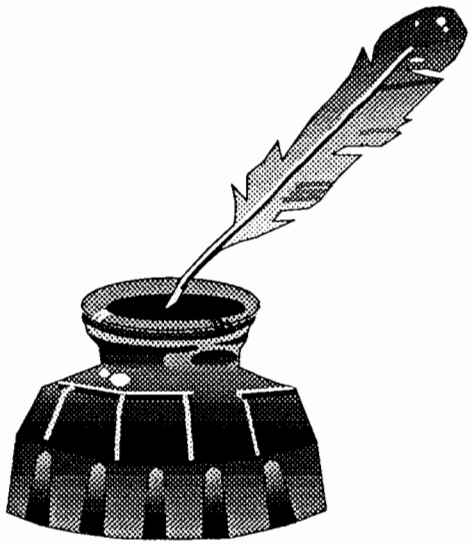
GUIDE FOR THE PREPARATION OF REPORTS

FOR THE

UTAH GEOLOGICAL SURVEY

By
William R. Lund



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THE UTAH GEOLOGICAL SURVEY is organized into three geologic programs with Administration, Editorial, and Computer Resources providing necessary support to the programs. The ECONOMIC GEOLOGY PROGRAM undertakes studies to identify coal, geothermal, uranium, hydrocarbon, and industrial and metallic mineral resources; to initiate detailed studies of the above resources including mining district and field studies; to develop computerized resource data bases; to answer state, federal, and industry requests for information; and to encourage the prudent development of Utah's geologic resources. The APPLIED GEOLOGY PROGRAM responds to requests from local and state governmental entities for engineering geologic investigations; and identifies, documents, and interprets Utah's geologic hazards. The GEOLOGIC MAPPING PROGRAM maps the bedrock and surficial geology of the state at a regional scale by county and at a more detailed scale by quadrangle. Information Geologists answer inquiries from the public and provide information about Utah's geology in a non-technical format.

THE UGS manages a library which is open to the public and contains many reference works on Utah geology and many unpublished documents on aspects of Utah geology by UGS staff and others. The UGS has begun several computer data bases with information on mineral and energy resources, geologic hazards, stratigraphic sections, and bibliographic references. Most files may be viewed by using the UGS Library. The UGS also manages a sample library which contains core, cuttings, and soil samples from mineral and petroleum drill holes and engineering geology investigations. Samples may be viewed at the Sample Library or requested as a loan for outside study.

The UGS publishes the results of its investigations in the form of maps, reports, and compilations of data that are accessible to the public. For information on UGS publications, contact the UGS Sales Office, 2363 South Foothill Drive, Salt Lake City, Utah 84109-1491, (801) 467-7970.

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GUIDE FOR THE PREPARATION OF REPORTS FOR THE UTAH GEOLOGICAL SURVEY

by William R. Lund
Utah Geological Survey

FOREWORD

The Utah Geological Survey is mandated to gather, interpret, and distribute information on Utah's geology, geologic hazards, topography, and geologic resources. Such information is essential to the public, industry, resource managers, scientists, and decision makers of all kinds. We as scientists and as public servants have not adequately fulfilled our assigned task until the results of UGS studies are communicated effectively to our intended audiences in a clear, concise, and understandable manner. To that end, the UGS is committed to producing geologic reports of the greatest accuracy and highest quality, regardless of whether the report is a lengthy monograph or a one-page memorandum.

This *Guide for the Preparation of Reports for the Utah Geological Survey* will assist UGS authors in producing geologic reports of the required clarity and quality. The Guide presents the policies governing the writing, review, and publication of UGS reports, and provides consistent editorial standards to help authors with the "nuts and bolts" of report preparation. Although extensive, the Guide is neither exhaustive nor dogmatic. Utah Geological Survey authors are expected to be as diligent and creative in writing their reports as they are in planning and conducting their geologic studies. This Guide is intended to allow authors the flexibility to be creative, while ensuring that all UGS reports share the basic elements of our publication style in common. How quickly a report moves through the UGS review and publication process will, in some measure, depend on how well authors incorporate these style elements in their manuscripts.

I strongly encourage all authors writing for the UGS to familiarize themselves with the contents of this Guide and to refer to it often as they prepare their own reports or review the work of their colleagues.

M. Lee Allison, Director
February, 1992

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UTAH GEOLOGICAL SURVEY

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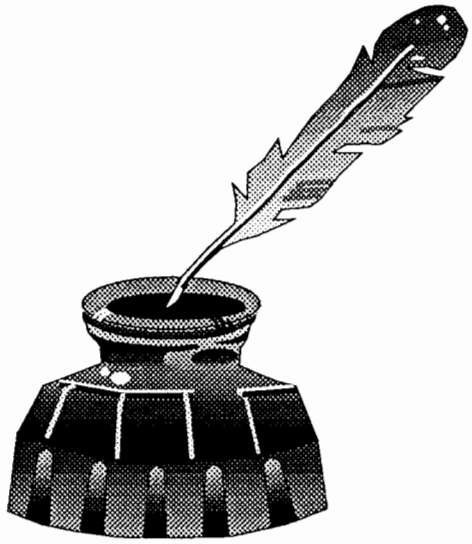
William R. Lund



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ABSTRACT

Reports on the geology of Utah are the principal product of the Utah Geological Survey (UGS). Utah Geological Survey reports 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 process and the responsbilities of the individuals (author, senior geologist, peer reviewers, deputy director, director, and editor) involved in the publication of UGS reports, (2) a list of standard reference works used in the preparation of UGS reports, (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 description of UGS publication series formats, 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 plagiarisim and give proper credit for the work of others, define the required steps and individual responsibilities in the UGS publication process, establish requirements for obtaining and documenting permission to use copyrighted or proprietary material, and identify the procedures authors must follow when publishing outside of the Utah Geological Survey.

INTRODUCTION

The Utah Geological Survey (UGS) publishes reports on the geology of Utah. The reports range from brief technical reports of limited distribution to monographs intended to stand as the definitive work on a geologic topic for many years. Regardless of the length or purpose of the report, the UGS' 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 of the desired quality.

No single set of editorial standards can meet the requirements of all scientific organizations (Mathewson, 1981; Cochran and others, 1984; Geological Society of America, 1985; Bates, 1988; Day, 1988; New Mexico Bureau of Mines and Mineral Resources, 1988; Beavers, 1990; Freeman and Bacon, 1990). Each organization that publishes reports on a regular basis has its own specialized editorial needs and must establish standards to meet those needs. 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.

Suggestions to Authors of the Reports of the United States Geological Survey (seventh edition) (Hansen, 1991) was the principal source of information used in compiling this guide. Utah Geological Survey authors are referred to that publication if additional information about preparing geologic reports is required. **However, be advised that this guide is not everywhere consistent with Suggestions to Authors Seven, and, where differences exist, this guide takes precedence when preparing UGS reports.** Other primary sources of information used in compiling this guide include the *United States Government Printing Office Style Manual 1984; The Chicago Manual of Style (thirteenth edition); Shipley Associates Technical Writing Manual;* and *Shipley Associates Style Guide.* The Selected Bibliography lists secondary sources of information. Appendix A provides additional resources and a suggested reading list.

In addition to the references listed above, the UGS uses three other publications as standard references in the report publication process. They are *Webster's Third New International Dictionary of the English Language (unabridged seventh edition); the American Geological Institute Glossary of Geology (third edition);* and the *North American Stratigraphic Code (1983).* Authors should consult these references, or their subsequent editions and revisions, concerning matters of spelling, geologic terminology, and the naming of rock-stratigraphic units.

THE UGS PUBLICATION PROCESS

The goal of the UGS publication process is to produce reports of the highest technical and editorial quality on the geology of Utah. The publication process is a team effort that normally involves the author, the author's senior geologist, peer reviewers, the deputy director, director, and editor (figure 1). Each team member has specific duties and responsibilities to fulfill if the UGS is to produce the best possible publications.

This guide provides a consistent set of editorial standards and policies for the preparation of UGS reports. Issues of technical adequacy and completeness are resolved through the publication review process. The publication review process consists of author-initiated informal peer reviews, a thorough technical and editorial review by the senior geologist and, for formal UGS publications, a minimum of one formal peer review by a technical expert (see Senior Geologist and Peer Review sections, figure 1, and appendix B).

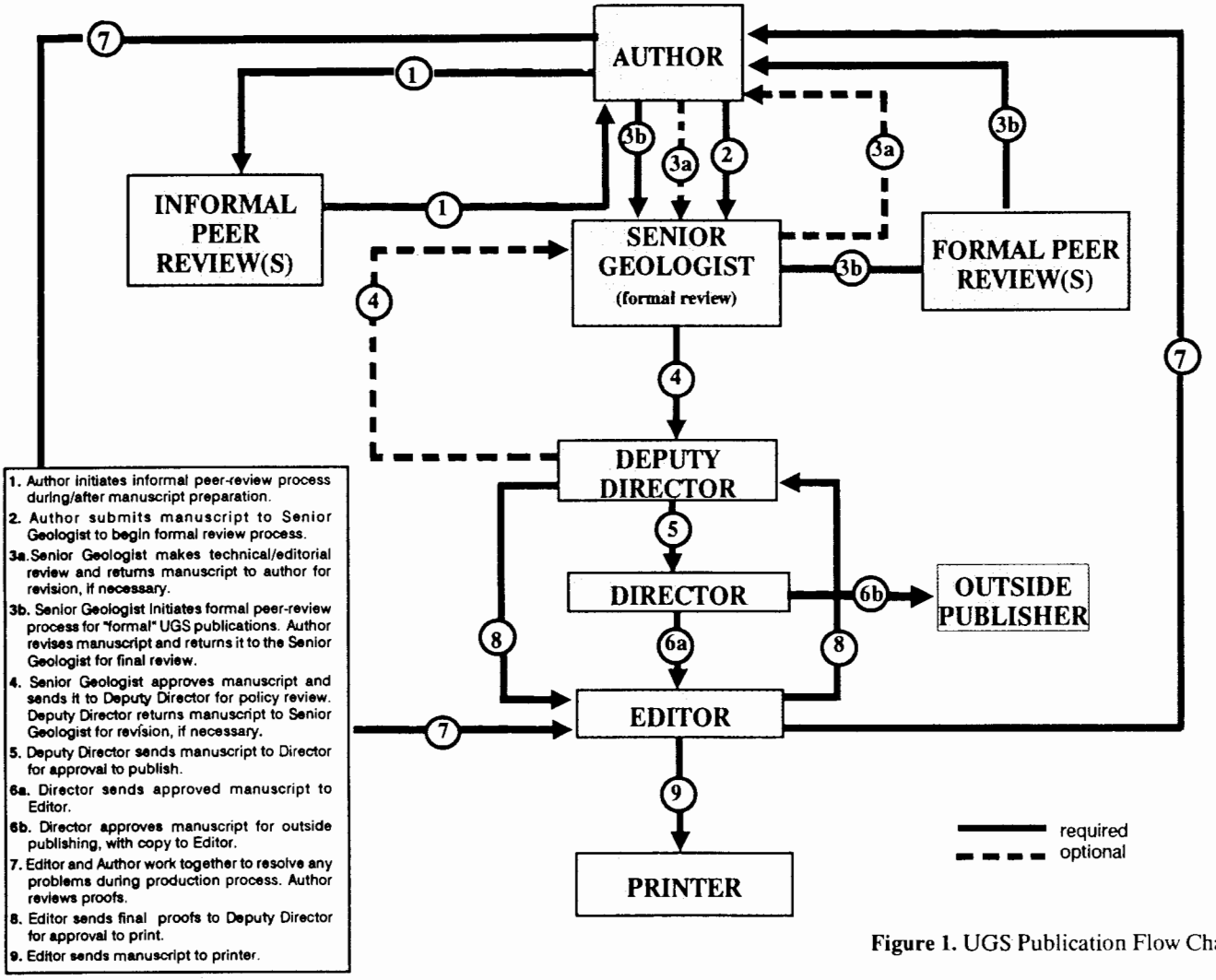

Figure 1. UGS Publication Flow Chart

Author

It is UGS policy 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, grade, or similar considerations are not criteria for determining authorship or co-authorship of UGS reports. In cases of multiple authors, it is the level of contribution by each individual that 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 senior geologist will make the final decision regarding authorship. If the disagreement involves the senior geologist, 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 extensive use of the informal review process (figure 1, path 1) when writing and revising their reports (see Peer Review section).

