

**PRELIMINARY INTEGRATED GEOLOGIC MAP DATABASES FOR THE UNITED STATES**

**DIGITAL DATA FOR THE PRELIMINARY BEDROCK GEOLOGIC MAP OF THE SEWARD PENINSULA, ALASKA, AND ACCOMPANYING CONODONT DATA**

by

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## INTRODUCTION

These digital files represent part of a systematic effort to release geologic map data for the United States in a uniform manner. Geologic data in this series has been compiled from a wide variety of sources, ranging from state and regional geologic maps to large-scale field mapping. It is presented for use at a nominal scale of 1:500,000, although the individual datasets herein contain data suitable for use at larger scales. This regional map is the result of the compilation and reinterpretation of published and unpublished 1:500,000-, 1:250,000-, and 1:63,360-scale mapping. The metadata associated with each release will provide more detailed information on sources and appropriate scales for use. Associated attribute databases accompany the spatial databases of the geology and are uniformly structured for all maps in the series for ease in developing regional- and national-scale maps. This compilation was done as part of the U.S. Geological Survey's National Surveys and Analysis project, whose goal is to compile geologic, geochemical, geophysical, and mineral occurrence data for the United States.

This 1:500,000-scale geologic map depicts the bedrock geology of Seward Peninsula, western Alaska, on the North American side of the Bering Straits. The map encompasses all of the Teller, Nome, Solomon, and Bendeleben 1:250,000-scale quadrangles, and parts of the Shishmaref, Kotzebue, Candle, and Norton Bay quadrangles. This map overlaps in part with Pattern and others (2009; digital data, Wilson and others, 2005).

Rolling, tundra-covered hills cover most of Seward Peninsula; trees and shrubs are present only in limited areas in the southern and eastern parts of the Peninsula. An extensive, unvegetated lava field occupies a central area and large areas in northernmost and easternmost Seward Peninsula. The York Mountains of western Seward Peninsula and hills adjacent to them on the east are underlain by bare, unvegetated carbonate rocks (Teller quadrangle). Four glacially carved mountain ranges, the York, Kigluaik, Bendeleben, and Darby Mountains, reach heights of 1,000-1,300 m; the highest point on the Peninsula, Mt. Osborn (1,437 m), is in the Kigluaik Mountains. Broad lowlands underlie large areas in central and northern Seward Peninsula.

The area covered by this map is 74,000 km<sup>2</sup>, an area slightly larger than West Virginia or Ireland.

### *Sources of data*

This geologic map is a compilation of published and unpublished geologic mapping and information derived from other published and unpublished sources. Published geologic maps at scales of 1:250,000, 1:63,360, and 1:50,000 were major sources and range in publication date from 1972 to 2005. More detailed studies, including theses, papers, and unpublished mapping, represent work done between 1980 and 2008.

The amount of geologic detail available varies significantly across the area of the map, because of variations both in degree of study and in quality of bedrock exposure. Bedrock exposure, outside of the mountain ranges, is generally poor in the northern Peninsula, and better in southern parts of the Peninsula. The most detailed geologic mapping on the peninsula has been concentrated in the York and Kigluaik Mountains, and the central Solomon quadrangle. The distribution of some metamorphic indicator minerals and conodont color alteration index (CAI) values presented on sheet 2 is limited by quality of exposure and amount of study in a given area.

The digital datasets that form the basis for this product were compiled and created using existing published and unpublished data. The spatial and text databases here are linked through use of two parallel key fields. These fields link to the associated attribute databases in slightly different ways.

The primary link on a statewide basis is a field called *nsaclass*, which is used in the statewide database, of which this map represents one part. This field provides a linkage through the databases to the age and lithology of the map units contained on each map. *Nsaclass* is used to cover the entire geologic time scale, whereas *qclass* is restricted to and provides finer detail for Quaternary map units. *Nsaclass* and the similar *qclass* field have been added to the polygon attribute table (PAT) of the spatial database (ARC/INFO coverage) and can also be found in the text databases of supplemental attribute data. These fields represent the link that correlates individual map units between sources. *Nsaclass* is used to make regional unit assignments and generally reflects a known or an inferred correlation of map units. For example, all “Surficial deposits, undivided” are assigned an *nsaclass* code of 100. The schema for *nsaclass* was developed as regional maps throughout Alaska were compiled and therefore reflects an iterative process. As new or additional information becomes available, the *nsaclass* code for a particular map unit may be changed, either to reflect lumping or, more generally, a finer separation of map units.

A third key field called *lith2* is specific to this regional map. The prime reason for use of *lith2* is that plutonic units on this map are subdivided in more detail than is used within the state database. Like *nsaclass*, *lith2* can provide a link to a detailed unit description age, as well as, an indirect link (via *nsaclass*) to age and lithology.

Fields called *source* and *nsamod* have also been added to the PAT. *Source* is a coded reference citation, indicating the manuscript or other source for the map information. The format for *source* is XX###, where XX is the two letter quadrangle code (CAPITAL letters) and ### is a three digit number (using leading zeros) to indicate a specific reference. *Nsamod* provides information with respect to hydrothermal alteration or contact metamorphism of a map unit, either for the entire unit or for an individual polygon. In this way, the *nsaclass* field needs only to store the primary map unit information. Fields also in the PAT are *class*, *label*, *min\_age*, and *max\_age*, which are more fully described below.

