Guidelines for Conducting Reviews of Geologic Names and Aquifer Names in U.S. Geological Survey Hydrogeologic Maps and Reports

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Abbreviations

B.P.	before present ("present" is 1950 C.E.)
b.y.	billion years
C.E.	Common Era
CMU	Correlation of Map Units
DMU	Description of Map Units
Ga	giga-annum (or billion [10^9] years ago)
GNC	Geologic Names Committee
GNR	geologic names review
ka	kilo-annum (or thousand [10^3] years ago)
k.y.	thousand years
LMU	List of Map Units
Ma	mega-annum (or million [10^6] years ago)
m.y.	million years
NACSN	North American Commission on Stratigraphic Nomenclature
SI units	International System of Units
STA7	Suggestions to Authors of Reports of the U.S. Geological Survey—Seventh Edition
USGS	U.S. Geological Survey
yr	year
yr B.P.	years before present

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Chapter E

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By Steven D. Craigg and Randall C. Orndorff

Introduction

The U.S. Geological Survey (USGS) is officially charged with assessment of various aspects of geology and hydrogeology throughout the Nation. Hence, USGS publications adhere to broadly uniform procedures in the classification and nomenclature of geologic and hydrogeologic units. Responsibility for this uniformity is under the technical guidance of the Geologic Names Committee (GNC), which formulates general policy and advises on specific nomenclatural issues. Central to the GNC proceedings is the North American Stratigraphic Code (hereafter referred to as "the Code") (North American Commission on Stratigraphic Nomenclature [NACSN], 2021).

Geologic reports typically contain geologic maps and cross sections, geologic unit names, lithologic descriptions, and stratigraphic correlation charts, as well as results of drilling activities and structure-contour, depth-to-top, depth-to-base, or sediment-thickness maps. Groundwater-resource maps and other hydrogeologic maps and reports can also contain many of these same elements. Groundwater-resource reports rarely contain original geologic mapping, revisions of stratigraphic nomenclature, or redefinitions or changes in the ranks or ages of geologic units; however, these reports usually contain descriptions and classifications of hydrogeologic units, and they also may introduce new or modify existing aquifer nomenclature.

The following general guidance is published for those designated as geologic and aquifer names reviewers.

Performing Geologic Names Reviews of Hydrogeologic Maps and Reports

All formal USGS publications that use geologic-unit names and (or) ages, including hydrogeologic maps and reports, must have a geologic names review (GNR) (see discussion in Orndorff, 2023 [this volume]). Such reviews generally consist of verifying the usage of geologic unit names, ranks, ages, and areal extents in a report, as well as if the usage is accepted by an authoritative agency (that is, by USGS, State geological survey, or other entity) and if usage follows the Code (NACSN, 2021). During these reviews, geologic names usage is verified against various lexicons, references, and other resources as appropriate. Geologic names reviewers scrutinize the entire body of a report, including the discussion and (if applicable) the Description of Map Units (DMU), Correlation of Map Units (CMU), maps, cross sections, illustrations, tables, and other correlation charts, to check that geologic nomenclature is used correctly.

Essential Publications and Resources for Geologic Names Reviewers

Several publications and online resources are available to assist geologic names reviewers. The Code (NACSN, 2021) defines procedures for classifying and naming formal geologic units, and it is recommended that designated reviewers have access to this publication. The review process can be greatly expedited by using the USGS National Geologic Map Database's online lexicon "Geolex" (available at https://ngmdb.usgs.gov/Geolex/). Geolex is an extensive, searchable database for geologic-unit names, ranks, and ages, and it contains a direct link to the Code (NACSN, 2021). Another essential resource is the time scale "Divisions of geologic time—Major chronostratigraphic and geochronologic units," published and periodically updated by the USGS (U.S. Geological Survey Geologic Names Committee, 2018; see also, Orndorff and others, 2023 [this volume]).

Older, hard-copy USGS publications such as "Lexicon of Geologic Names of the United States (Including Alaska)" (Wilmarth, 1938) and subsequently published lexicons of geologic names (Wilson and others, 1957, 1959; Keroher and others, 1966; Keroher, 1970; Luttrell and others, 1981, 1986, 1991) remain useful resources in conducting GNRs, as are previous editions of "Stratigraphic Notes" (U.S. Geological Survey, 1982, 1984, 1985, 1987, 1991, 1994a, b, 1995). A resource for geologic names reviewers is the chapter on geologic nomenclature in USGS' Suggestions to Authors (Hansen, 1991 [STA7], p. 43–64). Another useful publication for reviewers is the USGS' Water Resources Division Publications Guide (Alt and Iseri, 1986, p. 187–197), which contains a, concise discussion of geologic names.

State geological surveys also maintain geologic names databases. Various materials in previously published reports are commonly cited by authors; these should be obtained and checked by the reviewer if appropriate.

