lineweight .25 mm color 100% cyan H-8	
15.14	Former shoreline or marine limit—Identity or existence questionable, location accurate		.75 mm 12.0 mm	
15.15	Former shoreline or marine limit—Identity and existence certain, location approximate		3.5 mm	
15.16	Former shoreline or marine limit—Identity or existence questionable, location approximate		.75 mm .75 mm	
15.17	Former shoreline or marine limit—Identity and existence certain, location inferred		1.5 mm	
15.18	Former shoreline or marine limit—Identity or existence questionable, location inferred		.75 mm .75 mm	
15.19	Former shoreline or marine limit—Identity and existence certain, location concealed		.5 mm	
15.20	Former shoreline or marine limit—Identity or existence questionable, location concealed		.75 mm .75 mm	
15.21	Former shoreline or marine limit—Showing name (B, Bonneville)		H-8 (100% black)	

*For more information, see general guidelines on pages A-i to A-v.

15—LACUSTRINE AND MARINE FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
15.22	Shoreline cliff—Identity and existence certain, location accurate. Hachures point down cliff		color 100% cyan all lineweights .2 mm 	May also be shown in black or other colors.
15.23	Shoreline cliff—Identity or existence questionable, location accurate. Hachures point down cliff			
15.24	Shoreline cliff—Identity and existence certain, location approximate. Hachures point down cliff		3.5 mm 	
15.25	Shoreline cliff—Identity or existence questionable, location approximate. Hachures point down cliff			
15.26	Spit or bar—Identity and existence certain, location accurate		color 100% cyan all lineweights .2 mm 	
15.27	Spit or bar—Identity or existence questionable, location accurate			
15.28	Spit or bar—Identity and existence certain, location approximate		3.5 mm 	
15.29	Spit or bar—Identity or existence questionable, location approximate			

*For more information, see general guidelines on pages A-i to A-v.

16—EOLIAN FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
16.1	Dune crest		lineweight .25 mm dash .375 mm; space .3 mm	Dune forms shown by traces of dune crests.
16.2	Scarp on dune crest, caused by slip—Hachures point down slip face of dune		hachure lineweight .2 mm; height 1.0 mm; spacing 4.75 mm	
16.3	Blowout rim around closed depression of eolian origin in dune field—Hachures point into closed depression		all lineweights .15 mm hachure height .875 mm; spacing 3.5 mm long dash 1.4 mm; short dash .5 mm; space .375 mm	
16.4	Blowout rim around closed depression of eolian origin in bedrock—Accurately located. Hachures point into closed depression		all lineweights .2 mm hachure height .875 mm; spacing 2.5 mm	
16.5	Blowout rim around closed depression of eolian origin in bedrock—Approximately located. Hachures point into closed depression		2.5 mm 5 mm	
16.6	Edge of dry lakebed within closed depression of eolian origin in bedrock		lineweight .15 mm; dash length 1.5 mm; space .375 mm	
16.7	Sediment transport direction determined from dune forms		all lineweights .15 mm 1.5 mm .875 mm 5.0 mm .875 mm radius 20° 1.0 mm 1.25 mm	Point of observation is at the midpoint of the bearing line.
16.8	Sediment transport direction determined from dune bedding in horizontal section		1.25 mm .875 mm radius 1.5 mm 1.0 mm all lineweights .15 mm	
16.9	Sediment transport direction determined from eolian crossbedding in vertical or near-vertical section		.5 mm 2.5 mm 1.0 mm dot diameter .3 mm; spacing .225 mm 40°	

*For more information, see general guidelines on pages A-i to A-v.

17—LANDSLIDE AND MASS-WASTING FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
17.1	Outline of slip surface of landslide—Identity and existence certain, location accurate		linecolor 60% black lineweight .2 mm H-8 (60% black)	May be used to outline area of slip surface of landslide if desired. Do not use to outline landslide deposits (use a map-unit boundary contact instead).
17.2	Outline of slip surface of landslide—Identity or existence questionable, location accurate		12.0 mm .75 mm	
17.3	Outline of slip surface of landslide—Identity and existence certain, location approximate		3.5 mm	
17.4	Outline of slip surface of landslide—Identity or existence questionable, location approximate		.75 mm .75 mm	
17.5	Outline of slip surface of landslide—Identity and existence certain, location inferred		1.5 mm	
17.6	Outline of slip surface of landslide—Identity or existence questionable, location inferred		.75 mm .75 mm	
17.7	Outline of slip surface of landslide—Identity and existence certain, location concealed		.5 mm	
17.8	Outline of slip surface of landslide—Identity or existence questionable, location concealed		.75 mm .75 mm	
17.9	Area of slip surface of landslide		pattern 431-K in 50% black (rotated so lines parallel slip direction) outline of slip surface [lineweight .2 mm, in 60% black] contact [lineweight .15 mm] 50°/ 2.0 mm arrow lineweight .175 mm length and curve of arrow may vary	Downslope edge of slip surface is usually concealed by landslide deposits or debris materials. Landslide arrows may be shown singly or in pairs.
17.10	Direction of downslope movement of landslide			
17.11	Landslide deposits—Arrows show direction of downslope movement			
17.12	Head or main scarp of landslide—Active, sharp, distinct, and accurately located. Hachures point down scarp		all lineweights .25 mm hachure height 1.0 mm; spacing 1.75 mm	Place line along crown of scarp. May be shown in red or other colors.
17.13	Head or main scarp of landslide—Inactive, subdued, indistinct, and (or) approximately located. Hachures point down scarp		.5 mm 3.0 mm	
17.14	Head or main scarp of landslide—Showing height (in meters). Hachures point down scarp		0.8 HI-7	
17.15	Head or main scarp of rotated block in landslide—Arrow shows direction of oblique slip. Hachures point down scarp		5.0 mm 2.5 mm 15° arrow lineweight .175 mm	
17.16	Internal or minor scarp in landslide—Active, sharp, distinct, and accurately located. Hachures point down scarp		all lineweights .25 mm hachure height .75 mm; spacing 1.25 mm	
17.17	Internal or minor scarp in landslide—Inactive, subdued, indistinct, and (or) approximately located. Hachures point down scarp		.5 mm 2.0 mm	
17.18	Internal or minor scarp in landslide—Showing height (in meters). Hachures point down scarp		0.3 HI-6	
17.19	Internal or minor scarp of rotated block in landslide—Arrow shows direction of oblique slip. Hachures point down scarp		4.5 mm 15° 2.0 mm arrow lineweight .175 mm	

*For more information, see general guidelines on pages A-i to A-v.

17—LANDSLIDE AND MASS-WASTING FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
17.20	Main toe of landslide—Active, sharp, distinct, and accurately located		3.0 mm lineweight .25 mm	Place line along base of toe; sawteeth on over-riding block.
17.21	Main toe of landslide—Inactive, subdued, indistinct, and (or) approximately located		.5 mm 3.0 mm	May be shown in red or other colors.
17.22	Minor toe, internal thrust fault, or pressure ridge in landslide—Active, sharp, distinct, and accurately located		2.5 mm lineweight .25 mm	
17.23	Minor toe, internal thrust fault, or pressure ridge in landslide—Inactive, subdued, indistinct, and (or) approximately located		.5 mm 2.0 mm	
17.24	Minor toe, internal thrust fault, or pressure ridge in landslide, showing transport reversal—Active, sharp, distinct, and accurately located		lineweight .25 mm .85 mm	
17.25	Minor toe, internal thrust fault, or pressure ridge in landslide, showing transport reversal—Inactive, subdued, indistinct, and (or) approximately located		.5 mm 2.0 mm	
17.26	Right flank of landslide or right-lateral shear feature—Active, sharp, distinct, and accurately located		15° lineweight .25 mm arrow lineweight .175 mm	Arrow shows sense of lateral movement. Place arrow on side of moving ground or on displaced earth materials.
17.27	Right flank of landslide or right-lateral shear feature—Inactive, subdued, indistinct, and (or) approximately located		.5 mm 3.0 mm	
17.28	Right flank of landslide or right-lateral shear feature—Concealed by landslide deposits or debris materials		.5 mm 3.0 mm	In cross section, can also be used to show plane of slope failure. May be shown in red or other colors.
17.29	Right flank of landslide or right-lateral shear feature—Showing amount of offset (in meters)		2.3 2.3 HI-7	
17.30	Left flank of landslide or left-lateral shear feature—Active, sharp, distinct, and accurately located		2.5 mm lineweight .25 mm arrow lineweight .175 mm	
17.31	Left flank of landslide or left-lateral shear feature—Inactive, subdued, indistinct, and (or) approximately located		.5 mm 3.0 mm	
17.32	Left flank of landslide or left-lateral shear feature—Concealed by landslide deposits or debris materials		.5 mm 3.0 mm	
17.33	Left flank of landslide or left-lateral shear feature—Showing amount of offset (in meters)		2.3 2.3 HI-7	
17.34	Open tension crack or fracture on landslide		hachure height .5 mm all lineweights .2 mm	Hachures point into crack.
17.35	Tension crack or fracture on landslide (1st option)		1.0 mm all lineweights .2 mm	May be shown in red or other colors.
17.36	Tension crack or fracture on landslide (2nd option)		1.2 mm dash .375 mm; space .325 mm all lineweights .2 mm	
17.37	Tension crack or fracture on landslide (3rd option)		lineweight .2 mm	
17.38	En echelon cracks or fractures on landslide, indicating right-lateral shear		15° crack lineweights .2 mm arrow lineweight .175 mm	Arrow shows sense of lateral movement. May be shown in red or other colors.
17.39	En echelon cracks or fractures on landslide, indicating left-lateral shear		2.5 mm crack lineweights .2 mm arrow lineweight .175 mm	
17.40	Anticlinal soft-sediment fold, buckle fold, bulge, or linear ridge on landslide		line length can vary 2.0 mm lineweight .25 mm arrow lineweight .175 mm	May be shown in red or other colors.
17.41	Dome structure or bulge on landslide		line length can vary 60° 1.0 mm	
17.42	Synclinal soft-sediment fold or linear depression on landslide		lineweight .25 mm 1.0 mm line length can vary arrow lineweight .175 mm	
17.43	Basin structure or depression on landslide		1.0 mm line lengths can vary 60° .75 mm	

*For more information, see general guidelines on pages A-i to A-v.

17—LANDSLIDE AND MASS-WASTING FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
17.44	Crest line of lateral levee on landslide (1st option)		lineweights .175 mm .65 mm 1.0 mm \angle 60° 1.5 mm	
17.45	Crest line of lateral levee on landslide (2nd option)		lineweights .175 mm .65 mm 1.0 mm \angle 60° 1.5 mm	
17.46	Path of gully on landslide		all lineweights .2 mm 25° \angle 1.375 mm 4.5 mm 1.575 mm	
17.47	Soil creep or incipient sliding on landslide		lineweight .2 mm 1.0 mm \angle 20° 6.75 mm 1.5 mm	Arrow points downhill. May be shown in red or other colors.
17.48	Spring, seep, or drainage (runoff) on landslide		lineweight .2 mm circle diameter 1.5 mm; tail length 3.0 mm	Tail points downhill. May be shown in red or other colors.
17.49	Sag pond or closed depression on landslide (mapped to scale)		all lineweights .175 mm hachure height .875 mm; spacing 1.25 mm	Hachures point into depression.
17.50	Hummock on landslide (mapped to scale)		all lineweights .175 mm hachure height .875 mm; spacing 1.25 mm	Hachures point away from hummock.
17.51	Hummock on landslide (shown as point symbol when too small to outline at map scale)		all lineweights .175 mm 60° \angle .875 mm circle diameter 1.5 mm	
17.52	Tilt direction of surface of landslide		4.0 mm \angle 30° lineweight .2 mm 1.125 mm 2.0 mm	Usually shown on special-purpose landslide activity maps.
17.53	Tilt direction of surface of landslide—Showing angle of tilt		14 HI-6	May also be shown in red or other colors.
17.54	Displacement vector—Showing bearing		lineweight .2 mm 6.75 mm \angle 25° 1.75 mm	
17.55	Displacement vector—Showing bearing and distance		1.3 HI-7	
17.56	Active, reactivated, or historically active debris flow, showing a sharply defined morphology		4.0 mm \angle 20° 1.5 mm color 100% magenta	Usually shown on special-purpose landslide activity maps.
17.57	Dormant-young debris flow, showing a fresh and uneroded morphology but having no evidence of historic activity		color 50% magenta	If necessary, alphanumeric characters may be added to help distinguish landslide areas.
17.58	Active, reactivated, or historically active landslide (mapped to scale), showing a sharply defined morphology		fill color 60% magenta	May also be shown in red or other colors.
17.59	Dormant-young landslide (mapped to scale), showing a fresh and uneroded morphology but having no evidence of historic activity		fill color 40% magenta	
17.60	Dormant-mature landslide (mapped to scale), showing a smoothed and eroded morphology		fill color 20% magenta	
17.61	Dormant-old or relict landslide (mapped to scale), showing a weak morphology		fill color 8% magenta	
17.62	Rock slide, slump, block-glide landslide, rotational landslide, or Toreva block, consisting of a relatively intact mass of displaced materials		draft as shown \angle .5 mm 90° all lineweights .3 mm	Usually shown on special-purpose landslide activity maps.
17.63	Earth flow, consisting of a relatively thick and jumbled mixture of displaced materials		4.5 mm \angle 90° 1.0 mm all lineweights .3 mm	May also be shown in red or other colors.
17.64	Debris slide, consisting of a loose and relatively shallow veneer of displaced materials		draft as shown \angle 90° all lineweights .3 mm	If necessary, symbols may be enlarged or reduced.
17.65	Debris-slide slope (mapped to scale), consisting of coalesced scars of landslides and debris flows that are too small or numerous to be shown at map scale		fill color 20% black	Usually shown on special-purpose landslide activity maps.

*For more information, see general guidelines on pages A-1 to A-v.

18—VOLCANIC FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
18.1	Rim of volcanic crater—Identity and existence certain, location accurate. Hachures point into crater			Use to show outline of topographic wall. Rim may not outline crater completely. May also be shown in red, magenta, or other colors.
18.2	Rim of volcanic crater—Identity or existence questionable, location accurate. Hachures point into crater			
18.3	Rim of volcanic crater—Identity or existence certain, location approximate. Hachures point into crater			
18.4	Rim of volcanic crater—Identity or existence questionable, location approximate. Hachures point into crater			
18.5	Rim of volcanic crater—Identity and existence certain, location concealed. Hachures point into crater			
18.6	Rim of volcanic crater—Identity or existence questionable, location concealed. Hachures point into crater			
18.7	Rim of volcanic crater—Dot shows low point of crater			
18.8	Caldera margin (1st option)—Identity and existence certain, location accurate. Ticks point into caldera			May also be shown in red, magenta, or other colors.
18.9	Caldera margin (1st option)—Identity or existence questionable, location accurate. Ticks point into caldera			
18.10	Caldera margin (1st option)—Identity and existence certain, location approximate. Ticks point into caldera			
18.11	Caldera margin (1st option)—Identity or existence questionable, location approximate. Ticks point into caldera			
18.12	Caldera margin (1st option)—Identity and existence certain, location inferred. Ticks point into caldera			
18.13	Caldera margin (1st option)—Identity or existence questionable, location inferred. Ticks point into caldera			
18.14	Caldera margin (1st option)—Identity and existence certain, location concealed. Ticks point into caldera			
18.15	Caldera margin (1st option)—Identity or existence questionable, location concealed. Ticks point into caldera			
18.16	Caldera margin (2nd option)—Identity and existence certain, location accurate. Ticks point into caldera			
18.17	Caldera margin (2nd option)—Identity or existence questionable, location accurate. Ticks point into caldera			
18.18	Caldera margin (2nd option)—Identity and existence certain, location approximate. Ticks point into caldera			
18.19	Caldera margin (2nd option)—Identity or existence questionable, location approximate. Ticks point into caldera			
18.20	Caldera margin (2nd option)—Identity and existence certain, location inferred. Ticks point into caldera			
18.21	Caldera margin (2nd option)—Identity or existence questionable, location inferred. Ticks point into caldera			
18.22	Caldera margin (2nd option)—Identity and existence certain, location concealed. Ticks point into caldera			
18.23	Caldera margin (2nd option)—Identity or existence questionable, location concealed. Ticks point into caldera			

*For more information, see general guidelines on pages A-i to A-v.

18—VOLCANIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
18.24	Contact separating individual lava flows within same map unit—Identity and existence certain, location accurate		lineweight .2 mm color 100% red	May also be shown in magenta, black, or other colors.
18.25	Contact separating individual lava flows within same map unit—Identity or existence questionable, location accurate			
18.26	Contact separating individual lava flows within same map unit—Identity and existence certain, location approximate		3.5 mm 	
18.27	Contact separating individual lava flows within same map unit—Identity or existence questionable, location approximate			
18.28	Contact separating individual lava flows within same map unit—Identity and existence certain, location inferred		1.5 mm 	
18.29	Contact separating individual lava flows within same map unit—Identity or existence questionable, location inferred			
18.30	Contact separating individual lava flows within same map unit—Identity and existence certain, location concealed		.5 mm 	
18.31	Contact separating individual lava flows within same map unit—Identity or existence questionable, location concealed			
18.32	Flow lobe or lava-flow front—Identity and existence certain, location accurate. Hachures on side of overlying younger flow		all lineweights .2 mm color 100% red 	
18.33	Flow lobe or lava-flow front—Identity or existence questionable, location accurate. Hachures on side of overlying younger flow			
18.34	Flow lobe or lava-flow front—Identity and existence certain, location approximate. Hachures on side of overlying younger flow		3.5 mm 	
18.35	Flow lobe or lava-flow front—Identity or existence questionable, location approximate. Hachures on side of overlying younger flow			
18.36	Flow lobe or lava-flow front—Identity and existence certain, location concealed. Hachures on side of overlying younger flow		.5 mm 	
18.37	Flow lobe or lava-flow front—Identity or existence questionable, location concealed. Hachures on side of overlying younger flow			
18.38	Form line on lava flow		lineweight .2 mm color 100% red length and spacing may vary	
18.39	Flow lines on lava flow		color 100% red stem lineweight .175 mm 25° 2.0 mm stem length and spacing may vary	
18.40	Cracks on surface of lava flow		lineweight .25 mm color 100% red length and spacing may vary	
18.41	Volcanic fissure		lineweight .25 mm color 100% red	
18.42	Buried volcanic fissure		1.25 mm hachure lineweight .15 mm color 100% red	
18.43	Volcanic fissure where lava has been emitted		hachure lineweight .15 mm color 100% red	
18.44	Lava tube—Red circles indicate presence of skylights (not mapped to scale) along lava tube		circle lineweight .2 mm; diameter .75 mm; color 100% red lineweight .15 mm 1.375 mm 25°	
18.45	Lava tube—Red circles outline collapses (mapped to scale) along lava tube		lineweight .2 mm; color 100% red	
18.46	Crest line of pressure ridge or tumulus on lava flow		lineweight .2 mm color 100% red 60° 5.5 mm 1.0 mm	
18.47	Pressure ridge on lava flow		lineweight .2 mm color 100% red 60° 5.5 mm 1.0 mm	

*For more information, see general guidelines on pages A-i to A-v.

18—VOLCANIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
18.48	Ice-contact lava-flow margin—Identity and existence certain, location accurate. Rectangles on side of overlying younger flow		lineweight .2 mm color 100% red	May also be shown in magenta, black, or other colors.
18.49	Ice-contact lava-flow margin—Identity or existence questionable, location accurate. Rectangles on side of overlying younger flow		lineweight .2 mm color 100% red H-8 tick spacing 2.0 mm (at base) 12.0 mm 2.0 mm .75 mm .5 mm	
18.50	Ice-contact lava-flow margin—Identity and existence certain, location approximate. Rectangles on side of overlying younger flow		3.5 mm lineweight .2 mm color 100% red	
18.51	Ice-contact lava-flow margin—Identity or existence questionable, location approximate. Rectangles on side of overlying younger flow		.75 mm .75 mm	
18.52	Ice-contact lava-flow margin—Identity and existence certain, location concealed. Rectangles on side of overlying younger flow		.5 mm 2.5 mm	
18.53	Ice-contact lava-flow margin—Identity or existence questionable, location concealed. Rectangles on side of overlying younger flow		.75 mm .75 mm	
18.54	Outline of basalt-filled lava pond		all lineweights .2 mm tick spacing 2.0 mm (at base) color 100% red 1.0 mm 0.875 mm	May also be shown in magenta, black, or other colors.
18.55	Small cone, vent, cinder cone, or spatter cone		lineweight .2 mm color 100% red 60° 2.0 mm	May also be shown in magenta, black, or other colors.
18.56	Large cone, vent, cinder cone, or spatter cone		lineweight .2 mm color 100% red 2.625 mm 2.625 mm 60°	
18.57	Small hornito		lineweight .2 mm color 100% red 45° 2.0 mm 2.0 mm	
18.58	Large hornito		lineweight .2 mm color 100% red 45° 2.625 mm 2.625 mm	
18.59	Spatter rampart		lineweight .2 mm color 100% red 1.5 mm 5 mm 90°	
18.60	Rootless vent area on lava flow		lineweight .2 mm line color 100% red pattern 327-R	
18.61	Thermal area		lineweight .2 mm line color 100% red pattern 121-R in 50% red	
18.62	Thermal spring		color 100% red dot diameter 1.5 mm H-7 radius .5 mm lineweight .15 mm 2.0 mm	Rotate tail to downhill. May also be shown in magenta or other colors.
18.63	Geyser		lineweight .2 mm lineweight .375 mm lineweight .2 mm color 100% red radius .5 mm 2.75 mm ellipse height 1.25 mm; width 2.5 mm	May also be shown in magenta, black, or other colors.
18.64	Fumarole or steam vent		draft as shown 2.5 mm color 100% red ellipse height 1.25 mm; width 2.5 mm all lineweights .2 mm	
18.65	Recent volcano on small-scale maps		22.5° outer diameter 3.0 mm; inner diameter 1.375 mm all lineweights .2 mm	
18.66	Active volcano on small-scale maps		2.625 mm 60° lineweight .3 mm color 100% red	Usually reserved for maps at scales of 1:250,000 or smaller.
18.67	Inactive volcano on small-scale maps		90° 2.5 mm color 100% red lineweight .3 mm	May also be shown in magenta, black, or other colors.
18.68	Cinder cone on small-scale maps		circle diameter 1.375 mm lineweight .2 mm color 100% red	
18.69	Diatreme		dot diameter 1.375 mm H-7 color 100% red	
18.70	Breccia pipe		dot diameter 1.375 mm H-7 color 100% red	
18.71	Collapse structure—Indicating breccia pipe at		lineweight .2 mm circle diameter 1.375 mm H-7 color 100% red	

*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.1—Veins and mineralized areas; mineral resource areas; metamorphic facies boundary				
19.1.1	Vein, veinlet, or mineralized stringer—Identity and existence certain, location accurate		lineweight .25 mm color 100% red → 8.0 mm ← H-8 ? ? ↑ .75 mm	May also be shown in black or other colors.
19.1.2	Vein, veinlet, or mineralized stringer—Identity or existence questionable, location accurate		dot diameter .75 mm; spacing 4.5 mm	
19.1.3	Vein, veinlet, or mineralized stringer—Identity and existence certain, location approximate		3.625 mm ↑ .75 mm	
19.1.4	Vein, veinlet, or mineralized stringer—Identity or existence questionable, location approximate		↑ .75 mm	
19.1.5	Vein, veinlet, or mineralized stringer—Identity and existence certain, location concealed		.5 mm ↑ .75 mm	
19.1.6	Vein, veinlet, or mineralized stringer—Identity or existence questionable, location concealed		↑ .75 mm	
19.1.7	Vein, veinlet, or mineralized stringer—Showing type of mineral occurrence		Cu ← H-8 (100% black)	
19.1.8	Inclined vein, veinlet, or mineralized stringer (1st option)—Showing dip value and direction		tick length 1.75 mm; lineweight .2 mm 35 ← H-6 (100% black) tick color 100% black	Place tick, arrow, or other line-symbol decoration where observation was made. Add arrowhead or '90' to ticks showing dip if necessary for clarity.
19.1.9	Inclined vein, veinlet, or mineralized stringer (2nd option)—Showing dip value and direction		tick length 1.375 mm; lineweight .2 mm 15 ← .875 mm 30°	
19.1.10	Vertical or near-vertical vein, veinlet, or mineralized stringer (1st option)		tick length 2.5 mm; lineweight .2 mm	
19.1.11	Vertical or near-vertical vein, veinlet, or mineralized stringer (2nd option)		90 ← H-6 (100% black)	
19.1.12	Small, minor inclined vein, veinlet, or mineralized stringer—Showing strike and dip		H-6 (100% black) 70 lineweight .25 mm; line color 100% red 1.25 mm 5.5 mm	May also be shown in black or other colors.
19.1.13	Small, minor vertical or near-vertical vein, veinlet, or mineralized stringer—Showing strike		2.5 mm	
19.1.14	Zone of mineralized or altered rock (1st option)		pattern 405-R (at 45°)	Add labels to show specific types of alteration. May be used alone or may overprint other mapped units. May also be shown in black or other colors.
19.1.15	Zone of mineralized or altered rock (2nd option)		pattern 405-R in 50% red (at 45°)	
19.1.16	Zone of mineralized or altered rock, showing high level of mineralization		pattern 119-R	
19.1.17	Zone of mineralized or altered rock, showing low level of mineralization		pattern 117-R	
19.1.18	Area of identified resources		lineweight .5 mm color 100% red	Usually reserved for use on special-purpose maps, not on general-purpose geologic maps. Generally shown in red, but may also be shown in black or other colors.
19.1.19	Area of high mineral resource potential		lineweight .3 mm line and text color 100% red H-12 pattern 427-R in 50% red	
19.1.20	Area of moderate mineral resource potential		lineweight .3 mm H-12 pattern 229-R (at 45°) in 50% red	
19.1.21	Area of low mineral resource potential		lineweight .2 mm H-10	
19.1.22	Area considered to have mineral resource potential but not evaluated, mostly because of inadequate data		lineweight .2 mm H-10 dash 1.75 mm; space .5 mm	
19.1.23	Metamorphic facies boundary—Showing approximate boundary between diagnostic mineral assemblages		H-8 Greenschist Amphibolite dot diameter .5 mm; spacing .5 mm line and text color 100% red	