When satisfied with the report (including illustrations, tables, and format), the author attaches a signed UGS Document Routing Form (appendix B) to the manuscript and submits the report to the senior geologist 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 goes to the printer (figure 1, path 7), but only limited revisions will be allowed at that time.

Senior Geologist

A senior geologist is in charge of each of the UGS technical programs (Applied Geology, Economic Geology, and Geologic Mapping) and the Information Geology section. Senior geologists 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 senior geologist (figure 1, path 2).** The senior geologist makes a thorough technical and editorial review of the manuscript and, if necessary, returns it to the author for revision (figure 1, path 3a). If additional technical review is warranted, the senior geologist (normally in consultation with the author) selects a qualified individual(s) to perform a formal peer review(s) of the report (figure 1, path 3b). Following formal peer review(s), the author revises the manuscript and returns it to the senior geologist. When satisfied with the technical and editorial quality of the report, the senior geologist signs the UGS Document Routing Form and gives the manuscript to the deputy director (figure 1, path 4) for policy review.

Peer Review

Rigorous peer review insures 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. **A 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. Appendix B contains a UGS Document Technical Review Form that authors and senior geologists may use to facilitate the peer-review process.

Informal peer review(s) (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 senior geologist for formal review (figure 1, paths 2 and 3a if necessary). An informal peer review(s) is done at the request of the author, who is responsible for selecting the reviewer(s). Informal peer review(s) 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 informal reports of limited distribution (see Publication Series section), informal peer review(s) followed by the senior geologist's formal review is normally sufficient to insure the adequacy of the report. However, most manuscripts can benefit from additional formal peer review (figure 1, path 3b) regardless of their final publication format. **Reports in the formal UGS publication series (see Publication Series section) require a minimum of one**

formal peer review by an individual with technical expertise on the topic of the study. 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, for their ability as scientific writers, and for their willingness to complete the review in a thorough and timely manner. The senior geologist normally chooses formal peer reviewers in consultation with the author. In cases of dispute, final selection of formal peer reviewers resides with the senior geologist. The number of formal peer reviewers and whether they come from within or outside of the UGS, is a matter of judgement by the senior geologist. Their selection depends on the scope, technical complexity, intended audience, and proposed publication series of the report.

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. Appendix A contains several publications that provide specifics of the review process. The following 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 in a manuscript without the author's 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 constructive manner. Personal criticism of an author is 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.

Deputy Director

The deputy director has overall responsibility for implementing UGS publication policies. The deputy director reviews all manuscripts to insure compliance with State, Department of Natural Resources, and UGS policies. Critical components in the deputy director's review are the rigor of the informal/formal peer review process, compliance with UGS editorial standards, and the appropriateness of the publication series proposed for the report. The deputy director evaluates each manuscript and, if technical questions arise, editorial deficiencies exist, or policy issues are raised, returns the manuscript to the senior geologist for further revision (figure 1, path 4).

When all remaining issues are resolved, the deputy director approves the report by signing the UGS Document Routing Form and sends the 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 Routing Form, the director sends approved manuscripts to the editor for publication (figure 1, path 6a). Rejected manuscripts are returned to the deputy director. Manuscripts approved for outside publication are signed by the director and sent to the editor of the publishing organization (figure 1, path 6b) with a copy to the UGS editor for the permanent file. These functions are normally performed by the author after receiving the director's approval of the manuscript.

Editor

The editor reviews the manuscript for compliance with UGS editorial standards and supervises preparation of the report for publication. The editor works with the author to resolve questions or problems that may arise during this phase of the publication production process. Proofs are sent to the author for review (figure 1, path 7). After the author's revisions are incorporated, the editor sends the corrected proofs to the deputy director for final review (figure 1, path 8). Once approved by the deputy director, the report is sent to the printer (figure 1, path 9).

ETHICAL CONSIDERATIONS

The publication process places ethical constraints on all members of the UGS publication team, particularly on the author. Utah Geological Survey 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. Authors who leave UGS employment should finish all reports in progress or, if that is not possible, they should arrange through their senior geologist for another geologist to take over responsibility for their projects. 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. All UGS authors have the obligation to serve as a peer reviewer. 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 are never to 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. **Senior geologists bear a special responsibility to the authors they supervise. The senior geologist's role is as much that of teacher as it is supervisor, especially for inexperienced authors or those who lack report-writing skills.** To a large extent, the success of UGS authors depends on the time and effort spent by their senior geologist helping them learn how to write geologic reports.

THE PARTS OF A REPORT

Utah Geological Survey 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 judgement of the publication team. Nevertheless, most scientific reports have broad characteristics in common. The following general 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 month and year that the report was printed (for draft manuscripts the month and year that the report was submitted to the senior geologist for formal review).

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.

From time to time, the UGS enters into cooperative programs and projects with 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.

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.

Table of Contents

A table of contents is required for all formal UGS publications (see Publication Series section). The decision to include a table of contents in an informal publication depends on the length and complexity of the report. A complete table of contents for a scientific report consists of the "Contents," which lists the section headings exactly as they appear in the text; "Illustrations," which lists all figures and plates (see Illustrations section); and "Tables," which lists all the tables in the report. Heading rank in the "Contents" is indicated by indenting subordinate headings under the preceding related heading. Illustrations incorporated in the text of the report are called "figures." Oversize illustrations placed in a pocket in the back of the report are called "plates." Unlike the headings in the Contents section, captions for illustrations and tables can be shortened in the table of contents to save space, provided they still convey the essence of what the illustrations or tables are about.

Abstract

The purpose of an abstract is to convey in condensed form the essential information of a scientific report. An abstract is required for all but the briefest UGS reports. 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 (see Body of the Report section).

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 (usually a page or two at most), 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, all but the most specialized reports will have some or all of the following major subdivisions: introduction, study description and results, and conclusions.

The 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 a separate Acknowledgments section is not planned), and in some cases, summarize the study results and conclusions.

The study description and results section is usually the largest and most complex part of a report. It may consist of several main and numerous minor headings. Typical main headings include study methods, materials, analytical procedures, setting and physiography, geology (both regional and site specific), structure, stratigraphy, mineral and energy resources, geochemistry, 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 conclusions section sets forth the author's interpretation of the study results and presents any recommendations warranted by the study.

Acknowledgments

Authors are commonly indebted to others who provided them with assistance 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. Thanking individuals for moral support, while appropriate in a thesis or dissertation, is not a basis for acknowledgment in a UGS report.

An additional and important advantage of a well-prepared Acknowledgments section is that it tells the deputy director and editor who reviewed the report prior to their receiving it. Careful selection of qualified reviewers by the author and the senior geologist can save much time and effort in the publication process.

References

References in UGS reports are used to acknowledge the work and ideas of others and to tell the reader where to look for additional information. **Citing references is a critical part of the report-writing process and one that is often subject to error.** It is necessary to confirm 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 *Suggestions to Authors Seven*, p. 234-241).

References cited in the text: In the text, reference to a single author takes the form: "Cairnes (1987) reports . . ." or ". . . six active segments of the fault zone (Mack, 1989)." A reference with two authors uses both names: "Lutgens and Tarbuck (1990) discovered . . .," or ". . . a total of 57 wells were drilled (Claiborne and Fowler, 1988)." A reference with 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)." Multiple author references with the same senior author but different co-authors that are published in the same year appear as: (Martin, Blye, and others, 1984; Martin, Smith, and others, 1984). When multiple references are required, 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) provide information on . . .," or ". . . applicable geophysical techniques (Edgers and Harwood, 1968; Reid and others, 1970b; Crammer, 1973; Steed, 1982; Dillon and others, 1986)." Personal communications cited in the text should follow the form: "C.J. Andrews (verbal communication, 1990) stated . . .," or ". . . consisted of red arkosic sandstone (R.B. Klausen, written communication, 1957)." Credit is also extended for the use of unpublished information. This is done by inserting "(unpublished information)" at the appropriate place in the report text. **Except in tables, footnotes are not permitted in UGS publications.**

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 percent 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 percent), 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 comes from a copyrighted publication, the author must obtain written permission for its use and credit the permission in the Acknowledgments section or, at the publishers 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. 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.

Entries are in alphabetical-chronologic order according to the senior (first) author's last name. **Unlike the USGS, the UGS does not use "and others" for references with three or more authors in the reference list.** Entries with multiple authors give the names of all the authors. Initials are used for first and middle names. If only a first name is available, it is spelled out. Multiple references with 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. If the same date is given for more than one reference by the same author or authors, they are differentiated by appending an "a," "b," "c," and so on to the date of the reference. **The references are appended sequentially according to their order in the reference list, not the order in which they appear in the text.** Three short dashes are used in place of the author's name if the name is exactly the same as in the preceding reference. This rule holds true for references with multiple authors if all the names are identical. The dashes are not separated from the date by a comma or a space.

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. Personal communications, unpublished information, and reports "in preparation" normally are not placed in the reference list, but they may be included if the author feels there is a benefit in doing so.

Colons within titles are shown with a dash to avoid confusion with the colon that marks the end of the title.

Avoid using abbreviations in a reference list except for the following: (1) abbreviations or acronyms used in a title, (2) no., v., pt., and p., (3) Inc., (4) M.S. and Ph.D., (5) U.S. and D.C., and (6) No. if used as part of a title.

The following sample reference list contains examples of references commonly encountered in geologic reports. Consult *Suggestions to Authors Seven* if a reference does not fall into one these categories. 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 it is better to give too much information rather than too little.**

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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 Reference or Bibliography 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 contained in the glossary where they appear in the text.

Appendix

An appendix provides a convenient place to present basic data, well logs, stratigraphic sections, foldout maps, source codes for computer programs, or other information that is too voluminous or cumbersome to include in the report text. Alternately, the author may wish to present the data on which the report's conclusions are based, but realizes that only a few readers are 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, and so on) for easy reference in the text. They are paginated separately, and the page numbers are proceeded by the letter of the alphabet that corresponds to each appendix (A1, A2, A3, C22, C23, and so on).

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 editor if they wish a report to have an index.

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. Many poor reports have been salvaged by good illustrations. However, 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 locations referred to in the text?

Illustrations in UGS reports are either black and white line drawings, various types of color illustrations, or photographs. Illustrations bound into the report (including 11x17 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."

