GUIDE

FOR THE PREPARATION OF REPORTS FOR THE UTAH GEOLOGICAL SURVEY

Third Edition

by Michael D. Hylland,
William R. Lund, and Robert Ressetar

CIRCULAR 105
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a division of
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2008

UTAH DNR GEOLOGICAL SURVEY

Hylland, Lund, Ressetar

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PREFACE TO THE THIRD EDITION

Throughout its history, the Utah Geological Survey (UGS) has strived to produce reports of the highest technical and editorial quality. To achieve that end and establish the basis for a certain degree of uniformity among the various publication series of the UGS, the first edition of the *Guide for the Preparation of Reports for the Utah Geological Survey* (the *Guide*) was published as UGS Circular 85 in 1992. In addition to describing the UGS publication process and listing the publication series available to UGS and non-UGS authors, the *Guide* compiled and synthesized technical and stylistic information from a variety of sources to provide a primary reference for authors of UGS reports. In 2003, the *Guide* was revised and updated to reflect changes to the make-up of the UGS publication series, organizational changes at the UGS that had an effect on the document review process, and the increased use of digital word-processing, graphics, and map-production software in the publication process. The second edition of the *Guide* was published as UGS Miscellaneous Publication 03-7, and for the first time was accessible on the UGS Web site.

This third edition of the *Guide* retains much of the original text of the previous editions, but incorporates a few changes where needed. The UGS Publications section has been modified to reflect the present (as of this writing) make-up of the UGS publication series and to clarify the criteria for publication of a document in a particular series. The References section has been revised to make it easier to find examples of particular types of reference citations for reference lists. New sections of text address peer-review requirements and provide guidance for writing geologic map-unit descriptions. The geologic time scale recommended for use by the UGS has been modified to incorporate boundary ages recently ratified by the International Commission on Stratigraphy. Finally, various minor revisions reflect the ongoing evolution of English grammar and style.

Although we take full responsibility for the contents of this third edition of the *Guide*, we wish to acknowledge those who have assisted us in its preparation. In addition to the numerous individuals who provided advice and assistance during development of the previous editions, we thank our UGS colleagues who reviewed the current edition and/or provided valuable input, including Rick Allis, Gary Christenson, Vicky Clarke, Sandy Eldredge, Kimm Harty, Lucy Jordan, David Tabet, and Grant Willis.

M.D.H., W.R.L., and R.R.

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ABSTRACT

Reports prepared for publication by the Utah Geological Survey (UGS) are expected to be of the highest technical and editorial quality. This guide establishes policies governing the publication of UGS reports and provides editorial standards necessary for preparing publications of the desired quality.

Information in this guide includes (1) a description of the UGS publication series, including unpublished documents and UGS Web-site material, (2) a description of the UGS publication process and the responsibilities of the individuals involved in the review of manuscripts (author, peer reviewers, program manager, technical reviewer, deputy director, director, and publications manager), (3) a discussion of ethical considerations associated with the publication process, (4) a general description of the parts of a UGS report, (5) rules for preparing manuscripts, (6) style requirements for UGS reports, (7) writing tips, (8) a selected bibliography that includes writing resources as well as geologic references cited in the text, and (9) appendices that present resources and information useful in the report preparation process.

Policy statements in this guide establish criteria for report authorship, direct authors to avoid plagiarism and give proper credit for the work of others, define the required steps and individual responsibilities in the UGS publication process, establish guidelines for using the Utah Licensed Professional Geologist seal, establish requirements for obtaining and documenting permission to use copyrighted or proprietary material, and identify the procedures UGS authors must follow when publishing outside of the UGS.

This guide is being released as both a printed publication and a digital document on the UGS Web site. Periodic updates may be made to this guide, and these updates will appear in the online version before a new printed edition is published. Authors should therefore check the UGS Web site for the most up-to-date version of this guide.

INTRODUCTION

The Utah Geological Survey (UGS) publishes reports on all aspects of the geology of Utah. The reports range from brief technical reports of limited scope and distribution to comprehensive bulletins intended to stand as the definitive work on a geologic topic for many years. Regardless of the length or purpose of the report, the Survey's reputation as a scientific organization depends on the technical and editorial quality of its publications. This guide sets forth policies governing the publication of UGS reports and presents a consistent set of editorial standards that will assist authors in producing publications and other documents of the desired quality.

No single set of editorial standards can meet the requirements of all scientific organizations. Each organization that publishes reports on a regular basis has its own specialized editorial needs and must establish standards to meet those needs. The purpose of this *Guide for the Preparation of Reports for the Utah Geological Survey* is to help UGS authors achieve consistency and clarity of expression and logical organization in their writing and to facilitate the manuscript review and publication process.

The principal source of information used in compiling this guide was *Suggestions to Authors of the Reports of the United States*

Geological Survey (seventh edition; Hansen, 1991). UGS authors should refer to that publication for additional information about preparing geologic reports. However, this guide is not everywhere consistent with Hansen (1991), and, where differences exist, this guide takes precedence when preparing UGS reports. Other primary sources of information used in compiling this guide include *The Chicago Manual of Style* (14th edition), *Franklin Covey Style Guide*, and *United States Government Printing Office Style Manual*. The Selected Bibliography lists these and other useful references.

In addition to the references listed above, the UGS uses three other publications as standard references in the report publication process: *Webster's Third New International Dictionary of the English Language*, the American Geological Institute *Glossary of Geology* (fifth edition; Neuendorf and others, 2005), and the current edition of the *North American Stratigraphic Code* (North American Commission on Stratigraphic Nomenclature, 2005). Authors should consult these references, or their subsequent editions and revisions, concerning matters of spelling, geologic terminology, and the naming of lithostratigraphic units. Also, authors of geologic maps published by the UGS should consult UGS Circular 89, *Guide to Authors of Geologic Maps and Text Booklets of the Utah Geological Survey* (Doelling and Willis, 1995).

This guide is being released as both a printed publication and a digital document on the UGS Web site. This guide may periodically be updated when appropriate, and these updates will appear in the online version before a new printed edition is published. Authors should therefore check the UGS Web site for the most up-to-date version of this guide. UGS staff will be notified when any update is made to this guide.

UGS PUBLICATIONS

The UGS has a variety of publication series available to both staff and non-UGS authors to accommodate documents of varying purpose, project scope, and target audience. The different publication series receive different levels of technical and editorial review, and some are more widely distributed through library standing orders than others. Authors must consider these and other factors, discussed in more detail in the section on Selecting a Publication Series, early in the report-writing process to select the most appropriate publication series. The section on The UGS Publication Process gives details regarding manuscript review.

In general, the UGS restricts lead authorship of most UGS publications to UGS employees; however, non-UGS authors may serve as co-authors. The principal publication formats available to non-UGS authors are Miscellaneous Publications and Open-File Reports.

Publications in the earth sciences increasingly appear in digital format (for example, compact disk). Any of the UGS publication series may be released in the form of a digital product, and authors should always consider digital format as a publication option. Consult the section on Digital Format for a discussion of factors that must be considered for digital publications.

Publication Series

Formally Published Documents

Bulletins: Bulletins are topically and/or geographically comprehensive in nature. They may contain mostly original work or consist of a comprehensive synthesis of existing data of potential interest to a relatively broad segment of the scientific community. Bulletins undergo the full UGS review process (table 1) to ensure that they satisfy both scientific and format standards, and the UGS stands behind Bulletins as substantive scientific works. Bulletins require at least two formal peer reviews by subject-matter experts, preferably at least one of whom is outside of the UGS. Bulletins are authored by UGS staff but may have external co-authors.

Examples of documents published as UGS Bulletins include:

- *The Geology of Kane County, Utah—Geology, Mineral Resources, Geologic Hazards* (Doelling and Davis, 1989).
- *Quaternary Tectonics of Utah with Emphasis on Earthquake-Hazard Characterization* (Hecker, 1993).

- *Digital Geologic Resources Atlas of Utah* (Sprinkel, 1999).

Special Studies: The subject matter of Special Studies is typically more restricted than that of Bulletins. However, Special Studies generally contain significant amounts of original (non-compiled) material, and are of potential interest to a relatively broad segment of the scientific community. Special Studies undergo the full UGS review process (table 1) to ensure that they satisfy both scientific and format standards, and the UGS stands behind Special Studies as substantive scientific works. Special Studies require at least two formal peer reviews by subject-matter experts, preferably at least one of whom is outside of the UGS. Special Studies are authored by UGS staff but may have external co-authors.

Examples of documents published as UGS Special Studies include:

- *Fault Behavior and Earthquake Recurrence on the Provo Segment of the Wasatch Fault Zone at Mapleton, Utah County, Utah* (Lund and others, 1991).
- *Redefining the Lower Cretaceous Stratigraphy Within the Central Utah Foreland Basin* (Sprinkel and others, 1999).
- *The Geology of Cedar Valley, Iron County, Utah, and Its Relation to Ground-Water Conditions* (Hurlow, 2002).

Map series: The UGS publishes many different types of maps in its Map series, including original and compiled geologic quadrangle maps, economic-resource maps, ground-water recharge- and discharge-area maps, and various geologic-hazards maps. Maps undergo the full UGS review process (table 1) to ensure that they satisfy both scientific and format standards, and the UGS stands behind documents published in the Map series as substantive scientific works. Maps require at least two formal peer reviews by subject-matter experts, preferably at least one of whom is outside of the UGS. Geologic quadrangle mapping by non-UGS authors is typically published in the Miscellaneous Publication series and undergoes review commensurate with that series (see Miscellaneous Publication Series section, and table 1). However, in cases where the review meets the level required for a UGS Map and at the discretion of the UGS, geologic quadrangle mapping by a non-UGS author may be published in the Map series. Maps may be published in color or black-and-white, may comprise multiple plates, and may have an accompanying text booklet. UGS Circular 89—*Guide to Authors of Geologic Maps and Text Booklets of the Utah Geological Survey* (Doelling and Willis, 1995)—contains guidelines specific to the preparation of geologic quadrangle maps.

Examples of documents published as UGS Maps include:

- *Geologic Map of the Aurora Quadrangle, Sevier County, Utah* (Willis, 1988).
- *Landslide Map of Utah* (Harty, 1991).
- *Digital Geologic Map of Utah* (Hintze and others, 2000).

Circulars: Circulars address timely subjects, have a limited "shelf life" (may be subject to periodic updating), and typically are geared toward a relatively wide and non-specialized audience. They undergo the full UGS review process (table 1) to ensure that they satisfy both scientific and format standards. Circulars require at least one formal peer review by a subject-matter expert. Circulars are authored by UGS staff but may have external co-authors.

Examples of documents published as UGS Circulars include:

- *1996 Summary of Mineral Activity in Utah* (Bon and others, 1997).
- *A Preliminary Assessment of Paleontological Resources Within the Grand Staircase–Escalante National Monument, Utah* (Gillette and Hayden, 1997).
- This guide.

Reports of Investigation: Reports of Investigation present the results of site-specific or project-specific investigations undertaken by UGS staff. The investigations involve original work and are generally of limited scope and/or duration, and the resulting reports typically are of interest to a local audience and receive limited distribution. Reports of Investigation allow for more flexibility in format and content than Bulletins, Special Studies, and Circulars, but they nonetheless undergo the full UGS review process (table 1) to ensure that they retain scientific accuracy.

Reports of Investigation require at least one formal peer review by a subject-matter expert. A Report of Investigation may consist of a single report on a single topic, or a number of different reports on related topics.

Examples of documents published as UGS Reports of Investigation include:

- *Delineation of Drinking Water Source Protection Zones for the Newcastle Public Water Supply Well, Iron County, Utah* (Bishop, 1999).
- *Technical Reports for 1999, Applied Geology Program* (McDonald, 2000).
- *Movement History and Preliminary Hazard Assessment of the Heather Drive Landslide, Layton, Davis County, Utah* (Giraud, 2002).

Public Information series: The Public Information series consists of brief topical reports or brochures designed to make nontechnical geologic information available to the general public. Documents in this series may have either UGS or non-UGS authors. The documents undergo the full UGS review process (table 1) to ensure that they retain scientific accuracy, but they do not necessarily conform to UGS format standards. Documents in the Public Information series require at least one formal peer review by a subject-matter expert.

Examples of documents published in the UGS Public Information series include:

- *Homebuyers Guide to Earthquake Hazards in Utah* (Eldredge, 1996).
- *Geologic Maps—What Are You Standing On?* (Biek, 1999).
- *Rainbow of Rocks: Mysteries of Sandstone Colors and Concretions in Colorado Plateau Canyon Country* (Chan and Parry, 2002).

Miscellaneous Publication series: The Miscellaneous Publication series is the principal publication series available to non-UGS authors. Miscellaneous Publications may be substantive scientific works, but do not necessarily conform to UGS editorial or format standards. Miscellaneous Publications typically take the form of a single report on a single topic (non-UGS author, or UGS co-author but not senior author), or a number of different reports on related topics (non-UGS authors, but UGS volume editor or compiler). In general, draft manuscripts of single reports authored solely by non-UGS athors must be submitted to and approved by the UGS Editorial/Sales Committee before the UGS commits time and resources in support of publication (e.g., reviews, editorial assistance with illustrations). This requirement typically pertains to unsolicited manuscripts and not to work that is performed at the request of or under contract to the UGS. Nonetheless, the deputy director and director should be made aware of manuscripts prepared under these circumstances prior to UGS review. Under certain circumstances, some geologic maps having a UGS senior author may be published as a Miscellaneous Publication; this requires joint approval by the Geologic Mapping Program manager and UGS deputy director. Miscellaneous Publications receive varying levels of review depending on the specifics of authorship (table 1), as discussed below in The UGS Publication Process section. Geologic maps released as Miscellaneous Publications are subject to the same review requirements as single papers having a UGS co-author.

Examples of documents published as UGS Miscellaneous Publications include:

- *Earthquake Scenario and Probabilistic Ground Shaking Maps for the Salt Lake City, Utah, Metropolitan Area* (Wong and others, 2002).
- *Geologic Map of the Terrace Mountain West Quadrangle, Box Elder County, Utah* (Miller and McCarthy, 2002).

- *Proceedings Volume, Basin and Range Province Seismic Hazards Summit II* (Lund, 2005).

Survey Notes: The UGS publishes its official newsletter, *Survey Notes*, three times a year. *Survey Notes* is a nontechnical publication, and normally contains several related articles that highlight recent work related to one of the UGS programs. It also contains several regular feature articles and UGS news. All articles undergo the full UGS review process (with the exception of formal peer review; table 1) to ensure that they satisfy both scientific and format standards. Although articles are typically authored by UGS staff, non-UGS authors may also publish in *Survey Notes*.

Unpublished and Informally Published Documents

Technical Reports: Technical Reports typically present the results of site-specific, reconnaissance, and/or emergency-response investigations. The anticipated audience is small and distribution is limited. Even though Technical Reports are not formally published, they undergo the full UGS review process (with the exception of formal peer review; table 1) because their content frequently deals with public-safety (geologic hazards) issues.

Technical Reports require use of the Utah Licensed Professional Geologist seal when they contain geologic advice to a Utah state- or local-government agency (see Utah Licensed Professional Geologist Seal section). Technical Reports do not necessarily conform to UGS format standards. Technical Reports are sometimes combined and published as a Report of Investigation.

Contract deliverables: Contract deliverables consist of reports, maps, databases, and other materials produced by the UGS and delivered to a funding entity to fulfill contract or grant obligations. These documents receive limited UGS review (table 1) to ensure that they satisfy scientific standards, and are not subject to UGS editorial or format standards. Some contract deliverables will require use of the Utah Licensed Professional Geologist seal (see Utah Licensed Professional Geologist Seal section). When a contract deliverable is sent to the client, the author also sends a copy of the document to the UGS publications manager to be archived.

Open-File Reports: This publication series contains documents intended to stand either temporarily or permanently with minimal technical review and editing. Open-File Reports are convenient for releasing timely information to the public, heavily data-laden reports and databases, and preliminary maps and manuscripts that will be superseded after more data are added and/or more rigorous review and editing. Open-File Reports may have either UGS or non-UGS authors, and they receive limited UGS review (table 1). Some Open-File Reports authored solely by non-UGS authors may need to be submitted to and approved by the UGS Editorial/Sales Committee before the UGS commits time and resources (e.g., reviews, editorial assistance with illustrations) in support of publication. This requirement typically pertains to unsolicited manuscripts and not to work that is performed at the request of or under contract to the UGS. Nonetheless, the deputy director and director should be made aware of manuscripts prepared under these circumstances prior to UGS review.

Examples of documents published as UGS Open-File Reports include:

- *Petroleum Production and Well Data, Summit County, Utah* (Sprinkel, 1995).
- *Engineering Geologic Map Folio, Springdale, Washington County, Utah* (Solomon, 1996).
- *Interim Geologic Map of the Spanish Fork Quadrangle, Utah County, Utah* (Solomon and others, 2006).

UGS Web site: Authors may post documents to the UGS Web site following the guidelines given below. Release of a document on the UGS Web site is not the mechanism by which the document is considered published; however, a document published in one of the UGS publication series may also be released on the Web site.

Material released on the UGS Web site falls into one of three categories: (1) previously published UGS articles or reports, (2) articles, reports, or other material prepared specifically for the Web site, and (3) reports intended for release as a published UGS report (print run or digital) and concurrently made available on the Web site. The material may or may not require UGS review prior to Web-site release (see Review Procedures for UGS Web-Site Material). However, the author's program manager must approve all material considered for Web-site release, and the deputy director must approve all material that has not already been through the UGS review process. Authors also should consult with the UGS Web-site manager regarding suitability of materials and any other pertinent issues.

Selecting a Publication Series

When selecting the publication series in which to publish a report, significant factors that should be considered include study size and scope, geographic coverage, scientific merit, intended audience, and publishing cost. In most instances, the study characteristics will naturally point toward one of the available UGS publication series. For example, an in-depth study relating to a particular subdiscipline of geology and consisting largely of original work will typically be published as a Special Study, or, if a study is of particular scientific importance and is topically or geographically comprehensive, publication as a Bulletin would be appropriate. Conversely, a brief site investigation is best released as a Report of Investigation or Technical Report.

The author, in consultation with the program manager, should establish the appropriate publication series as early as possible in the planning phase of a study. Program managers retain the right to change the proposed publication series after reviewing the study results. If a question remains concerning the proper publication series for a report, consult with the publications manager and deputy director for guidance.

Digital Format

In some cases an author may wish to release all or part of a report in digital format (for example, compact disk, or on the UGS Web site), and in other cases the decision to publish in digital format may be driven largely by economics. Digital release may be preferable to a conventional print run when extensive use of color figures is desired, or when a document is heavily data laden. Authors should bear in mind the variability and possible limitations of end-user computer software and hardware capabilities, and in the case of Web-site material, the time it may take to download files. Authors considering digital format must consult with the publications manager and deputy director prior to finalizing publication plans.

An attractive aspect of digital publications, especially those that target a small, specialized audience, is the ability to print limited quantities of a report on an as-needed basis (print-on-demand). However, authors need to weigh advantages and disadvantages of print-on-demand and consult with the publications manager and deputy director prior to finalizing publication plans.

Outside Publications

Most UGS activities directly involve Utah geology and result in UGS publications. However, some material may be better suited to a wider or more specific audience for which publication outside the UGS would be desirable. The UGS supports outside publication, subject to approval by the author's program manager and the deputy director. Following approval and subject to availability of facilities, UGS resources and capabilities may be used in preparing outside publications. The work requires the director's approval if it involves a publication cost payable by the UGS; in general, the UGS discourages submitting manuscripts to journals that require a substantial page charge.

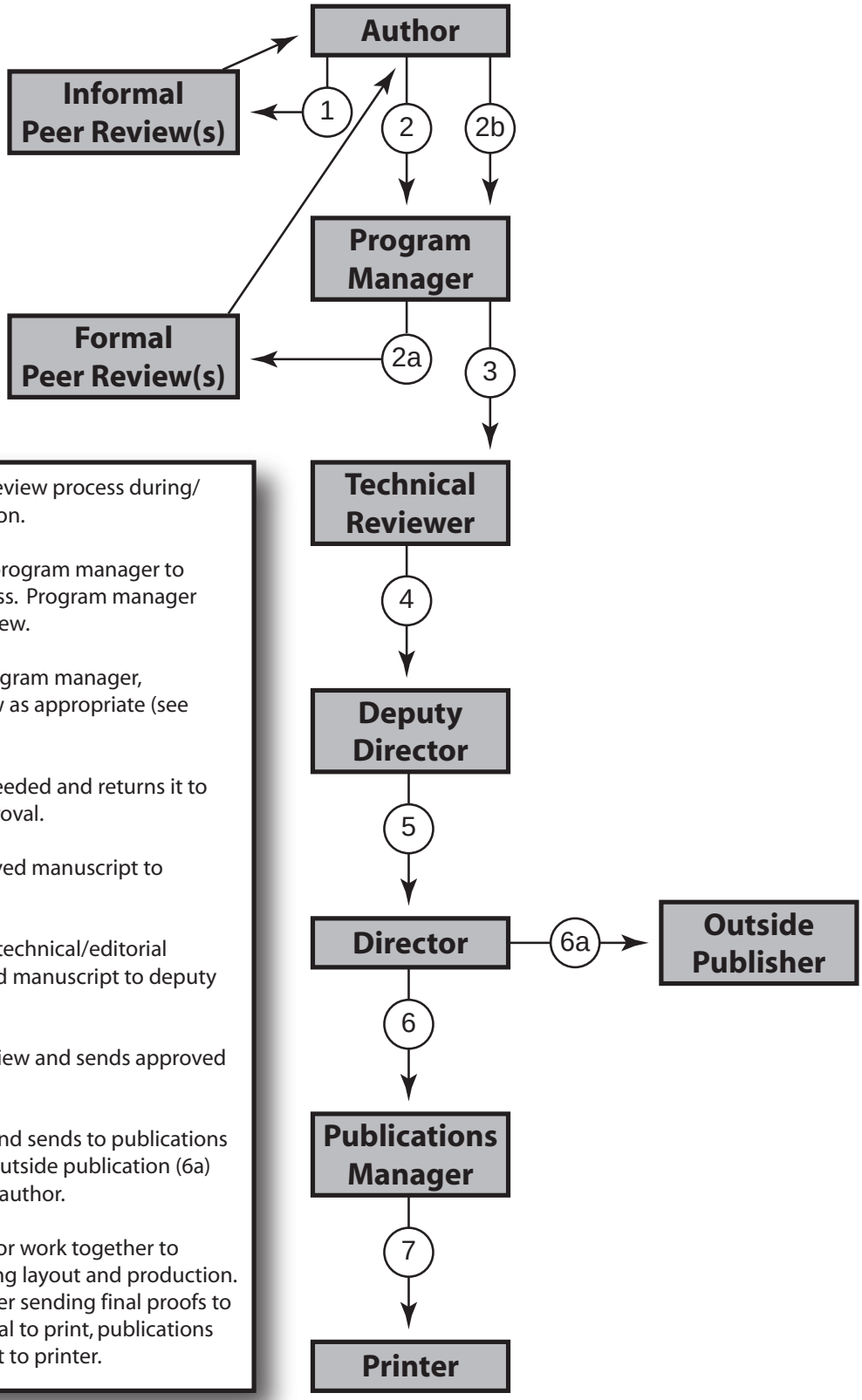
A manuscript intended for outside publication must undergo the full UGS review process prior to submittal to the outside publisher. Most publishers will arrange for peer review of the manuscript prior to publication. Depending on the extent and nature of changes to the manuscript in response to peer-review comments, subsequent approval of the revised manuscript by the deputy director and director may or may not be warranted; UGS authors should use their best judgment to determine if this step is necessary.

For manuscripts in a refereed publication such as a professional journal or guidebook, the UGS author or co-author forwards a copy of the published paper to the UGS librarian to be archived. This requirement excludes non-refereed material such as abstracts and newsletter articles.

THE UGS PUBLICATION PROCESS

The UGS publication process is a team effort that normally involves the author, the author's program manager, peer reviewers, and the UGS technical reviewer, deputy director, director, and publications manager (figure 1). Each team member has specific duties and responsibilities to fulfill if the UGS is to produce the best possible publications.

The publication review process addresses issues of technical adequacy, completeness of reports, and format and editorial standards.



1. Author initiates informal peer-review process during/after manuscript preparation.

2. Author submits manuscript to program manager to begin formal review process. Program manager does content/editorial review.

2a. Author, in consultation with program manager, initiates formal peer review as appropriate (see table 1).

2b. Author revises manuscript as needed and returns it to program manager for approval.

3. Program manager sends approved manuscript to technical reviewer.

4. Technical reviewer does formal technical/editorial review and sends approved manuscript to deputy director.

5. Deputy director does policy review and sends approved manuscript to director.

6. Director approves manuscript and sends to publications manager, or approves for outside publication (6a) and returns manuscript to author.

7. Publications manager and author work together to resolve any problems during layout and production. Author reviews proofs. After sending final proofs to deputy director for approval to print, publications manager sends manuscript to printer.

