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PRELIMINARY INTEGRATED GEOLOGIC MAP DATABASES FOR THE UNITED STATES:

DIGITAL DATA FOR THE RECONNAISSANCE GEOLOGIC MAP OF THE WESTERN ALEUTIAN ISLANDS, ALASKA

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. The map of the western Aleutian Islands and the accompanying digital files are the result of the compilation and reinterpretation of published and unpublished 1:250,000- and 1:63,360-scale mapping. The map area encompasses the land area of

five 1:250,000-scale quadrangles in extreme western Alaska. Locally, maps from differing sources were incompatible at their boundaries, for example at the southwest end of Kanaga Island; as a result some unit boundaries shown are straight lines, reflecting the boundaries of the sources. The metadata associated with this release will provide more detailed information on sources and appropriate scales for use. Associated attribute databases accompany the spatial database 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.

The reconnaissance geologic map of the western Aleutian Islands is presented at a range of scales, dependent on the detail of the available data. The map area consists of the western end of the Aleutian Island arc, from Great Sitkin and Umak Islands to Attu Island, spanning approximately 500 km (fig. 1). For the most part, mapping of these islands was conducted more than 50 years ago in the late 1940's and early 1950's as part of the USGS Investigations of Alaska Volcanoes project immediately following World War II. Results of these investigations were published as U.S. Geological Survey Bulletin 989-A and in the multiple chapters of Bulletin 1028. A summary of the geology of the Aleutian Islands was written for the Geological Society of America Decade of North American Geology volume on Alaska (Vallier and others, 1994). This publication summarizes the past work and the many topical studies undertaken since the Volcanoes project. In more recent time, the staff of the Alaska Volcano Observatory has begun studies of the active and potentially active volcanic centers in the region, as represented by Waythomas and others (2003) and Miller and others (2003). During the 1980's, a number of topical studies were undertaken in the western Aleutian Islands and these provide most of the data for age control of the rocks in the islands. In the Attu quadrangle, Alaid and Oubeloi Islands, just west of Shemya Island in the Semichi Island group, remain unmapped. On Gareloi and Tanaga Volcanoes, the contacts between map units are slightly modified from Coats (1959a) using data from recent unpublished mapping (Michele Coombs, USGS, written commun., 2005).

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 a field called nsaclass, which is related to the age and lithology of the map units contained on each map. 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, finer separation of map units. Nsaclass is used to cover the entire geologic time scale, whereas qclass is restricted to and provides finer detail for Quaternary map units. 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. Finally, a field called lith2 is in the PAT as a scratch field; no uniform schema has been developed for this field.

The arc attribute table (AAT) stores 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.

The geologic maps on which this compilation is based were published using either a Mercator projection or the Universal Transverse Mercator projection (UTM; Zones 59, 60, and 1), North American Datum 1927 (NAD-27). The spatial databases are provided in the UTM projection 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/.