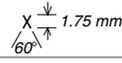
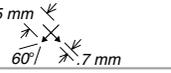
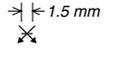
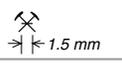
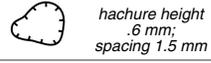
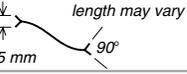
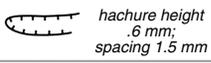
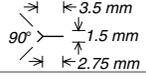
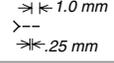
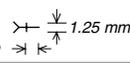
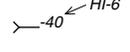
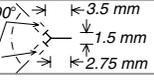
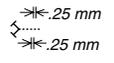
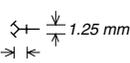
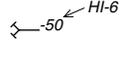
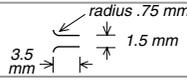
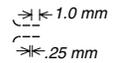
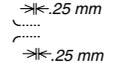
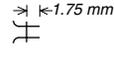
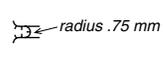
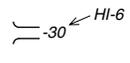
*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.2—Areas of extensively disturbed ground; surface workings; subsurface workings projected to surface				
19.2.1	Graded area—Extensive amount of mapped geologic unit has been removed		lineweight .2 mm line color 100% red pattern 226-R (at 45°)	Patterns should overlay other mapped units. Generally shown in black or red, but may also be shown in brown or other colors.
19.2.2	Strip mine (1st option)		lineweight .3 mm lineweight .15 mm pattern 226-K (at 45°)	
19.2.3	Strip mine (2nd option)		pattern 419-R in 50% red	
19.2.4	Artificial fill—Earth materials		lineweight .15 mm H-8 20% black	Show as separately mapped units. Generally shown in black or red, but may also be shown in other colors.
19.2.5	Artificial fill—Human-generated refuse (landfill)		lineweight .15 mm H-8 pattern 226-R (at 45°)	
19.2.6	Tailings		lineweights .125 mm draft as shown	Symbols should overlay other mapped units. Generally shown in red or black, but may also be shown in brown or other colors.
19.2.7	Mine dump (1st option)		all lineweights .125 mm dash length and spacing may vary draft as shown	
19.2.8	Mine dump (2nd option)		all lineweights .125 mm dash length and spacing may vary draft as shown	
19.2.9	Mine dump bench		.75 mm 2.5 mm all lineweights .125 mm	
19.2.10	Subsurface workings, projected to surface (1st option)		color 100% red lineweights .2 mm spacing may vary	Different symbols may be used to show different levels of workings. Symbols should overlay other mapped units. Generally shown in red, but may also be shown in black or other colors.
19.2.11	Subsurface workings, projected to surface (2nd option)		dash 3.0 mm; spacing .5 mm	
19.2.12	Subsurface workings, projected to surface (3rd option)		dash 1.5 mm; spacing .5 mm	
19.2.13	Subsurface workings, projected to surface (4th option)		dash .5 mm; spacing .5 mm	
19.2.14	Subsurface workings, projected to surface (5th option)		long dash 2.5 mm; short dashes .5 mm; spacing .5 mm	
19.2.15	Subsurface workings, projected to surface (6th option)		long dash 4.0 mm; short dash .5 mm; spacing .5 mm	

*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.3—Mining and mineral exploration (at surface)				
19.3.1	Prospect (pit or small open cut)	X	lineweight .2 mm 	
19.3.2	Sand, gravel, clay, or placer pit	✕	3.125 mm all lineweights .15 mm 60° 	
19.3.3	Abandoned sand, gravel, clay, or placer pit	✕	1.5 mm all lineweights .15 mm 	
19.3.4	Open pit, quarry, or glory hole	⌘	pick thickness .25 mm; radius 1.625 mm 1.5 mm 3.125 mm 1.5 mm lineweight .15 mm hammerhead thickness .3 mm; radius 1.625 mm 	
19.3.5	Abandoned open pit, quarry, or glory hole	⌘	all lineweights .15 mm 	
19.3.6	Open pit or quarry (mapped to scale)		all lineweights .25 mm  hachure height .6 mm; spacing 1.5 mm	
19.3.7	Trench (generalized trace)		1.5 mm length may vary 90° all lineweights .25 mm 	
19.3.8	Trench (drawn to scale)		all lineweights .25 mm  hachure height .6 mm; spacing 1.5 mm	
19.3.9	Adit or tunnel entrance (1st option)	└	all lineweights .175 mm 90° 3.5 mm 1.5 mm 2.75 mm 	Long line points in direction of adit or tunnel entrance at surface.
19.3.10	Approximately located adit or tunnel entrance (1st option)	└--	1.0 mm 25 mm 	Map position of adit or tunnel entrance is at intersection of long line and two short lines.
19.3.11	Destroyed adit or tunnel entrance (1st option)	└⋯	25 mm 25 mm 	
19.3.12	Abandoned or inaccessible adit or tunnel entrance (1st option)	└+	all lineweights .175 mm 1.75 mm 1.25 mm 	
19.3.13	Adit or tunnel entrance (1st option)—Showing angle of inclination (negative value indicates downward slope)	└-40	HI-6 -40 	Angle of inclination may be added to any adit or tunnel entrance symbol.
19.3.14	Adit or tunnel entrance (2nd option)	└	all lineweights .175 mm 90° 3.5 mm 1.5 mm 2.75 mm 1.0 mm 	Long line points in direction of adit or tunnel entrance at surface.
19.3.15	Approximately located adit or tunnel entrance (2nd option)	└--	1.0 mm 25 mm 	Map position of adit or tunnel entrance is at intersection of long line and two short lines.
19.3.16	Destroyed adit or tunnel entrance (2nd option)	└⋯	25 mm 25 mm 	
19.3.17	Abandoned or inaccessible adit or tunnel entrance (2nd option)	└+	all lineweights .175 mm 1.75 mm 1.25 mm 	
19.3.18	Adit or tunnel entrance (2nd option)—Showing angle of inclination (negative value indicates downward slope)	└-50	HI-6 -50 	Angle of inclination may be added to any adit or tunnel entrance symbol.
19.3.19	Portal		all lineweights .175 mm radius .75 mm 3.5 mm 1.5 mm 	Long lines point in direction of portal entry at surface.
19.3.20	Approximately located portal		1.0 mm 25 mm 	Map position of portal entry is between the two lines, at the position where the short curved lines intersect the long lines.
19.3.21	Destroyed portal		25 mm 25 mm 	
19.3.22	Abandoned or inaccessible portal	+	all lineweights .175 mm 1.75 mm 	
19.3.23	Portal and open cut		all lineweights .175 mm tick length .5 mm radius .75 mm 	Open cut may be added to any portal symbol.
19.3.24	Portal—Showing angle of inclination (negative value indicates downward slope)	-30	HI-6 -30 	Angle of inclination may be added to any portal symbol.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.3—Mining and mineral exploration (at surface) (continued)				
19.3.25	Drill hole for mineral exploration	○	<i>lineweight</i> .175 mm ○ diameter 1.5 mm	
19.3.26	Drill hole for mineral exploration—No geologic data available	○ ND	○ND ← H-6	
19.3.27	Drill hole for mineral exploration—Showing name and number	○ PAHUTE 2	○ PAHUTE 2 ← H-7	
19.3.28	Drill hole for mineral exploration—Showing type (DDH, diamond drill hole)	DDH ○	HI-6 → DDH ○	
19.3.29	Drill hole for exploration of low-grade ore	φ	<i>all lineweights</i> .175 mm φ 4.0 mm	
19.3.30	Drill hole for exploration of high-grade ore	●	● 4.0 mm	
19.3.31	Inclined drill hole for mineral exploration—Showing location of collar (circle) and projected trace (dashed line) and bottom (T) of drill hole	○-----┴	<i>all lineweights</i> .175 mm ○-----┴ length may vary ┴ 1.0 mm ┴ 1.5 mm	Projected trace of drill hole, angle of inclination, surface altitude, and total depth may be added to any drill hole symbol.
19.3.32	Inclined drill hole for mineral exploration—Showing angle of inclination (negative value indicates downward slope)	○-----┴ ⁻⁶⁵	○-----┴ ← HI-6 -65	
19.3.33	Inclined drill hole for mineral exploration—Showing surface altitude of collar (in meters)	2500 ○-----┴	HI-6 → 2500 ○-----┴	
19.3.34	Inclined drill hole for mineral exploration—Showing total depth of drill hole (in meters)	○-----┴ TD 1000	○-----┴ TD 1000 ← HI-6	
19.3.35	Vertical mine shaft, as shown on smaller scale or general-purpose maps	■	<i>lineweight</i> .175 mm ■ 1.5 mm	
19.3.36	Multiple vertical mine shafts, as shown on smaller scale or general-purpose maps	■■■	■■■	
19.3.37	Abandoned or inaccessible vertical mine shaft, as shown on smaller scale or general-purpose maps	■ ^A	■^A ← H-7	
19.3.38	Inclined mine shaft, as shown on smaller scale or general-purpose maps—Showing direction of inclination	┴	<i>all lineweights</i> .175 mm ┴ 1.0 mm	
19.3.39	Inclined mine shaft, as shown on smaller scale or general-purpose maps—Showing angle of inclination (negative value indicates downward slope)	┴ ₂₅	┴₂₅ ← HI-6	

*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.4—Mines and subsurface workings				
19.4.1	Vertical mine shaft at surface (drawn to scale), as shown on subsurface exploration maps		size may vary lineweight .175 mm	
19.4.2	Inclined mine shaft at surface (drawn to scale), as shown on subsurface exploration maps—Showing direction of inclination		all lineweights .175 mm lengths may vary	
19.4.3	Inclined mine shaft at surface (drawn to scale), as shown on subsurface exploration maps—Showing angle of inclination (negative value indicates downward slope)		-30 ← HI-6	
19.4.4	Mine shaft, above and below level (drawn to scale), as shown on subsurface exploration maps		size may vary all lineweights .175 mm	
19.4.5	Bottom of mine shaft (drawn to scale), as shown on subsurface exploration maps		size may vary all lineweights .175 mm	
19.4.6	Winze or head of raise (drawn to scale), as shown on subsurface exploration maps		size may vary all lineweights .175 mm	
19.4.7	Raise or winze extending through level (drawn to scale), as shown on subsurface exploration maps		size may vary all lineweights .175 mm	
19.4.8	Raise or foot of winze (drawn to scale), as shown on subsurface exploration maps		size may vary all lineweights .175 mm	
19.4.9	Crosscut tunnel or intersection of workings (drawn to scale), as shown on subsurface exploration maps		radius 1.25 mm lineweight .175 mm	size may vary
19.4.10	Workings (drawn to scale), as shown on subsurface exploration maps		spacing may vary lineweights .175 mm	
19.4.11	Caved or otherwise inaccessible workings (drawn to scale), as shown on subsurface exploration maps		all lineweights .175 mm length of crossbar may vary dash 1.5 mm; spacing .5 mm	spacing may vary
19.4.12	Inclined workings, as shown on subsurface exploration maps (drawn to scale)—Chevrons point down-slope (multiple chevrons indicate steeper slope)		all lineweights .175 mm spacing may vary 90°	
19.4.13	Ore chute (drawn to scale), as shown on subsurface exploration maps		1.5 mm spacing may vary all lineweights .15 mm	
19.4.14	Lagging or cribbing along drift (drawn to scale), as shown on subsurface exploration maps		all lineweights .15 mm spacing may vary circle diameter .75 mm; spacing .75 mm	.55 mm
19.4.15	Elevation of roof or back, as shown on subsurface exploration maps		1.0 mm 60° 2801' ← HI-6	all lineweights .15 mm
19.4.16	Elevation of floor or sill, as shown on subsurface exploration maps		1.0 mm HI-6 → 2809' 60°	
19.4.17	Stoped area (drawn to scale), as shown on subsurface exploration maps (section view)		all lineweights .15 mm dash 1.5 mm; spacing .5 mm	
19.4.18	Inferred stoped area (drawn to scale), as shown on subsurface exploration maps (section view)		pattern 226-K (at 45°) dash .3 mm; spacing .3 mm	

*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.5—Oil and gas fields; wells drilled for hydrocarbon exploration or exploitation				
19.5.1	Oil field—Extent defined		lineweight .2 mm fill color 50% green line color 100% green	Patterned areas (extent defined) should be shown as separately mapped units. Outlined areas (extent not yet defined) should overlay other mapped units. Generally shown in red and (or) green, but may also be shown in other colors or patterns.
19.5.2	Oil field—Extent not yet defined		lineweight .2 mm dash .5 mm; spacing .5 mm line color 50% green	
19.5.3	Gas field—Extent defined		lineweight .2 mm fill color 50% red line color 100% red	
19.5.4	Gas field—Extent not yet defined		lineweight .2 mm dash 2.0 mm; spacing .5 mm line color 100% red	
19.5.5	Oil and gas field—Extent defined		lineweight .2 mm pattern 426 (at 45°)	
19.5.6	Oil and gas field—Extent not yet defined		lineweight .2 mm long dash 2.0 mm; short dash .5 mm; space .5 mm	
19.5.7	Core (nonspecific depth)		lineweight .2 mm dot diameter .5 mm 1.75 mm	May also be shown in other colors.
19.5.8	Shallow core			Use if both shallow and deep cores are shown on map.
19.5.9	Deep core		all lineweights .2 mm circle diameter 2.75 mm	May also be shown in other colors.
19.5.10	Drilling well or well location for hydrocarbon exploration or exploitation		lineweight .2 mm diameter 1.5 mm	Name, number, and total depth may be added to any type of well symbol. May also be shown in green (oil), red (gas), or other colors.
19.5.11	Drill hole for hydrocarbon exploration or exploitation—No data available			
19.5.12	Drill hole for hydrocarbon exploration or exploitation—Showing name and number			
19.5.13	Drill hole for hydrocarbon exploration or exploitation—Showing total depth (in meters)			
19.5.14	Inclined drill hole for hydrocarbon exploration or exploitation—Showing location of collar (circle) and projected trace (dashed line) and bottom (T) of drill hole		all lineweights .2 mm length of trace may vary 1.0 mm 1.5 mm 5 mm	Projected trace of drill hole, angle of inclination, surface altitude, and total depth may be added to any type of well symbol. May also be shown in green (oil), red (gas), or other colors.
19.5.15	Inclined drill hole for hydrocarbon exploration or exploitation—Showing angle of inclination			
19.5.16	Inclined drill hole for hydrocarbon exploration or exploitation—Showing surface altitude of collar (in meters)			
19.5.17	Inclined drill hole for hydrocarbon exploration or exploitation—Showing total depth of drill hole (in meters)			
19.5.18	Multiple wells drilled from single platform—Showing location of collar (open circle) on platform. Types of wells indicated at drill hole bottoms			Any type of well symbol may be shown at bottoms of drill holes.

*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.5—Oil and gas fields; wells drilled for hydrocarbon exploration or exploitation (continued)				
19.5.19	Dry hole (nonspecific depth)		all lineweights .2 mm .625 mm diameter 1.5 mm	May also be shown in other colors.
19.5.20	Dry hole—Showing map unit at surface (Km) and at bottom of hole (Kd). Also showing altitude at surface and total depth of hole (in meters)		all lineweights .2 mm Km 2809 Kd 4996 H-7	
19.5.21	Shallow dry hole			Use if both shallow and deep dry holes are shown on map.
19.5.22	Deep dry hole		all lineweights .2 mm outer circle diameter 2.75 mm	May also be shown in other colors.
19.5.23	Junked hole (nonspecific depth)		all lineweights .2 mm .625 mm	May also be shown in other colors.
19.5.24	Shallow junked hole			Use if both shallow and deep junked holes are shown on map.
19.5.25	Deep junked hole		all lineweights .2 mm outer circle diameter 2.75 mm	May also be shown in other colors.
19.5.26	Disposal well (nonspecific depth)		2.0 mm 60° linewidth .2 mm	May also be shown in other colors.
19.5.27	Plugged and abandoned disposal well (nonspecific depth)		all lineweights .2 mm 4.0 mm	
19.5.28	Shallow disposal well			Use if both shallow and deep disposal wells are shown on map.
19.5.29	Plugged and abandoned shallow disposal well			May also be shown in other colors.
19.5.30	Deep disposal well		all lineweights .2 mm circle diameter 2.75 mm	
19.5.31	Plugged and abandoned deep disposal well		all lineweights .2 mm 4.0 mm	
19.5.32	Salt-water disposal well (nonspecific depth)		2.0 mm 60° all lineweights .2 mm circle diameter 1.0 mm	May also be shown in other colors.
19.5.33	Plugged and abandoned salt-water disposal well (nonspecific depth)		all lineweights .2 mm 4.0 mm	
19.5.34	Shallow salt-water disposal well			Use if both shallow and deep salt-water disposal wells are shown on map.
19.5.35	Plugged and abandoned shallow salt-water disposal well			May also be shown in other colors.
19.5.36	Deep salt-water disposal well		all lineweights .2 mm outer circle diameter 2.75 mm	
19.5.37	Plugged and abandoned deep salt-water disposal well		all lineweights .2 mm 4.0 mm	

*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.5—Oil and gas fields; wells drilled for hydrocarbon exploration or exploitation (continued)				
19.5.38	Oil seep		lineweight .2 mm diameter 1.5 mm	May also be shown in green or other colors.
19.5.39	Oil show		lineweight .2 mm diameter 1.5 mm	
19.5.40	Oil well (nonspecific depth)		diameter 1.5 mm	Use if both shallow and deep oil wells are shown on map.
19.5.41	Suspended oil well (nonspecific depth)		lineweight .2 mm 4.0 mm	
19.5.42	Plugged and abandoned oil well (nonspecific depth)		lineweight .2 mm 4.0 mm	May also be shown in green or other colors.
19.5.43	Shallow oil well			
19.5.44	Suspended shallow oil well			Use if both shallow and deep oil wells are shown on map.
19.5.45	Plugged and abandoned shallow oil well			
19.5.46	Deep oil well		lineweight .2 mm inner dot diameter 1.5 mm outer circle diameter 2.75 mm	May also be shown in green or other colors.
19.5.47	Suspended deep oil well		all lineweights .2 mm 4.0 mm	
19.5.48	Plugged and abandoned deep oil well		all lineweights .2 mm 4.0 mm	May also be shown in red or other colors.
19.5.49	Gas seep		all lineweights .2 mm 90° 90° 1.2 mm diameter 1.5 mm	
19.5.50	Gas show		all lineweights .2 mm diameter 1.5 mm	Use if both shallow and deep gas wells are shown on map.
19.5.51	Gas well (nonspecific depth)		all lineweights .2 mm diameter 1.5 mm	
19.5.52	Suspended gas well (nonspecific depth)		all lineweights .2 mm 4.0 mm	May also be shown in red or other colors.
19.5.53	Plugged and abandoned gas well (nonspecific depth)		all lineweights .2 mm 4.0 mm	
19.5.54	Shallow gas well			Use if both shallow and deep gas wells are shown on map.
19.5.55	Suspended shallow gas well			
19.5.56	Plugged and abandoned shallow gas well			May also be shown in red or other colors.
19.5.57	Deep gas well		inner circle diameter 1.5 mm; outer circle diameter 2.75 mm all lineweights .2 mm .625 mm	
19.5.58	Suspended deep gas well		all lineweights .2 mm 4.0 mm	Use if both shallow and deep gas wells are shown on map.
19.5.59	Plugged and abandoned deep gas well		all lineweights .2 mm 4.0 mm	
19.5.60	Deep gas well, plugged back and producing shallow gas		all lineweights .2 mm 1.25 mm	May also be shown in red or other colors.

*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.5—Oil and gas fields; wells drilled for hydrocarbon exploration or exploitation (continued)				
19.5.61	Oil and gas seep		all lineweights .2 mm 90° 90° .625 mm diameter 1.5 mm	May also be shown in other colors.
19.5.62	Oil and gas show		all lineweights .2 mm .625 mm diameter 1.5 mm	
19.5.63	Oil and gas well (nonspecific depth)		all lineweights .2 mm .625 mm diameter 1.5 mm	Use if both shallow and deep oil and gas wells are shown on map. May also be shown in other colors.
19.5.64	Suspended oil and gas well (nonspecific depth)		all lineweights .2 mm 4.0 mm	
19.5.65	Plugged and abandoned oil and gas well (nonspecific depth)		all lineweights .2 mm 4.0 mm	
19.5.66	Shallow oil and gas well			
19.5.67	Suspended shallow oil and gas well			
19.5.68	Plugged and abandoned shallow oil and gas well			
19.5.69	Deep oil and gas well		inner dot diameter 1.5 mm; outer circle diameter 2.75 mm all lineweights .2 mm .625 mm	
19.5.70	Suspended deep oil and gas well		all lineweights .2 mm 4.0 mm	
19.5.71	Plugged and abandoned deep oil and gas well		all lineweights .2 mm 4.0 mm	
19.5.72	Condensate show		lineweight .2 mm diameter 1.5 mm	
19.5.73	Condensate well (nonspecific depth)		lineweight .2 mm diameter 1.5 mm	
19.5.74	Suspended condensate well (nonspecific depth)		lineweight .2 mm 4.0 mm	Use if both shallow and deep condensate wells are shown on map. May also be shown in other colors.
19.5.75	Plugged and abandoned condensate well (nonspecific depth)		lineweight .2 mm 4.0 mm	
19.5.76	Shallow condensate well			
19.5.77	Suspended shallow condensate well			
19.5.78	Plugged and abandoned shallow condensate well			
19.5.79	Deep condensate well		all lineweights .2 mm inner dot diameter 1.5 mm outer circle diameter 2.75 mm	
19.5.80	Suspended deep condensate well		all lineweights .2 mm 4.0 mm	
19.5.81	Plugged and abandoned deep condensate well		all lineweights .2 mm 4.0 mm	

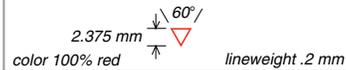
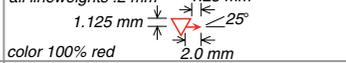
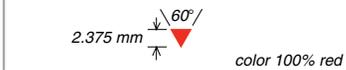
*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.5—Oil and gas fields; wells drilled for hydrocarbon exploration or exploitation (continued)				
19.5.82	Gas and condensate show		all lineweights .2 mm diameter 1.5 mm 	May also be shown in other colors.
19.5.83	Gas and condensate well (nonspecific depth)		all lineweights .2 mm diameter 1.5 mm 	
19.5.84	Suspended gas and condensate well (nonspecific depth)		all lineweights .2 mm 	
19.5.85	Plugged and abandoned gas and condensate well (nonspecific depth)		all lineweights .2 mm 	
19.5.86	Shallow gas and condensate well			Use if both shallow and deep gas and condensate wells are shown on map. May also be shown in other colors.
19.5.87	Suspended shallow gas and condensate well			
19.5.88	Plugged and abandoned shallow gas and condensate well			
19.5.89	Deep gas and condensate well		inner circle diameter 1.5 mm; outer circle diameter 2.75 mm all lineweights .2 mm 	
19.5.90	Suspended deep gas and condensate well		all lineweights .2 mm 	
19.5.91	Plugged and abandoned deep gas and condensate well		all lineweights .2 mm 	
19.5.92	Gas storage well (nonspecific depth)		1.75 mm 	May also be shown in other colors.
19.5.93	Plugged and abandoned gas storage well (nonspecific depth)		lineweight .2 mm 	
19.5.94	Shallow gas storage well			Use if both shallow and deep gas storage wells are shown on map. May also be shown in other colors.
19.5.95	Plugged and abandoned shallow gas storage well			
19.5.96	Deep gas storage well		lineweight .2 mm outer circle diameter 2.75 mm 	
19.5.97	Plugged and abandoned deep gas storage well		all lineweights .2 mm 	
19.5.98	Observation well for gas-storage field (nonspecific depth)		diameter 1.5 mm all lineweights .2 mm 0.725 mm 	May also be shown in other colors.
19.5.99	Plugged and abandoned observation well for gas-storage field [nonspecific depth]		all lineweights .2 mm 	
19.5.100	Shallow observation well for gas-storage field			Use if both shallow and deep observation wells are shown on map. May also be shown in other colors.
19.5.101	Plugged and abandoned shallow observation well for gas-storage field			
19.5.102	Deep observation well for gas-storage field		all lineweights .2 mm outer circle diameter 2.75 mm 	
19.5.103	Plugged and abandoned deep observation well for gas-storage field		all lineweights .2 mm 	

*For more information, see general guidelines on pages A-i to A-v.

