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Alaska Geochemical Database Version 2.0 (AGDB2)—Including “Best Value” Data Compilations for Rock, Sediment, Soil, Mineral, and Concentrate Sample Media

Data Series 759

U.S. Department of the Interior
U.S. Geological Survey

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft.)	0.3048	meter (m)

SI to Inch/Pound

Multiply	By	To obtain
	Volume	
liter (L)	0.2642	gallon (gal)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz.)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F=(1.8×°C)+32

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C=(°F-32)/1.8

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

List of Acronyms

AA	atomic absorption spectrometry
AGDB	Alaska Geochemical Database (USGS Data Series 637)
AGDB2	Alaska Geochemical Database Version 2.0
AES	inductively coupled plasma-atomic emission spectrometry
AMRAP	Alaska Minerals Resource Assessment Program
CM	colorimetric spectrophotometry
DCP	direct-current plasma atomic emission spectrometry
EDX	energy dispersive X-ray fluorescence spectrometry
ES	direct current-arc emission spectrography
FA	fire assay
HSSR	Hydrogeochemical and Stream Sediment Reconnaissance
LIMS	Laboratory Information Management System
LLD	lower limit of determination
MDIRA	Minerals Data Information Rescue in Alaska
MS	inductively coupled plasma-mass spectrometry
NA	instrumental neutron activation analysis
NGDB	National Geochemical Database
NURE	Atomic Energy Commission National Uranium Resource Evaluation
PLUTO	in-house USGS geochemistry database used from mid-1970s through the mid-1990s
RASS	USGS Rock Analysis Storage System
REE	rare-earth elements
USGS	U.S. Geological Survey
WDX	wavelength dispersive X-ray fluorescence spectrometry
XRF	X-ray fluorescence spectrometry

Useful websites:

USGS main webpage...
http://www.usgs.gov/
USGS publications search page ....
http://pubs.er.usgs.gov/
USGS Alaska Science Center..
http://alaska.usgs.gov/
USGS Mineral Resources On-line Spatial Data...
http://mrdata.usgs.gov/
USGS Open-File Report 99-433, Rock Analysis Storage System (RASS)...
http://pubs.usgs.gov/of/1999/of99-433/
USGS Open-File Report 97-492, National Geochemical Database (NURE, HSSR)...............................
http://pubs.usgs.gov/of/1997/ofr-97-0492/
USGS Data Series 637, Alaska Geochemical Database (AGDB) ....
http://pubs.usgs.gov/ds/637/
Alaska Department of Natural Resources...
http://dnr.alaska.gov/

Alaska Geochemical Database Version 2.0 (AGDB2)—Including “Best Value” Data Compilations for Rock, Sediment, Soil, Mineral, and Concentrate Sample Media

By Matthew Granitto, Jeanine M. Schmidt, Nora B. Shew, Bruce M. Gamble, and Keith A. Labay

Abstract

The Alaska Geochemical Database Version 2.0 (AGDB2) contains new geochemical data compilations in which each geologic material sample has one “best value” determination for each analyzed species, greatly improving speed and efficiency of use. Like the Alaska Geochemical Database (AGDB) before it, the AGDB2 was created and designed to compile and integrate geochemical data from Alaska in order to facilitate geologic mapping, petrologic studies, mineral resource assessments, definition of geochemical baseline values and statistics, environmental impact assessments, and studies in medical geology. This relational database, created from the AGDB that was released in 2011, serves as a data archive in support of present and future Alaskan geologic and geochemical projects, and contains data tables in several different formats describing historical and new quantitative and qualitative geochemical analyses. The analytical results were determined by 85 laboratory and field analytical methods on 264,095 rock, sediment, soil, mineral and heavy-mineral concentrate samples. Most samples were collected by U.S. Geological Survey (USGS) personnel and analyzed in USGS laboratories or, under contracts, in commercial analytical laboratories. These data represent analyses of samples collected as part of various USGS programs and projects from 1962 through 2009. In addition, mineralogical data from 18,138 nonmagnetic heavy-mineral concentrate samples are included in this database. The AGDB2 includes historical geochemical data originally archived in the USGS Rock Analysis Storage System database, used from the mid-1960s through the late 1980s and the USGS PLUTO database used from the mid-1970s through the mid-1990s. All of these data are currently maintained in the National Geochemical Database (NGDB). Retrievals from the NGDB were used to generate most of the AGDB data set. These data were checked for accuracy regarding sample location, sample media type, and analytical methods used. This arduous process of reviewing, verifying and, where necessary, editing all USGS geochemical data resulted in a significantly improved Alaska geochemical dataset. USGS data that were not previously in the NGDB because the data predate the earliest USGS geochemical databases, or were once excluded for programmatic reasons, are included here in the AGDB2 and will be added to the NGDB. The AGDB2 data provided here are the most accurate and complete to date, and should be useful for a wide variety of geochemical studies. The AGDB2 data provided in the linked database may be updated or changed periodically.