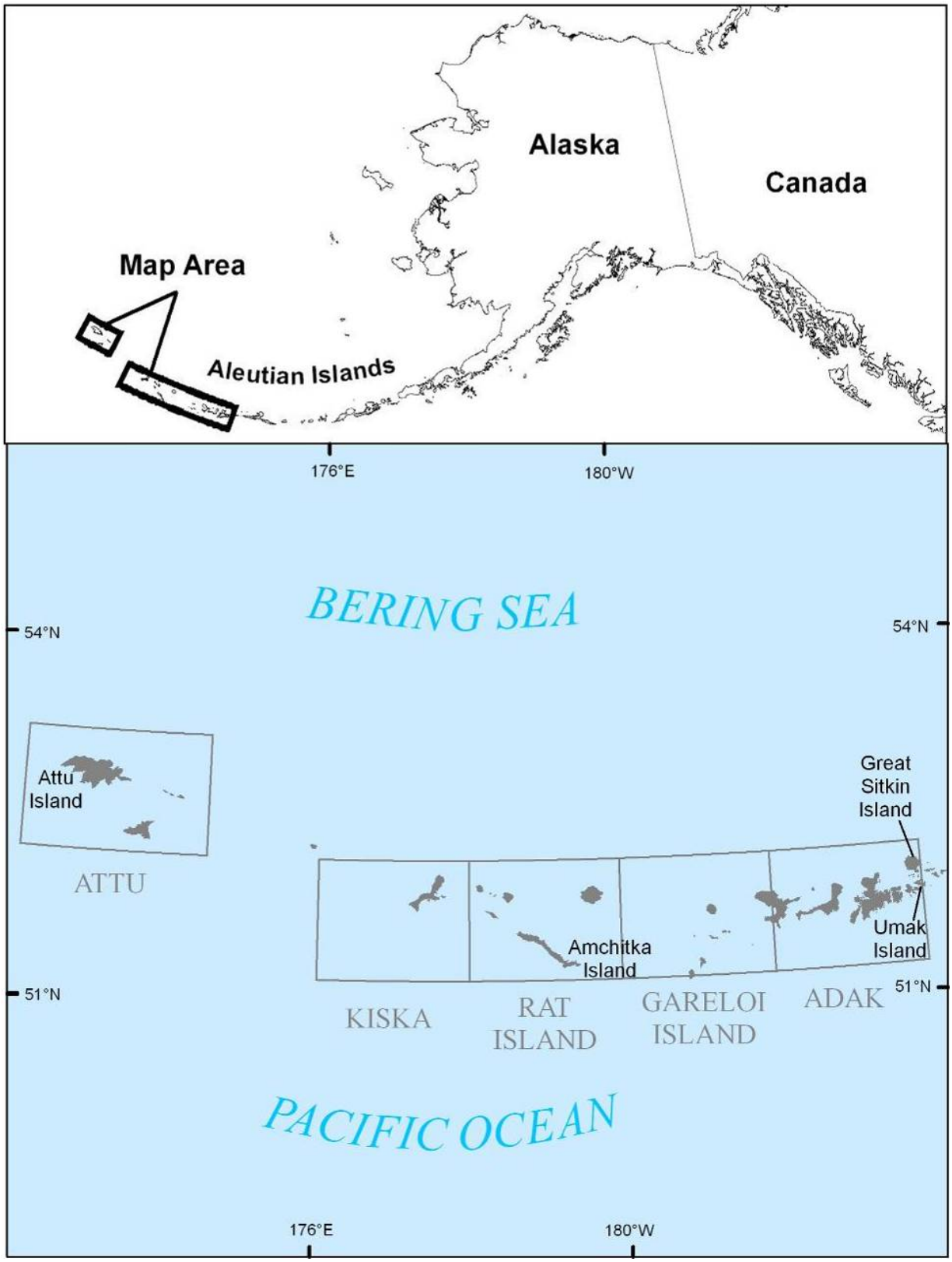

Figure 1. Location of the reconnaissance geologic map of the western Aleutian Islands showing the geographic setting and corresponding 1:250,000 scale quadrangles.

DATABASE TABLES

In order to manage the textural and coding information related to the western Aleutian Islands region geologic map, we have created a series of related and interlinked databases. These databases are a subset of the databases maintained statewide. As provided here, in addition to the native database format files (.fp5), 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 (version 5 or 6) 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. 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 FP5 databases. These fields are *class*, *nsaclass*, *qclass*, *label*, *min_ma*, *max_ma*, and *source*.

Eleven database tables are included here. They are:

WAUNITS: A subset of the statewide database containing abstracted geologic unit descriptions for each source map in the western Aleutian Islands map area. Four .PAT fields, *class*, *nsaclass*, *qclass*, and *source*, mentioned above, are duplicated in this database.

WADESCRIP: Database ties *nsaclass* numbers to the more complete unit descriptions used on the western Aleutian Islands map. Linked to the WAUNITS database through the *nsaclass* field.

