

GUIDE

FOR THE
PREPARATION OF
REPORTS FOR THE
UTAH GEOLOGICAL SURVEY

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

FOURTH EDITION

GEOLOGIC MAP OF THE RUSH VALLEY
30' X 60' QUADRANGLE, TOOELE,
UTAH, AND SALT LAKE COUNTIES, UTAH
by Donald L. Clark, Stefan M. Kirby, and Charles G. Oviatt

Commonly Asked Questions About Utah's
Great Salt Lake and Ancient Lake Bonneville
by [unclear]

UTAH MINING 2022
Metals, Industrial Minerals, Uranium, Coal, and Unconventional Fuels
by Andrew Rupke, Stephanie E. Mills, Michael D. Vanden Berg, and Taylor Bodine



Shallow Groundwater Hazard in Utah
By Jessica J. Castleton
Utah Geological Survey Public Information Series 105 • 2023 • <https://doi.org/10.34191/PI-105>

WHAT IS GROUNDWATER?

Groundwater occurs beneath the land surface at various depths within soil and rock. The water typically fills the space (**pores**) between the grains of soil and fractures within rock. Groundwater exists in two zones: the **unsaturated zone** and the **saturated zone**. The **unsaturated zone** contains both water and air in the soil and rock, whereas water completely fills the pore spaces in the **saturated zone**. The boundary between the two zones is called the **water table**.



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PREFACE TO THE FOURTH EDITION

Throughout its history, the Utah Geological Survey (UGS) has strived to produce reports of the highest technical and editorial quality. To achieve that end and establish the basis for a certain degree of uniformity among the various publication series of the UGS, the first edition of the *Guide for the Preparation of Reports for the Utah Geological Survey* (the *Guide*) was published as UGS Circular 85 in 1992. The *Guide* was updated, revised, and published as a second edition (Miscellaneous Publication 03-7) and third edition (Circular 105) in 2003 and 2012, respectively.

This fourth edition of the *Guide* retains much of the original text of the previous editions but incorporates revisions and additional text to address moving the technical review process into the digital age. Hardcopy review was not feasible during the COVID-19 pandemic and new review procedures regarding digital documents have since been adopted. Additionally, in 2021 the Data Management Program was created to address the increase in web applications and therefore the Website section has been substantially revised. Appendix B, Disclaimers for Use in UGS Publications, has also been revised by consolidating disclaimers having similar text and function, reducing the number from 11 to 7 disclaimers. Finally, various minor revisions reflect the ongoing evolution of English grammar and style.

Although we take full responsibility for the contents of this fourth edition of the *Guide*, we wish to acknowledge those who have assisted us in its preparation. In addition to the numerous individuals who provided advice and assistance during development of the previous editions, we thank our UGS colleagues who reviewed the current edition and/or provided valuable input, including Bill Keach, Jen Miller, Stefan Kirby, Don Clark, Michael Vanden Berg, Doug Sprinkel (UGS retired) and Grant Willis (UGS retired).

S.M.C. and M.D.H.

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INTRODUCTION

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

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

The principal source of information used in compiling this guide was *Suggestions to Authors of the Reports of the United States Geological Survey* (seventh edition; Hansen, 1991). UGS authors should refer to that publication for additional information about preparing geologic reports. However, this guide is not everywhere consistent with Hansen (1991), and, where differences exist, this guide takes precedence when preparing UGS reports. Other primary sources of information used in compiling this guide include *The Chicago Manual of Style* (17th edition), *Franklin Covey Style Guide*, and *United States Government Printing Office Style Manual*. The Selected Bibliography lists these and other useful references.

In addition to the references listed above, the UGS uses two other publications as standard references in the report publication process: the American Geological Institute *Glossary of Geology* (fifth edition [revised]; Neuendorf et al., 2005), and the current edition of the *North American Stratigraphic Code* (North American Commission on Stratigraphic Nomenclature, 2021). Authors should consult these references, or their subsequent editions and revisions, concerning matters of spelling, geologic terminology, and the naming of lithostratigraphic units. Also, authors of geologic maps published by the UGS should consult UGS Circular 89, *Guide to Authors of Geologic Maps and Text Booklets of the Utah Geological Survey* (Doelling and Willis, 1995).

UGS PUBLICATIONS

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

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

UGS publications are released in digital format on the UGS website, and most are available for print on demand through the Natural Resources Map & Bookstore. *Survey Notes* is the only publication released in both digital and physical form, although any publication can be released in both formats at the discretion of UGS administration.

Publication Series

Formal Publications

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

Examples of documents published as UGS Bulletins include:

- *Quaternary Tectonics of Utah with Emphasis on Earthquake-Hazard Characterization* (Hecker, 1993).
- *Digital Geologic Resources Atlas of Utah* (Sprinkel, 1999).
- *Produced Water in the Uinta Basin, Utah: Evaluation of Reservoirs, Water Storage Aquifers, and Management Options* (Chidsey, 2017).

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

Examples of documents published as UGS Special Studies include:

- *Redefining the Lower Cretaceous Stratigraphy Within the Central Utah Foreland Basin* (Sprinkel et al., 1999).
- *Characterization of the Groundwater System in Ogden Valley, Weber County, Utah, with Emphasis on Groundwater–Surface-Water Interaction and the Groundwater Budget* (Jordan et al., 2019).
- *Paleoseismic Investigation of the Taylorsville Fault at the Airport East Site, West Valley Fault Zone, Salt Lake County, Utah* (Hylland et al., 2022).

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

Examples of documents published as UGS Maps include:

- *Landslide Map of Utah* (Harty, 1991).
- *Digital Geologic Map of Utah* (Hintze et al., 2000).
- *Geologic Map of the Salt Lake City South Quadrangle, Salt Lake County, Utah* (McKean, 2019).

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

Examples of documents published as UGS Circulars include:

- *A Preliminary Assessment of Paleontological Resources Within the Grand Staircase–Escalante National Monument, Utah* (Gillette and Hayden, 1997).
- *Utah Mining 2018: Metals, Industrial Minerals, Coal, Uranium, and Unconventional Fuels* (Mills et al., 2019).
- This guide.

Reports of Investigation: Reports of Investigation present the results of site-specific or project-specific investigations undertaken by UGS staff. The investigations involve original work and are generally of limited scope and/or duration, and the resulting reports typically are of interest to a local audience and receive limited distribution. Reports of Investigation allow for more flexibility in format and content than Bulletins, Special Studies, and Circulars, but they nonetheless undergo the full UGS review process (Table 1) to ensure that they retain scientific accuracy. Reports of Investigation require at least one peer review by a subject-matter expert. A Report of Investigation may consist of a single report on a single topic, or several different reports on related topics.

Examples of documents published as UGS Reports of Investigation include:

- *Assessment of Wetland Condition and Wetland Mapping Accuracy in Upper Black Fork and Smiths Fork, Uinta Mountains, Utah* (Menuz et al., 2016).
- *Investigation of the August 24, 2019, Cable Mountain Rock Avalanche, Zion National Park Utah* (Castleton and Erickson, 2019).
- *Salt Crust, Brine, and Marginal Groundwater of Great Salt Lake’s North Arm (2019 to 2021)* (Jagniecki et al., 2021).

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

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

- *Rainbow of Rocks: Mysteries of Sandstone Colors and Concretions in Colorado Plateau Canyon Country* (Chan and Parry, 2002).
- *Liquefaction Hazards in Utah* (Milligan, 2016).
- *Commonly Asked Questions about Utah’s Great Salt Lake and Ancient Lake Bonneville* (Davis et al., 2022).

Miscellaneous Publications: The Miscellaneous Publication series is the principal publication series available to non-UGS authors. Miscellaneous Publications may be substantive scientific works, but do not necessarily conform to UGS editorial or format standards. Miscellaneous Publications typically take the form of a single report on a single topic (non-UGS author,

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

Examples of documents published as UGS Miscellaneous Publications include:

- *Geologic Map of the Terrace Mountain West Quadrangle, Box Elder County, Utah* (Miller and McCarthy, 2002).
- *Proceedings Volume, Basin and Range Province Seismic Hazards Summit II* (Lund, 2005).
- *Geothermal Characteristics of the Roosevelt Hot Springs System and Adjacent FORGE EGS Site, Milford, Utah* (Allis and Moore, 2019).

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

Informal and Unpublished Documents

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

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

- *Engineering Geologic Map Folio, Springdale, Washington County, Utah* (Solomon, 1996).
- *Great Salt Lake North Arm Salt Crust Monitoring, Spring 2017 Update* (Rupke and Boden, 2020).
- *National Wetland Inventory Report for the Provo River, Utah* (Goodwin and Stimmel, 2023).

Data Series: This publication series contains datasets, databases, and their accompanying documents and is intended as a repository for information gathered in support of various UGS projects that focus on data collection with minimal interpretation. In addition to the data, the publication may contain noninterpretive information such as purpose and scope, collection methods, summaries, and/or interpretive information such as analysis of the data, conclusions, and other information. Also included in this series are extended descriptions of digital content such as scientific video, multimedia, photographs, and software manuals and documentation, where the actual content is released separately. Data Series documents may have either UGS or non-UGS authors, and they receive limited UGS review (Table 1). Some Data Series documents may need to be submitted to and approved by the UGS Editorial /Sales Committee before the UGS commits time and resources (e.g., reviews, editorial assistance with illustrations) in support of publication. This requirement typically pertains to unsolicited data and documents and not to work that is performed at the request of or under contract to the UGS. Nonetheless, the deputy director and director should be made aware of data and documents prepared under these circumstances prior to UGS review.

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

- progress reports and quarterly reports (archive the final technical report only),
- deliverables that are also or will be submitted for review as another publication such as an Open-File Report or Special Study, and
- deliverables for projects for which the UGS is a subcontractor.

Selecting a Publication Series

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

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

Outside Publications

Most UGS activities result in some type of UGS publication. However, some material may be better suited to a wider or more specific audience for which publication outside the UGS would be desirable. The UGS supports outside publication, subject to approval by the author's program manager. Following approval, UGS resources and capabilities may be used in preparing outside publications. The work requires the director's approval if it involves a publication cost (e.g., page charges) payable by the UGS.

A manuscript intended for outside publication must undergo the full UGS review process (not including peer review) prior to submittal to the outside publisher (Table 1). Most publishers will arrange for peer review of the manuscript prior to publication. Depending on the extent and nature of changes to the manuscript in response to peer-review comments, subsequent approval of the revised manuscript by the deputy director and director may or may not be warranted; UGS authors should use their best judgment to determine if this step is necessary.

THE UGS WEBSITE

All documents written for the UGS publication series, excluding contract deliverables, will be digitally published and released on the UGS website. Select contract deliverables may be released on the website after obtaining permission from the funding agency. Authors may post various types of documents and data to the UGS website following the guidelines given below.

Articles, reports, conference posters, and materials prepared specifically for the website are subject to the Data Management Program's review process. This material also includes data collected for database-driven, interactive web applications. Authors should consult with the Data Management Program manager regarding suitability of materials and for questions and procedures regarding development of new web applications and updates to existing web applications.

THE UGS PUBLICATION PROCESS

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

The publication review process addresses issues of scientific rigor, organization and completeness of reports, and format and editorial standards. The process typically consists of author-initiated subject-matter peer reviews; a thorough technical and editorial review by the program manager; and review and approval by the UGS technical reviewer, deputy director, and director (Figure 1). Some variations exist in the level of review required for the different UGS publication series, and review requirements may differ for UGS versus non-UGS authors (Table 1).

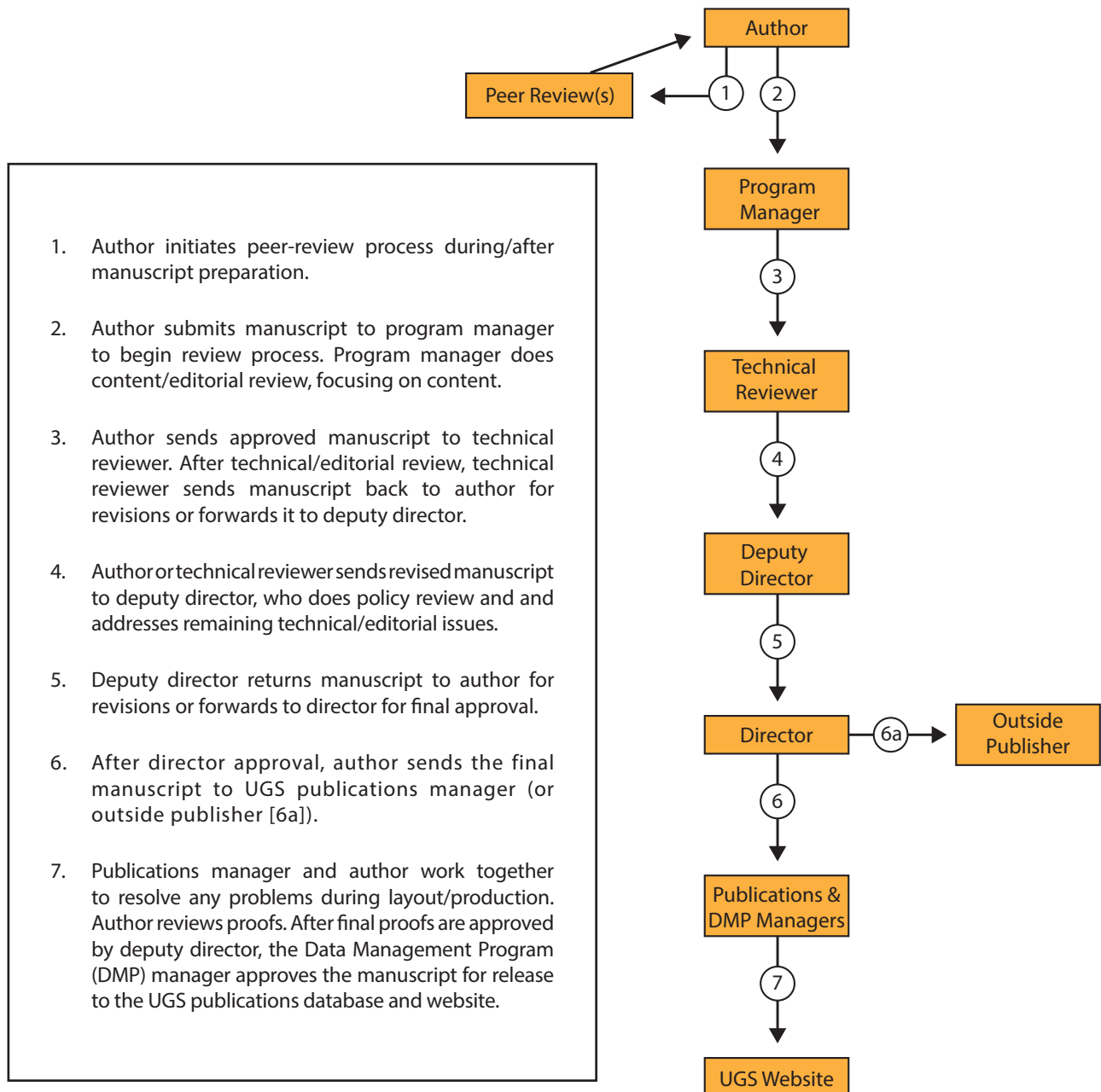


Figure 1. Idealized path of a document through the UGS publication process. Note that a document may be returned to the author at any point in the publication process to address issues that may arise. Also, review requirements vary for individual UGS publications; refer to Table 1 for specific review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

Author

Utah Geological Survey policy is that the person in principal charge of an investigation and preparation of the subsequent report receives credit as principal author of the resulting publication. Seniority, position/title, or similar considerations are not criteria for determining authorship or co-authorship of UGS reports. In cases of multiple authors, the level of contribution by each individual determines authorship or co-authorship. When two or more researchers contribute equally, they will be listed as authors in alphabetical order according to their last names unless they agree in advance to some other mutually satisfactory arrangement.