The arc attribute table (AAT) is used to store attributes indicating the type of line features in the coverages and shape-files. Inherent in the coding is information defining the type of line shown, such as a stratigraphic or fault contact, and location (certain, approximate, inferred, or concealed). In addition, each arc within a spatial database has a *source* attribute.

The standardized supplemental attribute tables were generated by extracting information from the legends of the source maps and from unpublished data by the compilers of this regional map. Thus, the age and lithologic information in the attribute tables may, in some cases, conflict with the information on the legends of the original source maps. This reflects new information for map areas for which maps may have been compiled decades ago. The standardized supplemental attribute tables record an abstracted map unit description, lithologic and age information, and references.

All geologic maps on which this compilation is based were published using the Universal Transverse Mercator projection (UTM; Zones 5 and 6), North American Datum 1927 (NAD-27). The spatial databases are provided in the native UTM projection of the sources as well as geographic coordinates. The UTM projection parameters are described in the metadata. Because of the distortions use of the UTM projection would produce on a map of small scale and large area,

regional-scale products derived from this data that cross UTM zones should be plotted using a more appropriate Albers Equal-area projection. Regional maps in Alaska are commonly presented using an Albers Equal-area projection and the parameters for this projection are as follows:

Projection: Albers Equal-area

Horizontal datum: NAD'27

Spheroid: Clarke, 1866

1st Standard parallel: 55 degrees North

2nd Standard parallel: 65 degrees North

Central meridian: 154 degrees West

Latitude of projection origin: 50 degrees North

Units: meters

False easting (meters): 0

False northing (meters): 0

ArcView files can be viewed with the free viewer, ArcExplorer, which can be downloaded from: <http://www.esri.com/software/arcexplorer/>.

## DATABASE TABLES

In order to manage the textural and coding information related to the Seward Peninsula geologic map, we created a series of related and interlinked databases. These databases are a subset of the databases being created and maintained statewide. As provided here, in addition to the native database format files (.fp7), as well as “.dbf” and “.csv” (comma separated values) files, we also include a runtime version of the primary databases, which are maintained using the commercial Filemaker Pro (versions 7 through 10) database software. These databases are not directly connected to the ARC/INFO coverages; however, the data can be linked through the .csv or .dbf files that accompany this report. Additionally, the native Filemaker Pro files can be linked in ArcGIS through ODBC. In a standalone mode, these databases can be used to guide searches of the coverages seeking particular sorts of information. By way of background, the PAT files of the coverages have seven fields in them that correspond to fields in the .fp7 databases. These fields are *class*, *nsaclass*, *qclass*, *label*, *min\_ma*, *max\_ma*, and *source*.

Eleven database tables are included here. They are:

**SPUNITS:** A subset of the statewide database containing abstracted geologic unit descriptions for each source map in the Seward Peninsula map area. Five .PAT fields, *class*, *nsaclass*, *qclass*, *lith2*, and *source*, mentioned above, are duplicated in this database.

**SPDESCRIP:** This database ties *lith2* numbers to the more complete unit descriptions used on the Seward Peninsula map. Linked to the SPUNITS database through the *lith2* field. For 8.3 software compatibility, may be renamed SPDESCRP.

**SPREFS:** A subset of the statewide database containing the references for the source maps of the Seward Peninsula map. Linked to the SPUNITS database through the *source* field.

**NSAKEY:** The statewide database that shows the color symbol and label to be used for each *nsaclass* in the state. Note that these are **not** the colors and labels used on the Seward Peninsula map. We have provided the color symbols and labels appropriate for the Seward Peninsula map in the SPDESCRIP database. NSAKEY is linked to the SPUNITS database through the

*nsaclass* field. The required ARC/INFO shadeset and ARCMAP stylesheet are included with this report.

**NSAQKEY:** Database similar to NSAKEY but it is used to subdivide the Quaternary surficial deposits by assigning color symbols and labels to only the Quaternary units. As the Seward Peninsula map does not show subdivisions of surficial deposits, this table is only included for compatibility with the statewide database. Linked to SPUNITS through *qclass*.

**NSALITH:** The statewide database that provides information to assign to geologic units specific rock types, lithologic form or mode of occurrence, and relative proportion of the unit that rock type represents. Linked to the SPUNITS database through the *nsaclass* field.

**LITHLIST:** Database containing all the lithologic terms (rock types) used in the lithologic coding – duplicated here in appendix 1 of this document. Note, the metamorphic rock schema in this list is somewhat modified from previous releases of these databases. Linked to the NSALITH database.

**LITHFORM:** Database containing the lithologic-form terms used for lithologic coding of geologic units – duplicated here in appendix 1 of this document. Linked to the NSALITH database.

**NSAAGE:** The statewide database that provides information to assign specific ages to geologic units. Linked to the SPUNITS database through the *nsaclass* field.