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).

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 them with care since poor originals result in even poorer printed illustrations. Dot-matrix or equivalent printers do not produce quality line drawings and are not acceptable except for informal reports (see Publication Series section). 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 editor's advice.

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

- Oversize (larger than the report format, usually 8 ½ x11 inches) illustrations present a variety of production problems and increased publication costs. Authors should consult with the editor if oversize illustrations are planned for a report. Options include one illustration covering two facing pages, or a one-page foldout plus the facing page.
- Figures should fit upright on a page whenever possible. The editor will reduce or enlarge figures as necessary when preparing publications for printing. Authors with a preference for a particular figure size in the final report should consult with the editor early in the publication production process.
- Draft line drawings, including graphs and charts, in black ink on a good-quality medium such as bond, vellum, or mylar.
- Copies of original illustrations are acceptable only when the line quality of the copy is equal to that of the original. Photostatic reproductions are not acceptable as original illustrations, and photocopies are only

rarely acceptable. Photomechanical transfers are acceptable if they match the quality of the original illustration.

- 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 a line drawing with care. Fine dot or line patterns are frequently lost or blurred when an illustration is photographically reduced.
- A bar scale should accompany all scaled drawings. All maps require a north arrow and should include township and range and latitude and longitude when appropriate.
- Illustrations drafted onto an pre-existing base map must give credit for the base.
- Figures in the report text are numbered consecutively; plates at the back of a report are also numbered consecutively but independently of the figures.
- Write the name of the report, name(s) of the authors, and the figure/plate number on the back of all illustrations submitted with manuscripts for review and production.

Oversize maps represent a special category of illustrations published by the UGS. In addition to their large size, these maps are often printed in color. Authors should consult UGS publication *Guide to Authors of Geologic Maps and Text Booklets of the Utah Geological Survey* for information and requirements concerning the preparation of maps.

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 editor and deputy director.** This requirement applies to maps, figures, photographs, charts, or any other color work

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 2) or a text description. Photographs are considered figures and are numbered accordingly.

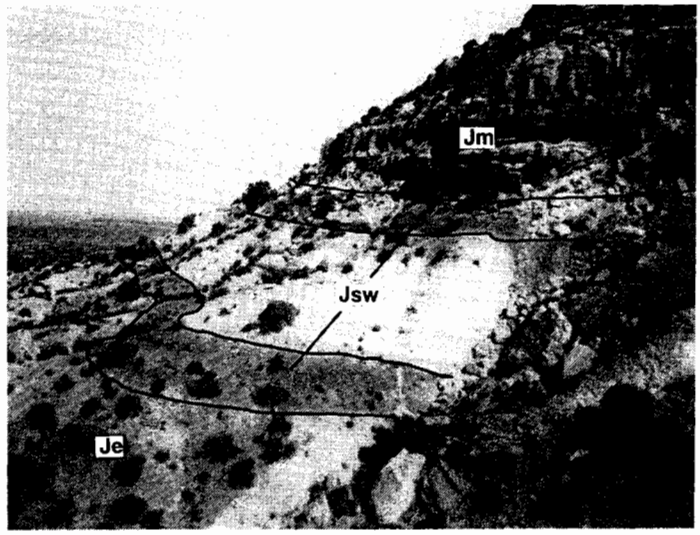

Figure 2. White Point member of the Summerville (?) Formation (Jsw) below Triangle Point near Cat Pasture in Kane County. The earthy weathering White Point Member at the base of the cliffy Morrison Formation (Jm) is about 40 feet (12 m) thick, and includes the two dark bands and the white horizon between them (after Doelling and Davis, 1989).

Submit good quality, black-and-white glossy photographs (so duplicate review copies may be easily made) with review copies of the manuscript. Color prints, slides, and negatives are acceptable for the production phase of the publication process, provided the author has obtained prior approval for all colored illustrations. 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 (slide or print).

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 (5.1 cm) across." Avoid mathematical 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 should indicate necessary cropping of the photograph on an overlay.

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, an up arrow if necessary, and credit for the photograph if taken by someone other than the author on a piece of tape and attached to the back of the photograph. Instructions to the editor 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 it is not necessary to begin a caption or title "Photograph of" or "Map of." The best captions and titles are usually short, but long captions and titles are acceptable when used to present various kinds of explanatory material. The author must exercise judgement in determining if the explanatory material is properly placed in a caption or title, or in the report 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 included in captions appear in the reference list at the end of the report. References on plates are listed separately from the title and are included in the report reference list.**

Captions 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. Authors should write the figure number and caption on the back of all illustrations submitted with manuscripts for review and production. Titles for plates are usually drafted directly on the illustration. Examples of well-prepared captions and titles follow:

Figure 1. Fluid inclusion homogenization temperature (T_h) from the Bullion Canyon area. Height of bar represents the number of inclusions measured (frequency) of that temperature, n is the total number of inclusions measured.

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 B5 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 *Suggestions to Authors Seven*, which contains detailed instructions for preparing tables, when a complex table is necessary. A table requires at least two columns and should fit upright on a single page whenever possible. Tables are numbered sequentially in the order of their appearance in the report. Unlike figures, table captions precede the body of the table. Abbreviations are acceptable in tables to save space. If abbreviations are used, their meaning must be clear to the reader. **Footnotes are acceptable in tables.** Footnote reference numbers are indicated in the table by superscripted numerals ([1][2][3]...), and are in numerical order from left to right across the table. 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 International) in both the text and tables. It is not necessary to include unit conversions in tables. Do not leave blank spaces in a table. If a test or measurement was made without result, enter "0." If no data are available, record "n.d." or "n.a." and explain with a footnote. If no entry is made, use a line. The following are examples of effective tables:

Table 1.
Radiocarbon ages and thermoluminescence (TL) age estimates from the Mapleton North (MN) and Mapleton South (MS) trench sites.

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 2. Univariate statistics for the Bullion Canyon data set, Antelope Range mining district. All values in parts per million.

Subset	Element	n*	Mean	Maximum	Minimum**	Standard Deviation	90th Percentile	Threshold for highly anomalous samples
Vein Samples	Au	199	.23	7.19	.001	.85	.3	1.6
	Ag	199	5.7	88.4	.1	11.1	16	45.0
	Cu	199	368	6700	1	854	1050	2000
	Pb	199	1491	27,000	1	3599	4830	8000
	Zn	199	1321	26,000	5	3086	3871	8000
	As	199	112	3100	1	269	208	510
Non-Vein Samples	Au	51	.06	.82	.001	.13	.16	
	Ag	51	1.9	37.3	.1	5.3	3.1	
	Cu	49	95	2600	1	380	150	
	Pb	51	119	1800	1	227	201	
	Zn	51	214	3800	1	359	254	
	As	51	69	380	1	91	228	
								Anomalous thresholds, outliers removed
Vein Samples with Outliers Removed	Au	195	.12	1.50	.001	.24	.32	.48
	Ag	195	4.7	40.1	.1	7.1	14.8	15.0
	Cu	188	194	1900	1	356	647	800
	Pb	189	802	7800	1	1545	2627	3400
	Zn	191	825	7700	5	1401	3083	3100
	As	195	81	500	1	92	182	225

*n = Number of samples

** = Minimum values or lower limit of detection

Table 3. Principal organisms found in Great Salt Lake, in general decreasing order of their tolerance to salinity

Common name	Scientific name	Principal habitat (dates of occurrence)
Red bacteria	*Halobacterium* sp. *Halococcus* sp.	Water and sediment of the northern part (1960–83)
Red brine algae	*Dunaliella salina*	Water of the northern part (1960–83)
Biostrome blue-green algae	*Coccochloris elebens*	Biostromes of the southern part (unknown–1983)
Green brine algae	*Dunaliella viridis*	Water of the southern part (unknown–1983) Water of the northern part (1983–86)
Brine fly (two species)	*Ephydra cinerea* *Ephydra hians*	Sediment and biostromes of the southern part (unknown–1986)
Brine shrimp	*Artemia salina*	Water of the southern part (unknown–1986) Water of the northern part (unknown–1986)
Blue-green algae (several species)	*Nodularia spumigena*	Water of the southern part (1983–86)
Diatoms (four species)	*Amphora coffeiformis*	Do.
	Navicula graciloides	Do.
	Navicula tripunctata	Do.
	Rhopalodia musculus	Do.
Water boatman	*Trichocorixa verticalis*	Shallow surface water of the southern part (1973–86)

Equations and Formulas

Type mathematical equations and chemical formulas in the line of text whenever possible. This is especially true 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:

$$g_z = 12.76 + P(L + [L + (z^2 + R^2)\ ½ - ([z + L]^2 + R^2)\ ½])$$

where:

g_z = Gravity anomaly (in microgals) at the radius where the average drawdown (L) occurs.

P = Change in water density (in g/cm^3), use specific yield for P because the density of most shallow water is 1 g/cm^3 and therefore $S_y = P$.

L = Thickness of the layer (in feet) in which the density changed. Use a value equal to the average drawdown within the drawdown cone to a radius where the drawdown is roughly 2 percent of the drawdown at the well bore for L.

z = Depth to water table before drawdown (in feet).

R = Radius used to calculate L (in feet).

Number related equations or formulas in the report in the order which they appear in the text for easy reference by the author and ease of understanding by the reader.

Eq. 1 $y(h) = 2.0 + 8.5[(1.5h/^3) - (0.5h3/27)],\ h < 3$

Eq. 2 $y(h) = 2.0 + 8.5 = 10.5,\ h \geq 3$

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

1. 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.

2. If unavailable in typewritten or digital format, carefully write Greek letters, other special symbols, and superscripts and subscripts on draft manuscripts.

3. Use parentheses () and square brackets [] whenever possible; brackets {} are difficult to print.

4. Use fractional exponents ($5^{1/2}$), not square roots.

5. Show the valence of ions as Ca^{2+} not Ca^{++}.

6. Isotope numbers precede the element (^{14}C).

THE MANUSCRIPT

Manuscript Preparation

The author must prepare a properly formatted manuscript before submitting a report to the senior geologist for formal review. **A complete manuscript is one that is well organized, legible, includes review copies of all illustrations and tables, and incorporates the elements of UGS editorial style.** Clear photostatic or blue-line copies

are adequate for most illustrations; however, it may be necessary to provide prints of photographs if they do not reproduce well on a copy machine. **Manuscripts submitted to the senior geologist for formal review must include a UGS Document Routing Form (Appendix B).**

Page Format

The following rules apply to UGS manuscripts submitted for review:

1. Type the manuscript double spaced on good quality white paper. The double-spacing requirement applies to all copy without exception including the title page, abstract, captions, quoted matter, and references.

2. Use 10-point or larger type and avoid condensed-face type styles (for example, Helvica 10-point condensed).

3. Leave margins of at least 1 inch (2.5 cm) on both sides and at the top and bottom of each page.

4. Do not right justify the text.

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

6. Indent the first line of each paragraph five spaces, and leave a blank line between paragraphs.

7. Type tables separately and place them behind the page on which they are first mentioned in the text.

8. Place review copies of text figures behind the page on which they are first mentioned in the text. Review copies of figures and plates should include the complete caption and the figure/plate number. Original illustrations submitted to the editor for production should have the name of the report, name(s) of the authors, caption, up arrow if necessary, and figure/plate number written on the back (use tape to protect photographs).