Introduction

The U.S. Geological Survey (USGS) began scientific investigations in Alaska in 1889, shortly after its purchase from the Russian Empire in 1867, but much Alaskan scientific data had not always been readily accessible to the public. The USGS participated in the Congressionally-funded, multi-agency Minerals Data Information Rescue in Alaska (MDIRA) Program from 1997 to 2003 in order to make its Alaska scientific data digital, correct, user-friendly, and accessible. The MDIRA program and subsequent efforts resulted in release of the Alaska Geochemical Database (Granitto and others, 2011; Granitto and others, 2012). The Alaska Geochemical Database (AGDB) provided comprehensive data on the analytical chemistry, mineralogy, and characteristics of geologic materials collected in Alaska from 1962–2009. Because of the complexity and diversity of the data, the Alaska Geochemical Database

Version 2.0 (AGDB2) presented here contains new geochemical data compilations in which each geologic material sample has one “best value” determination for each analyzed species, greatly improving speed and efficiency of use.

The AGDB2 includes analyses of rocks, sediments (collected from streams, lakes, and various sources), soils, minerals, and heavy-mineral concentrates (derived from stream sediments, soils or rocks) compiled in part during the MDIRA process (Bailey and others, 1999), together with analyses of a variety of geologic materials from 1996 through 2010. Many of the analyses were the result of mineral resource investigations conducted by the Alaska Mineral Resource Assessment Program (AMRAP) in the mid-1970s through early 1990s; some of the data were produced in support of other USGS programs such as National Geologic Mapping, Volcano Hazards, Development of Assessment Techniques, and Energy Resources.

Most of these data were originally entered into the USGS Rock Analysis Storage System (RASS) or PLUTO databases. The RASS database, which contained over 730,000 data records, was used by the USGS Geologic Division from the late 1960s through the late 1980s to archive geochemical data produced by the Branch of Exploration Services primarily from mineral resource studies. The PLUTO database, which contained over 530,000 data records, was used by the USGS Geologic Division from the late 1960s through 1997 to archive geochemical data from the Branch of Analytical Chemistry and successor branches. More recent geochemical data are presently stored in the commercial Laboratory Information Management System (LIMS) database (1996 to present). Data from these databases have been merged and are maintained in the Oracle-based National Geochemical Database (NGDB; available at *http://mrdata.usgs.gov/*) which currently contains nearly 2 million data records. Many of these determinations have been previously published in hardcopy or digital USGS Open-File Reports by the original sample submitters or analysts; however, some have never before been published.

These data were generated over a span of nearly 50 years from 1962 to 2010 in USGS laboratories or, under contracts, in commercial analytical laboratories. Upon completion of the sampling and analysis, data for the original RASS and PLUTO databases were keypunched for digital storage. Automated data entry from a LIMS was begun in the late 1980’s in the PLUTO database. Over the years, USGS scientists recognized several problems with the databases. Three primary issues were: (1) erroneous or missing sample locality coordinates, (2) sample media were often not adequately identified, and (3) analytical methods were poorly identified (often missing from the early PLUTO database structure). Beginning in 1998, a major review of Alaska samples from these databases was initiated to confirm sample and lab numbers for analyses, correct errors in sample site locations, add sample site locations when missing, and to correctly identify the sample media and analytical protocols for each record. This re-processing consisted of comparing the recorded digital information to the information found in original sample submittal forms, the original analytical reports, published reports, field notebooks and field sheets (sample locality maps), and follow-up discussions with submitters and analysts (when available). As necessary, additional data fields were added to the database structure to more fully describe sample preparation methods and sample media. Geochemical datasets that were not entered in RASS and PLUTO during the re-processing have been incorporated into the AGDB2 database, resulting in the addition of thousands of sample data records to the NGDB. The RASS and PLUTO analytical data were not checked in great detail, but obvious errors were corrected. Discussion of these corrections and additions is found in Appendix 3 of Granitto and others, 2011.

The AGDB2 is the most current, complete, and accurate data compilation for new and historical geochemical analyses of rock, sediment, soil, and concentrate samples. The AGDB2 also contains mineralogical information from optical examination of the nonmagnetic fractions of heavy-mineral concentrate samples. In addition, geochemical data from reanalyses of sediment samples collected under the Atomic Energy Commission National Uranium Resource Evaluation (NURE) Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) program (henceforth called NURE), and reanalyses (2007–2009) of AMRAP sediment samples from the Alaska Range have been included in the AGDB2. Data from other recent projects in Taylor Mountains Quadrangle, southwestern Alaska, Fortymile district, and statewide Surveys and Analysis are also included in the AGDB2.