Credit for co-authorship is given to individuals who make a significant contribution to an investigation even though they may not take an active part in writing the report. Usually, the designation of principal and co-authors is a straightforward matter. Clear assignment of duties and responsibilities among investigators early in the study normally resolves potential questions or disagreement on this sometimes sensitive subject. When disagreement occurs, the program manager will make the final decision regarding authorship. If the disagreement involves the program manager, the deputy director will make the decision.

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

When satisfied with the report (including illustrations, tables, and format) after peer review, the author completes and signs a digital UGS Document Review and Approval Sheet (Appendix A; contact the technical reviewer for a PDF copy) and submits the manuscript and routing sheet to the program manager to begin the formal internal UGS review process (Figure 1, path 2). At various points in the review process the manuscript may be returned to the author for revision. Authors should consider all review comments and incorporate those that improve the report. The author will have an opportunity to review the manuscript proofs before the report is published (Figure 1, path 7), but only limited revisions will be allowed at that time. Authors should keep copies of completed Document Review and Approval Sheets in their files for future reference.

Peer Review

Rigorous peer review ensures the usefulness of a scientific report to its intended audience. Peer review can help identify deficiencies in report organization, content, and editorial style, and may provide authors with new insights regarding their study. Thorough peer review by technical specialists 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.

For formal UGS publications, peer review (Figure 1, path 1) typically takes place immediately after the report-writing phase of the publication process and before submitting the manuscript to the program manager for review. However, peer review can occur concurrent to program manager review or after program manager review at the discretion of the program manager. Peer reviewers are normally chosen by the author in consultation with the program manager. Many reports in the UGS publication series require a minimum of one or two peer reviews, preferably at least one of which is by an individual outside of the UGS having technical expertise on the topic of the study (Table 1). No upper limit is placed on the number of peer reviews that may be sought, and multiple reviews are recommended. Peer reviewers should be selected for their technical understanding of the topic; their ability as scientific writers, or their ability to translate technical information into language that is easily understood by a general or nontechnical audience, as appropriate; and their willingness to complete the review in a thorough and timely manner. Appendix A contains a Peer Review Form for authors to send to peer reviewers along with the manuscript to facilitate the peer review process, though use of the form is optional.

Manuscripts prepared for publication outside the UGS generally do not require peer review prior to program manager review. These peer reviews are typically coordinated by the outside publisher.

Table 1. Publication review and approval requirements.

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

¹ Subject-matter expert, preferably outside UGS.² Primarily policy review.³ Final approval for publication.

If a report includes geographic information system (GIS) files, a GIS specialist must review the files on a computer that is different from the one on which the files were generated. The files for review should be in a finalized form. When satisfied with the content and accessibility of the files, the GIS reviewer should sign the UGS Document Review and Approval Sheet (Appendix A) in the appropriate box.

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 reviewing. However, individuals who do not believe themselves qualified, who lack the time to do a thorough review, or who have a conflict of interest should decline the reviewer's role. The Selected Bibliography contains several publications that provide specific review guidelines (for example, Malde, 1986; Hansen, 1991). The following general guidelines apply to all manuscript reviews:

- Reviewers are obligated to treat manuscripts as confidential documents and must not show, disclose, appropriate, use, or publish information contained in a manuscript without the author's expressed consent.
- Reviewers should be alert to the failure of the author to cite relevant work by other scientists.
- Reviewers should explain and support their comments so that the author can understand the basis on which they were made. Vague or cryptic comments are of no use to the author.
- Reviewers should carefully check all mathematics and chemical formulas for accuracy.
- Reviewers may find it necessary to criticize a manuscript but should do so in a respectful and objective manner. Be straightforward when offering constructive criticism; attempts at humor are more likely to offend than amuse. Sarcasm and personal criticism of an author are never justified.

Authors owe a responsibility to their peer reviewers. A comprehensive scientific 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 free of typographical errors. A reviewer who must spend time tracking down parts of a report (an illustration or reference, for instance), or has difficulty deciphering the report because of poor writing or organization, is unlikely to agree to serve as a peer reviewer for the author in the future.

Program Manager

A program manager oversees each of the UGS technical programs. Program managers have responsibility for the scientific and editorial quality of the reports produced by their programs. The review process begins when the author completes a manuscript and discusses it with the program manager. The program manager works with the author to choose an appropriate peer reviewer(s) for the manuscript, and decides whether to begin their review either before, concurrent with, or after the peer review(s). The program manager makes a thorough technical and editorial review of the manuscript and, if necessary, returns it to the author for revision. When satisfied with the scientific and editorial quality of the report, the program manager signs the UGS Document Review and Approval Sheet and then the author sends the manuscript and approval sheet to the technical reviewer (Figure 1, path 3). By signing the Document Review and Approval Sheet, the program manager certifies that the document represents the program's best professional efforts, and shares with the author personal responsibility for the document's technical quality and compliance with UGS editorial standards.

The only documents that are not reviewed by program managers are Miscellaneous Publications authored solely by non-UGS personnel (Table 1). However, program managers are responsible for ensuring that these documents receive a peer review by a UGS employee having the appropriate background in the subject matter.

Technical Reviewer

The UGS technical reviewer is responsible for ensuring technical accuracy and compliance with UGS editorial standards. The primary issues considered by the technical reviewer include any technical/scientific problems not previously addressed by the author, the organization and clarity of the report, consistency among the various components of the report, and compliance with UGS editorial standards. The technical reviewer generally works directly with the author to resolve

any non-technical issues, but may consult with both the author and program manager if substantial technical issues arise. When satisfied with the scientific and editorial quality of the report, the technical reviewer or author sends the approved manuscript to the deputy director for review (Figure 1, path 4). In addition to manuscripts for release in a UGS publication series, the technical reviewer also reviews documents, text, and webpage content prepared for release on the UGS website as well as text and metadata prepared for UGS web applications (please consult with the Data Management Program manager regarding the review process for website materials).

Deputy Director

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

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

Director

The director gives final approval for all UGS publications and approves all manuscripts prepared by UGS authors for publication outside of the UGS. After signing the UGS Document Review and Approval Sheet, the director returns the approved manuscript to the author for submittal to the UGS publications manager for publication (Figure 1, path 6). Rejected manuscripts are returned to the author to address outstanding issues prior to approval. Manuscripts approved for outside publication are signed by the director and returned to the author, who forwards the manuscript to the publishing organization's editor (Figure 1, path 6a).

Publications Manager

The publications manager reviews manuscripts for compliance with UGS editorial standards and supervises finalization and layout of reports for publication. The publications manager works with the author to resolve questions or problems that may arise at any phase of the publication process. To streamline the publication process, authors should consult with the publications manager early and often to address issues such as oversized figures (plates), creating appendices for multi-page tables, and preferred file types.

Once the publications manager approves the report for digital publication, proofs are sent to the author for review. After the author's revisions are incorporated, the publications manager sends the corrected proofs to the deputy director and director for final review. Once approved by the deputy director and director, the publications manager sends the finished publication to the Data Management Program manager, who approves the publication for release to the UGS publications database and website (Figure 1, path 7).

Review Procedures for UGS Website Materials

Static Web Content

Previously published UGS articles or reports: If the material has undergone full UGS publication review, no additional review is required. However, authors must consult with their program manager and the UGS website manager regarding the material's appropriateness for posting on the website. Website materials are intended for use by the general public and should not be detailed, technical documents. Once approved, the author may then submit the materials to the UGS website manager using the Review and Approval Sheet for Static Web Content (Appendix A).

Previously unpublished or non-reviewed UGS materials: With the exceptions described in the following paragraph, articles and reports prepared specifically for the website that have not received prior UGS review must be approved by the author's program manager and then submitted to the UGS technical reviewer, website manager, and the Data Management Program manager for review using the Review and Approval Sheet for Static Web Content (Appendix A). Following review by the Data Management Program manager, the materials must be approved by the deputy director.

Nonscientific materials such as meeting announcements, notices of field reviews, and routine updates of website pages by the website manager (for example, adding new entries to calendars, conference listings, publications lists) need not be submitted for review, but such materials should be proofread thoroughly before being posted. Program managers must approve all project updates submitted by program staff before submitting the material to the website manager and must use the Review and Approval Sheet for Static Web Content (Appendix A) to track the approvals.

Non-UGS Materials

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

Interactive Web Applications

New web applications: Developing web applications requires early and frequent communication with the Data Management Program manager. The author should be prepared with a detailed scope regarding expectations of the new application including the intended audience and why the application is warranted. The author should also include a detailed description of the types of data the application should show and how the data will be displayed/visualized. The data should be reviewed by two peers (including a GIS analyst) and the author's program manager. The technical reviewer should be included in the review process if the web application materials include text (complete sentences or paragraphs). Together, the Data Management Program manager, the author, and the author's program manager will determine the path forward after the initial development meeting.

Existing web applications: Updates and additions to existing web applications should be submitted using the current online form (e.g., Github, Jira, etc.) being used by the Data Management Program (consult with the Data Management Program manager for details and instructions). The updates and additions do not need approval from the deputy director or the director; however, updated text will need technical reviewer approval.

Proofreading

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

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

- After composing a rough draft, look through the text file for any grammar and spelling mistakes using the spelling- and grammar-checking tools of the software. Although not infallible, these tools will help you find many problems that typically crop up, such as subject-verb disagreement, voice and tense problems, and improper word usage.
- Plan ahead; try to allow time to let your writing sit before coming back to proofread it. This allows you to read your writing more objectively.
- Proofread not only the first draft, but all subsequent drafts as well. Mistakes have a way of creeping into manuscripts at any phase of the publication process.
- Proofread hard copy. Mistakes are easier to catch when reading words printed on paper than when reading words on a computer monitor.
- Read your writing out loud to yourself. Mistakes are easier to catch when the words are vocalized than when read silently.

ETHICAL CONSIDERATIONS

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

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

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

THE PARTS OF A REPORT

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

Text

Title Page

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

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

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

Disclaimers: Most UGS reports include the standard UGS disclaimer in their front matter. For draft manuscripts, the standard disclaimer should appear at the bottom of the title page, unless other disclaimers are also used (for example,

disclaimers for work performed under contract with the federal government). When multiple disclaimers are used, they should appear together on a separate page. The UGS may choose to release some reports without the standard disclaimer; this will be determined on a case-by-case basis. Consult with the deputy director on issues involving use of the standard or other disclaimers. The UGS has authorized the following standard disclaimer wording:

The Utah Department of Natural Resources, Utah Geological Survey, makes no warranty, expressed or implied, regarding the suitability of this product for a particular use, and does not guarantee accuracy or completeness of the data. The Utah Department of Natural Resources, Utah Geological Survey, shall not be liable under any circumstances for any direct, indirect, special, incidental, or consequential damages with respect to claims by users of this product.

UGS geologists increasingly rely on the Global Navigation Satellite System (GNSS; e.g., the Global Positioning System [GPS]) for fieldwork. In some projects, GPS receivers may be used simply for navigation or for locating data collection points. In other projects, however, the GPS data themselves become a significant part of the project's database and affect the report's conclusions. Authors of these latter types of reports should avoid implying that they conducted a land survey in addition to or instead of a scientific work by using the following in the disclaimer:

Some types of geologic work performed by the UGS use Global Navigation Satellite System instruments. The data collected by the UGS using these instruments is intended only for use in scientific analysis. This geologic work should not be used for determining or locating property boundaries or for any of the other purposes that are the responsibility of a Professional Land Surveyor, as defined by the Utah Code, Title 58, Chapter 22, Section 102.

UGS geologists often use specialized commercial software and equipment for research, data collection, and reporting. When referring to any such item in a publication, authors should include the non-endorsement disclaimer below along with other disclaimers at the beginning of the manuscript:

The Utah Geological Survey does not endorse any products or manufacturers. Reference to any specific commercial product, process, service, or company by trade name, trademark, or otherwise, is for informational purposes only and does not constitute endorsement or recommendation by the Utah Geological Survey.

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

Utah Licensed Professional Geologist seal: Documents that may be interpreted as containing geologic advice to a Utah state- or local-government agency, or other client, must include the seal of a Utah Licensed Professional Geologist. In general, the seal will be that of the report's lead author or other person having responsible charge over the project (e.g., the lead author's program manager). Use of the seal must follow the Professional Geologist Licensing Act (Utah Code, Title 58, Chapter 76) and Rules (Utah Administrative Code, R156-76).