20—HAZARDOUS WASTE SITES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
20.1	Hazardous waste site		 2.375 mm color 100% red linewidth .2 mm	Generally shown in red, but may also be shown in black or other colors.
20.2	Hazardous waste site—Showing direction of surface-leachate flow from site		 all lineweights .2 mm 1.125 mm color 100% red 2.0 mm 25°	
20.3	Active (operating) hazardous waste site		 2.375 mm color 100% red 60°	
20.4	Inactive (closed) hazardous waste site		 triangle linewidth .2 mm bar linewidth .3 mm color 100% red 3.75 mm	
20.5	Hazardous waste site—Clean-up activities are in progress		 color 100% red linewidth .25 mm	
20.6	Hazardous waste site—Clean-up activities have been completed		 color 100% red linewidth .25 mm	
20.7	Hazardous waste site, showing smaller restricted area (mapped to scale)		 linewidth .25 mm color 100% red pattern 226-R (at 45°)	
20.8	Hazardous waste site, showing larger restricted area (mapped to scale)		 1.5 mm color 100% red	

*For more information, see general guidelines on pages A-i to A-v.

21—NEOTECTONIC AND EARTHQUAKE-HAZARD FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
21.1	Earthquake epicenter, magnitude 7.5 or larger		color 100% violet outer circle diameter 7.0 mm; inner circle diameter 5.75 mm; linewidth .25 mm inner dot diameter 4.5 mm	The type of scale used for measuring earthquakes should be noted. May also be shown in black or other colors.
21.2	Earthquake epicenter, magnitude 7–7.49		color 100% violet dot diameter 4.25 mm	
21.3	Earthquake epicenter, magnitude 6.5–6.99		color 100% violet inner dot diameter 2.375 mm circle diameter 4.0 mm; linewidth .25 mm	
21.4	Earthquake epicenter, magnitude 6–6.49		color 100% violet dot diameter 2.25 mm	
21.5	Earthquake epicenter, magnitude 5.5–5.99		color 100% violet circle diameter 2.25 mm; linewidth .25 mm	
21.6	Earthquake epicenter, magnitude 4–5.49		color 100% violet circle diameter 1.4 mm; linewidth .225 mm	
21.7	Earthquake epicenter, magnitude less than 4		color 100% violet circle diameter .875 mm; linewidth .2 mm	
21.8	Fault-plane or focal-mechanism diagram for vertical, down-to-the-left offset along north-striking, vertical fault—Black quadrant indicates region of compression		size may vary 	Note that two types of fault motion and (or) two different fault-plane orientations could be represented by the same focal-mechanism diagram. For example, the focal-mechanism diagram that shows right-lateral strike-slip offset along a north-striking, vertical fault (ref. no. 21.9) could also show left-lateral strike-slip offset along an east-west-striking, vertical fault.
21.9	Fault-plane or focal-mechanism diagram for right-lateral strike-slip offset along north-striking, vertical fault—Black quadrants indicate regions of compression			
21.10	Fault-plane or focal-mechanism diagram for left-lateral strike-slip offset along north-striking, vertical fault—Black quadrants indicate regions of compression			
21.11	Fault-plane or focal-mechanism diagram for normal, down-to-the-left offset along north-striking, west-dipping (at 45°) fault—Black quadrants indicate regions of compression			
21.12	Fault-plane or focal-mechanism diagram for normal, down-to-the-left offset along northwest-striking, southwest-dipping (at 30°) fault—Black quadrants indicate regions of compression			
21.13	Fault-plane or focal-mechanism diagram for reverse, left-side-up offset along north-striking, west-dipping (at 45°) fault—Black quadrant indicates region of compression			
21.14	Fault-plane or focal-mechanism diagram for reverse, left-side-up offset along northwest-striking, southwest-dipping (at 60°) fault—Black quadrant indicates region of compression			
21.15	Fault-plane or focal-mechanism diagram for oblique reverse, left-side-up offset along northwest-striking, southwest-dipping (at 60°) fault—Black quadrants indicate regions of compression			
21.16	Outer limit of subsidence caused by shock—Identity and existence certain, location accurate. Hachures point into subsided area		all linewidths .275 mm 1.25 mm 12.0 mm 1.75 mm	May also be shown in purple or other colors.
21.17	Outer limit of subsidence caused by shock—Identity or existence questionable, location accurate. Hachures point into subsided area			
21.18	Outer limit of subsidence caused by shock—Identity or existence certain, location approximate. Hachures point into subsided area			
21.19	Outer limit of subsidence caused by shock—Identity or existence questionable, location approximate. Hachures point into subsided area			
21.20	Outer limit of subsidence caused by shock—Identity or existence certain, location inferred. Hachures point into subsided area			
21.21	Outer limit of subsidence caused by shock—Identity or existence questionable, location inferred. Hachures point into subsided area			
21.22	Outer limit of subsidence caused by shock—Identity and existence certain, location concealed. Hachures point into subsided area			
21.23	Outer limit of subsidence caused by shock—Identity or existence questionable, location concealed. Hachures point into subsided area			

*For more information, see general guidelines on pages A-i to A-v.

21—NEOTECTONIC AND EARTHQUAKE-HAZARD FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
21.24	Rim crest or crater with rim, formed by shock or sand blowouts—Identity and existence certain, location accurate. Hachures point into crater		all lineweights .2 mm 	May also be shown in purple or other colors.
21.25	Rim crest or crater with rim, formed by shock or sand blowouts—Identity or existence questionable, location accurate. Hachures point into crater			
21.26	Rim crest or crater with rim, formed by shock or sand blowouts—Identity or existence certain, location approximate. Hachures point into crater		3.5 mm 	
21.27	Rim crest or crater with rim, formed by shock or sand blowouts—Identity or existence questionable, location approximate. Hachures point into crater			
21.28	Rim crest or crater with rim, formed by shock or sand blowouts—Identity and existence certain, location concealed. Hachures point into crater		1.25 mm 	
21.29	Rim crest or crater with rim, formed by shock or sand blowouts—Identity or existence questionable, location concealed. Hachures point into crater			
21.30	Sinkhole or crater without rim, formed by shock—Identity and existence certain, location accurate. Hachures point into sinkhole		all lineweights .2 mm 	
21.31	Sinkhole or crater without rim, formed by shock—Identity or existence questionable, location accurate. Hachures point into sinkhole			
21.32	Sinkhole or crater without rim, formed by shock—Identity or existence certain, location approximate. Hachures point into sinkhole		3.5 mm 	
21.33	Sinkhole or crater without rim, formed by shock—Identity or existence questionable, location approximate. Hachures point into sinkhole			
21.34	Sinkhole or crater without rim, formed by shock—Identity or existence certain, location concealed. Hachures point into sinkhole		.5 mm 	
21.35	Sinkhole or crater without rim, formed by shock—Identity or existence questionable, location concealed. Hachures point into sinkhole			
21.36	Fissures or cracks, formed in ground by earthquake		lineweights .2 mm 	
21.37	Fissures and sand and (or) other material ejected during earthquake		lineweights .3 mm 	

*For more information, see general guidelines on pages A-i to A-v.

22—PLATE-TECTONIC FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
22.1	Active spreading axis or mid-oceanic ridge, with rift—Accurately located. Sawteeth point in direction of spreading		color 100% red $\setminus 60^\circ$ linewidth .375 mm 1.25 mm spacing may vary sawtooth linewidth .25 mm; spacing 12.5 mm	May also be shown in black or other colors.
22.2	Active spreading axis or mid-oceanic ridge, with rift—Approximately located. Sawteeth point in direction of spreading		10.0 mm 2.5 mm	
22.3	Active spreading axis or mid-oceanic ridge, without rift—Accurately located. Sawteeth point in direction of spreading		color 100% red $\setminus 60^\circ$ linewidth .625 mm 1.25 mm spacing may vary sawtooth linewidth .25 mm; spacing 12.5 mm	
22.4	Active spreading axis or mid-oceanic ridge, without rift—Approximately located. Sawteeth point in direction of spreading		10.0 mm 2.5 mm	
22.5	Ancient spreading axis or mid-oceanic ridge—Accurately located. Sawteeth point in direction of spreading		1.25 mm all linewidths .25 mm sawtooth spacing 12.5 mm	May also be shown in other colors.
22.6	Ancient spreading axis or mid-oceanic ridge—Approximately located. Sawteeth point in direction of spreading		10.0 mm 2.5 mm	
22.7	Surface trace of active deep-seismofocal or subduction zone—Accurately located. Sawteeth on upper plate		linewidth .375 mm color 100% red 1.25 mm 6.25 mm sawtooth radius 3.0 mm	May also be shown in black or other colors.
22.8	Surface trace of active deep-seismofocal or subduction zone—Approximately located. Sawteeth on upper plate		5.25 mm 1.0 mm	
22.9	Surface trace of active deep-seismofocal or subduction zone—Showing fore-arc sediments. Sawteeth on upper plate		pattern 427-R	
22.10	Active convergent plate boundary—Accurately located. Sawteeth on upper plate		linewidth .375 mm color 100% red 6.25 mm 2.0 mm 60°	
22.11	Active convergent plate boundary—Approximately located. Sawteeth on upper plate		5.25 mm 1.0 mm	
22.12	Active convergent plate boundary—Showing accretionary prism. Sawteeth on upper plate		pattern 429-R	
22.13	Ancient convergent plate boundary—Accurately located. Sawteeth on upper plate		linewidth .25 mm 6.25 mm 1.75 mm 60°	May also be shown in other colors.
22.14	Ancient convergent plate boundary—Approximately located. Sawteeth on upper plate		5.25 mm 1.0 mm	
22.15	Active transform fault, sense of offset unspecified—Accurately located		color 100% red linewidth .375 mm	May also be shown in black or other colors.
22.16	Active transform fault, sense of offset unspecified—Approximately located		3.5 mm 1.0 mm	
22.17	Active transform fault, right-lateral offset—Accurately located. Arrows show relative motion		arrow linewidth .3 mm 25° 1.75 mm color 100% red 5.0 mm linewidth .375 mm	
22.18	Active transform fault, right-lateral offset—Approximately located. Arrows show relative motion		3.5 mm 1.0 mm	
22.19	Active transform fault, left-lateral offset—Accurately located. Arrows show relative motion		arrow linewidth .3 mm 1.75 mm 25° color 100% red 5.0 mm linewidth .375 mm	
22.20	Active transform fault, left-lateral offset—Approximately located. Arrows show relative motion		3.5 mm 1.0 mm	
22.21	Active transform fault, normal offset—Accurately located. Hachures on downthrown side		color 100% red linewidth .375 mm 1.0 mm hachure linewidth .175 mm; spacing .375 mm	
22.22	Active transform fault, normal offset—Approximately located. Hachures on downthrown side		3.5 mm 1.0 mm	
22.23	Ancient transform fault, sense of offset unspecified—Accurately located		linewidth .275 mm	May also be shown in black or other colors.
22.24	Ancient transform fault, sense of offset unspecified—Approximately located		3.5 mm 1.0 mm	

*For more information, see general guidelines on pages A-i to A-v.

22—PLATE-TECTONIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
22.25	Continental slope—Accurately located. Rectangles point downslope		lineweight 25 mm tooth height .875 mm; width 1.5 mm	May also be shown in other colors.
22.26	Continental slope—Approximately located. Rectangles point downslope		 5.25 mm 1.0 mm 6.25 mm	
22.27	Continental slope—Showing margin filled by sedimentation. Rectangles point downslope		pattern 119-K 	
22.28	Outline of basin—Accurately located. Sawteeth point into basin		all lineweights .2 mm 6.25 mm 90° .75 mm	
22.29	Outline of basin—Approximately located. Sawteeth point into basin		 5.25 mm 1.0 mm 6.25 mm	
22.30	Deep-sea trench—Patterned where filled by sedimentation		all lineweights .2 mm pattern 119-K	
22.31	Margin of oceanic rise—Accurately located. Hachures point downslope		all lineweights .2 mm .625 mm 6.25 mm 90° 1.0 mm	
22.32	Margin of oceanic rise—Approximately located. Hachures point downslope		 5.25 mm 1.0 mm 6.25 mm	
22.33	Volcanic ridge or edifice—Accurately located. Hachures point downslope		all lineweights .2 mm .625 mm 3.125 mm 90°	
22.34	Volcanic ridge or edifice—Approximately located. Hachures point downslope		 5.25 mm 1.0 mm 6.25 mm	
22.35	Guyot—Hachures point downslope		all lineweights .2 mm hachure height .625 mm; spacing .5 mm	
22.36	Seamount, nonvolcanic origin—Sawteeth point downslope		sawtooth spacing 5.0 mm 60° 1.0 mm all lineweights .2 mm	
22.37	Seamount, volcanic origin—Sawteeth point downslope			
22.38	Seamount, nonvolcanic origin (shown as point symbol when too small to outline at map scale)		all lineweights .2 mm .625 mm circle diameter 1.375 mm	
22.39	Seamount, volcanic origin (shown as point symbol when too small to outline at map scale)		lineweights .2 mm dot diameter 1.375 mm	

*For more information, see general guidelines on pages A-i to A-v.

23—MISCELLANEOUS UPLIFT AND COLLAPSE FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
23.1	Outline of metamorphic core complex—Identity and existence certain, location accurate. Hachures on upper plate		<i>lineweight .25 mm</i> <i>H-8</i>	
23.2	Outline of metamorphic core complex—Identity or existence questionable, location accurate. Hachures on upper plate		<i>hachure lineweight .2 mm</i> <i>.75 mm</i> <i>12.0 mm</i> <i>1.25 mm</i> <i>.75 mm</i>	
23.3	Outline of metamorphic core complex—Identity and existence certain, location approximate. Hachures on upper plate		<i>3.5 mm</i>	
23.4	Outline of metamorphic core complex—Identity or existence questionable, location approximate. Hachures on upper plate		<i>.75 mm</i> <i>.75 mm</i>	
23.5	Outline of metamorphic core complex—Identity and existence certain, location inferred. Hachures on upper plate		<i>1.5 mm</i> <i>2.5 mm</i>	
23.6	Outline of metamorphic core complex—Identity or existence questionable, location inferred. Hachures on upper plate		<i>.75 mm</i> <i>.75 mm</i>	
23.7	Outline of metamorphic core complex—Identity and existence certain, location concealed. Hachures on upper plate		<i>.5 mm</i> <i>2.5 mm</i>	
23.8	Outline of metamorphic core complex—Identity or existence questionable, location concealed. Hachures on upper plate		<i>.75 mm</i> <i>.75 mm</i>	
23.9	Collapse structure or sinkhole (too small to draw to scale)		<i>lineweight .2 mm</i> <i>circle diameter 2.0 mm; dot diameter .5 mm</i>	
23.10	Collapse structure or sinkhole (drawn to scale)		<i>all lineweights .2 mm</i> <i>hachure height .55 mm; spacing 1.25 mm</i>	
23.11	Crater outline, unspecified origin		<i>dash length 1.25 mm; spacing .375 mm</i> <i>lineweight .2 mm</i>	
23.12	Uplift—Local, intensely disturbed		<i>circle diameter 2.5 mm; lineweight .25 mm</i> <i>crossbar lineweight .175 mm</i>	
23.13	Salt dome		<i>dot diameter 1.625 mm</i> <i>H-7</i>	
23.14	Possible salt dome		<i>lineweight .2 mm</i> <i>circle diameter 1.625 mm</i> <i>H-7</i>	
23.15	Salt and (or) shale diapirs		<i>100% black</i>	

*For more information, see general guidelines on pages A-i to A-v.

25—PLANETARY GEOLOGY FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
25.1	Contact, planetary—Location accurate		lineweight .15 mm	
25.2	Contact, planetary—Location approximate		3.5 mm tick length .75 mm	
25.3	Contact, planetary—Location inferred		1.5 mm tick length .75 mm	
25.4	Contact, planetary—Location concealed		.5 mm tick length .75 mm	
25.5	Fault, planetary, sense of offset unspecified—Location accurate		lineweight .375 mm	
25.6	Fault, planetary, sense of offset unspecified—Location approximate		3.5 mm tick length .75 mm	
25.7	Fault, planetary, sense of offset unspecified—Location inferred		1.5 mm tick length .75 mm	
25.8	Fault, planetary, sense of offset unspecified—Location concealed		.5 mm tick length .75 mm	
25.9	Normal fault, planetary—Location accurate. Ball and bar on downthrown block		lineweight .375 mm ball diameter .875 mm tick length 1.0 mm; lineweight .175 mm	
25.10	Normal fault, planetary—Location approximate. Ball and bar on downthrown block		3.5 mm tick length .75 mm	
25.11	Normal fault, planetary—Location inferred. Ball and bar on downthrown block		1.5 mm tick length .75 mm	
25.12	Normal fault, planetary—Location concealed. Ball and bar on downthrown block		.5 mm tick length .75 mm	
25.13	Strike-slip fault, planetary, right-lateral offset—Location accurate. Arrows show relative motion		lineweight .375 mm arrow length 1.75 mm arrow lineweight .2 mm 25° 5.0 mm	
25.14	Strike-slip fault, planetary, right-lateral offset—Location approximate. Arrows show relative motion		3.5 mm tick length .75 mm	
25.15	Strike-slip fault, planetary, right-lateral offset—Location inferred. Arrows show relative motion		1.5 mm tick length .75 mm	
25.16	Strike-slip fault, planetary, right-lateral offset—Location concealed. Arrows show relative motion		.5 mm tick length .75 mm	
25.17	Strike-slip fault, planetary, left-lateral offset—Location accurate. Arrows show relative motion		lineweight .375 mm arrow length 1.75 mm arrow lineweight .2 mm 25° 5.0 mm	
25.18	Strike-slip fault, planetary, left-lateral offset—Location approximate. Arrows show relative motion		3.5 mm tick length .75 mm	
25.19	Strike-slip fault, planetary, left-lateral offset—Location inferred. Arrows show relative motion		1.5 mm tick length .75 mm	
25.20	Strike-slip fault, planetary, left-lateral offset—Location concealed. Arrows show relative motion		.5 mm tick length .75 mm	
25.21	Thrust fault, planetary—Location accurate. Sawteeth on upper plate		sawtooth height 1.5 mm lineweight .375 mm 60°	
25.22	Thrust fault, planetary—Location approximate. Sawteeth on upper plate		3.5 mm tick length .75 mm	
25.23	Thrust fault, planetary—Location inferred. Sawteeth on upper plate		1.5 mm tick length .75 mm 2.5 mm	
25.24	Thrust fault, planetary—Location concealed. Sawteeth on upper plate		.5 mm tick length .75 mm 2.5 mm	

*For more information, see general guidelines on pages A-i to A-v.

25—PLANETARY GEOLOGY FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
25.25	Graben trace, planetary (shown as single line where bounding normal faults cannot be mapped separately)—Location accurate		lineweight .375 mm dot diameter 1.375 mm	
25.26	Graben trace, planetary (shown as single line where bounding normal faults cannot be mapped separately)—Location approximate		3.5 mm 1.5 mm .75 mm	
25.27	Graben trace, planetary (shown as single line where bounding normal faults cannot be mapped separately)—Location inferred		1.5 mm .75 mm	
25.28	Graben trace, planetary (shown as single line where bounding normal faults cannot be mapped separately)—Location concealed		.5 mm .75 mm	
25.29	Regional fracture, planetary		lineweight .3 mm color 100% cyan	
25.30	Partly buried regional fracture, planetary		1.5 mm .75 mm	
25.31	Arcuate fracture, planetary		lineweight .2 mm color 100% purple	
25.32	Partly buried arcuate fracture, planetary		1.5 mm .75 mm	
25.33	Radial fracture, planetary (associated with coronae)		lineweight .325 mm color 100% purple	
25.34	Concentric fracture, planetary (associated with coronae)		lineweight .25 mm color 100% violet	
25.35	Fold crest, planetary		lineweight .3 mm color 100% red	
25.36	Broad warp, planetary		lineweight .635 mm color 100% red	.75 mm .75 mm
25.37	Wrinkle ridge, planetary		lineweight .25 mm color 100% magenta	
25.38	Ribbon trends, planetary		lineweight .25 mm color 100% green	
25.39	Ridge belt, planetary		all lineweights .25 mm color 100% red	1.75 mm
25.40	Broad ridge crest, planetary (generally associated with coronae)		lineweight .635 mm color 100% red	
25.41	Ridge crest, planetary (1st option)		3.0 mm 65° lineweight .25 mm	
25.42	Ridge crest, planetary (2nd option)		all lineweights .25 mm	
25.43	Ridge crest, planetary (1st option)—Arrowhead shows abrupt termination of ridge		65° 1.375 mm	
25.44	Ridge crest, planetary (2nd option)—Arrowhead shows abrupt termination of ridge			
25.45	Ridge crest (possible dike), planetary		70° all lineweights .25 mm 3.5 mm	
25.46	Corona annulus ridge, planetary—Showing axial trace and plunge. Short arrow indicates steeper limb or scarp bounding corona trough		3.75 mm all lineweights .25 mm 75° 2.0 mm	

*For more information, see general guidelines on pages A-i to A-v.

25—PLANETARY GEOLOGY FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
25.47	Groove (generic), planetary		lineweight .25 mm	
25.48	Sharp groove, planetary		all lineweights .25 mm .825 mm > < 1.5 mm	
25.49	Subdued groove, planetary		all lineweights .25 mm 1.5 mm	
25.50	Radially grooved ejecta (schematic), planetary		.75 mm .75 mm .25 mm .75 mm .75 mm .75 mm	
25.51	Furrow, planetary		lineweight .25 mm 1.75 mm > < 1.75 mm	
25.52	Trough or narrow depression, planetary		lineweight .25 mm 3.0 mm 65°	
25.53	Depression (mapped to scale), planetary		all lineweights .25 mm hachure height .875 mm; spacing 3.5 mm	
25.54	Large depression (mapped to scale), planetary		all lineweights .25 mm pattern 118-K hachure height 6.25 mm; spacing 3.5 mm	
25.55	Shallow, linear depression or valley, or narrow channel, planetary		lineweight .25 mm color 100% cyan	
25.56	Channel (canali), planetary		lineweight .25 mm long dash 2.5 mm; short dash .5 mm; spacing .5 mm	
25.57	Channel (canali), planetary—Two short dashes where structureless or indefinite		lineweight .25 mm long dash 2.5 mm; short dashes .5 mm; spacing .5 mm	
25.58	Narrow channel (possible lava channel), planetary—Arrows point in direction of flow		all lineweights .175 mm 4.0 mm 45° 1.875 mm > <	
25.59	Erosional boundary, planetary—Erosion increases in direction of arrows		2.5 mm lineweight .175 mm 1.5 mm 30° 2.0 mm	
25.60	Angular unconformity, planetary—Hachures indicate truncated beds		lineweight .3 mm lineweight .2 mm hachure height 1.75 mm; spacing 2.5 mm	
25.61	Angular unconformity, planetary—Uncertain. Hachures indicate truncated beds		2.25 mm .5 mm	
25.62	Layer, planetary		1.125 mm > < lineweight .2 mm .75 mm > <	
25.63	Lineament, planetary		lineweight .3 mm 1.5 mm .5 mm	
25.64	Layering in canyon wall, planetary		all lineweights .2 mm lengths and spacing will vary	
25.65	Fabric of short radar-bright lineaments (schematic), planetary		all lineweights .25 mm lengths and spacing will vary	
25.66	Penetrative lineations, within tessera terrain, planetary		all lineweights .125 mm lengths and spacing will vary	
25.67	Flow direction, planetary		lineweight .175 mm 3.0 mm 30° 1.5 mm length may vary	
25.68	Wind streaks, planetary—Arrow points in inferred wind direction		all lineweights .2 mm 3.5 mm 30° 1.875 mm length may vary	
25.69	Area of channelized erosion and scouring, planetary—Arrow points in direction of interpreted flow		lineweight .375 mm 2.75 mm 6.0 mm 30°	
25.70	Area of eolian transport, planetary—Arrow points in direction of air flow		all lineweights .375 mm 2.75 mm 6.0 mm 30°	

*For more information, see general guidelines on pages A-i to A-v.

25—PLANETARY GEOLOGY FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
25.71	Scarp, planetary—Hachures point downscarp		all lineweights .25 mm 	
25.72	Lobate scarp, planetary—Hachures point downscarp		all lineweights .25 mm 	
25.73	Basal scarp, planetary—Hachures point downscarp		all lineweights .25 mm 	
25.74	Base of scarp, planetary—Barb points downscarp		lineweight .25 mm 	
25.75	Dome, edifice, or circular scarp, planetary (mapped to scale)—Hachures point downscarp		all lineweights .25 mm 	
25.76	Very small shield, dome, or volcanic construct, planetary (not mapped to scale)		all lineweights .4 mm 	
25.77	Small shield, dome, or volcanic construct, planetary (not mapped to scale)		all lineweights .6 mm 	
25.78	Large, steep-sided shield, dome, or volcanic construct, planetary (not mapped to scale)		all lineweights .375 mm circle diameter 4.0 mm 	
25.79	Mesa, planetary (not mapped to scale)		all lineweights .375 mm circle diameter 4.0 mm all barb lengths 1.625 mm 	
25.80	Large shield, dome, or volcanic construct, planetary (mapped to scale)—Hachures point downscarp		all lineweights .3 mm 	
25.81	Large cone, planetary (mapped to scale)—Hachures point downscarp		all lineweights .25 mm 	
25.82	Knob or central peak, planetary (not mapped to scale)		all lineweights .25 mm circle diameter 2.0 mm 	
25.83	Knob, planetary (mapped to scale)—Bar and ball indicate apical fissure. Hachures point downscarp		dot diameter 1.25 mm all lineweights .25 mm 	
25.84	Elevated plateau, planetary (mapped to scale)—Hachures point downscarp		all lineweights .25 mm 	
25.85	Steep-sided edifice, planetary (not mapped to scale)		2.0 mm all lineweights .25 mm 	
25.86	Steep-sided edifice, planetary (not mapped to scale)—Dotted where concealed or buried		short dashes .5 mm; spacing .5 mm 	
25.87	Large edifice, planetary (not mapped to scale)		all lineweights .25 mm 	
25.88	Very small tholi, planetary (not mapped to scale)		lineweight .25 mm 	
25.89	Small tholi, planetary (not mapped to scale)		all lineweights .25 mm circle diameter 3.0 mm 	
25.90	Small tholi, planetary (mapped to scale)		all lineweights .25 mm 	
25.91	Corona, planetary		lineweight .25 mm dash length 1.5 mm; spacing .75 mm 	
25.92	Nova, planetary		lineweight .5 mm dash length 2.25 mm; spacing .75 mm 	
25.93	Palimpsest ring, planetary		dot diameter .875 mm; spacing .375 mm 	

*For more information, see general guidelines on pages A-i to A-v.