**IUGSLIST:** Database containing the minimum and maximum ages for every Eon, Era, Period, Epoch, and Age. Linked to the NSAAGE database through *Eon, Era, Period, and Epoch*. The age assignments are based on the 2006 IUGS time scale (Gradstein and others, 2005), a change from previous releases in this series, which were based on the 1983 DNAG time scale (Geological Society of America, 1983).

**SPRADIO:** Database listing K/Ar, Ar/Ar, and fission-track radiometric ages from the map area.

**SPU-PB:** Database listing U-Pb age determinations from the map area.

## **RUNTIME APPLICATION**

Included with this data release is a runtime application of the Filemaker Pro database tables. This application, which only functions under the Windows operating system, is provided as a zipped directory which contains the database tables and the necessary files to provide much of the functionality of the Filemaker Pro software. To use this application, unzip the supplied zip file, which will create a folder (directory) containing needed files. Within that folder will be a file named SEWPEN.exe. Double click on this file to start the runtime application. The database tables can be scrolled by clicking on the “rolodex”-like icon in the upper left corner. Searches can be made by selecting the “Find mode”, found under the “View” tab and typing the desired search item in the appropriate field on the Find screen. A complete explanation of the software is not appropriate here, but experimentation will reveal many capabilities.

## **DATABASE STRUCTURES**

### **SPUNITS database**

The main database for the project is called SPUNITS. Entered into this database (table 1) are brief abstracts of the unit descriptions from each source map, which are then classified into regional or statewide units. This database is the root for correlations of units, although not necessarily the final word (more on this below). For example, Early Cretaceous granodiorite from various maps

might get the same *nsaclass* and therefore be assigned to a single map unit, yet when drawn to produce a particular map, it might be given the same symbol and color as granite and quartz monzonite of that age (only for that map). Specific to the Seward Peninsula map, a number of Cretaceous plutonic rock map units have been given common *nsaclass* values and are distinguished for the map using the *lith2* values. The standard view (called “GSA color”) of the database in Filemaker Pro software has portals to four other related databases, NSAKY, SPREFS, NSAAGE, and NSALITH, which show the related values in these databases. These databases are linked through either the *nsaclass* or *source* fields in the SPUNITS database. The first seven fields in the database come directly from the source map, each of the other fields is assigned either at the time of entry into the database or later.

**Table 1.** SPUNITS field definitions.

	Field name	Information type	Field type	Links
1	<i>Quadrangle</i>	1:250,000–scale quadrangle, with the name fully spelled out. If a map covers multiple quadrangles, each quadrangle will have a set of entries for the appropriate units from that map in the database.	Text	-
2	<i>Map unit</i>	Label given on the source map for a geologic unit. Some maps do not use labels; hence a color or pattern description would be entered here. In other cases, a unit subdivided using an overprint pattern (such as limestone lenses in a clastic unit) will have an entry for each variation.	Text	-
3	<i>Unit name</i>	Map unit name from the source map. If a map is divided in regions, terranes, or allochthons, etc., or the unit name explicitly mentions stratigraphic divisions, then this information is included in the unit name (for example, “Lisburne Group, Kuna Formation”, or “Greenstone of Venetie Subterrane of Arctic Alaska Terrane”). However, in general terrane terminology is not used in this database.	Text	-
4	<i>Age</i>	Geologic age of the unit as given in the source. (Note this is the age and not the stratigraphic position; convert Upper to Late and Lower to Early.) In some cases, the age assignment has been subsequently revised; nevertheless, the age from the source map is entered here.	Text	-

**Table 1.** SPUNITS field definitions (cont.)

	Field name	Information type	Field type	Links
5	<i>Description</i>	An abstracted version of the unit description from the source map. Focuses on lithology and important relationships as described on the source map. Also includes any special notes regarding this unit from the source. This field, though of unlimited length, is kept short.	Text	-
6	<i>Fossil</i>	Brief notes on any fossil control mentioned on the source map.	Text	-
7	<i>Radiometric age</i>	Brief notes on radiometric ages.	Text	-
8	<i>Source</i>	Unique code assigned to each source; uses the 2-letter quadrangle code and a three digit number. By default, 001 is reserved for the topographic map for each quadrangle. Numbers above 100 indicate sources that may be significant, but not captured digitally.	Text and number combined	SPREFS, Arc coverage
9	<i>Rock class</i>	General classification of unit: Igneous, Sedimentary, Metamorphic, Unconsolidated, or Melange. For mixed units, the dominant category.	Text, defined values	-
10	<i>Nsamod</i>	An item to indicate if unit is altered, contact metamorphosed, or has a queried unit assignment. Some maps show contact metamorphosed areas as separate units; these units are assigned the <i>nsaclass</i> for the appropriate protolith and have “HFS” selected as <i>nsamod</i> value. If only a few polygons of a unit are altered or contact metamorphosed, then the <i>nsamod</i> value will be set for those polygons only in the ARC coverage. Queried units, Tk? versus Tk for example, have the same <i>nsaclass</i> codes, but Tk? will have “Q” selected as <i>nsamod</i> value.	Text, defined values	Arc coverage
11	<i>Class</i>	Unique numeric code assigned to each source unit. (Unique only within a given quadrangle and specific to each source.)	Number	Arc coverage
12	<i>Nsaclass</i>	Regional numeric code assigned to like units – the main key field in the database.	Number	Arc coverage, NSAKEY, NSALITH, SPRADIO