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

Foreword and Preface

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

Executive Summary

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

Table of Contents

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

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

List of Acronyms and Abbreviations

When a lengthy report contains numerous acronyms and/or abbreviations, it can be helpful to include a list of the acronyms and abbreviations used along with their written-out meanings. The list is ordered alphabetically based on the letters of the acronyms and abbreviations, rather than by the spelled-out words. The list of acronyms and abbreviations comes after the table of contents.

Abstract

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

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

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

Body of the Report

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

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

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

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

Acknowledgments

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

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

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

References

References are used to acknowledge the work and ideas of others and to tell the reader where to look for additional information. References cited in UGS reports typically include (1) printed publications such as maps, books, and journal articles, (2) electronic-media documents, including databases and reports published on the Internet, and (3) verbal or written personal correspondence. Citing references is a critical part of the report-writing process and one that is often subject to error. Regardless of the type of reference, it is always necessary to confirm details such as the spelling of the author’s name(s), the title of the reference, the date of publication, the name of the journal or other publication in which the reference appears, and such things as journal volume and number, page numbers, and map scales. A common error is citing a reference in the text but omitting it from the reference list at the end of the report. With minor exceptions (see below), the UGS follows USGS reference style (see Hansen, 1991, p. 234–241).

Electronic-media documents, in particular websites, pose unique challenges to authors who wish to use them as reference materials in formal technical publications. These challenges stem from such circumstances as the often-ephemeral nature of the content of web pages, ambiguous authorship, and the lack of peer review. UGS authors need to carefully evaluate the advantages and disadvantages of using electronic-media documents as reference sources in their reports. If the reliability or veracity of information in an electronic-media document is uncertain, the document should not be used as a reference. Also, if the information exists in traditional (paper) published form as well as electronic form, the published paper document should be referenced. The web address or digital object identifier (DOI) of the electronic-media document should then be included at the end of the reference in the References list. Electronic-media documents may be cited in the text and listed in the References list of UGS reports only if (1) the information provides data or documentation necessary to the report, and (2) the author determines that the information does not exist in a traditional published form.

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

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

Provide references in the text for significant personal communications, including verbal (for example, telephone conversations or face-to-face meetings) and written (unpublished documents such as letters or memos, and e-mail correspondence). Personal communications should be referenced in the text as follows: “E.G. Sable (U.S. Geological Survey, verbal communication, March 17, 1990) stated . . . , “ or ”. . . consists of red arkosic sandstone (W.L. Stokes, University of Utah, written communication, 1987).” An affiliation should be given after the name as a courtesy to the person supplying the information and as a convenience to the reader. However, when the same person is referenced

multiple times in a report, the affiliation need not be given every time the person is referenced. Credit is extended for the use of other unpublished information by inserting “(unpublished information)” at the appropriate place in the report text. Note that references for personal communications and unpublished information are not included in the reference list at the end of the report.

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

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

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

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

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

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

If the illustration includes satellite or other imagery from a commercial source, such as Google, the author must indicate the source and date of the image in the illustration caption.

Figure 3. *Satellite image of the evaporation ponds at Intrepid Potash Inc.’s mining operation near Moab. Image from Google Earth, ©2018 Google.*

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

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

The general format for reference citations consists of the following:

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

A colon serves a structural purpose in the reference citations; it separates items 1 through 5 in the above list from items 6 through 11. Colons within report titles should be replaced with an em dash in the reference citation to avoid confusion with the colon that marks the end of the title (see Dashes section). Avoid using abbreviations in a reference list except for the following: (1) abbreviations or acronyms used in a title, (2) v., no., pt., and p., (3) Inc., (4) M.S. and Ph.D., (5) U.S. and D.C., and (6) [abs.].

Scientific documents published online typically have a digital object identifier (DOI) assigned to them. The DOI is a direct link to the publication. If a cited paper has a DOI, include it at the end of the reference citation in the reference list. The UGS publications manager assigns a DOI to all new UGS publications, and previously published UGS papers have retroactively been assigned a DOI. Therefore, all citations of UGS publications in a reference list should include the publication's DOI.

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

List entries in alphabetical-chronologic order according to the senior (first) author's last name. Entries having multiple authors include the names of all the authors. An exception to this guideline is when "and others" or "et al." appears on the title page of the original document, rather than individual co-author names. Use initials for first and middle names. Multiple references having the same first author but different second or third authors are listed alphabetically by the second, or if necessary, the third author's last name. For multiple references having the same senior author and either the same or different co-authors and published in the same year, append an "a," "b," "c," and so on to the date of the reference. Append the references sequentially according to their order in the reference list, not necessarily the order in which they appear in the text.

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

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

Glossary

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

Appendix

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

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

Index

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

Summary Paragraph for Publications

Draft materials for all publication series, excluding Contract Deliverables, should include a brief paragraph that describes the contents of the publication. The paragraph, which will appear on the Natural Resources Map & Bookstore website, should include sufficient information to give a prospective reader a good description of the publication and any data included, and how the data may be used. This information might address such things as whether the data represent original research or are compiled, types of data (e.g., maps, cross sections, well logs, core photos, databases, bibliographies), scale of map compilation, whether or not the publication includes spatial data/geographic information system files, and any other pertinent aspects that would help someone decide if the publication would be useful to them.

Illustrations

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

- Do the proposed illustrations make a significant contribution to the report?
- Are the illustrations clear and complete? Can they stand alone without reference to the text or other illustrations?
- Are the illustrations “in phase” with the text, neither cluttered with unnecessary or redundant information, nor omitting important information (such as locations) referred to in the text?

Illustrations in UGS reports include maps, various types of line drawings, graphs, and photographs. Illustrations within the report are referred to as “Figures”; illustrations are termed “Plates” if they require an oversize plotter (larger than 11 x 17-inch format) to print the illustration at a zoom factor of 100%.

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

In digital draft manuscripts, compile figures into one document (e.g., Adobe PDF is preferred, but Microsoft Word and Google Docs are acceptable) or keep them as individual files in a common folder. DO NOT place them at the end of the digital text file. Include a caption with each figure regardless of how the digital file is submitted for review. Make sure that all figures and their respective captions are clearly labeled with the appropriate figure number.

Line Drawings

Most line drawings are created using vector graphics software (e.g., Adobe Illustrator) and geographic information system software (e.g., ArcMap and ArcGIS). These illustrations should be of high resolution.

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

- Oversize illustrations, those larger than 8½ by 11 inches, will not be published as part of the text. Instead, such illustrations should be designated as plates or included as part of an appendix that will be published at the end of the digital document or as a separate file.
- Figures should fit upright on a page wherever possible. Editorial staff will reduce or enlarge figures as necessary during layout of the publication. Authors preferring a particular figure size in the final report should consult with the publications manager early in the publication production process.
- Copies of original illustrations are acceptable only when the line quality of the copy is equal to that of the original (for example, modifying or using a figure from a non-UGS publication). If necessary and appropriate, contact the original author or publisher for a high-resolution copy of the illustration.
- Authors should use one font style for figures whenever possible. Maps are an exception as multiple fonts are often necessary for clarity and appearance. Consult with the publications manager to receive guidance and advice.
- Select patterns and colors used on line drawings with care. Fine dot or line patterns are frequently lost or blurred when the size of an illustration is reduced. For questions regarding line colors and patterns, consult with the publications manager.
- A bar scale must accompany all scaled drawings and maps and should use whole, round-number increments (e.g., 0, 5, 10, 15 miles, not 0, 1.5, 3.0, 4.5, 6.0 miles). Numeric scales in figures are discouraged because the published figure size may be different from the original size.
- All maps require a north arrow and should include township and range or latitude and longitude border markings as appropriate.
- Illustrations drafted onto a pre-existing base map must give credit for the base.
- Submit illustrations in their original digital format (e.g., Adobe Illustrator, Microsoft Word, etc.) to the publications manager upon request for the production phase of the publication process. Illustrations/maps created in ESRI software (e.g., ArcMap, etc.) should be exported to an editable file format such as Adobe Illustrator or PDF.

Figure 3 shows an example of a good line drawing that has clear labels (labels do not overlap lines), an explanation, location map, scale bar, and north arrow.

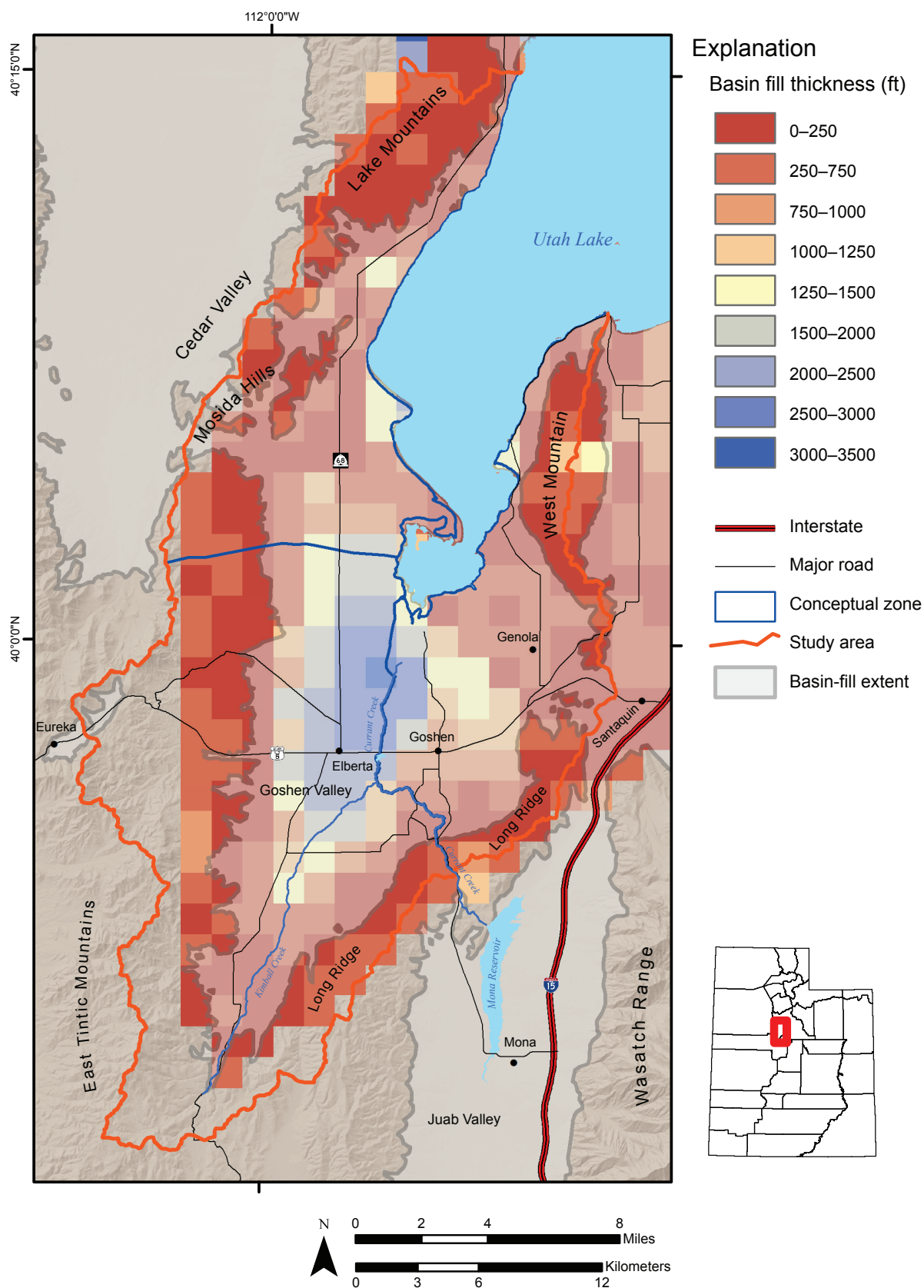


Figure 3. An example of a well-constructed line drawing. (Figure from Kirby et al., 2022).

Geologic quadrangle maps represent a special category of illustration published by the UGS. Authors should consult UGS Circular 89, *Guide to Authors of Geologic Maps and Text Booklets of the Utah Geological Survey* (Doelling and Willis, 1995) for specific guidelines concerning the preparation of geologic quadrangle maps.

Graphs

A well-prepared graph can convey relationships and trends among numerical data more effectively than a written description alone. The most effective graphs are simple and uncluttered, and supplement the text by presenting information that is critical to the reader's understanding of the report. Authors are responsible for the final appearance of graphs; editorial staff will make little to no modification of graphs prior to publication. Figure 4 shows the difference between a poorly displayed and well-displayed graph, and Figure 5 gives an example of an unnecessary graph.