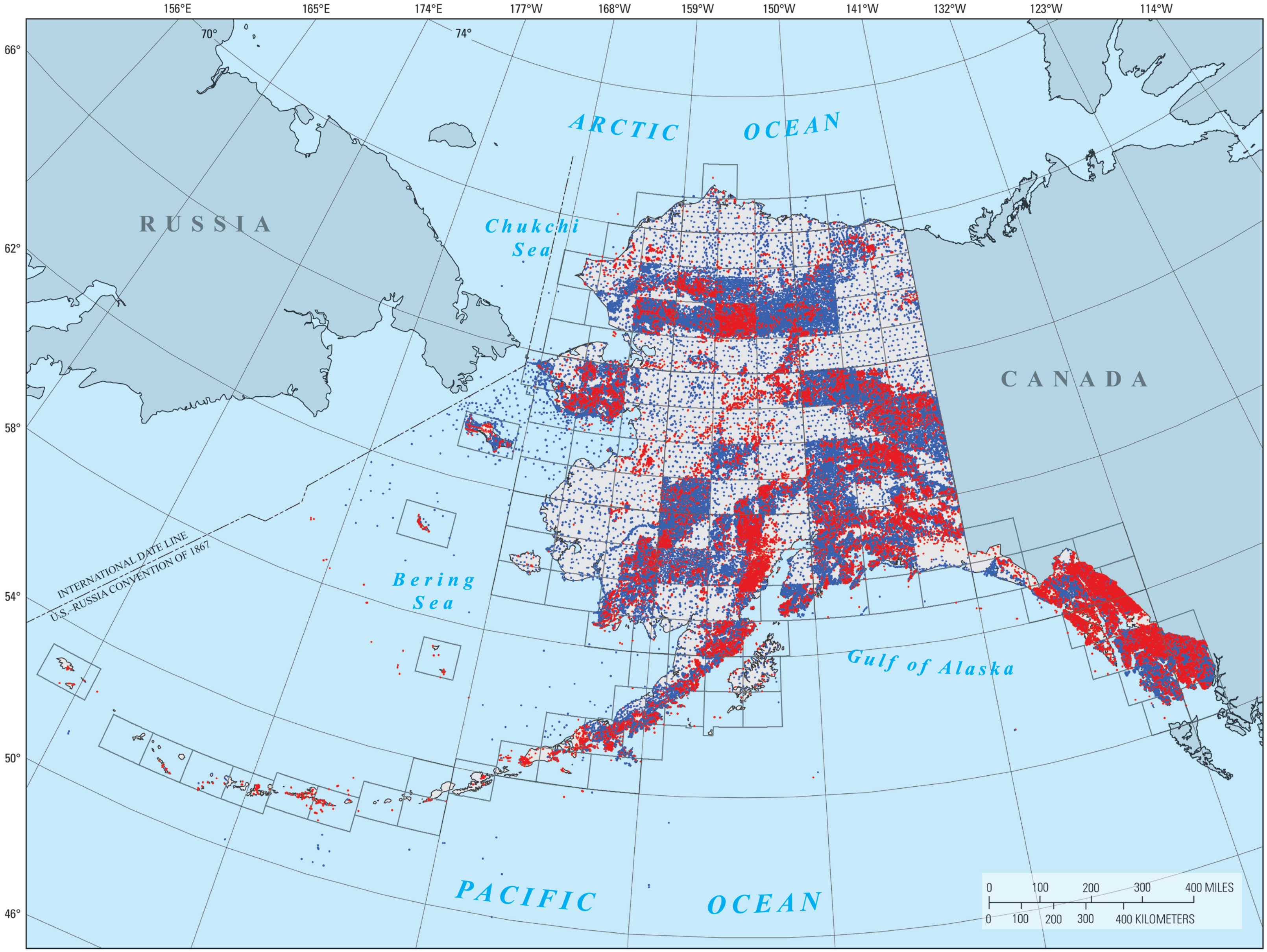
Geographic Setting

The geographic boundaries of the AGDB2 include all of Alaska as well as Federal and International waters of the Arctic and Pacific Oceans that are reasonable for inclusion. The current AGDB data extents are 71.6000°N. latitude, 50.1834°N. latitude, 129.9939°W. longitude, and 173.1°E. longitude (fig. 1).