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

10. Underline words to be printed in italics.

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.

<u>First-level headings:</u> First-level headings are main section titles. Headings such as **ABSTRACT, INTRODUCTION, STUDY METHODS,** and **REFERENCES** are in this group. Two blank lines separate a first-level heading from the preceding text. Center first-level headings and type in all **CAPITAL LETTERS.**

<u>Second-level headings:</u> Second-level headings are subdivisions of each major section. Subdivision of a main section requires at least two second-level headings. A single blank line separates second-level headings and all subsequent headings from the preceding text. Center second-level headings and type in Upper and Lowercase Letters.

<u>Third-level headings:</u> Third-level headings are subdivisions of second-level headings. At least two third-level headings are required if a second-level heading is subdivided. Left justify third-level headings and type in Upper and Lowercase Letters.

Fourth-level headings: 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 should end in a colon and is underlined. The text continues two spaces after the colon.

Pagination

Review 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, and so on) and is paginated separately. Page numbers within appendices are proceeded by the letter of the alphabet that corresponds to each appendix (A1, A2, A3, B10, B11, C22, C23). Page numbers in printed publications are assigned by the editor during the publication production process.

Digital Format

Most authors compose UGS reports on desk-top computers using word-processing software to create an electronic manuscript. System compatibility may become a problem if an author uses a word-processing program other than the one used by the UGS. In those instances, the author should submit both a paper (hard) copy of the manuscript and a 5.25 inch (13.3 cm) diskette with the manuscript and any digital data files in MS-DOS ASCII format. Authors requiring assistance with format conversion should consult with UGS data processing personnel. Graphics files must be compatible with current UGS graphics software. Check with the editor for current software specifications.

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MATTERS OF STYLE
Abbreviations and Symbols

Abbreviations 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. As a general rule, abbreviations are used sparingly in the text of UGS reports. Abbreviations standardized through common use need not be defined when used; for example, "a.m." for ante meridiem and "$" for dollars. Place less well-known abbreviations 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)," and NVTD thereafter.

Appendix C is a compilation of abbreviations used in UGS reports. Lists of abbreviations are also available in *Suggestions to Authors Seven; the U.S. Government Printing Office Style Manual, 1984; The Chicago Manual of Style* (thirteenth edition); and *Webster's Third New International Dictionary* (unabridged seventh edition).

General Rules

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

- Do not use an abbreviation unless you plan to use it more than once.
- If abbreviations or symbols are used in a report, use them consistently throughout the document.
- Spell out abbreviations that begin sentences, except for commonly abbreviated words that are never spelled out (for example Mr., Ms., ASTM).
- 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.
- Spell out abbreviated words that are connected to other words by hyphens (3-meter displace ment, not 3-m displacement).
- 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 or geologic terms (for example, UB for Uinta Basin or WFZ for Wasatch fault zone) in the report text no matter how frequently they are used.
- Eliminate periods after abbreviations except where required by convention (see appendix C). Spaces are not needed between joined abbreviations (U.S. Geological Survey, Washington D.C.)
- Do not use the symbol form of an abbreviation (38.1 percent, not 38.1%) except in illustrations, formulas, and tables to save space. Exceptions are the dollar sign "$" ($156,730,769 in annual sales), the degree mark "°" (63°F, N. 34° E.), and chemical symbols (K-Ar dating methods).
- Use parentheses and brackets when necessary in mathematical expressions for clarity ([7y] x 36 = [15z] x 12).
- Avoid using abbreviations in a reference list except for the following: (1) abbreviations or acronyms used in a title, (2) no., v., pt., and p., 3) Inc., (4) M.S. and Ph.D., (5) U.S. and D.C., and (6) No. if used as part of a title.
- When in doubt, spell it out.

Degree Mark

The degree mark "°" is used with numerals in statements of temperature, strike, dip, bearing, azimuth, latitude, and longitude. The word "degree" is generally written out when reporting angles and slope (except in tables or where space is otherwise limited). 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° E.
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 degrees to the north
a right angle equates to 90 degrees

Land Tract Designations

Report descriptions of tracts of public land as follows:

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

Latin Abbreviations

The use of Latin abbreviations is discouraged in UGS reports, the written-out English equivalent is preferred.

Latin Abbreviation	Preferred UGS Usage
ca. (circa)	about a given date
cf. (confer)	compare or see
e.g. (exempli gratia)	for example
etc. (et cetera)	and so forth
et al. (et alli)	and others
i.e. (id est)	that is

Lithologic and Time-Stratigraphic Terms

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

Term or Lithology	Abbreviation	
	Formal	Informal
Group	Gp.	
Formation	Fm.	
Member	Mbr.	mbr.
Sandstone	Ss.	ss.
Siltstone	Slts.	slts.
Shale	Sh.	sh.
Mudstone	Mdst.	mdst.
Claystone	Clyst.	clyst.
Limestone	Ls.	ls.
Dolomite	Dol.	dol.
Conglomerate	Cgl.	cgl.
Quartzite	Qzt.	qtz.
Granite	Gr.	gr.

Gneiss	Gn.	gn.
Rhyolite	Rhy.	rhy.
Volcanics	Volc.	volc.

System, Period, Era	Abbreviation	Symbol
Quaternary	Quat.	Q
Tertiary	Tert.	T
Cretaceous	Cret.	K
Jurassic	Jur.	J
Triassic	Tri.	Ꞧ
Permian	Perm.	P
Pennsylvanian	Penn.	IP
Mississippian	Miss.	M
Devonian	Dev.	D
Silurian	Sil.	S
Ordovician	Ord.	O
Cambrian	Camb.	Є
Cenozoic	Cen.	Cz
Mesozoic	Mes.	Mz
Paleozoic	Pal.	Pz
Precambrian	Prec.	pЄ

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).

Time

Age estimates: 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 *(North American Stratigraphic Code, 1983).* Time measured from the present is implicit in ka, Ma, and Ga; therefore, neither "before present" nor "ago" are added to these abbreviations (Colman and others, 1987). Radiocarbon dating has established the use of yr B.P. (years before present) to indicate ^{14}C ages measured from A.D. 1950. To avoid confusion, restrict the use of yr B.P. to radiocarbon ages (Colman and others, 1987). Calendar-calibrated radiocarbon ages are reported as cal B.P. (calendar years before present) (Stuiver and Pearson, 1986).

> When calendar-calibrated, a ^{14}C age of 590 ± 60 yr B.P. on charcoal from a pre-event burn layer exposed in trench TR-6 indicates that the most recent event (MRE) on the middle segment of the Red Rock fault occurred after 540 cal B.P.

> A $^{40}Ar/^{39}Ar$ age of 986 ka and a K-Ar age of 1.22 Ma identify the age of the tuff unit as early Pleistocene, and nearly 10 million years younger than previously suspected.

Geologic time: The abbreviations "ky" for thousands of years and "my" 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 138 million years ago and 66 million years ago respectively (Hansen, 1991); the interval of time represented by the Cretaceous is 72 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.

> Approximately 14,500 years B.P., Lake Bonneville breached its outlet at Red Rock Pass near Zenda, Idaho and

rapidly drained to the level of the Provo shoreline (elevation 1,445 meters [4,740 ft]; estimated age 14,000 to 14,500 years old).

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.

February 1950
February 14, 1950
14 February 1950
the 14th of February, 1950
March 21, 1949, to February 14, 1950
1981-82, but 1998-2001

Clock time: Use "a.m." (ante meridiem) and "p.m." (post meridiem) with numerals to denote clock time (3 a.m. or 7:15 p.m.). Time zones in the conterminous United States are abbreviated e.s.t., c.s.t., m.s.t., and P.s.t. For daylight saving time, use e.d.t., c.d.t., m.d.t., and P.d.t. Other time zones are spelled out the first time used.

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.

  Professor Richard Lewis
  Dr. Richard Lewis is a professor of geology
  Marriott Library
  Rich County
  Daggett and Uintah Counties
  Weber and Provo Rivers
  Utah Geological Association

- Capitalize all important words in the titles of books, articles, and reports that appear in the report text (for example, *Geology of Utah* by William Lee Stokes). Note that titles in a reference list are an exception (see The Reference List section and Suggestions to Authors 7, 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
  Water-Supply Paper 16
  State-of-the-Art Geophysical Techniques

- 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.

Utah State
state of Utah
Sandy City
city of Sandy
the state
the Federal Government
federal agencies
federal and state employees

- "State" and "federal" are lowercase when they refer to a geographic area rather than a political (legislative) entity.

  largest mountain range in the state
  federal land in the state of Utah

- 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
  Department of Natural Resources
  Department of Natural Resource divisions

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

  Foraminifera
  Bathymyonia
  Spiriferina (Punctospirifer) pulcher

- 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 names of formal rock-stratigraphic units are proper nouns and are capitalized.

  Navajo Sandstone
  Morrison Formation
  Belt Supergroup
  Sinbad Limestone Member

A sequence of formation names such as the Navajo Sandstone, Moenkopi Formation, Twin Creek Limestone, and Mancos Shale can for convenience be written as the Navajo, Moenkopi, Twin Creek, and Mancos Formations. Note that "Formations" is capitalized.

- Do not capitalize unit terms (lithology or formation) in the names of informal rock-stratigraphic units *(North American Stratigraphic Code, 1983).*

  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
  Great Salt Lake
  Island in the Sky
  Salt Lake City area

- 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
  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

  Suggestions to Authors Seven (page 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
  Paradox basin (a geologic feature)

  Note that some geologic names through long association with a geographic area are now capitalized by convention. Refer to the U.S. Geological Survey (1988) 1:500,000 scale topographic map of the State of Utah to determine which geologic terms fall into this category. Examples include:

  San Rafael Swell
  Upheaval Dome
  Waterpocket Fold

- 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 Divisions of Geologic Time section).

- "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.

Geographic Names

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

Geologic Names

Geologic names are assigned to formal and informal rock-stratigraphic units, structural features, and divisions of geologic time. Rules applying to the use of geologic names are summarized below. A detailed discussion of the issues associated with the use of geologic names is contained in *Suggestions to Authors Seven* and the *North American Stratigraphic Code (1983).*

Rock-Stratigraphic Units

In order to make a geologic map, geologists must subdivide the rocks comprising the earth's crust into recognizable units based on their physical characteristics and, when possible, geologic age. Formal rock-stratigraphic units are defined in accordance with the current or previously accepted versions of the North American Stratigraphic Code (1933, 1961, 1970, 1983), or they have achieved acceptance through long usage prior to adoption of the codes. Informal rock-stratigraphic units are sometimes useful locally but, for whatever reasons, they do not comply with the requirements of the current stratigraphic code. **Use informal rock-stratigraphic units in UGS reports with care, and in all cases, clearly identify them as informal units.**

The first time a formal rock-stratigraphic 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 rock-stratigraphic unit in a UGS publication, the proposed unit must meet all the requirements of the *North American Stratigraphic Code (1983).* The USGS Geologic Names Committee maintains a record of all formal rock-stratigraphic unit names of the United States as they are used in publications. The committee's records are available for reference to all geologists. Utah Geological Survey authors should consult with the USGS Geologic Names Committee before proposing a new rock-unit name.

Structural Geologic Features

There are no rules equivalent to the North American Stratigraphic Code (1983) for naming geologic structural 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.