WAREFS: Subset of the statewide database containing the references for the source maps of the western Aleutian Islands map. Linked to the WAUNITS database through the *source* field.

NNSAKEY: 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 western Aleutian Islands map. We have provided the symbol and label codes appropriate for the map in the WADESCRIP database. NNSAKEY is linked to the WAUNITS database through the *nsaclass* field. The required ARC/INFO shadesets are not included with this report; please contact the senior author for information on obtaining this shadeset or the color definitions. Alternatively, the statewide shadeset can be downloaded from the following url in the arc-related files section of Wilson and others (1998): http://geopubs.wr.usgs.gov/open-file/of98-133-a/.

NSAQKEY: Database is similar to NNSAKEY but it is used to subdivide the Quaternary surficial deposits by assigning color symbols and labels to the Quaternary units. Linked to WAUNITS through q*class*.

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 WAUNITS database through the *nsaclass* field.

LITHLIST: Database containing all the lithologic terms used in the lithologic coding – duplicated here in Appendix 1 of this document. Linked to the NSALITH database.

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

NSAAGE: Statewide database that provides information to assign specific ages to geologic units. Linked to the WAUNITS database through the *nsaclass* field.

TIME THESAURUS: Database containing the time terms used in age coding of geologic units. Linked to the NSAAGE database.

AGELIST: 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*.

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 that 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 WAunits Solution.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

WAUNITS database

The main database for the project is called WAUNITS. 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, which have different *nsaclass* codes. The standard view (called "GSA color") of the database has portals to three other related databases, NNSAKEY, WAREFS, and NSALITH, which show the related values in these databases. These databases are linked through either the *nsaclass* or *Source* fields in the WAUNITS database. The first seven fields in the database come directly from the source, each of the other fields is assigned either at the time of entry into the database or later.

Table 1. WAUNITS field definitions.

	Field name	Information type	Field type	Links
1	*Quadrangle*	1:250,000–scale quadrangle, with the name fully spelled out. If a map covers multiple quadrangles, each quadrangle will have entries for the appropriate units from that source map in the database.	Text	

Table 1. WAUNITS field definitions (cont.).

	Field name	Information type	Field type	Links
2	*Map unit*	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 overprint patterns (such as limestone lenses in a clastic unit) will have an entry for each variation.	Text	
3	*Unit name*	Map unit name from the source map. If a map is divided in regions, terranes, or allocthons, 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	*Age*	Geologic age of the unit as given in the source. (Note this is age and not 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.	Text	
5	*Description*	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	*Fossil*	Brief notes on any fossil control mentioned on the source map.	Text	
7	*Radiometric age*	Brief notes on radiometric ages.	Text	
8	*Source*	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	WAREFS, Arc coverage

Table 1. WAUNITS field definitions (cont.).

	Field name	Information type	Field type	Links
9	*Rock class*	General classification of unit: Igneous, Sedimentary, Metamorphic, Unconsolidated, or Melange. For mixed units, pick the dominant category.	Text, defined values	
10	*Nsamod*	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 *nsaclass* for the appropriate protolith and have "HFS" selected as *nsamod* value. If only a few polygons of a unit are altered or contact metamorphosed, then the *nsamod* value will be set for those polygons only in the ARC coverage. Queried units, Tk? versus Tk for example, have the same *nsaclass* codes, but Tk? will have "Q" selected as *nsamod* value.	Text, defined values	Arc coverage
11	*Class*	Unique numeric code assigned to each *source* unit. (Unique only within a given quadrangle and specific to each *source*.)	Number	Arc coverage
12	*Nsaclass*	Regional numeric code assigned to like units – the main key field in the database.	Number	Arc coverage, NNSAKEY, NSALITH
13	*Maplabel*	Label used on the western Aleutian Islands map.	Text	WADESCRIP
14	*Qclass*	Similar to *nsaclass*; allows finer subdivision of Quaternary geologic units.	Number	Arc coverage

Using the WAUNITS 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 differing purposes or at different stages of the project.