25—PLANETARY GEOLOGY FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
25.94	Raised rim of larger impact crater, planetary— Hachures point into crater		all lineweights .3 mm hachure height .75 mm; spacing of hachure pairs .5 mm	
25.95	Raised rim of smaller impact crater, planetary		lineweight .3 mm	
25.96	Raised rim of impact crater, planetary—Showing visible ejecta blanket		lineweight .15 mm	
25.97	Degraded impact crater rim, planetary (1st option)		lineweight .3 mm	dash length 1.0 mm; spacing .5 mm
25.98	Rimless impact crater, subdued impact crater rim, degraded impact crater rim (2nd option), or buried impact crater rim, planetary		lineweight .3 mm	long dash 4.0 mm; short dashes .2 mm; spacing .5 mm
25.99	Secondary impact crater chain and cluster, planetary		lineweight .25 mm	dash length 1.5 mm; spacing .5 mm
25.100	Basin ring, planetary		lineweight .375 mm	dash length .75 mm; spacing .75 mm
25.101	Central peak of impact crater, planetary (1st option)		ellipse width 1.875 mm; height 2.625 mm	 all lineweights .2 mm
25.102	Central peak of impact crater, planetary (2nd option)		2.375 mm	 all lineweights .2 mm
25.103	Pit of impact crater floor, planetary (1st option)		lineweight .2 mm	
25.104	Pit of impact crater floor, planetary (2nd option)		dot diameter .875 mm	
25.105	Pit-crater chain (mapped to scale), planetary		lineweight .2 mm	
25.106	Small endogenic crater, planetary		dot diameter 1.0 mm	
25.107	Small endogenic crater (mapped to scale), planetary		lineweight .25 mm	
25.108	Medium-sized endogenic crater (mapped to scale), planetary		lineweight .25 mm dot diameter 1.0 mm	
25.109	Large endogenic crater (mapped to scale), planetary		all lineweights .25 mm	hachure height 1.25 mm; spacing 3.175 mm
25.110	Chain craters or collapsed lava tube (mapped to scale), planetary		lineweight .2 mm	
25.111	Caldera, planetary		all lineweights .25 mm	hachure height .625 mm; spacing .875 mm
25.112	Volcano, planetary, having summit crater		lineweight .15 mm	
25.113	Volcano, planetary, without summit crater—Queried if origin is conjectural			
25.114	Flow front, planetary—Arrow indicates flow direction		1.375 mm lineweight .25 mm	1.125 mm arrow line weight .25 mm 40°
25.115	Mountain (rugged), planetary—Origin uncertain		lineweight .2 mm	line color 50% black
25.116	Channel bars, planetary—May be erosional or depositional		lineweight .2 mm	line color 30% black
25.117	Slide or slump material, planetary—Arrow indicates direction of movement		lineweight .25 mm	1.75 mm arrow line weight .2 mm 2.5 mm 60°

*For more information, see general guidelines on pages A-i to A-v.

25—PLANETARY GEOLOGY FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
25.118	Dark-colored ejecta, planetary		<i>pattern</i> 428-K	May also be shown in red or other colors.
25.119	Light-colored ejecta, planetary		<i>pattern</i> 429-K	
25.120	Terrace deposits, planetary		<i>pattern</i> 427-K	
25.121	Dark-colored mantling material, planetary		<i>pattern</i> 214-K (at 45°)	
25.122	Secondary crater field, planetary		<i>pattern</i> 102-R	May also be shown in black or other colors.
25.123	Diffuse highland-lowland boundary scarp, planetary		<i>pattern</i> 134-R	
25.124	Joint or fracture pattern, planetary		<i>pattern</i> 430-K	May also be shown in red or other colors.
25.125	Area of reticulate grooves, planetary—Showing trend		<i>pattern</i> 327-K	
25.126	Detached lobe, planetary—Arrow points in direction of interpreted landslide or debris flow		<i>pattern</i> 116-K 1.75 mm lineweight .3 mm; length 4.5 mm 60°	
25.127	Low albedo smooth material, planetary—Interpreted as eolian material		<i>pattern</i> 136-K	
25.128	Airburst spot		<i>pattern</i> 434-K	
25.129	Mantling material, planetary—Light-colored		<i>pattern</i> 435-K in 50% black	
25.130	Splotch, planetary—Circular, radar-bright halo on surface		<i>pattern</i> 116-K	
25.131	Reticulate pattern on plains, planetary		<i>pattern</i> 119-K	
25.132	Fracture zone, planetary		<i>pattern</i> 137-K	
25.133	Superficial crater material having weak radar backscatter coefficient, planetary		<i>pattern</i> 436-K	
25.134	Crater-associated ejecta halo, planetary		<i>pattern</i> 429-K	
25.135	Halo without associated crater, planetary		<i>pattern</i> 429-C	

*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
26.1—Water wells				
26.1.1	Water well, type unspecified	○	lineweight .15 mm ○ diameter 1.75 mm	May also be shown in cyan or other colors.
26.1.2	Unused water well	∅	bar lineweight .3 mm ∅ 3.725 mm circle lineweight .2 mm	
26.1.3	Capped water well	⊖	1.235 mm ⊖ 1.125 mm all lineweights .2 mm	
26.1.4	Shut-in water well	⊖	1.125 mm ⊖ 1.235 mm all lineweights .2 mm	
26.1.5	Dry hole used for water exploration	⊖	1.0 mm ⊖ 1.0 mm all lineweights .2 mm	
26.1.6	Well used for collection of water data	⊖	1.0 mm ⊖ all lineweights .2 mm	
26.1.7	Well used for domestic-water supply	●	● diameter 1.75 mm	
26.1.8	Flowing artesian well used for domestic-water supply	▲	2.0 mm ▲ 1.25 mm arrow lineweight .15 mm	
26.1.9	Nonflowing artesian well used for domestic-water supply	⊖	1.375 mm ⊖ radius .3125 mm lineweight .175 mm	
26.1.10	Recharge or waste-injection well, once used for domestic-water supply	▼	2.0 mm ▼ 1.25 mm arrow lineweight .15 mm	
26.1.11	Observation well used for domestic-water supply	⊖	bar lineweight .3 mm ⊖ 3.725 mm 45°	
26.1.12	Observation well used for domestic-water supply—Equipped with a recorder	⊖ ^R	⊖ ^R ← H-6	
26.1.13	Dry well, once used for domestic-water supply	⊖	bar lineweight .2 mm ⊖ 3.725 mm 45°	
26.1.14	Destroyed well, once used for domestic-water supply	⊖	bar lineweights .2 mm ⊖ 90° 3.725 mm	
26.1.15	Test hole for well used for domestic-water supply	⊖	.6 mm ⊖ 2.75 mm bar lineweights .15 mm	
26.1.16	Well used for stock-water supply	○	lineweight .25 mm ○ diameter 1.75 mm	
26.1.17	Flowing artesian well used for stock-water supply	▲	2.0 mm ▲ 1.25 mm arrow lineweight .15 mm	
26.1.18	Nonflowing artesian well used for stock-water supply	⊖	1.375 mm ⊖ radius .3125 mm lineweight .175 mm	
26.1.19	Recharge or waste-injection well, once used for stock-water supply	▼	2.0 mm ▼ 1.25 mm arrow lineweight .15 mm	
26.1.20	Observation well used for stock-water supply	⊖	bar lineweight .3 mm ⊖ 3.725 mm 45°	
26.1.21	Observation well used for stock-water supply—Equipped with a recorder	⊖ ^R	⊖ ^R ← H-6	
26.1.22	Dry well, once used for stock-water supply	⊖	bar lineweight .2 mm ⊖ 3.725 mm 45°	
26.1.23	Destroyed well, once used for stock-water supply	⊖	bar lineweights .2 mm ⊖ 90° 3.725 mm	
26.1.24	Test hole for well used for stock-water supply	⊖	.6 mm ⊖ 2.75 mm bar lineweights .15 mm	

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
26.1—Water wells (continued)				
26.1.25	Well used for irrigation-water supply		outer circle diameter 2.0 mm; lineweight .2 mm inner circle diameter 1.125 mm; lineweight .15 mm	May also be shown in cyan or other colors.
26.1.26	Flowing artesian well used for irrigation-water supply		2.0 mm 1.25 mm arrow lineweight .15 mm	
26.1.27	Nonflowing artesian well used for irrigation-water supply		1.375 mm radius .3125 mm lineweight .175 mm	
26.1.28	Recharge or waste-injection well, once used for irrigation-water supply		2.0 mm 1.25 mm arrow lineweight .15 mm	
26.1.29	Observation well used for irrigation-water supply		bar lineweight .3 mm 3.725 mm 45°	
26.1.30	Observation well used for irrigation-water supply— Equipped with a recorder		R ← H-6	
26.1.31	Dry well, once used for irrigation-water supply		bar lineweight .2 mm 45° 3.725 mm	
26.1.32	Destroyed well, once used for irrigation-water supply		bar lineweights .2 mm 90° 3.725 mm	
26.1.33	Test hole for well used for irrigation-water supply		.6 mm 2.75 mm bar lineweights .15 mm	
26.1.34	Well used for industrial-water supply		outer circle diameter 2.0 mm; lineweight .2 mm inner dot diameter 1.125 mm	
26.1.35	Flowing artesian well used for industrial-water supply		2.0 mm 1.25 mm arrow lineweight .15 mm	
26.1.36	Nonflowing artesian well used for industrial-water supply		1.375 mm radius .3125 mm lineweight .175 mm	
26.1.37	Recharge or waste-injection well, once used for industrial-water supply		2.0 mm 1.25 mm arrow lineweight .15 mm	
26.1.38	Observation well used for industrial-water supply		bar lineweight .3 mm 3.725 mm 45°	
26.1.39	Observation well used for industrial-water supply— Equipped with a recorder		R ← H-6	
26.1.40	Dry well, once used for industrial-water supply		bar lineweight .2 mm 45° 3.725 mm	
26.1.41	Destroyed well, once used for industrial-water supply		bar lineweights .2 mm 90° 3.725 mm	
26.1.42	Test hole for well used for industrial-water supply		.6 mm 2.75 mm bar lineweights .15 mm	

*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
26.1—Water wells (continued)				
26.1.43	Well used for public-water supply	○	line weight .375 mm ○ diameter 2.0 mm	May also be shown in cyan or other colors.
26.1.44	Flowing artesian well used for public-water supply	⤴	2.0 mm ⤴ 1.25 mm arrow line weight .15 mm	
26.1.45	Nonflowing artesian well used for public-water supply	⊕	1.375 mm ⊕ radius .3125 mm line weight .175 mm	
26.1.46	Recharge or waste-injection well, once used for public-water supply	⤵	2.0 mm ⤵ 1.25 mm arrow line weight .15 mm	
26.1.47	Observation well used for public-water supply	⊗	bar line weight .3 mm ⊗ 3.725 mm 45°	
26.1.48	Observation well used for public-water supply— Equipped with a recorder	⊗ ^R	⊗ ^R ← H-6	
26.1.49	Dry well, once used for public-water supply	∅	bar line weight .2 mm ∅ 45° 3.725 mm	
26.1.50	Destroyed well, once used for public-water supply	⊗	bar line weights .2 mm 90° ⊗ 3.725 mm	
26.1.51	Test hole for well used for public-water supply	⊕	.6 mm ⊕ bar line weights .15 mm 2.75 mm	

*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
26.2—Springs				
26.2.1	Spring, type of use unspecified		all lineweights .15 mm draft "tail" as shown circle diameter 1.75 mm	Rotate "tail" to point in direction of flow. May also be shown in cyan, red, or other colors.
26.2.2	Unused spring		bar lineweight .3 mm circle and "tail" lineweight .2 mm 3.725 mm	
26.2.3	Spring used for collection of water-quality data		circle and "tail" lineweight .2 mm dot diameter .375 mm	
26.2.4	Spring used for domestic-water supply		"tail" lineweight .2 mm draft "tail" as shown dot diameter 1.75 mm	
26.2.5	Thermal spring used for domestic-water supply		H-6 →	
26.2.6	Mineral spring used for domestic-water supply		H-6 →	
26.2.7	Extinct spring, once used for domestic-water supply		3.725 mm bar lineweight .2 mm	
26.2.8	Spring used for stock-water supply		"tail" lineweight .2 mm draft "tail" as shown circle diameter 1.75 mm; lineweight .2 mm	
26.2.9	Thermal spring used for stock-water supply		H-6 →	
26.2.10	Mineral spring used for stock-water supply		H-6 →	
26.2.11	Extinct spring, once used for stock-water supply		3.725 mm bar lineweight .2 mm	
26.2.12	Spring used for irrigation-water supply		inner circle diameter 1.125 mm; lineweight .15 mm draft "tail" as shown "tail" lineweight .2 mm outer circle diameter 1.75 mm; lineweight .2 mm	
26.2.13	Thermal spring used for irrigation-water supply		H-6 →	
26.2.14	Mineral spring used for irrigation-water supply		H-6 →	
26.2.15	Extinct spring, once used for irrigation-water supply		3.725 mm bar lineweight .2 mm	
26.2.16	Spring used for industrial-water supply		inner dot diameter 1.125 mm draft "tail" as shown "tail" lineweight .2 mm outer circle diameter 1.75 mm; lineweight .2 mm	
26.2.17	Thermal spring used for industrial-water supply		H-6 →	
26.2.18	Mineral spring used for industrial-water supply		H-6 →	
26.2.19	Extinct spring, once used for industrial-water supply		3.725 mm bar lineweight .2 mm	
26.2.20	Spring used for public-water supply		"tail" lineweight .2 mm draft "tail" as shown circle diameter 2.0 mm; lineweight .375 mm	
26.2.21	Thermal spring used for public-water supply		H-6 →	
26.2.22	Mineral spring used for public-water supply		H-6 →	
26.2.23	Extinct spring, once used for public-water supply		3.725 mm bar lineweight .2 mm	

*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
26.3—Water gaging stations				
26.3.1	Water gaging station, type of measurement unspecified		2.25 mm $\backslash / 60^\circ$ lineweight .15 mm	May also be shown in cyan or other colors.
26.3.2	Discontinued water gaging station		bar lineweight .3 mm triangle lineweight .2 mm	
26.3.3	Continuous-record water gaging station		2.25 mm $\backslash / 60^\circ$	
26.3.4	Continuous-record water gaging station—Equipped with a telephone or radio		1.25 mm $\backslash / 60^\circ$ "antenna" lineweight .175 mm .875 mm \rightarrow	
26.3.5	Continuous-record peak-flow measurement water gaging station		2.0 mm $\rightarrow 25^\circ$ arrow lineweight .15 mm	
26.3.6	Continuous-record low-flow measurement water gaging station		2.0 mm $\rightarrow 25^\circ$ arrow lineweight .15 mm	
26.3.7	Continuous-record stage-measurement water gaging station		3.0 mm \rightarrow \rightarrow bar lineweight .2 mm	
26.3.8	Partial-record water gaging station (floods)		2.25 mm $\backslash / 60^\circ$ [same angle for both triangles] outer triangle lineweight .175 mm	
26.3.9	Partial-record water gaging station (floods)—Equipped with a telephone or radio		1.25 mm $\backslash / 60^\circ$ "antenna" lineweight .175 mm .875 mm \rightarrow	
26.3.10	Partial-record peak-flow measurement water gaging station (floods)		2.0 mm $\rightarrow 25^\circ$ arrow lineweight .15 mm	
26.3.11	Partial-record low-flow measurement water gaging station (floods)		2.0 mm $\rightarrow 25^\circ$ arrow lineweight .15 mm	
26.3.12	Partial-record stage-measurement water gaging station (floods)		3.0 mm \rightarrow \rightarrow bar lineweight .2 mm	
26.3.13	Measurement site without a gage		2.25 mm $\backslash / 60^\circ$ lineweight .25 mm	
26.3.14	Measurement site without a gage—Equipped with a telephone or radio		1.25 mm $\backslash / 60^\circ$ "antenna" lineweight .175 mm .875 mm \rightarrow	
26.3.15	Peak-flow measurement site without a gage		2.0 mm $\rightarrow 25^\circ$ arrow lineweight .15 mm	
26.3.16	Low-flow measurement site without a gage		2.0 mm $\rightarrow 25^\circ$ arrow lineweight .15 mm	
26.3.17	Stage-measurement site without a gage		3.0 mm \rightarrow \rightarrow bar lineweight .2 mm	

*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
26.4—Quality-of-water sites				
26.4.1	Quality-of-water site, type of measurement unspecified		<i>lineweight .15 mm</i> 2.25 mm 60°	May also be shown in cyan or other colors.
26.4.2	Inactive quality-of-water site		triangle lineweight .2 mm 3.75 mm bar lineweight .3 mm	
26.4.3	Active quality-of-water site		2.25 mm 60°	
26.4.4	Active quality-of-water site, chemical measurement		1.25 mm bar lineweight .25 mm	
26.4.5	Active quality-of-water site, temperature measurement		1.25 mm bar lineweight .25 mm	
26.4.6	Active quality-of-water site, biological measurement		1.25 mm bar lineweight .25 mm	
26.4.7	Active quality-of-water site, sediment measurement		1.25 mm bar lineweight .25 mm	
26.4.8	Active quality-of-water site—Equipped with a monitor		<i>lineweight .375 mm</i> 2.25 mm 60°	
26.4.9	Active quality-of-water site, chemical measurement—Equipped with a monitor		1.25 mm bar lineweight .25 mm	
26.4.10	Active quality-of-water site, temperature measurement—Equipped with a monitor		1.25 mm bar lineweight .25 mm	
26.4.11	Active quality-of-water site, biological measurement—Equipped with a monitor		1.25 mm bar lineweight .25 mm	
26.4.12	Active quality-of-water site, sediment measurement—Equipped with a monitor		1.25 mm bar lineweight .25 mm	

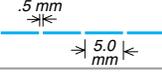
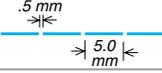
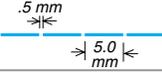
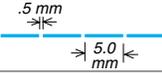
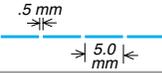
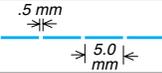
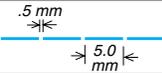
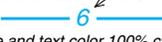
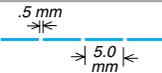
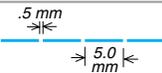
*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
26.5—Geohydrologic contours				
26.5.1	Structure contour (index), as shown on hydrologic maps, showing altitude of top or base of, or horizon within, stratigraphic unit, aquifer, or confining bed—Accurately located		lineweight .375 mm line and text color 100% red	On most maps, every fourth or fifth contour is an index contour, and usually only index contours are labeled. May be shown in black or other colors.
26.5.2	Structure contour (index), as shown on hydrologic maps, showing altitude of top or base of, or horizon within, stratigraphic unit, aquifer, or confining bed—Approximately located		.5 mm 	
26.5.3	Structure contour (intermediate), as shown on hydrologic maps, showing altitude of top or base of, or horizon within, stratigraphic unit, aquifer, or confining bed—Accurately located		lineweight .275 mm line color 100% red	
26.5.4	Structure contour (intermediate), as shown on hydrologic maps, showing altitude of top or base of, or horizon within, stratigraphic unit, aquifer, or confining bed—Approximately located		.5 mm 	
26.5.5	Bedrock contour (index), as shown on hydrologic maps, showing altitude of bedrock surface—Accurately located		lineweight .375 mm line and text color 100% violet	On most maps, every fourth or fifth contour is an index contour, and usually only index contours are labeled. May be shown in black or other colors.
26.5.6	Bedrock contour (index), as shown on hydrologic maps, showing altitude of bedrock surface—Approximately located		.5 mm 	
26.5.7	Bedrock contour (intermediate), as shown on hydrologic maps, showing altitude of bedrock surface—Accurately located		lineweight .275 mm line color 100% violet	
26.5.8	Bedrock contour (intermediate), as shown on hydrologic maps, showing altitude of bedrock surface—Approximately located		.5 mm 	
26.5.9	Water-table contour (index), showing altitude of unconfined water table [date]—Accurately located		lineweight .375 mm line and text color 100% cyan	Use only in reference to unconfined (water-table) conditions. On most maps, every fourth or fifth contour is an index contour, and usually only index contours are labeled. May be shown in black or other colors.
26.5.10	Water-table contour (index), showing altitude of unconfined water table [date]—Approximately located		.5 mm 	
26.5.11	Water-table contour (intermediate), showing altitude of unconfined water table [date]—Accurately located		lineweight .275 mm line color 100% cyan	
26.5.12	Water-table contour (intermediate), showing altitude of unconfined water table [date]—Approximately located		.5 mm 	
26.5.13	Potentiometric or water-level contour (index), showing altitude at which water level would have stood in tightly cased wells [date]—Accurately located		lineweight .375 mm line and text color 100% cyan	Use in reference to either confined (artesian) or unconfined conditions, when they are not differentiated on map. On most maps, every fourth or fifth contour is an index contour, and usually only index contours are labeled. May be shown in black or other colors.
26.5.14	Potentiometric or water-level contour (index), showing altitude at which water level would have stood in tightly cased wells [date]—Approximately located		.5 mm 	
26.5.15	Potentiometric or water-level contour (intermediate), showing altitude at which water level would have stood in tightly cased wells [date]—Accurately located		lineweight .275 mm line color 100% cyan	
26.5.16	Potentiometric or water-level contour (intermediate), showing altitude at which water level would have stood in tightly cased wells [date]—Approximately located		.5 mm 	
26.5.17	Water-quality-zone contour (index), showing altitude of top or base of, or horizon within, [type of] water-quality zone or water in aquifer [date]—Accurately located		lineweight .375 mm line and text color 100% green	On most maps, every fourth or fifth contour is an index contour, and usually only index contours are labeled. May be shown in black or other colors.
26.5.18	Water-quality-zone contour (index), showing altitude of top or base of, or horizon within, [type of] water-quality zone or water in aquifer [date]—Approximately located		.5 mm 	
26.5.19	Water-quality-zone contour (intermediate), showing altitude of top or base of, or horizon within, [type of] water-quality zone or water in aquifer [date]—Accurately located		lineweight .275 mm line color 100% green	
26.5.20	Water-quality-zone contour (intermediate), showing altitude of top or base of, or horizon within, [type of] water-quality zone or water in aquifer [date]—Approximately located		.5 mm 	

*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
26.6—Geohydrologic lines				
26.6.1	Line of equal, average, mean, or median (etc.) annual, monthly, or daily (etc.) precipitation [date]—Accurately located	—24—	lineweight .375 mm  line and text color 100% cyan	Negative values must be preceded by a minus (-) sign. Date needed only for parameters that vary with time. May be shown in black or other colors.
26.6.2	Line of equal, average, mean, or median (etc.) annual, monthly, or daily (etc.) precipitation [date]—Approximately located	- - - - -	.5 mm 	
26.6.3	Line of equal depth to geologic formation, bedrock, aquifer, or water (etc.) [date]—Accurately located	—100—	lineweight .375 mm  line and text color 100% cyan	
26.6.4	Line of equal depth to geologic formation, bedrock, aquifer, or water (etc.) [date]—Approximately located	- - - - -	.5 mm 	
26.6.5	Line of equal thickness of geologic formation, aquifer, confining bed, or saturated material (etc.) [date]—Accurately located	—50—	lineweight .375 mm  line and text color 100% cyan	
26.6.6	Line of equal thickness of geologic formation, aquifer, confining bed, or saturated material (etc.) [date]—Approximately located	- - - - -	.5 mm 	
26.6.7	Line of equal water temperature [date]—Accurately located	—10—	lineweight .375 mm  line and text color 100% cyan	
26.6.8	Line of equal water temperature [date]—Approximately located	- - - - -	.5 mm 	
26.6.9	Line of equal specific conductance [date]—Accurately located	—2000—	lineweight .375 mm  line and text color 100% cyan	
26.6.10	Line of equal specific conductance [date]—Approximately located	- - - - -	.5 mm 	
26.6.11	Line of equal dissolved-solids concentration, hardness, or chemical-constituent concentration [date]—Accurately located	—500—	lineweight .375 mm  line and text color 100% cyan	
26.6.12	Line of equal dissolved-solids concentration, hardness, or chemical-constituent concentration [date]—Approximately located	- - - - -	.5 mm 	
26.6.13	Line of equal water-level change, rise, or decline [date]—Accurately located	—20—	lineweight .375 mm  line and text color 100% cyan	
26.6.14	Line of equal water-level change, rise, or decline [date]—Approximately located	- - - - -	.5 mm 	
26.6.15	Line of equal runoff [date]—Accurately located	—6—	lineweight .375 mm  line and text color 100% cyan	
26.6.16	Line of equal runoff [date]—Approximately located	- - - - -	.5 mm 	
26.6.17	Line of equal transmissivity, hydraulic conductivity, or porosity (etc.)—Accurately located	—10,000—	lineweight .375 mm  line and text color 100% cyan	
26.6.18	Line of equal transmissivity, hydraulic conductivity, or porosity (etc.)—Approximately located	- - - - -	.5 mm 	

*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
26.7—Miscellaneous geohydrologic features				
26.7.1	Watershed basin boundary, drainage divide, or surface-water basin boundary		lineweight .6 mm dash length 7.5 mm dot diameter .625 mm; spacing .5 mm	May also be shown in cyan or other colors.
26.7.2	Watershed subbasin boundary, drainage subdivide, or surface-water subbasin boundary		lineweight .425 mm dash length 5.0 mm dot diameter .45 mm; spacing .5 mm	
26.7.3	Ground-water divide—Accurately located		 dot diameter .675 mm; spacing .575 mm	
26.7.4	Ground-water divide—Approximately located		lineweight .15 mm circle diameter .675 mm; spacing .575 mm	
26.7.5	Ground-water barrier (geologic)—Accurately located		lineweight .175 mm dot diameter .675 mm; spacing .575 mm	
26.7.6	Ground-water barrier (geologic)—Approximately located		lineweight .175 mm circle lineweight .15 mm; diameter .675 mm; spacing .575 mm	
26.7.7	Infiltration gallery		all lineweights .15 mm 1.75 mm 1.125 mm .625 mm	
26.7.8	Direction of ground-water flow (1st option)—Accurately located		 1.125 mm 5.75 mm 2.125 mm 30°	
26.7.9	Direction of ground-water flow (2nd option)—Accurately located		lineweight .15 mm 	
26.7.10	Direction of ground-water flow (1st option)—Approximately located		 6.75 mm all lineweights .25 mm 2.75 mm 1.5 mm 25°	
26.7.11	Direction of ground-water flow (2nd option)—Approximately located		dash 1.5 mm; space .5 mm 	

*For more information, see general guidelines on pages A-i to A-v.