Divisions of Geologic Time

The major divisions of geologic time (Eons, Eras, Periods, and Epochs) have been established through long use and careful study. Nevertheless, disagreement exists regarding the exact ages of the boundaries between some time divisions (Palmer, 1983; Snelling, 1985; Hansen, 1991). The UGS accepts the geologic time scale proposed by the USGS Geologic Names Committee in 1980 and published in *Suggestions to Authors Seven* (figure 3). Authors choosing to use an alternative time scale must clearly state which scale they are using and why it is better suited to their purpose.

A clear distinction exists between divisions of geologic time (geochronologic divisions) and divisions of stratigraphic position (chronostratigraphic divisions). Figure 3 shows the major series and provincial series terms used in the United States. Provincial series terms used in UGS reports should conform to those in common use in North America. However, European stage terms are used for divisions of the Upper and Lower Cretaceous in most of the United States, including Utah. Note that in figure 3 "Early," "Middle," and "Late" denote relative position in time, while the terms "Lower," "Middle," and "Upper" denote similar distinctions of stratigraphic position. Where shown in figure 3, these terms are part of the formal time and series names and are capitalized accordingly (Late Permian time, Middle Triassic red beds). Where not shown in figure 3, these terms are informal and are not capitalized (early Holocene age, lower Tertiary rocks).

Italics

Italicized words are underlined in the draft manuscript. 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).

- Italicize formal names of genera, species, subspecies, and varieties of plants and animals. Do not italicize the names of phyla, classes, orders, and families.

- 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. 61-74.

- 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.

Subdivisions (and their symbols)						Age estimates of boundaries in mega-annum (Ma) [1]	Other age estimates 1, 5	Age and stage names commonly used in Utah 1, 6
Eon or Eonothem	Era or Erathem	Period, System, Subperiod, Subsystem		Epoch or Series				
Phanerozoic [2]	Cenozoic [2] (Cz)	Quaternary [2] (Q)		Holocene		0.010	0.01	
				Pleistocene		1.6 (1.6 - 1.9)	1.6	
		Tertiary (T)	Neogene [2] Subperiod or Subsystem	Pliocene		5 (4.9 - 5.3)	5.3	
				Miocene		24 (23 - 26)	23.7	Maastrichtian 66.4
			Paleogene [2] Subperiod or Subsystem	Oligocene		38 (34 - 38)	36.6	Campanian 74.5 (4)
				Eocene		55 (54 - 56)	57.8	Santonian 84.0 (4.5)
				Paleocene		66 (63 - 66)	66.4	Coniacian 87.5 (4.5)
	Mesozoic [2] (Mz)	Cretaceous (K)		Late	Upper	96 (95 - 97)	97.5	Turonian 88.5 (2.5)
				Early	Lower	138 (135 - 141)	144	Cenomanian 91 (2.5)
		Jurassic (J)		Late	Upper		163 (15)	Albian 97.5 (2.5)
				Middle	Middle		187 (34)	Aptian 113 (4)
				Early	Lower	205 (200 - 215)	208 (18)	Neocomian 119 (9)
		Triassic (Ꞧ)		Late	Upper		230 (22)	144 (5)
				Middle	Middle		240 (22)	
				Early	Lower	~240	245 (20)	Ochoan 250
	Paleozoic [2] (Pz)	Permian (P)		Late	Upper		258	Guadalupian 255
				Early	Lower	290 (290 - 305)	286 (12)	Leonardian 270
		Pennsylvanian (IP)		Late	Upper			Wolfcampian 275
				Middle	Middle			Virgilian 290
				Early	Lower	~330	320	Missourian Desmoinesian 310
		Mississippian (M)		Late	Upper			Atokan
				Early	Lower	360 (360 - 365)	360 (10)	Morrowan 330
		Devonian (D)		Late	Upper		374 (18)	Chesterian 340
				Middle	Middle		387 (28)	Meramecian
				Early	Lower	410 (405 - 415)	408 (12)	Osagean
		Silurian (S)		Late	Upper		421 (12)	Kinderhookian 365
				Middle	Middle	435 (435 - 440)	438 (12)	
				Early	Lower		458 (16)	
		Ordovician (O)		Late	Upper		478 (16)	
				Middle	Middle	500 (495 - 510)	505 (32)	
				Early	Lower		523 (36)	
		Cambrian (Є)		Late	Upper		540 (28)	
				Middle	Middle	~570 [3]	570	
				Early	Lower	900	900	
Proterozoic (P)	Late Proterozoic (Z)	None defined				1600	1600	
	Middle Proterozoic (Y)	None defined				2500	2500	
	Early Proterozoic (X)	None defined				3000	3000	
Archean (A)	Late Archean (W)	None defined				3400	3400	
	Middle Archean (V)	None defined				3800 ?	3800 ?	
	Early Archean (U)	None defined						
pre-Archean (pA) [4]								

[1]Ranges reflect uncertainties of isotopic and biostratigrapic age assignments. Age boundaries not closely bracketed by existing date shown by –. Decay constants and isotopic ratios are cited in Steiger and Jäger (1977). Designation m.y. used for an interval of time.

[2]Modifiers (lower, middle, upper or early, middle, late) when used with these items are informal divisions of the larger units; the first letter of the modifier is lowercase.

[3]Rocks older than 570 Ma also called Precambrian (pC), a time term without specific rank.

[4]Informal term without specific rank.

[5]From Palmer (1983) uncertainty in parentheses.

[6]Cretaceous from Palmer (1983); Mississippian, Pennsylvanian, and Permian from Cosuna Chart (Hintze, 1985).

Figure 3. Geologic time scale (after Hansen, 1991).

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 include commas, and numerals or letters are not used to identify each item, separate the items with semicolons.

The board members present included: Mr. James Berry, Chairman; Mr. Ralph Huges, Secretary-Treasurer; Mr. L.E. Smith, Chief Financial Officer; and Mr. Robert Kinley, Ex officio member.

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 in 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. 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 (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 percent
   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 1,000 or larger except for page and serial numbers and dates. Do not use commas to the right of a decimal point.

   5,271
   14,629
   12.4269
   no. E-462591-15-326A
   p. 1148
   February 14, 1950

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 2,000 analyses.

7. Use numerals when two or more related numerical expressions are grouped together in a sentence, even if the numbers are less than 10.

   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 are as follows:

1. Use decimals rather than fractions whenever possible.

2. Always represent decimals with numerals; do not write them out.

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

4. Retain zeros after a decimal point only if they are significant figures (3.208 but not 3.200 unless both zeros are significant).

Rules for using fractions include:

1. Replace fractions with decimals whenever possible.

2. Use numerals when fractions express a measurement.

   ½-inch pipe
   6 ½-inch O.D. well casing

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

   The project is two-thirds complete.

Significant Figures

When presenting numerical data, report only digits that legitimately convey actual 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. The concept of significant figures does not apply to whole numbers that represent exact counts such as the number of ore samples submitted to a laboratory, or to defined constants such as pi that consist of an infinite number of significant digits. Two definitions are important when considering significant figures:

Accuracy: The error-free level or degree of conformity to which a calculated value corresponds 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 estimates are accurate to the degree that they correctly estimate the true age of the material, and precise to the extent that the results of the dating process are reproducible in the laboratory.

Because a result cannot be more accurate or precise than the data from which it was obtained, the significant figures reported for a result cannot exceed the significant figures of the least accurate piece of data used to obtain the result. Numbers used in making calculations or obtained from a series of observations should be rounded to conform to the significant figures of the least accurate value involved. Guidelines for determining significant figures are presented below.

1. The digits 1 through 9 are always significant regardless of their position in a number.

2. The digit 0 is significant only if it occurs between other significant digits. A 0 is not significant when placed to the right or left of a number to fix a decimal place. For example, the number 0.00057 has two significant figures, but 703.01 has five significant figures.

3. Zeros that appear at the end of a number may or may not be significant. When they are, it should be clearly stated. Writing the number in scientific notation can remove any uncertainty. For example, write 572,000 as 5.72000×10^5 if the zeros are significant, and 5.72×10^5 if they are not significant.

4. When rounding numbers to n significant figures, all digits to the right of the nth digit are dropped. Rules 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 (rounded to four significant figures 45.7832 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).

Carefully consider significant figures when converting from one measurement system to another. Determining the correct number of significant figures to retain in the converted value is often difficult without prior knowledge of the precision and accuracy of the original quantity. For example, if the stratigraphic thickness of a sandstone interval is 100 feet, the exact conversion to the International System is 32.808 meters. However, the reported thickness might be rounded to the nearest foot or the nearest 5 feet depending on how the original measurement was taken. In the first instance, it is correct to present the metric conversion to the nearest 0.1 meter (32.8 m). In the second case, rounding to the nearest whole meter is more appropriate (33 m). When converting quantities for which the accuracy or precision are unknown, do not retain more significant figures than are reasonably justified.

Punctuation

Punctuation consists of a system of standardized marks or signs inserted in written material to clarify and enhance its meaning. For instance, consider the distinction created by the addition of a hyphen in these otherwise identical sentences.

He carried the 18 gallon jugs to the top of the mountain.

He carried the 18-gallon jugs to the top of the mountain.

Although some punctuation rules are more or less universally accepted (for example, the comma in February 14, 1950), 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. However, the role of punctuation in any kind of writing is to clarify the author's meaning; if a punctuation mark does not contribute to that end, omit it.

The following sections discuss the most common punctuation marks used in UGS reports. For a more complete presentation on the intricacies of punctuation in geologic reports see *Suggestions to Authors Seven* (p. 130-140).

Periods, Question Marks, and Exclamation Points

The period (.), question mark (?), and exclamation point (!) are used mainly as marks of termination. Every complete sentence must end with one of these three punctuation marks. Periods end sentences that are direct statements. Question marks terminate questions, and exclamation points end emphatic or exclamatory statements.

The Emma mine is 16 miles (26 km) from town.

How far is it from town to the Emma mine?

It is still miles to the Emma mine!

Some abbreviations require periods and periods are used with numerals to represent a decimal point.

yr B.P.
1.05

A question mark enclosed in parentheses can be used to indicate uncertainty with regard to information in the text or with numerical or graphical information.

Rocks in the quadrangle include Miocene lava flows and ash-flow tuffs, as well as an assortment of sedimentary basin-fill deposits of Miocene to Pliocene(?) age.

Formation contacts are queried (?) where uncertain.

Exclamation points follow emphatic interjections.

Help!

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 (coordinate clauses) joined by and, but, or, for, nor, so, and yet. The comma is omitted if the coordinate clauses are short.

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

We 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 required if the clause or phrase is essential to the meaning of the sentence.

The eastern fault scarp, which is 5 meters (17 ft) high, was trenched during the 1987 field season.

Units 3 through 5 were then locally eroded by a stream that subsequently deposited units 6A and 6B.

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.

> From 1870 to 1946, the Emma mine 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 B.P.

Commas separate two or more adjectives that equally modify the same noun. Note that if two adjectives proceed a noun and the first adjective modifies the second, a hyphen is required.

> The steep-dipping, overturned limb of the anticline strikes N. 30° E.
>
> The host rock consists of a well-cemented, brown, quartz sandstone throughout the lower levels of the mine.
>
> The alluvial-fan surface is crisscrossed by active stream channels.

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, nonethe less, on the contrary, on the other hand, then, thus.