**Table 1.** SPUNITS field definitions (cont.)

	Field name	Information type	Field type	Links
13	<i>Lith2</i>	Numeric code specific to Seward Peninsula map that is used to distinguish all map units.	Number	Arc coverage, SPDESCRIP
14	<i>Maplabel</i>	Label used on the Seward Peninsula map.	Text	SPDESCRIP
15	<i>Qclass</i>	Similar to <i>nsaclass</i> ; allows finer subdivision of Quaternary geologic units.	Number	Arc coverage

Using the SPUNITS database, a user can determine the disposition of any geologic unit from any source map for the map area that is in the statewide database. As such, it includes unit descriptions from maps used for different purposes or at different stages of the project that may not be explicitly reflected in this regional compilation.

Each source map used in the compilation will have all of its geologic units entered in this database. If a source map covers more than one quadrangle, units are entered for all covered quadrangles; however, only the geologic units that actually appear in a quadrangle will be entered for a quadrangle. The reference record for the source map will have an entry for each quadrangle covered by the map.

Within the database itself (see runtime version), portals in the SPUNITS database provide views into the SPDESCRIP, NSAKEY, NSALITH, NSAAGE, and SPREFS database tables, allowing the user to see the linked data applicable to any record.

### **NSAKEY database**

The second most used database is called NSAKEY (table 2). This table is analogous to an ARC/INFO lookup table from which labels and colors are applied to the map. In fact, the primary lookup table used within ARC for many derivative products is derived directly from this database by importing it (NSAKEY) into INFO. The primary field in this database is *nsaclass*, linking it to the SPUNITS and SETTING databases and to the ARC coverages for each quadrangle. It is here that each unit gets assigned a symbol (color), overprint pattern, and tentative label to be used on geologic map products. Note, the labels and assignments provided in this database table are **not** the same as those used on the Seward Peninsula map, but rather reflect a statewide focus. This database allows control of the symbols and labels assigned to units and it helps to eliminate undesired duplication. The database also includes a *description* field, which summarizes the regional unit in a sentence or less and commonly lists the *source* maps that contain the unit. This database is not only exported to INFO to create the lookup table but is also exported to MS Word to assist in the classification of units. Portals in the NSAKEY database provide a view into SPUNITS and back into itself (NSAKEY). The portal that looks inward is particularly useful because it allows a user to see instantly what other units have been assigned a particular symbol. This is important, because although our shadeset or stylesheet ostensibly has 999 colors, in reality, only about 130 can be distinguished by eye on plots. As a result, colors must be assigned to more than one unit and overprint patterns must be used to distinguish subsets. The NSAKEY database is also used to assign duplicate colors and labels to units that are lumped in some map products, but otherwise need to be maintained as separate units in the database.



**Table 2.** NSAKEY field definitions

	Field name	Information type	Field type	Links
1	<i>Symbol</i>	Color number used, derived from an ARC/INFO shadeset.	Number	NSAKEY (self-linked)
2	<i>Overprnt</i>	Pattern number used, also derived from an ARC/INFO shadeset or stylesheet.	Number	-
3	<i>Label</i>	Map label printed on map products.	Text	-
4	<i>Nsaclass</i>	Regional numeric code assigned to like units – the main key field in the database.	Number	SPUNITS, NSAKEY, Arc coverage
5	<i>Description</i>	Brief (5-10 words) summary of unit on a regional basis.	Text	-

**SPDESCRIP database**

This database (table 3) ties *nsaclass* numbers to the more complete unit descriptions used on the Seward Peninsula map compilation. This table is linked to the SPUNITS database through the *nsaclass* field and has portals into SPUNITS and NSAKEY databases.

**Table 3.** SPDESCRIP field definitions

	Field name	Information type	Field type	Links
1	<i>Label</i>	Map unit label as used on the Seward Peninsula map.	Text	-
2	<i>Name</i>	Map unit name as used on the Seward Peninsula map.	Text	-
3	<i>Nsaclass</i>	Regional numeric code assigned to like units – the main key field in the database.	Number	Arc coverage, SPUNITS, NSAKEY
4	<i>Lith2</i>	Numeric code specific to Seward Peninsula map that is used to distinguish all map units.	Number	Arc coverage, SPUNITS
5	<i>Age</i>	Assigned age (range).	Text	-
6	<i>Description</i>	Full text of unit description as used on the Seward Peninsula map or as published in Wilson and others (1998).	Text	-
7	<i>Sources</i>	Source for unit descriptions (not the same form the “ <i>source</i> ” in other database tables).	Text	-
8	<i>Map_sym</i>	Symbol for color used for unit on map	Number	Shadeset or style
	<i>Overprint</i>	Symbol for overprint pattern used for unit on map	Number	Shadeset or style

**SPREFS database**

The SPREFS database (table 4) contains the reference citation for each source map and other publication used. Included in the reference database will be maps that have been digitized, as well as other publications that result in changes to the map (for example, a paper reassigning some rocks

from one unit to another or providing new age determinations). It will also list as "written commun." the source of unpublished information responsible for changes to particular aspects of the map. If a source map covers multiple quadrangles, it will be assigned an identification code for each quadrangle covered. This database has a portal into SPUNITS, showing the map units from that source that have been entered in the SPUNITS database.