***Figure 1**. Idealized path of a document through the UGS publication process. Note that a document may be returned to the author at any point in the publication process to address issues that may arise. Also, review requirements vary for individual UGS publications; refer to table 1 for specific review requirements.*

The process typically consists of author-initiated informal peer reviews; a thorough technical and editorial review by the program manager and, for most UGS publications, a minimum of one formal peer review by a technically qualified subject-matter expert; and review and approval by the UGS technical reviewer, deputy director, and director (figure 1). Some variations exist in the level of review required for the different UGS publication series, and review requirements may differ for UGS versus non-UGS authors. Table 1 summarizes the review requirements discussed below.

Author

Utah Geological Survey policy is that the person in principal charge of an investigation and preparation of the subsequent report receives credit as principal author of the resulting publication. Seniority, position/title, or similar considerations are not criteria for determining authorship or co-authorship of UGS reports. In cases of multiple authors, the level of contribution by each individual determines authorship or co-authorship. When two or more researchers contribute equally, they will be listed as authors in alphabetical order according to their last names unless they agree in advance to some other mutually satisfactory arrangement. Credit for co-authorship is given to individuals who make a significant contribution to an investigation even though they may not take an active part in writing the report. Usually, the designation of principal and co-authors is a straightforward matter. Clear assignment of duties and responsibilities among investigators early in the study normally resolves potential questions or disagreement on this sometimes sensitive subject. When disagreement occurs, the program manager will make the final decision regarding authorship. If the disagreement involves the program manager, the deputy director will make the decision.

The author receives credit for the publication and bears final responsibility for the technical and editorial quality of the report. If either is inadequate, it is the author's competence and reputation that are questioned. Regardless of the scope of the study, publication format, or intended audience, UGS publications are expected to conform to the highest standards of scientific literature. Every manuscript submitted for publication should represent the author's best professional effort. Therefore, it is in every author's best interest to make good use of the peer review process when writing and revising reports (see Peer Review section below).

When satisfied with the report (including illustrations, tables, and format), the author attaches a signed UGS Document Review and Approval Sheet (appendix A) to the manuscript and submits the report to the program manager to begin the formal review process (figure 1, path 2). At various points in the formal review process the manuscript may be returned to the author for revision. Authors must consider all review comments and incorporate those that improve the report. The author will have an opportunity to review the manuscript proofs before the report is published (figure 1, path 7), but only limited revisions will be allowed at that time. Authors should keep copies of completed Document Review and Approval Sheets in their files for future reference.

Peer Review

Rigorous peer review ensures the usefulness of a scientific report to its intended audience. The peer review process is the best way to identify and correct technical and editorial problems with a manuscript. Thorough peer review by geologists or others familiar with the subject of the report is an essential part of the UGS publication process. The purpose of a peer review is not to stifle the author scientifically or to force acceptance of ideas held by the reviewers, but to help bring out the best in the author's work.

Informal peer review (figure 1, path 1) takes place during or immediately after the report-writing phase of the publication process, but before submitting the manuscript to the program manager for formal review. Informal peer review is done at the request of the author, who is responsible for selecting the reviewer(s). Informal peer review of a draft manuscript can help identify deficiencies in report organization, content, and editorial style, and may provide authors with new insights regarding their study as a whole.

For some reports in the UGS publication series, informal peer review followed by the program manager's formal review is sufficient to ensure the adequacy of the report. However, most manuscripts can benefit from additional peer review (figure 1, path 2a) regardless of their final publication format. Many reports in the UGS publication series require a minimum of one or two formal peer reviews, preferably by individuals outside of the UGS having technical expertise on the topic of the study (table 1). No upper limit is placed on the number of formal peer reviews that may be sought, and multiple reviews are recommended. Formal peer reviewers are selected for their technical understanding of the topic; their ability as scientific writers, or their ability to translate technical information into language that is easily understood by a general or nontechnical audience; and their willingness to complete the review in a thorough and timely manner. Formal peer reviewers are normally chosen by the author in consultation with the program manager.

Appendix A contains a Peer Review Form for authors to send to formal peer reviewers (subject-matter experts) along with the

Table 1. *Publication review and approval requirements.*

Publication Series	Informal Peer Reviewer	Program Manager	Formal Peer Reviewer(s)[1]	Technical Reviewer	Deputy Director[2]	Director[3]
Formally Published Documents						
Bulletin	Yes	Yes	Yes (at least 2)	Yes	Yes	Yes
Special Study	Yes	Yes	Yes (at least 2)	Yes	Yes	Yes
Map Series	Yes	Yes	Yes (at least 2)	Yes	Yes	Yes
Circular	Yes	Yes	Yes (at least 1)	Yes	Yes	Yes
Report of Investigation	Yes	Yes	Yes (at least 1)	Yes	Yes	Yes
Public Information Series	Yes	Yes	Yes (at least 1)	Yes	Yes	Yes
Miscellaneous Publication:						
Multi-paper volume having UGS editor	Yes	Yes (all papers in volume)	Yes (at least 1)	Yes (only papers having UGS co-author)	Yes	Yes
Single paper having UGS co-author	Yes	Yes	Yes (at least 1)	Yes	Yes	Yes
No UGS affiliation	Yes	No	Yes (at least 2)	No	Yes	Yes
Survey Notes	Yes	Yes	No	Yes	Yes	Yes
Outside Publication	No	Yes	Yes (typically coordinated by publisher)	Yes	Yes	Yes
Unpublished and Informally Published Documents						
Technical Report	Yes	Yes	No	Yes	Yes	Yes
Contract Deliverable	No	Yes	No	Yes	Yes	Yes
Open-File Report	No	Yes	No	Yes	Yes	Yes
UGS author/co-author	No	Yes	No	Yes	Yes	Yes
No UGS affiliation	No	Yes	No	No	Yes	Yes
UGS Web site	No	Yes	No	No	Yes[4]	No

[1] Subject-matter expert, preferably outside UGS.
[2] Primarily policy review.
[3] Final approval for publication.
[4] Materials must be reviewed by Web-site manager prior to review by deputy director.

manuscript to facilitate the peer review process. For Bulletins, Special Studies, and Maps (other than geologic quadrangle maps), completed Peer Review Forms as well as copies of the marked-up manuscript must accompany the revised manuscript submitted to the UGS technical reviewer. This process, similar to that used by editors of refereed journals, helps to ensure that the scientific content of the report has been adequately reviewed. For documents other than Bulletins, Special Studies, and Maps, use of the Peer Review Form is optional.

If a report includes digital geographic information system (GIS) files, a GIS specialist must review the files on a computer that is different from the one on which the files were generated. The files for review should be in a finalized form on the medium on which they will be released (e.g., compact disk). When satisfied with the content and accessibility of the files, the GIS reviewer should sign the UGS Document Review and Approval Sheet (appendix A) in the box along with the other peer reviewers. Review of GIS files should take place prior to review of the complete document by the deputy director.

Because peer review of manuscripts is an essential part of the UGS publication process, all UGS authors have an obligation to do their fair share of the reviewing. However, individuals who do not believe themselves qualified, who lack the time to do a thorough review, or who have a conflict of interest should decline the reviewer's role. The Selected Bibliography contains several publications that provide specific review guidelines (for example, Malde, 1986; Hansen, 1991). The following general guidelines apply to all manuscript reviews whether informal or formal:

- Reviewers are obligated to treat manuscripts as confidential documents and must not show, disclose, appropriate, use, or publish information contained in a manuscript without the author's expressed consent.

- Reviewers should be alert to the failure of the author to cite relevant work by other scientists.

- Reviewers should explain and support their comments so that the author can understand the basis on which they were made. Vague or cryptic comments are of no use to the author.

- Reviewers should carefully check all mathematics and chemical formulas for accuracy.

- Reviewers may find it necessary to criticize a manuscript but should do so in a friendly and objective manner. Be straightforward when offering constructive criticism; attempts at humor are more likely to offend than amuse. Sarcasm and personal criticism of an author are never justified.

Authors owe a responsibility to their peer reviewers. A comprehensive technical and editorial review is a painstaking and time-consuming task. Reviewers take considerable time away from their own projects to improve someone else's report and ultimately to safeguard the author's reputation. Therefore, the author must provide reviewers with a manuscript that is complete, well organized, and legible. A reviewer who must spend time tracking down parts of a report (an illustration or reference, for instance), or has difficulty deciphering the report because of poor writing or organization, is unlikely to agree to serve as a peer reviewer for the author in the future.

Program Manager

A program manager is in charge of each of the UGS technical programs. Program managers have oversight responsibility for the technical and editorial quality of the reports produced by their programs. The formal review process begins when the author submits a manuscript to the program manager (figure 1, path 2). The program manager makes a thorough technical and editorial review of the manuscript and, if necessary, returns it to the author for revision. If the chosen publication series requires formal peer review, qualified individuals are chosen by the author in consultation with the program manager (figure 1, path 2a). Following formal peer review(s), the author revises the manuscript and returns it to the program manager. When satisfied with the technical and editorial quality of the report, the program manager signs the UGS Document Review and Approval Sheet and gives the manuscript to the technical reviewer (figure 1, path 3). By signing the Document Review and Approval Sheet, the program manager certifies that the document represents the program's best professional efforts, and shares with the author personal responsibility for the document's technical quality and compliance with UGS editorial standards.

The only documents that are not reviewed by program managers are Miscellaneous Publications authored solely by non-UGS

personnel. However, program managers are responsible for ensuring that these documents receive an informal peer review by a UGS employee having the appropriate background in the subject matter.

Technical Reviewer

The UGS technical reviewer is responsible for ensuring technical accuracy and compliance with UGS editorial standards. The primary issues considered by the technical reviewer include any technical/scientific problems not previously addressed by the author and program manager, the organization and clarity of the report, consistency among the various components of the report, and compliance with UGS editorial standards. The technical reviewer generally works directly with the author to resolve any non-technical issues, but may consult with both the author and program manager if substantial technical issues arise. When satisfied with the technical and editorial quality of the report, the technical reviewer sends the approved manuscript to the deputy director for policy review (figure 1, path 4).

The technical reviewer does not review Miscellaneous Publications or Open-File Reports authored solely by non-UGS personnel, or documents prepared solely for release on the UGS Web site.

Deputy Director

The deputy director has overall responsibility for implementing UGS publication policies. The deputy director reviews all manuscripts to ensure compliance with State, Department of Natural Resources, and UGS policies, and evaluates the appropriateness of the publication series proposed for the report. If a significant issue arises, the deputy director may return the manuscript to the program manager for further revision.

When all remaining issues are resolved, the deputy director sends the approved manuscript to the director (figure 1, path 5) for final approval.

Director

The director gives final approval for all UGS publications and must approve all manuscripts prepared by UGS authors for publication outside of the UGS. After signing the UGS Document Review and Approval Sheet, the director sends approved manuscripts to the publications manager for publication (figure 1, path 6). Rejected manuscripts are returned to the deputy director. Manuscripts approved for outside publication are signed by the director and returned to the author, who forwards the manuscript to the publishing organization's editor (figure 1, path 6a).

Publications Manager

The publications manager reviews manuscripts for compliance with UGS editorial standards and supervises finalization and layout of reports for publication. The publications manager works with the author to resolve questions or problems that may arise at any phase of the publication process. To streamline the publication process, authors should consult with the publications manager early and often to address issues such as oversized figures (plates), the use of color, and conversion of digital files.

Proofs are sent to the author for review; after the author's revisions are incorporated, the publications manager sends the corrected proofs to the deputy director and director for final review. Once approved by the deputy director and director, the publications manager sends the report to the printer (figure 1, path 7).

Review Procedures for UGS Web-Site Material

Previously Published UGS Articles or Reports

If the material has undergone full UGS review, no additional review is required. However, authors must consult with their program manager regarding the material's appropriateness for posting on the Web site. Authors may have their program manager initial the approved materials rather than including a Document Review and Approval Sheet. The author then submits approved materials to the UGS Web-site manager.

Previously Unpublished or Non-Reviewed UGS Materials

With the exceptions described in the following paragraph, articles and reports prepared specifically for the Web site that have not received prior UGS review must be approved by the author's program manager and then submitted to the UGS Web-site manager for review. Following review by the Web-site manager, the materials must be approved by the deputy director. Use the Document Review and Approval Sheet for Web Site (appendix A) to track the approvals.

Nonscientific materials such as meeting announcements, notices of field reviews, and routine updates of Web-site pages by the Web-site manager (for example, adding new entries to calendars, conference listings, publications lists) need not be submitted for review, but such materials should be proofread thoroughly before being posted. Program managers must approve all project updates submitted by geologic program staff before submitting the material to the Web-site manager.

Materials Released Concurrently as a UGS Publication and Web-Site Document

Articles and reports prepared for publication and concurrent release on the UGS Web site undergo the full UGS review process for the chosen publication series as summarized in table 1. Note on the Document Review and Approval Sheet (in the Format and Comments areas) that the publication is also intended for inclusion on the UGS Web site.

Non-UGS Materials

The UGS will consider articles and reports by non-UGS authors for posting on the UGS Web site on a case-by-case basis, but in most cases the UGS will establish a link to such material at another site. An exception would be when the information is not available on another Web site, and the UGS posts it with permission. Following consultation with the Web-site manager, the appropriate program manager and the deputy director must approve all material originating with a non-UGS author prior to submitting the material to the Web-site manager.

Proofreading

An important, but sometimes neglected, step in the document-publication process is the proofreading of one's own writing. Adequate proofreading on the part of the author typically saves time in the document-review process. Proofreading is also a courtesy to peer reviewers in that they can focus their attention on technical matters without being distracted by poor writing.

Here are a few suggestions to maximize the effectiveness of time spent proofreading:

- After you have composed a rough draft on your word processor, go through the text file using the spelling- and grammar-checking tools. Although not infallible, these tools will help you find many problems that typically crop up, such as subject-verb disagreement, voice and tense problems, and improper word usage.

- Plan ahead; try to allow time to let your writing sit before coming back to proofread it. This allows you to read your writing more objectively.

- Proofread not only the first draft, but all subsequent drafts as well. Mistakes have a way of creeping into manuscripts at any phase of the publication process.

- Proofread hard copy. Mistakes are easier to catch when reading words printed on paper than when reading words on a computer monitor.

- Read your writing out loud to yourself. Mistakes are easier to catch when the words are vocalized than when read silently.

ETHICAL CONSIDERATIONS

The publication process places ethical constraints on all members of the UGS publication team, most particularly on the author. UGS authors must credit the ideas and work of others used in UGS reports (see References section), and they have an absolute responsibility to avoid plagiarism in their work. Authors also are responsible for completing their reports in a timely manner. When an author leaves UGS employment prior to completing a report, the program manager arranges to have the report completed either by the original author or by having another geologist take over responsibility for the project. Authors have the responsibility to acknowledge individuals and organizations that contribute to their success (see Acknowledgments section) and to extend the honor of co-authorship to individuals who make major, original contributions to a report. If a UGS study results in the reinterpretation of the geology of an area or some other aspect of a previous investigator's work, UGS authors must take care to present their findings in a scientific and objective manner and to avoid undue criticism of others. Authors must never use UGS publications to vilify other investigators with whom they disagree.

The author and the UGS rely on the peer review process to provide the technical and editorial quality control necessary for good publications. Once a commitment to do a review is made, peer reviewers have a responsibility to complete the review in a thorough and timely manner. Peer reviewers have a strict responsibility to hold all review materials in confidence (see Peer Review section).

Other members of the UGS publication team (see The UGS Publication Process section) have a responsibility similar to that of peer reviewers with regard to manuscript confidentiality. In addition, they owe the author their best efforts to produce the highest quality publication possible. Program managers bear a special responsibility to the authors they supervise. The program manager's role is as much that of mentor as it is supervisor, especially for inexperienced authors or those who may lack report-writing skills. To a large extent, the success of UGS authors depends on the time and effort spent by their program manager helping them learn how to write geologic reports.

THE PARTS OF A REPORT

UGS authors write on a wide range of geologic topics at different levels of detail and have a variety of publication series formats available to them (see Publication Series section). For these reasons, there is no "standard" UGS report. The organization of a report and the format selected for its publication depend on several factors including the subject of the report, the scope and complexity of the study, the intended audience, and the judgment of the publication team. Nevertheless, most scientific reports have broad characteristics in common. The following discussion of the parts of a "typical" geologic report will assist authors in deciding what to include and what they can safely omit from their reports.

Text

Title Page

A title page is required for all UGS reports. The title page presents the full title of the report, the name(s) of the author(s), the author(s) affiliation if other than the UGS, a statement of cooperation with other agencies if applicable, and the year that the report was printed (for draft manuscripts the month and year that the report was submitted to the program manager for formal review). The title page may also include the standard UGS disclaimer and the author's Utah Licensed Professional Geologist seal (see discussions below).

The author should select the report title with care. It must reflect the subject and scope of the report and the geographic location of the study if applicable. Brief titles that avoid needless or unusual words, jargon, and abbreviations are the most effective. Key wording—selecting important (key) words from a report title for inclusion in a library reference list—is a widespread practice. Authors should keep that process in mind when preparing titles.

The UGS often enters into cooperative programs and projects with other state and federal agencies, educational institutions, and private industry. Where those efforts result in a UGS publication, the affiliation and address of the non-UGS authors should appear on the title page along with a statement of cooperation among the agencies.

Disclaimers: Most UGS reports include the standard UGS disclaimer in their front matter. For draft manuscripts, the standard disclaimer should appear at the bottom of the title page, unless other disclaimers are also used (for example, disclaimers for work performed under contract with the federal government). When multiple disclaimers are used, they should appear together on a separate page. The UGS may choose to release some reports without the standard disclaimer; this will be determined on a case-by-case basis. Consult with the deputy director on issues involving use of the standard or other disclaimers. The UGS has authorized the following standard disclaimer wording:

> *Although this product represents the work of professional scientists, the Utah Department of Natural Resources, Utah Geological Survey, makes no warranty, expressed or implied, regarding its suitability for a particular use. The Utah Department of Natural Resources, Utah Geological Survey, shall not be liable under any circumstances for any direct, indirect, special, incidental, or consequential damages with respect to claims by users of this product.*

Some UGS publications (e.g., Open-File Reports and Miscellaneous Publications) require the use of other disclaimers in addition to the standard disclaimer, or modified wording of the standard disclaimer. Appendix B gives approved disclaimer wording for a variety of specific publication types; authors should consult with their program manager to select the appropriate disclaimer(s).

Utah Licensed Professional Geologist seal: Documents that may be interpreted as containing geologic advice to a Utah state- or local-government agency, or other client, must include the seal of a Utah Licensed Professional Geologist. In general, the seal will be that of the program manager who is the supervising professional geologist; however, if the lead author is someone other than the program manager and is also licensed, the seal may be that of the lead author. Use of the seal must follow the Professional Geologist Licensing Act (Utah Code, Title 58, Chapter 76) and Rules (Utah Administrative Code, R156-76).

The seal should be affixed to the title page of the final, original copy of the document being sent to the client. Additionally, a copy of the sealed page must be given to the UGS administrative secretary for archiving. Utah Geological Survey documents that may require use of the seal include Technical Reports and contract deliverables. Unless requested, use of the seal is not required for grant or contract work for federal agencies. The seal is also not required for other UGS publications.

Foreword and Preface

The foreword and preface are brief introductory statements about the report. A carefully prepared abstract and the introductory section of the report make a foreword or preface unnecessary in most instances. However, if the report is particularly important, the product of a cooperative project, one of a series, or in some other way significant, a foreword or preface (or both) may be desirable. A foreword is written by someone other than the author; a preface is a statement by the author. They appear prior to the table of contents. In reports that contain both, the foreword comes first.

Executive Summary

Many reports can benefit from having an executive summary. The purpose of an executive summary, which appears at the beginning of the report, is to present everything a busy supervisor, manager, or contracting officer needs to know in order to make an informed decision. The executive summary should contain all of the major assumptions, conclusions, and recommendations discussed in the body of the report, but should avoid presenting detailed data and results. An executive summary is similar to an abstract, but gives more background information and includes more complete discussions of conclusions and recommendations. In general, reports that include an executive summary do not also require an abstract. The UGS recommends the use of an executive summary in all reports submitted as a contract requirement to a funding entity.

Table of Contents

Whether or not a report includes a table of contents depends on the length and complexity of the report; most UGS reports include a table of contents. A complete table of contents for a scientific report consists of the “Contents,” which lists the section headings (including appendices) exactly as they appear in the text; “Figures,” which lists all illustrations in the main body of the report; “Tables,” which lists all the tables in the main body of the report; and “Plates,” which lists all oversize illustrations not bound into the report (figure 2). Indicate heading rank in the “Contents” by indenting subordinate headings under the preceding related heading. Unlike the headings in the Contents section, a caption for an illustration or table can be shortened in the table of contents to save space, provided it still conveys the essence of the illustration or table.

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Figure 2. *Example table of contents. Page numbers should be left blank in draft manuscripts.*

Abstract

The purpose of an abstract is to convey in condensed form the essential information of a scientific report. Many readers scan the abstract to decide whether or not to read the report. Additionally, abstracts are often reproduced in abstract journals and commonly are key-worded for library catalogs and computerized bibliographies. An abstract is not replaced by, nor is it a replacement for, the report introduction or summary/conclusions (see Body of the Report section). An abstract is required for most UGS reports; exceptions may include Technical Reports, reports published in the Public Information series, *Survey Notes* articles, Open-File

Reports, contract-deliverable reports that include an executive summary, and other very brief reports.

Abstracts are of two general types: descriptive and informative. Descriptive abstracts indicate the subject and contents of the report but do not discuss results and conclusions. Descriptive abstracts are appropriate for review papers, conference reports, edited collections of papers, and other kinds of summary documents. The abstract accompanying this guide is a descriptive abstract. Informative abstracts are required for scientific reports. They summarize the purpose of the study, the methods used, the study results, and any conclusions drawn.

The abstract is by nature short (typically a page or two of draft text), but it is not an outline, nor is it a list of topic sentences. An abstract is independent of the main report and cannot refer to illustrations, tables, or references in the report. An abstract should never include information or conclusions that are not in the report. Authors should write abstracts in the active voice whenever possible and avoid phrases such as "is discussed," "was investigated," or "are given."

Body of the Report

Each UGS report is a unique product that reflects the subject and scope of the study, the needs of the intended audience, and the author's creativity. However, nearly all reports have in common a basic structure that includes an introduction, a description of the study and results, and conclusions.

The report's introduction should explain the purpose and scope of the study. It may present a brief history of previous work, describe cooperative agreements between agencies, acknowledge help (if the report does not include acknowledgments in a separate section), and in some cases, summarize the study results and conclusions.

The section describing the study and results is typically the longest and most complex part of a report. It may consist of several main and numerous minor headings. Typical main headings include Study Methods, Setting and Physiography, Geology (both regional and site specific), Stratigraphy, Structure, Mineral and Energy Resources, Water Resources, Hydrology, Geologic Hazards, Results, or any of numerous other possible topics. This part of the report discusses the data collected and observations made during the study, and presents the study results.

The report's conclusions state the author's interpretation of the study results. This section may also give any recommendations warranted by the study. The conclusions are typically presented in the context of a summary of the report, but are not merely a restating of facts already presented in the description of the study and results. Whereas a simple summary may be adequate in some cases, most reports require a concise set of concluding statements that describe the significance and implications of the study results.

Acknowledgments

Authors are commonly indebted to others who assisted them during their study. The assistance may include financial support, data provided, analyses performed, help with office or field activities, equipment loaned, or review of the draft report. Courteous authors thank those who contribute to their success.

Acknowledgments are simple and direct; effusive expressions of gratitude are not appropriate. A simple "I thank Joe Kessel for the use of his backhoe" is preferable to "Joe Kessel is gratefully acknowledged for unselfishly providing a backhoe, without which this study could not have been accomplished." Extending thanks for assistance is mandatory, but placing a colleague in the awkward position of defending the report because of careless wording in the Acknowledgments section is an extreme discourtesy. Avoid giving the impression that those who provided assistance with the study also endorse the report's conclusions, particularly if the report is controversial.

Individuals or organizations that are paid for their services need not be acknowledged. Moral support, while appropriate to acknowledge in a thesis or dissertation, is not a basis for acknowledgment in a UGS report.

References

References are used to acknowledge the work and ideas of others and to tell the reader where to look for additional information. References cited in UGS reports typically include (1) printed publications such as maps, books, and journal articles, (2) electronic-

media documents, including information on the Internet and compact disk, and (3) verbal or written personal correspondence. Citing references is a critical part of the report-writing process and one that is often subject to error. Regardless of the type of reference, it is always necessary to confirm details such as the spelling of the author's name(s), the title of the reference, the date of publication, the name of the journal or other publication in which the reference appears, and such things as journal volume and number, page numbers, and map scales. A common error is citing a reference in the text but omitting it from the reference list at the end of the report. With minor exceptions (see below), the UGS follows USGS reference style (see Hansen, 1991, p. 234–241).

Electronic-media documents, in particular Internet sites, pose unique challenges to authors who wish to use them as reference materials in formal technical publications. These challenges stem from such circumstances as the often-ephemeral nature of the content of Internet pages, ambiguous authorship, and the lack of peer review. UGS authors need to carefully evaluate the advantages and disadvantages of using electronic-media documents as reference sources in their reports. If the reliability or veracity of information in an electronic-media document is uncertain, the electronic-media document should not be used as a reference. Also, if the information exists in traditional (paper) published form, the published document should be referenced rather than the electronic-media document. Electronic-media documents may be cited in the text and listed in the References list of UGS reports only if (1) the information provides data or documentation necessary to the report, and (2) the author determines that the information does not exist in a traditional published form. The author should make a hard copy of all electronic-media documents used as reference material, and keep these copies in a project file.