> Accordingly, a new drift was started on a bearing of N. 55° W. and continued for a distance of 1,200 feet (375 m).

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 test well was completed on June 6, 1988, but the final report was not released until July 1990.
>
> For further information about the deep-drilling project, contact Hydrojet Inc., Salt Lake City, UT 84070.
>
> M. Lee Allison, Ph.D., was appointed director of the Utah Geological Survey by Governor Bangerter in October 1989.
>
> Shubat, M.A., and McIntosh, W.S., 1988, Geology and mineral potential of the Antelope Range mining district, Iron County, Utah: Utah Geological and Mineral Survey Bulletin 125, 26 p.
>
> Sincerely,

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.

> Both volcanic members are dark colored; sparsely porphyritic consisting of plagioclase, minor clinopyroxene, and magnetite; flow banded; and densely welded.

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).

Metals produced from the mining district over the years include: gold, silver, lead, zinc, and copper.

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.

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.

Parentheses and Brackets

Parentheses: 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 commonly denote:

- 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,
- references to figures and tables in the report text, and
- subordinate information that clarifies or explains what is being presented in the 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 feet (7,620-9,145 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: 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 [4,123.4 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).

Dashes

A dash (—) sets off parenthetical expressions and abrupt changes in thought. Dashes are more emphatic than either commas or parentheses, and in a manner similar to colons, shift emphasis to the thought following the dash. Dashes are seldom used in scientific writing.

The Emma mine was a small but steady producer—50 tons (45 MT) per year—through the 1940s and 50s.

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 rule to remember, as with any punctuation mark, is to maintain consistency within a report.

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

pale-green shale
ground-water reservoir
surface-water study
60-meter-wide graben
fine-grained sandstone
½-inch crystals

Compound modifiers are not hyphenated if the first word ends in "ly," the first modifier is a comparative, or if they follow the word being modified.

moderately indurated sandstone
finer grained sandstone
The sandstone is fine grained.

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.

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 D, the *AGI Glossary of Geology (third edition)*, and *Suggestions to Authors Seven*, if 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.

thirty-three
four-fifths

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 (unabridged seventh edition)*.

Hyphens are not used to substitute for the word "to" in the report text when indicating a range of values. A hyphen is used with the equivalent measurement shown in parentheses.

The thickness of the unit was 300 to 400 feet (91-122 m).
The age of the charcoal was 390 to 485 years (not 390-485 years).

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, titles of individually published or produced works such as books, maps, magazines, and newspapers are typeset in italics in UGS publications and are underlined in draft manuscripts (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.

When quotation marks are required, place any associated commas and periods inside the quotation marks. Place other punctuation marks inside quotation marks only if they are part of the quoted material.

Ellipsis Marks

Ellipsis marks show that nonpertinent material is omitted from quoted matter. Ellipsis marks consist of three periods (. . .) or three asterisks (* * *) separated by spaces (see Quotations section). Indicate the omission of a complete paragraph by a line of several ellipsis marks (. . . . . .) or (* * * * * * *).

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).
- Form possessives of plural words that end in "s" or "es" by adding an apostrophe only (General Dynamics', the Joneses' house).
- In cases of joint possession, use an apostrophe only with the last owner (Mike and Susan's truck).
- Do not use an apostrophe in the plural of proper names (all the Jims in the office, the two Koreas).
- Apostrophes indicate omitted letters or words in a contraction (don't, you're, won't, who's).

Remember that "it's" is the contraction for "it is" and that "its" is the possessive form of "it."

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 (6 m) 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)

When quoting directly, there is no obligation to reproduce incorrect spelling, punctuation, or grammar

contained in the original material. 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 E). As a general rule, the metric system is used in reports intended for a scientific audience and English units are used in nontechnical reports. The equivalent measurement in the alternative system should follow in parentheses. 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, attempt to convert all of the data to one system or the other. However, if this results in long or awkward numbers, it is preferable to leave the data in its original form and include an appropriate explanation in the text.

Units of measure are unabbreviated except for ratios that are otherwise unwieldy and for equivalent measurements that follow in parentheses. Do not use hyphens with measurements outside of parentheses; measurements inside parentheses are hyphenated as necessary. Do not abbreviate units of measurement that are not used with a number.

The alluvial-fan surface was displaced 2.8 meters (9.2 ft) down to the east along the main antithetic fault, creating a graben approximately 25 to 30 meters (82-98 ft) wide.

A displacement of 3.0 meters (9.8 ft) and a recurrence interval of 2,000 years gives a maximum slip rate of 1.5 mm/yr (0.06 in/yr).

Several hundred pounds of zinc ore from the Blackjack mining district were shipped to a smelter in Arizona during 1925.

Equivalent measurements are not required for numerical data presented in illustrations and tables.

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

Sentences and Paragraphs

The sentence is the basic building block of writing. The purpose of a sentence is to present one clear, complete thought. A sentence consists of one or more words combined and punctuated in a way that says something meaningful. 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. Identify key words and concepts and join them together in a logical sequence. Eliminate unnecessary words and phrases and scrutinize long or multi-syllable words, replacing them with shorter, simpler words whenever possible. Avoid jargon unless no other word will do the job. Then repeat the process as many times as necessary until the final sentence is as clear and concise as possible.

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. Active sentences are usually shorter and more concise than passive sentences.

Active Voice: Meandering streams deposited several hundred feet of unconsolidated sediment in the valley. (12 words)

Passive Voice: Several hundred feet of unconsolidated sediment were deposited in the valley by meandering streams. (14 words)

Authors can recognize the passive voice by its use of the verb "to be" (is, are, was, were, being, been), combine with verbs that often end in "ed" or "en." Additionally, in passive sentences the reader commonly arrives at the ver and still does not know who is doing the action. In everyday speech about 75 percent of our sentences are phrased i the active voice and 25 percent in the passive voice (Kurt Weiland, Shipley Associates, verbal communication, 1991 Conversely, most scientific writing uses about 75 percent passive voice and 25 percent active voice. This overuse o the passive voice adds unnecessary words to scientific reports and masks responsibility for whatever action occurre

Use the active voice whenever possible. Restrict use of the passive voice to instances when the subject (doe 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.

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 6,200 feet [1,890 m] per second) in the compressional wave velocity at the water table. (18 words)

The compressional wave velocity increases to 6,200 feet (1,890 m) per second at the water table. (13 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. (24 words)

The life of the mine may be extended by as much as 20 years if the exploration drilling program is successful. (20 words)

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.

This schedule is arranged to facilitate a timely, cost-effective completion of the research program. (15 words)

This schedule facilitates the timely, cost-effective completion of the research project. (12 words)

We made a decision to terminate the boring at the Chinle-Moenkopi contact. (13 words)

We terminated the boring at the Chinle-Moenkopi contact. (9 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. Do not use hybrid pronouns like he/she or his/her; 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.

Similarly, terms like manmade, foreman, and layman are best replaced with nongender-specific words such as engineered, supervisor, and general public.

Jargon

Most branches of science, and geology is no exception, have their own specialized terminology. 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. However, to the general public 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 words are necessary even though the report will have a general audience, a glossary of terms will assist nontechnical readers.

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 when 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, I 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, in my opinion, 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 D 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 visual and "o" pronounced as in one.

a cleat	a hogback	a eutrophic lake	a uranium anomaly
an anticline	an alluvial fan	an effect	a historical event

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.

He hopes 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.

Data

Data is plural and datum is singular; choose the appropriate verb tense when using these words.

Debris Flow and Mudflow

For reasons that are entirely obscure, debris flow is two words and mudflow is one word *(AGI Glossary of Geology, third edition)* despite similar physical characteristics and genesis.

Geologic, Geological, Geographic, Geographical

Geologic and geological are adjectives and are synonymous. The same holds true for geographic and geographical.

Ground Water

Depending on the organization or reference consulted, "ground water" is written as one word, two words, or hyphenated. The USGS uses ground water as two words. The UGS 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.

UGS PUBLICATIONS

The UGS has several publication series available for both staff and non-UGS authors. The "formal" UGS publication series consists of monographs, bulletins, water-resource bulletins, special studies, a map series, and circulars. Formal publications receive extensive technical and editorial review, are typeset for printing, and are reproduced in multiple copies. "Informal" publication series include Survey Notes, the miscellaneous publication series, the public information series, reports of investigation, open-file reports, contract reports, and technical reports. These publication categories receive varying levels of review and may or may not be typeset and printed. In general, authorship of formal publications is restricted to UGS employees; however, non-UGS authors can serve as co-authors. The principal publication formats available to non-UGS authors are Survey Notes, the miscellaneous publication series, and contract reports.

Publication Series

Monographs

Monographs represent the highest level of publication at the UGS. A monograph is a comprehensive work or compilation of wide scientific interest and importance. Topics may be specific or general, but a monograph is expected to contain significant new data and interpretations. The technical value of a monograph should last for at least 15 years. Monographs are considered a standard work and are hardbound, may use color, and may have accompanying plates.

Bulletins

Bulletins represent a work or compilation of significant scientific worth, but they are generally more limited in scope or geographic coverage than a monograph. A bulletin is expected to retain its technical value for 10 or more years. The topic of a bulletin may be specific or general. A bulletin may consist of several papers on a related subject. Bulletins are softbound and may use color and plates.

Water-Resources Bulletins

Water-resources bulletins have identical criteria to a bulletin, but on a water-related subject.

Special Studies

Special Studies represent a work on a scientific topic of interest to a limited or specialized audience. The information in a special study is expected to retain its technical value for up to 5 years. Special studies may consist of several papers on a related topic. The use of color and plates is determined on a case-by-case basis in consultation with the deputy director and editor.

Map Series

The UGS has a legislative mandate to publish geologic quadrangle maps at a scale of 1:24,000. These maps are usually published in color with an accompanying text booklet. Utah Geological Survey staff and contractors may prepare these maps for publication. The map series includes other kinds of maps (geologic, economic, and applied among others) at various scales and in color or black and white. Guidelines for the preparation of maps are available in *UGS publication Guide to Authors of Geologic Maps and Text Booklets of the Utah Geological Survey.*

Circulars

Circulars address timely subjects with limited long-term value (for example, Utah Coal Production 1991). The information in a circular is expected to retain its value for 1 to 3 years. Some circulars are updated periodically. The use of color is determined on a case-by-case basis. Plates are discouraged in a circular.

Survey Notes

Survey Notes is published quarterly and is the official newsletter of the UGS. It is nontechnical in nature, and normally contains a lead article or several related articles on a UGS activity or program, UGS history, or some aspect of Utah geology. It also contains shorter articles on topics of geologic interest, progress reports, UGS news, and meeting notices. Survey Notes is typeset, makes extensive use of photographs, and may use color in its cover. All figures are restricted to an 8 ½ x 11 inch (21.6x27.9 cm) format or smaller. Non-UGS authors may publish in Survey Notes.

Miscellaneous Publication Series

The Miscellaneous Publication Series is the principal publication format available to non-UGS authors. It is used to publish the results of Mineral Lease Special Projects, the results of other contract studies, or the work of other agencies or private industry that is of value to the geologic community or the public. Publications in this category require author-arranged formal review but otherwise are released as received with no additional UGS editing. The use of color and plates is discouraged in the Miscellaneous Publications Series, but may be considered on a case-by-case basis.