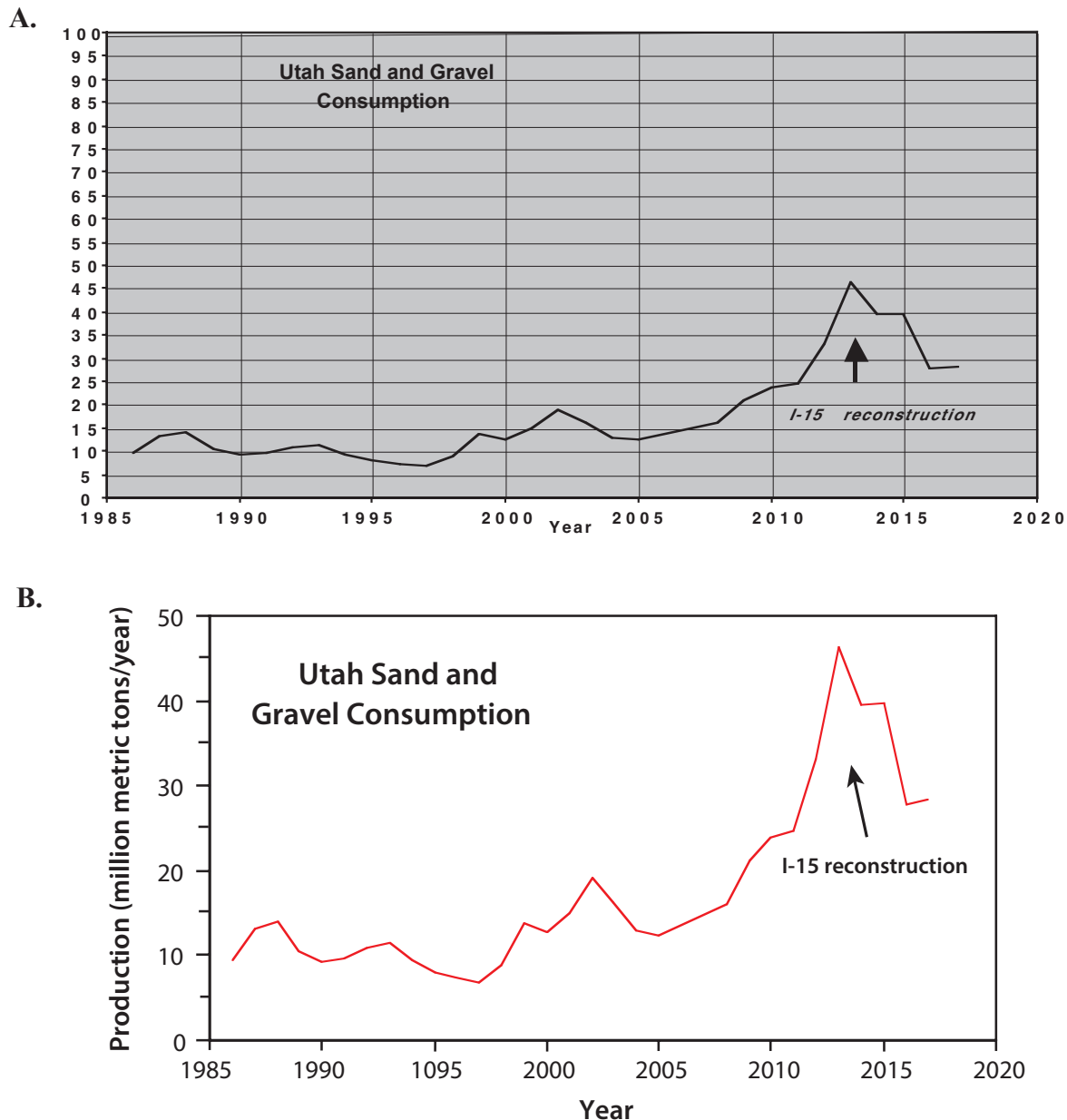


Figure 4. **A.** Poorly displayed graph. Grid lines and background shading are unnecessary, vertical axis is not scaled efficiently (total range and interval), and label fonts are too small. **B.** The same data in a well-displayed graph.

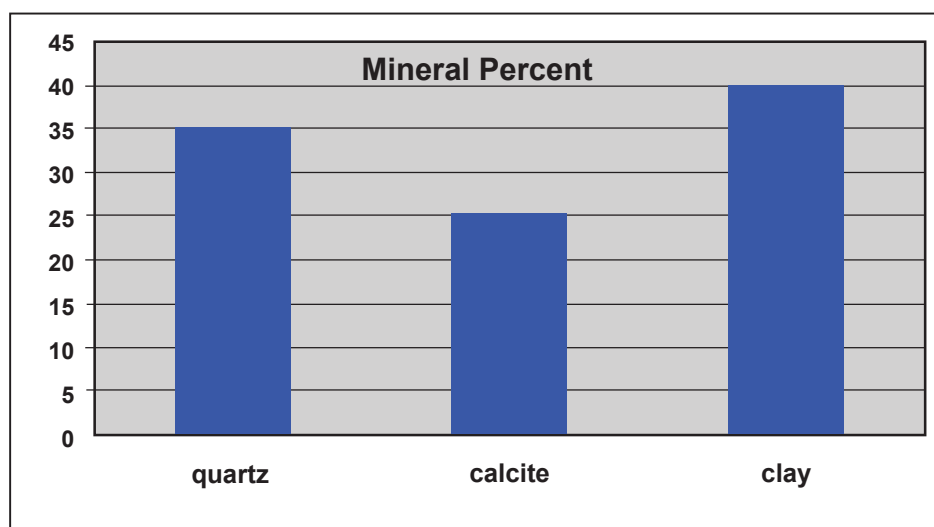


Figure 5. Example of an unnecessary graph. This graph could be replaced by the sentence, “The sample consists of 35% quartz, 25% calcite, and 40% clay.”

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

- Keep graphs as simple as possible. This often involves overriding software default settings that do not produce the best appearance for publication.
- Avoid use of grid lines, which typically add unnecessary clutter. However, authors may outline the graph with a box that coincides with the graph axes.
- When using color in the plot area use a white background so there is good contrast between the background and data, making the data clearly visible. Avoid using green and red text, bars, lines, etc. on the same graph.
- Avoid over-labeling axis tick marks. Label tick marks at regular intervals that are sufficient and necessary for a clear interpretation of the graph.
- Make the appearance of similar types of graphs uniform throughout the report.
- Submit graphs in their original digital format (e.g., Microsoft Excel, Microsoft Word, etc.) to the publications manager upon request for the production phase of the publication process.

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

Submit original, digital, high-resolution files (e.g., JPG, TIFF, etc.) to the publications manager upon request for the production phase of the publication process.

Sharp, well-focused photographs with proper contrast are vital for a good, published image. Framing your shot is vital as well; the object of interest should occupy more than three-fourths of the total image. Most photographs in geologic reports require a scale. Familiar objects of a recognizable size, a rock hammer or camera lens cap for instance, are commonly used, although for close-ups a small ruler or photo-scale card is useful. The scale can be included in the figure caption; for example, “Largest pebble is 2 inches (5 cm) across.” Avoid numeric scales (photomicrograph X 2.5) unless you are sure the photograph will not

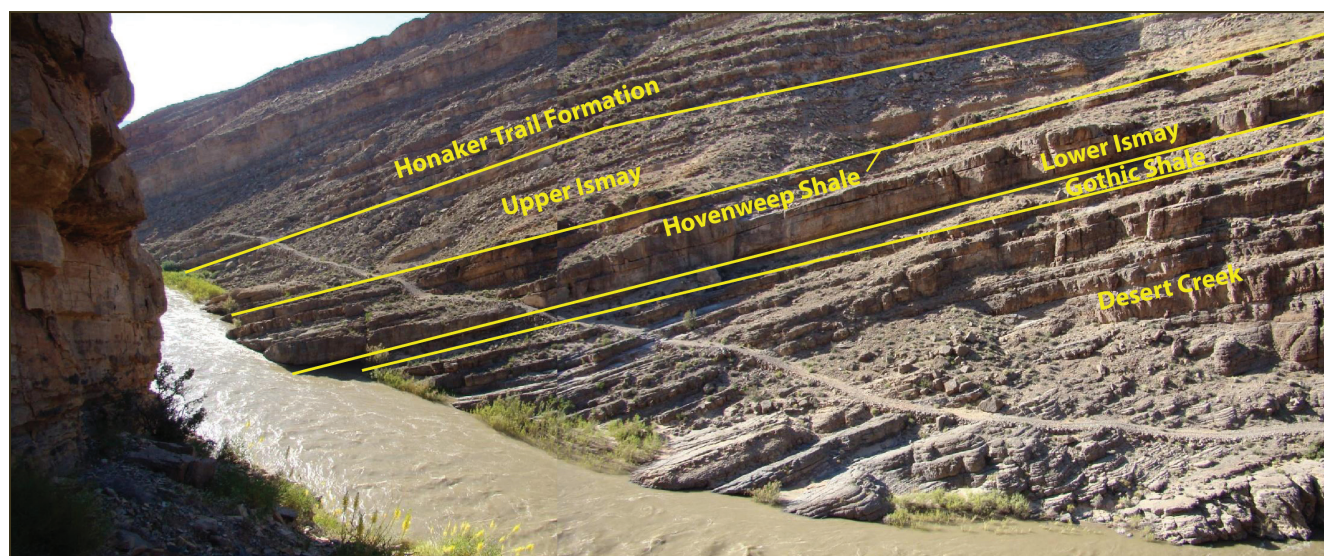


Figure 6. Effective use of a photograph as an illustration in a report. View to the west down river of the upper Desert Creek through the Ismay zones, including the Gothic and Hovenweep shales, to the Honaker Trail Formation. (Figure from Chidsey, 2016.)

be enlarged or reduced during the report preparation process. Eliminate the problem by annotating the photograph with a bar scale. Crop or enlarge photographs to emphasize significant features. Instructions to the publications manager about desired final figure size, cropping, or other treatment should accompany the photographs.

If adding lines or labels to the photograph, make sure to use colors that have good contrast with the photo and are easy to read. Avoid using red and green lines and annotation on the same photo as it may be difficult for readers to discern differences between the colors.

Captions and Titles

All illustrations require a caption (figure) or title (plate). Captions and titles should be clear and concise, expressing the content of the illustration and geographic location if a map. Readers can recognize the generic nature of illustrations, so avoid beginning a caption or title with “Photograph of” or “Map of.” Typically the best captions and titles are short, but long captions and titles are acceptable when used to present various kinds of explanatory material. Authors must exercise judgment in determining if the explanatory material is more appropriately placed in a caption or title, or in the report text. Captions and titles should explain the purpose of the figure and should avoid referring the reader back to the text. Captions for photographs should note geologic features shown, the location of the area, and the direction of view. Credit is required for photographs taken by someone other than the author. When appropriate, the caption should reference the work or ideas of others (see References for Illustrations section). References cited in captions appear in the reference list at the end of the report.

Captions typically appear below figures and are formatted as part of the editorial process. Make sure that all captions are clearly labeled with the correct figure number. Titles for plates are usually drafted directly on the illustration. Examples of well-prepared captions and titles follow:

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

Figure 2. Schematic cross section through onlapping lacustrine deposits of the Bonneville basin: B, Bonneville Alloformation; CD, Cutler Dam Alloformation; LV, Little Valley Alloformation; F, Fielding Geosol; P, Promontory (Dimple Dell) Geosol. Query indicates that the lower altitudinal limit of the Promontory Geosol is unknown (modified from Oviatt et al., 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 Hansen (1991), which contains detailed instructions for preparing tables, when a complex table is necessary.

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

Trench	Field Sample Number	Laboratory Identification Numbers	Material Type and Geologic Unit	Radiocarbon age (¹⁴ C B.P.)	Calibrated ¹ Charcoal and AMRT ages (1 σ error) ²	TL age estimate	Remarks
MN-1	MN1-RC1	³ Beta-21306	Charcoal from burn layer	445 ⁴ (± 70)	510 ⁴ (+120, -190)	—	Post-MRE
MN-1	MN1-RC2	⁵ Pitt--0188	Charcoal from burn layer	490 (± 65)	520 (+120, -60)	—	Post-MRE
MN-1	MN1-RC3	Pitt--0189	Charcoal from unit 4s soil	730 (± 40)	680 (+40, -20)	—	Post-MRE
MN-2	MN2-RC1	Pitt--0191	Charcoal at unit 6/8 contact	330 (± 50)	330, 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--0192	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 (+120, -190)	—	(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

¹Calibration procedure after Stuiver and Reimer (1986); CALIB & DISPLAY software distributed by Quaternary Isotope Laboratory, Quaternary Research Center, University of Washington.

²Radiocarbon 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-AMRT 1 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.

³Beta Analytic Inc., Coral Gables, FL 33124.

⁴All radiocarbon ages are reported in years before present (yr B.P.); by convention, present is considered A.D. 1950.

⁵University of Pittsburgh, Applied Research Center Radiocarbon Laboratory, Pittsburgh, PA 15238.

⁶University of Colorado, Center for Geochronological Research, Boulder, CO 80309.

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

Hole (no.)	Location (sec.)	Depth to Top (ft)	Depth to Bottom (ft)	Thickness (ft)	Avg. Yield (gal/ton.)	In-Place Resource per Acre (bbls)
38M	NENW sec 2	64.0	154.4 ^B	90.4 ^P	14.13	98,970
38R		107.9	147.9	40.0	21.82	63,940
39M	SWNW sec 4	54.8 ^T	181.5 ^B	126.7 ^{PG}	10.35	104,700
39R		115.5	156.3	40.8	18.50	56,600
40M	NWNW sec 13	57.6	173.2 ^B	115.6 ^P	10.85	99,690
40R		106.3	150.2	43.9	17.02	56,660
41M	NWSE sec 26	30.9	166.6 ^B	135.7 ^{PG}	9.34	102,000
41R		68.3	143.6	75.4 ^G	10.67	63,970
^T = Top of assayed core samples ^P = Unit only partially represented because core starts/ends within unit ^B = Bottom of assayed core sample ^G = Unit interrupted by gap of 25 feet or more yielding <5 gal/ton						

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

Tables are numbered sequentially in the order of their appearance in the report. Unlike figures, table captions precede the body of the table. Avoid lengthy captions for tables; brief table captions are best. Generate tables with their captions separate from the main text file and compile all tables in one file (either Microsoft Word or Microsoft Excel, Google Docs or Sheets, or Adobe PDF file).

Equations and Formulas

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

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

where:

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

Center equations or formulas that are set out of the text. Number these equations or formulas in the order in which they appear in the text for easy reference by the author and ease of understanding by the reader. Place the equation number in parentheses at the right margin. Do not use parentheses when the equation is referred to in the text (e.g., “The results from Equation 1 were used to generate the model.”)

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

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

THE MANUSCRIPT

Manuscript Preparation

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

Page Format

The following rules apply to UGS manuscripts submitted for review:

1. Submit a digital copy of the manuscript that is double-spaced. The double-spacing requirement applies to the body of the manuscript, including the abstract and references.
2. For the main body of text, use 12-point type, Times New Roman font; avoid condensed-face type styles.
3. Leave margins of at least 1 inch on both sides and at the top and bottom of each page.
4. Indent the first line of each paragraph one-half inch, and leave a blank line between paragraphs. Within paragraphs, use a single space between a period and the sentence that follows.
5. Do not right-justify the text; doing so makes it difficult to identify missing or extra spaces in a line of text.
6. Place page numbers at the bottom center of each page beginning with the abstract.
7. Figures and tables in the report text are numbered consecutively; plates are also numbered consecutively but independently of the figures in the text. Figures and tables in appendices are also numbered consecutively and independently of those in the text; appendix figure and table numbers are preceded by the letter corresponding to the appendix (e.g., Figures A1, A2, and A3 in Appendix A).
8. Illustrations and tables should be saved as separate files and not embedded in the text. They can be grouped into a single digital file or provided as individual files. Although not required, it is helpful to editorial staff for the author to insert “Table x near here” or “Figure x near here” at the appropriate place in the text.