**Table 4.** SPREFS field definitions

	Field name	Information type	Field type	Links
1	<i>Source</i>	Unique code assigned to each source that uses the two letter quadrangle id and a three digit number. This field is forced to have only unique entries by the database software.	Text and number, must be unique	SPUNITS, Arc coverage
2	<i>Refnum</i>	A unique tracking number assigned by the database to each reference.	Number, auto entry	-
3	<i>Reference</i>	USGS style reference citation. Also lists written communications where appropriate for modifications to maps.	Text	-

#### NSAQKEY database

The NSAQKEY database (table 5) is similar to NSAQKEY but it is used to subdivide the Quaternary surficial deposits by assigning color symbols and labels to the Quaternary units. The table can also be used as an ARC/INFO lookup table to assign the symbols, overprints, and labels to the surficial deposits.

**Table 5.** NSAQKEY field definitions

	Field name	Information type	Field type	Links
1	<i>Symbol</i>	Color number used, derived from an ARC/INFO shadeset.	Number	-
2	<i>Overprint</i>	Pattern number used, also derived from an ARC/INFO shadeset.	Number	-
3	<i>Unit Label</i>	Map label printed on map products.	Text	-
4	<i>Nsaiclass</i>	Regional numeric code assigned to like units – the main key field in the database.	Number	-
5	<i>Qclass</i>	Numeric code used to subdivide surficial deposits.	Number	SPUNITS, Arc coverage
6	<i>Geologic Unit</i>	Brief (5-10 words) summary of unit on a regional basis.	Text	-
7	<i>Sources</i>	<i>Source</i> code for reference containing the unit and label of unit on original source map.	Text	-

#### NSALITH database

The NSALITH database (table 6) contains lithologic coding for each *nsaiclass* in the database. It uses a lithologic dictionary that is contained in special linked database tables called LITHLIST and

LITHFORM (listed in appendices 1 and 2, herein). It allows for the entry of as many lithologies for a unit as needed and therefore has a many-to-one relationship through the *nsaclass* field. This database has a portal into the SPUNITS database, showing which source maps contain that *nsaclass*.

A special field in this database combines the values of 5 other fields in the database. This field allows searching of the database at any level of the lithologic hierarchy without the need to be concerned about the level of a given term. Possible searches, for example, are for any unit containing carbonate rocks or for any unit where limestone is a major lithology. The *rank* field has four defined values allowed; Major, meaning greater than or equal to 33 percent; Minor, between 10 and 33 percent; Incidental, less than 10 percent; and Indeterminate (major). Major is added to the indeterminate category to insure “fail safe” or inclusive searches for major rock types, as rock types listed in the indeterminate category could well be major components of a map unit. These can be eliminated from search results by explicitly omitting “Indeterminate” from the result.

**Table 6.** NSALITH field definitions

	Field name	Information type	Field type	Links
1	<i>Nsaclass</i>	Regional numeric code assigned to like units – the main key field in the database.	Number	SPUNITS
2	<i>Lith1</i>	Highest level lithologic classification.	Text, value list	-
3	<i>Lith2</i>	Next level lithologic classification, values are based on the value of <i>lith1</i> field.	Text, value list	-
4	<i>Lith3</i>	As above, based on the value of <i>lith2</i> field.	Text, value list	-
5	<i>Lith4</i>	As above, based on the value of <i>lith3</i> field.	Text, value list	-
6	<i>Lith5</i>	As above, based on the value of <i>lith4</i> field.	Text, value list	-
7	<i>Form</i>	Description of form of units, uses a value list based on the value of <i>lith1</i> field.	Text, value list	-
8	<i>Rank</i>	Values allowed are: Major, Minor, Incidental, and Indeterminate (major).	Text, value list	-
9	<i>Lithology</i>	Field from an earlier lithologic classification and generally not used.	Text	-
10	<i>Percent</i>	Optional field containing an estimate of percent of unit that given lithology represents. This information is rarely available in Alaska.	Number	-
11	<i>Comment</i>	Free form comment field – optional.	Text	-
12	<i>Record_no</i>	Unique tracking number assigned by the database to each record.	Number, auto entry	-
13	<i>Totallith</i>	Text string that combines the information in all of the <i>lith</i> fields, allowing searches based on any aspect of the lithologic hierarchy.	Text, auto entry	-

## NSAAGE database

The NSAAGE database table (table 7) is used like the NSALITH table to assign a uniform age to each *nsaclass* unit. The fields in it are assigned using a data dictionary (using the IUGSLIST database table) derived from a slightly modified version of the 2004 IUGS time scale (Gradstein and others, 2005) to assign maximum and minimum ages to geologic units. Previous version of this database used the 1983 DNAG time scale (Geological Society of America, 1983). The database software then creates a field that has the full definition of the minimum or maximum age of the unit, allowing searches based on any part of the time scale, similar to the *totalith* field described above. For example, searches could be for units that are Paleozoic but no older than Devonian. Because minimum and maximum numeric ages are also populated in the databases, any unit can be searched based on a numeric maximum and minimum age as well.