Elements of a Geologic Names Review of USGS Hydrogeologic Maps and Reports

Designated geologic names reviewers need to carefully scrutinize hydrogeologic maps and reports to ensure that the geologic nomenclature is used correctly and consistently. The following is a brief discussion of the elements to check when performing a geologic names review on a hydrogeologic map or report[1] (a more comprehensive discussion of these elements is provided in Orndorff, 2023 [this volume]):

- Stratigraphic names are consistently used.
- Stratigraphic nomenclature follows the Code.
- Source of the geologic nomenclature used, including on correlation charts and maps, is cited where appropriate (for example, "the geologic nomenclature used in this report is that of the Georgia Geologic Survey").
- Names (including spelling and capitalization) and ages of formal and informal geologic units are proper and consistent.
- Formal ranks of units (Group, Formation, Member, and so on) are used correctly, and the ranking of units to represent parent-child relations among units is logical and accurate.
- Chronostratigraphic (position) and geochronologic (age) terms (System or Period, Series or Epoch, and so on) and their subdivisions, both formal (Lower or Early, Middle, Upper or Late) and informal (lower or early, middle, upper or late), are used correctly and consistently.
- Abbreviations are used properly to designate either points in time (ages) or durations of time:
  - Durations of time lack a specific reference to the present (yr, single year; k.y., thousand years; m.y., million years; b.y., billion years).
  - Points in time (ages) are specified in International System of Units (SI units) abbreviations (ka, kilo-annum, or thousand years ago; Ma, mega-annum, or million years ago; Ga, giga-annum, or billion years ago). The redundant terms "ago" and "before present" are not used, except for radiocarbon ages, which are given in years before present (yr B.P.); the abbreviation "B.P." means before 1950 C.E.
- In the discussion text of a hydrogeologic map or report, stratigraphy is discussed in order from the oldest to the youngest unit (for example, bedrock units are discussed before surficial units, followed by a discussion of the structure, and so on). To reinforce this, units are mentioned (and unit ages are provided) in oldest-to-youngest order within the discussion.
- In the DMU of a hydrogeologic map or report (and, if applicable, in the corresponding List of Map Units [LMU]), units are listed in stratigraphic order, from youngest to oldest, and the ages of units are specified in youngest-to-oldest order. To reinforce this, when mentioning other units within the text of the map-unit descriptions, ages are provided (and other units are listed) in youngest-to-oldest order.
- In the CMU, time-stratigraphic relations of the units are correct, as indicated by age brackets and headings; the ranks of units (System or Period, Series or Epoch, and so on) are used correctly; the ages of units are listed correctly and are given in youngest-to-oldest order; and the geologic nomenclature (unit names and ages) is consistent with the discussion and the DMU.
- In explanations and captions for illustrations, units are listed from youngest to oldest (top to bottom), and ages are given in youngest-to-oldest order.
- On correlation charts in illustrations, units are shown from youngest to oldest (top to bottom), and ages are given in youngest-to-oldest order; time-stratigraphic relations and ranks and ages of units are correct; and nomenclature is cited where appropriate.
- In illustrations and tables that are modified from a previous publication, the sources for geologic nomenclature are cited in the caption for illustrations or, for tables, in headnotes or footnotes.

Some Common Problems Encountered During a Geologic Names Review of Hydrogeologic Maps and Reports

Common misuses of geologic nomenclature include the improper use of time, age, and rock-position terms, and sometimes these types of terms are used interchangeably in a report (see examples in table 1). The examples provided in table 1 are only a select few nomenclatural issues that reviewers may encounter. Owen (1978, 2009) provided an extensive discussion on this topic. In addition, a comprehensive guide for handling these issues is presented in Orndorff (2023 [this volume]).

Performing Aquifer Names Reviews

When aquifers are being discussed in a map or report, an aquifer names review is needed. For USGS hydrogeologic maps and reports, aquifer names reviews typically are conducted concurrently with, or just after, the GNR.

[1]Note that the content of this discussion is only appropriate for GNRs of hydrogeologic maps and reports. Geologic maps and reports typically require a more rigorous, comprehensive GNR; when performing a GNR on a geologic map or report, please follow the guidance provided in Orndorff (2023 [this volume]).

Table 1. Examples of correct and incorrect usage of chronostratigraphic (position) and geochronologic (time) terms for ages.

Incorrect usage	Problem	Correct usage
Upper Cretaceous age	Upper is a position term, not a time term	Late Cretaceous age
Lower Cretaceous age	Lower is a position term, not a time term	Early Cretaceous age
Late Jurassic Series	Series is a chronostratigraphic (position) unit, but Late is a geochronologic (time) term	Upper Jurassic Series (position), or Late Jurassic Epoch (time)
Lower Jurassic Epoch	Epoch is a geochronologic (time) unit, but Lower is a chronostratigraphic (position) term	Early Jurassic Epoch (time), or Lower Jurassic Series (position)
Late Triassic Period	Late Triassic is a formally recognized subdivision (epoch, not period) of the Triassic	Late Triassic Epoch
In the Late Miocene …	Late Miocene is not a formally recognized subdivision of the Miocene (and so is lowercased)	In the late Miocene …
The Lower Paleocene strata …	Lower Paleocene is not a formally recognized subdivision of the Paleocene (and so is lowercased)	The lower Paleocene strata …

Essential Publications and Resources for Aquifer Names Reviewers

Recognizing the need for consistent use of aquifer nomenclature, USGS published guidelines for aquifer names reviewers in "Aquifer Nomenclature Guidelines" (Laney and Davidson, 1986). An updated version of this report was provided in the chapter "Guidelines for Naming Aquifers" in STA7 (Hansen, 1991, p. 65–82). In addition, brief discussions of aquifer nomenclature were included in the USGS' Water Resources Division's publications guide (Alt and Iseri, 1986, p. 198–200) and illustration standards (Miller and Balthrop, 1995).