27—WEATHER STATIONS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
27.1	Weather station, type of measurement unspecified		2.0 mm all lineweights .15 mm	
27.2	Discontinued weather station		bar lineweight .3 mm "foursquare" lineweight .2 mm	
27.3	Snow-survey course—Equipped with a telephone or radio		1.25 mm "foursquare" lineweight .2 mm	60° "antenna" lineweight .175 mm
27.4	Snow-survey course—Equipped with a recorder			← H-6
27.5	Weather station measuring precipitation—Equipped with a telephone or radio			
27.6	Weather station measuring precipitation—Equipped with a recorder			
27.7	Weather station measuring evaporation—Equipped with a telephone or radio			
27.8	Weather station measuring evaporation—Equipped with a recorder			
27.9	Weather station measuring temperature—Equipped with a telephone or radio			
27.10	Weather station measuring temperature—Equipped with a recorder			
27.11	Weather station measuring humidity—Equipped with a telephone or radio			
27.12	Weather station measuring humidity—Equipped with a recorder			
27.13	Weather station measuring solar radiation—Equipped with a telephone or radio			H-6 →
27.14	Weather station measuring solar radiation—Equipped with a recorder			
27.15	Weather station measuring wind velocity—Equipped with an arrow and a telephone or radio		arrow lineweight .175 mm	5.0 mm 25° 1.25 mm
27.16	Weather station measuring wind velocity—Equipped with a recorder			
27.17	Complete weather station—Equipped with a telephone or radio			
27.18	Complete weather station—Equipped with a recorder			

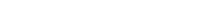
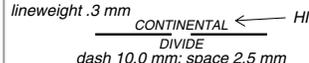
*For more information, see general guidelines on pages A-i to A-v.

28—TRANSPORTATION FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
28.1	Highway (generic)		 lineweight .325 mm; line color 70% black	May be used on non-topographic maps to show highways and streets.
28.2	Road or street (generic)		 lineweight .25 mm; line color 50% black	
28.3	Primary highway, undivided (Class 1)		outlines: lineweight .125 mm in 100% black .5 mm fill: lineweight .5 mm; line color 100% red	
28.4	Primary highway, divided by centerline (Class 1)		.5 mm .5 mm	
28.5	Primary highway, divided by median strip (Class 1)		.5 mm ← spacing may vary	
28.6	Secondary highway, undivided (Class 2)		 fill: dash length 3.0 mm; space 3.0 mm	
28.7	Secondary highway, divided by centerline (Class 2)		.5 mm .5 mm	
28.8	Secondary highway, divided by median strip (Class 2)		.5 mm ← spacing may vary	
28.9	Light-duty road, paved (Class 3)		outlines: lineweight .125 mm in 100% black .5 mm fill: lineweight .5 mm; line color 50% black	
28.10	Light-duty road, gravel (Class 3)		.5 mm fill: dash length 3.0 mm; space 1.5 mm	
28.11	Light-duty road, dirt (Class 3)		.5 mm fill: dash length 1.5 mm; space 3.0 mm	
28.12	Street in urban area; light-duty road, composition unspecified (Class 3)		lineweights .125 mm .5 mm	
28.13	Unimproved road (Class 4)		lineweights .125 mm .5 mm dash length 1.25 mm; space .5 mm	
28.14	Four-wheel-drive road (Class 5)		lineweights .125 mm .5 mm dash length 1.25 mm; space .5 mm	
28.15	Trail		lineweight .15 mm dash length 1.25 mm; space .5 mm	
28.16	Interstate route marker		H-6 (100% red) draft as shown lineweight .2 mm; line color 100% red	
28.17	U.S. route marker		H-6 (100% red) draft as shown lineweight .2 mm; line color 100% red	
28.18	State route marker		H-6 (100% red) circle diameter 4.375 mm lineweight .2 mm; line color 100% red	
28.19	Railroad (single track)		all lineweights .125 mm 5.0 mm 1.0 mm	
28.20	Railroad (more than one track)—Showing number of tracks		all lineweights .125 mm 1.325 mm 5.0 mm 5.0 mm HI-5 → 4 TRACKS	

*For more information, see general guidelines on pages A-i to A-v.

29—BOUNDARIES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
29.1	Boundary—National		line weight .4 mm  H-7 long dash 6.35 mm; short dash 1.75 mm; space .835 mm	
29.2	Boundary—State, territory		line weight .3 mm long dash 6.35 mm; short dash 1.75 mm; space .835 mm	
29.3	Boundary—County, parish, Alaska borough, municipio, judicial division		line weight .25 mm long dash 6.35 mm; short dash 1.75 mm; space .835 mm	
29.4	Boundary—Civil township, town, district, precinct, barrio		line weight .175 mm dash length 4.325 mm; space .835 mm	
29.5	Boundary—Incorporated city, village, town, borough, or hamlet		line weight .175 mm long dash 2.0 mm; short dash 1.0 mm; space .5 mm	
29.6	Boundary—National or state park, monument, reservation, forest, grassland, wilderness area, or wildlife refuge; Hawaii Homestead, Forest Reserve		line weight .175 mm dot diameter .25 mm dash length 6.35 mm; space 2.5 mm	
29.7	Boundary—Small park		line weight .125 mm dash length 1.0 mm; space .5 mm	
29.8	Continental Divide		line weight .3 mm  H-5 dash 10.0 mm; space 2.5 mm	

*For more information, see general guidelines on pages A-i to A-v.

30—TOPOGRAPHIC AND HYDROGRAPHIC FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
30.1—Topographic, bathymetric, and glacier contours				
30.1.1	Index topographic contour (1st option)		lineweight .25 mm line and text color 100% brown HI-6	On most maps, every fourth or fifth contour is an index contour. Usually only index and supplementary contours are labeled. Negative values must be preceded by a minus (-) sign.
30.1.2	Index topographic contour (1st option)—Approximate or indefinite		1.75 mm .5 mm HI-6	
30.1.3	Intermediate topographic contour (1st option)		lineweight .15 mm line color 100% brown	
30.1.4	Intermediate topographic contour (1st option)—Approximate or indefinite		1.75 mm .5 mm	
30.1.5	Supplementary topographic contour (1st option)		lineweight .2 mm line and text color 100% brown HI-6	
30.1.6	Supplementary topographic contour (1st option)—Approximate or indefinite		1.75 mm .5 mm HI-6	
30.1.7	Index topographic depression contour (1st option)		tick lineweight .15 mm; length .5 mm; spacing 3.0 mm contour lineweight .25 mm line color 100% brown	Hachures are added to indicate closed areas of low values.
30.1.8	Intermediate topographic depression contour (1st option)		tick length .5 mm; spacing 3.0 mm all lineweights .15 mm line color 100% brown	
30.1.9	Supplementary topographic depression contour (1st option)		tick lineweight .15 mm; length .5 mm; spacing 3.0 mm contour lineweight .2 mm line color 100% brown	
30.1.10	Topographic depression contours (1st option)—Showing tick spacing of adjacent contours		tick spacing 1.0 mm on lowest contour; on next contour, 2.0 mm; on all others, 3.0 mm (lineweights, etc., are given above)	
30.1.11	Index topographic contour (2nd option)		lineweight .25 mm 300 line and text color 50% black HI-6	
30.1.12	Index topographic contour (2nd option)—Approximate or indefinite		1.75 mm .5 mm HI-6	
30.1.13	Intermediate topographic contour (2nd option)		lineweight .15 mm line color 50% black	Negative values must be preceded by a minus (-) sign.
30.1.14	Intermediate topographic contour (2nd option)—Approximate or indefinite		1.75 mm .5 mm	
30.1.15	Supplementary topographic contour (2nd option)		lineweight .2 mm 185 line and text color 50% black HI-6	
30.1.16	Supplementary topographic contour (2nd option)—Approximate or indefinite		1.75 mm .5 mm HI-6	
30.1.17	Index topographic depression contour (2nd option)		tick lineweight .15 mm; length .5 mm; spacing 3.0 mm contour lineweight .25 mm line color 50% black	
30.1.18	Intermediate topographic depression contour (2nd option)		tick length .5 mm; spacing 3.0 mm all lineweights .15 mm line color 50% black	
30.1.19	Supplementary topographic depression contour (2nd option)		tick lineweight .15 mm; length .5 mm; spacing 3.0 mm contour lineweight .2 mm line color 50% black	
30.1.20	Topographic depression contours (2nd option)—Showing tick spacing of adjacent contours		tick spacing 1.0 mm on lowest contour; on next contour, 2.0 mm; on all others, 3.0 mm (lineweights, etc., are given above)	

*For more information, see general guidelines on pages A-i to A-v.

30—TOPOGRAPHIC AND HYDROGRAPHIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
30.1—Topographic, bathymetric, and glacier contours (continued)				
30.1.21	Index primary bathymetric contour		lineweight .275 mm 	On most maps, every fourth or fifth contour is an index contour. Do not break contours for contour values. Bathymetric contour values are always given in "below sea-level" units, so they are not preceded by a minus (-) sign.
30.1.22	Index primary bathymetric contour—Approximate			
30.1.23	Primary bathymetric contour		lineweight .175 mm 	
30.1.24	Primary bathymetric contour—Approximate			
30.1.25	Supplementary bathymetric contour		lineweight .2 mm 	
30.1.26	Supplementary bathymetric contour—Approximate			
30.1.27	Index bathymetric contour		lineweight .25 mm 	
30.1.28	Index bathymetric contour—Approximate			
30.1.29	Intermediate bathymetric contour		lineweight .15 mm 	
30.1.30	Intermediate bathymetric contour—Approximate			
30.1.31	Index primary bathymetric depression contour		tick lineweight .175 mm; length .375 mm (spacing varies) 	Hachures are added to the lowest contour(s) to indicate a closed area of low values (depression) and also an area of higher value (rise) inside a depression.
30.1.32	Index primary bathymetric rise contour (inside depression)			
30.1.33	Primary bathymetric depression contour		tick length .375 mm (spacing varies) 	
30.1.34	Primary bathymetric rise contour (inside depression)			
30.1.35	Supplementary bathymetric depression contour		tick lineweight .175 mm; length .375 mm (spacing varies) 	
30.1.36	Supplementary bathymetric rise contour (inside depression)			
30.1.37	Index bathymetric depression contour		tick lineweight .175 mm; length .375 mm (spacing varies) 	
30.1.38	Index bathymetric rise contour (inside depression)			
30.1.39	Intermediate bathymetric depression contour		tick length .375 mm (spacing varies) 	
30.1.40	Intermediate bathymetric rise contour (inside depression)			
30.1.41	Bathymetric rise contour (inside depression)— Showing hachure spacing for closed contours less than 12.7 mm in circumference		tick spacing 1.0 mm 	
30.1.42	Bathymetric depression contours—Showing hachure spacing for closed contours less than 12.7 mm in circumference		tick spacing 1.0 mm 	
30.1.43	Bathymetric depression or rise contours—Showing hachure spacing for closed contours between 12.7 mm and 76.2 mm in circumference		tick spacing 2.0 mm 	
30.1.44	Bathymetric depression or rise contours—Showing hachure spacing for closed contours more than 76.2 mm in circumference		tick spacing 2.5 mm 	

30—TOPOGRAPHIC AND HYDROGRAPHIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE
30.1—Topographic, bathymetric, and glacier contours (continued)				
30.1.45	Index contour on glacier or permanent snowfield		line weight .225 mm line color 100% cyan	On most maps, every fourth or fifth contour is an index contour.
30.1.46	Index contour on glacier or permanent snowfield—Approximate or indefinite		2.5 mm tick length .5 mm	
30.1.47	Intermediate contour on glacier or permanent snowfield		line weight .125 mm line color 100% cyan	
30.1.48	Intermediate contour on glacier or permanent snowfield—Approximate or indefinite		2.5 mm tick length .5 mm	
30.1.49	Index depression contour on glacier or permanent snowfield		tick line weight .15 mm; length .5 mm; spacing 3.0 mm contour line weight .225 mm line color 100% cyan	Hachures are added to indicate closed areas of low values.
30.1.50	Intermediate depression contour on glacier or permanent snowfield—Approximate or indefinite		tick length .5 mm; spacing 3.0 mm all line weights .125 mm line color 100% cyan	

*For more information, see general guidelines on pages A-i to A-v.

30—TOPOGRAPHIC AND HYDROGRAPHIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
30.2—Drainage features				
30.2.1	Perennial river, stream, or creek (single-line drainage)			Letter size and spacing may be increased along longer features.
30.2.2	Intermittent river, stream, creek, or wash (single-line drainage)			
30.2.3	Perennial river, stream, or creek (double-line drainage)			Letter size and spacing may be increased along wider features.
30.2.4	River mileage marker			
30.2.5	Intermittent river, stream, creek, or wash (double-line drainage)			
30.2.6	Braided river, stream, or creek			
30.2.7	Canal or ditch (single-line drainage)			
30.2.8	Canal or ditch (double-line drainage)			
30.2.9	Canal lock (single-line drainage) (1st option)			
30.2.10	Canal lock (single-line drainage) (2nd option)			
30.2.11	Canal lock (double-line drainage)			
30.2.12	Floodgate			
30.2.13	Tidegate			
30.2.14	Sluice gate			
30.2.15	Fish ladder			
30.2.16	Aqueduct (single-line drainage)			
30.2.17	Aqueduct (double-line drainage)			
30.2.18	Underground or underwater aqueduct			
30.2.19	Aboveground water pipeline			
30.2.20	Underground or submerged water pipeline			
30.2.21	Elevated water pipeline			
30.2.22	Flume			
30.2.23	Siphon			
30.2.24	Penstock			

30—TOPOGRAPHIC AND HYDROGRAPHIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
30.2—Drainage features (continued)				
30.2.25	Falls (single-line drainage)		TBI-7 (100% black) line color 100% cyan all lineweights .2 mm 1.25 mm	
30.2.26	Falls (double-line drainage)		lineweights .125 mm	
30.2.27	Rapids (single-line drainage)		6 mm 1.25 mm	
30.2.28	Rapids (double-line drainage)		lineweights .125 mm	
30.2.29	Shoreline—Showing open water		line color 100% cyan color fill 20% cyan lineweight .2 mm	
30.2.30	Indefinite or unsurveyed shoreline		dash length 1.75 mm; spacing .5 mm	
30.2.31	Approximate mean low water line		lineweight .15 mm	
30.2.32	Perennial lake or pond—Showing name		TI-8 (100% black) line color 100% cyan color fill 20% cyan lineweight .2 mm	Letter size and spacing may be increased within larger features.
30.2.33	Intermittent lake or pond		lineweight .2 mm; dash length 1.75 mm; spacing .5 mm pattern 132-C line color 100% cyan	
30.2.34	Dry lake or pond		pattern 132-B	
30.2.35	Land subject to inundation		pattern 231-C (@90°)	
30.2.36	Reservoir with natural shoreline		line color 100% cyan color fill 20% cyan	
30.2.37	Dammed reservoir		color fill 20% cyan lineweight .3 mm	
30.2.38	Area to be submerged behind dam		pattern 132-C	
30.2.39	Reservoir (uncovered) with man-made shoreline		lineweight .15 mm color fill 20% cyan	
30.2.40	Covered water storage reservoir		lineweight .15 mm pattern 214-K (@45°) [pattern overprints 20% cyan color fill]	
30.2.41	Salt flat		H-7 line color 100% cyan lineweight .2 mm	
30.2.42	Carolina bay		dash length 1.75 mm; spacing .5 mm line color 100% cyan lineweight .2 mm	
30.2.43	Tailings pond		H-7 line color 100% brown pattern 232-B dash length 1.75 mm; spacing .5 mm; lineweight .2 mm	
30.2.44	Outline of glacier or permanent snowfield		color 100% cyan lineweight .2 mm dash length 1.75 mm; spacing .5 mm	
30.2.45	Outline of glacier or permanent snowfield—Form lines show glacial trend		pattern 522-C (rotated perpendicular to glacial trend)	
30.2.46	Marsh, wetland, swamp, or bog		pattern 420-C	
30.2.47	Mangrove area		pattern 424-C	
30.2.48	Rice field		pattern 423-C	

30—TOPOGRAPHIC AND HYDROGRAPHIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
30.3—Miscellaneous topographic and hydrographic features				
30.3.1	Open pit mine or quarry, as shown on topographic maps or on general-purpose or smaller scale maps	Quarry	H-7 → Quarry draft as shown	
30.3.2	Gravel, sand, clay, or borrow pit, as shown on topographic maps or on general-purpose or smaller scale maps	Gravel Pit	H-7 → Gravel Pit 2.235 mm .75 mm line weight .15 mm	
30.3.3	Adit or mine tunnel entrance, as shown on topographic maps or on general-purpose or smaller scale maps	Mine	H-7 → Mine 2.225 mm 1.175 mm 1.75 mm 55° all line weights .15 mm	Rotate symbol so that long line points in direction of cave or mine entrance.
30.3.4	Cave entrance, as shown on topographic maps or on general-purpose or smaller scale maps	Cave	H-7 → Cave	
30.3.5	Prospect, as shown on topographic maps or on general-purpose or smaller scale maps	Prospect	H-7 → Prospect line weight .15 mm 1.75 mm 45°	
30.3.6	Mine shaft, as shown on topographic maps or on general-purpose or smaller scale maps—Showing name	Garnet Mine	line weight .15 mm 1.0 mm Garnet Mine ← H-7	
30.3.7	Landmark object, as shown on topographic maps or on general-purpose or smaller scale maps	Lookout	H-7 → Lookout dot diameter .225 mm circle diameter 1.0 mm line weight .15 mm	Add label for type of object (as is shown for example of "lookout").
30.3.8	Windmill, as shown on topographic maps or on general-purpose or smaller scale maps	Windmill	H-7 → Windmill 1.125 mm 1.25 mm windmill arm angles 110°, 70° .675 mm line weight .15 mm	
30.3.9	Oil or gas well, as shown on topographic maps or on general-purpose or smaller scale maps	Well	H-7 → Well circle diameter 1.0 mm line weight .15 mm	
30.3.10	Water well, as shown on topographic maps or on general-purpose or smaller scale maps	Well	H-7 → Well circle diameter 1.0 mm line weight .2 mm line color 100% cyan	
30.3.11	Geothermal well, as shown on topographic maps or on general-purpose or smaller scale maps	Geothermal	H-7 → Geothermal circle diameter 1.0 mm line weight .2 mm line color 100% cyan	
30.3.12	Spring, as shown on topographic maps or on general-purpose or smaller scale maps	Spring	H-7 → Spring circle diameter 1.0 mm draft "tail" as shown line color 100% cyan line weight .2 mm	
30.3.13	Geyser, fumarole, mud pot, or thermal spring, as shown on topographic maps or on general-purpose or smaller scale maps	Geyser	H-7 → Geyser circle diameter 1.0 mm line weight .2 mm line color 100% cyan	
30.3.14	Gaging station, as shown on topographic maps or on general-purpose or smaller scale maps	Gaging Station	H-7 → Gaging Station circle diameter 1.25 mm line weight .15 mm	
30.3.15	Pumping station, as shown on topographic maps or on general-purpose or smaller scale maps	Pumping Station	H-7 → Pumping Station .875 mm	
30.3.16	Rock	Rock	H-7 → Rock 60° line weight .2 mm 1.25 mm	
30.3.17	Exposed wreck		line weight .15 mm draft as shown	
30.3.18	Coral reef	Coral	H-7 → Coral line weight .15 mm	
30.3.19	Shoal	Shoal	dash length .2 mm; spacing .425 mm Shoal ← H-7 line weight .2 mm	
30.3.20	Ruins	Ruins	dash length 1.0 mm; spacing .5 mm Ruins ← H-7 line weight .15 mm	
30.3.21	Power transmission line		line weight .125 mm dot diameter .425 mm .825 mm line weight .125 mm	
30.3.22	Telephone line	TELEPHONE	line weight .125 mm dash length 2.5 mm; space .5 mm TELEPHONE ← HI-5	
30.3.23	Underground gas or oil pipeline	PIPELINE	PIPELINE ← HI-5 line weight .125 mm	
30.3.24	Aboveground gas or oil pipeline	ABOVEGROUND PIPELINE	ABOVEGROUND PIPELINE ← HI-5 line weight .125 mm	

31—MISCELLANEOUS MAP ELEMENTS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
31.1	Township and range line—Definite		<i>line and text color 100% red</i>	<p>On larger scale maps (for example, 1:24,000 scale), usually every section (nos. 1–36) is numbered.</p> <p>On smaller scale maps (for example, 1:100,000 scale), usually only corner sections (nos. 1, 6, 31, 36) are numbered (type size may be decreased if necessary).</p> <p>Every township and range, regardless of scale, should be numbered.</p> <p>May also be shown in 50% black, especially if contours or other base-map information is shown in 50% black (see Section 30.1).</p>
31.2	Township and range line—Location approximate		<i>lineweight .275 mm</i>	
31.3	Township label	T 32 N	<i>lineweight .15 mm</i>	
31.4	Range label	R 44 E	<i>lineweight .15 mm</i>	
31.5	Section line—Definite		<i>lineweight .275 mm; dash length 2.5 mm; space .5 mm</i>	
31.6	Section line—Location approximate		<i>lineweight .15 mm; dash length 2.5 mm; space .5 mm</i>	
31.7	Section number	5		
31.8	Map neatline		<i>lineweight .25 mm</i>	
31.9	Map neatline—Showing latitude or longitude tick and value	40°37'30"	<i>lineweight .25 mm</i>	
31.10	Cross section line and label	A—A'	<i>lineweight .2 mm</i>	
31.11	Leader		<i>lineweight .175 mm</i>	
31.12	Map-unit label (add leader where necessary)		<i>contact [lineweight .15 mm]</i> <i>leader [lineweight .175 mm]</i>	
31.13	Map-unit label containing geologic age character (add leader where necessary)		<i>FG-8</i> <i>H-8</i>	
31.14	Area of outcrop (1st option)		<i>100% black</i>	<p>Patterns should overprint other map units. Do not outline with contact (use scratch boundary instead). May be shown in other colors.</p>
31.15	Area of outcrop (2nd option)		<i>scratch boundary [lineweight 0.0 mm]</i> <i>50% black</i>	
31.16	Area of outcrop (3rd option)		<i>100% red</i>	
31.17	Area of outcrop (4th option)		<i>50% red</i>	
31.18	Area of outcrop in surficial deposits (1st option)		<i>pattern 134-K</i>	
31.19	Area of outcrop in surficial deposits (2nd option)		<i>pattern 134-K in 50% black</i>	
31.20	Area of outcrop in surficial deposits (3rd option)		<i>pattern 134-R</i>	
31.21	Sample locality—Showing sample number	● 98-103	<i>dot diameter 1.25 mm</i>	<p>May be shown in red or other colors.</p>
31.22	Field station locality, as shown on small-scale maps or on page-size illustrations	●	<i>dot diameter .5 mm</i>	
31.23	Chronostratigraphic zone, chronozone, or stage boundary		<i>dot diameter .5 mm; spacing .5 mm</i> <i>color 100% red</i>	<p>May be shown in black or other colors. Names may either be placed along zone boundary or within zones.</p>
31.24	Chronostratigraphic-zone, chronozone, or stage boundary—Showing names of stratigraphic ages	Aptian Albian	<i>color 100% red</i>	

*For more information, see general guidelines on pages A-i to A-v.