Note that the ages assigned in this database are for an *nsaclass* unit and may not necessarily match the assignments made on any given source map. The assignment of a geologic unit to an *nsaclass* controls the lithology and the age referenced to that unit by the database. For example, a source map may call a unit Paleozoic, yet current knowledge may indicate that unit is actually Permian in age. The SPUNITS database will show the Paleozoic age as shown in the source whereas the NSAAGE database will most likely show the Permian age assignment, based on current knowledge and the assignment of an appropriate *nsaclass*.

**Table 7.** NSAAGE field definitions

	Field name	Information type	Field type	Links
1	<i>Nsaclass</i>	Regional unit code as used above.	Number	SPUNITS, Arc coverage
2	<i>Unit_link</i>	Field only used in the conterminous US and is similar in some respects to <i>nsaclass</i> (included for compatibility with Conterminous US databases).	Text	(Conterminous US databases)
3	<i>Min_eon</i>	The minimum or youngest age assignment for the eon of the unit, based on geologic interpretation.	Text, value list	-
4	<i>Min_era</i>	As above, for era.	Text, value list	-
5	<i>Min_period</i>	As above, for period.	Text, value list	-
6	<i>Min_epoch</i>	As above, for epoch.	Text, value list	-
7	<i>Min_age</i>	As above, for age.	Text, value list	-
8	<i>Full_min</i>	Complete, concatenated minimum age assignment.	Text, auto entry	-
9	<i>Max_eon</i>	The maximum or oldest age assignment for the eon of the unit, based on geologic knowledge.	Text, value list	-
10	<i>Max_era</i>	As above, for era.	Text, value list	-

**Table 7.** NSAAGE field definitions (cont.)

	Field name	Information type	Field type	Links
11	<i>Max_period</i>	As above, for period.	Text, value list	-
12	<i>Max_epoch</i>	As above, for epoch.	Text, value list	-
13	<i>Max_age</i>	As above, for age.	Text, value list	-
14	<i>Full_max</i>	Complete, concatenated maximum age assignment.	Text, auto entry	-
15	<i>Type</i>	Unit age assigned relatively (stratigraphic position or fossils) or absolutely (radiometric age).	Text, value list (Relative or Absolute)	-
16	<i>Cmin_age</i>	The most precise minimum age coded, derived from the <i>full_min</i> field.	Text, auto entry	-
17	<i>Cmax_age</i>	The most precise maximum age coded, derived from the <i>full_max</i> field.	Text, auto entry	-
18	<i>Min_Ma</i>	Numeric, either from the DNAG table or radiometric determinations.	Number, auto entry	-
19	<i>Max_Ma</i>	Numeric, either from the DNAG table or radiometric determinations.	Number, auto entry	-
20	<i>Age_comments</i>	Free form comment field – optional.	Text	-

### SPRADIO database

The SPRADIO database table (table 8) contains radiometric age data for samples analyzed by K/Ar, 40Ar/39Ar and fission-track methods for age determination. This table is linked through the *nsaclass* field to the other database tables. Note that the ages reported in this database table are for samples we have assigned to particular *nsaclass* units; the ages shown may not necessarily match the age range assigned to the geologic unit represented by that *nsaclass* if the age was interpreted as not reflecting the emplacement age of the unit.

**Table 8.** SPRADIO field definitions

	Field name	Information type	Field type	Links
1	<i>Quad</i>	1:250,000-scale quadrangle.	Text	-
2	<i>Latdeg</i>	Degrees of latitude.	Number	-
3	<i>Latmin</i>	Minutes of latitude (to be added to degrees).	Number	-
4	<i>Latdir</i>	Hemisphere of sample location (N or S).	Text	-
5	<i>Longdeg</i>	Degrees of longitude.	Number	-
6	<i>Longmin</i>	Minutes of longitude (to be added to degrees).	Number	-
7	<i>Longdir</i>	Hemisphere of sample location (W or E).	Text	-
8	<i>Sample</i>	Sample number.	Text	-
9	<i>Rock_type</i>	Rock type of sample dated.	Text	-