References cited in the text: In the text, references are cited by giving the author's name(s) and the date of publication. If the reference lacks a publication date, indicate as such by using "undated." References accepted for publication, but not yet published, are "in press" and are referenced as such. The phrase "in press" replaces the date in the citation. Similarly, reports being prepared for publication but which have not yet been accepted for publication are referenced as "in preparation"; authors should generally avoid referencing this type of preliminary information unless there is a clear benefit to the reader in doing so.

Reference to a single author takes the form: "Cairnes (1987) reported . . ." or ". . . six active segments of the fault zone (Mack, 1989)." A reference having two authors uses both names: "Lutgens and Tarbuck (1990) discovered . . ." or ". . . drilled a total of 57 wells (Claiborne and Fowler, 1988)." A reference having three or more authors appears as: "Jackson and others (1984) employed multiple . . ." or ". . . an estimated ore reserve of 26 million tons (Zimmer and others, in press)." When a sentence requires multiple references, they are listed in chronologic-alphabetic order. Examples include: "Stringham (1963), Reid and others (1970a), Bills and Walters (1981), Burger and Smith (1981), and Nelson and others (1984) provided information on . . ." or ". . . applicable geophysical techniques (Edgers and Harwood, 1968; Reid and others, 1968; Crammer, 1973; Steed, 1982; Dillon and others, 1986)." For multiple references by the same author(s) and published in the same year, append a letter designation to the date (for example, 1993a, 1993b). This rule also applies in the case of multiple references having three or more authors where the senior author is the same but the co-authors are different.

Provide references in the text for significant personal communications, including verbal (for example, telephone conversations or face-to-face meetings) and written (unpublished documents such as letters or memos, and e-mail correspondence). Personal communications should be referenced in the text as follows: "E.G. Sable (U.S. Geological Survey, verbal communication, March 17, 1990) stated . . . ," or ". . . consists of red arkosic sandstone (W.L. Stokes, University of Utah, written communication, 1987)." An affiliation should be given after the name as a courtesy to the person supplying the information and as a convenience to the reader. However, when the same person is referenced multiple times in a report, the affiliation need not be given every time the person is referenced. Credit is extended for the use of other unpublished information by inserting "(unpublished information)" at the appropriate place in the report text. Note that references for personal communications and unpublished information are not included in the reference list at the end of the report.

References for illustrations: If an illustration from another publication is used in a UGS report, it must be properly referenced. The reference is incorporated in the caption (see below). If the borrowed material is used in its original form, the reference is preceded by the word "from."

> **Figure 4.** Plot of maximum scarp angle versus log of scarp height for selected scarps in the Cedar City quadrangle (from Anderson and Christenson, 1989).

If the illustration is somewhat modified from the original (15% maximum), the reference is preceded by the word "after."

> **Figure 9.** Gold anomaly map for Bullion Canyon and adjacent area (after Shubat and McIntosh, 1988).

When an illustration is extensively modified (more than 15%), the reference is preceded by the words “modified from.”

Figure 20. Geologic map of the Goslin Mountain landslide (modified from Hansen, 1961).

Illustration references are included in the reference list at the end of the report. If the borrowed illustration is from a copyrighted publication, the author must obtain written permission for its use and credit the permission in the Acknowledgments section or, at the publisher’s request, at some other location in the report (usually in the illustration caption or title; see Copyrighted and Proprietary Material section).

The reference list: A complete list of references cited in the text appears in the report immediately after the Acknowledgments section or at the end of the report text if there are no acknowledgments. Personal communications, unpublished information, and reports “in preparation” normally are not placed in the reference list, but they may be included if the author believes there is a benefit in doing so. If only the references cited in the report are included in the list, the heading “References” is used. If the list is more extensive it is called a “Selected Bibliography,” or “Bibliography” if the list is exhaustive.

The general format for reference citations consists of the following:

1. Name of the author(s) or authoring organization.
2. Year of publication if known, or “undated” if unknown.
3. Document title.
4. Volume editor(s) (if applicable).
5. Title of volume in which document is included (if applicable).
6. Publisher.
7. Publication series (if applicable).
8. Pages (page range if reference is for a document within a larger volume, or total pages if reference is for a complete volume such as a book), or note “unpaginated” or “variously paginated” as appropriate.
9. Number of appendices and/or plates (optional; this may be useful in cases where a document contains many plates or voluminous appendices).
10. Map scale (if applicable).

A colon serves a structural purpose in the reference citations; it separates items 1 through 5 in the above list from items 6 through 10. Colons within report titles should be replaced with an em dash in the reference citation to avoid confusion with the colon that marks the end of the title (see Dashes section). Avoid using abbreviations in a reference list except for the following: (1) abbreviations or acronyms used in a title, (2) v., no., pt., and p., (3) Inc., (4) M.S. and Ph.D., (5) U.S. and D.C., and (6) [abs.].

References for electronic-media documents follow the same general format as for traditional documents. The citation should list the author(s) or organization; year of publication if known, or “undated” if unknown; title (or general description); publisher (if different from author/organization); publication series (if applicable); media type (online, compact disk, magnetic tape); protocol and address; and date accessed (if applicable). For some Web sites, much of this information may be unknown, and the reference may be treated in the same way as a personal communication by simply listing the site address in the text (refer to the discussion above on considering the appropriateness of using certain electronic-media documents as references).

List entries in alphabetical-chronologic order according to the senior (first) author’s last name. Entries having multiple authors include the names of all the authors. An exception to this guideline is when “and others” appears on the title page of the original document, rather than individual co-author names. Use initials for first and middle names. Multiple references having the same

first author but different second or third authors are listed alphabetically by the second, or if necessary, the third author's last name. For multiple references having the same senior author and either the same or different co-authors and published in the same year, append an "a," "b," "c," and so on to the date of the reference. Append the references sequentially according to their order in the reference list, not necessarily the order in which they appear in the text. In the past, multiple references having exactly the same authorship followed the convention of writing out the author name(s) in the first listing, and then using a dash to indicate the same authorship in the subsequent listings. Many publishers, including the UGS, no longer follow this convention (largely to facilitate reference-citation database searches); author names should be written out for each reference listing.

Examples of reference citations in a reference list: The following list gives examples of how different types of documents should be cited in the reference list of a UGS report. Consult Hansen (1991) if a reference does not follow one of these examples. Remember that some references, especially in the "gray literature," do not fit a "standard" format. In those cases, authors should do the best they can and remember that giving too much information is better than giving too little.

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Machette, M.N., Personius, S.F., and Nelson, A.R., 1986, Late Quaternary segmentation and slip rate history of the Wasatch fault zone [abs.]: EOS (Transactions of the American Geophysical Union), v. 7, no. 44, p. 1107.

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Jacoby, G.C., 2000, Dendrochronology, *in* Noller, J.S., Sowers, J.M., and Lettis, W.R., editors, Quaternary geochronology—methods and applications: Washington, D.C., American Geophysical Union, AGU Reference Shelf 4, p. 11–20.

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Martinsen, R.S., and Marrs, R.W., 1985, Comparison of major lineament trends to sedimentary rock thicknesses and facies distribution, Powder River Basin, Wyoming, *in* Cook, J.J., editor, Remote sensing for exploration geology, Proceedings of the International Symposium on Remote Sensing of Environments, Fourth Thematic Conference, San Francisco, California: Ann Arbor, Environmental Research Institute of Michigan, v. 1, p. 9–20.

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Woodward-Clyde Federal Services, 1996, Evaluation of potential seismic and salt dissolution hazards at the Atlas uranium mill tailings site, Moab, Utah: Oakland, California, unpublished consultant's report for Smith Environmental Technologies and Atlas Corporation, variously paginated, 3 appendices.

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Arabasz, W.J., Smith, R.B., and Richins, W.D., editors, 1979, Earthquake studies in Utah 1850 to 1978: Salt Lake City, University of Utah Seismograph Stations, Department of Geology and Geophysics, 552 p.

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Schweickert, N.L., Bogen, G.H., Girty, G.H., Hanson, R.E., and Merguerian, C., 1984, Timing and structural expression of the Nevadan orogeny, Sierra Nevada, California: Geological Society of America Bulletin, v. 95, no. 8, p. 967–979.

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Jackson, M.E., 1988, Thermoluminescence dating of Holocene paleoseismic events on the Nephi and Levan segments, Wasatch fault zone, Utah: Boulder, University of Colorado, M.S. thesis, 149 p.

Petersen, D., 1990, The structure and stratigraphy of the Hayes Canyon quadrangle, Utah: Provo, Utah, Brigham Young University, M.S. thesis, 49 p.

Petersen, J.F., 1981, Topographic profile analysis of piedmont scarps, northern Wasatch Front, Utah: Salt Lake City, University of Utah, Ph.D. dissertation, 125 p.

Glossary

A glossary of terms is necessary if a report contains a large number of technical words that are not familiar to the intended audience. The glossary comes after the References section. Entries in a glossary are arranged in alphabetical order, each on a separate line. A period is not required unless the definition consists of more than one complete sentence. The author may choose to bold the words in the text that appear in the glossary.

Appendix

An appendix provides a convenient place to present basic data, well logs, measured stratigraphic sections, foldout maps, source codes for computer programs, or other information that is too voluminous or cumbersome to include in the report text. Similarly, the author may wish to use an appendix to present the data on which the report's conclusions are based, realizing that only a few readers will be interested in all of the details. In reports intended for a general audience, an appendix is a good place for explanatory technical material that will help the nontechnical reader make the best possible use of the report.

Multiple appendices are designated sequentially by capital letters (appendix A, appendix B, etc.) for easy reference in the text. In draft documents appendices are paginated separately, and the page numbers are preceded by the letter of the alphabet that corresponds to each appendix (A-1, A-2, A-3, C-22, C-23, etc.).

Index

An index is seldom required for UGS reports. Indexing is an editorial function and is done from the final proof of the report text. Authors should consult with the publications manager if they wish a report to have an index.

Summary Paragraph for Reports Published on Compact Disk

Draft materials for a report to be published on compact disk (CD) should include a brief paragraph that describes the contents of the CD. The paragraph, which will typically appear on the back of the CD case, should include sufficient information to give a prospective user a good idea of the type of data the CD contains and how the data may be used. This information might address such things as whether the data represent original research or are compiled, types of data (e.g., maps, cross sections, well logs, core photos, databases, bibliographies), scale of digital map compilation, whether or not the CD includes spatial data/geographic information system files, and any other pertinent aspects of the CD that would help someone decide if the CD would be useful to them.

Illustrations

Illustrations supplement and enhance the text and are an important part of most UGS reports. They deserve particular care in their preparation and handling. Poorly prepared or ineffective illustrations can seriously reduce the utility and acceptance of good scientific research. Critically review illustrations of all kinds according to the following criteria:

- Do the proposed illustrations make a significant contribution to the report?

- Are the illustrations clear and complete? Can they stand alone without reference to the text or other illustrations?

- Are the illustrations "in phase" with the text, neither cluttered with unnecessary or redundant information, nor omitting important information (such as locations) referred to in the text?

Illustrations in UGS reports are either black-and-white line drawings, graphs, various types of color illustrations, or photographs. In printed reports, illustrations bound into the report (including 11 x 17-inch foldout pages) are referred to as "figures"; illustrations that require a separate sheet in a pocket at the end of the report are termed "plates." In digital reports, use the term "plate" to identify illustrations that require an oversize plotter (larger than 8-1/2 x 11-inch format) to print the illustration at a scale factor of 100%.

Properly reference illustrations borrowed from other sources that are used in UGS reports (see References for Illustrations section). Written permission is required for the use of copyrighted or proprietary material (see Copyrighted and Proprietary Material section).

In draft manuscripts, print illustrations separately (i.e., do not insert into the main text) and place them together at the end of the text. Also, create figure captions separate from the figures and list all the captions together at the end of the text. Make sure that all figures and their respective captions are clearly labeled with the appropriate figure number.

Line Drawings

Line drawings are illustrations without color or fine screens—technically, anything less than 40-line-per-inch screen or the equivalent dot pattern. Line drawings may be produced with pen and ink, scribing and photo transfer, or by one of several computer-assisted methods. Prepare line drawings with care since poor originals result in even poorer printed illustrations. Photographically reducing the image size sometimes can enhance illustrations of marginal quality. Nevertheless, authors should anticipate the final image size and produce an original that avoids unreadable lettering and the loss of fine distinctions between patterns when printed. If uncertain about the proper illustration size, authors should seek the publications manager's advice.

The following general rules apply to line drawings prepared for UGS reports:

- Oversize (larger than the report format, usually 8-1/2 x 11 inches) illustrations present a variety of production problems and increased publication costs. Authors should consult with the publications manager if oversize illustrations are planned for a report. Options include (1) one illustration covering two facing pages, (2) a one-page foldout plus the facing page, (3) two foldouts plus a facing page, (4) a separate plate placed in a pocket in the back of the report, or (5) publication in digital format.

- Figures should fit upright on a page wherever possible. Editorial staff will reduce or enlarge figures as necessary when preparing publications for printing. Authors having a preference for a particular figure size in the final report should consult with the publications manager early in the publication production process.

- Hand-drawn line drawings should be drafted in black ink on a good-quality medium such as bond, vellum, or Mylar®. Computer-generated line drawings should be printed on good-quality paper using a high-resolution printer; submit the digital file(s) to the publications manager for final production.

- Copies of original illustrations are acceptable only when the line quality of the copy is equal to that of the original.

- Make all lettering clear, precise, and consistent; unusual lettering styles are discouraged. Authors should use one lettering style for all illustrations whenever possible.

- Select patterns used on line drawings with care. Fine dot or line patterns are frequently lost or blurred when the size of an illustration is reduced.

- A bar scale must accompany all scaled drawings and maps. Numeric scales in figures are discouraged because the published figure size may be different from the original size.

- All maps require a north arrow and should include township and range or latitude and longitude border markings as appropriate.

- Illustrations drafted onto a pre-existing base map must give credit for the base.

Geologic quadrangle maps represent a special category of illustration published by the UGS. In addition to their large size, these maps are typically printed in color. Authors should consult UGS Circular 89, *Guide to Authors of Geologic Maps and Text Booklets of the Utah Geological Survey* (Doelling and Willis, 1995) for specific guidelines concerning the preparation of geologic quadrangle maps.

Graphs

A well-prepared graph can convey relationships and trends among numerical data more effectively than a written description alone. The most effective graphs are simple and uncluttered, and supplement the text by presenting information that is critical to the reader's understanding of the report. Authors are responsible for the final appearance of graphs; editorial staff will make little to no modification of graphs prior to publication. Figure 3 shows the difference between a poorly displayed and well-displayed graph, and figure 4 gives an example of an unnecessary graph.

The following general rules apply to graphs prepared for UGS reports:

- Keep graphs as simple as possible. For graphs constructed using spreadsheet software, this often involves overriding default settings that do not produce the best appearance for publications.

- Avoid use of grid lines, which typically add unnecessary clutter. However, authors may outline the graph with a box that coincides with the graph axes.

- Use of color in the plot area is acceptable only when the published version of the graph will be in color. When using color, make sure there is good contrast between the background and data so that the data can be seen clearly. For graphs that will be published in black-and-white, plot the data on a white background. When using spreadsheet software, this may require turning a default background color setting off.

- Avoid over-labeling axis tick marks. Label tick marks at regular intervals that are sufficient and necessary for a clear interpretation of the graph.

- Make the appearance of similar types of graphs uniform throughout the report.

Color Illustrations

Color illustrations require time-consuming and expensive methods of production and are more costly to print than line drawings. Any use of color in a UGS report requires pre-approval (preferably early in the planning stage of a project) by the publications manager and deputy director. This requirement applies to maps, figures, photographs, charts, or any other color work. Authors should seriously consider digital format when color illustrations are desired (see Digital Format section).

A

B

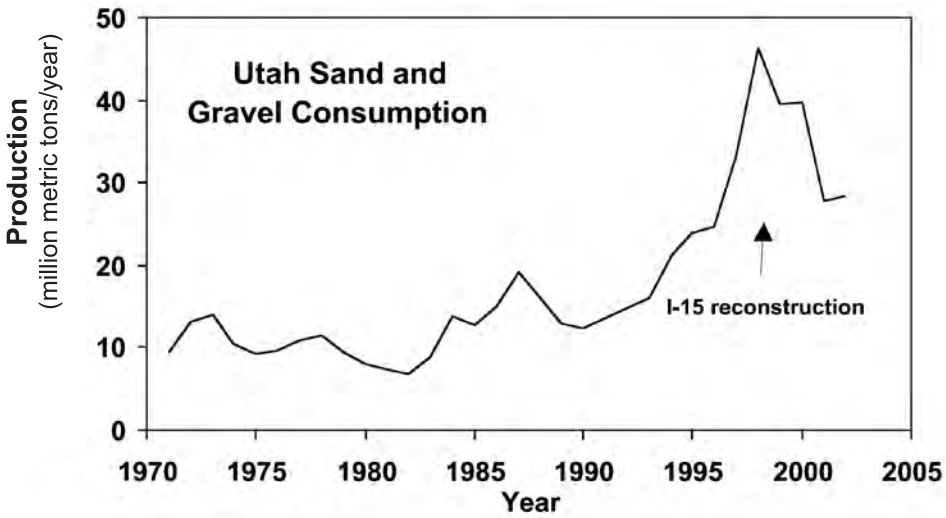

***Figure 3**. **A.** Poorly displayed graph. Grid lines and background shading are unnecessary, vertical axis is not scaled efficiently (total range and interval), and label fonts are too small. **B.** The same data in a well-displayed graph.*

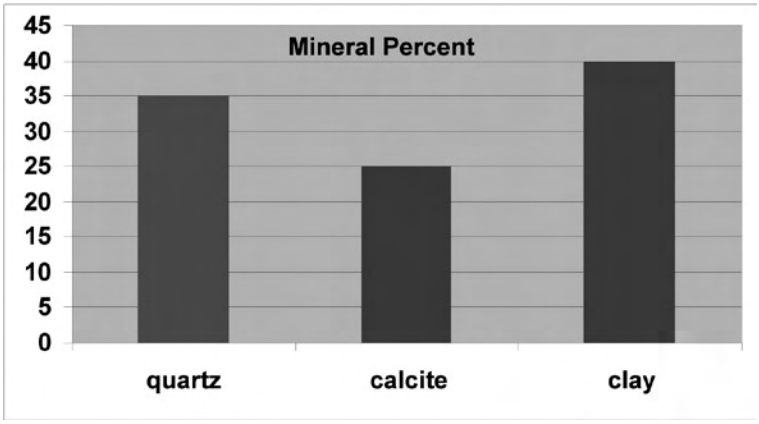

***Figure 4**. Example of an unnecessary graph. This graph could be replaced by the sentence, "The sample consists of 35% quartz, 25% calcite, and 40% clay."*

Photographs

Carefully selected photographs make excellent illustrations in geologic reports. A photograph often can show a particular feature or relationship more clearly than a line drawing (figure 5) or a text description. Photographs are considered figures and are numbered accordingly.

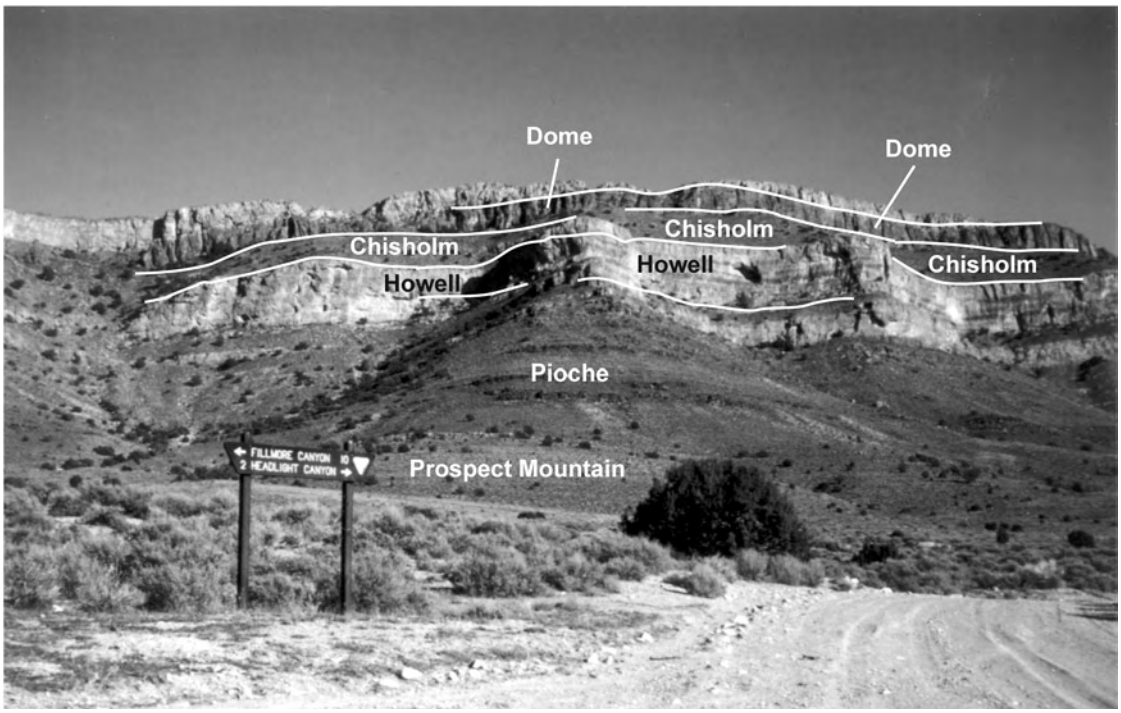

***Figure 5**. Effective use of a photograph as an illustration in a report. West side of Cricket Mountains near Petes Knoll. Prospect Mountain Quartzite is exposed at base of hill. Pioche Formation makes up dark, ledgy slope to base of light cliff, which is Howell Limestone. Slope above Howell is Chisholm Formation. Cliff on ridge on skyline is Dome Limestone. This sequence is exposed repeatedly in fault blocks in the Cricket Mountains. (Figure from Hintze and Davis, 2003.)*

Submit copies of photographic material (for example, photocopies, printed versions of scanned photographs, or printed versions of digital photographs) with draft manuscripts, making sure the elements of the photographs can be clearly distinguished. Do not include original photographic material (such as color or black-and-white prints, slides, or negatives) with a draft manuscript, as the material could become damaged or lost during the review process. Submit original photographic material, including digital files, to the publications manager upon request for the production phase of the publication process.

Sharp, well-focused photographs with proper contrast are vital for a good printed image. Framing your shot is vital as well; the object of interest should occupy more than three-fourths of the total image. Most photographs in geologic reports require a scale. Familiar objects of a recognizable size, a rock hammer or camera lens cap for instance, are commonly used, although for close-ups a small ruler or photo-scale card is useful. The scale can be included in the figure caption; for example, "Largest pebble is 2 inches (5 cm) across." Avoid numeric scales (photomicrograph X 2.5) unless you are sure the photograph will not be enlarged or reduced during the report preparation process. Eliminate the problem by drafting a bar scale on an overlay attached to the photograph. Crop or enlarge photographs to emphasize significant features. The author may indicate desired cropping of a photograph on an overlay, for cropping by the publications manager.

Handle photographs with care. Do not mount photographs on cardboard or other material, and avoid paper clips and staples. Never draw directly on photographs. Draft lines or symbols that are to appear on the photograph on a transparent overlay that is carefully registered to the photograph. Do not write on the back of photographs. Write the figure number, author's name, report title, and an up arrow if necessary on a piece of tape and attach to the back of the photograph. Instructions to the publications manager about desired final figure size, cropping, or other treatment should accompany the photographs on a separate sheet.

Captions and Titles

All illustrations require a caption (figure) or title (plate). Captions and titles should be clear and concise, expressing the content of the illustration and geographic location if a map. Readers can recognize the generic nature of illustrations, so avoid beginning a caption or title with "Photograph of" or "Map of." Typically the best captions and titles are short, but long captions and titles are acceptable when used to present various kinds of explanatory material. Authors must exercise judgment in determining if the explanatory material is more appropriately placed in a caption or title, or in the report text. Captions and titles should explain

the purpose of the figure or table, and should avoid referring the reader back to the text. Captions for photographs should note geologic features shown, the location of the area, and the direction of view. Credit is required for photographs taken by someone other than the author. When appropriate, the caption should reference the work or ideas of others (see References for Illustrations section). References cited in captions appear in the reference list at the end of the report.

Captions typically appear below figures and are typeset as part of the editorial process. They should not be part of the original figure except in Reports of Investigation, Open-File Reports, and Technical Reports. Make sure that all captions are clearly labeled with the correct figure number. Titles for plates are usually drafted directly on the illustration. Examples of well-prepared captions and titles follow:

Figure 1. Major physiographic subdivisions of Utah and location of the Beaver basin study area.