32—GEOLOGIC AGE SYMBOL FONT ("FGDC-GeoAge")

REF NO	STRATIGRAPHIC AGE	SUBDIVISION TYPE	AGE SYMBOL*	KEYBOARD POSITION FOR "FGDC-GeoAge" FONT*
32.1	Cenozoic	Era	Cz	{ (left curly bracket = shift-left square bracket)
32.2	Quaternary	Period	Q	No keyboard substitution needed (or, use Helvetica)
32.3	Tertiary	Period	T	No keyboard substitution needed (or, use Helvetica)
32.4	Neogene	Subperiod	N	No keyboard substitution needed (or, use Helvetica)
32.5	Paleogene	Subperiod	Pē	: (colon = shift-semi-colon)
32.6	Mesozoic	Era	Mz	} (right curly bracket = shift-right square bracket)
32.7	Cretaceous	Period	K	No keyboard substitution needed (or, use Helvetica)
32.8	Jurassic	Period	J	No keyboard substitution needed (or, use Helvetica)
32.9	Triassic	Period	T̄	^ (caret = shift-6)
32.10	Paleozoic	Era	Pz	(vertical line = shift-backslash)
32.11	Permian	Period	P	No keyboard substitution needed (or, use Helvetica)
32.12	Carboniferous	Period	C	No keyboard substitution needed (or, use Helvetica)
32.13	Pennsylvanian	Period	P*	* (asterisk = shift-8)
32.14	Mississippian	Period	M	No keyboard substitution needed (or, use Helvetica)
32.15	Devonian	Period	D	No keyboard substitution needed (or, use Helvetica)
32.16	Silurian	Period	S	No keyboard substitution needed (or, use Helvetica)
32.17	Ordovician	Period	O	No keyboard substitution needed (or, use Helvetica)
32.18	Cambrian	Period	€	_ (underscore = shift-hyphen)
32.19	Precambrian	Era	p€	= (equal sign)
32.20	Proterozoic	Eon	P	< ("less than" sign = shift-comma)
32.21	Late Proterozoic	Era	Z	No keyboard substitution needed (or, use Helvetica)
32.22	Middle Proterozoic	Era	Y	No keyboard substitution needed (or, use Helvetica)
32.23	Late Middle Proterozoic	Era	Y ³	E (capital E = shift-e)
32.24	Middle Middle Proterozoic	Era	Y ²	F (capital F = shift-f)

*For more information, see general guidelines on pages A-i to A-v.

32—GEOLOGIC AGE SYMBOL FONT ("FGDC-GeoAge") (continued)

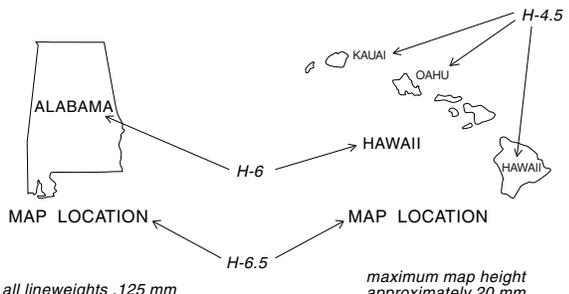
REF NO	STRATIGRAPHIC AGE	SUBDIVISION TYPE	AGE SYMBOL*	KEYBOARD POSITION FOR "FGDC-GeoAge" FONT*
32.25	Early Middle Proterozoic	Era	Y ¹	G (capital G = shift-g)
32.26	Early Proterozoic	Era	X	No keyboard substitution needed (or, use Helvetica)
32.27	Late Early Proterozoic	Era	X ³	I (capital I = shift-i)
32.28	Middle Early Proterozoic	Era	X ²	L (capital L = shift-l)
32.29	Early Early Proterozoic	Era	X ¹	R (capital R = shift-r)
32.30	Archean	Eon	A	No keyboard substitution needed (or, use Helvetica)
32.31	Late Archean	Era	W	No keyboard substitution needed (or, use Helvetica)
32.32	Middle Archean	Era	V	No keyboard substitution needed (or, use Helvetica)
32.33	Early Archean	Era	U	No keyboard substitution needed (or, use Helvetica)
32.34	pre-Archean	Eon	pA	B (capital B = shift-b)

**For more information, see general guidelines on pages A-i to A-v.*

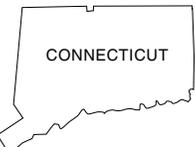
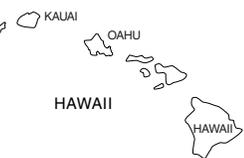
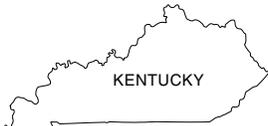
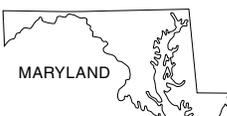
33—SUGGESTED RANGES OF MAP-UNIT COLORS FOR VOLCANIC AND PLUTONIC ROCKS AND FOR STRATIGRAPHIC AGES OF SEDIMENTARY AND METAMORPHIC ROCKS

CMYK* values (K = 0): A = 8%; 1 = 13%; 2 = 20%; 3 = 30%; 4 = 40%; 5 = 50%; 6 = 60%; 7 = 70%; X = 100%									
33.1—Suggested range of map-unit colors for volcanic and plutonic rocks*									
010	030	050	070	0X0	057	07X	036	047	05X
A60	270	3X0	150	370	5X0	033	055	077	0XX
33.2—Suggested range of map-unit colors for stratigraphic ages of sedimentary and metamorphic rocks*									
Q 007	001		0A6		005		003		
T 037	0A3	A4X	A37	026	014	A25	024		
K 507	104	517	415	406	305				
J 604	202	705	504	303					
Ṛ 602	20A	6A3	402	301					
P 600	300	701	501	40A					
Ṗ 620	4A0	72A	61A	510					
M 431	21A	531	42A	32A					
D 540	220	650	440	330					
S 350	A20	460	34A	230					
O 051	02A	A51	041	031					
€ 054	022	A54	043	A33					
p€ 446	A11	455	344	233	122	121			
	A12	457	346	235	124	A13			
	1A3	537	436	326	324	214			
	1AA	533	433	422	322	211			

34—STATE LOCATION MAPS

CARTOGRAPHIC SPECIFICATIONS	NOTES ON USAGE
 <p>all lineweights .125 mm maximum map height approximately 20 mm</p>	<p>State location maps are at various scales; projection is Albers Equal-Area, based on parallels 29 1/2° and 45 1/2°.</p> <p>Maps are modified from the United States Base Map (U.S. Geological Survey, 1965, scale 1:3,168,000) and the Digital Shaded-Relief Image of Alaska (J.R. Riehle and others, 1997, U.S. Geological Survey Miscellaneous Investigations Map I-2585, scale 1:2,500,000; see fig. 2, approximate scale 1:8,000,000).</p> <p>To show a quadrangle or map-area location, place a small black-filled rectangle (■) or polygon (▣) that shows the approximate location within state (adjust size and shape accordingly). Reposition state name if necessary.</p> <p>If a quadrangle or map-area location is within two or more adjoining states, create one new location map that contains each state by extracting states from location map of 48 conterminous states (see Section 34.2). Rotate new location map so that it is approximately horizontal, and resize it so that it is about 2–2.5 cm high. Add rectangle or polygon showing location of mapped area, then add names to each state. Center "MAP LOCATION" below new location map.</p>

34.1—Individual states; District of Columbia; Guam; Puerto Rico; U.S. Virgin Islands

 ALABAMA MAP LOCATION	 ALASKA MAP LOCATION	 ARIZONA MAP LOCATION	 ARKANSAS MAP LOCATION
 CALIF. MAP LOCATION	 COLORADO MAP LOCATION	 CONNECTICUT MAP LOCATION	 DEL. MAP LOCATION
 FLORIDA MAP LOCATION	 GEORGIA MAP LOCATION	 GUAM MAP LOCATION	 HAWAII MAP LOCATION
 IDAHO MAP LOCATION	 ILLINOIS MAP LOCATION	 INDIANA MAP LOCATION	 IOWA MAP LOCATION
 KANSAS MAP LOCATION	 KENTUCKY MAP LOCATION		
 LOUISIANA MAP LOCATION	 MAINE MAP LOCATION	 MARYLAND MAP LOCATION	 MASSACHUSETTS MAP LOCATION
 MICHIGAN MAP LOCATION			

34—STATE LOCATION MAPS (continued)

34.1—Individual states; District of Columbia; Guam; Puerto Rico; U.S. Virgin Islands (continued)



MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



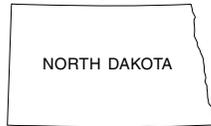
MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



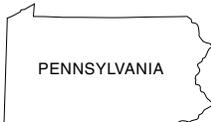
MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



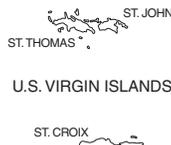
MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



MAP LOCATION



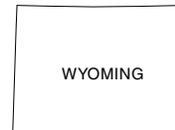
MAP LOCATION



MAP LOCATION



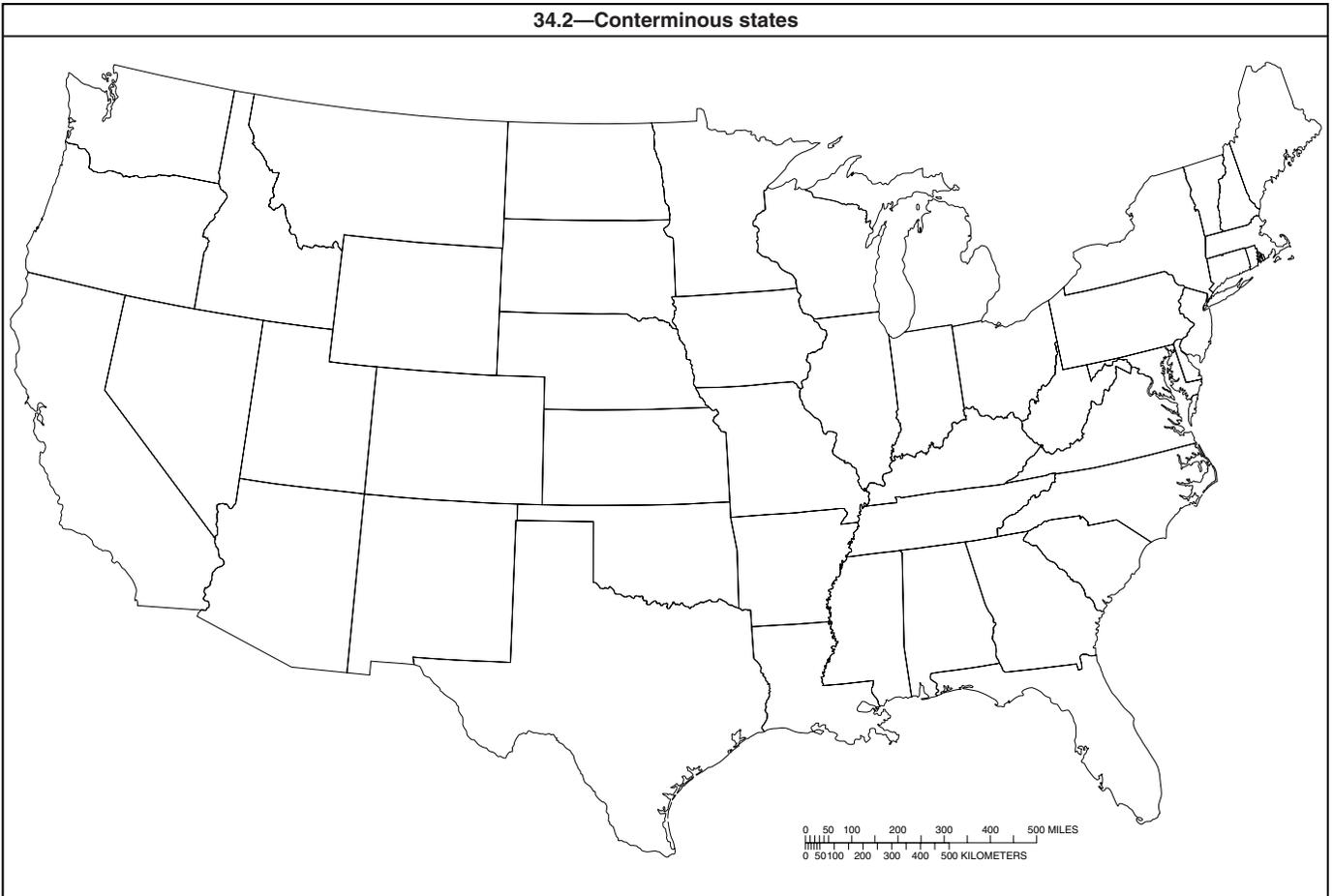
MAP LOCATION



MAP LOCATION

34—STATE LOCATION MAPS (continued)

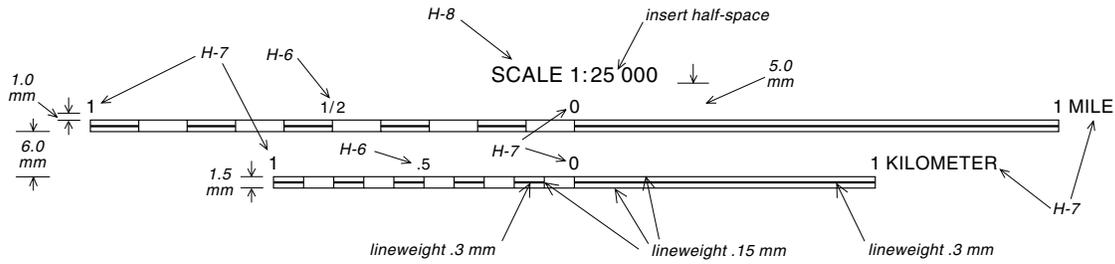
34.2—Conterminous states



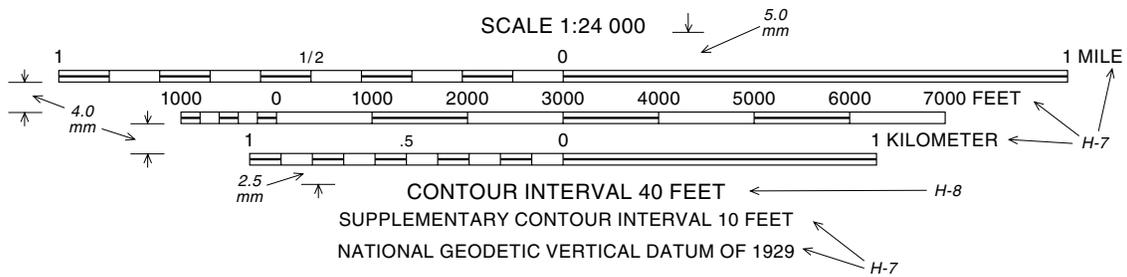
35—BAR SCALES

CARTOGRAPHIC SPECIFICATIONS

2 UNITS OF MEASUREMENT:



3 UNITS OF MEASUREMENT:



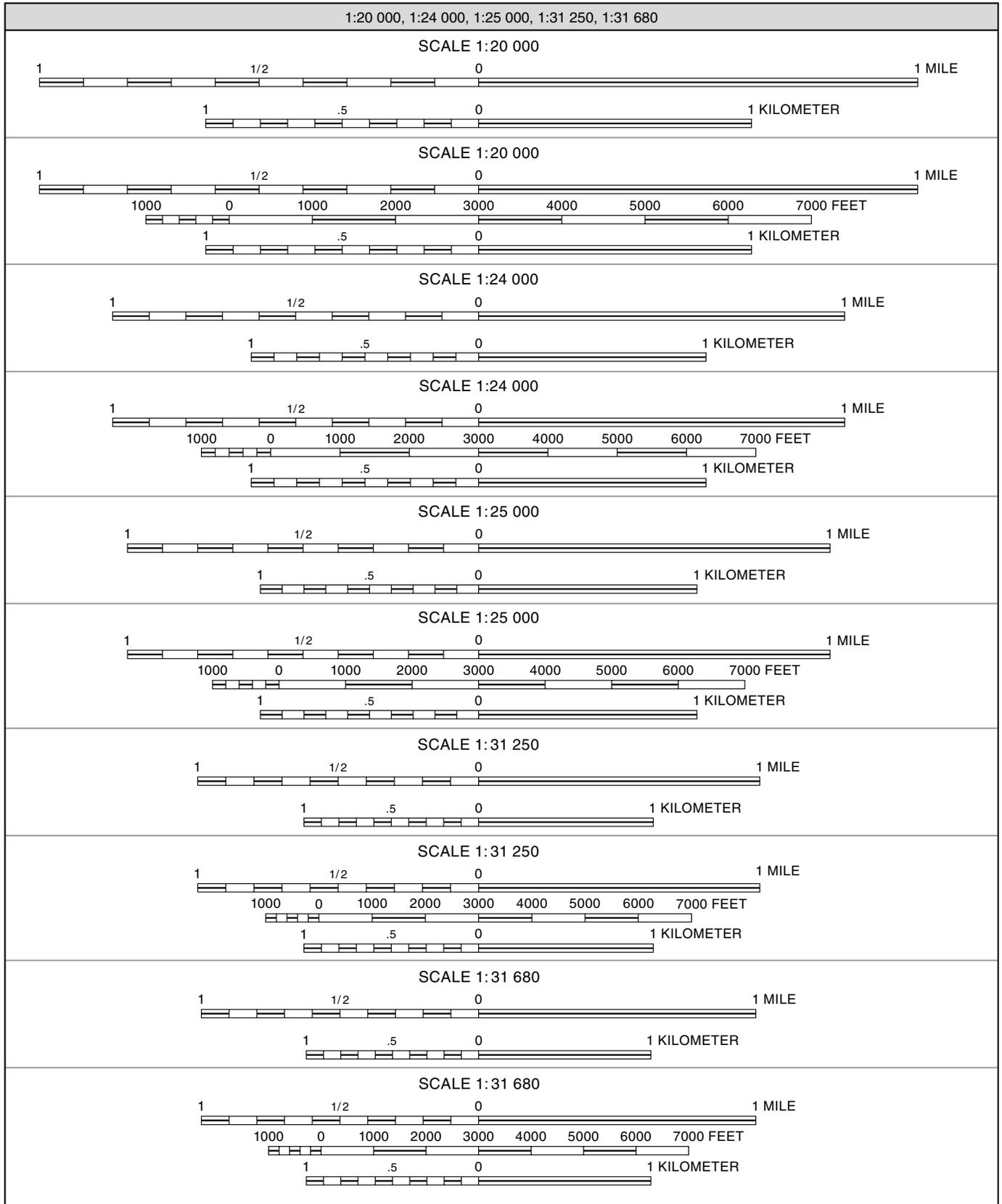
DISTANCE MEASURES

MEASUREMENT EQUIVALENTS

		Metric	English
1 mile (mi)	= 63,360 inches (in) = 5,280 feet (ft)	1 millimeter (mm) = 1/10 cm = 1/1000 m	= 0.039 in
1 kilometer (km)	= 3,280.833 ft = 0.62137 mi	1 centimeter (cm) = 10 mm = 1/100 m	= 0.393 in
		1 meter (m) = 100 cm = 1,000 mm = 1/1,000 km	= 39.37 in or 3.28 ft or 0.00062 mi
		1 kilometer (km) = 1,000 m = 100,000 cm = 1,000,000 mm	= 3,280.833 ft or 0.62137 mi

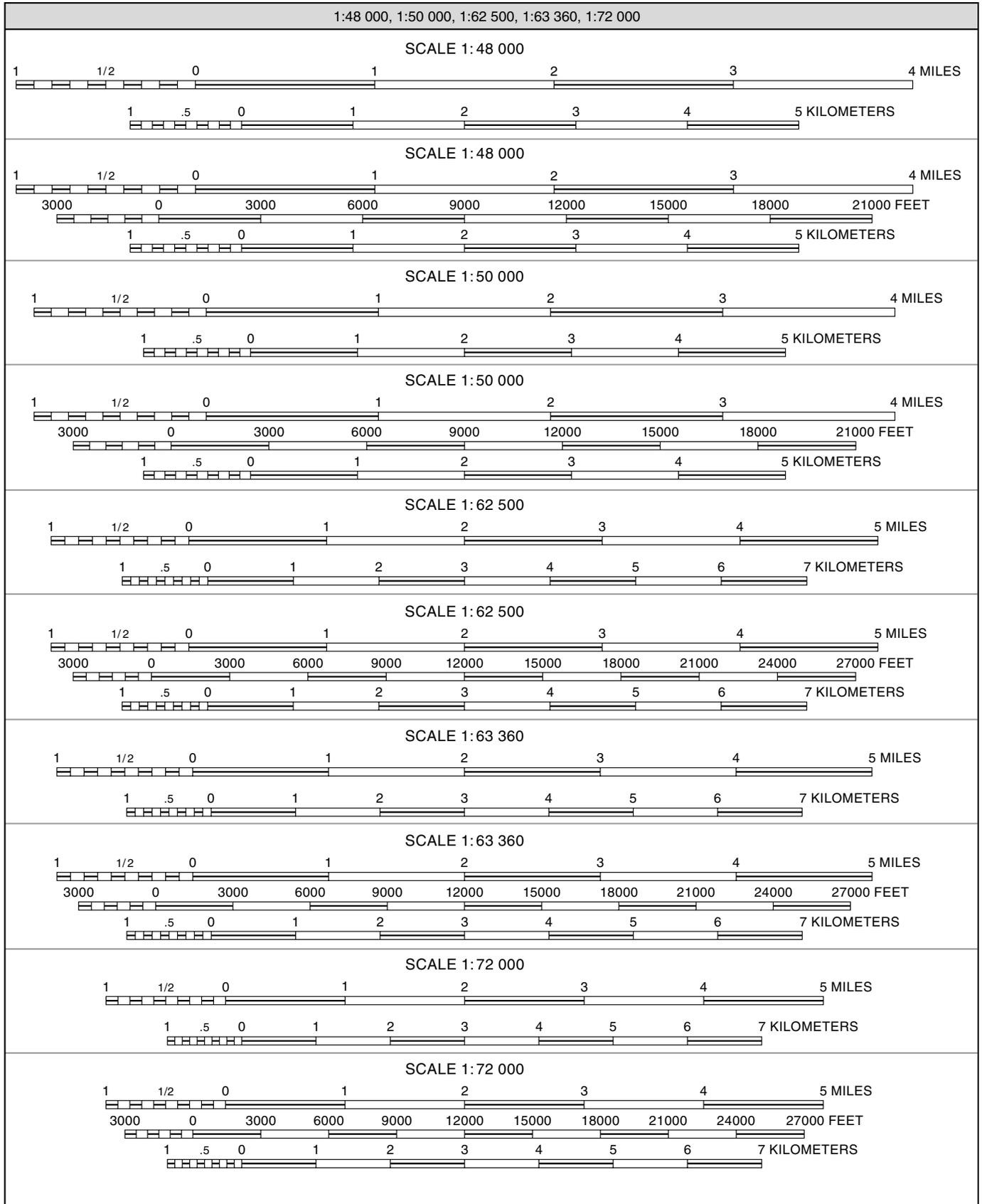
35—BAR SCALES (continued)

1:20 000, 1:24 000, 1:25 000, 1:31 250, 1:31 680



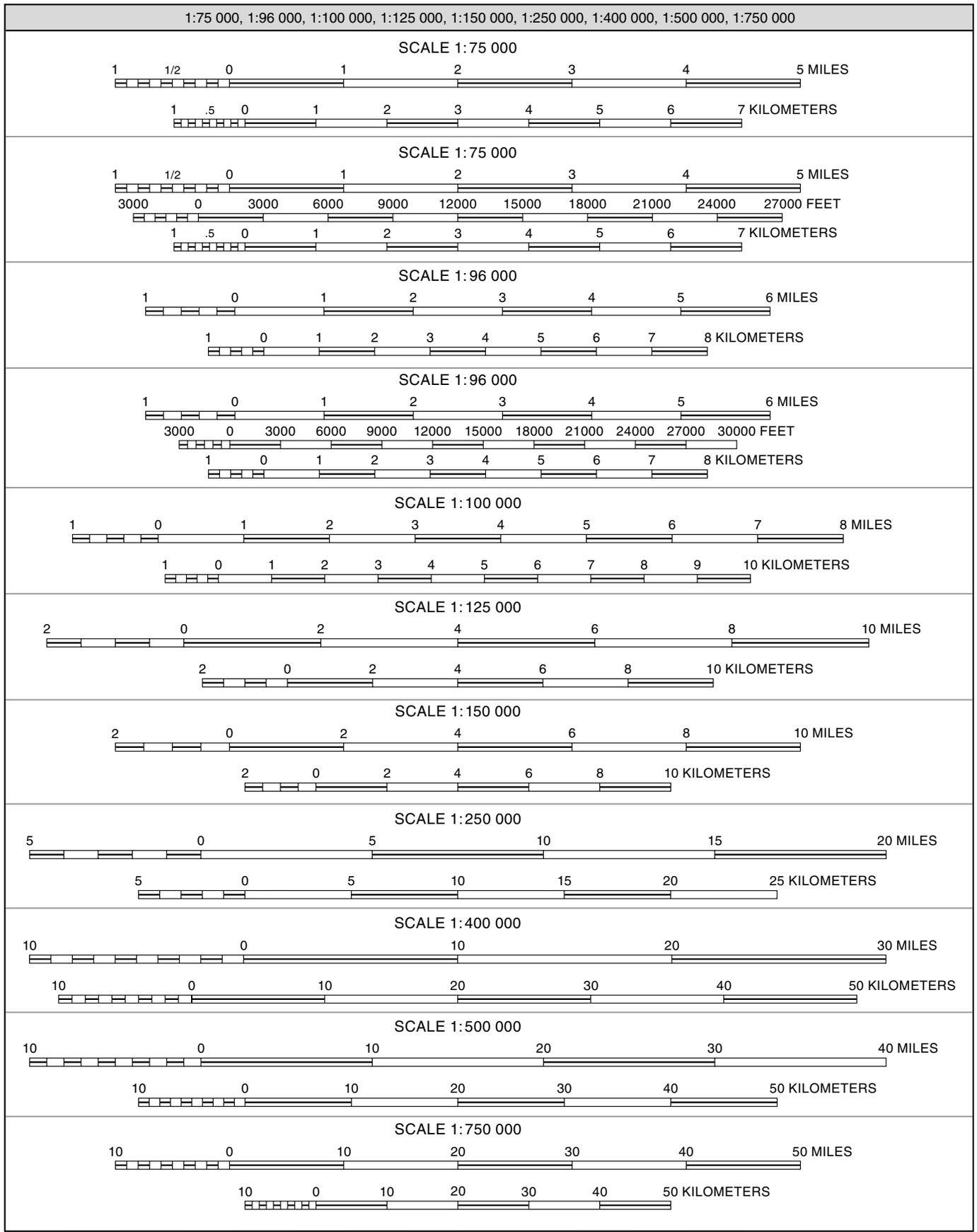
35—BAR SCALES (continued)