These guidelines not only contain uniform aquifer-naming conventions, but they are flexible enough to address aquifer nomenclature issues in a wide variety of hydrogeologic settings and at various study-area scales. It is worth noting, however, that the aquifer names reviewer needs to exercise common sense in applying these guidelines because, in some States, certain aquifer names are considered "traditional" and are "grandfathered in" by historical precedent; such terms also may have legal implications (water rights and use). Therefore, a reviewer should not compel an author to change such established nomenclature. The USGS' Regional Aquifer-System Analysis project established regional nomenclatures that are contained in USGS' Hydrologic Atlas 730 (U.S. Geological Survey, 2000) and its various segments (see, for example, Planert and Williams, 1995; Trapp and Horn, 1997; Miller, 1999). These regional nomenclatures should not be modified by reviewers unless they are subsequently revised or updated in a Bureau-approved USGS publication. In addition, USGS has put forth a National Aquifer Code Reference List, which may be useful for looking up aquifer names (available online at https://water.usgs.gov/ogw/NatlAqCode-reflist.html).

Elements of an Aquifer Names Review of USGS Groundwater-Resource and Other Hydrogeologic Maps and Reports

As is stated in the Code (NASCN, 2021, p. 166), most aquifer (and confining unit) names are considered informal and, thus, are lowercased: "Most economic units, such as aquifers, oil sands, coal beds, quarry layers, and ore-bearing 'reefs,' are informal, even though they may be named." However, a few notable examples exist (NASCN, 2005, p. 1560): "Some such units, however, are so significant scientifically and economically that they merit formal recognition as beds, members, or formations." A significant example of a formalized name is the Floridan aquifer system, which consists of the Upper and Lower Floridan aquifers.

Similar to the elements for a GNR listed in the previous section, designated aquifer names reviewers need to scrutinize the following elements of a report to ensure that aquifer names and other hydrogeologic nomenclature are used correctly and consistently:

- In all parts of a hydrogeologic map or report, aquifer-nomenclature schemes generally follow the guidelines in Laney and Davidson (1986) and STA7 (Hansen, 1991); however, exceptions may occur owing to historical-use precedence.
- New aquifer nomenclature is not introduced, unless absolutely necessary. Such newly introduced nomenclature may be superfluous, subsequently proliferating and cluttering the hydrogeologic literature and, thereby, confusing later workers.
- Aquifer names (including spelling and capitalization) are correctly and consistently used.

- Source of the hydrogeologic nomenclature is cited where appropriate (for example, "the hydrogeologic nomenclature used in this report is that of the New Mexico Bureau of Mines and Mineral Resources").
- In the discussion of a report, the hydrogeology typically is discussed from top to bottom (as strata would be penetrated by a well); however, this order can differ, depending on the thrust and logic of the report.
- In illustration explanations, units are shown in stratigraphic order (youngest to oldest).
- On correlation charts in illustrations, units are shown in stratigraphic order (youngest to oldest); time-stratigraphic relations of units are correct; rank and ages of units are correct; and nomenclature is cited where appropriate.
- In illustrations and tables that are modified from a previous publication, the sources for aquifer nomenclature are cited in the caption for illustrations or, for tables, as footnotes.

Some Common Problems Encountered During an Aquifer Names Review

A common aquifer nomenclature problem is using a hydrogeologic unit that has its rank included in the aquifer name (see table 2). Other common problems include the improper use of time, age, and rock-position terms (sometimes these types of terms are [incorrectly] used interchangeably in a report), and geologic age terms that are used for aquifer names (for example, Late Cretaceous aquifer system); however, terms such as "water from Upper Cretaceous rocks" and so forth are acceptable. For further clarification of and suggestions for aquifer naming schemes, refer to Laney and Davidson (1986) and STA7 (Hansen, 1991, p. 65–82). Note that the examples in table 2 are only a select few nomenclatural issues that reviewers may encounter.

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Table 2. Examples of correct and incorrect usage of aquifer names.

Incorrect usage	Problem	Correct usage
Floridan aquifer	The Floridan is a system that includes other named aquifers and other hydrostratigraphic units (no "Floridan aquifer" exists)	Floridan aquifer system
Upper Floridan aquifer system	Upper Floridan is an aquifer within the Floridan aquifer system	Upper Floridan aquifer
Black Mingo Group aquifer	Lithostratigraphic units are not included in hydrostratigraphic nomenclature	Black Mingo aquifer
Dakota Sandstone aquifer	Lithologic modifiers are not used in hydrostratigraphic nomenclature	Dakota aquifer

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