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 WAUNITS database look into the WADESCRIP, NNSAKEY, NSALITH, NSAAGE, and WAREFS databases, allowing the user to see the linked data applicable to any record.

NNSAKEY database

The second most used database is called NNSAKEY (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 (NNSAKEY) into INFO. The primary field in this database is *nsaclass*, linking it to the WAUNITS database 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. 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 NNSAKEY database provide a view into WAUNITS and back into itself (NNSAKEY). 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 ostensibly has 999 colors, in reality, only about 130 can be distinguished by eye on plots. As a result, a color will get assigned to more than one unit and overprint patterns must be used to distinguish subsets. The ARC/INFO Shadeset used can be downloaded from the following url in the arc-related files section of (Wilson and others, 1998): http://geopubs.wr.usgs.gov/open-file/of98-133-a/. The NNSAKEY 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. NNSAKEY field definitions

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

WADESCRIP database

This database (Table 3) ties *nsaclass* numbers to the more complete unit descriptions used on the western Aleutian Islands map and it is linked to the WAUNITS database through the *nsaclass* field. This database has portals into WAUNITS and NNSAKEY databases. The ARC/INFO Shadeset used can be downloaded from the following url in the arc-related files section of (Wilson and others, 1998): http://geopubs.wr.usgs.gov/open-file/of98-133-a/ .

Table 3. WADESCRIP field definitions

	Field name	Information type	Field type	Links
1	*Label*	Map unit label as used on the western Aleutian Islands map.	Text	
2	*Name*	Map unit name as used on the western Aleutian Islands map.	Text	
3	*Nsaclass*	Regional numeric code assigned to like units – the main key field in the database.	Number	WAUNITS, NNSAKEY
4	*Age*	Assigned age (range).	Text	
5	*Description*	Full text of unit description as used on the western Aleutian Islands map.	Text	
6	*Sources*	Source for unit descriptions, in this case, the western Aleutian Islands map.	Text	
7	*Symbol*	The color number used, derived from an ARC/INFO shadeset. Included here because a custom color assignment was used that differs from NNSAKEY.	Number	
8	*Overprnt*	The pattern number used, also derived from an ARC/INFO shadeset. Included here because a custom color assignment was used that differs from NNSAKEY.	Number	

WAREFS database

The WAREFS 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. This database has a portal into WAUNITS, showing the units from any given source in the WAUNITS database.

Table 4. WAREFS field definitions

	Field name	Information type	Field type	Links
1	*Source*	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	WAUNITS, Arc coverage
2	*Refnum*	A unique tracking number assigned by the database software to each reference.	Number, auto entry	
3	*Reference*	The 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 NNSAKEY but it is used to subdivide the Quaternary surficial deposits by assigning color symbols and labels to the Quaternary units. The table is 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	*Symbol*	Color number used, derived from an ARC/INFO shadeset.	Number	
2	*Overprnt*	Pattern number used, also derived from an ARC/INFO shadeset.	Number	
3	*Unit Label*	Map label printed on map products.	Text	
4	*Nsaclass*	Regional numeric code assigned to like units – the main key field in the database.	Number	
5	*Qclass*	Numeric code used to subdivide surficial deposits.	Number	WAUNITS, Arc coverage
6	*Geologic Unit*	Brief (5-10 words) summary of unit on a regional basis.	Text	
7	*Sources*	Sources containing the unit and name of unit on original source map.	Text	

NSALITH database

The NSALITH database (Table 6) contains lithologic coding for each *nsaclass* in the database. It uses a lithologic dictionary that is contained in special linked database tables called LITHLIST and LITHFORM (listed as 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 WAUNITS 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 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 “failsafe” 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	*Nsaclass*	Regional numeric code assigned to like units – the main key field in the database.	Number	WAUNITS

Table 6. NSALITH field definitions (cont.)