Public Information Series

The public information series consists of brief, topical reports designed to make translated (nontechnical) geologic information available to the general public. The public information series may make use of color.

Reports of Investigation

Reports of investigation present the results of site-specific or short project-specific investigations for which the anticipated audience is small and the technical value is constrained by project requirements. A report of investigation may consist of several technical reports on related topics. Reports of investigation are generally short and are typically reproduced in limited quantities by photocopying and binding with a cover. They may make use of photographs and 11x17-inch (27.9x43.2-cm) foldouts, but the use of color and plates is not an option in this publication format.

Open-File Reports

Any report by a UGS author that is intended to stand either temporarily or permanently without formal technical review and editing is open filed. Open-file reports are a convenient way to release timely information to the public and to temporarily release information during the review and production phases of the publication process. Digital-format data reports are typically released as open-file reports. A disclaimer stating that the material in the open file has not received UGS review and editing accompanies all open-file reports.

Contract Reports

Contract reports are prepared by non-UGS authors under contract to the UGS. They provide a means of making the results of Mineral Lease Special Projects and other contract studies quickly available to the public. The UGS does not require formal peer review of contract reports (see Miscellaneous Publication Series section for comparison). All contract reports are released as received and are not subject to UGS technical review or editing. A disclaimer stating that the material in the report has not received UGS review and editing accompanies all contract reports.

Technical Reports

Technical reports typically present the results of site-specific investigations or reconnaissance investigations. The anticipated audience is small and distribution is limited. Some UGS programs combine all of their technical reports into a single report of investigation on an annual basis. Technical reports commonly take the form of a memorandum and are reproduced by photocopying.

Selecting a Publication Series

Study size and scope, scientific merit, intended audience, geographic coverage, and cost are significant considerations when selecting the publication series in which to publish a report. In most instances, the study characteristics will naturally point toward one of the available UGS publication series. For example, an in-depth study of a timely geologic subject that is of wide interest may justify publication as a bulletin or, if a study is of particular scientific importance and long-term value, publication as a monograph would be appropriate. Conversely, a brief site investigation is best released as a report of investigation or as a technical report.

The appropriate publication series should be established as early as possible in the planning phase of a study. Ideally, the publication series is determined jointly by the author and the senior geologist. Senior geologists retain the right to change the proposed publication series after reviewing the study results. If, after reviewing the publication formats described above, a question remains concerning the proper publication series for a report, consult with the editor and deputy director for guidance. The publication series selected for all formal UGS publications must be approved by the deputy director.

Outside Publications

Although most UGS activities result in UGS publications, UGS authors may on occasion find it desirable to publish in a guidebook, technical journal, USGS series, or other outside publication. Any activity of a UGS employee on matters relating to earth science is a concern of the UGS. Therefore, any project that will result in an outside publication credited to a UGS employee, either as author or co-author, must receive prior supervisory approval. With approval and subject to availability of facilities, UGS resources and capabilities may be used in preparing outside publications. If a charge to the UGS is involved, the director's approval is required. A manuscript intended for outside publication must undergo the same technical and editorial review as an in-house publication. **The director's approval is required before the final manuscript leaves the UGS, and a copy of the manuscript must be placed on file with the UGS editor (see Director section). All manuscripts submitted for outside publication must be accompanied by the standard UGS copyright transfer form (see Copyrighted and Proprietary Materials section).**

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APPENDIX A

ADDITIONAL READING AND RESOURCES

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APPENDIX B

UGS DOCUMENT ROUTING AND REVIEW FORMS

UTAH GEOLOGICAL SURVEY
DOCUMENT ROUTING FORM

Program: _____

Title: _____

Author(s): _____

Recommended Publication Series: _____

This document has been through the UGS document review process. The individuals who have reviewed the document are listed below. All review comments have been addressed by the author.

Inside Reviewers: _____

_____

_____

Outside Reviewers and Organization: _____

_____

_____

We believe this document is now ready for publication.

Author _____ Date _____

Project Manager/ _____ Date _____

Section Chief _____ Date _____

Document Review Coordinator _____ Date _____

Senior Geologist _____ Date _____

Please review this document and, if you concur with our recommendation, sign below and forward to the Editor.

Deputy Director _____ Date _____

Director _____ Date _____

Location of Document Materials:

Paper copy of text: _____

Computer copy of text: _____

Illustration originals: _____

Mylar copy map/cross sections: _____

Colored copy map/cross sections: _____

Plate II materials: _____

Other: _____

UTAH GEOLOGICAL SURVEY - TECHNICAL REVIEW FORM

Author(s): _____

Title: _____

Proposed form of Publication: _____

Reviewer(s): _____

Main purpose and point of paper: _____

MANUSCRIPT

(Check appropriate box)	No Desirable Change	Minor Revision Needed	Major Revision Needed	Did Not Evaluate	Comments
Accuracy of data					
Validity of conclusions					
References (sufficient and accurate)					
Organization					
Clarity and Readability					
Length					
Illustrations (number and clarity)					
Mathematics and arithmetic					
Overall evaluation					

PLATES (MAPS AND CROSS SECTIONS)

(Check appropriate box)	No Desirable Change	Minor Revision Needed	Major Revision Needed	Did Not Evaluate	Comments
Symbols					
Contacts					
Cross sections					
Columnar section					
Description of map units					
Correlation of map units					
Structure contours					
Overall evaluation					

UTAH GEOLOGICAL SURVEY - TECHNICAL REVIEW FORM

GENERAL COMMENTS

(Circle appropriate range)	High									Low
Originality of material presented	X	X	X	X	X	X	X	X	X	X
Thoroughness of treatment	X	X	X	X	X	X	X	X	X	X
Appropriateness of proposed form of publication	X	X	X	X	X	X	X	X	X	X
Readiness for publication	X	X	X	X	X	X	X	X	X	X

COMMENTS (summarize major strengths and weakness - use additional sheets as needed):

APPENDIX C
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
astronomical unite (in English)	AU
Atlantic standard time	A.s.t.
Atlantic time	A.t.
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 of N_a
avoirdupois	avdp
avoirdupois pound	lb, avdp
azimuth	az
bachelor of science	B.S., S.B. or B.Sc.
bachelor or arts	B.A. or A.B.
barometer	bar.
barrels	bbls
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 of gas	BCFG/D per day
billion cubic feet (billion = 10^9)	Bcf
billion years	byr
billion years ago (age dates 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 C
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	c.d.t.
central standard time	c.s.t.
central time	c.t.
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.
Company (commercial)	Co.
compensated neutron log (hybrid)	CNL
completed, completion	comp
concentrate	conc
concentrated	concd
conductivity	cond or γ
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
cubic millimeter	mm^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	e.d.t.
eastern standard time	e.s.t.
eastern time	e.t.
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 ($FeSiO_3$)	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	ft
foot, cubic	ft^3
foot, feet	ft
foot per minute	ft/min
foot per minute, cubic	ft^3/min ft
foot per minute, square	ft^2/min
foot per second, squared	ft/s^2
foot per second, square	ft^2/s
foot per second	ft/s
foot per second, cubic	ft^3/s
foot per second, cubed	ft/s^3
foot pound-force	ft-lbf
foot, square	ft^2
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* of *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	GTS
gas- 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	≯
much greater than	≫
greater than approximately equal to	≥
greater than or equal to	≥ or ≧
greenstone	grnst
Greenwich civil time	G.c.t.
Greenwich mean astronomical time	G.m.a.t.
Greenwich mean time	G.m.t.
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
hypersthene	P
identical with	≡
not identical with	≢
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	ircg
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	≪
not much less than	≮
less than approximately equal to	≲
less than or equal to	≤ or ≦
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	l.s.t.
local time	l.t.
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.
longitudinal velocity; P-wave velocity	v_p
low frequency	lf
magnetite	Mag
mass	m
mass number	A
Master of Arts	M.A. or A.M.
Master of Science	M.S. or S.M.
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
micron (obsolete, use micrometer, µm)	µ
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	mm
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 (age dates 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
modified Mercalli	MM
molarity, molar (concentration)	*M*
mole (unit of substance)	mol
molecular weight	mol. wt
month	mo.
mountain daylight time	m.d.t.
mountain, mountains	mtn. mts.
mountain standard time	m.s.t.
mountain time	m.t.
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.
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	n.d.
no record, not reported	n.r.
nodular	nod
none available	n.a.
normality, normal (concentration)	*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 AOI degrees	GTY
oil- and gas-cut mud	O&GCM
olivine	Ol
olivine	O
oölitic	oöl
Ordovician	Ord. or O
orthoclase	Or
ounce (avoirdupois)	oz
outcrop	otcp
outside diameter	od
oxidation-reduction potential	Eh
Pacific daylight time	P.d.t.
Pacific standard time	P.s.t.
Pacific time	P.t.
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 ration	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 cubic foot	lbf/ft^3
pound-force per square foot	lbf/ft^2
pound-force per square inch	lbf/in^2
pounds per square inch	psi
Precambrian	Prec. or Pc
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	$\bar{x}$
sample mean of logarithms	$\bar{u}$
sample standard deviation	*s*
sample variance	s^2
sample variance of logarithms	s_u^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	s·ft
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 (Na_2CO_3)	nc
sodium metasilicate	ns
soluble	sol
solution	soln
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	τ
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)	T
Terrace (in addresses only)	Ter.
Territory, Territories, Territorial	Terr.
Tertiary	Tert. or T
testing	tstg
thenardite, (Na_2SO_4)	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 (age dates 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	Tri. or Tr
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. Army	USA
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	v or *u*
velocity, *P*-wave	v_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	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
wildcat	WC
wollastonite	Wo
xenolith	xen
yard	yd
yard, cubic	yd^3
yard, square	yd^2
year	yr
years before present (^{14}C age dates only)	yr B.P.
yields	→
Young's modulus of elasticity	E
zircon	Zrn
zoologic(al)	zool.