Figure 2. Schematic cross section through onlapping lacustrine deposits of the Bonneville basin: B, Bonneville Alloformation; CD, Cutler Dam Alloformation; LV, Little Valley Alloformation; F, Fielding Geosol; P, Promontory (Dimple Dell) Geosol. Query indicates that the lower altitudinal limit of the Promontory Geosol is unknown (modified from Oviatt and others, 1987, figure 2).

Figure 3. View to the north of the two main scarps at the East Ogden trench site taken by Gilbert (1928, plate 15 A; USGS Photographic Library Gilbert Archive no. 3,480) in 1901 from a position about 115 meters (375 ft) northwest of trench EO-5 (figure 6).

Figure 4. View southwestward from the south edge of Tooele, showing the Stockton bar in the middle distance and the B_5 shoreline angle and shore platform at the toe of the Oquirrh Mountains (to the left of what is now Utah Highway 36). The Stockton bar was the sediment sink for longshore transport of sediment sources that include the now scree-mantled quartzite cliffs in the left foreground and the arcuate bluff in highly erodible pre-Bonneville fan gravels in the left middle ground (photograph credit, Barnum Brown, 1934).

Plate 1. Mapped faults of the Antelope Range mining district, Utah.

Plate 2. Cross section along line B-B' of plate 1.

Tables

Tables present difficult-to-display information (usually numerical data) in an orderly and concise manner. A well-thought-out table can replace several paragraphs of text. Tables should contain only information that is essential to the reader's understanding of the report and should not be duplicated in the text. Background information of secondary importance that the author wishes to include in a report for completeness is best placed in an appendix. Simple tables are best. Complicated or long tables often are difficult to understand and may be ignored. Authors should consult Hansen (1991), which contains detailed instructions for preparing tables, when a complex table is necessary.

Editorial staff may modify the appearance of a table prior to publication, but the author is responsible for providing a complete and clearly presented draft copy. A table requires at least two columns and should fit upright on a single page wherever possible. Abbreviations may be used in tables to save space, but their meaning must be clear to the reader; use footnotes to explain potentially unfamiliar or obscure abbreviations (note that tables are the only place where footnotes are acceptable in UGS publications). Save additional space by placing units of measurement and orders of magnitude in column headings rather than carrying them through the table. Use the same primary system of measurement (English or SI) in both the text and tables. Do not leave blank spaces in a table. If no entry is made, use a line. If a test or measurement was made without result, enter "NR" and explain with a footnote. If no data are available, enter "ND" or "NA" and explain with a footnote. Use superscripted Arabic numerals ($^{1\,2\,3}$. . .) to indicate footnote reference numbers; footnote text appears at the bottom of the table. Tables 2 and 3 are examples of effective tables.

Table 2. *Example table—radiocarbon ages and thermoluminescence (TL) age estimates from the Mapleton North (MN) and Mapleton South (MS) trench sites (table from Lund and others, 1991).*

Trench	Field Sample Number	Laboratory Identification Numbers	Material Type and Geologic Unit	Radiocarbon age (^{14}C B.P.)	Calibrated[1] Charcoal and AMRT ages (1 σ error)[2]	TL age estimate	Remarks
MN-1	MN1-RC1	[3]Beta-21306	Charcoal from burn layer	445[4] (±70)	510[4] (+120, -190)	——	Post-MRE
MN-1	MN1-RC2	[5]Pitt-0188	Charcoal from burn layer	490 (± 65)	520 (+120, -60)	——	Post-MRE
MN-1	MN1-RC3	Pitt-0189	Charcoal from unit 4s soil	730 (± 40)	680 (+40, -20)	——	Pre-MRE
MN-2	MN2-RC1	Pitt-0191	Charcoal at unit 6/8 contact	330 (± 50)	430, 360, 330 (+70, -40)	——	Charcoal at same stratigraphic position as burn layer in trench MN-1.
MN-2	MN2-RC2	Beta-21733	Charcoal from unit 2s soil	770 (± 100)	690 (+230, -140)	——	2s soil in trench MN-2 correlates with 4s soil in trench MN-1.
MN-2	MN2-RC3	Pitt-1092	Charcoal from unit 11A	850 (± 35)	740 (+160, -50)	——	Detrital charcoal stratigraphically out of place.
MS-1	MS-RC1	Beta-23528 ETH-3544	Charcoal from unit 4F	1350 (± 100)	1290 (+130, -230)	——	Accelerator Mass Spectrometry (AMS) date.
MS-1	MS-RC2	Beta-23527 ETH-3543	Charcoal from unit 2s soil	2810 (± 95)	2930, 2900, 2890 (+280, -130)	——	AMS date
MS-1	MS-AMRT1	Beta-26117 GRL-787-0	Organics from unit 2s soil	2890 (± 80)	2820 (+150, -130)	——	200 years subtracted from radiocarbon age prior to calendar calibration to account for mean residence time of buried soil.
MS-1	MS-TL1	[6]ITL-70	Unit 2s soil	——	——	3300 (± 300)	Collected at same location as sample MS-AMRT 1

[1]Calibration procedure after Stuiver and Reimer (1986); CALIB & DISPLAY software distributed by Quaternary Isotope Laboratory, Quaternary Research Center, University of Washington.
[2]Radiocarbon age calibrated with CALIB software: 20-year atmospheric record, lab error multiplier of 2, method A used to calculate intercepts and age range, age span of 0 except for MS-AMRT1 for which an age span of 250 years was assigned to the organic soil fraction. See text for a discussion of AMRT-dating considerations. All calendar-corrected dates rounded to the nearest decade.
[3]Beta Analytic Inc., Coral Gables, FL 33124.
[4]All radiocarbon ages are reported in years before present (yr B.P.); by convention, present is considered A.D. 1950.
[5]University of Pittsburgh, Applied Research Center Radiocarbon Laboratory, Pittsburgh, PA 15238.
[6]University of Colorado, Center for Geochronological Research, Boulder, CO 80309.

Table 3. *Example table—drill-hole oil-shale intercepts and average yield in T. 12 S., R. 18 E., Carbon and Uintah Counties, Utah (from Trudell and others, 1982). Includes data for both Mahogany (M) zone and richer central part (R) of Mahogany zone (table from Gloyn and others, 2003).*

Hole (no.)	**Location** (sec.)	**Depth to Top** (ft)	**Depth to Bottom** (ft)	**Thickness** (ft)	**Avg. Yield** (gal/ton.)	**In-Place Resource per Acre** (bbls)
38M	NENW sec 2	64.0	154.4[B]	90.4[P]	14.13	98,970
38R		107.9	147.9	40.0	21.82	63,940
39M	SWNW sec 4	54.8[T]	181.5[B]	126.7[PG]	10.35	104,700
39R		115.5	156.3	40.8	18.50	56,600
40M	NWNW sec 13	57.6	173.2[B]	115.6[P]	10.85	99,690
40R		106.3	150.2	43.9	17.02	56,660
41M	NWSE sec 26	30.9	166.6[B]	135.7[PG]	9.34	102,000
41R		68.3	143.6	75.4[G]	10.67	63,970

[T] = Top of assayed core samples
[P] = Unit only partially represented because core starts/ends within unit
[B] = Bottom of assayed core sample
[G] = Unit interrrupted by gap of 25 feet or more yielding <5 gal/ton

Tables are numbered sequentially in the order of their appearance in the report. Unlike figures, table captions precede the body of the table. Generate tables and their captions separate from the main text file, and in draft manuscripts print each table and its associated caption separately (i.e., not inserted into the main text) and place all tables together at the end of the text.

Equations and Formulas

Type mathematical equations and chemical formulas in the line of text wherever possible, especially if they are short and contain no special symbols (for example, $FeCO_3$, y = 5.7x + 15, or pH + pOH = 14). Set complex equations or formulas and those that require more than one line out of the text as follows:

$$g_{fa} = g_o - g_t + (\delta g/\delta z)h \qquad (1)$$

where:

g_{fa} =	the free-air anomaly (in milligals).
g_o =	observed gravity (in milligals).
g_t =	theoretical gravity at the surface of the referenced ellipsoid (in milligals).
$(\delta g/\delta z)$ =	0.3086 mGal/m (average vertical gravity gradient per meter of elevation above sea level).
h =	station altitude above sea level (in meters).

Center equations or formulas that are set out of the text. Number these equations or formulas in the order in which they appear in the text for easy reference by the author and ease of understanding by the reader. Place the equation number in parentheses at the right margin.

Rules for formulas and equations in the report text are as follows:

- A space precedes and follows plus, minus, multiplication, greater than, less than, and equal signs. The slash symbol (/), when used to indicate division, is not set off with spaces.
- Use fractional exponents ($5^{1/2}$), not square roots.

THE MANUSCRIPT

Manuscript Preparation

The author must prepare a properly formatted manuscript before submitting a report to the program manager for formal review. A complete manuscript is one that is well organized, legible, includes copies of all illustrations and tables, and incorporates the elements of UGS editorial style. Manuscripts submitted to the program manager for formal review must include a UGS Document Review and Approval Sheet (appendix A).

Page Format

The following rules apply to UGS manuscripts submitted for review:

1. Print hard copy of the manuscript double-spaced. The double-spacing requirement applies to all text without exception, including the title page, abstract, captions, quoted matter, and references.

2. For the main body of text, use 12-point type and avoid condensed-face type styles.

3. Leave margins of at least 1 inch on both sides and at the top and bottom of each page.

4. Indent the first line of each paragraph one-half inch, and leave a blank line between paragraphs. Within paragraphs, use a single space between a period and the sentence that follows.

5. Do not right-justify the text; doing so makes it difficult to identify missing or extra spaces in a line of text.

6. Do not break words at the end of the line; during typesetting the hyphen might be mistaken for part of the spelling.

7. Place page numbers at the bottom center of each page beginning with the abstract.

8. Figures and tables in the report text are numbered consecutively; plates at the back of a report are also numbered consecutively but independently of the figures in the text. Figures and tables in appendices are also numbered consecutively and independently of those in the text; appendix figure and table numbers are preceded by the letter corresponding to the appendix (e.g., figures A1, A2, and A3 in appendix A).

9. Print tables separately and place them together at the end of the text. Although not required, it is helpful to editorial staff for the author to insert "table x near here" at the appropriate place in the text.

10. Do not embed illustrations into the text file. Editorial staff cannot work with illustrations that have been inserted into digital files created by word-processing software, and page formatting will have to be redone. Print illustrations separately (with captions in a separate text file) and place them together at the end of the text. Although not required, it is helpful to editorial staff for the author to insert "figure x near here" at the appropriate place in the text.

Section Headings

For most reports, no more than four levels of section headings are necessary. If more than four levels are needed, consider reorganizing the report. Headings should conform to the following formats:

EXAMPLE OF FIRST-LEVEL HEADING

First-level headings are main section titles. Headings such as ABSTRACT, INTRODUCTION, STUDY METHODS, and REFERENCES are in this group. First-level headings are separated from preceding text by two blank lines, and from subsequent text by one blank line. Center first-level headings and type in bold, all uppercase letters.

Example of Second-Level Heading

Second-level headings are subdivisions of each major section. Subdivision of a main section requires at least two second-level headings. Single blank lines separate second-level headings from previous and subsequent text. Center second-level headings and type in bold upper- and lowercase letters.

Example of Third-Level Heading

Third-level headings are subdivisions of second-level headings. At least two third-level headings are required if a second-level heading is subdivided. Single blank lines separate third-level headings from previous and subsequent text. Left-justify third-level headings and type in bold upper- and lowercase letters.

Example of fourth-level heading: Fourth-level headings are usually the smallest division in a report. They subdivide third-level headings into two or more parts. Left-justify fourth-level headings and capitalize only the first letter of the heading (plus proper names); the heading is bold and ends in a colon. The text continues one space after the colon.

Pagination

Draft manuscripts are paginated consecutively at the center bottom of each page beginning with the abstract. If the report includes a glossary or a single appendix, they are paginated consecutively with the report text. If the report contains more than one appendix, each appendix is assigned a letter designation (appendix A, appendix B, etc.) and is paginated separately. Page numbers within appendices are preceded by the letter of the alphabet that corresponds to each appendix (A-1, A-2, A-3, B-10, B-11, C-22, C-23). The publications manager assigns final page numbers during the publication production process.

Manuscript Submittal for Review

A typical manuscript for a UGS report is created on a personal computer using word-processing, and perhaps graphics and spreadsheet, software. For reports that will be published in printed form, the draft manuscript submitted for review must be a paper (hard) copy. Following manuscript approval, the author submits both a hard copy and the digital file(s) to the publications manager. For reports that will be published digitally (e.g., on compact disk), the author may either submit both digital and hard copy for review, or submit hard copy only; one or the other may be preferable depending on the nature of the document. Authors requiring assistance with file format conversion or any other aspects of digital document production should consult with UGS data-processing personnel or the publications manager. Graphics files must be compatible with current UGS graphics software. Check with the publications manager for current software specifications.

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MATTERS OF STYLE

Abbreviations, Acronyms, and Symbols

Abbreviations, acronyms, and symbols constitute a form of shorthand used in scientific writing to avoid repetition of long, awkward, or frequently used words and phrases. They are particularly useful in illustrations and tables where space is limited. Abbreviations, acronyms, and symbols standardized through common use need not be defined when used—for example, *a.m.* for *ante meridiem*, *radar* for *ra*dio *d*etecting *a*nd *r*anging, and *$* for *dollars*. Place less well known abbreviations and acronyms, and those that are unique to a report, in parentheses following the spelled-out form the first time they are used—for example, *net vertical tectonic displacement (NVTD)* the first time, and *NVTD* thereafter. In a lengthy document where an abbreviation or acronym is used early in the text and then not again until near the end of the text, give the spelled-out form again as a convenience to the reader.

Avoid a proliferation of ad-hoc abbreviations that may not be intuitively familiar to the target audience. Use of abbreviations should be determined largely by custom and convenience to the reader.

Appendix D is a compilation of abbreviations used in UGS reports. Lists of abbreviations are also available in Hansen (1991), *U.S. Government Printing Office Style Manual*, *The Chicago Manual of Style* (14th edition), and *Webster's Third New International Dictionary*.

General Rules

Rules for the use of abbreviations, acronyms, and symbols in UGS publications include the following:

- Be consistent in the use of abbreviations, acronyms, and symbols throughout the document.
- Spell out symbols and figures that begin sentences, or recast the sentence.
- Use a single period when an abbreviation ends a sentence. If the sentence ends with a question mark or an exclamation point, place them after the period used with the abbreviation. The same rule applies to colons, semicolons, and commas within a sentence.
- Do not abbreviate the names of months and days in the report text. Their abbreviation is acceptable in illustrations and tables to save space.
- Do not abbreviate geographic names (for example, Great Salt Lake, not GSL; Uinta Basin, not UB). Abbreviating cumbersome geologic names that appear numerous times throughout the text is acceptable (for example, FSLC for Farmington Siding landslide complex; WVFZ for West Valley fault zone).
- Eliminate periods after abbreviations except where required by convention (see appendix D). Spaces are not needed between joined abbreviations (U.S. Geological Survey; Washington, D.C.).
- Do not use two-letter postal-service abbreviations (for example, UT) in the report text to abbreviate state names (see appendix D). Postal-service abbreviations are acceptable where used with a correspondence address.
- In isotope abbreviations, the mass number is shown as a superscript and precedes the element with no space between (^{14}C).
- Avoid using abbreviations in a reference list except for the following: (1) abbreviations or acronyms used in a title, (2) v., no., pt., and p., (3) Inc., (4) M.S. and Ph.D., (5) U.S. and D.C., and (6) [abs.].

- When in doubt, spell it out. This particularly applies to reports written for a nontechnical audience, who may find certain abbreviations or symbols cryptic.

Degree Mark

The degree mark (°) is used with numerals in statements of temperature, strike, dip, slope inclination, bearing, azimuth, latitude, and longitude. No spacing is used with the degree mark when reporting temperature. Do not use a degree mark when reporting Kelvin temperature. A space follows the degree mark in terms of direction.

32°F equates to 0°C and 273.15 K
strike N. 66° E., dip 46° SE.
a bearing of S. 35° W. equates to an azimuth of 215°
latitude 40°45'15" N. or 40°45.25' N.
longitude 112°33'30" W. or 112°33.5' W.
the ground surface slopes 33° to the north
a right angle equates to 90°

Land Tract Designations

Report descriptions of tracts of public land as follows:

NW1/4SE1/4 section 16, T. 17 N., R. 11 W., Salt Lake Base Line and Meridian
sections 12 and 16, T. 42 S., R. 3 E., Uinta Base Line and Meridian

Latin Abbreviations

In general, the use of Latin abbreviations is discouraged in UGS reports; the written-out English equivalent is preferred, especially in reports written for a nontechnical audience. However, the following relatively common Latin abbreviations may be used in UGS reports:

Latin Abbreviation		English Equivalent
ca.	*circa*	about
e.g.	*exempli gratia*	for example
etc.	*et cetera*	and so forth
i.e.	*id est*	that is

Note that "for example" and "that is" are transitional expressions; a comma should follow the Latin abbreviations for these phrases.

The sequence shows evidence of sediment deposition in a variety of environments (e.g., lagoon, tidal flat, beach).

The Latin abbreviation *et al.* (*et alia*; "and others") may not be used in reference citations; UGS reference style follows that of the U.S. Geological Survey in writing out "and others" in reference citations in the text (see References section).

Lithologic and Time-Stratigraphic Terms

Do not abbreviate lithologic and time-stratigraphic terms in the report text. Abbreviations are acceptable in illustrations and tables where necessary to save space. Capitalize lithologic abbreviations when they follow a formal rock-unit name (e.g., Navajo Ss.). When used informally to refer to a general rock type, the lithologic abbreviation is lowercase (sandstone, ss.). Always capitalize time-stratigraphic abbreviations. Table 4 summarizes abbreviations used for lithologic and time-stratigraphic terms, and symbols are shown on figure 6.

Table 4. *Abbreviations used for lithologic and time-stratigraphic terms in draft documents.*

Term/Lithology	Abbreviation		System/Period, Era/Erathem	Abbreviation
	Formal	Informal		
Group	Gp.	-	Quaternary	Quat.
Formation	Fm.	-	Tertiary	Tert.
Member	Mbr.	mbr.	Cretaceous	Cret.
Claystone	Clyst.	clyst.	Jurassic	Jur.
Conglomerate	Cgl.	cgl.	Triassic	Tri.
Dolomite	Dol.	dol.	Permian	Perm.
Gneiss	Gn.	gn.	Pennsylvanian	Penn.
Granite	Gr.	gr.	Mississippian	Miss.
Limestone	Ls.	ls.	Devonian	Dev.
Mudstone	Mdst.	mdst.	Silurian	Sil.
Quartzite	Qzt.	qzt.	Ordovician	Ord.
Rhyolite	Rhy.	rhy.	Cambrian	Camb.
Sandstone	Ss.	ss.	Cenozoic	Cen.
Shale	Sh.	sh.	Mesozoic	Mes.
Siltstone	Slts.	slts.	Paleozoic	Pal.
Volcanics	Volc.	volc.	Neoproterozoic	Neoprot.
			Mesoproterozoic	Mesoprot.
			Paleoproterozoic	Paleoprot.
			Neoarchean	Neoarch.
			Mesoarchean	Mesoarch.
			Paleoarchean	Paleoarch.

Number

The abbreviations "no." and "No." for number often lead to confusion. The lowercase *no.* refers to serial numbers (no. 14558-789-D) and the number in a publication citation (v. 6, no. 12). The uppercase *No.* identifies individual data points in a series or collection (specimen No. 567).

Percent Symbol

Use of the percent symbol (%) is acceptable in technical documents and reports. For documents and reports written for a nontechnical audience (e.g., *Survey Notes* articles), "percent" should be written out in the text, but the symbol may be used in illustrations and tables.

Time

Age estimates: As set forth in the *North American Stratigraphic Code*, the abbreviations *ka* for *kilo-annum* (thousand years), *Ma* for *mega-annum* (million years), and *Ga* for *giga-annum* (billion years) are reserved for reporting geologic ages. Time measured from the present is implicit in ka, Ma, and Ga; therefore, neither "before present" nor "ago" is added to these abbreviations (Colman and others, 1987). Use *^{14}C yr B.P.* to indicate uncalibrated radiocarbon ages (radiocarbon years before present, where present is taken to be A.D. 1950). Calendar-calibrated radiocarbon ages are reported as *cal yr B.P.* (calendar years before present).

> An ^{40}Ar/^{39}Ar age of 986 ka and a K-Ar age of 1.22 Ma identify the age of the tuff as early Pleistocene, and nearly 10 million years younger than previously suspected.
>
> The radiocarbon age of 3650 ± 70 ^{14}C yr B.P. (4400–3600 cal yr B.P.) obtained from the buried A horizon corresponds well with the thermoluminescence age of 4200 ± 400 yr obtained from the loess unit.

Geologic time: The abbreviations "kyr" for thousands of years and "myr" for millions of years are acceptable in illustrations, tables, and where space is otherwise limited. Avoid using abbreviations for intervals of geologic time in the report text.

> The beginning and the end of the Cretaceous Period are calibrated at 145.5 Ma and 65.5 Ma, respectively (Gradstein and others, 2004); the interval of time represented by the Cretaceous is 80 million years.

The phrase "years B.P." (not *yr B.P.*) may be used to indicate an interval of time extending from the present into the past.

> The data indicate a period of seismotectonic quiescence since about 3500 years B.P.

Calendar dates: The two epochs of the Gregorian calendar are abbreviated "A.D." for "anno Domini" (in the year of our Lord), and "B.C." (before Christ). Note the order in which the abbreviations are used:

> 621 B.C. A.D. 1950

Use numerals for all dates.

> January 1994
> May 18, 1980
> 2 September 1992
> the 12th of March, 1934
> April 17, 1983, to August 26, 1995

Capitalization

Rules governing capitalization are numerous and subject to many exceptions. The following rules are those commonly applied in UGS reports.

- Capitalize the first letter of the first word of sentences.

- Capitalize the first letter of all proper names. Do not capitalize conjunctions, short prepositions, and articles (for example, *a, an, and, of,* and *the*) in long proper names unless they are the first word in the name. Personal titles are capitalized only when they appear before a proper name.

  > UGS Director Richard G. Allis
  > Rick Allis is director of the Utah Geological Survey
  > Marriott Library
  > Rich County
  > Daggett and Uintah Counties
  > Weber and Provo Rivers
  > Utah Geological Association
  > Department of Natural Resources

- Capitalize all important words in the titles of books, articles, and reports that appear in the report text (for example, *Geologic History of Utah* by Lehi F. Hintze). Note that titles in a reference list are an exception (see The Reference List section and Hansen [1991, p. 239]).

- Capitalize hyphenated words in titles and headings except for conjunctions, short prepositions, and articles unless they appear as the first word.