1:48 000, 1:50 000, 1:62 500, 1:63 360, 1:72 000



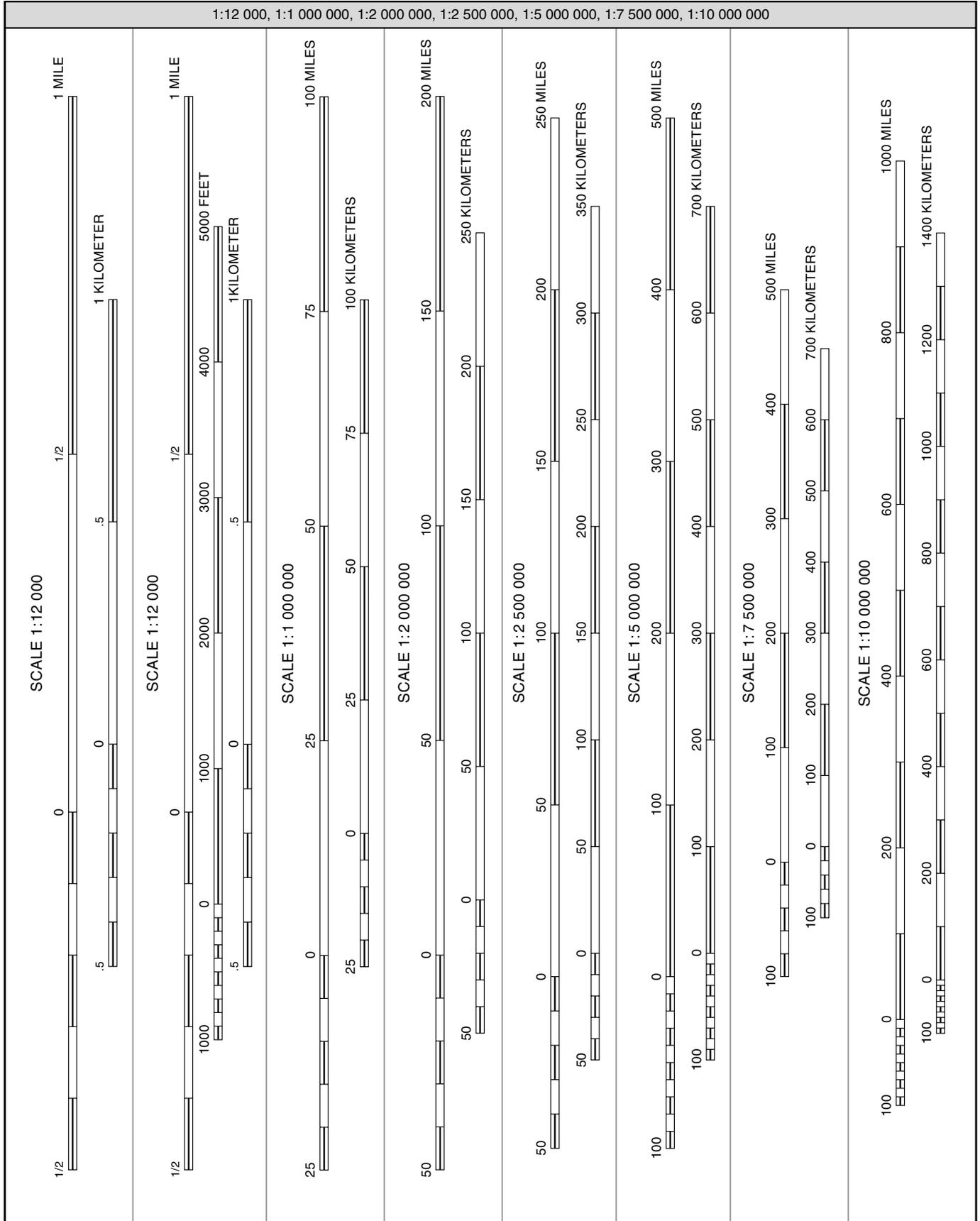
35—BAR SCALES (continued)

1:75 000, 1:96 000, 1:100 000, 1:125 000, 1:150 000, 1:250 000, 1:400 000, 1:500 000, 1:750 000



35—BAR SCALES (continued)

1:12 000, 1:1 000 000, 1:2 000 000, 1:2 500 000, 1:5 000 000, 1:7 500 000, 1:10 000 000



35—BAR SCALES (continued)

BAR SCALE CALCULATIONS — MILES (1 mile = 63,360 inches)							
FRACTIONAL SCALE	SCALE TO MAP REPRESENTATION		TO FIND MILES PER INCH (x in ratio)	MILES PER INCH	TOTAL MILES ON SCALE	TO FIND TOTAL SCALE LENGTH IN INCHES (y in ratio)	TOTAL SCALE LENGTH (INCHES)
	Scale Unit :	represents Map Unit	Use ratio below or $\frac{\text{SCALE}}{63\ 360}$			Use ratio below or $\frac{\text{Miles on scale}}{\text{Miles per inch}}$	
1:12 000	1inch	12 000 in	$\frac{63\ 360}{1} = \frac{12\ 000}{x}$	0.1893939	1.5	$\frac{0.1893939}{1} = \frac{1.5}{y}$	7.920
1:20 000	1inch	20 000 in	$\frac{63\ 360}{1} = \frac{20\ 000}{x}$	0.3156565	2	$\frac{0.3156565}{1} = \frac{2}{y}$	6.336
1:24 000	1inch	24 000 in	$\frac{63\ 360}{1} = \frac{24\ 000}{x}$	0.3787878	2	$\frac{0.3787878}{1} = \frac{2}{y}$	5.280
1:25 000	1inch	25 000 in	$\frac{63\ 360}{1} = \frac{25\ 000}{x}$	0.3945707	2	$\frac{0.3945707}{1} = \frac{2}{y}$	5.068
1:31 250	1inch	31 250 in	$\frac{63\ 360}{1} = \frac{31\ 250}{x}$	0.4932133	2	$\frac{0.4932133}{1} = \frac{2}{y}$	4.055
1:31 680	1inch	31 680 in	$\frac{63\ 360}{1} = \frac{31\ 680}{x}$	0.500	2	$\frac{0.500}{1} = \frac{2}{y}$	4.000
1:48 000	1inch	48 000 in	$\frac{63\ 360}{1} = \frac{48\ 000}{x}$	0.7575757	5	$\frac{0.7575757}{1} = \frac{5}{y}$	6.600
1:50 000	1inch	50 000 in	$\frac{63\ 360}{1} = \frac{50\ 000}{x}$	0.7891414	5	$\frac{0.7891414}{1} = \frac{5}{y}$	6.336
1:62 500	1inch	62 500 in	$\frac{63\ 360}{1} = \frac{62\ 500}{x}$	0.9864267	6	$\frac{0.9864267}{1} = \frac{6}{y}$	6.082
1:63 360	1inch	63 360 in	$\frac{63\ 360}{1} = \frac{63\ 360}{x}$	1.000	6	$\frac{1.000}{1} = \frac{6}{y}$	6.000
1:72 000	1inch	72 000 in	$\frac{63\ 360}{1} = \frac{72\ 000}{x}$	1.1363636	6	$\frac{1.1363636}{1} = \frac{6}{y}$	5.280
1:75 000	1inch	75 000 in	$\frac{63\ 360}{1} = \frac{75\ 000}{x}$	1.1837121	6	$\frac{1.1837121}{1} = \frac{6}{y}$	5.068
1:96 000	1inch	96 000 in	$\frac{63\ 360}{1} = \frac{96\ 000}{x}$	1.5151515	7	$\frac{1.5151515}{1} = \frac{7}{y}$	4.620
1:100 000	1inch	100 000 in	$\frac{63\ 360}{1} = \frac{100\ 000}{x}$	1.5782828	9	$\frac{1.5782828}{1} = \frac{9}{y}$	5.702
1:125 000	1inch	125 000 in	$\frac{63\ 360}{1} = \frac{125\ 000}{x}$	1.9728535	12	$\frac{1.9728535}{1} = \frac{12}{y}$	6.082
1:150 000	1inch	150 000 in	$\frac{63\ 360}{1} = \frac{150\ 000}{x}$	2.3674242	12	$\frac{2.3674242}{1} = \frac{12}{y}$	5.068

To find miles per inch on 1: 12 000 map . . .		Solution . . .	$63\ 360 \cdot x = 12\ 000 \cdot 1$
63,360 inches = 1 mile	Let SCALE (12 000) be in inches	$\frac{63\ 360}{1} = \frac{12\ 000}{x}$	$\frac{63\ 360}{63\ 360} x = \frac{12\ 000}{63\ 360}$
Show in ratio as ...	Fractional scale says 1 inch represents 12,000 in		$x = \frac{12\ 000}{63\ 360}$ (SCALE)
$\frac{63\ 360}{1}$ inches	Let x be miles that 1 inch represents on map		$x = 0.1893939$
1 miles	Show in ratio as ...	$\frac{12\ 000}{x}$ inches	
		x miles	

35—BAR SCALES (continued)

BAR SCALE CALCULATIONS — MILES (1 mile = 63,360 inches)—continued							
FRACTIONAL SCALE	SCALE TO MAP REPRESENTATION		TO FIND MILES PER INCH (x in ratio)	MILES PER INCH	TOTAL MILES ON SCALE	TO FIND TOTAL SCALE LENGTH IN INCHES (y in ratio)	TOTAL SCALE LENGTH (INCHES)
	Scale Unit	represents Map Unit	Use ratio below or $\frac{\text{SCALE}}{63\,360}$			Use ratio below or $\frac{\text{Miles on scale}}{\text{Miles per inch}}$	
1:250 000	1inch	250 000 in	$\frac{63\,360}{1} = \frac{250\,000}{x}$	3.945707	25	$\frac{3.945707}{1} = \frac{25}{y}$	6.336
1:400 000	1inch	400 000 in	$\frac{63\,360}{1} = \frac{400\,000}{x}$	6.3131313	40	$\frac{6.3131313}{1} = \frac{40}{y}$	6.336
1:500 000	1inch	500 000 in	$\frac{63\,360}{1} = \frac{500\,000}{x}$	7.8914141	50	$\frac{7.8914141}{1} = \frac{50}{y}$	6.336
1:750 000	1inch	750 000 in	$\frac{63\,360}{1} = \frac{750\,000}{x}$	11.837121	60	$\frac{11.837121}{1} = \frac{60}{y}$	5.068
1:1 000 000	1inch	1 000 000 in	$\frac{63\,360}{1} = \frac{1\,000\,000}{x}$	15.782828	125	$\frac{15.782828}{1} = \frac{125}{y}$	7.920
1:2 000 000	1inch	2 000 000 in	$\frac{63\,360}{1} = \frac{2\,000\,000}{x}$	31.565656	250	$\frac{31.565656}{1} = \frac{250}{y}$	7.920
1:2 500 000	1inch	2 500 000 in	$\frac{63\,360}{1} = \frac{2\,500\,000}{x}$	39.45707	300	$\frac{39.45707}{1} = \frac{300}{y}$	7.603
1:5 000 000	1inch	5 000 000 in	$\frac{63\,360}{1} = \frac{5\,000\,000}{x}$	78.914141	600	$\frac{78.914141}{1} = \frac{600}{y}$	7.603
1:7 500 000	1inch	7 500 000 in	$\frac{63\,360}{1} = \frac{7\,500\,000}{x}$	118.37121	600	$\frac{118.37121}{1} = \frac{600}{y}$	5.068
1:10 000 000	1inch	10 000 000 in	$\frac{63\,360}{1} = \frac{10\,000\,000}{x}$	157.82828	1100	$\frac{157.82828}{1} = \frac{1100}{y}$	6.969

To find miles per inch on 1: 250 000 map . . .

63,360 inches = 1 mile
 Show in ratio as ...
 $\frac{63\,360}{1} \frac{\text{inches}}{\text{miles}}$

Let SCALE (250 000) be in inches
 Fractional scale says 1 inch represents 250,000 in
 Let x be miles that 1 inch represents on map
 Show in ratio as ...
 $\frac{250\,000}{x} \frac{\text{inches}}{\text{miles}}$

Solution . . .

$$63\,360 \cdot x = 250\,000 \cdot 1$$

$$\frac{63\,360}{1} = \frac{250\,000}{x}$$

$$\frac{63\,360 x}{63\,360} = \frac{250\,000}{63\,360}$$

$$x = \frac{250\,000}{63\,360} \text{ (SCALE)}$$

$$x = 3.945707$$

35—BAR SCALES (continued)

BAR SCALE CALCULATIONS — FEET (1 foot = 12 inches)							
FRACTIONAL SCALE	SCALE TO MAP REPRESENTATION		TO FIND FEET PER INCH (x in ratio)	FEET PER INCH	TOTAL FEET ON SCALE	TO FIND TOTAL SCALE LENGTH IN INCHES (y in ratio)	TOTAL SCALE LENGTH (INCHES)
	Scale Unit :	represents Map Unit	Use ratio below or $\frac{SCALE}{12}$			Use ratio below or $\frac{Feet\ on\ scale}{Feet\ per\ inch}$	
1:12 000	1inch	12 000 in	$\frac{12}{1} = \frac{12\ 000}{x}$	1000.000	6000	$\frac{1000.000}{1} = \frac{6000}{y}$	6.000
1:20 000	1inch	20 000 in	$\frac{12}{1} = \frac{20\ 000}{x}$	1666.6666	8000	$\frac{1666.6666}{1} = \frac{8000}{y}$	4.800
1:24 000	1inch	24 000 in	$\frac{12}{1} = \frac{24\ 000}{x}$	2000.000	8000	$\frac{2000.000}{1} = \frac{8000}{y}$	4.000
1:25 000	1inch	25 000 in	$\frac{12}{1} = \frac{25\ 000}{x}$	2083.3333	8000	$\frac{2083.3333}{1} = \frac{8000}{y}$	3.840
1:31 250	1inch	31 250 in	$\frac{12}{1} = \frac{31\ 250}{x}$	2604.1666	8000	$\frac{2604.1666}{1} = \frac{8000}{y}$	3.072
1:31 680	1inch	31 680 in	$\frac{12}{1} = \frac{31\ 680}{x}$	2640.000	8000	$\frac{2640.000}{1} = \frac{8000}{y}$	3.030
1:48 000	1inch	48 000 in	$\frac{12}{1} = \frac{48\ 000}{x}$	4000.000	24 000	$\frac{4000.000}{1} = \frac{24\ 000}{y}$	6.000
1:50 000	1inch	50 000 in	$\frac{12}{1} = \frac{50\ 000}{x}$	4166.6666	24 000	$\frac{4166.6666}{1} = \frac{24\ 000}{y}$	5.760
1:62 500	1inch	62 500 in	$\frac{12}{1} = \frac{62\ 500}{x}$	5208.3333	30 000	$\frac{5208.3333}{1} = \frac{30\ 000}{y}$	5.760
1:63 360	1inch	63 360 in	$\frac{12}{1} = \frac{63\ 360}{x}$	5280.000	30 000	$\frac{5280.000}{1} = \frac{30\ 000}{y}$	5.681
1:72 000	1inch	72 000 in	$\frac{12}{1} = \frac{72\ 000}{x}$	6000.000	30 000	$\frac{6000.000}{1} = \frac{30\ 000}{y}$	5.000
1:75 000	1inch	75 000 in	$\frac{12}{1} = \frac{75\ 000}{x}$	6250.000	30 000	$\frac{6250.000}{1} = \frac{30\ 000}{y}$	4.800
1:96 000	1inch	96 000 in	$\frac{12}{1} = \frac{96\ 000}{x}$	8000.000	33 000	$\frac{8000.000}{1} = \frac{33\ 000}{y}$	4.125

To find feet per inch on 1: 12 000 map . . .

12 inches = 1 foot
 Show in ratio as ...
 $\frac{12}{1} \frac{\text{inches}}{\text{feet}}$

Let SCALE (12 000) be in inches
 Fractional scale says 1 inch represents 12,000 in
 Let x be feet that 1 inch represents on map
 Show in ratio as ...

$$\frac{12\ 000}{x} \frac{\text{inches}}{\text{feet}}$$

Solution . . .

$$\frac{12}{1} = \frac{12\ 000}{x}$$

$$12 \cdot x = 12\ 000 \cdot 1$$

$$\frac{12x}{12} = \frac{12\ 000}{12}$$

$$x = \frac{12\ 000}{12} \text{ (SCALE)}$$

$$x = 1000.00$$

35—BAR SCALES (continued)

BAR SCALE CALCULATIONS — KILOMETERS (1 kilometer = 100,000 centimeters)								
FRACTIONAL SCALE	SCALE TO MAP REPRESENTATION		TO FIND KILOMETERS PER CENTIMETER (CM) (x in ratio)	KILOMETERS PER CM	TOTAL KILOMETERS ON SCALE	TO FIND TOTAL SCALE LENGTH IN CENTIMETERS (y in ratio)	TOTAL SCALE LENGTH IN	
	Scale Unit	represents Map Unit	Use ratio below or $\frac{\text{SCALE}}{100\,000}$			Use ratio below or $\frac{\text{Kilometers on scale}}{\text{Kilometers per cm}}$	CENTI-METERS	MILLI-METERS
1:12 000	1cm	12 000 cm	$\frac{100\,000}{1} = \frac{12\,000}{x}$	0.120	1.5	$\frac{0.120}{1} = \frac{1.5}{y}$	12.500	125.00
1:20 000	1cm	20 000 cm	$\frac{100\,000}{1} = \frac{20\,000}{x}$	0.200	2	$\frac{0.200}{1} = \frac{2}{y}$	10.000	100.00
1:24 000	1cm	24 000 cm	$\frac{100\,000}{1} = \frac{24\,000}{x}$	0.240	2	$\frac{0.240}{1} = \frac{2}{y}$	8.333	83.33
1:25 000	1cm	25 000 cm	$\frac{100\,000}{1} = \frac{25\,000}{x}$	0.250	2	$\frac{0.250}{1} = \frac{2}{y}$	8.000	80.00
1:31 250	1cm	31 250 cm	$\frac{100\,000}{1} = \frac{31\,250}{x}$	0.3125	2	$\frac{0.3125}{1} = \frac{2}{y}$	6.400	64.00
1:31 680	1cm	31 680 cm	$\frac{100\,000}{1} = \frac{31\,680}{x}$	0.3168	2	$\frac{0.3168}{1} = \frac{2}{y}$	6.313	63.13
1:48 000	1cm	48 000 cm	$\frac{100\,000}{1} = \frac{48\,000}{x}$	0.480	6	$\frac{0.480}{1} = \frac{6}{y}$	12.500	125.00
1:50 000	1cm	50 000 cm	$\frac{100\,000}{1} = \frac{50\,000}{x}$	0.500	6	$\frac{0.500}{1} = \frac{6}{y}$	12.000	120.00
1:62 500	1cm	62 500 cm	$\frac{100\,000}{1} = \frac{62\,500}{x}$	0.625	8	$\frac{0.625}{1} = \frac{8}{y}$	12.800	128.00
1:63 360	1cm	63 360 cm	$\frac{100\,000}{1} = \frac{63\,360}{x}$	0.6336	8	$\frac{0.6336}{1} = \frac{8}{y}$	12.626	126.26
1:72 000	1cm	72 000 cm	$\frac{100\,000}{1} = \frac{72\,000}{x}$	0.720	8	$\frac{0.720}{1} = \frac{8}{y}$	11.111	111.11
1:75 000	1cm	75 000 cm	$\frac{100\,000}{1} = \frac{75\,000}{x}$	0.750	8	$\frac{0.750}{1} = \frac{8}{y}$	10.666	106.66
1:96 000	1cm	96 000 cm	$\frac{100\,000}{1} = \frac{96\,000}{x}$	0.960	9	$\frac{0.960}{1} = \frac{9}{y}$	9.375	93.75
1:100 000	1cm	100 000 cm	$\frac{100\,000}{1} = \frac{100\,000}{x}$	1.000	11	$\frac{1.000}{1} = \frac{11}{y}$	11.000	110.00
1:125 000	1cm	125 000 cm	$\frac{100\,000}{1} = \frac{125\,000}{x}$	1.250	12	$\frac{1.250}{1} = \frac{12}{y}$	9.600	96.00
1:150 000	1cm	150 000 cm	$\frac{100\,000}{1} = \frac{150\,000}{x}$	1.500	12	$\frac{1.500}{1} = \frac{12}{y}$	8.000	80.00

To find kilometers per centimeter on 1: 12 000 map . . .

100 000 centimeters = 1 kilometer
 Show in ratio as ...

$$\frac{100\,000 \text{ centimeters}}{1 \text{ kilometers}}$$

Let SCALE (12 000) be in centimeters
 Fractional scale says 1 centimeter represents
 12,000 centimeters
 Let x be kilometers that 1 cm represents on map
 Show in ratio as ...

$$\frac{12\,000 \text{ centimeters}}{x \text{ kilometers}}$$

Solution . . .

$$100\,000 \cdot x = 12\,000 \cdot 1$$

$$\frac{100\,000}{1} = \frac{12\,000}{x} \quad \frac{100\,000}{100\,000} x = \frac{12\,000}{100\,000}$$

$$x = \frac{12\,000 \text{ (SCALE)}}{100\,000}$$

$$x = 0.120$$

35—BAR SCALES (continued)

BAR SCALE CALCULATIONS — KILOMETERS (1 kilometer = 100,000 centimeters)—continued								
FRACTIONAL SCALE	SCALE TO MAP REPRESENTATION		TO FIND KILOMETERS PER CENTIMETER (CM) (x in ratio)	KILOMETERS PER CM	TOTAL KILOMETERS ON SCALE	TO FIND TOTAL SCALE LENGTH IN CENTIMETERS (y in ratio)	TOTAL SCALE LENGTH IN	
	Scale Unit	represents Map Unit	Use ratio below or $\frac{\text{SCALE}}{100\,000}$			Use ratio below or $\frac{\text{Kilometers on scale}}{\text{Kilometers per cm}}$	CENTI-METERS	MILLI-METERS
1:250 000	1cm	250 000 cm	$\frac{100\,000}{1} = \frac{250\,000}{x}$	2.500	30	$\frac{2.500}{1} = \frac{30}{y}$	12.000	120.00
1:400 000	1cm	400 000 cm	$\frac{100\,000}{1} = \frac{400\,000}{x}$	4.000	60	$\frac{4.000}{1} = \frac{60}{y}$	15.000	150.00
1:500 000	1cm	500 000 cm	$\frac{100\,000}{1} = \frac{500\,000}{x}$	5.000	60	$\frac{5.000}{1} = \frac{60}{y}$	12.000	120.00
1:750 000	1cm	750 000 cm	$\frac{100\,000}{1} = \frac{750\,000}{x}$	7.500	60	$\frac{7.500}{1} = \frac{60}{y}$	8.000	80.00
1:1 000 000	1cm	1 000 000 cm	$\frac{100\,000}{1} = \frac{1\,000\,000}{x}$	10.000	125	$\frac{10.000}{1} = \frac{125}{y}$	12.500	125.00
1:2 000 000	1cm	2 000 000 cm	$\frac{100\,000}{1} = \frac{2\,000\,000}{x}$	20.000	300	$\frac{20.000}{1} = \frac{300}{y}$	15.000	150.00
1:2 500 000	1cm	2 500 000 cm	$\frac{100\,000}{1} = \frac{2\,500\,000}{x}$	25.000	400	$\frac{25.000}{1} = \frac{400}{y}$	16.000	160.00
1:5 000 000	1cm	5 000 000 cm	$\frac{100\,000}{1} = \frac{5\,000\,000}{x}$	50.000	800	$\frac{50.000}{1} = \frac{800}{y}$	16.000	160.00
1:7 500 000	1cm	7 500 000 cm	$\frac{100\,000}{1} = \frac{7\,500\,000}{x}$	75.000	800	$\frac{75.000}{1} = \frac{800}{y}$	10.666	106.66
1:10 000 000	1cm	10 000 000 cm	$\frac{100\,000}{1} = \frac{10\,000\,000}{x}$	100.000	1500	$\frac{100.000}{1} = \frac{1500}{y}$	15.000	150.00

To find kilometers per centimeter on 1: 250 000 map . . .