**Table 8.** SPRADIO field definitions (cont.)

	Field name	Information type	Field type	Links
10	<i>Method</i>	Dating method used.	Text	-
11	<i>Mineral</i>	Mineral or phase dated.	Text	-
12	<i>Age</i>	Reported in age in millions of years.	Number	-
13	<i>Comment</i>	Comments about analysis or sample.	Text	-
14	<i>Reference</i>	Reference citation for age determination.	Text	-
15	<i>Latitude</i>	Calculated in decimal degrees from <i>Latdeg</i> and <i>Latmin</i> .	Number	-
16	<i>Longitude</i>	Calculated in decimal degrees from <i>Longdeg</i> and <i>Longmin</i> .	Number	-
17	<i>Error</i>	Analytical error for age determination.	Number	-
18	<i>Rec_no</i>	Record number of entry in database for editing purposes	Number	-
19	<i>Nsaiclass</i>	Regional unit code as used above.	Number	KBUNITS, Arc coverage

**SPU-PB database**

The SPU-PB database table (table 9) contains radiometric age data for samples analyzed by uranium-lead (U-Pb) methods for age determination. This table is linked through the *nsaiclass* field to the other database tables. Note that the ages reported in this database table are for samples we have assigned to particular *nsaiclass* units; the ages shown may not necessarily match the age range assigned to the geologic unit represented by that *nsaiclass* if the age was interpreted as not reflecting the emplacement age of the unit.

**Table 9.** SPU-PB field definitions

	Field name	Information type	Field type	Links
1	<i>Quad</i>	1:250,000-scale quadrangle.	Text	-
2	<i>Latdeg</i>	Degrees of latitude.	Number	-
3	<i>Latmin</i>	Minutes of latitude (to be added to degrees).	Number	-
4	<i>Latdir</i>	Hemisphere of sample location (N or S).	Text	-
5	<i>Longdeg</i>	Degrees of longitude.	Number	-
6	<i>Longmin</i>	Minutes of longitude (to be added to degrees).	Number	-
7	<i>Longdir</i>	Hemisphere of sample location (W or E).	Text	-
8	<i>Sample</i>	Sample number.	Text	-
9	<i>Rock_type</i>	Rock type of sample dated.	Text	-
10	<i>Method</i>	Dating method used.	Text	-
11	<i>Mineral</i>	Mineral or phase dated.	Text	-
12	<i>Age</i>	Reported in age in millions of years.	Number	-
	<i>Error</i>	Reported analytical error	Number	-
13	<i>Comment</i>	Comments about analysis or sample.	Text	-
14	<i>Reference</i>	Reference citation for age determination.	Text	-

**Table 9.** SPU-PB field definitions (cont.)

	Field name	Information type	Field type	Links
15	<i>Nsaclass</i>	Regional unit code as used above.	Number	KBUNITS, Arc coverage
16	<i>Latitude</i>	Calculated in decimal degrees from <i>Latdeg</i> and <i>Latmin</i> .	Number	-
17	<i>Longitude</i>	Calculated in decimal degrees from <i>Longdeg</i> and <i>Longmin</i> .	Number	-
18	<i>Description</i>	Additional notes on sample analysis.	Text	-
19	<i>Method</i>	Specific method if data available.	Text	-

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## APPENDIX 1. LITHOLOGIC DATA DICTIONARY

Lith1	Lith2	Lith3	Lith4	Lith5
Unconsolidated				
	Coarse-detrital			
		Boulders		
		Gravel		
		Sand		
	Fine-detrital			
		Clay		
		Silt		
	Coral			
	Marl			
	Peat			
Sedimentary				
	Clastic			
		Mixed-clastic		
			Conglomerate-mudstone	
			Conglomerate-sandstone	
			Sandstone-mudstone	
			Siltstone-mudstone	
		Conglomerate Sandstone		
			Arenite	
				Calcarenite
			Arkose	
			Graywacke	
		Siltstone		
		Mudstone		
			Claystone	
				Bentonite
			Shale	
				Black-shale
				Oil-shale
				Phosphatic-shale
		Sedimentary-breccia		
	Carbonate			
		Dolostone		
		Limestone		
			Chalk	
			Coquina	
		Marlstone		
	Chemical			
		Banded-iron-formation		
		Barite		
		Chert		
		Diatomite		



**APPENDIX 1. LITHOLOGIC DATA DICTIONARY (CONT.)**

Lith1	Lith2	Lith3	Lith4	Lith5
Sedimentary				
		Evaporite		
			Anhydrite	
			Gypsum	
			Salt	
		Novaculite		
		Phosphorite		
	Coal			
		Anthracite		
		Bituminous		
		Lignite		
		Sub-bituminous		
Igneous				
	Plutonic			
		Granitic		
			Alkali-feldspar-granite	
				Alkali-granite
			Granite	
				Monzogranite
				Syenogranite
			Granodiorite	
			Leucocratic-granitic	
				Alaskite
				Aplite
				Pegmatite
				Quartz-rich-granitoid
			Tonalite	
				Trondhjemite
		Charnockite		
		Syenitic		
			Alkali-feldspar-syenite	
			Monzonite	
			Quartz-alkali-feldspar-syenite	
			Quartz-monzonite	
			Quartz-syenite	
			Syenite	
		Dioritic		
			Diorite	
			Monzodiorite	
			Quartz-monzodiorite	
			Quartz-diorite	