UNITED STATES

State and possessions	Customary abbre-viations	Postal Service abbre-viations
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
Canal Zone	C.Z.	CZ
District of Columbia	D.C.	DC
Guam	Guam	GU
Puerto Rico	P.R.	PR
Virgin Island	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	Z
zirconium	Zr

APPENDIX D

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
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
coalbed
coalfield
downdip
downslope
downstream
downthrown
easternmost
fieldwork
floodplain (or flood plain)
floodwater
footwall
foreset
foreshock
groundmass
guidebook
headwall
headwater
highland
hillslope
highstand
hillwash
horsetail
lakebed
lakeshore
lakeside
landform
midslope
mudflow
mudslide
nearshore
northernmost
offshore
orebody
outcrop
outwash
overthrust
photogeologic
photointerpretation
photomap
postdate
radiocarbon
rimrock
roadbed
rockslide
shoreline
sinkhole
snowline
snowmelt
southernmost
streamflood
streamflow
streamhead
timberline
toolpusher
topset
topsoil
township
updip
upslope

sheetflood
streamflood
upstream
upthrown
upwarp
upwelling
watercourse
waterfall
watershed
wastewater
westernmost
wetlands

TWO WORDS
(Hyphenated 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
cross section
cut and fill
debris flood
debris flow
debris slide
dip angle
fall line
field trip
flash flood
flood plain (or floodplain)
fly ash
ground water
hard rock
head wall
hinge line
lake bed
lake plain
mud pump
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

WORDS THAT ARE ALWAYS HYPHENATED

acre-foot
cross-bed
cross-bedding
cross-grading
cross-stratification
cul-de-sac
double-serrate
foot-pound
half-life
kilowatt-hour
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
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/most
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
alike/identical
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 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 E
UNITED STATES CUSTOMARY AND INTERNATIONAL SYSTEM OF UNITS

U.S. CUSTOMARY UNITS

Length

unit	abbreviation		approximate metric measurement
mile, nautical	(nmi)	6,076.115 ft (2,025.372 yd)	1.852 km
mile, statute	(mi)	5,280 ft (1,760 yd)	1.609 m
rod	(rd)	16.50 ft (5.50 yd)	5.029 m
yard	(yd)	3 ft (36 in)	0.9144 m
foot	(ft)	12 in (0.333 yd)	0.3048 m
inch	(in)	0.083 ft (0.027 yd)	2.54 cm

Area

square mile	(mi^2)	640 acres (3,097,600 yd^2)	259 ha
acre		43,560 ft^2 (4,840 yd^2)	0.4047 ha 4047 m^2
square rod	(rd^2)	272.25 ft^2 (30.25 yd^2)	25.293 m^2
square yard	(yd^2)	9 ft^2 (1,296 in^2)	0.836 m^2
square foot	(ft^2)	144 in^2 (0.111 yd^2)	0.0929 m^2
square inch	(in^2)	0.007 ft^2 (0.00077 yd^2)7	6.452 cm^2

Mass (avoirdupois)

ton, long		2,240 lb	1.016 MT
ton, short		2,000 lb	0.907 MT
pound	(lb)	16 oz (7,000 gr)	0.454 kg
ounce	(oz)	16 dr (437.5 gr)	28.349 g
dram	(dr)	27.343 gr (0.0625 oz)	1.771 g
grain	(gr)	0.36 dr (0.002285 oz)	0.0648 g

U.S. CUSTOMARY UNITS--continued

unit	abbreviation		approximate metric measurement
Mass (troy)			
pound	(lb t)	12 oz (5,760 gr)	0.373 kg
ounce	(oz t)	480 gr	31.103 g
grain	(gr t)	0.002083 oz	0.0648 g
Volume			
cubic yard	(yd^3)	27 ft^3 (46,656 in^3)	0.765 m^3
cubic foot	(ft^3)	1,728 in^3 (0.0370 yd^3)	0.028 m^3
cubic inch	(in^3)	0.00058 ft^3 (0.000021 yd^3)	16.387 cm^3
Capacity (U.S. Liquid Measure)			
acre-foot	(acre-ft)	43,560 ft^3	0.001233 hm^3 1,233 m^3
barrel, petroleum	(bbl)	42 gal (5.615 ft^3)	0.159 m^3
gallon	(gal)	4 qt (231 in^3)	3.785 L
quart	(qt)	2 pt (57.75 in^3)	0.9463 L
pint	(pt)	16 fl oz (28.875 in^3)	0.463 L
fluid ounce	(fl oz)	1.804 in^3	29.573 cm^3

INTERNATIONAL SYSTEM (SI METRIC) UNITS

Length

unit	abbreviation	number of meters	approximate U.S. equivalent
myriameter	(mym)	10,000	6.2137 mi
kilometer	(km)	1,000	0.62137 mi
hectometer	(hm)	100	109.36 yd
dekameter	(dam)	10	32.81 ft
meter	(m)	1	3.281 ft (39.37 in)
decimeter	(dm)	0.1	3.937 in
centimeter	(cm)	0.01	0.3937 in
millimeter	(mm)	0.001	0.0394 in

Area

		number of square meters	
square kilometer	(km^2)	1,000,000	0.3861 mi^2
hectare	(ha)	10,000	2.471 acres
are	(a)	100	119.60 yd^2
centar	(ca)	1	10.7636 ft^2 (1550 in^2)
square centimeter	(cm^2)	0.0001	0.155 in^2

Mass

		number of grams	
metric ton, tonne or Megagram	(MT or t) (Mg)	1,000,000	2,205.1 lb
quintal	(q)	100,000	220.46 lb
kilogram	(kg)	1,000	2.2046 lb
hectogram	(hg)	100	3.5274 oz
dekagram	(dag)	10	0.3527 oz
gram	(g)	1	0.0353 oz
decigram	(dg)	0.1	1.543 gr
centigram	(cg)	0.01	0.154 gr
milligram	(mg)	0.001	0.015 gr

INTERNATIONAL SYSTEM (SI METRIC) UNITS--continued

Volume

unit	abbreviation	number of meters cubed	approximate U.S. equivalent
dekastere	(das)	10	13.10 yd^3
stere	(s)	1	1.31 yd^3
decistere	(ds)	0.1	3.53 ft^3
cubic centimeter	(cm^3)	0.000001	0.061 in^3

Capacity

		number of liters	
kiloliter	(kl)	1,000 (1 m^3)	1.31 yd^3 (264.17 gal)
hectoliter	(hl)	100 (0.1 m^3)	3.53 ft^3 (26.41 gal)
dekaliter	(dal)	10 (10 dm^3)	0.353 ft^3 (2.64 gal)
liter	(L)	1 (1 dm^3)	61.02 in^3 (1.057 qt)
deciliter	(dl)	0.1 (0.1 dm^3)	6.1 in^3 (0.21 pt)
centiliter	(cl)	0.001 (10 cm^3)	0.61 in^3 (0.338 fl oz)
milliliter	(ml)	0.001 (1 cm^3)	0.06 in^3 (0.034 fl oz)

Conversion factors for SI metric and U.S. customary units of measurement

A. Factors for converting SI metric units to U.S. customary units

To convert from	To	Multiply by
Length		
millimeter (mm)	inch (in)	0.03927
meter (m)	foot (ft)	3.281
	yard (yd)	1.094
kilometer (km)	mile (mi)	0.6214
	mile, nautical (nmi)	0.5400
Area		
meter^2 (m^2)	foot^2 (ft^2)	10.76
	yard^2 (yd^2)	1.196
	acre	0.0002471
hectare (ha)	acre	2.471
hectometer^2 (hm^2)		
kilometer^2 (km^2)	mile^2 (mi^2)	0.3861
Volume		
centimeter^3 (cm^3)	inch^3 (in^3)	0.016102
liter (L)	inch^3 (in^3)	61.02
	pint (pt)	2.113
	quart (qt)	1.057
	gallon (gal)	0.2642
	foot^3 (ft^3)	0.03531
meter^3 (m^3)	foot^3 (ft^3)	35.31
	yard^3 (yd^3)	1.308
	gallon (gal)	264.2
	barrel (bbl), petroleum, (1 bbl = 42 gal)	6.290
	acre-foot (acre-ft)	0.0008107
hectometer^3 (hm^3)	acre-foot (acre-ft)	810.7

Conversion factors for SI metric and U.S. customary units of measurement--continued

A. Factors for converting SI metric units to U.S. customary units--continued

To convert from	To	Multiply by
Volume per unit time (includes flow)		
decimeter^3 per second (dm^3/s)	foot^3 per second (ft^3/s)	0.03531
	gallon per minute (gal/min)	15.85
	barrel per day (bbl/d), (petroleum)	543.4
meter^3 per second (m^3/s)	foot^3 per second (ft^3/s)	35.31
	gallon per minute (gal/min)	15,850
Mass		
gram (g)	ounce avoirdupois (oz avdp)	0.03527
kilogram (kg)	pound avoirdupois (lb avdp)	2.205
megagram (Mg)	ton, short (2,000 lb)	1.102
	ton, long (2,240 lb)	0.9842
Pressure		
kilopascal (Kpa)	pound-force per inch^2 (lbf/in^2)	0.1450
	atmosphere, standard (atm)	0.0009869
	bar	0.01
	inch of mercury at 60°F (in. Hg)	0.2961
Temperature		
kelvin (K)	degree Fahrenheit (°F)	[3]
degree Celsius (°C)	degree Fahrenheit (°F)	[4]

[3]Temp °F=1.8 temp K-459.67

[4]Temp °F=1.8 temp °C+32

Conversion factors for SI metric and U.S. customary units of measurement--continued

B. Factors for converting U.S. customary units to SI metric units

Length		
To convert from	To	Multiply by
inch (in)	millimeter (mm)	25.4
foot (ft)	meter (m)	0.3048
yard (yd)	meter (m)	0.9144
mile (mi)	kilometer (km)	1.609
mile, nautical (nmi)	kilometer (km)	1.852

Area		
foot^2 (ft^2)	meter^2 (m^2)	0.09290
yard^2 (yd^2)	meter^2 (m^2)	0.8361
acre	meter^2 (m^2)	4,047
	hectometer^2 (hm^2)	0.4047
mile^2 (mi^2)	kilometer^2 (km^2)	2.590

Volume		
inch^3 (in^3)	centimeter^3 (cm^3)	16.39
	decimeter^3 (dm^3)	0.01639
foot^3 (ft^3)	decimeter^3 (dm^3)	28.32
	meter^3 (m^3)	0.02832
yard^3 (yd^3)	meter^3 (m^3)	0.7646
pint (pt)	decimeter^3 (dm^3)	0.4732
quart (qt)	decimeter^3 (dm^3)	0.9464
gallon (gal)	decimeter^3 (dm^3)	3.785
	meter^3 (m^3)	0.003785
barrel (bbl), petroleum, 1 bbl = 42 gal)	meter^3 (m^3)	0.1590
acre-foot (acre-ft)	meter^3 (m^3)	1,233
	hectometer^3 (hm^3)	0.001233

Conversion factors for SI metric and U.S. customary units of measurement--continued

B. Factors for converting U.S. customary units to SI metric units--continued

To convert from	To	Multiply by
Volume per unit time (includes flow)		
foot^3 per second (ft^3/s)	decimeter^3 per second (dm^3/s)	28.32
	meter^3 per second (m^3/s)	0.02832
gallon per minute (gal/min)	decimeter^3 per second (dm^3/s)	0.06309
	meter^3 per second (m^3/s)	0.00006309
barrel per day (bbl/d), petroleum	decimeter^3 per second (dm^3/s)	0.001840
Mass		
ounce avoirdupois (oz avdp)	gram (g)	28.35
pound avoirdupois (lb avdp)	kilogram (kg)	0.4536
ton, short (2,000 lb)	megagram (Mg)	0.9072
ton, long (2,240 lb)	megagram (Mg)	1.016
Pressure		
pound-force per inch^2 (lbf/in^2)	kilopascal (kpa)	6.895
atmosphere, standard (atm)	kilopascal (kpa)	101.3
bar	kilopascal (kpa)	100
inch of mercury at 60°F (in. Hg)	kilopascal (kpa)	3.377
Temperature		
degree Fahrenheit (°F)	kelvin (K)	[3]
degree Fahrenheit (°F)	degree Celsius (°C)	[4]

[3]Temp K=(temp °F+ 459.67/1.8

[4]Temp °C=(temp °F-32)/1.8

Prefixes and their symbols for SI units

Multiplying factors			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
1 000	=	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	ton, tonne	t	1 t = 1,000 kg = 1 Mg
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 However, for temperature intervals Δ 1°C = Δ 1 K
time	minute	min	1 min = 60 s
	hour	h	1 h = 3,600 s
	day	d	1 d = 86,400 s
	year	a	
volume	liter	L	1 L = 1 dm^3