  > Open-File Report 88-546
  > Long-Term Slip Rates
  > State-of-the-Art Geophysical Techniques

EONOTHEM/EON	ERATHEM/ERA	SYSTEM/PERIOD, SUBSYSTEM/SUBPERIOD		SERIES/EPOCH	STAGE/AGE[1]	BOUNDARY AGE[2] (Ma)	INFORMAL SUBDIVISION[3]
Phanerozoic	Cenozoic (Cz)	Quaternary (Q)		Holocene		0.0118	
				Pleistocene[4]	upper/late	0.126	
					middle	0.781	
					lower/early	1.806	
		Tertiary[5] (T)	Neogene	Pliocene	Gelasian		upper/late
					Piacenzian	3.600	
					Zanclean	5.332	lower/early
				Miocene	Messinian		upper/late
					Tortonian	11.608	
					Serravallian		middle
					Langhian	15.97	
					Burdigalian		lower/early
					Aquitanian	23.03	
			Paleogene	Oligocene	Chattian	28.4 ± 0.1	upper/late
					Rupelian	33.9 ± 0.1	lower/early
				Eocene	Priabonian	37.2 ± 0.1	upper/late
					Bartonian		middle
					Lutetian	48.6 ± 0.2	
					Ypresian	55.8 ± 0.2	lower/early
				Paleocene	Thanetian		upper/late
					Selandian	61.7 ± 0.2	
					Danian	65.5 ± 0.3	lower/early
	Mesozoic (Mz)	Cretaceous (K)		Upper/Late	Maastrichtian Campanian Santonian Coniacian Turonian Cenomanian	99.6 ± 0.9	
				Lower/Early	Albian Aptian Barremian Hauterivian Valanginian Berriasian	145.5 ± 4.0	
		Jurassic (J)		Upper/Late	Tithonian Kimmeridgian Oxfordian	161.2 ± 4.0	
				Middle	Callovian Bathonian Bajocian Aalenian	175.6 ± 2.0	
				Lower/Early	Toarcian Pliensbachian Sinemurian Hettangian	199.6 ± 0.6	
		Triassic (TR)		Upper/Late	Rhaetian Norian Carnian	228.0 ± 2.0	
				Middle	Ladinian Anisian	245.0 ± 1.5	
				Lower/Early	Olenekian Induan	251.0 ± 0.4	
	Paleozoic (Pz)	Permian (P)		Upper/Late	Ochoan	260.4 ± 0.7	
				Middle	Guadalupian	270.6 ± 0.7	
				Lower/Early	Leonardian Wolfcampian	299.0 ± 0.8	
		Carboniferous	Pennsylvanian (IP)	Upper/Late	Virgilian Missourian	306.5 ± 1.0	
				Middle	Desmoinesian Atokan	311.7 ± 1.1	
				Lower/Early	Morrowan	318.1 ± 1.3	
			Mississippian (M)	Upper/Late	Chesterian Meramecian	340*	
				Lower/Early	Osagean Kinderhookian	359.2 ± 2.5	
		Devonian (D)		Upper/Late	Famennian Frasnian	385.3 ± 2.6	
				Middle	Givetian Eifelian	397.5 ± 2.7	
				Lower/Early	Emsian Pragian Lochkovian	416.0 ± 2.8	
		Silurian (S)		Upper/Late	Pridolian Ludlovian	422.9 ± 2.5	
				Lower/Early	Wenlockian Llandoverian	443.7 ± 1.5	
		Ordovician (O)		Upper/Late	Ashgillian Caradocian	460.9 ± 1.6	
				Middle	Llandeilian Llanvirnian	471.8 ± 1.6	
				Lower/Early	Arenigian Tremadocian	488.3 ± 1.7	
		Cambrian (Є)		Upper/Late	Sunwaptan Steptoean		
				Middle	Marjuman Delamaran	501.0 ± 2.0 513.0 ± 2.0†	
				Lower/Early	Dyeran Montezuman undesignated	542.0 ± 1.0	
Precambrian[6] (pЄ)	Proterozoic (P)	Neoproterozoic (Z)				900	
		Mesoproterozoic (Y)				1600	
		Paleoproterozoic (X)				2500	
	Archean (A)	Neoarchean (W)				3000	
		Mesoarchean (V)				3400	
		Paleoarchean (U)				3800	
	Hadean (pA)						

Figure 6. *Geochronologic and chronostratigraphic units, boundary age estimates, and map symbols recommended for use in UGS publications (but see note 5 and figure 7 regarding Tertiary stages/ages).*

Notes to figure 6:

1. Names used in Utah by convention (but see note 5 for Tertiary stages/ages).
   Tertiary, Cretaceous, Jurassic, Triassic, and Devonian – from Palmer and Geissman (1991) and Gradstein and others (2004).
   Permian and Carboniferous – North American provincial series terms; refer to Hansen (1991) and references therein.
   Silurian, Ordovician, and Cambrian – from Palmer and Geissman (1999).
2. Except where otherwise indicated, boundary ages for subdivisions of the Phanerozoic are from Gradstein and others (2004). For boundary ages of individual stages/ages, refer to Gradstein and others (2004) and references therein.
   * Boundary age from Haq and Van Eysinga (1998).
   † Boundary age from Geologic Names Committee (2007).
3. Boundaries from Palmer and Geissman (1999).
4. In North America, Pleistocene stages/ages are informal by convention.
5. In Utah, North American land mammal ages are generally preferred as temporal subdivisions of the Tertiary epochs; see figure 7.
6. Boundary ages from Reed and others (1993) and Palmer and Geissman (1999). “Precambrian” = time term without specific rank.

- Capitalize political divisions when they follow a proper name and form a part of it. Political divisions are lowercase when they precede a proper name or refer to a general group. “State” is lowercase when it refers to a geographic area rather than a political (legislative) entity.

  State of Utah [government entity; . . . studies undertaken by the State of Utah . . .]
  state of Utah [geographic area; . . . largest lake in the state of Utah . . .]
  the State [governing body]
  the state [geographic area]
  State lands [designated lands administered by the State of Utah]
  Sandy City
  city of Sandy
  the federal government
  federal agencies
  federal and state employees

- The full names of legislative, administrative, and judicial bodies, departments, bureaus, and offices are capitalized. The nouns derived from them are capitalized when they pertain to a specific organization, but are lowercase when they refer to a general group.

  Utah Geological Survey
  the Survey [UGS]
  [Utah] State Legislature
  the several state legislatures
  Division of Water Resources
  Department of Natural Resources divisions

- Singular nouns used to replace proper nouns that are several words long (excluding names of legislative, administrative, and judicial organizations as discussed above) are not capitalized.

  Grand Staircase–Escalante National Monument [*but* “the monument”]
  Zion National Park [*but* “the park”]

- Capitalize the name of biological phylum, class, order, family, or genus, but not species, subspecies, or variety.

  Foraminifera
  Bathymyonia

Spiriferina (Punctospirifer) pulcher

See Hansen (1991, p. 100–103) for additional information regarding paleontologic terminology.

- Capitalize the names of geologic eras, periods, systems, series, epochs, and ages.

  Precambrian
  Triassic Period
  Ordovician System
  Eocene
  Late Jurassic Epoch
  Keweenawan Age
  Wisconsin Glaciation

- The geochronologic terms "early," "middle," and "late" and the chronostratigraphic terms "lower," "middle," and "upper" are capitalized when used as part of a formal geologic time or rock series name, but are lowercase when used informally (see Division of Geologic Time section).

- The names of formal lithostratigraphic units are proper nouns and are capitalized.

  Navajo Sandstone
  Morrison Formation
  Belt Supergroup
  Sinbad Limestone Member

- A sequence of three or more formation names, such as the Wingate Sandstone, Kayenta Formation, Navajo Sandstone, and Carmel Formation, may for convenience be written as the Wingate, Kayenta, Navajo, and Carmel Formations. Note that "Formations" is capitalized.

- Do not capitalize unit terms (lithology or formation) in the names of informal lithostratigraphic units.

  formation of Aurora
  Huckleberry Ridge ash bed
  Left Creek quartzite

- Proper geographic names are capitalized, but areas of indefinite extent are lowercase.

  Monument Valley
  Wasatch Range
  Oquirrh Mountains
  Great Salt Lake
  Salt Lake City area
  Great Basin
  Uinta Basin
  Bonneville basin

- By convention, *mining district, oil field, gas field, field, mine, smelter*, and other terms related to mineral or hydrocarbon extraction and processing are not capitalized when included as part of a proper name.

  City Creek mining district
  Grassy Trail Creek oil field
  Wasatch Plateau coalfield
  Bingham Canyon mine
  Black Rock smelter

- The terms "province" and "section" are generally considered common nouns, and as such are not capitalized. However, long usage when referring to particular physiographic regions has resulted in their being considered part of the proper name for those regions, and as such they are capitalized. Examples include:

  Basin and Range Province
  Lower California Province
  Blue Mountain Section
  but
  Colorado Plateau province
  Great Plains province
  Middle Rocky Mountains section

  Hansen (1991, p. 88) presents additional information on this topic.

- Structural geologic terms such as caldera, anticline, syncline, fault, arch, and so on are not capitalized when included as part of a geologic name.

  White Springs caldera
  Sulphur Creek anticline
  Wasatch fault zone
  Oquirrh basin [a geologic feature]

  Note that some geologic names are used interchangeably with a geographic area whose name has been codified; both are now capitalized by convention. Refer to the U.S. Geological Survey (1988) 1:500,000-scale *State of Utah* topographic map to determine which geologic terms fall into this category. Examples include:

  San Rafael Swell
  Upheaval Dome
  Waterpocket Fold

- "Quadrangle" is not capitalized when used as part of a proper name (for instance, the Park City East quadrangle), but is capitalized when citing a USGS geologic quadrangle map (a publishing series)—USGS Quadrangle Map GQ-126.

- Do not capitalize the words "figure," "table," and "appendix" when they are used in the report text unless they appear as the first word in a sentence.

Divisions of Geologic Time

The major divisions of geologic time (eons, eras, and periods) have been established through long use and careful study. Nevertheless, details of the geologic time scale continue to be debated and refined as more data are collected, and differences in ages of the boundaries between some time divisions exist on contemporaneous time scales (compare, for example, Palmer, 1983; Snelling, 1985; Hansen, 1991; Palmer and Geissman, 1999; Gradstein and others, 2004; Geologic Names Committee, 2007). Figure 6 summarizes boundary age estimates, nomenclature, and map symbols recommended for use in UGS publications, and figure 7 summarizes North American land mammal age (LMA) subdivisions of the Tertiary Period.

A clear distinction exists between divisions of geologic time (geochronologic divisions) and divisions of stratigraphic position (chronostratigraphic divisions). "Early," "Middle," and "Late" denote relative position in time, whereas the terms "Lower," "Middle," and "Upper" denote similar distinctions of stratigraphic position (see discussion in Owen, 1987 [online at www.agiweb.org/nacsn/JSP_commentary.htm]). As indicated on figure 6, these terms are capitalized when used in a formal sense (Mesozoic

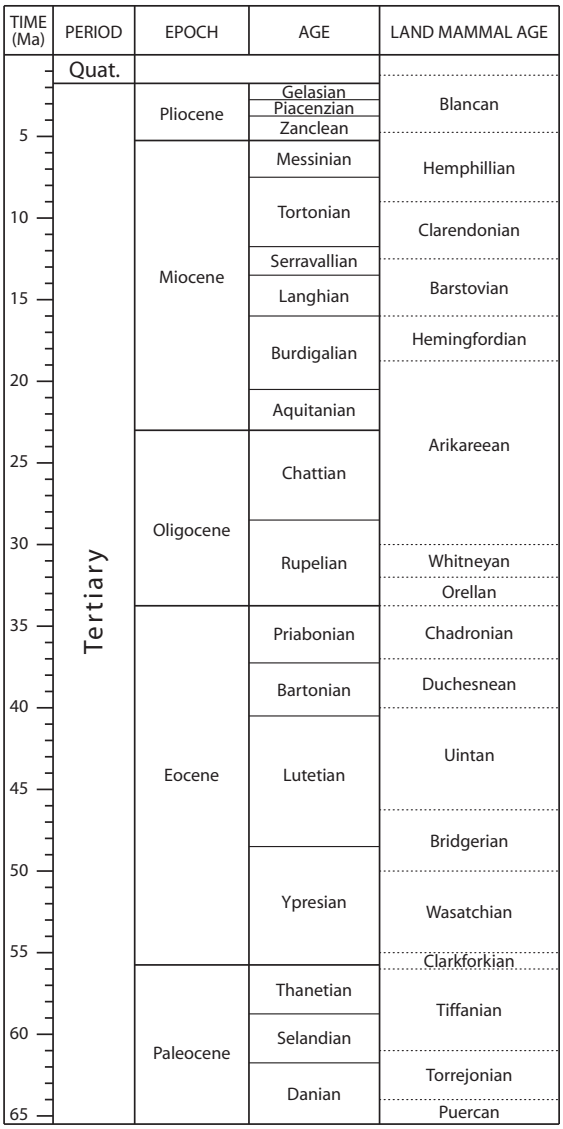

Figure 7. *Geologic time scale for the Tertiary Period. European age terms and boundary ages from Gradstein and others (2004). In Utah, North American land mammal ages (LMAs) are generally preferable to the European ages; refer to Woodburne (2004) and references therein for LMA age boundaries and uncertainties.*

and Paleozoic series/epochs; e.g., Upper Triassic, Early Pennsylvanian) and are not capitalized when used in an informal sense (subdivisions of Tertiary series/epochs; e.g., early Miocene, upper Eocene). Note that these terms are informal when used with *Quaternary*, *Tertiary*, *Cenozoic*, *Mesozoic*, and *Paleozoic*, and thus are not capitalized (e.g., early Tertiary, upper Paleozoic). Finally, following the convention of Reed and others (1993), the subdivisions of the Proterozoic and Archean eras shown on figure 6 are geochronologic units and have no corresponding chronostratigraphic units (i.e., erathems)—for example, "Neoproterozoic" has no "Upper Proterozoic" counterpart.

Geographic Names

Currently accepted formal geographic names are listed in the USGS Geographic Names Information System (GNIS) computer database (online at geonames.usgs.gov). Formal names proposed for geographic (geomorphic) features must comply with naming requirements established by the U.S. Board on Geographic Names. Authors proposing new formal geographic names in UGS reports should consult with the publications manager, who is the UGS representative on the Utah State Committee on Geographic Names (an affiliate of the U.S. Board of Geographic Names). Authors should clearly identify all informal geographic names used in UGS reports.

Geologic Map-Unit Descriptions

Geologic maps typically require a stratigraphically ordered list of descriptions of bedrock units and unconsolidated deposits, and other geologic reports may include similar information in an appendix. Although the content of these types of descriptions may vary considerably, a few general guidelines and examples are given below to help in making the format of these descriptions relatively uniform. Note that this discussion applies to geologic quadrangle maps and similar maps where the geologic mapping itself is the focus of the document, as opposed to geologic maps used as figures in a report.

Every unit shown on a geologic map and cross section needs a written description. The description should include sufficient information on the unit's essential attributes to allow recognition in the field. The essential attributes may vary depending on the nature of the unit and the quality and accessibility of exposures, but generally will include age, lithology, mineralogy, color, texture, cementation, bedding and outcrop characteristics, fossil content, and thickness. To aid the reader, these attributes should be described in approximately the same order for each unit.

Sentence Structure

Geologists often write map-unit descriptions as grammatically abbreviated phrases rather than complete sentences. Although acceptable, this can result in unwieldy sequences of text, especially if the description is relatively long and involved. Numerous incomplete phrases strung together by commas and semicolons can be difficult for the reader to negotiate. Descriptions should be written as complete sentences if doing so adds clarity, particularly when the description includes comments on the unit's geologic history, and when the unit consists of two or more subunits described separately.

Even if the description consists of incomplete phrases, it is acceptable to separate phrases that differ significantly in content with periods. For example:

> Lower red member—Slope-forming, red siltstone and fine-grained arkosic sandstone, commonly cross-bedded, coarsening upward; upper contact unconformable. About 50–75 m thick, thickening westward. Depositional environment: very shallow, low-energy marine to deltaic.

Conversely, do not use less emphatic (internal) punctuation marks such as commas and semicolons to separate complete sentences. For example:

> Conglomerate member—Gray, cobble to boulder conglomerate; lithic clasts dominantly Paleozoic carbonate; bedding chaotic to crudely stratified. The member is a basal rift-basin deposit unconformably overlying carbonate marine strata.

Compound Modifiers

Compound modifiers (adjectives) consist of two or more words or numbers that combine to describe a noun. The words forming the compound modifier are usually, but not always, connected by hyphens. General guidelines for hyphen use are given in the Punctuation, Hyphens section. Geologic map-unit descriptions, however, are often replete with compound modifiers, and the vagaries of hyphenation rules can be a source of confusion and frustration for writers and editors. A few rules are reiterated here along with numerous examples specific to map-unit descriptions to promote consistency.

Use a hyphen to connect words used as a compound modifier preceding the word being modified.

> Kirkman Limestone—Light-gray, thick- to medium-bedded, fine-grained dolomitic limestone; contains dark-gray, gray-weathering intraformational breccia.

> Kaibab Formation—Gray to yellowish-gray, slope- and ledge-forming, coral- and crinoid-bearing limestone in upper part. Underlain by cliff-forming, medium- to coarse-grained sandstone.

Olivine basalt—Dark-gray, dense to vesicular basalt; calcite-filled vesicles contain ½-inch crystals.

Exception 1: Do not use a hyphen if the first word in the compound modifier is an adverb ending in "ly."

Colluvium—Poorly to moderately sorted, clay- to boulder-sized, locally derived material on gently sloping surfaces.

Ankareh Formation—Thinly laminated, moderately indurated, greenish-gray, poorly exposed sandstone.

Exception 2: Do not use a hyphen if the first word in a three-word unit modifier is an adverb that describes the second word.

Kirkman Limestone—Very light gray to very dark gray dolomitic limestone.

North Horn Formation—Light-gray, thick- to very thick bedded sandstone and conglomerate.

Note that neither exception 1 or 2 automatically applies when a compound modifier is preceded by an adverb such as "mainly," "mostly," "dominantly," "rarely," or similar adverb of degree.

Straight Cliffs Formation—Dominantly cliff-forming, fine- to medium-grained sandstone.

Here, "dominantly" is not a part of the compound modifier, nor does it modify "cliff," "fine," or "medium." However, if an adverb of degree precedes a compound modifier that would otherwise not be hyphenated, hyphens should be omitted.

Straight Cliffs Formation—Dominantly cliff-forming, very fine grained, moderately indurated sandstone.

Do not use a hyphen if the compound modifier follows the noun being modified, unless the modifier is one that is always hyphenated by convention (see appendix E and the AGI *Glossary of Geology* [fifth edition] for examples).

Colton Formation—Interbedded calcareous sandstone and limestone. Sandstone is medium to coarse grained, thin bedded, and cross-bedded. Light-gray limestone is fine grained and thin bedded, with fossil-rich subunits.

Geologic Names

Geologic names are assigned to formal and informal lithostratigraphic units and structural features. Rules applying to the use of geologic names are summarized below. The *North American Stratigraphic Code* (North American Commission on Stratigraphic Nomenclature, 2005; online at ngmdb.usgs.gov/Info/NACSN/05_1547.pdf) and Hansen (1991) give detailed discussions of the issues associated with the use of geologic names, and Owen (1987; online at www.agiweb.org/nacsn/JSP_commentary.htm) provides a useful commentary on the ways that these issues frequently cause problems for authors.

Lithostratigraphic Units

Formal lithostratigraphic units are defined in accordance with the current or previously accepted versions of the *North American Stratigraphic Code* (Ashley and others, 1933; American Commission on Stratigraphic Nomenclature, 1961, 1970; North American Commission on Stratigraphic Nomenclature, 1983, 2005), or they have achieved acceptance through long usage prior to adoption of the codes. Informal lithostratigraphic units are sometimes useful locally, but, for whatever reasons, they do not comply with the requirements of the current stratigraphic code. Use informal lithostratigraphic units in UGS reports with care, and in all cases, clearly identify them as informal units.

The first time a formal lithostratigraphic unit name is used in a report, write out the complete name (both geographic name

and rank). Thereafter, authors may, at their discretion, refer to the unit by its geographic name only. For example, use "Chinle Formation" initially and "Chinle" in subsequent reference to the rock unit.

If an author wishes to establish a new formal lithostratigraphic unit in a UGS publication, the proposed unit must meet all the requirements of the current edition of the *North American Stratigraphic Code*. Authors should also consult "GEOLEX" (ngmdb.usgs.gov/Geolex), the online USGS database containing records of all formal lithostratigraphic unit names of the United States as they are used in publications.

Structural Geologic Features

There are no rules equivalent to the *North American Stratigraphic Code* for naming structural geologic features. Authors may choose names as they see fit, provided that the feature has not been named previously in the literature. Common sense, good taste, and close adherence to the rule of precedence serve as the guides for authors proposing to name structural features in UGS publications.

Italics

The following rules apply to the use of italics in UGS reports:

- Use italics for titles of works that are individually published or produced such as books, maps, magazines, newspapers, plays, and movies. Enclose titles of individual papers in a scientific journal, chapters in a book, and newspaper articles and editorials in quotation marks. Do not italicize them (see Quotation Marks section). Note that these rules do not apply to reference citations.

  > The article "New Mapping of Earthquake Hazards Along the Wasatch Front," which appeared in the August 2001 issue of *Survey Notes*, . . .

- Italicize formal names of genera, species, subspecies, and varieties of plants and animals. Do not italicize the names of phyla, classes, orders, and families. See Hansen (1991, p. 100–103) for additional information regarding paleontologic terminology.

- Use italics for the names of vessels, aircraft, and spacecraft (for example, the research vessel *Glomar Challenger*, and the *Voyager* spacecraft).

- Italicize the preposition "in" when citing a reference contained in another document.

  > Todd V.R., 1983, Late Miocene displacement of pre-Tertiary and Tertiary rocks in the Matlin Mountains, northwestern Utah, *in* Miller, D.M., Todd, V.R., and Howard, K.A., editors, Tectonic and stratigraphic studies in the eastern Great Basin: Geological Society of America Memoir 157, p. 239–270.

- Italicize the names of legal cases, for example, *Jones v. Entwhistle et al.* Note that the legal profession has a set of standard abbreviations all its own.

- Italics are not used in UGS publications for emphasis or for foreign words.

Lists

It is often necessary to display or organize a group of related items in a report. For large volumes of material or data that are related in some systematic way, a graph or table is often the best method of presenting the information. However, in many cases, a simple list will suffice. Authors may incorporate lists within a sentence or display them vertically.

Sentence Lists

If a list is short and simple, incorporate it directly into a sentence. Numerals or letters enclosed in parentheses may be used to identify each item in a sentence list. Lists incorporated in a sentence are not preceded by a colon if the list follows a preposition or a verb.

> Descriptions of samples collected by the authors accompany analytical data for Au, Ag, Cu, Pb, Zn, and As.
>
> Selection of anomalous thresholds involved the application and comparison of three standard statistical techniques: (1) the mean plus two standard deviations, (2) the 90th percentile, and (3) prominent gaps in histograms.

Commas normally separate items in a sentence list. If the items themselves include commas, use semicolons to separate the items unless numerals or letters are used to identify each item; in that case use commas to separate the items.

> The board members present included Mr. James Berry, Chairman; Mr. Ralph Hughes, Secretary-Treasurer; Mr. L.E. Smith, Chief Financial Officer; and Mr. Robert Kinley, Ex officio member.
>
> Much of the unit is (1) red, pink, or gray, (2) medium to coarse grained, and (3) equigranular or slightly porphyritic.

Vertical Lists

A list that is long, contains complete sentences, or merits special emphasis should be indented and displayed vertically. Numerals, letters, bullets, or dashes can be used to identify the items in a vertically displayed list. Numbers or letters may or may not imply a particular hierarchy of items in the list, but in either case are useful if the items are referred to in the text. The use of bullets or dashes implies that there is no particular order to the items in the list.

Normally a colon at the end of an introductory sentence introduces a vertically displayed list. However, if the introductory sentence is long and the anticipatory word or phrase occurs early in the sentence, or if another sentence comes between the introductory sentence and the list, the introductory sentence ends with a period. Use at least one blank line to separate items in a vertical list.

> A genetic model of mineralization in the Antelope Range mining district is presented below. Elements discussed in the model are depicted on figure 18.
>
> 1. Northwest-striking, extension-related faulting (middle to late Miocene) in the area largely preceded mineralization and alteration. Faults produced during this deformation host all known occurrences of mineralized veins.
>
> 2. Eruption of rhyolitic flows and intrusion of possible subvolcanic rocks occurred 8.5 to 8.4 million years ago.
>
> 3. Heat derived from emplacement of rhyolitic magmas induced a hydrothermal system in the surrounding host rocks. Extensional structures served as conduits for rising, dominantly meteoric, hydrothermal solutions.

If a vertical list consists of a series of complete sentences, capitalize the first letter of the first word of each item and end the items with a period. If the items in a vertical list complete the introductory sentence a colon is still required, the items are not capitalized, each intermediate item is followed by a comma, and the last item in the list ends with a period.

> The investigation of the Red Rock fault zone proceeded by:
>
> 1. mapping the surficial geology along the fault zone at 1:12,000 scale,

2. excavating trenches across single- and multiple-event scarps identified during the mapping,

3. carefully logging the trench walls to determine the number and size of paleoearthquakes, and

4. collecting samples of organic material (charcoal and bulk soil organics) for radiocarbon dating.

All lists, whether in a sentence or displayed vertically, must maintain parallel structure by beginning each item with the same part of speech (for example, noun, adjective, verb).

Numbers

General Rules

The following rules apply to the use of numbers in UGS reports:

1. Use numerals in the text for numbers of 10 or larger. Numbers smaller than 10 are spelled out, except for serial numbers and expressions of time, measurement, money, and percent.

   8:00 a.m.
   3 meters
   $20.00
   7%
   24 samples,
   but
   eight people
   three wells

2. Use a comma to separate groups of three digits to the left of a decimal point in numbers of 10,000 or larger except for serial numbers. Do not use commas to the right of a decimal point.

   5271
   14,629
   no. E-462591-15-326A

3. Use a combination of numerals and words for round numbers larger than 1 million.

   $37.5 million
   4 billion years,
   but
   425,000
   $13,256,630.56

4. Write out numbers that begin a sentence. Try to avoid beginning a sentence with a very large number.

5. Form the plural of a number expressed as a numeral by adding a lowercase “s.” Note that this usage does not conform to USGS style which uses an apostrophe with the “s.” Form the plurals of numbers that are written out in the same way as the plurals of other words.

   The organization doubled in size during the 1980s.

   Temperatures will reach the high 90s today.

   The values are all in the low thirties.

6. Write out indefinite expressions or exaggerations, but use numerals for approximations based on experience or fact.

   We must have received a thousand inquiries today.

   The conclusions are based on about 2000 analyses.

7. Use numerals when related numerical expressions that include numbers both greater and less than 10 are grouped together in a sentence.

   The inventory consisted of 6 lengths of drill pipe, 2 drill bits, 14 bags of cement, and 3 core boxes.

Decimals and Fractions

Rules for the use of decimals in UGS reports include the following:

1. Use decimals rather than fractions wherever possible.

2. If a decimal is not associated with a whole number, insert a zero before the decimal point (0.56 not .56).

3. Zeros are retained after a decimal point only if they are significant figures (3.208 but not 3.200 unless both zeros are significant; see Numerical Data and Significant Figures section).

Sometimes established convention makes the use of fractions preferable to decimals. Rules for using fractions include the following:

1. Use numerals when fractions express a measurement.

   1/2-inch pipe
   6-1/2-inch O.D. well casing

2. Spell out and hyphenate fractions that stand alone in the text.

   The project is two-thirds complete.