	Field name	Information type	Field type	Links
2	*Lith1*	Highest level lithologic classification.	Text, value list	
3	*Lith2*	Next level lithologic classification, values are based on the value of *lith1* field.	Text, value list	
4	*Lith3*	As above, based on the value of *lith2* field.	Text, value list	
5	*Lith4*	As above, based on the value of *lith3* field.	Text, value list	
6	*Lith5*	As above, based on the value of *lith4* field.	Text, value list	
7	*Form*	Description of form of units, derived from a list based on the value of *lith1* field.	Text, value list	
8	*Rank*	Values allowed are: Major, Minor, Incidental, and Indeterminate (major).	Text, value list	
9	*Lithology*	This is a field from an earlier lithologic classification and is generally not used.	Text	
10	*Percent*	Optional field containing an estimate of percent of unit that given lithology represents. This information is rarely available in Alaska.	Number	
11	*Comment*	Free form comment field – optional.	Text	
12	*Record_no*	Unique tracking number assigned by the database software to each record.	Number, auto entry	
13	*Totallith*	Text string that combines the terms in all of the *lith* 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 AGELIST database table) derived from the 1983 DNAG time scale (Geological Society of America, 1983) to assign maximum and minimum ages (using the TIME THESAURUS database) to geologic units. 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 WAUNITS database will list 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	*Nsaclass*	Regional unit code as used above.	Number	WAUNITS, Arc coverage
2	*Unit_link*	Field only used in the conterminous US and is similar in some respects to *nsaclass* (included for compatibility with Conterminous US databases).	Text	(Conterminous US databases)
3	*Min_eon*	Minimum or youngest age assignment for the eon of the unit, based on current geologic interpretation.	Text, value list	
4	*Min_era*	As above, for era.	Text, value list	
5	*Min_period*	As above, for period.	Text, value list	
6	*Min_epoch*	As above, for epoch.	Text, value list	
7	*Min_age*	As above, for age.	Text, value list	
8	*Full_min*	Complete, concatenated minimum age assignment.	Text, auto entry	
9	*Max_eon*	Maximum or oldest age assignment for the eon of the unit, based on current geologic interpretation.	Text, value list	
10	*Max_era*	As above, for era.	Text, value list	
11	*Max_period*	As above, for period.	Text, value list	
12	*Max_epoch*	As above, for epoch.	Text, value list	
13	*Max_age*	As above, for age.	Text, value list	
14	*Full_max*	Complete, concatenated maximum age assignment.	Text, auto entry	
15	*Type*	Unit age assigned relatively (stratigraphic position or fossils) or absolutely (radiometric age).	Text, value list (Relative or Absolute)	
16	*Cmin_age*	The most precise minimum age coded, derived from the *full_min* field.	Text, auto entry	

Table 7. NSAAGE field definitions (cont.)

	Field name	Information type	Field type	Links
17	*Cmax_age*	The most precise maximum age coded, derived from the *full_max* field.	Text, auto entry	
18	*Min_Ma*	Numeric, either from the DNAG table or radiometric determinations.	Number, auto entry	
19	*Max_Ma*	Numeric, either from the DNAG table or radiometric determinations.	Number, auto entry	
20	*Age_comments*	Free form comment field – optional.	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		
			Alkalli-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		
	Argillite		
	Eclogite		
	Gneiss		
		Orthogneiss	
		Paragneiss	
	Granofels		
	Granulite		
	Greenstone		
	Hornfels		
	Marble		
	Metasedimentary		
	Metavolcanic		
	Migmatite		
	Phyllite		
	Quartzite		
	Schist		
	Serpentinite		
	Skarn		
	Slate		
Tectonite			
	Cataclastite		
	Mylonite		
		Phyllonite	
	Melange		
Water			
Ice			
Indeterminate			

APPENDIX 2. LITHFORM DATA DICTIONARY

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