**APPENDIX 1. LITHOLOGIC DATA DICTIONARY (CONT.)**

Lith1	Lith2	Lith3	Lith4	Lith5
Igneous				
	Plutonic			
		Gabbroic		
			Gabbro	
				Gabbronorite
				Norite
				Troctolite
			Monzogabbro	
			Quartz-gabbro	
			Quartz-monzogabbro	
		Anorthosite		
		Ultramafic		
			Hornblendite	
			Peridotite	
				Dunite
				Kimberlite
			Pyroxenite	
		Foidal-syenitic		
			Foid-syenite	
			Cancrinite-syenite	
			Nepheline-syenite	
			Sodalite-syenite	
		Foidal-dioritic		
		Foidal-gabbroic		
		Foidolite		
		Melilitic		
		Intrusive-carbonatite		
	Hypabyssal			
		Felsic-hypabyssal		
			Hypabyssal-dacite	
			Hypabyssal-felsic-alkaline	
			Hypabyssal-latite	
			Hypabyssal-quartz-latite	
			Hypabyssal-quartz-trachyte	
			Hypabyssal-rhyolite	
			Hypabyssal-trachyte	
		Mafic-hypabyssal		
			Hypabyssal-andesite	
			Hypabyssal-basalt	
			Hypabyssal-basaltic-andesite	
			Hypabyssal-mafic-alkaline	
		Lamprophyre		

**APPENDIX 1. LITHOLOGIC DATA DICTIONARY (CONT.)**

Igneous				
	Volcanic			
		Alkalic-volcanic		
			Basanite	
			Foidite	
			Phonolite	
		Felsic-volcanic		
			Dacite	
			Latite	
			Quartz-latite	
			Quartz-trachyte	
			Rhyolite	
			Trachyte	
		Mafic-volcanic		
			Andesite	
			Basalt	
			Basaltic-andesite	
		Ultramafic		
			Komatiite	
			Picrite	
Metamorphic				
	Amphibolite			
	Eclogite			
	Gneiss			
		Biotite-gneiss		
		Calc-silicate-gneiss		
		Hornblende-gneiss		
		Muscovite-gneiss		
	Granoblastic			
		Granofels		
		Hornfels		
	Granulite			
	Hydrothermally-altered			
		Greisen		
		Keratophyre		
		Skarn		
		Spilite		
	Metaigneous			
		Greenstone		
		Metaintrusive		
			Metaanorthosite	
			Metadiabase	
			Metadiorite	
			Metagabbro	
			Metagranite	
			Metaultramafic	
				Metadunite
				Metaperidotite
				Metapyroxenite

**APPENDIX 1. LITHOLOGIC DATA DICTIONARY (CONT.)**

Metamorphic	Metaigneous			
		Metavolcanic		
			Metarhyolite	
			Metadacite	
			Metaandesite	
			Metabasalt	
		Orthogneiss		
		Serpentinite		
	Metasedimentary			
		Calc-silicate-rock		
		Metacarbonate		
			Marble	
		Metaclastic		
			Argillite	
			Metaconglomerate	
			Metasandstone	
				Metagraywacke
			Metasiltstone	
			Pelitic-schist	
			Phyllite	
			Quartzite	
			Slate	
		Paragneiss		
	Migmatite			
	Schist			
		Amphibole-schist		
		Calc-silicate-schist		
		Mica-schist		
			Biotite-schist	
			Muscovite-schist	
		Quartz-feldspar-schist		
Tectonite				
	Cataclastite			
	Mylonite			
		Phyllonite		
	Melange			
Water				
Ice				
Indeterminate				

## APPENDIX 2. LITHFORM DATA DICTIONARY

Lith1	Lithologic form	Lith1	Lithologic form
Unconsolidated		Igneous	
	Alluvial		Batholith
	Beach		Diabase
	Bed		Dike or sill
	Colluvial		Dome
	Eolian		Flow
	Eolian, loess		Flow, pillows
	Estuarine		Laccolith
	Flow, mass movement		Melange
	Fluvial		Pluton
	Glacial		Pyroclastic
	Glacial, drumlin		Pyroclastic, air fall
	Glacial, esker		Pyroclastic, ash-flow
	Glacial, outwash		Pyroclastic, cinder cone
	Glacial, rock glacier		Pyroclastic, tuff
	Glacial, till		Stock or pipe
	Lacustrine		Volcaniclastic
	Landslide		Volcaniclastic, lahar
	Mass wasting		Volcaniclastic, volcanic breccia
	Solifluction	Metamorphic	
	Swamp		Amphibolite
	Tailings		Amphibolite, epidote-amphibolite
	Terrace		Eclogite
	Terrace, marine		Blueschist
	Terrace, stream		Granulite
Sedimentary			Greenschist
	Bed		Hornfels
	Calcareous		Hornfels, biotite
	Carbonaceous		Hornfels, hornblende
	Coquina		Hornfels, pyroxene
	Deltaic		Hornfels, sanidine
	Dome		Zeolitic (prehnite-pumpellyite)
	Glauconitic	Tectonite	
	Lens		Melange, blocks
	Melange		Melange, matrix
	Olistostrome	Water	
	Reef		Lake, stream, or ocean
	Tuffaceous	Ice	
			Mass