Numerical Data and Significant Figures

When presenting numerical data, report only digits that legitimately convey significant information. A significant figure is any digit that is necessary to define the accuracy of a specific value or quantity resulting from a measurement or an arithmetic computation. Because a result cannot be more accurate or precise than the data from which it was obtained, a reported result should not imply a greater accuracy than that of the least accurate piece of data used to obtain the result.

Two aspects of numerical data are important when considering significant figures:

Accuracy—The error-free level or degree of conformity to which a calculated value corresponds to or approaches a true or specified value. The smaller the error, the greater the accuracy.

Precision—The extent to which a measured value can be reproduced or repeated, or the degree of mutual agreement between individual measurements.

Some values exhibit the characteristics of both accuracy and precision. For example, radiocarbon age determinations are accurate

to the degree that they correctly match the true age of the material, and precise to the extent that the results of the dating process are reproducible in the laboratory.

When reporting numerical data, the number of significant figures should equal the number of digits that are confidently known, plus the trailing digit, which may be an estimation or approximation. For example, the thickness of a stratigraphic unit, measured with an accuracy of one meter, might be reported as 238 meters (three significant figures); this indicates the thickness is confidently known to be greater than 230 meters, by approximately 8 meters. The same unit measured with an accuracy of 10 meters should be reported as 240 meters (two significant figures). Guidelines for determining which figures are significant are as follows:

1. The digits 1 through 9 are always significant regardless of their position in a number, to the extent that the accuracy of the measurement permits.

2. The digit 0 is significant when it occurs between other significant digits, but is not significant when placed to the left of a digit to fix a decimal place. For example, the number 0.0057 has two significant figures, but 703.01 has five.

3. Zeros that trail the decimal place are considered significant, again to the extent that the accuracy of the measurement permits. The number 43.00, therefore, has four significant figures.

4. Trailing zeros in a number without a decimal point (e.g., 3600) may be significant if they were determined by actual measurement. When dealing with data for which this is not known, assume the zeros are not significant. Authors can avoid ambiguity by using scientific notation. For example, 3600 could be written with two significant figures (3.6×10^3), three significant figures (3.60×10^3), or four significant figures (3.600×10^3).

The concept of significant figures does not apply to whole numbers that represent exact counts, such as the number of samples used to calculate an average, or to defined constants such as π that consist of an infinite number of significant digits.

Significant figures in calculations: The number of significant figures in the result of a calculation depends on the mathematical operation performed. In addition and subtraction, the result may have more or fewer significant figures than any one of the numbers used in the calculation, but cannot have more decimal places than the least accurate piece of data. For example, a mining district's total monthly coal production is the sum from three mines that report production to different levels of accuracy (table 5). The total has the same number of decimal places (zero) as the least accurate production report (from mine B). Note also in this case, the result has one more significant figure than one of the numbers used in the calculation (four versus three).

Table 5. *Example of significant figures in a calculation involving addition.*

Mine	Production (tons)
A	332.2
B	657
C	97.56
Total district production	1087

In multiplication and division, the result cannot have more significant figures than the number having the fewest significant figures. For example, a mine produced 165,500 tons of 1.15% copper ore at a time when copper was worth 97 cents per pound. The dollar value of the copper produced equals:

165,500 tons x 2000 lb/ton x 0.0115 lb Cu/lb ore x 0.97 dollar/lb Cu = $3,692,305

Since the price of copper is the number having the fewest significant figures (two), the result should be reported as $3.7 million.

When using spreadsheet software to process numerical data, care must be taken to ensure that results are reported with the proper number of significant figures. Spreadsheets typically default to a preset number of digits or decimal places, regardless of their

significance, and may inadvertently distort the reported accuracy. For example, a spreadsheet calculation of the average of a hypothetical series of fault-scarp height measurements, accurate to one decimal place, returned a result with two decimal places (table 6). Similarly, the spreadsheet calculated the standard deviation to nine decimal places. Since the measured values all have two significant figures, accurate to one decimal place, the average and standard deviation should be reported as 1.5 ± 0.3 meters.

Table 6. *Example of a spreadsheet's default settings introducing extraneous digits to calculations of an average and a standard deviation.*

Site	Scarp Height (m)
A	1.3
B	1.7
C	1.1
D	1.5
E	1.9
F	2.1
G	1.6
H	1.4
I	1.2
J	1.1
Average	1.49
Standard deviation	0.338132124

Uncertainty: Authors of UGS reports should always bear in mind that the numerical data they report may be relied upon by the public, industry, and regulatory agencies for making decisions; consequently, authors should always specifically state the uncertainty associated with their data. Quantifying and reporting uncertainty is an essential part of the scientific process and enhances, rather than diminishes, the value of a publication. When reporting average values derived from a series of observations, authors should also report standard deviation as a guide to assess the variability of the data and validate the number of significant figures.

Converting measurement systems: When converting from one measurement system to another, the converted value should imply the same degree of precision and accuracy as the original value. Since readers and reviewers seldom have access to the original data, authors need to carefully consider the accuracy of their original measurements when converting data so that the conversions have the appropriate number of significant figures. For example, when reporting the stratigraphic thickness of a sandstone interval as 100 feet, the exact conversion to the metric system is 30.48 meters. However, reporting the converted value with four significant figures is clearly inappropriate, and the appropriate number of significant figures depends on how the original value was obtained. If the original value resulted from careful measurement using a stadia rod and is accurate to ± 1 foot, it would be appropriate to present the metric conversion to the nearest 0.1 meter (30.5 m). If the original value resulted from a quick eye-height estimate while hiking up the slope and is accurate to ± 5 feet, it would be more appropriate to present the metric conversion to the nearest whole meter (30 m).

Rounding: When rounding numbers to significant figures, all digits to the right of the *nth* digit are dropped. Guidelines for rounding are as follows:

- If the first discarded digit is greater than 5, add 1 to the *nth* digit (45.7882 rounded to four significant figures is 45.79).
- If the first discarded digit is less than 5, leave the *nth* digit unchanged (45.7832 rounded to four significant figures is 45.78).
- If the first discarded digit is 5 and all following digits are zeros, round the *nth* digit to the nearest even number (342.65 rounds to 342.6, and 68.35 rounds to 68.4).
- If the first digit discarded is a 5 and is followed by any digit 1 through 9, add 1 to the *nth* digit (3.44538 rounded to three significant figures is 3.45).

Refer to Hansen (1991, p. 119–121) for additional information on significant figures and rounding.

Punctuation

Although some punctuation rules are more or less universally accepted (for example, the comma in July 4, 1776), many others are subject to interpretation and seemingly endless debate. Two broad categories of punctuation style exist in the English language: formal and informal. Formal punctuation style requires a greater number of punctuation marks than does informal punctuation style. For the sake of precision and clarity, scientific writing normally uses formal punctuation style and inserts punctuation marks that might otherwise be omitted in nontechnical publications.

The following sections discuss some of the most common punctuation marks used in UGS reports. For a more complete presentation on the intricacies of punctuation in geologic reports see Hansen (1991, p. 132–140).

Apostrophes

An apostrophe (’) indicates possession, some plurals, and omitted letters. The following rules govern the use of apostrophes in UGS reports:

- Form possessives of singular words by adding an “’s” (the prospector’s mule, Kennecott’s Bingham Canyon mine, Bob’s compass). However, remember that “its” (no apostrophe) is the possessive form of “it” and “it’s” is the contraction for “it is.”

- Form possessives of plural words that end in “s” or “es” by adding an apostrophe only (General Dynamics’ headquarters, the Joneses’ house, the drillers’ logs).

- In cases of joint possession, use an apostrophe only with the last owner (Ann and Bob’s truck).

- Do not use an apostrophe to form the plural of words (all the Jims in the office, in the mid-1980s).

- Do not use an apostrophe as a substitute for the prime symbol (′) (e.g., minutes of angle). Likewise, do not use a quotation mark as a substitute for the double-prime symbol (″) (e.g., seconds of angle). For example, latitude 38º12′30″ N. (not 38º12’30” N.).

Colons

A colon (:) is a mark of anticipation; it directs the reader’s attention to what follows. The principal uses for colons are to link related thoughts and to introduce lists. When linking thoughts, the colon shifts the emphasis toward the second thought, making it the most important part of the sentence.

> The zinc anomaly was less elusive: sediment samples from several streams showed high values for zinc.
>
> One task remained before finalizing the mine plan: blocking out the limits of the ore body.

Depending on the characteristics of the list, the items following a colon are either included as part of a sentence or indented separately (see Lists section).

> The project will consist of two phases: (1) detailed subsurface exploration and analysis, and (2) construction monitoring.
>
> The objectives of the exploration program are:
>
> 1. identification of a major gold/silver ore body within the Delmar-Iron Springs mineral belt,

2. completion of the exploration project on schedule (18 months) and within budget ($1.25 million), and

3. compliance, within the parameters of the project time schedule and budget, with all applicable environmental rules and regulations affecting exploration activities.

Colons are also used after salutations in a formal letter (Dear Mr. Halfton:), to separate hours from minutes (3:45 p.m.), to separate the two halves of a ratio (3/4:1), and to separate the author and title of a reference from the publisher (see section on The Reference List).

Lawton, T.F., and Willis, G.C., 1987, The geology of Salina Canyon, *in* Beus, S.S., editor, Rocky Mountain Section of the Geological Society of America Centennial Field Guide Volume 2: Boulder, Colorado, Geological Society of America, p. 265–268.

Commas

A comma (,) indicates a slight separation between grammatical units. It is similar to a brief pause in speech. Commas are critical to both the meaning and movement of writing and, for that reason, are the most commonly used punctuation mark. However, when used incorrectly, commas can interrupt the smooth flow of words and confuse the reader.

Commas separate complete thoughts (independent clauses) joined by *and, but, or, for, nor, so,* and *yet*. The comma is omitted if the independent clauses are short.

The lab used a simplified gas-liquid chromatography method to perform the analyses, and we recorded the results in the statewide mineral database.

The lab performed the analyses and we recorded the results.

Commas separate a long introductory phrase or clause from the main body of the sentence.

Following the most recent surface-rupturing earthquake, a series of debris-flow and fluvial units were deposited on the alluvial-fan surface.

Commas separate nonrestrictive (nonessential) clauses and phrases from the sentence, especially those beginning with *who, which,* and *that*. Commas are not used if the clause or phrase is essential to the meaning of the sentence.

The scarp, which is 12 m high, is the result of recurrent surface faulting.

The scarp that is 12 m high is the result of recurrent surface faulting.

Commas set off interrupting or parenthetical elements within a sentence.

These ash-flow tuffs, along with a series of later basalt flows, were emplaced in the Oligocene and early Miocene.

The upper sandstone unit, ranging in color from red to light tan, is laterally continuous throughout the map area.

Commas separate items in a series consisting of three or more words, phrases, or clauses.

The mine had produced large amounts of gold, silver, and lead.

The soil A horizon is correlated with unit 4s on the basis of stratigraphic position, relation

to surface faulting, and a radiocarbon age on charcoal from the A horizon of 690 cal yr B.P.

Commas separate two or more adjectives that equally modify the same noun (parallel adjectives; adjectives are parallel if "and" can be inserted between them or if their order can be reversed with no change in meaning). Note that if two adjectives precede a noun and the first adjective modifies the second, a hyphen is required.

The host rock consists of a brown, fine-grained sandstone. [parallel adjectives, comma required]

Several short tributary streams . . . [nonparallel adjectives, no comma required]

Commas set off the following transitional words and expressions when they are used to introduce a sentence: *accordingly, consequently, for example, for instance, further, furthermore, however, indeed, nevertheless, nonetheless, on the contrary, then, thus*.

Accordingly, a new drift was started on a bearing of N. 55° W. and continued for a distance of 1200 ft.

Commas follow adverbial conjunctions (*accordingly, besides, consequently, furthermore, hence, however, moreover, nevertheless, still, therefore, thus*) that join independent clauses.

The name of a suite of related rocks combines a geographic term, the term "suite," and an adjective denoting the fundamental character of the suite; thus, we have names such as the North Mountain Metamorphic Suite, Beaver Flats Intrusive Suite, and Cassandra Volcanic Suite.

Commas are used in conventional places with dates, addresses, titles and degrees, references, and correspondence.

The debris flow of June 6, 1988, damaged two houses.

For further information about the deep-drilling project, contact Hydrojet Inc., Salt Lake City, UT 84070.

The meeting in Reno, Nevada, concludes on Wednesday.

J.P. Stone, Ph.D., began his research in 1967.

Ashland, F.X., 2001, Site-response characterization for implementing SHAKEMAP in northern Utah: Utah Geological Survey Report of Investigation 248, 10 p., 2 plates, scale 1:500,000.

Sincerely,

Dashes

There are several types of dashes, but only two (the relatively longer em dash [—] and the relatively shorter en dash [–]) are typically used in scientific writing, and their use is generally infrequent. An em dash sets off an abrupt change in thought or a clarifying or emphasizing phrase. Em dashes are more emphatic than either commas or parentheses, and in a manner similar to colons, shift emphasis to the thought following the dash.

Chemical analysis indicates a probable Mississippian source—oil derived from rocks within the Hingeline region.

The Emma mine was a small but steady producer—50 tons per year—through the 1940s and 50s.

In reference lists, use an em dash to replace a colon that appears within the document title to avoid possible confusion with the colon that is used to mark the end of the document title (see The Reference List section).

An en dash is shorter than an em dash and longer than a hyphen. The principal use of the en dash is to connect inclusive numbers, such as dates, page ranges, and ranges of values given as equivalent units of measure in parentheses. Non-inclusive numbers are separated by hyphens (see Hyphens section). En dashes are also used in compound adjectives when at least one of the elements of the adjective is an open (unhyphenated) compound or when the elements are hyphenated compounds.

1945–78
p. 312–327
20 to 30 feet (6–9 m)
central Utah thrust belt–Hingeline play
scarp-height–slope-angle plot

Do not use en dashes to substitute for the word *to* or *and* when used with *from* or *between*, respectively, to indicate a range of values.

Nitrate concentration ranges from 2.6 to 9.3 mg/L. [*not* from 2.6–9.3 mg/L]

Fine-grained sediments accumulated in a shallow lake between 40 and 45 million years ago. [*not* between 40–45 million years ago]

We measured several 31- to 66-m-long profiles. [*not* 31–66-m-long]

No spaces precede or follow dashes.

Ellipsis Marks

Ellipsis marks show that nonpertinent material is omitted from quoted matter. Ellipsis marks generally consist of three periods (. . .) separated by spaces (see Quotations section). When the omitted material is at the end of a sentence, use four periods (. . . .). Indicate the omission of a complete paragraph by a line of several ellipsis marks (. . . . . .).

Hyphens

A hyphen (-) connects two or more words used as a single expression, and keeps parts of other words distinct. The rules governing hyphenation are many, varied, and frequently subject to debate. General rules for the use of hyphens are presented below, but the most important rules to remember, as with any punctuation mark, are to use them to aid the reader's understanding and to maintain consistency within a report.

Hyphens may connect words that are used as compound modifiers (adjectives).

pale-green shale
ground-water reservoir
60-meter-wide graben
fine-grained sandstone
fine- to coarse-grained sandstone
1/2-inch crystals
northwest-trending fault
30 x 60-minute quadrangle

Compound modifiers are not hyphenated if the first word is an adverb that ends in "ly," or if the first word of a three-word unit modifier is an adverb that modifies the second word. Compound modifiers are not hyphenated if they follow the word being modified, unless they are always hyphenated by convention (refer to appendix E and the AGI *Glossary of Geology* [fifth edition] for examples).

moderately indurated sandstone [*but* early-formed magma]

very fine grained sandstone

The sandstone is fine grained. [*but* The sandstone is cross-bedded.]

However, when describing rock units in stratigraphic sections, well logs, and other lists, compound modifiers following a noun (rock name) are traditionally hyphenated in the geologic literature.

Sandstone: blue-gray, thinly bedded, coarse-grained, . . .

Welded tuff: reddish-brown, flow-banded, . . .

Because this practice can be confusing, it is optional in UGS reports. Authors may omit hyphens in this instance if they so choose, but must be consistent throughout the report whichever convention they choose to follow. For more information related to the use of hyphens and other punctuation in stratigraphic descriptions of geologic map units, see the Geologic Map-Unit Descriptions section.

A number of compound nouns exist in the geologic vocabulary. Some are hyphenated (acre-foot, cross-bed, cross-stratification, meta-arkose), and others are not (cross section, dip angle, dike swarm, solution banding). Authors should consult appendix E, the AGI *Glossary of Geology* (fifth edition), and Hansen (1991) when questions arise concerning the proper form of a compound geologic noun.

Compound numbers between twenty-one and ninety-nine and fractions are hyphenated when written out. Hyphens are also used to separate non-inclusive numbers, such as telephone numbers and serial numbers.

thirty-three
four-fifths
801-537-3300
no. 14558-789-D
UGS Miscellaneous Publication 03-7

Use a hyphen with the prefixes *ex*, *self*, and *quasi*; most other prefixes and suffixes do not require a hyphen when added to a word. A hyphen is required if a prefix is added to a capitalized word (non-UGS) and to prevent the doubling of a vowel (re-evaluate). When in doubt about the use of a hyphen with a prefix, consult *Webster's Third New International Dictionary*.

Hyphens are used where numbers and units of measure form a compound modifier, but a hyphen is not needed in the equivalent measurement in parentheses.

A 4-foot-thick (1.2 m) fossiliferous limestone bed is at the top of the interval.

Parentheses and Brackets

Parentheses [()] enclose incidental information or explanatory material, and are the most common type of punctuation found in scientific reports after commas and periods. Parentheses come in pairs, and are used in the following instances:

- abbreviations the first time they appear in the report text,
- references to the work of others that are inserted in the report text,
- alternative units of measurement, and
- references to figures, tables, and appendices in the report text.

For example:

> Differences in the timing of the most recent event (MRE) along a fault zone are used to define fault segments (Schwartz, 1988) (table 4).
>
> The deposition rate was rapid during the Pennsylvanian and Permian, resulting in a total accumulation of 25,000 to 30,000 ft (7600–9100 m) of marine sediments (figure 3).
>
> The Emery high (or Piute platform as it is now called) and the Kaibab uplift (a poorly defined band of uplifts) have been identified by the thinning or absence of Pennsylvanian formations.

Parentheses are also used with letters of the alphabet or numerals to enumerate points in a list.

Brackets ([]) serve the same function as parentheses; however, brackets are usually restricted to situations where it is necessary to enclose information within an existing set of parentheses.

> Kings Peak (elevation 13,528 feet [4123.4 m]) is the highest point in Utah.

Brackets are also used in equations and formulas, and to insert brief editorial comments or corrections into quoted material (see Equations and Formulas, and Quotations sections).

Quotation Marks

Quotation marks (“ ”) set off direct speech and material quoted verbatim from other sources that are included in the text (see Quotations section). Quotation marks enclose the titles of individual papers published in scientific journals, chapters in a book, and newspaper articles and editorials when those titles appear in the text. However, italics are used for titles of individually published or produced works such as books, maps, magazines, and newspapers (see Italics section). Quotation marks also enclose words used in a special way.

> “The House Range, Western Utah—Cambrian Mecca” by Hintze and Robison (1987) in *Rocky Mountain Section of the Geological Society of America Centennial Field Guide, Volume 2* provides a succinct description of an important fossil locality in Utah.
>
> “Caliche” usually refers to an indurated layer of calcium carbonate accumulation in a soil; “hardpan” is a more general term that refers to any indurated soil layer resulting from the precipitation of soluble materials in the soil profile.

Commas and periods are always placed inside of closing quotation marks; colons and semicolons are always placed outside of closing quotation marks. All other punctuation marks are placed inside of quotation marks only if they are part of the quoted material.

As described above in the Apostrophes section, do not use a quotation mark as a substitute for the double-prime symbol (″) (e.g., seconds of angle).

Semicolons

A semicolon (;) indicates a pronounced separation between grammatical units. It is stronger than a comma and almost as full as a period. The principal use for the semicolon is to separate two or more complete thoughts (independent clauses) within a single sentence. The use of a semicolon instead of a period implies a closer relationship between the thoughts than does a period. Semicolons used to link complete thoughts do not require a conjunction; however, a semicolon is necessary when an adverbial conjunction (*accordingly, besides, consequently, furthermore, hence, however, instead, moreover, nevertheless, otherwise, still, therefore, thus*) connects the thoughts. Do not use a semicolon with simple coordinating conjunctions (*and, or, for, nor, yet, so,* and *but*).

> Estimates of the timing of the most recent ground-rupturing earthquake from the two trench sites are within 40 years of each other; this close correlation in time indicates that the same event is recorded at both sites.
>
> The full extent of the Escalante silver vein was known only after extensive exploration; consequently, a number of smaller ore deposits in the district were overlooked for many years.

A second use for semicolons is to separate items in a series when one or more of the items require a comma (see section on Lists).

Quotations

Direct quotations contain the original words of a speaker or written material taken verbatim from another document. When quoting directly, especially copyrighted material, clearly identify the quoted matter with quotation marks (see Quotation Marks section), and give full credit to the speaker or original author. Indicate omissions in quoted matter by ellipsis marks (see Ellipsis Marks section). Short quotations are incorporated directly into the report text. Dr. Jones stated ". . . when fully grown, the *Tyrannsaurus rex* stood more than 20 feet tall." Indent and single space long quotations (usually more than one sentence), but do not enclose them with quotation marks.

> It is useless to ask when this disaster [an earthquake] will occur. Our occupation of the country has been too brief to learn how fast the Wasatch grows; indeed, it is only by such disasters that we can learn. By the time experience has taught us this, Salt Lake City will have been shaken down.
>
> G.K. Gilbert, *Salt Lake Tribune*, 1883 (Gilbert, 1884)

Reproduce titles and references exactly as written in the original except for obvious typographical errors. Reproduce other words in error exactly and then follow them by "[sic]" to indicate that the erroneous word or passage is exactly reproduced. If necessary, use brackets to insert other comments or corrections into quoted material (see example above).

Units of Measurement

Authors may use either United States customary (English) or International System (SI [metric]) units in UGS publications (appendix F). Whichever system is used, it should be used consistently throughout the report. As a general rule, the metric system is used in reports intended for a scientific audience and English units are used in nontechnical reports. However, the use of English versus metric units of measurement is often a matter of convention and varies among scientific disciplines. Writers of UGS reports should use the system appropriate to the type of report they are writing; that is, the units of measurement should be readily understandable by the report's target audience. In reports that are of a general, "multiple-use" nature, equivalent units of measure should be given. If the report contains only a few relatively straightforward units of measure, equivalent measurement in the alternative system should follow in parentheses. If the report contains numerous, varied, or complicated units of measure, however, equivalent measurements in the alternative system incorporated within the text can result in awkward or cumbersome sentences and can impede, rather than facilitate, comprehension. In these cases, a conversion table included at the beginning of the report can be helpful. Equivalent measurements are not required for numerical data presented in illustrations and tables.

A problem may arise in reports that combine data from a variety of sources. If the combined data set contains both English and metric units, it is preferable to leave the data in its original form and include an appropriate explanation in the text. Alternatively, data may be converted to the primary measurement system used in the report, but an explanatory comment should be given where precision is important and could be compromised by rounding. For example: At the type section, the sandstone bed is 18.4 m thick (measured as 60.2 ft by Johnson, 1981). Refer to the Numerical Data and Significant Figures section for a discussion of representing appropriate precision and accuracy when rounding converted values.

In general, units of measure are unabbreviated except for ratios that are otherwise unwieldy and for equivalent measurements that follow in parentheses. However, primary units of measure may be abbreviated in technical reports intended for a scientific or

specialized audience. Note that the abbreviation *yr* is used only when reporting geologic ages (see section on Time), and in ratios. Do not abbreviate units of measurement that are used in the absence of a number.

> A displacement of 3.0 meters (9.8 ft) and a recurrence interval of 2000 years gives a maximum slip rate of 1.5 mm/yr (0.06 in/yr) [for general audience].
>
> A displacement of 3.0 m and a recurrence interval of 2000 years give a maximum slip rate of 1.5 mm/yr [for scientific/specialized audience].
>
> The mesa covers an area of 15 square miles (39 km^2).
>
> In places, the zone of alteration is several meters thick [*not* several m thick].

WRITING TIPS

The principal rule for effective writing is to know your audience and to communicate your ideas to them in an organized and clear manner. In practical terms that means arranging the fewest number of precise, simple words possible into straightforward sentences and paragraphs. In scientific writing, authors are faced with the challenge of communicating technical and often abstract information and ideas. Not only must the science be technically sound, but the writing must be presented in a clear, logical manner, and must be free of incorrect grammar, misspelled words, and flawed punctuation. Otherwise, the result is a loss of clarity that can lead to reduced comprehension on the part of the reader. In addition to obscuring good science, poor writing can also damage the credibility and reputation of the author and publisher.

A few comments on the writing process are included here for the benefit of UGS authors. Several references in the Selected Bibliography contain additional information on writing in general, and scientific writing in particular.