Section Headings

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

EXAMPLE OF FIRST-LEVEL HEADING

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

Example of Second-Level Heading

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

Example of Third-Level Heading

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

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

Pagination

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

Manuscript Submittal for Review

A typical manuscript for a UGS report is created using word-processing, graphics, and spreadsheet software. The draft manuscript should be submitted for review in digital form. Following manuscript approval, the author submits the digital file(s) to the publications manager. Authors requiring assistance with graphics production should consult with the publications manager. Graphics files must be compatible with current UGS graphics software. Check with the publications manager for current software specifications.

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MATTERS OF STYLE

Abbreviations, Acronyms, and Symbols

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

Avoid a proliferation of ad-hoc abbreviations that may not be intuitively familiar to the target audience. Use of abbreviations should be determined largely by custom and convenience to the reader. If the ubiquitous use of abbreviations is necessary and cannot be avoided, then compile a list of acronyms and abbreviations and their meaning to include at the beginning of the report. Place the list after the table of contents and before the abstract or summary.

Appendix D is a compilation of abbreviations used in UGS reports. Lists of abbreviations are also available in Hansen (1991), *U.S. Government Printing Office Style Manual*, and *The Chicago Manual of Style* (17th edition).

General Rules

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

- Be consistent in the use of abbreviations, acronyms, and symbols throughout the document.
- Beginning a sentence with an abbreviation or acronym is acceptable. However, avoid beginning a sentence with a symbol or figure (i.e., number); either spell out symbols and figures that begin a sentence, or recast the sentence.
- Use a single period when an abbreviation ends a sentence. If the sentence ends with a question mark or an exclamation point, place them after the period used with the abbreviation. The same rule applies to colons, semicolons, and commas within a sentence.
- Do not abbreviate the names of months and days in the report text. Their abbreviation is acceptable in illustrations and tables to save space.
- Do not abbreviate geographic names (for example, Great Salt Lake, not GSL; Uinta Basin, not UB). Abbreviating cumbersome geologic names that appear numerous times throughout the text is acceptable (for example, FSLC for Farmington Siding landslide complex; WVFZ for West Valley fault zone).
- Eliminate periods after abbreviations except where required by convention (see Appendix D). Spaces are not needed between joined abbreviations (U.S. Geological Survey; Washington, D.C.).

- Do not use two-letter postal-service abbreviations (for example, UT) in the report text to abbreviate state names (see Appendix D). Postal-service abbreviations are acceptable where used with a correspondence address.
- In isotope abbreviations, the mass number is shown as a superscript and precedes the element with no space between (¹⁴C).
- Avoid using abbreviations in a reference list except for the following: (1) abbreviations or acronyms used in a title, (2) v., no., pt., and p., (3) Inc., (4) M.S. and Ph.D., (5) U.S. and D.C., and (6) [abs.].
- When in doubt, spell it out. This particularly applies to reports written for a nontechnical audience, who may find certain abbreviations or symbols cryptic.

Degree Mark

The degree mark (°) is used with numerals in statements of temperature, strike, dip, slope inclination, bearing, azimuth, latitude, and longitude. No spacing is used with the degree mark when reporting temperature. When giving a range of temperatures using an en dash, use a degree mark with both values (e.g., 10°–15°C, not 10–15°C). Do not use a degree mark when reporting Kelvin temperature. A space follows the degree mark in terms of direction.

32°F equates to 0°C and 273.15 K

strike N. 66° E., dip 46° SE.

a bearing of S. 35° W. equates to an azimuth of 215°

latitude 40°45'15" N. or 40°45.25' N.

longitude 112°33'30" W. or 112°33.5' W.

the ground surface slopes 33° to the north

a right angle equates to 90°

Land Tract Designations

Report descriptions of tracts of public land as follows:

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

Latin Abbreviations

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

<u>Latin Abbreviation</u>	<u>English Equivalent</u>
ca. <i>circa</i>	about
e.g. <i>exempli gratia</i>	for example
etc. <i>et cetera</i>	and so forth
i.e. <i>id est</i>	that is
et al. <i>et alia</i>	and others

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

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

The Latin phrase “in situ,” meaning “in place,” can be used in technical documents and reports. Do not use italics or hyphenate the phrase. Use “in place” for nontechnical documents such as *Survey Notes* articles.

Lithologic and Time-Stratigraphic Terms

Do not abbreviate lithologic and time-stratigraphic terms in the report text. Abbreviations are acceptable in illustrations and tables where necessary to save space. Capitalize lithologic abbreviations when they follow a formal rock-unit name (e.g., Navajo Ss.). When used informally to refer to a general rock type, the lithologic abbreviation is lowercase (sandstone, ss.). Always capitalize time-stratigraphic abbreviations. Table 4 summarizes abbreviations used for lithologic and time-stratigraphic terms, and symbols are shown on Figure 7.

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

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

Number

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

Percent Symbol

Use of the percent symbol (%) is acceptable in technical documents and reports as well as nontechnical publications (e.g., *Survey Notes* articles). When giving a range of percentages using an en dash, use a percent symbol with both values (e.g., 50%–80%, not 50–80%).

Time

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

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

The radiocarbon age of 3650 ± 70 ^{14}C yr B.P. (4400–3600 cal yr B.P.) obtained from the buried A horizon corresponds well with the thermoluminescence age of 4200 ± 400 yr obtained from the loess unit.

Intervals of geologic time: The abbreviations “kyr” for thousands of years and “myr” for millions of years can be used to denote an interval, or a duration, of time not measured back from the present. The abbreviations “ka,” “Ma,” and “Ga,” which mark a “point” in time (such as a depositional or crystalline rock age estimate), should not be used to denote time intervals.

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

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

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

Calendar dates: The two epochs of the Gregorian calendar are abbreviated “AD” for “anno Domini” (in the year of our Lord) or “CE” for “common era,” and “BC” (before Christ) or “BCE” for “before common era.” Note the order in which the abbreviations are used:

621 BC or 621 BCE

AD 1950 or 1950 CE

Use numerals for all dates.

January 1994

May 18, 1980

2 September 1992

the 12th of March, 1934

April 17, 1983, to August 26, 1995

Capitalization

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

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

UGS Director Bill Keach

Bill Keach is director of the Utah Geological Survey

Marriott Library

Rich County

Daggett and Uintah Counties

Weber and Provo Rivers

Utah Geological Association

Department of Natural Resources

- Capitalize all important words in the titles of books, articles, and reports that appear in the report text (for example, *Geologic History of Utah* by L.F. Hintze and B.J. Kowallis). Note that titles in a reference list are an exception (see The Reference List section and Hansen [1991, p. 239]).
- Capitalize hyphenated words in titles and headings except for conjunctions, short prepositions, and articles unless they appear as the first word.

Open-File Report 88-546

Long-Term Slip Rates

State-of-the-Art Geophysical Techniques

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

State of Utah [government entity; . . . studies undertaken by the State of Utah . . .]

state of Utah [geographic area; . . . largest lake in the state of Utah . . .]

the State [governing body]

the state [geographic area]

State lands [designated lands administered by the State of Utah]

Sandy City

city of Sandy

the federal government

federal agencies

federal and state employees

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

Utah Geological Survey

the Survey [UGS]

[Utah] State Legislature

the several state legislatures

Division of Water Resources

Department of Natural Resources divisions

- Singular nouns used to replace proper nouns that are several words long (excluding names of legislative, administrative, and judicial organizations as discussed above) are not capitalized.
 Grand Staircase–Escalante National Monument [*but* “the monument”]
 Zion National Park [*but* “the park”]
- Capitalize the name of biological phylum, class, order, family, or genus, but not species, subspecies, or variety.
 Foraminifera
 Bathymyonia
 Spiriferina (Punctospirifer) pulcher
 See Hansen (1991, p. 100–103) for additional information regarding paleontologic terminology.
- Capitalize the names of geologic eras, periods, systems, series, epochs, and ages.
 Precambrian
 Triassic Period
 Ordovician System
 Eocene
 Late Jurassic Epoch
 Keweenawan Age
 Wisconsin Glaciation
- The geochronologic terms “early,” “middle,” and “late” and the chronostratigraphic terms “lower,” “middle,” and “upper” are capitalized when used as part of a formal geologic time or rock series name, but are lowercase when used informally (see Division of Geologic Time section).
- The names of formal lithostratigraphic units are proper nouns and are capitalized.
 Navajo Sandstone
 Morrison Formation
 Belt Supergroup
 Sinbad Limestone Member
- A sequence of three or more formation (or member) names, such as the Wingate Sandstone, Kayenta Formation, Navajo Sandstone, and Carmel Formation, may for convenience be written as the Wingate, Kayenta, Navajo, and Carmel Formations. Note that “Formations” is capitalized.
- Do not capitalize unit terms (lithology or formation) in the names of informal lithostratigraphic units.
 formation of Aurora
 Huckleberry Ridge ash bed
 Left Creek quartzite
- Proper geographic names are capitalized, but areas of indefinite extent are lowercase.
 Monument Valley
 Wasatch Range
 Oquirrh Mountains
 Great Salt Lake
 Salt Lake City area
 Great Basin
 Uinta Basin
 Bonneville basin

However, sometimes the geographic name of an area of indefinite extent will be capitalized through longstanding convention and widespread use.

Paradox Basin

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

City Creek mining district

Grassy Trail Creek oil field

Wasatch Plateau coalfield

Bingham Canyon mine

Black Rock smelter

Formal paleontological sites are capitalized.

Stikes Quarry

Doellings Bowl

Mill Canyon Dinosaur Tracksite

Doellings Bowl bonebed

- 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 [or just “Colorado Plateau”]

Great Plains province [or just “Great Plains”]

Middle Rocky Mountains section [or just “Middle Rocky Mountains”]

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

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

White Springs caldera

Sulphur Creek anticline

Wasatch fault zone

Oquirrh basin [a geologic feature]

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

San Rafael Swell

Upheaval Dome

Waterpocket Fold

- “Quadrangle” is not capitalized when used as part of a proper name (for instance, the Park City East quadrangle), but is capitalized when citing a USGS geologic quadrangle map (a publishing series)—USGS Quadrangle Map GQ-126.
- Capitalize the words “Figure,” “Table,” “Plate,” and “Appendix” when they are used in the report text.

Divisions of Geologic Time

The major divisions of geologic time (eons, eras, and periods) have been established through long use and careful study. Nevertheless, details of the geologic time scale continue to be debated and refined as more data are collected, and differences in ages of the boundaries between some time divisions exist on contemporaneous time scales (compare, for example, Palmer, 1983; Snelling, 1985; Hansen, 1991; Palmer and Geissman, 1999; Gradstein et al., 2004, 2012b; Geologic Names Committee, 2018). Figure 7 summarizes boundary age estimates, nomenclature, and map symbols recommended for use in UGS publications, and Figure 8 summarizes North American land mammal age (LMA) subdivisions of the Tertiary Period.

A clear distinction exists between divisions of geologic time (geochronologic divisions) and divisions of stratigraphic position (chronostratigraphic divisions). “Early,” “middle,” and “late” denote relative position in time, whereas the terms “lower,” “middle,” and “upper” denote similar distinctions of stratigraphic position (see discussion in Owen, 1987, 2009, http://www.agiweb.org/nacsn/10570_articles_article_file_1642.pdf). As indicated on Figure 7, these terms are capitalized when used in a formal sense (Mesozoic and Paleozoic series/epochs; e.g., Upper Triassic, Early Pennsylvanian). Note that these terms are informal when used with *Quaternary*, *Tertiary*, *Cenozoic*, *Mesozoic*, and *Paleozoic*, and thus are not capitalized (e.g., early Tertiary, upper Paleozoic). Finally, following the convention of Reed et al. (1993), the subdivisions (eras) of the Proterozoic and Archean eons shown on Figure 7 are geochronologic units and have no corresponding chronostratigraphic units (i.e., erathems)—for example, “Neoproterozoic” has no “Upper Proterozoic” counterpart.

Geographic Names

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

Geologic Map-Unit Descriptions

Geologic maps typically require a stratigraphically ordered list of descriptions of bedrock units and unconsolidated deposits, and other geologic reports may include similar information in an appendix. Although the content of these types of descriptions may vary considerably, a few general guidelines and examples are given below to help in making the format of these descriptions relatively uniform. Note that this discussion applies to geologic quadrangle maps and similar maps where the geologic mapping itself is the focus of the document, as opposed to geologic maps used as figures in a report. For additional guidelines related to geologic maps, authors should consult UGS Circular 89, *Guide to Authors of Geologic Maps and Text Booklets of the Utah Geological Survey* (Doelling and Willis, 1995).

Every unit shown on a geologic map and cross section needs a written description. The description should include sufficient information on the unit’s essential attributes to allow recognition in the field. The essential attributes may vary depending on the nature of the unit and the quality and accessibility of exposures, but generally will include age, lithology, mineralogy, color, texture, cementation, bedding and outcrop characteristics, fossil content, and thickness. To aid the reader, these attributes should be described in approximately the same order for each unit. The age of the unit should be given as a geochronologic division for consistency and simplicity (e.g., Early Cretaceous, not Lower Cretaceous). Authors should use “Neogene” and “Paleogene,” instead of “Tertiary,” in the description of map units and in map booklet text, although “Tertiary” can be used for more broad descriptions in the text.

Figure 7. Geochronologic and chronostratigraphic units, boundary age estimates, and map symbols recommended for use in UGS publications (but see note 3 and Figure 8 regarding Tertiary stages/ages).