Solution . . .

$$100\,000 \cdot x = 250\,000 \cdot 1$$

100 000 centimeters = 1 kilometer
 Show in ratio as ...

$$\frac{100\,000 \text{ centimeters}}{1 \text{ kilometers}}$$

Let SCALE (250 000) be in centimeters
 Fractional scale says 1 centimeter represents
 250,000 centimeters
 Let x be kilometers that 1 cm represents on map
 Show in ratio as ...

$$\frac{250\,000 \text{ centimeters}}{x \text{ kilometers}}$$

$$\frac{100\,000}{1} = \frac{250\,000}{x} \quad \frac{100\,000}{100\,000} x = \frac{250\,000}{100\,000}$$

$$x = \frac{250\,000}{100\,000} \text{ (SCALE)}$$

$$x = 2.5$$

36—MEAN DECLINATION ARROWS

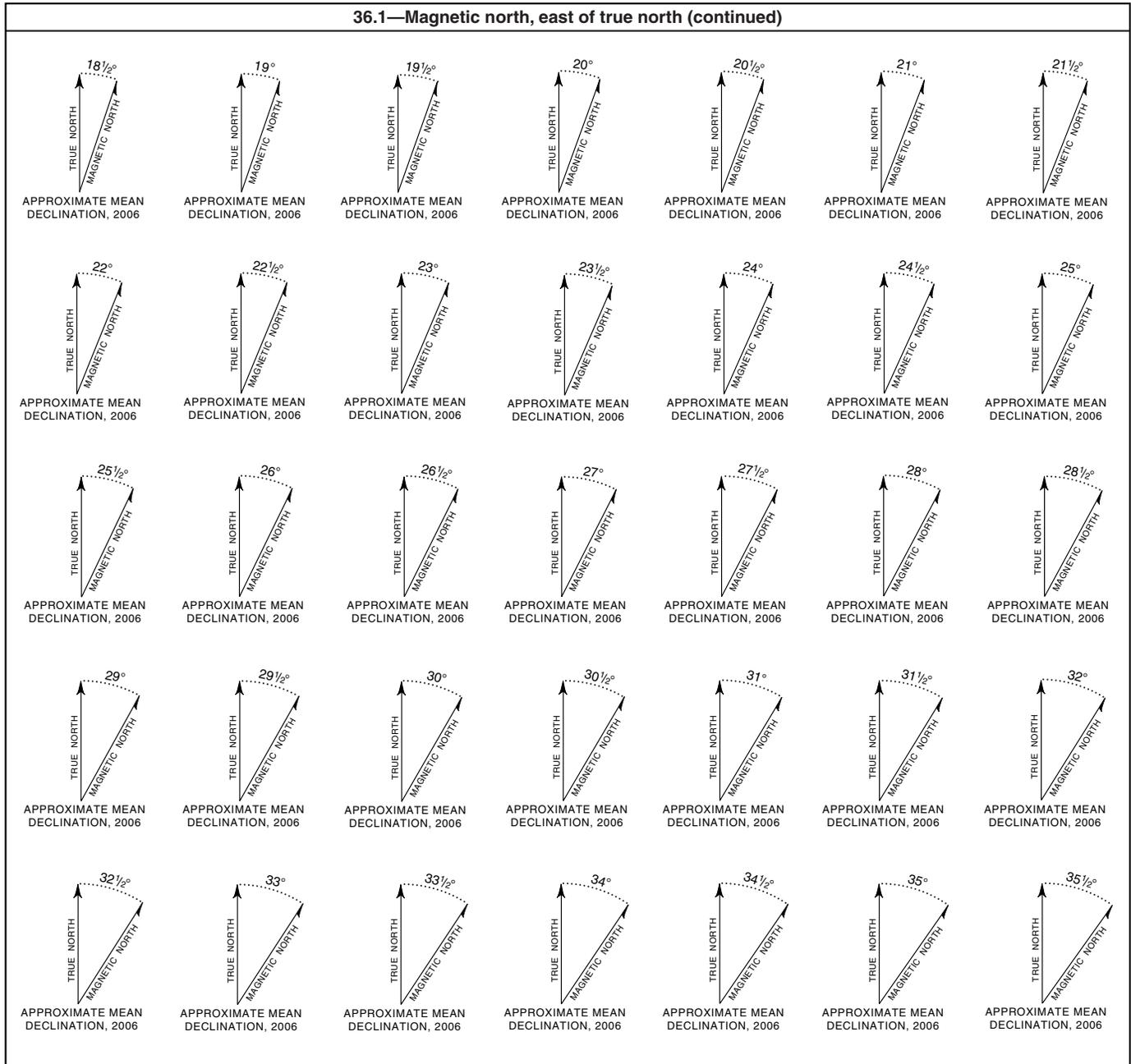
CARTOGRAPHIC SPECIFICATIONS	NOTES ON USAGE
	<p>Because magnetic declination changes over time, the degree of declination should be determined at the time of publication, and the year of the declination measurement should be changed to the year of publication.</p> <p>In northern latitudes where the change in declination can be significant, it may be helpful to also note what the degree of declination was at the time of mapping, especially if the geologic information was gathered several years before the date of publication.</p>

36.1—Magnetic north, east of true north

APPROXIMATE MEAN DECLINATION, 2006						
APPROXIMATE MEAN DECLINATION, 2006						
APPROXIMATE MEAN DECLINATION, 2006						
APPROXIMATE MEAN DECLINATION, 2006						
APPROXIMATE MEAN DECLINATION, 2006						

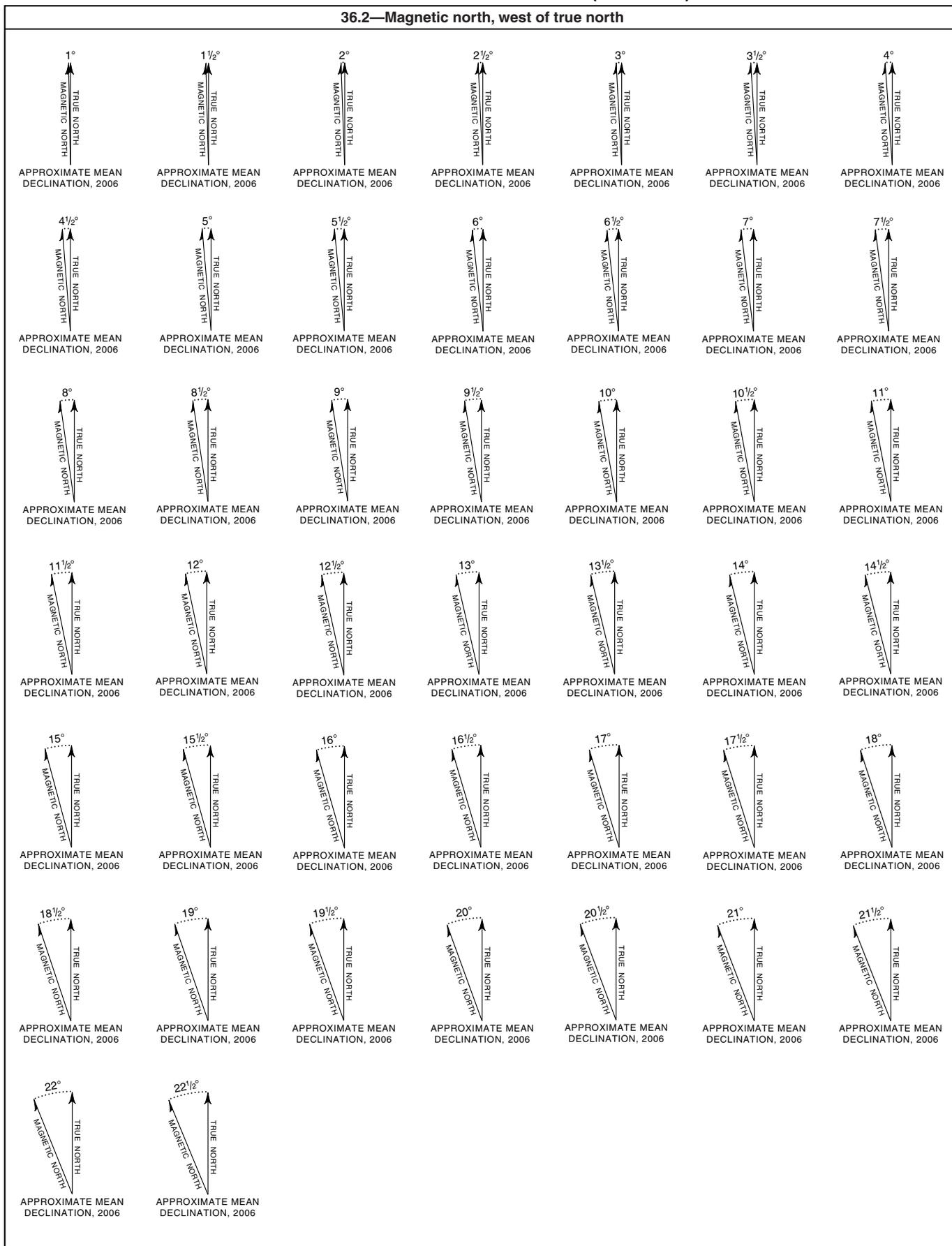
36—MEAN DECLINATION ARROWS (continued)

36.1—Magnetic north, east of true north (continued)



36—MEAN DECLINATION ARROWS (continued)

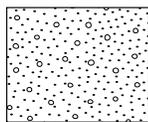
36.2—Magnetic north, west of true north



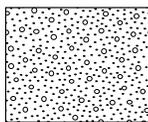
37—LITHOLOGIC PATTERNS

[Lithologic patterns are usually reserved for use on stratigraphic columns, sections, or charts]

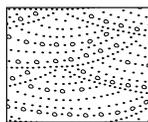
37.1—Sedimentary-rock lithologic patterns



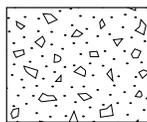
601
Gravel or conglomerate (1st option)



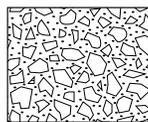
602
Gravel or conglomerate (2nd option)



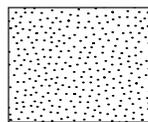
603
Crossbedded gravel or conglomerate



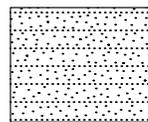
605
Breccia (1st option)



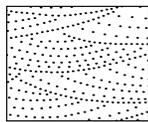
606
Breccia (2nd option)



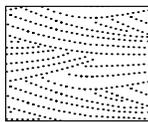
607
Massive sand or sandstone



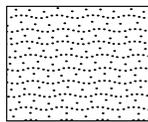
608
Bedded sand or sandstone



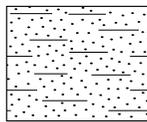
609
Crossbedded sand or sandstone (1st option)



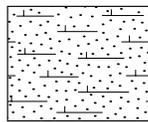
610
Crossbedded sand or sandstone (2nd option)



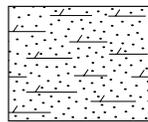
611
Ripple-bedded sand or sandstone



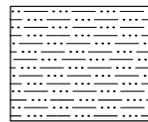
612
Argillaceous or shaly sandstone



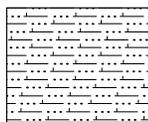
613
Calcareous sandstone



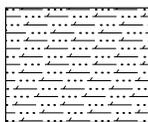
614
Dolomitic sandstone



616
Silt, siltstone, or shaly silt



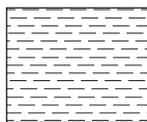
617
Calcareous siltstone



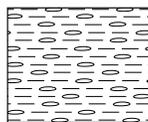
618
Dolomitic siltstone



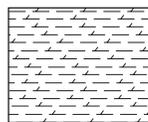
619
Sandy or silty shale



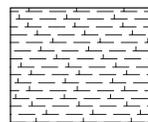
620
Clay or clay shale



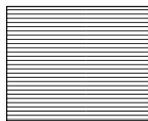
621
Cherty shale



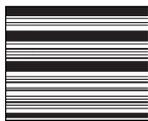
622
Dolomitic shale



623
Calcareous shale or marl



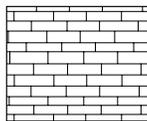
624
Carbonaceous shale



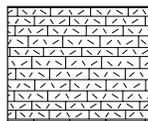
625
Oil shale



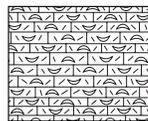
626
Chalk



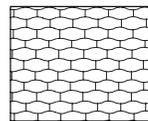
627
Limestone



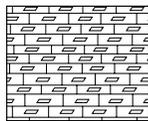
628
Clastic limestone



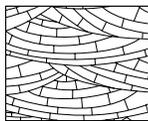
629
Fossiliferous clastic limestone



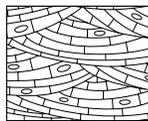
630
Nodular or irregularly bedded limestone



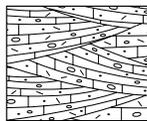
631
Limestone, irregular (burrow?) fillings of saccharoidal dolomite



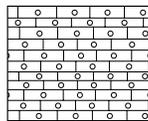
632
Crossbedded limestone



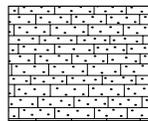
633
Cherty crossbedded limestone



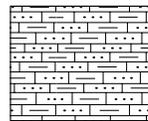
634
Cherty and sandy crossbedded clastic limestone



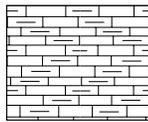
635
Oolitic limestone



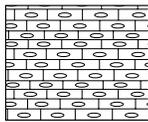
636
Sandy limestone



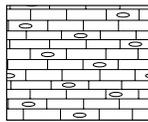
637
Silty limestone



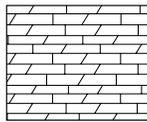
638
Argillaceous or shaly limestone



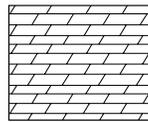
639
Cherty limestone (1st option)



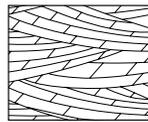
640
Cherty limestone (2nd option)



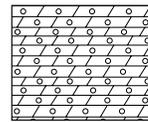
641
Dolomitic limestone, limy dolomite, or limy dolomite



642
Dolostone or dolomite



643
Crossbedded dolostone or dolomite



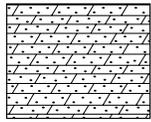
644
Oolitic dolostone or dolomite

*For more information, see general guidelines on pages A-i to A-v.

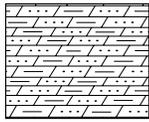
37—LITHOLOGIC PATTERNS (continued)

[Lithologic patterns are usually reserved for use on stratigraphic columns, sections, or charts]

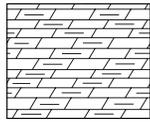
37.1—Sedimentary-rock lithologic patterns (continued)



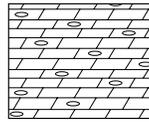
645
Sandy dolostone
or dolomite



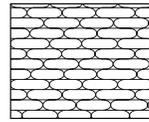
646
Silty dolostone
or dolomite



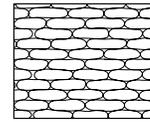
647
Argillaceous or
shaly dolostone
or dolomite



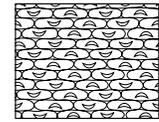
648
Cherty dolostone
or dolomite



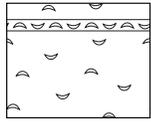
649
Bedded chert
(1st option)



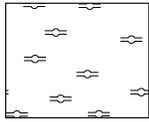
650
Bedded chert
(2nd option)



651
Fossiliferous
bedded chert



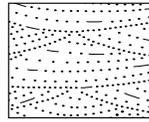
652
Fossiliferous rock



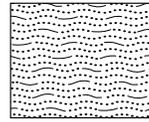
653
Diatomaceous
rock



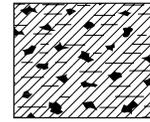
654
Subgraywacke



655
Crossbedded
subgraywacke



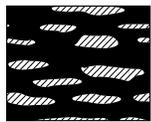
656
Ripple-bedded
subgraywacke



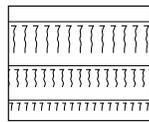
657
Peat



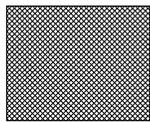
658
Coal



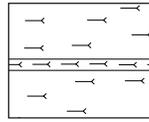
659
Bony coal or
impure coal



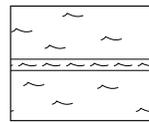
660
Underclay



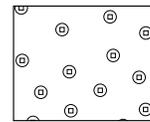
661
Flint clay



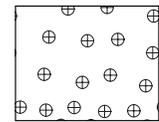
662
Bentonite



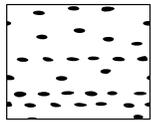
663
Glauconite



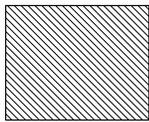
664
Limonite



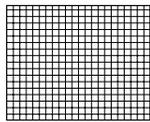
665
Siderite



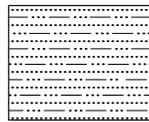
666
Phosphatic-nodular
rock



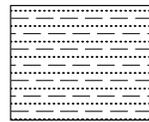
667
Gypsum



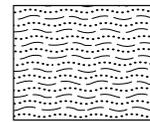
668
Salt



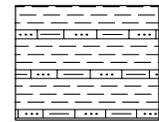
669
Interbedded
sandstone and
siltstone



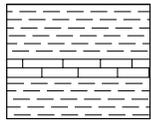
670
Interbedded
sandstone and
shale



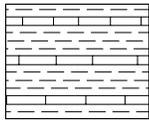
671
Interbedded ripple-
bedded sandstone
and shale



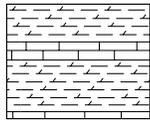
672
Interbedded shale
and silty limestone
(shale dominant)



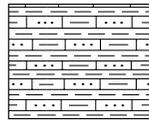
673
Interbedded shale
and limestone
(shale dominant)
(1st option)



674
Interbedded shale
and limestone
(shale dominant)
(2nd option)



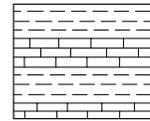
675
Interbedded calcareous
shale and limestone
(shale dominant)



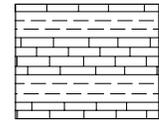
676
Interbedded
silty limestone
and shale



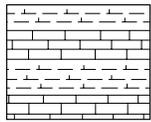
677
Interbedded
limestone and
shale (1st option)



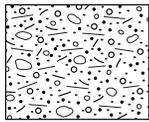
678
Interbedded
limestone and
shale (2nd option)



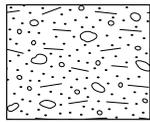
679
Interbedded
limestone and shale
(limestone dominant)



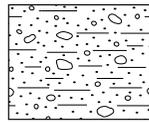
680
Interbedded
limestone and
calcareous shale



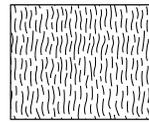
681
Till or diamiction
(1st option)



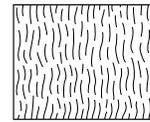
682
Till or diamiction
(2nd option)



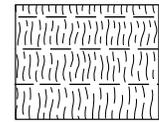
683
Till or diamiction
(3rd option)



684
Loess (1st option)



685
Loess (2nd option)



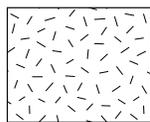
686
Loess (3rd option)

*For more information, see general guidelines on pages A-i to A-v.

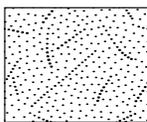
37—LITHOLOGIC PATTERNS (continued)

[Lithologic patterns are usually reserved for use on stratigraphic columns, sections, or charts]

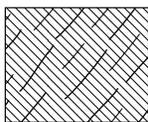
37.2—Metamorphic-rock, igneous-rock, and vein-matter lithologic patterns



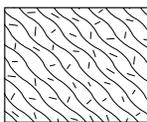
701
Metamorphism



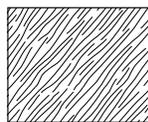
702
Quartzite



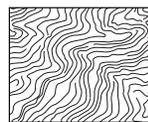
703
Slate



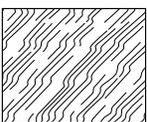
704
Schistose or
gneissoid granite



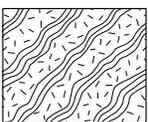
705
Schist



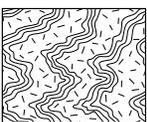
706
Contorted schist



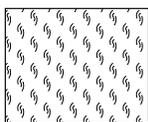
707
Schist and gneiss



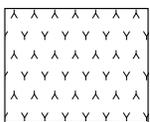
708
Gneiss



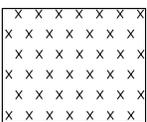
709
Contorted gneiss



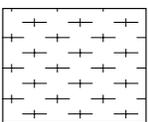
710
Soapstone, talc,
or serpentine



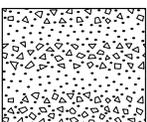
711
Tuffaceous rock



712
Crystal tuff



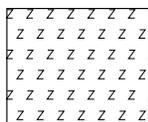
713
Devitrified
tuff



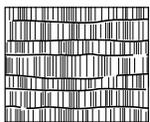
714
Volcanic breccia
and tuff



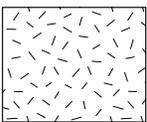
715
Volcanic breccia
or agglomerate



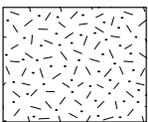
716
Zeolitic rock



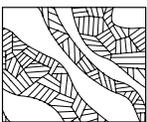
717
Basaltic flows



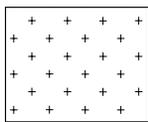
718
Granite (1st option)



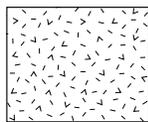
719
Granite (2nd option)



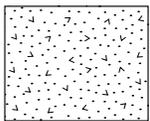
720
Banded
igneous rock



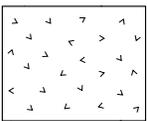
721
Igneous rock
(1st option)



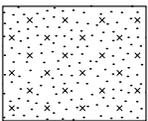
722
Igneous rock
(2nd option)



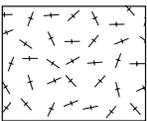
723
Igneous rock
(3rd option)



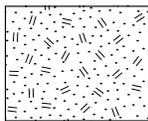
724
Igneous rock
(4th option)



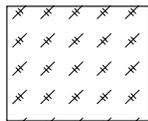
725
Igneous rock
(5th option)



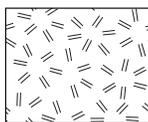
726
Igneous rock
(6th option)



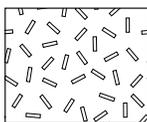
727
Igneous rock
(7th option)



728
Igneous rock
(8th option)



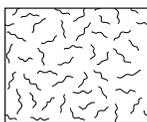
729
Porphyritic rock
(1st option)



730
Porphyritic rock
(2nd option)



731
Vitrophyre



732
Quartz



733
Ore

*For more information, see general guidelines on pages A-i to A-v.

38—EXPLANATION FOR PATTERN CHART

DISCUSSION*	
<p>This diagram provides some basic information on how to use the new Pattern Chart, which is enclosed in the sleeve on the inside back cover of this standard volume. For more specific information on the use of patterns (and color) on geologic maps, see Section 5, entitled "Guidelines for Map Color and Pattern Selection," in the accompanying introductory text.</p> <p>Most patterns on this new chart were designed (in Adobe Illustrator 8.0.1) to closely replicate patterns in the informal "Technical Cartographic Standards" volume (U.S. Geological Survey, ca. 1975). In some cases, however, lineweights of pattern elements had to be increased to facilitate higher resolution (1800 dpi) digital output; therefore, some patterns may not plot or print correctly if output at lower resolutions.</p> <p>Each pattern has been assigned a new pattern number (see below each box). In addition, each pattern now has associated with it a generic look-up table number that can be used to access a pattern if it has been incorporated into a patternset.</p>	
DESCRIPTION	
Abbreviations used in pattern numbers:	• K, black; C, cyan; M, magenta; DO, dropout; R, red; B, brown
Overprint patterns have white background	<ul style="list-style-type: none"> • Pattern is in front. One bounding box (having Fill and Stroke set to 'None') is in back • White background is transparent (underlying map-unit color will be visible)
Dropout patterns have black background	<ul style="list-style-type: none"> • Pattern is in front. Two bounding boxes are in back: box directly beneath pattern has Fill set to 100% black and Stroke set to 'None'; box to rear has both Fill and Stroke set to 'None' • Black background represents underlying map-unit color. If white pattern is used "as is," it will knock out the underlying map-unit color; if pattern is changed to one of the CMYK values in the underlying map-unit color, it will knock out the other CMYK value(s) in map-unit color

IGNEOUS PATTERNS (Series 300)

Pattern number shown below box

Generic lookup-table number shown in upper left-hand corner of box (can be used to access a particular pattern from a patternset)

39—EXPLANATION FOR CMYK COLOR CHART

DISCUSSION*

This diagram explains how to use the new CMYK Color Chart, which is enclosed in the sleeve on the inside back cover of this standard volume. For more specific information on the use of color (and patterns) on geologic maps, see Section 5, entitled "Guidelines for Map Color and Pattern Selection," in the accompanying introductory text.

This new CMYK Color Chart was designed in Adobe Illustrator 8.0.1 (Macintosh) to closely replicate the colors on the U.S. Geological Survey's original offset-printed process-ink color chart, entitled "Printing Colors and Screens in Use by the U.S. Geological Survey for Geologic and Hydrologic Maps" [yellow/magenta/cyan version], which has long been used at the USGS for choosing colors on geologic maps. The new color chart contains the same colors that were in the original offset-printed USGS color chart; however, the old color codes indicating the YMC (yellow/magenta/cyan) values have been updated to show CMYK (cyan/magenta/yellow, with K = 0) values, to conform to industry standards.

In addition, each color now has associated with it a generic look-up table number that can be used to access a particular color if it has been incorporated into a shadeset.

CMYK (K = 0) value shown below box (see left side of diagram for explanation of abbreviations used)

Generic lookup-table number shown in upper left-hand corner of box (can be used to access a particular color from a shadeset)



Abbreviations used to specify CMY values

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