Sentences and Paragraphs

A sentence, which is the basic building block of writing, should present one clear, complete thought. A characteristic of good scientific writing is the ability to produce lean, concise sentences. Few sentences are so well written the first time that they require no revision. Authors should revise each sentence until it communicates exactly what they wish to say. Eliminate unnecessary words and phrases and scrutinize long words, replacing them with shorter, simpler words whenever possible. Avoid jargon unless no other word will do the job.

After the sentence, the paragraph is the most basic structural element of writing. A paragraph combines closely related information in a meaningful way. A paragraph may consist of one sentence but more commonly contains several related sentences. Grouping paragraphs together allows related ideas to be organized in a logical and effective manner. A paragraph begins with a topic sentence. A topic sentence presents the main idea of a paragraph, and it is the sentence to which all other statements in the paragraph are related. Craft topic sentences with care. Strong topic sentences produce strong, effective paragraphs. Weak, confused, or improperly placed topic sentences produce poor paragraphs and ultimately poor reports. Paragraphs should receive the same rigorous scrutiny and revision as the sentences from which they are constructed.

Active and Passive Voice

Sentence constructions are either active or passive and, as a consequence, sentences are said to have voice. In the active voice, the subject of the sentence does the action. In the passive voice, the subject of the sentence is acted upon. Authors can recognize the passive voice by its use of the verb *to be* (*is, are, was, were, being, been*), combined with verbs that often end in “ed” or “en.” Overuse of the passive voice can add many unnecessary words to a report; active sentences are typically shorter and more concise than passive sentences.

> **Passive Voice:** Thick alluvium was deposited in the valley by meandering streams. (10 words)

Active Voice: Meandering streams deposited thick alluvium in the valley. (8 words)

Additionally, in passive sentences the reader commonly arrives at the verb and still does not know who is doing the action. Passive voice often masks responsibility for whatever action occurred.

Passive Voice: The earlier version of the database was revised and updated. [Was the database revised and updated by the author, or by someone else?]

Active Voice: We revised and updated the earlier version of the database.

Favor the active voice over the passive. Restrict use of the passive voice to instances when the subject (doer of the action) is unknown, the receiver of the action is more important than the doer, or the passive voice provides a smoother transition between sentences.

Strong Verbs

Strong verbs are forceful and efficient; weak verbs are wordy and wishy-washy. Strong verbs convey the action in a sentence with fewer words and greater impact than weak verbs. Weak verbs commonly include a form of the verb "to be" (*am, is, are, was, were, being, been*), and a simple verb (such as *have, had, did, done, came,* and *make*), usually in combination with an "___ion" word.

They are performing an investigation of the site. (8 words)
They are investigating the site. (5 words)

We opted for termination of the borehole at the Chinle-Moenkopi contact. (12 words)
We terminated the borehole at the Chinle-Moenkopi contact. (9 words)

False Subjects

A false subject is created when a pronoun ("there" and "it" are the most common) is used as the subject of a sentence without a clearly identified antecedent. False subjects add extra words to a sentence; eliminate them whenever possible.

There is a large increase (to 6200 ft/s) in the compressional wave velocity at the water table. (17 words)
The compressional wave velocity increases to 6200 ft/s at the water table. (12 words)

It is anticipated that the life of the mine may be extended by as much as 20 years if the exploratory drilling program is successful. (25 words)
The life of the mine may be extended by as much as 20 years if the exploratory drilling program is successful. (21 words)

Gender Bias

Language that expresses or assumes a gender bias when none is warranted is inappropriate. Authors should avoid using masculine pronouns such as *he, him,* or *his* when referring to a group that could include both men and women. Avoid using hybrid pronouns like *he/she* or *his/her* whenever possible; they are awkward and add unnecessary words to a sentence.

Someone left his rock hammer on the outcrop.
Someone left a rock hammer on the outcrop.

When an author has completed his/her first draft he/she should initiate the peer-review process.
When the first draft is complete, the author should initiate the peer-review process.

Consider the following non-gender-specific alternatives:

- *Artificial*, *engineered*, *anthropogenic*, or *human-induced*, for *man-made* (for example, artificial fill, human-induced subsidence).
- *Supervisor*, for *foreman*.
- *Nonspecialist* or *general public*, for *layman*.

Jargon

Most branches of science have their own specialized terminology, and geology is no exception. This special vocabulary, or jargon, is useful within the science because it permits the communication of wordy phrases or complex concepts in a more efficient manner. To the general public, however, jargon is obscure at best and pretentious at worst. The extent to which jargon is appropriate in a report depends on the intended audience. For a technically sophisticated audience, the use of jargon may be justified. For a general audience, jargon is best used sparingly. In cases where specialized vocabulary is necessary even though the report will have a general audience, give definitions of terms in the text or include a glossary of terms.

Personal Pronouns

The use of personal pronouns (*I, we, you, he, she, it,* and *they*) was long considered unacceptable in scientific writing. However, times change, and UGS authors are encouraged to include personal pronouns where appropriate in their reports. Personal pronouns allow the author to take direct responsibility for the contents of the report. In this age of increasingly impersonal technology, we believe this represents an encouraging trend.

The word *author*, when used in phrases such as "it is the opinion of the author" or "the author believes," is a poor substitute for a personal pronoun. Such phrases are wordy and can sound trite and pompous. Replacing "author" with "I" or "we" results in a more concise sentence. The use of personal pronouns also leads naturally to active-voice sentence constructions.

Problem Words

Appendix E contains lists of words and phrases that are commonly misused or overused in scientific writing; authors should familiarize themselves with the contents of those lists. A few words are misused so regularly that they merit special attention and are discussed here.

A and An

Deciding whether to use "a" or "an" depends on the sound of the word that follows rather than the initial letter. "A" is used before words that begin with a sounded *h* or a consonant sound. "An" is used before words that begin with a silent *h* and all vowels except *u* as in *ukelele* and *o* as in *one*.

a cleat	an anticline
a eutrophic lake	an effect
a uranium anomaly	an unconformity
a historic event	an hour
a once-productive mine	an oncolite

Affect and Effect

"Affect" and "effect" are similar in both appearance and sound, but they are not synonyms. Either word can be used as a verb or as a noun. As a verb, "affect" means to influence or to have an effect or bearing on. "Effect" as a verb means to bring about, to accomplish, or to produce. Of the two words, "effect" is the one most commonly used as a noun, and means something that inevitably follows an antecedent action, or an outward sign. The use of "affect" as a noun is limited to a narrowly defined meaning within the psychological sciences.

The new discovery will affect gold prices worldwide.

They hope to effect the change before the new mill begins operation.

The effect of a large earthquake on unreinforced masonry structures is often catastrophic.

Age and Date

For geologic purposes, Colman and others (1987) define "date" as a specific point in time, and "age" as an interval of time measured back from the present. As a noun, "date" connotes calendar years and, therefore, a degree of accuracy that is seldom justified in reporting the age of geologic features, materials, or events. Most geologic "dates" are better described as "age estimates" or simply "ages" (see Age Estimates section). Exceptions include dates from historical records and some dates obtained from tree rings and varves. Use of "date" as a verb or adjective to describe the production of age estimates (for example, radiocarbon dating, K-Ar dating, dating methods) is generally accepted. Abandon the phrase "age dating," which is redundant and meaningless.

Compose, Comprise, Consist, and Constitute

The word *comprise* is best avoided, but if used, the traditional rule states that the whole *comprises* the parts. Similarly, the whole *consists of* the parts. Conversely, the parts *constitute*, or *compose*, the whole. Use of the phrase "is comprised of" is generally discouraged.

The Oquirrh Group comprises [consists of] several thick formations consisting of carbonate and siliciclastic rocks.

The Triassic, Jurassic, and Cretaceous Systems constitute [compose] the Mesozoic Erathem.

Data

The word *data* is plural and *datum* is singular; choose the appropriate verb form when using these words to avoid disagreement in number.

Ground Water

Depending on the organization or reference consulted, "ground water" is written as one word, two words, or hyphenated. The USGS writes "ground water" as two words, and the UGS also follows that convention. Ground water is hyphenated when used as an adjective (ground-water resources).

Historic and Historical

A distinction is drawn between things or events that are historic and those that are historical. "Historic" refers to something that is important in history. The gold rush of 1849 is a historic event. Things that are historical pertain to history or are based on history, but are not individually important in the historical record.

With

The word *with* is a preposition that causes trouble for many writers. It is commonly misused as a conjunction, inaccurately connecting two words:

To the north, the fault zone consists of a single trace with only minor vertical offset.

[alternative] To the north, the fault zone consists of a single trace that has only minor vertical offset.

"With" is also often misused in place of "and," "but," "having," and "using."

The sequence of events is complex, with several interpretations being possible.

[alternative] The sequence of events is complex, and several interpretations are possible.

Hansen (1991, p. 131) gives several good examples of various improper uses of the word "with."

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APPENDICES

APPENDIX A

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APPENDIX D

ABBREVIATIONS

4-Arm High Resolution Dipmeter	HDT
abandoned	abnd
absolute (temperature and gravity)	abs
absolute value of	| |
absorbance	A
absorptivity	a
abstract	abs.
abundant	abnt
academy	acad.
acicular	acic
acmite	Acm
acre-foot	acre-ft
aggregate	aggr
agricultural	agr.
Agricultural Stabilization and Conservation Service	ASCS
albite	Ab
alternating current	ac
altitude	alt, *h*
American	Am.
American Association of Petroleum Geologists	AAPG
American Geological Institute	AGI
American Geophysical Union	AGU
American Petroleum Institute	API
American Society for Testing and Materials	ASTM
amorphous	amor
amount	amt
ampere	a
analytic(al)	anal.
andesite	and
angle	∡
angstrom	Å
angular	ang
anhedral	anhed
anhydrite	Anh
anno Domini, in the year of our Lord	A.D.
annual	ann.
anorthite	An
ante meridiem, before noon	a.m.
antilogarithm	antilog
apatite	Ap
apothecary pound	lb ap
appendix	app.
applied	appl.
approaches	→
approximate(ly)	approx
approximately (nearly) equal to	≈
approximately identical with	≅
aqueous	aq
arenaceous	aren
argillaceous	arg
arkosic	ark
asphaltic	asph
association	assoc
Association of Engineering Geologists	AEG
astronomical unit (in English)	AU
Atlantic standard time	AST
Atlantic time	AT
atmosphere	atm
atmosphere (infrequently, As)	atm
atmosphere, technical	at
atomic mass	m_a or m
atomic number	at. no., Z
atomic weight	at. wt.
auxiliary	aux.
avenue	ave
Avenue (in addresses only)	Ave.
average	ave
Avogadro's number	N or N_a
avoirdupois	avdp
avoirdupois pound	lb, avdp
azimuth	az
bachelor of science	B.S., S.B., or B.Sc.
bachelor of arts	B.A. or A.B.
barometer	bar.
barrels	bbl
barrels of oil	BO
barrels of oil per day	BOPD
barrels of water	BW
barrels of water per day	BWPD
barrels per day	BPD or bpd
bedded	bdd
bedding	bdg
before Christ	B.C.
before present	B.P.
bench mark (in illustrations)	BM
bench mark (in text)	B.M.
bentonite	bent
Bernoulli number	*B*
BHC Acoustilog	BHC
BHC Sonic Log	BHC
bibliographic(al)	bibliog.
biennial	bienn.
billion cubic feet (billion = 10^9)	Bcf
billion cubic feet of gas per day	BCFG/D
billion years	byr
billion years ago (geologic ages only)	Ga
biologic(al)	biol.
biotite	Bt
bituminous	bit
boiling point	bp
bottom-hole pressure	BHP
bottom-hole temperature	BHT
boulder	bldr
Boulevard (in addresses only)	Blvd.

brachiopod	brach
Brinell hardness number	Bhn
British thermal unit	Btu
building(s)	bldg(s).
Bureau of Indian Affairs	BIA
Bureau of Land Management	BLM
calcareous	calc
calcite	Cal
calculated	calc
calendar-calibrated	cal B.P.
Caliper	CAL
calorie	cal
Cambrian	Camb. or Є
carat	kt
carbonaceous	carb
Cartesian coordinates	x, y, z
casing	csg
cast-iron bridge plug	CIBP
cavernous	cav
Celsius	C
Celsius, degree	°C
cemented	cmt
Cenozoic	Cen. or Cz
centi (prefix)	c
centigram	cg
centiliter	cL
centimeter	cm
centimeter, cubed	cm^3
centimeter, square	cm^2
centimeter-gram-second (unit)	cgs
centipoise	cp
central daylight time	CDT
central standard time	CST
central time	CT
chalcedony	chal
chapter	chap.
chemical oxygen demand	cod
chi-square statistic	χ^2
choke	ck
chromite	Chr
circulated	circ
class	cl.
classification	classn.
claystone	clst.
cobble	cbl
coefficient	coef
cologarithm	colog
column	col.
communication(s)	commun.
compact disc	CD
Company (commercial)	Co.
compensated neutron log (hybrid)	CNL
completed, completion	comp
concentrate	conc
concentrated	concd
conductivity	cond or g
conference	conf.
conglomerate	Cgl. or cgl.
constant	const
contact	ctc
conventional inch of mercury	inhg
cooperation, cooperative	coop.
cored	crd
Corporation (commercial)	Corp.
corrected	cor
correlation coefficient	*r*
corundum	Crn
cosecant	csc
cosecant, hyperbolic	csch
cosine	cos
cosine, hyperbolic	cosh
cotangent, hyperbolic	coth
coulomb	C
counts per minute	c/min
Cretaceous	Cret. or K
cross-bedded	xbdd
cross-bedding	xbdg
cross-laminated	xlam
crystal	xl
crystalline	xln
crystalline, crystallographic	cryst
crystallographic axes	a, b, c
cubic feet of gas per day	CFGP/D
cubic foot (cu ft is obsolete)	ft^3
cubic inch (cu in. is obsolete)	in^3
curie	Ci
darcy	D
day	d
deci (prefix, one-tenth)	d
decigram	dg
deciliter	dL
decimeter	dm
decimeter, cubic	dm^3
decimeter, square	dm^2
degree	deg.
degree (symbol)	°
degrees of freedom	d.f.
deka (prefix, 10)	da
dekagram	dag
dekaliter	daL
dekameter	dam
dekameter, cubic	dam^3
dekameter, square	dam^2
density (relative)	d
depth	h
derrick floor	DF
development	devel.
Devonian	Dev. or D
diameter	diam. or d
different	diff
dilute	dil
diopside	Di
direct current	dc
direct-current (unit modifier)	d-c
discharge; rate of discharge; recharge	Q
disseminated	dissem
dissertation	dissert.

dissociation constant	K
dissolved oxygen	do
dissolved solids	ds
distribution	distrib.
district	dist
ditto (the same)	do.
divided by	÷
Doctor of Philosophy	Ph.D.
document	doc.
dollar	dol
dolomite	Dol
dozen	doz
dram	dr
drilling	drlg
drillstem test	DST
dry and abandoned	D&A
dry basis	db
dual induction-laterolog	DIL
dual laterolog	DLL
dyne	dyn
east	E
eastern daylight time	EDT
eastern standard time	EST
eastern time	ET
economic(al)	econ(s).
edition(s)	ed(s).
editor(s)	ed(s).
educational	educ.
efficiency	eff
electric(al)	elec
electron	e
elevation	elev
elevation of kelly bushing	EKB
energy	E
engineering	eng.
enstatite	En
Environmental Protection Agency	EPA
equal to	=
not equal to	≠
equilibrium constant	*K*
equivalent	equiv.
equivalent weight	equiv wt
erg	erg
estimated	est
evaporitic	evap
examination	exam.
experiment	expt
experimental	exptl
exposure	exp
extremely high frequency	EHF
faculty	fac
Fahrenheit, degree	°F
fayalite	Fa
feldspar	F
feldspathic	feld
ferrosilite (FeSiO3)	Fs
figure(s)	fig(s).
final flowing pressure	FF
final shut-in pressure	FSIP
flowed	FLWD
flowing pressure	FP
fluorescence	fluor
fluorite	Fl
foliated	fol
foot/feet	ft
foot, cubic	ft^3
foot cubic, per minute	ft^3/min
foot cubic, per second	ft^3/s
foot per minute	ft/min
foot per second	ft/s
foot per second cubed	ft/s^3
foot per second squared	ft/s^2
foot pound-force	ft/lbf
foot, square	ft^2
foot square, per minute	ft^2/min
foot square, per second	ft^2/s
foot-pound	ft-lb
foraminifera	foram.
force	*F*
formation	Fm. or fm.
formation density log (compensated)	FDC
Formation Tester	FT
forsterite	Fo
fracture	frac
fractured	frac
fragmental	frag
freezing point	fp
frequency	*f* or ν
friction, coefficient of	μ or *f*
gallon	gal
gallons per minute	gal/min
gallons per second	gal/s
gamma ray log	GRL
gas and oil cut water	G&OCW
gas cut	GC
gas cut mud	GCM
gas cut water	GCW
gas to oil ratio	GOR
gas to surface	GTSgas- and
oil-cut mud	G&OCM
gas-cut mud	GCM
gas-oil ratio	GOR
gauss	G
geochemical	geochem.
geodetic	geod.
geographic(al)	geog.
geologic(al)	geol.
Geological Society of America	GSA
geophysical	geophys.
giga (prefix, 1 billion)	G
glauconitic	glanc
government	govt.
graded elevation	gr

gradient	∇
grain	gr
gram	g
gram per cubic centimeter	g/cm^3
granite	gr
granodiorite	grd
granular	gran
graptolite	grap
gravitational acceleration, acceleration of free fall, local acceleration due to gravity	*g*
gravitational constant	*G*
gray (unit of measure for absorbed dose)	Gy
graywacke	gwke
greater than	>
not greater than	$\ngtr$
much greater than	$\gg$
greater than or equal to	$\geq$
greenstone	grnst
Greenwich civil time	GCT
Greenwich mean astronomical time	GMAT
Greenwich mean time	GMT
gross	gr
gross weight	gr wt
ground level, graded level	GL
group	Gp.
gypsiferous	gyp
half-life	$T^1/_2$
halite (NaCl)	Hl
heavily oil-cut mud	HOCM
hectare	ha
hecto (prefix, 100)	h
hectogram	hg
hectoliter	hL
hectometer	hm
hectometer, cubic	hm^3
hectometer, square	hm^2
height	h
hematite	Hem
hematitic	hem
hemic	H
henry	H
hertz (cycles per second)	hz
high frequency	HF
highly gas and oil cut mud	HG&OCM
highly oil and gas cut water	HO&GCW
historic(al)	hist.
horizontal	horiz
hornblende	Hbl
hornfels	hfls
horsepower	hp
horsepower-hour	hph
hour	h
hydrogen ion activity	pH
hydrogen ion concentration	pH
hydrologic(al)	hydrol.
hydrostatic pressure	HP
hypersthene	hy
identical with	$\equiv$
not identical with	$\not\equiv$
igneous	ign
ilmenite	Ilm
inch (when used with ft, lb, exponents, omit period)	in.
inch, cubic	in^3
inch per hour	in/h
inch per second	in/s
inch, square	in^2
inch-pound	in-lb
inclusion	incl
Incorporated (commercial)	Inc.
index of refraction	*n*
indices of refraction for biaxial crystals	n_x, n_y, and n_z
indices of refraction for uniaxial crystals	n_o and n_E
infinity	∞
infrared	ir
initial flowing pressure	IFP
initial potential	IP
initial potential flowing	IPF
initial potential pumping	IPP
initial production	IP
initial shut-in pressure	ISIP
inside diameter	id
insoluble	insol.
institute, institution	inst.
interbedded	intbdd
international	internat.
interval of time extending from the present into the past	years B.P.
intrusion	intr
investigation(s)	inv.
iron (metallic)	ir
irregular	ireg
joint	jnt
joule	j
junior	jr
Jurassic	Jur. or J
kaliophilite	KP
kelly bushing	kb
Kelvin	K
Kelvin (degree symbol improper)	K
kilo (prefix, 1,000)	k
kilogram	kg
kiloliter	kL
kilometer	km
kilometer, cubic	km^3
kilometer per hour	km/h
kilometer, square	km^2
knot (speed)	kn
laboratory	lab.
laminated	lam
latitude (abbreviated only when used with illustrations)	lat.
lenad	L
length	l
less than	<

much less than	$\ll$
not less than	$\not<$
less than or equal to	$\leq$
leucite	Lct
library	libr.
Library of Congress	LC
limestone	Ls. or ls.
limit	lim
liquid	liq
liter	L
liter per second	L/s
local standard time	LST
local time	LT
location	loc
logarithm	log
logarithm (common)	log
logarithm (natural)	$\log_e$ or ln
longitude (when used with lat, omit period; abbreviated only when used with figures; use "long." if may be confused with adjective)	long.
velocity; P-wave velocity	longitudinal v_p
low frequency	lf
magnetite	Mag
mass	m
mass number	*A*
Master of Arts	M.A.
Master of Science	M.S.
maximum	max
mean, a statistic to estimate the mean of lognormally distributed observations	*m*
mean sea level	m.s.l.
mean square error	M.S.E.
medium frequency	mf
mega (prefix, 1 million)	M
melting point	mp
member	Mbr. or mbr.
memoir	mem.
memorandum	memo
Mesozoic	Mes. or Mz
metamorphic	met
meter	m
meter, cubic	m^3
meter, square	m^2
micro (prefix, one-millionth)	μ
micro-laterolog	MLL
microbar	μbar
microgram	μg
microlog	ML
micrometer	μm
micrometer, cubic	μm^3
micrometer, square	μm^2
micromicron (obsolete, use picometer, pm)	μμ
microsecond	μs
mile	mi
mile per hour	mi/h
mile, square	mi^2
mile(s) per gallon	mi/gal
milli (prefix, one-thousandth)	m
millibar	mbar
millidarcy, millidarcies	md
milliequivalent	meq
milligram	mg
milliliter	mL
millimeter	mm
millimeter, square	mm^2
million (as per oil industry)	MM
million cubic feet of gas	MMCFG
million cubic feet per day	MMcf/d, MMcf/D, MMCFGD
million cubic feet (million = 10^6)	MMcf
million gallons per day	MMgal/d
million years ago (geologic ages only)	Ma
millions of years (intervals of geologic time)	myr
millisecond	ms
mineralogical	mineralog.
minimum	min
minus	-
minus or plus	±
minute(s) (time)	min
miscellaneous	misc.
Mississippian	Miss. or M
mitic	M
imodified Mercalli	MM
molarity, molar (concentration)	*M*
mole (unit of substance)	mol
molecular weight	mol. wt
month	mo.
mountain, mountains	mtn., mts.
mountain daylight time	MDT
mountain standard time	MST
mountain time	MT
moving in rig	MIR
mud cake	MC
mud cut water	MCW
mud filtrate	MF
mud log	ML
mud weight	MW
mudstone	mdst.
multiplied by	x
muscovite	Ms
nano (prefix, one-billionth)	n
nanometer (millimicron, obsolete)	nm
nanosecond	ns
national	natl.
National Oceanic and Atmospheric Administration	NOAA
National Science Foundation	NSF
natural log or logarithm	n.l.
Natural Resources Conservation Service	NRCS
nautical mile	nmi
nepheline	Ne
neutron	n
new genus	n. gen.
new series	new ser.
new species	n. sp.
new variety	n. var.
newton	N

no data	ND
no record, not reported	NR
nodular	nod
none available	n.a.
normality, normal (concentration)	N
north	N
not available, not applicable	NA
not determined	n.d.
number of observations (sample size)	*n*
number of observations in a population	N
number(s)	no(s)
oil and gas	O&G
oil and salt water	O&SW
oil cut	OC
oil-cut mud	OCM
oil-cut water	OCW
oil, gas and mud cut water	OG&MCW
oil gravity in API degrees	GTY
oil- and gas-cut mud	O&GCM
olivine	Ol
olivine	O
oolitic	oöl
Ordovician	Ord. or O
orthoclase	Or
ounce (avoirdupois)	oz
outcrop	otcp
outside diameter	od
oxidation-reduction potential	Eh
Pacific daylight time	PDT
Pacific standard time	PST
Pacific time	PT
packer	pkr
page(s)	p.
paleogeographic(al)	paleogeog.
paleontologic(al)	paleont.
Paleozoic	Pal. or Pz
paragraph	par.
part(s)	pt(s).
part(s) per billion	ppb
part(s) per million	ppm
particle-size diameter	Φ
pascal	Pa
pebble	pbl
Pennsylvanian	Penn. or IP
percent	pct
percent water saturation in flushed zone	S_{xo}
percent water saturation in uninvaded zone	Sw
perforated	perf
perforations	perfs
peridotite	perid
permeability	perm
Permian	Perm. or P
perovskite	Prv
petrographic(al)	petrog.
petrologic(al)	petrol.
phenocryst	phen
phosphatic	phos
physiographic(al)	physiog.
pi (mathematical constant)	ϖ
picosecond	ps
pint	pt
plagioclase	Pl
plugged and abandoned	P&A
plugged back	PB
plus	+
plus or minus	±
point	pt
Poisson ratio	ν or μ
population coefficient of variation	γ
population mean	μ
population standard deviation	σ
porphyritic	porph
post meridiem (afternoon)	p.m.
potassium metasilicate	ks
pound	lb
pound apothecary	lb ap
pound avoirdupois	lb avdp
pound per cubic foot	lb/ft^3
pound per foot	lb/ft
pound per square foot	lb/ft^2
pound-force foot	lbf/ft
pound-force per foot	lbf/ft
pound-force per square foot	lbf/ft^2
pound-force per square inch	lbf/in^2
pounds per square inch	psi
Precambrian	Prec. or p€
preliminary	prelim.
pressure	*P* or *p*
primary wave	*P*-wave
probable	prob
proceedings	proc.
producing gas well	PGW
producing oil well	POW
production drillstem test	PDST
productivity index	PI
Professor (used in a title)	Prof.
project	proj
publication(s)	pub(s).
pyrite	Py
pyritized	py
pyroxene	P
quadrangle	quad.
quadrillion (10^{15})	quad
quart	qt
quarterly	quart.
quartz	Qtz
quartzite	Qtz. or qtz.
Quaternary	Quat. or Q
radian	rad
radiocarbon	^{14}C
radius	r or *R*
railroad	RR.
railway	Ry.
range(s) (legal land term)	R(s).
rankine	R
rankine, degree	°R
ratio; is to	:
reaming	rmg