Notes to Figure 7:

- Names used in Utah by convention (but see note 3 for Tertiary stages/ages)
 Quaternary Stage/Age from Cohen et al. (2023)
 Tertiary, Cretaceous, Jurassic, Triassic, and Devonian – Gradstein et al. (2004, 2012b).
 Permian and Carboniferous – North American provincial series terms; refer to Hansen (1991) and references therein for stage names.
 Silurian, Ordovician, and Cambrian – Palmer and Geissman (1999).
- Boundary ages are from Gradstein et al. (2004, 2012b) or updates subsequently published by the International Commission on Stratigraphy.
- In Utah, North American land mammal ages are generally preferred as temporal subdivisions of the Tertiary epochs; see Figure 8.
 “Precambrian” = time term without specific rank.

TIME (Ma)	PERIOD	EPOCH	AGE	LAND MAMMAL AGE
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Figure 8. Geologic time scale for the Tertiary Period. European age terms and boundary ages from Gradstein et al. (2004, 2012b). In Utah, North American land mammal ages (LMAs) are generally preferable to the European ages; refer to Woodburne (2004) and references therein for LMA age boundaries and uncertainties.

Sentence Structure

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

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

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

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

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

Compound Modifiers

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Geologic Names

Geologic names are assigned to formal and informal lithostratigraphic units and structural features. Rules applying to the use of geologic names are summarized below. The *North American Stratigraphic Code* (North American Commission on Stratigraphic Nomenclature, 1983, 2005, 2021; online at https://ngmdb.usgs.gov/Geolex/resources/docs/NACSN_Code_2021.pdf) and Hansen (1991) give detailed discussions of the issues associated with the use of geologic names, and Owen (1990; http://www.agiweb.org/nacsn/10570_articles_article_file_1642.pdf) provides a useful commentary on the ways that these issues frequently cause problems for authors.

Lithostratigraphic Units

Formal lithostratigraphic units are defined in accordance with the current or previously accepted versions of the *North American Stratigraphic Code* (Ashley et al., 1933; American Commission on Stratigraphic Nomenclature, 1961, 1970; North American Commission on Stratigraphic Nomenclature, 1983, 2005, 2021), or they have achieved acceptance through long usage prior to adoption of the codes. Informal lithostratigraphic units are sometimes useful locally, but, for whatever reasons, they do not comply with the requirements of the current stratigraphic code. Use informal lithostratigraphic units in UGS reports with care, and in all cases, clearly identify them as informal units.

The first time a formal lithostratigraphic unit name is used in a report, write out the complete name (both geographic name and rank). Thereafter, authors may, at their discretion, refer to the unit by its geographic name only. For example, use “Chinle Formation” initially and “Chinle” in subsequent reference to the rock unit.

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

Structural Geologic Features

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

Italics

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

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

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

- Italicize formal names of genera, species, subspecies, and varieties of plants and animals. Do not italicize the names of phyla, classes, orders, and families. See Hansen (1991, p. 100–103) for additional information regarding paleontologic terminology.
- Use italics for the names of vessels, aircraft, and spacecraft (for example, the research vessel *Glomar Challenger*, the *Voyager* spacecraft, and the Mars rover *Perseverance*).
- Italicize the preposition “in” when citing a reference contained in another document.
 Todd V.R., 1983, Late Miocene displacement of pre-Tertiary and Tertiary rocks in the Matlin Mountains, northwestern Utah, *in* Miller, D.M., Todd, V.R., and Howard, K.A., editors, Tectonic and stratigraphic studies in the eastern Great Basin: Geological Society of America Memoir 157, p. 239–270.
- Italicize the names of legal cases, for example, *Jones v. Entwistle et al.* Note that the legal profession has a set of standard abbreviations all its own.
- Italics are not used in UGS publications for emphasis or for foreign words.

Lists

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

Sentence Lists

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

Descriptions of samples collected by the authors accompany analytical data for Au, Ag, Cu, Pb, Zn, and As.

Selection of anomalous thresholds involved the application and comparison of three standard statistical techniques: (1) the mean plus two standard deviations, (2) the 90th percentile, and (3) prominent gaps in histograms.

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

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

Much of the unit is (1) red, pink, or gray, (2) medium to coarse grained, and (3) equigranular or slightly porphyritic.

Vertical Lists

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

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

A genetic model of mineralization in the Antelope Range mining district is presented below. Elements discussed in the model are depicted on Figure 18.

1. Northwest-striking, extension-related faulting (middle to late Miocene) in the area largely preceded mineralization and alteration. Faults produced during this deformation host all known occurrences of mineralized veins.
2. Eruption of rhyolitic flows and intrusion of possible subvolcanic rocks occurred 8.5 to 8.4 million years ago.
3. Heat derived from emplacement of rhyolitic magmas induced a hydrothermal system in the surrounding host rocks. Extensional structures served as conduits for rising, dominantly meteoric, hydrothermal solutions.

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

The investigation of the Red Rock fault zone proceeded by:

1. mapping the surficial geology along the fault zone at 1:12,000 scale,
2. excavating trenches across single- and multiple-event scarps identified during the mapping,
3. carefully logging the trench walls to determine the number and size of paleoearthquakes, and
4. collecting samples of organic material (charcoal and bulk soil organics) for radiocarbon dating.

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

Numbers

General Rules

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

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

8:00 a.m.

3 meters

\$20.00

7%

24 samples,

but

eight days

three wells

2. For technical writing, use a comma to separate groups of three digits to the left of a decimal point in numbers of 10,000 or larger except for serial numbers. When writing for a general audience, such as an article for *Survey Notes*, use a comma to separate three digits to the left of a decimal point in numbers of 1,000 or larger. Do not use commas to the right of a decimal point.

5271 for technical audience (5,271 for general audience)

14,629

no. E-462591-15-326A

3. Use a combination of numerals and words for round numbers larger than 1 million.
\$37.5 million
4 billion years,
but
425,000
\$13,256,630.56
4. Write out numbers that begin a sentence. Try to avoid beginning a sentence with a very large number.
5. Form the plural of a number expressed as a numeral by adding a lowercase “s.” Note that this usage does not conform to USGS style which uses an apostrophe with the “s.” Form the plurals of numbers that are written out in the same way as the plurals of other words.
The organization doubled in size during the 1980s.
Temperatures will reach the high 90s today.
The values are all in the low thirties.
6. Write out indefinite expressions or exaggerations but use numerals for approximations based on experience or fact.
We must have received a thousand inquiries today.
The conclusions are based on about 2000 analyses.
7. Use numerals when related numerical expressions that include numbers both greater and less than 10 are grouped together in a sentence.
The inventory consisted of 6 lengths of drill pipe, 2 drill bits, 14 bags of cement, and 3 core boxes.
8. Use percent and degree symbols after numbers that show a range or are joined by a conjunction.
The temperature ranges from 38° to 50°C.
Temperatures fell within a range of 38°– 50°C.
The sandstone contains between 85% and 90% quartz.

Decimals and Fractions

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

1. Use decimals rather than fractions wherever possible.
2. If a decimal is not associated with a whole number, insert a zero before the decimal point (0.56 not .56).
3. Zeros are retained after a decimal point only if they are significant figures (3.208 but not 3.200 unless both zeros are significant; see Numerical Data and Significant Figures section).

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

1. Use numerals when fractions express a measurement.
1/2-inch pipe
6-1/2-inch O.D. well casing
2. Spell out and hyphenate fractions that stand alone in the text.
The project is two-thirds complete.

Numerical Data and Significant Figures

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

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

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

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

Some values exhibit the characteristics of both accuracy and precision. For example, radiocarbon age determinations are accurate to the degree that they correctly match the true age of the material, and precise to the extent that the results of the dating process are reproducible in the laboratory.

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

1. The digits 1 through 9 are always significant regardless of their position in a number, to the extent that the accuracy of the measurement permits.
2. The digit 0 is significant when it occurs between other significant digits, but is not significant when placed to the left of a digit to fix a decimal place. For example, the number 0.0057 has two significant figures, but 703.01 has five.
3. Zeros that trail the decimal place are considered significant, again to the extent that the accuracy of the measurement permits. The number 43.00, therefore, has four significant figures.
4. Trailing zeros in a number without a decimal point (e.g., 3600) may be significant if they were determined by actual measurement. When dealing with data for which this is not known, assume the zeros are not significant. Authors can avoid ambiguity by using scientific notation. For example, 3600 could be written with two significant figures (3.6×10^3), three significant figures (3.60×10^3), or four significant figures (3.600×10^3).

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

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

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

$$165,500 \text{ tons} \times 2000 \text{ lb/ton} \times 0.0115 \text{ lb Cu/lb ore} \times 0.97 \text{ dollar/lb Cu} = \$3,692,305$$

Since the price of copper is the number having the fewest significant figures (two), the result should be reported as \$3.7 million. When using spreadsheet software to process numerical data, care must be taken to ensure that results are reported with the proper number of significant figures. Spreadsheets typically default to a preset number of digits or decimal places, regardless of their significance, and may inadvertently distort the reported accuracy. For example, a spreadsheet calculation of the average of a hypothetical series of fault-scarp height measurements, accurate to one decimal place, returned a result with two decimal places (Table 6). Similarly, the spreadsheet calculated the standard deviation to nine decimal places. Since the measured values all have two significant figures, accurate to one decimal place, the average and standard deviation should be reported as 1.5 ± 0.3 meters.

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

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

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

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

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

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

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

- If the first discarded digit is greater than 5, add 1 to the *n*th digit (45.7882 rounded to four significant figures is 45.79).
- If the first discarded digit is less than 5, leave the *n*th digit unchanged (45.7832 rounded to four significant figures is 45.78).
- If the first discarded digit is 5 and all following digits are zeros, round the *n*th 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 *n*th digit (3.44538 rounded to three significant figures is 3.45).

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

Punctuation

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

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

Apostrophes

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

- Form possessives of singular words by adding an "s" (the prospector's mule, Kennecott's Bingham Canyon mine, Bob's compass). However, remember that "its" (no apostrophe) is the possessive form of "it" and "it's" is the contraction for "it is."
- Form possessives of plural words that end in "s" or "es" by adding an apostrophe only (General Dynamics' headquarters, the Joneses' house, the drillers' logs).
- In cases of joint possession, use an apostrophe only with the last owner (Ann and Bob's truck).
- Do not use an apostrophe to form the plural of words (all the Jims in the office, in the mid-1980s).

- Do not use an apostrophe as a substitute for the prime symbol (') (e.g., minutes of angle). Likewise, do not use a quotation mark as a substitute for the double-prime symbol (") (e.g., seconds of angle). For example, latitude 38°12'30" N. (not 38°12'30" N.).
- Do not use an apostrophe for proper names of geographic locations (Parleys Canyon, Kings Peak, Joes Valley).

Colons

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

The zinc anomaly was less elusive: sediment samples from several streams showed high values for zinc.

One task remained before finalizing the mine plan: blocking out the limits of the ore body.

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

The project will consist of two phases: (1) detailed subsurface exploration and analysis, and (2) construction monitoring.

The objectives of the exploration program are:

1. identification of a major gold/silver ore body within the Delmar–Iron Springs mineral belt,
2. completion of the exploration project on schedule (18 months) and within budget (\$1.25 million), and
3. compliance, within the parameters of the project time schedule and budget, with all applicable environmental rules and regulations affecting exploration activities.

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

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

Commas

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

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

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

The lab performed the analyses and we recorded the results.

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

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

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

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

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

Commas set off interrupting or parenthetical elements within a sentence.

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

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

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

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

The soil A horizon is correlated with unit 4s on the basis of stratigraphic position, relation to surface faulting, and a radiocarbon age on charcoal from the A horizon of 690 cal yr B.P.

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

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

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

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

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

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

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

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

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

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

The meeting in Reno, Nevada, concludes on Wednesday.

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

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

Sincerely,

Dashes

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

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

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

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

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

1945–78

p. 312–327

20 to 30 feet (6–9 m)

central Utah thrust belt–Hingeline play

scarp-height–slope-angle plot

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

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

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

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

No spaces precede or follow dashes.

Ellipsis Marks

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

Hyphens

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

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

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

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

moderately indurated sandstone [but early-formed magma]
 very fine grained sandstone
 The sandstone is fine grained. [but The sandstone is cross-bedded.]

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

Sandstone: blue-gray, thinly bedded, coarse-grained, . . .
 Welded tuff: reddish-brown, flow-banded, . . .

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

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

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

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

Use a hyphen with the prefixes *ex*, *self*, and *quasi*; most other prefixes and suffixes do not require a hyphen when added to a word. A hyphen is required if a prefix is added to a capitalized word (non-UGS) and to prevent the doubling of a vowel (re-evaluate).

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

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

Parentheses and Brackets

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

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

For example:

Differences in the timing of the most recent event (MRE) along a fault zone are used to define fault segments (Schwartz, 1988) (Table 4).

The deposition rate was rapid during the Pennsylvanian and Permian, resulting in a total accumulation of 25,000 to 30,000 ft (7600–9100 m) of marine sediments (Figure 3).

The Emery high (or Piute platform as it is now called) and the Kaibab uplift (a poorly defined band of uplifts) have been identified by the thinning or absence of Pennsylvanian formations.

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

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

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

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

Quotation Marks

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

“The House Range, Western Utah—Cambrian Mecca” by Hintze and Robison (1987) in *Rocky Mountain Section of the Geological Society of America Centennial Field Guide, Volume 2* provides a succinct description of an important fossil locality in Utah.

“Caliche” usually refers to an indurated layer of calcium carbonate accumulation in a soil; “hardpan” is a more general term that refers to any indurated soil layer resulting from the precipitation of soluble materials in the soil profile.

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

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

Semicolons

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

Estimates of the timing of the most recent ground-rupturing earthquake from the two trench sites are within 40 years of each other; this close correlation in time indicates that the same event is recorded at both sites.

The full extent of the Escalante silver vein was known only after extensive exploration; consequently, a number of smaller ore deposits in the district were overlooked for many years.

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

Quotations

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

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

G.K. Gilbert, *Salt Lake Tribune*, 1883 (Gilbert, 1884)

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

Units of Measurement

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

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

In general, units of measure are unabbreviated except for ratios that are otherwise unwieldy and for equivalent measurements that follow in parentheses. However, primary units of measure may be abbreviated in technical reports intended for a scientific or specialized audience. Note that the abbreviation *yr* is used only when reporting geologic ages (see section on Time), and in ratios. Do not abbreviate units of measurement that are used in the absence of a number.

A displacement of 3.0 meters (9.8 ft) and a recurrence interval of 2000 years gives a maximum slip rate of 1.5 mm/yr (0.06 in/yr) [for general audience].

A displacement of 3.0 m and a recurrence interval of 2000 years give a maximum slip rate of 1.5 mm/yr [for scientific/specialized audience].

The mesa covers an area of 15 square miles (39 km²).

In places, the zone of alteration is several meters thick [*not* several m thick].

WRITING TIPS

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

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

Sentences and Paragraphs

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

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

Active and Passive Voice

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

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

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

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

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

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

Favor the active voice over the passive. However, neither active nor passive voice should be used to excess. Whereas excessive passive voice can lead to wordiness and ambiguity, excess active voice can lead to stilted and choppy wording. Use the passive voice in instances where the subject (doer of the action) is unknown, the receiver of the action is more important than the doer, or the passive voice provides a smoother transition between sentences.

Strong Verbs

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

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

They are investigating the site. (5 words)

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

We terminated the borehole at the Chinle-Moenkopi contact. (9 words)

False Subjects

A false subject is created when a pronoun (“there” and “it” are the most common) is used as the subject of a sentence without a clearly identified antecedent. False subjects add extra words to a sentence and should be used sparingly.

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

The compressional wave velocity increases to 6200 ft/s at the water table. (12 words)

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

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

Gender Bias

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

Someone left his rock hammer on the outcrop.

Someone left a rock hammer on the outcrop.

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

When the first draft is complete, the author should initiate the peer-review process.

Consider the following non-gender-specific alternatives:

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

Jargon

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

Personal Pronouns

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

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

Problem Words

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

A and An

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

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

Affect and Effect

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

The new discovery will affect gold prices worldwide.

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

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

Age and Date

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

Compose, Comprise, Consist, and Constitute

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

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

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

Data

The word *data* is plural and *datum* is singular; choose the appropriate verb form when using these words to avoid disagreement in number. However, *data* is sometimes used to refer to a large body of information, and in that case, should be followed by a singular verb.

Groundwater

Depending on the organization or reference consulted, “groundwater” is written as one word, two words, or hyphenated. The UGS follows the convention given in the American Geological Institute *Glossary of Geology* (fifth edition; Neuendorf et al., 2005) and writes “groundwater” as one word.

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.

Part and Portion

The words *part* and *portion* are synonyms. However, when used as a noun, a part is a fraction of the whole, whereas a portion is an allocated amount. In general, the word *part* is preferred.

The study area is in the south part of the quadrangle.

With

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

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

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

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

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

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

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

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APPENDICES

APPENDIX A

UGS DOCUMENT REVIEW FORMS

The forms in this appendix are to be used during the document review and approval process. Please contact your program manager or the technical reviewer for a copy of the digital files. Specific guidelines for their use include the following:

UGS Document Review and Approval Sheet—Use this form to track peer reviews and UGS approvals for manuscripts and maps published in a UGS publication series, including *Survey Notes*, and for UGS-authored manuscripts for publication outside the UGS. The form should be filled out and included with the draft manuscript when given to the reviewer. Refer to The UGS Publication Process section in the main text for additional information.

Review and Approval Sheet for Static Web Content—Use this form to track peer reviews and UGS approvals for manuscripts prepared solely for release on the UGS website (i.e., not also published in a UGS publication series). The form should be filled out and included with the draft materials when given to the reviewer. Refer to The UGS Publication Process, Review Procedures for UGS Website Material section in the main text for additional information.

UGS Peer Review Form—Use this form to facilitate peer review of manuscripts published in a formal UGS publication series. For manuscripts proposed for publication (other than a geologic quadrangle map), copies of this form can be provided to peer reviewers, and the completed forms can be included along with the edited manuscript when review materials are submitted to the UGS technical reviewer. Authors should fill out the top part of the form, and reviewers should complete the Reviewer's Comments section. Refer to The UGS Publication Process, Peer Review section in the main text for additional information.

**UTAH GEOLOGICAL SURVEY
DOCUMENT REVIEW AND APPROVAL SHEET**

<p>Title:</p> <p>Authors:</p>		<p>Funding Code (if applicable):</p> <hr/> <p>Program:</p> <hr/> <p>Publication Type:</p> <p><input type="checkbox"/> Bulletin</p> <p><input type="checkbox"/> Special Study</p> <p><input type="checkbox"/> Map</p> <p><input type="checkbox"/> Circular</p> <p><input type="checkbox"/> Report of Investigation</p> <p><input type="checkbox"/> Public Information Series</p> <p><input type="checkbox"/> Miscellaneous Publication</p> <p><input type="checkbox"/> Survey Notes</p> <p><input type="checkbox"/> Contract Deliverable</p> <p><input type="checkbox"/> Open-File Report</p> <p><input type="checkbox"/> Outside Publication</p> <p><input type="checkbox"/> Data Series</p>
Corresponding Author e-mail:		<p>Will this document require Utah PG stamp? <input type="checkbox"/> Yes <input type="checkbox"/> No</p>
Funding Agency (for Contract Deliverable):		<p>Descriptive Paragraph Included? (not required for contract deliverables, Survey Notes articles, or outside publications) <input type="checkbox"/> Yes <input type="checkbox"/> No</p>
Publisher (for Outside Publication):		

Peer Reviewers/Program:		
Technical Specialist Reviewers/Affiliation:		
<p>Document includes GIS files? <input type="checkbox"/> Yes <input type="checkbox"/> No</p>	GIS Reviewer/Program:	

*This document has been through the UGS peer review process; the individuals who have reviewed the document are listed above.
All review comments have been addressed by the author(s), and this document is now ready for publication.*

Senior Author	Date
Program Manager	Date received Date approved
Technical Reviewer	Date received Date approved
Deputy Director	Date received Date approved
Director	Date received Date approved

Comments:

Location of document materials:

Text, Illustration, Table, and Appendix Files:
GIS Files:

REVIEW AND APPROVAL SHEET FOR STATIC WEB CONTENT

(Simple web pages with basic text and graphics content)

*Web design/structure changes, please see Data Management Program Manager

*New/modifications to web applications, please see Data Management Program Manager

Title: Authors: 	Funding Code: (if applicable) Program:
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Peer Reviewers/Program
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<i>*This document has been peer reviewed; the individuals who have reviewed this document are listed above. All review comments have been addressed by the author(s), and this document is now ready for approval for web release.</i>	
Author(s)	Date

Program Manager	Date received	Date approved
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Technical Reviewer	Date received	Date approved
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Website Manager	Date received	Date approved
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Data Management Program Manager	Date received	Date approved
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Deputy Director	Date received	Date approved
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Comments:

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TITLE OF PAPER: _____

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- Data accurate and consistent: _____

- Equations, formulas, and mathematics correct/accurate: _____

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APPENDIX D

ABBREVIATIONS

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

bentonite	bent	chapter	chap.
Bernoulli number	<i>B</i>	chemical oxygen demand	cod
BHC Acoustilog	BHC	chi-square statistic	χ^2
BHC Sonic Log	BHC	choke	ck
bibliographic(al)	bibliog.	chromite	Chr
biennial	bienn.	circulated	circ
billion cubic feet (billion = 10^9)	Bcf	class	cl.
billion cubic feet of gas per day	BCFG/D	classification	classn.
billion years	byr	claystone	clst.
billion years ago (geologic ages only)	Ga	cobble	cbl
biologic(al)	biol.	coefficient	coef
biotite	Bt	cologarithm	colog
bituminous	bit	column	col.
boiling point	bp	communication(s)	commun.
bottom-hole pressure	BHP	compact disc	CD
bottom-hole temperature	BHT	Company (commercial)	Co.
boulder	bldr	compensated neutron log (hybrid)	CNL
Boulevard (in addresses only)	Blvd.	completed, completion	comp
brachiopod	brach	concentrate	conc
Brinell hardness number	Bhn	concentrated	concd
British thermal unit	Btu	conductivity	cond or g
building(s)	bldg(s).	conference	conf.
Bureau of Indian Affairs	BIA	conglomerate	Cgl. or cgl.
Bureau of Land Management	BLM	constant	const
calcareous	calc	contact	etc
calcite	Cal	conventional inch of mercury	inhg
calculated	calc	cooperation, cooperative	coop.
calendar-calibrated	cal B.P.	cored	crd
Caliper	CAL	Corporation (commercial)	Corp.
calorie	cal	corrected	cor
Cambrian	Camb. or \mathbb{C}	correlation coefficient	<i>r</i>
carat	kt	corundum	Crn
carbonaceous	carb	cosecant	csc
Cartesian coordinates	x, y, z	cosecant, hyperbolic	csch
casing	csg	cosine	cos
cast-iron bridge plug	CIBP	cosine, hyperbolic	cosh
cavernous	cav	cotangent, hyperbolic	coth
Celsius	C	coulomb	C
Celsius, degree	°C	counts per minute	c/min
cemented	cmt	Cretaceous	Cret. or K
Cenozoic	Cen. or Cz	cross-bedded	xbdd
centi (prefix)	c	cross-bedding	xbdg
centigram	cg	cross-laminated	xlam
centiliter	cL	crystal	xl
centimeter	cm	crystalline	xln
centimeter, cubed	cm ³	crystalline, crystallographic	cryst
centimeter, square	cm ²	crystallographic axes	a, b, c
centimeter-gram-second (unit)	cgs	cubic feet of gas per day	CFGP/D
centipoise	cp	cubic foot (cu ft is obsolete)	ft ³
central daylight time	CDT	cubic inch (cu in. is obsolete)	in ³
central standard time	CST	curie	Ci
central time	CT	darcy	D
chalcedony	chal	day	d

deci (prefix, one-tenth)	d	economic(al)	econ(s).
decigram	dg	edition(s)	ed(s).
deciliter	dL	editor(s)	ed(s).
decimeter	dm	educational	educ.
decimeter, cubic	dm ³	efficiency	eff
decimeter, square	dm ²	electric(al)	elec
degree	deg.	electron	e
degree (symbol)	°	elevation	elev
degrees of freedom	f.	elevation of Kelly bushing	EKB
deka (prefix, 10)	da	energy	E
dekagram	dag	engineering	eng.
dekaliter	daL	enstatite	En
dekameter	dam	Environmental Protection Agency	EPA
dekameter, cubic	dam ³	equal to	=
dekameter, square	dam ²	not equal to	≠
density (relative)	d	equilibrium constant	K
depth	h	equivalent	equiv.
derrick floor	DF	equivalent weight	equiv wt
development	devel.	erg	erg
Devonian	Dev. or D	estimated	est
diameter	diam. or d	evaporitic	evap
different	diff	examination	exam.
dilute	dil	experiment	expt
diopside	Di	experimental	exptl
direct current	dc	exposure	exp
direct-current (unit modifier)	d-c	extremely high frequency	EHF
discharge; rate of discharge; recharge	Q	faculty	fac
disseminated	dissem	Fahrenheit, degree	°F
dissertation	dissert.	fayalite	Fa
dissociation constant	K	feldspar	F
dissolved oxygen	do	feldspathic	feld
dissolved solids	ds	ferrosilite (FeSiO ₃)	Fs
distribution	distrib.	figure(s)	fig(s).
district	dist	final flowing pressure	FF
ditto (the same)	do.	final shut-in pressure	FSIP
divided by	÷	flowed	FLWD
Doctor of Philosophy	Ph.D.	flowing pressure	FP
document	doc.	fluorescence	fluor
dollar	dol	fluorite	Fl
dolomite	Dol	foliated	fol
dozen	doz	foot/feet	ft
dram	dr	foot, cubic	ft ³
drilling	drlg	foot cubic, per minute	ft ³ /min
drillstem test	DST	foot cubic, per second	ft ³ /s
dry and abandoned	D&A	foot per minute	ft/min
dry basis	db	foot per second	ft/s
dual induction-laterolog	DIL	foot per second cubed	ft/s ³
dual laterolog	DLL	foot per second squared	ft/s ²
dyne	dyn	foot pound-force	ft/lbf
east	E	foot, square	ft ²
eastern daylight time	EDT	foot square, per minute	ft ² /min
eastern standard time	EST	foot square, per second	ft ² /s
eastern time	ET	foot-pound	ft-lb

foraminifera	foram.	much greater than	>>
force	<i>F</i>	greater than or equal to	≥
formation	Fm. or fm.	greenstone	grnst
formation density log (compensated)	FDC	Greenwich civil time	GCT
Formation Tester	FT	Greenwich mean astronomical time	GMAT
forsterite	Fo	Greenwich mean time	GMT
fracture	frac	gross	gr
fractured	frac	gross weight	gr wt
fragmental	frag	ground level, graded level	GL
freezing point	fp	group	Gp.
frequency	<i>f</i> or <i>v</i>	gypsiferous	gyp
friction, coefficient of	μ or <i>f</i>	half-life	$T^{1/2}$
gallon	gal	halite (NaCl)	HI
gallons per minute	gal/min	heavily oil-cut mud	HOCM
gallons per second	gal/s	hectare	ha
gamma ray log	GRL	hecto (prefix, 100)	h
gas and oil cut water	G&OCW	hectogram	hg
gas cut	GC	hectoliter	hL
gas cut mud	GCM	hectometer	hm
gas cut water	GCW	hectometer, cubic	hm ³
gas to oil ratio	GOR	hectometer, square	hm ²
gas to surface	GTSgas- and	height	h
oil-cut mud	G&OCM	hematite	Hem
gas-cut mud	GCM	hematitic	hem
gas-oil ratio	GOR	hemic	H
gauss	G	henry	H
geochemical	geochem.	hertz (cycles per second)	hz
geodetic	geod.	high frequency	HF
geographic(al)	geog.	highly gas and oil cut mud	HG&OCM
geographic information system	GIS	highly oil and gas cut water	HO&GCW
geologic(al)	geol.	historic(al)	hist.
Geological Society of America	GSA	horizontal	horiz
geophysical	geophys.	hornblende	Hbl
giga (prefix, 1 billion)	G	hornfels	hfls
glauconitic	glanc	horsepower	hp
global positioning system	GPS	horsepower-hour	hph
government	govt.	hour	h
graded elevation	gr	hydrogen ion activity	pH
gradient	∇	hydrogen ion concentration	pH
grain	gr	hydrologic(al)	hydrol.
gram	g	hydraulic fracture	frac
gram per cubic centimeter	g/cm ³	hydrostatic pressure	HP
granite	gr	hypersthene	hy
granodiorite	grd	identical with	≡
granular	gran	not identical with	≠
graptolite	grap	igneous	ign
gravitational acceleration, acceleration of free fall, local acceleration due to gravity	<i>g</i>	ilmenite	Ilm
gravitational constant	<i>G</i>	inch (when used with ft, lb, exponents, omit period)	in.
gray (unit of measure for absorbed dose)	Gy	inch, cubic	in ³
graywacke	gwke	inch per hour	in/h
greater than	>	inch per second	in/s
not greater than	≧	inch, square	in ²