reaumur, degree	°R
reconnaissance	reconn.
recovered	rec
recrystallized	recryst
regular	reg
report(s)	rept(s).
resistivity of the mud cake	RMC
resistivity of the mud filtrate	RMF
resistivity of the mud (drilling)	RM
resistivity of the flushed zone	R_{xo}
resistivity of the fm. water	Rw
review(s)	rev.
revolutions per minute	r/min
revolutions per second	r/s
Reynolds number	R
rhyolite	rhy
Road (in address only)	Rd.
rocks	rx
root mean square	rms
rounded	rnd
rutile	Rt
Saint, Sainte, Saints	St. Ste., SS.
salt water	SW
sample coefficient of variation	*C*
sample mean	ϖ
sample mean of logarithms	$\bar{u}$
sample standard deviation	*s*
sample variance	s^2
sample variance of logarithms	s^2
sampling variability	ξ_R
sandstone	Ss. or ss.
saturated, saturation	sat
science(s), scientific	sci.
secant	sec
secant, hyperbolic	secj
second (time)	s
second-foot	sAft
secondary	sec
secondary wave	*S*-wave
section(s) (subdivision of township)	sec(s).
sedimentary	sed
seismographic	seismog.
seismologic(al)	seismol.
self-potential	SP
series	ser.
serpentine	Srp
session	sess.
shale	Sh. or sh.
shear velocity; S-wave velocity	v_s
shut in	SI
shut-in bottom-hole pressure	SIBHP
shut-in gas well	SIGW
shut-in pressure	SIP
Sidewall Neutron Log (n-e)	SNP
siliceous	sil
siltstone	Sts., sts. or sltst
Silurian	Sil. or S
sine	sin
sine, hyperbolic	sinh
slightly gas and water cut mud	SG&WCM
slightly gas cut mud	SGCM
slightly oil, gas and mud cut water	SOG&MCW
slug	slug
society, societies	soc., socs.
sodium carbonate (Na2CO3)	nc
sodium metasilicate	ns
soluble	sol
solution	soln
south	S
species (singular)	sp.
(plural)	spp.
specific gravity	sp gr
specific heat	sp ht
specific heat capacity	*c*
specific volume	sp vol
speleological	speleol
Spherically Focused Log	SFL
spinel	Spl
square	sq
square millimeter	mm^2
Square (in address or as part of the place name)	Sq.
standard	std
standard deviation	σ
standard temperature and pressure	STP
station	sta
station(s) (used only with numbers)	sta(s).
stock-tank barrel	STB
strain, shear	γ
stratigraphic(al)	strat.
Street (in addresses only)	St.
stress, normal	σ
stress, shear	*r*
structure	struc
Student's t-statistic	*t*
sum	Σ
sum of squares	SS
summary	summ.
superhigh frequency	SHF
Superintendent	Supt.
swabbed	swbd
tabular	tab
tangent	tan
tangent, hyperbolic	tanh
temperature	temp
temporarily abandoned	TA
tera (prefix, 1 trillion)	G
Terrace (in addresses only)	Ter.
Territory, Territories, Territorial	Terr.
Tertiary	Tert. or T
testing	tstg
thenardite, (Na2SO4)	th
therefore	$\therefore$
thickness	*t* or *d*
thousand (7k = 7,000)	k
thousand (as per oil industry)	M
thousand cubic feet gas	MCFG
thousand cubic feet	Mcf, MCF
thousand cubic feet per day	Mcf/d, Mcf/D,

	MCFD
thousand years ago (geologic ages only)	ka
thousands of years (interval of geologic time)	kyr
tilic (shene)	T
time	*t*
ton	ton
ton, metric	t, m
tonne (metric ton)	t, m
too small to measure	tstm
topographic(al)	topog.
total depth	TD
Township(s) (legal land division)	T.
trace	tr.
Triassic	Ŧ
trillion cubic feet of gas	TCFG
trillion cubic feet (trillion = 10^{12})	Tcf
trillion cubic ft	Tft^3
true resistivity	Rt
true vertical depth	TVD
tubing pressure	TP
U.S. Department of Agriculture	USDA
U.S. No. 40, U.S. Highway No. 40	U.S. 40
ultrahigh frequency	UHF
ultraviolet	uv
unconformity	unconf
undetermined	undet.
United States (adjective)	U.S.
United States of America	U.S.A.
universal time	u.t.
unknown quantity	x
vacuum	vac
vapor pressure	vp
variegated	vrgt
vegetation	veg
velocity	ν or υ
velocity, P-wave	ν_p
versus, against	vs.
vertebrate	vrtb
very high frequency	VHF
very low frequency	VLF
very slightly gas cut mud	VSGCM
very slightly oil cut mud	VSOCM
volcanic(s)	Vol., volc. or vol.
volt	V
volume (publishing)	v.
water	wtr
water cushion	WC
water cut mud	WCM
water injection well	WIW
watt	W
wavelength	λ
weight	wt
weight per volume	w/v
weight per weight	w/w
west	W
wildcat	WC
wollastonite	Wo
xenolith	xen
yard	yd
yard, cubic	yd^3
yard, square	yd^2
year	yr
years before present (14C age dates only)	yr B.P.
yields	→
Young's modulus of elasticity	E
zircon	Zrn
zoologic(al)	zool.

UNITED STATES

States and possessions	Customary abbreviations	Postal Service abbreviations
Alabama	Ala.	AL
Alaska	Alaska	AK
Arizona	Ariz.	AZ
Arkansas	Ark.	AR
California	Calif.	CA
Colorado	Colo.	CO
Connecticut	Conn.	CT
Delaware	Del.	DE
Florida	Fla.	FL
Georgia	Ga.	GA
Hawaii	Hawaii	HI
Idaho	Idaho	ID
Illinois	Ill.	IL
Indiana	Ind.	IN
Iowa	Iowa	IA
Kansas	Kans.	KS
Kentucky	Ky.	KY
Louisiana	La.	LA
Maine	Maine	ME
Maryland	Md.	MD
Massachusetts	Mass.	MA
Michigan	Mich.	MI
Minnesota	Minn.	MN
Mississippi	Miss.	MS
Missouri	Mo.	MO
Montana	Mont.	MT
Nebraska	Nebr.	NE
Nevada	Nev.	NV
New Hampshire	N.H.	NH
New Jersey	N.J.	NJ
New Mexico	N.M.	NM
New York	N.Y.	NY
North Carolina	N.C.	NC
North Dakota	N. Dak.	ND
Ohio	Ohio	OH
Oklahoma	Okla.	OK
Oregon	Oreg.	OR
Pennsylvania	Pa.	PA
Rhode Island	R.I.	RI
South Carolina	S.C.	SC
South Dakota	S. Dak.	SD
Tennessee	Tenn.	TN
Texas	Tex.	TX
Utah	Utah	UT
Vermont	Vt.	VT
Virginia	Va.	VA
Washington	Wash.	WA
West Virginia	W. Va.	WV
Wisconsin	Wis.	WI
Wyoming	Wyo.	WY
District of Columbia	D.C.	DC
Guam	Guam	GU
Puerto Rico	P.R.	PR
Virgin Islands	V.I.	VI

CHEMICAL ELEMENTS

actinium ..... Ac
aluminum ..... Al
americium ..... Am
antimony ..... Sb
argon ..... Ar
arsenic ..... As
astatine ..... At
barium ..... Ba
berkelium ..... Bk
beryllium ..... Be
bismuth ..... Bi
boron ..... B
bromine ..... Br
cadmium ..... Cd
calcium ..... Ca
californium ..... Cf
carbon C
cerium ..... Ce
cesium ..... Cs
chlorine Cl
chromium ..... Cr
cobalt ..... Co
columbium ..... Cb
copper ..... Cu
curium ..... Cm
deuterium ..... D
dysprosium ..... Dy
einsteinium ..... Es
erbium ..... Er
europium ..... Eu
fermium ..... Fm
fluorine ..... F
francium ..... Fr
gadolinium ..... Gd
gallium ..... Ga
germanium ..... Ge
gold ..... Au
hafnium ..... Hf
helium ..... He
holmium ..... Ho
hydrogen ..... H
indium ..... In
iodine I
iridium ..... Ir
iron ..... Fe
krypton ..... Kr
lanthanum ..... La
lawrencium ..... Lr
lead ..... Pb
lithium Li
lutetium ..... Lu
magnesium ..... Mg
manganese ..... Mn
mendelevium ..... Md
mercury ..... Hg
molybdenum ..... Mo
neodymium ..... Nd
neon ..... Ne
neptunium ..... Np
nickel ..... Ni
niobium ..... Nb
nitrogen ..... N
nobelium ..... No
osmium ..... Os
oxygen ..... O
palladium ..... Pd
phosphorus ..... P
platinum ..... Pt
plutonium ..... Pu
polonium ..... Po
potassium ..... K
praseodymium ..... Pr
promethium ..... Pm
protactinium ..... Pa
radium ..... Ra
radon ..... Rn
rhenium ..... Re
rubidium ..... Rb
ruthenium ..... Ru
samarium ..... Sm
scandium ..... Sc
selenium ..... Se
silicon ..... Si
silver ..... Ag
sodium ..... Na
strontium ..... Sr
sulfur ..... S
tantalum ..... Ta
technetium ..... Tc
tellurium ..... Te
terbium ..... Tb
thallium ..... Tl
thorium ..... Th
thulium ..... Tm
tin ..... Sn
titanium ..... Ti
tritium ..... T
tungsten ..... W
uranium ..... U
vanadium V
xenon ..... Xe
ytterbium ..... Yb
yttrium ..... Y
zinc ..... Zn
zirconium ..... Zr

APPENDIX E

PROBLEM WORDS AND PHRASES

Words That are Commonly Misused or Confused

a/an
accept/except
affect/effect
all ready/already
all right/alright
all together/altogether
alternate(ly)/alternative(ly)
altitude/elevation
among/between
assure/ensure/insure
average/mean/median
because/since
bench mark/benchmark
beside/besides
can/may
capital/capitol
cite/sight/site
city's/cities
compose/comprise/consist
continual(ly)/continuous(ly)
course/coarse
data/datum
drier/dryer
each/either
farther/further
good/well
historic/historical
in/into
its/it's
lay/lie
like/such as
manner/manor
method/methodology
on to/onto
oral/verbal
past/last
personal/personnel
principal/principle
regardless/irregardless
relation/relationship
shall/should
shear/sheer
set/sit
some time/sometime
stationary/stationery
than/then
that/which
their/there/they're
these/this
to/too/two
weather/whether
who(ever)/whom(ever)
who's/whose

Compound Words

aftershock
backfill
backhoe
backset
backshore
backwater
badlands
borehole
coalfield
downcutting
downdip
downgradient
downslope
downstream
downthrown
easternmost
fieldwork
floodplain
floodwater
footwall
foreset
foreshock
groundmass
guidebook
headwall
headwater
highland
hillslope
highstand
hillwash
horsetail
lakebed
lakeshore
lakeside
landform
lowstand
midslope
mudflow
mudslide
nearshore
northernmost
offshore
orebody
outcrop
outwash
overthrust
photogeologic
photointerpretation
photomap
photomosaic
postdate
radiocarbon
rimrock
riprap
roadbed
rockslide
semiconsolidated
sheetflood
shoreline
sinkhole
snowline
snowmelt
southernmost
statewide
stillstand
streamflood
streamflow
streamhead
timberline
toolpusher
topset
topsoil
township
updip
upslope
upstream
upthrown
upwarp
upwelling
watercourse
waterfall
watershed
wastewater
westernmost
wetlands
worldwide

Two Words

(Hypenated When Used As Adjectives)

alluvial fan
ash flow
base level
base line
bench mark (survey)
borrow pit
cable tool
cap rock
cell wall
center line
chill zone
coal bed
cross section
cut and fill
cut slope
debris flood
debris flow
debris slide
dip angle
drain field
fall line
field trip
flash flood
fly ash
ground water
hanging wall
hard rock
head wall
hinge line
lake plain
mud pump
oil field
rill wash
road cut
road log
road metal
rock fall
sea level
slope wash
snow course
snow cover
soft rock
stream bank
stream bed
stream channel
strike slip
surface water
wall rock
water table
Web site

Words That Are Always Hyphenated

acre-foot
by-product
co-author
cross-bed
cross-bedding
cross-grading
cross-stratification
cul-de-sac
double-serrate
foot-pound
half-life
kilowatt-hour
rip-up (structure; clast)
terra-cotta
time-correlation
twenty-one through ninety-nine
two-thirds (and all fractions)

Simplification Of Words

accomplished/did, done
accordingly/so
additional/more
additionally/also
analogous to/similar to, like
approximately/about
circumvent/avoid
commence/start
component/part
concur/agree
configuration/shape
consequently/so
constrained/limited
construct/build
delineate/outline, depict
disseminate/spread
employ/use
encounter/meet
exemplify/show
exhibit/show
feasible/likely, possible
fracture/break
furthermore/besides
hence/so
imminent/near
impacted/affected
implement/begin
initiate/start
likewise/also
manifest/show
moreover/besides
nevertheless/but
periphery/edge, boundary
portion/part
principal/chief, main
prioritized/ranked, ordered
ramification/result
subsequently/later
substantially/mainly
substantiate/verify
terminate/end
utilize/use

Simplification Of Phrases

a great number of times/often
a greater number of/more
a large number of/many
a little less than/almost
a majority of/most
a small number of/few
a sufficient number of/enough
absolutely essential/essential
actual experience/experience
all of a sudden/suddenly
along the lines of/like
as a general rule/usually
as a matter of fact/in fact
as early as possible/soon
as regards/about
at a later date/later
at present/now
at that time/then
at the present time/now
at this point in time/now
at regular intervals/regularly
at the conclusion of/after
at the rear of/behind
at which time/when
basic fundamentals/fundamentals
beyond a doubt/doubtless
by the time that/when
by way of illustration/for example
call attention to the fact/remind
completely destroyed/destroyed
despite the fact that/although
detailed information/details
draw to a close/end
due to the fact that/because
during the course of/during
during the time that/when
during which time/while
empty cavity/cavity
estimated at about/about
estimated roughly at/estimated
few in number/few
filled to capacity/full
finally ended/ended
for the purpose of/for
for the reason that/because
for this reason/so
from time to time/occasionally
heat up/heat
if that were the case/if
important essentials/essentials
in accordance with/by, under
in addition to/also, besides
inasmuch as/because, since
in a logical fashion/logically
in connection with/with
in consideration of/because
in excess of/more, greater
in favor of/for
in few instances/seldom
in many cases/often
in most cases/usually
in order to/to
in other words/or
in reference to/about
in regard to/about
in the event of/if
in the event that/should
in the first place/first
in the matter of/about
in the nature of/like
in the near future/soon
involve the necessity of/require
is representative of/typifies
it is anticipated that/it is expected
it is apparent that/apparently
it is clear that/clearly
it is evident that/evidently
it is obvious that/obviously
it is plain that/plainly
it is recommended that/we recommend
large-sized bucket/large bucket
last of all/last
lift up/lift
make an investigation of/investigate
make contact with/meet
major portion of/most
merged together/merged
of the opinion that/believe
off of/off
on a daily basis/daily
on account of/because
on behalf of/for
on the other hand/conversely
on two different occasions/twice
outside of/except
past experience/experience
period of time/period, interval
pertaining to/about
prior to/before
pursuant to/following
qualified expert/expert
red in color/red
revise downward/lower
specific example/example
subsequent to/after, following
there is no doubt that/doubtless
through the use of/by
ultimately resulted in/resulted in
until such time as/until
up to now/formerly
with reference to/about
with regard to/about, regarding
with respect to/about, respecting
with the exception of/except

APPENDIX F

UNITS OF MEASUREMENT: U.S. CUSTOMARY UNITS AND INTERNATIONAL SYSTEM OF UNITS (SI)

U.S. Customary Units and their Equivalents

Length

inch	in.	0.083 ft	0.027 yd
foot	ft	12 in.	0.33 yd
yard	yd	3 ft	36 in.
rod	rd	16.50 ft	5.50 yd
mile, statute	mi	5280 ft	1760 yd
mile, nautical	nmi	6076.115 ft	2025.372 yd

Area

square inch	in^2	0.0069 ft^2	0.00077 yd^2
square foot	ft^2	144 in^2	0.111 yd^2
square yard	yd^2	9 ft^2	1296 in^2
square rod	rd^2	272.25 ft^2	30.25 yd^2
acre	-	43,560 ft^2	4840 yd^2
square mile	mi^2	640 acres	3,097,600 yd^2

Volume

cubic inch	in^3	0.00058 ft^3	0.000021 yd^3
cubic foot	ft^3	1728 in^3	0.0370 yd^3
cubic yard	yd^3	27 ft^3	46,656 in^3

Mass (Avoirdupois)

grain	gr	0.036 dr	0.002285 oz
dram	dr	27.343 gr	0.0625 oz
ounce	oz	16 dr	437.5 gr
pound	lb	16 oz	7000 gr
ton, short	-	2000 lb	-
ton, long	-	2240 lb	-

Mass (Troy)

grain	gr t	0.002083 oz	-
ounce	oz t	480 gr	-
pound	lb t	12 oz	5760 gr

Capacity (U.S. Liquid Measure)

fluid ounce	fl oz	1.804 in^3	-
pint	pt	16 fl oz	28.875 in^3
quart	qt	2 pt	57.75 in^3
gallon	gal	4 qt	231 in^3
barrel (petroleum)	bbl	42 gal	5.615 ft^3
acre-foot	acre-ft	43,560 ft^3	-

International System of Units (SI)
(Modern Metric System)

The International System of Units (*Le Système International d'Unitès,* abbreviated SI) uses a combination of base units, prefixes (multiplication factors), and derived units. For example, the SI base unit for length is the meter (m); combining the base unit with the prefix kilo (k, = 1000) gives kilometer (km, = 1000 meters). Similarly, the SI derived unit for veolcity is meter per second (m/s). The following tables give SI base units, prefixes, and non-SI units that are permissible for use within SI.

SI Base Units

Quantity	Unit	Symbol
length	meter	m
mass	kilogram*	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

*Kilogram is the only SI base unit whose name, for historical reasons, contains a prefix. Multiples and submultiples of the unit of mass are formed by attaching prefixes to the word gram or prefix symbols to the symbol g.

Prefixes and their Symbols for SI Units

Multiplication factor			Prefix	Symbol
1,000 000 000 000 000 000	=	10^{18}	exa	E
1,000 000 000 000 000	=	10^{15}	peta	P
1,000 000 000 000	=	10^{12}	tera	T
1,000 000 000	=	10^{9}	giga	G
1,000 000	=	10^{6}	mega	M
1000	=	10^{3}	kilo	k
100	=	10^{2}	hecto	h
10	=	10^{1}	deca	da
0.1	=	10^{-1}	deci	d
0.01	=	10^{-2}	centi	c
0.001	=	10^{-3}	milli	m
0.000 001	=	10^{-6}	micro	μ
0.000 000 001	=	10^{-9}	nano	n
0.000 000 000 001	=	10^{-12}	pico	p
0.000 000 000 000 001	=	10^{-15}	femto	f
0.000 000 000 000 000 001	=	10^{-18}	atto	a

Non-SI Units Permissible Within SI

Quantity	Name	Symbol	Definition
area	hectare	ha	1 ha = 1 hm^2 = 10,000 m^2
mass	metric ton, tonne	t, m	1 t, m = 1000 kg
plane angle	degree	°	1° = (π/180) rad
	minute	'	1' = (π/10,800) rad
	second	"	1"= (π/648,000) rad
temperature	degree Celsius	°C	0°C = 273.15 K
time	minute	min	1 min = 60 s
	hour	h	1 h = 3600 s
	day	d	1 d = 86,400 s
	year	a	-
volume	liter	L	1 L = 1 dm^3

Selected Conversion Factors Between U.S. Customary and SI Units

U.S. Customary Unit	Conversion Factor	Metric Unit	Conversion Factor	U.S. Customary Unit
Length				
inch (in.)	2.540	centimeter (cm)	0.3937	inch (in.)
foot (ft)	0.3048	meter (m)	3.281	foot (ft)
yard (yd)	0.9144	meter (m)	1.094	yard (yd)
mile, statute (mi)	1.609	kilometer (km)	0.6214	mile, statute (mi)
mile, nautical (nmi)	1.852	kilometer (km)	0.5400	mile, nautical (nmi)
Area				
square inch (in^2)	6.452	square centimeter (cm^2)	0.1550	square inch (in^2)
square foot (ft^2)	0.09290	square meter (m^2)	10.76	square foot (ft^2)
square yard (yd^2)	0.8361	square meter (m^2)	1.196	square yard (yd^2)
acre	4047	square meter (m^2)	0.0002471	acre
acre	0.4047	square hectometer (hm^2) (= hectare [ha])	2.471	acre
square mile (mi^2)	2.590	square kilometer (km^2)	0.3861	square mile (mi^2)
Volume				
cubic inch (in^3)	16.39	cubic centimeter (cm^3)	0.06102	cubic inch (in^3)
cubic foot (ft^3)	0.02832	cubic meter (m^3)	35.31	cubic foot (ft^3)
cubic yard (yd^3)	0.7646	cubic meter (m^3)	1.308	cubic yard (yd^3)
pint (pt)	0.4732	cubic decimeter (dm^3) (= liter [L])	2.113	pint (pt)
quart (qt)	0.9464	cubic decimeter (dm^3) (= liter [L])	1.057	quart (qt)
gallon (gal)	3.785	cubic decimeter (dm^3) (= liter [L])	0.2642	gallon (gal)
barrel (bbl), petroleum	0.1590	cubic meter (m^3)	6.290	barrel (bbl)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm^3)	810.7	acre-foot (acre-ft)

Selected U.S. Customary – SI Conversion Factors – continued

U.S. Customary Unit	Conversion Factor	Metric Unit	Conversion Factor	U.S. Customary Unit
Volume per unit time (includes flow)				
cubic foot per second (ft^3/s)	28.32	cubic decimeter per second (dm^3/s) (=L/s)	0.03531	cubic foot per second (ft^3/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)
gallon per minute (gal/min)	0.06309	cubic decimeter per second (dm^3/s) (=L/s)	15.85	gallon per minute (gal/min)
gallon per minute (gal/min)	0.00006309	cubic meter per second (m^3/s)	15,850	gallon per minute (gal/min)
barrel per day (bbl/d), petroleum	0.001840	cubic decimeter per second (dm^3/s) (=L/s)	543.4	barrel per day (bbl/d), petroleum
Mass				
ounce avoirdupois (oz avdp)	28.35	gram (g)	0.03527	ounce avoirdupois (oz avdp)
pound avoirdupois (lb avdp)	0.4536	kilogram (kg)	2.205	pound avoirdupois (lb avdp)
ton, short (2000 lb)	0.9072	megagram (Mg)	1.102	ton, short (2000 lb)
ton, long (2240 lb)	1.016	megagram (Mg)	0.9842	ton, long (2240 lb)
Pressure				
pound-force per square inch (lbf/in^2)	6.895	kilopascal (kpa)	0.1450	pound-force per square inch (lbf/in^2)
atmosphere, standard (atm)	101.3	kilopascal (kpa)	0.0009869	atmosphere, standard (atm)
bar	100	kilopascal (kpa)	0.01	bar
inch of mercury at 60°F (in. Hg)	3.377	kilopascal (kpa)	0.2961	inch of mercury at 60°F (in. Hg)
Temperature				
degree Fahrenheit (°F)	(°F + 459.67)/1.8	kelvin (K)	(K x 1.8) - 459.67	degree Fahrenheit (°F)
degree Fahrenheit (°F)	(°F - 32)/1.8	degree Celsius (°C)	(°C x 1.8) + 32	degree Fahrenheit (°F)

APPENDIX G

COMMON EDITING SYMBOLS USED AT THE UGS

or [ ]	Delete or take out	≡	Use capital letter(s)
∧	Insert a word, phrase, or punctuation mark	↓	Use lowercase letter(s)
⌐⌐	Transpose letters, words, or phrases.	⌢	Close up a space
←[	Move to the left	#	Add a space
]→	Move to the right	¶	Make a new paragraph
stet	Retain letter, word, or other matter marked for corrections or omission (nullifies editorial comment)		

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