inch-pound	in-lb	library	libr.
inclusion	incl	Library of Congress	LC
Incorporated (commercial)	Inc.	light detection and ranging	lidar
index of refraction	n	limestone	Ls. or ls.
indices of refraction for biaxial crystals	n_x , n_y , and n_z	limit	lim
indices of refraction for uniaxial crystals	n_o and n_E	liquid	liq
infinity	∞	liter	L
infrared	ir	liter per second	L/s
initial flowing pressure	IFP	local standard time	LST
initial potential	IP	local time	LT
initial potential flowing	IPF	location	loc
initial potential pumping	IPP	logarithm	log
initial production	IP	logarithm (common)	log
initial shut-in pressure	ISIP	logarithm (natural)	log _e or ln
inside diameter	id	longitude (when used with lat, omit period; abbreviated only when used with figures; use "long." if may be confused with adjective)	long.
insoluble	insol.	longitudinal velocity; P-wave velocity	v_p
institute, institution	inst.	low frequency	lf
interbedded	intbdd	magnetite	Mag
interferometric synthetic aperture radar	inSAR	mass	m
international	internat.	mass number	A
interval of time extending from the present into the past	years B.P.	Master of Arts	M.A.
intrusion	intr	Master of Science	M.S.
investigation(s)	inv.	maximum	max
iron (metallic)	ir	mean, a statistic to estimate the mean of lognormally distributed observations	m
irregular	ireg	mean sea level	m.s.l.
joint	jnt	mean square error	M.S.E.
joule	j	medium frequency	mf
junior	jr	mega (prefix, 1 million)	M
Jurassic	Jur. or J	melting point	mp
kaliophilite	KP	member	Mbr. or mbr.
kelly bushing	kb	memoir	mem.
Kelvin	K	memorandum	memo
Kelvin (degree symbol improper)	K	Mesozoic	Mes. or Mz
kilo (prefix, 1,000)	k	metamorphic	met
kilogram	kg	meter	m
kiloliter	kL	meter, cubic	m^3
kilometer	km	meter, square	m^2
kilometer, cubic	km^3	micro (prefix, one-millionth)	μ
kilometer per hour	km/h	micro-laterolog	MLL
kilometer, square	km^2	microbar	μ bar
knot (speed)	kn	microgram	μ g
laboratory	lab.	microlog	ML
laminated	lam	micrometer	μ m
latitude (abbreviated only when used with illustrations)	lat.	micrometer, cubic	μm^3
lenad	L	micrometer, square	μm^2
length	l	micromicron (obsolete, use picometer, pm)	$\mu\mu$
less than	<	microsecond	μ s
much less than	\ll	mile	mi
not less than	\nless	mile per hour	mi/h
less than or equal to	\leq	mile, square	mi^2
leucite	Lct		

mile(s) per gallon	mi/gal	Natural Resources Conservation Service	NRCS
milli (prefix, one-thousandth)	m	nautical mile	nmi
millibar	mbar	nepheline	Ne
millidarcy, millidarcies	md	neutron	n
milliequivalent	meq	new genus	n. gen.
milligram	mg	new series	new ser.
milliliter	mL	new species	n. sp.
millimeter	mm	new variety	n. var.
millimeter, square	mm ²	newton	N
million (as per oil industry)	MM	no data	ND
million cubic feet of gas	MMCFG	no record, not reported	NR
million cubic feet per day	MMcf/d, MMcf/D, MMCFGD	nodular	nod
	MMcf	none available	n.a.
million cubic feet (million = 10 ⁶)	MMgal/d	normality, normal (concentration)	N
million gallons per day	Ma	north	N
million years ago (geologic ages only)	myr	not available, not applicable	NA
millions of years (intervals of geologic time)	ms	not determined	n.d.
millisecond	mineralog.	number of observations (sample size)	n
mineralogical	min	number of observations in a population	N
minimum	-	number(s)	no(s)
minus	±	oil and gas	O&G
minus or plus	min	oil and salt water	O&SW
minute(s) (time)	misc.	oil cut	OC
miscellaneous	Miss. or M	oil-cut mud	OCM
Mississippian	M	oil-cut water	OCW
mitic	MM	oil, gas and mud cut water	OG&MCW
imodified Mercalli	M	oil gravity in API degrees	GTY
molarity, molar (concentration)	mol	oil- and gas-cut mud	O&GCM
mole (unit of substance)	mol. wt	olivine	Ol
molecular weight	mo.	olivine	O
month	mtn., mts.	oolitic	od
mountain, mountains	MDT	Ordovician	Ord. or O
mountain daylight time	MST	orthoclase	Or
mountain standard time	MT	ounce (avoirdupois)	oz
mountain time	MIR	outcrop	otcp
moving in rig	MC	outside diameter	od
mud cake	MCW	oxidation-reduction potential	Eh
mud cut water	MF	Pacific daylight time	PDT
mud filtrate	ML	Pacific standard time	PST
mud log	MW	Pacific time	PT
mud weight	mdst.	packer	pkr
mudstone	x	page(s)	p.
multiplied by	Ms	paleogeographic(al)	paleogeog.
muscovite	n	paleontologic(al)	paleont.
nano (prefix, one-billionth)	nm	Paleozoic	Pal. or Pz
nanometer (millimicron, obsolete)	ns	paragraph	par.
nanosecond	natl.	part(s)	pt(s).
national	NOAA	part(s) per billion	ppb
National Oceanic and Atmospheric Administration	NSF	part(s) per million	ppm
National Science Foundation	n.l.	particle-size diameter	F
natural log or logarithm		pascal	Pa
		pebble	pbl
		Pennsylvanian	Penn. or P

percent	pct	publication(s)	pub(s).
percent water saturation in flushed zone	Sxo	pyrite	Py
percent water saturation in uninvaded zone	Sw	pyritized	py
perforated	perf	pyroxene	P
perforations	perfs	quadrangle	quad.
peridotite	perid	quadrillion (10^{15})	quad
permeability	perm	quart	qt
Permian	Perm. or P	quarterly	quart.
perovskite	Prv	quartz	Qtz
petrographic(al)	petrog.	quartzite	Qtz. or qtz.
petrologic(al)	petrol.	Quaternary	Quat. or Q
phenocryst	phen	radian	rad
phosphatic	phos	radiocarbon	^{14}C
physiographic(al)	physiog.	radius	r or R
pi (mathematical constant)	π	railroad	RR.
picosecond	ps	railway	Ry.
pint	pt	range(s) (legal land term)	R(s).
plagioclase	Pl	rankine	R
plugged and abandoned	P&A	rankine, degree	°R
plugged back	PB	ratio; is to	:
plus	+	reaming	rmg
plus or minus	\pm	reaumur, degree	°R
point	pt	reconnaissance	reconn.
Poisson ratio	n or m	recovered	rec
population coefficient of variation	g	recrystallized	recryst
population mean	m	regular	reg
population standard deviation	s	report(s)	rept(s).
porphyritic	porph	resistivity of the mud cake	RMC
post meridiem (afternoon)	p.m.	resistivity of the mud filtrate	RMF
potassium metasilicate	ks	resistivity of the mud (drilling)	RM
pound	lb	resistivity of the flushed zone	R_{xo}
pound apothecary	lb ap	resistivity of the fm. water	Rw
pound avoirdupois	lb avdp	review(s)	rev.
pound per cubic foot	lb/ft ³	revolutions per minute	r/min
pound per foot	lb/ft	revolutions per second	r/s
pound per square foot	lb/ft ²	Reynolds number	R
pound-force foot	lbf/ft	rhyolite	rhy
pound-force per foot	lbf/ft	Road (in address only)	Rd.
pound-force per square foot	lbf/ft ²	rocks	rx
pound-force per square inch	lbf/in ²	root mean square	rms
pounds per square inch	psi	rounded	rnd
Precambrian	Prec. or pC	rutile	Rt
preliminary	prelim.	Saint, Sainte, Saints	St. Ste., SS.
pressure	P or p	salt water	SW
primary wave	P-wave	sample coefficient of variation	C
probable	prob	sample mean	\bar{w}
proceedings	proc.	sample mean of logarithms	\bar{u}
producing gas well	PGW	sample standard deviation	s
producing oil well	POW	sample variance	s^2
production drillstem test	PDST	sample variance of logarithms	s^2
productivity index	PI	sampling variability	ξ_R
Professor (used in a title)	Prof.	sandstone	Ss. or ss.
project	proj	saturated, saturation	sat

science(s), scientific	sci.	station	sta
secant	sec	station(s) (used only with numbers)	sta(s).
secant, hyperbolic	secj	stock-tank barrel	STB
second (time)	s	strain, shear	γ
second-foot	sAft	stratigraphic(al)	strat.
secondary	sec	Street (in addresses only)	St.
secondary wave	S-wave	stress, normal	σ
section(s) (subdivision of township)	sec(s).	stress, shear	r
sedimentary	sed	structure	struc
seismographic	seismog.	Student's t-statistic	t
seismologic(al)	seismol.	sum	Σ
self-potential	SP	sum of squares	SS
series	ser.	summary	summ.
serpentine	Srp	superhigh frequency	SHF
session	sess.	Superintendent	Supt.
shale	Sh. or sh.	swabbed	swbd
shear velocity; S-wave velocity	v_s	tabular	tab
shut in	SI	tangent	tan
shut-in bottom-hole pressure	SIBHP	tangent, hyperbolic	tanh
shut-in gas well	SIGW	temperature	temp
shut-in pressure	SIP	temporarily abandoned	TA
Sidewall Neutron Log (n-e)	SNP	tera (prefix, 1 trillion)	G
siliceous	sil	Terrace (in addresses only)	Ter.
siltstone	Sts., sts. or sltst	Territory, Territories, Territorial	Terr.
Silurian	Sil. or S	Tertiary	Tert. or T
sine	sin	testing	tstg
sine, hyperbolic	sinh	thenardite, (Na ₂ SO ₄)	th
slightly gas and water cut mud	SG&WCM	therefore	\therefore
slightly gas cut mud	SGCM	thickness	t or d
slightly oil, gas and mud cut water	SOG&MCW	thousand (7k = 7,000)	k
slug	slug	thousand (as per oil industry)	M
society, societies	soc., socs.	thousand cubic feet gas	MCFG
sodium carbonate (Na ₂ CO ₃)	nc	thousand cubic feet	Mcf, MCF
sodium metasilicate	ns	thousand cubic feet per day	Mcf/d, Mcf/D, or MCFD
soluble	sol		
solution	soln	thousand years ago (geologic ages only)	ka
south	S	thousands of years (interval of geologic time)	kyr
species (singular)	sp.	tilic (shene)	T
(plural)	spp.	time	t
specific gravity	sp gr	ton	ton
specific heat	sp ht	ton, metric	t, m
specific heat capacity	c	tonne (metric ton)	t, m
specific volume	sp vol	too small to measure	tstm
speleological	speleol	topographic(al)	topog.
Spherically Focused Log	SFL	total depth	TD
spinel	Spl	Township(s) (legal land division)	T.
square	sq	trace	tr.
square millimeter	mm ²	Triassic	$\overline{\text{R}}$
Square (in address or as part of the place name)	Sq.	trillion cubic feet of gas	TCFG
standard	std	trillion cubic feet (trillion = 10 ¹²)	Tcf
standard deviation	σ	trillion cubic ft	Tft ³
standard temperature and pressure	STP	true resistivity	Rt
		true vertical depth	TVD

tubing pressure	TP
U.S. Department of Agriculture	USDA
U.S. No. 40, U.S. Highway No. 40	U.S. 40
ultrahigh frequency	UHF
ultraviolet	uv
unconformity	unconf
undetermined	undet.
United States (adjective)	U.S.
United States of America	U.S.A.
universal time	u.t.
unknown quantity	x
unmanned aerial vehicle	UAV
unmanned aerial system	UAS
vacuum	vac
vapor pressure	vp
variegated	vrgt
vegetation	veg
velocity	v or v
velocity, P-wave	v _p
versus, against	vs.
vertebrate	vrtr
very high frequency	VHF
very low frequency	VLF
very slightly gas cut mud	VSGCM
very slightly oil cut mud	VSOCM
volcanic(s)	Vol., volc., or vol.
volt	V
volume (publishing)	v.
water	wtr
water cushion	WC
water cut mud	WCM
water injection well	WIW
watt	W
wavelength	λ
weight	wt
weight per volume	w/v
weight per weight	w/w
west	W
wildcat	WC
wollastonite	Wo
xenolith	xen
yard	yd
yard, cubic	yd ³
yard, square	yd ²
year	yr
years before present (14C age dates only)	yr B.P.
yields	—>
Young's modulus of elasticity	E
zircon	Zrn
zoologic(al)	zool.

UNITED STATES

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

CHEMICAL ELEMENTS

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

APPENDIX E

PROBLEM WORDS AND PHRASES

Words That are Commonly Misused or Confused

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

Compound Words

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

Two Words

(Hyphenated When Used as Adjectives)

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

Words That Are Always Hyphenated

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

Simplification of Words

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

Simplification of Phrases

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

APPENDIX F

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

U.S. Customary Units and their Equivalents

Length

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

Area

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

Volume

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

Mass (Avoirdupois)

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

Mass (Troy)

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

Capacity (U.S. Liquid Measure)

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

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

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

SI Base Units

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

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

Prefixes and their Symbols for SI Units

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

Non-SI Units Permissible Within SI

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

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

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

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

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



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