Methods of Study

Sample Media and Collection

Analyses of 108,966 rock samples, 92,694 sediment samples, 6,869 soil samples, 7,470 mineral samples, and 48,096 heavy-mineral concentrate samples are incorporated into the AGDB2. Samples in the AGDB2 were collected between 1962 and 2009 and prepared according to a variety of USGS standard methods (variously described in Arbogast, 1990, 1996; Miesch, 1976; Taggart, 2002) or by NURE methods (described in Smith, 1997). The database includes analyses of 1,589 stream-sediment samples, originally collected during the USGS Heavy Metals and AMRAP programs (1966–1995), and reanalyzed during 2007–2010 by the Federal Lands in



Base modified from the Alaska Department of Natural Resources. The U.S.–Russia Convention of 1867 line is adapted from the U.S. Dept. of State Treaty Document 101–22, available at *http://www.state.gov/documents/organization/125431.pdf.* Boundary is approximate and for display purposes only.

Figure 1. Geographic area covered by **Alaska Geochemical Database Version 2.0.** The state of Alaska is in the center of the map. Gray rectangles are the 1:250,000 topographic quadrangle outlines. The red dots are sediment, soil, and heavy-mineral concentrate sample localities. The blue dots are rock and mineral sample localities.

Alaska-Geologic Studies project (Bailey and others, 2010; Gamble and others, 2010); analyses of 3,015 rock, sediment, soil, mineral, and concentrate samples collected during the 2004–2010 Taylor Mountains quadrangle project (Bailey and others, 2007; Klimasauskas and others, 2007; Klimasauskas, Miller, Bradley, Bundtzen and others, 2006; Klimasauskas, Miller, Bradley, Karl and others, 2006); data from 6,686 NURE sediment samples that were reanalyzed, including, in part, 4,804 for the National Geochemical Survey project between 1998–2008 (U.S. Geological Survey, 2004) and 1,640 for AMRAP projects; and analyses of 536 rock, sediment, and soil samples collected during the 2007–2009 Concealed Deposits—Pebble Cu-Au-Mo porphyry deposit project (Anderson and others, 2011; Fey and others, 2009, 2008). Existing NGDB data from Alaskan water, leachate, and organic samples (including humus and peat) have been excluded from this database but are planned to be compiled, verified, and included in a later version of the AGDB.

Analytical Techniques

Eighty-five different field and laboratory analytical methods were used to produce geochemical data included in the AGDB2. These methods reflect the evolution of analytical chemistry from 1960 to 2009. Appendix 1 provides a complete list of the analytical methods included in the AGDB2 and descriptive information for each. The **AnalyticMethod** table in the AGDB2 provides detailed information about techniques and the **AnalyticMethodBiblio** table contains citations for the analytical methods.

Quality Assurance/Quality Control

Quality assurance and quality control (QA/QC) procedures varied over the time of AGDB2 sample processing and analysis, and are not included in this database. Data from field sample-site duplicates and analytical replicates (splits of a single sample to check laboratory precision) are included in the database. USGS and contract laboratories reporting these analyses use constituent standards (for example, USGS geochemical reference rock standard STM–1, nepheline syenite) and blanks for their internal QA/QC controls (Arbogast, 1990; Taggart, 2002). Data for commonly used reference samples are described at (*http://minerals.cr.usgs.gov/geo_chem_stand/*).

“Best Value” Concept

The comprehensive nature of the first AGDB (Granitto and others, 2011) meant that it included as many as four separate values for a given element, where samples were analyzed by multiple analytical methods. The AGDB contained 7,346,935 cases where there is only one determination of a given species (element) for a given sample record; 1,086,397 cases with two determinations; 54,761 cases with three determinations; and 3,998 matches where there are four different determinations of a given species for a given sample record. Species that have the most multiple determination matches are Ag, As, Au, Bi, Cd, Cu, Mo, Pb, Sb, and Zn. While these comprehensive data are complete, for many users such multiple analyses raise difficult questions of which value to use in their work.

This Alaska Geochemical Database Version 2.0 (AGDB2) includes a subset of data that represents one “best value” per species for each of its samples. Where used in this report, the term “best value” means that single value per element per sample chosen by the rubric and reasoning described below. This rubric was designed to provide the best values for mineral exploration and assessment purposes and should not be assumed to be appropriate for other purposes (for example, evaluation of environmental background and baseline geochemical values would require development of a different “best value” ranking). The best values subset greatly reduces the total number of determinations a user must consider for a given sample, and facilitates use of the AGDB for geochemical mapping, data synthesis, and regional evaluation in Alaska.

Determining “Best Value” Rankings

Different analytical determinations of the same element for any given sample do not have equal value to a user for different purposes. Some analytical methods result in values that are more quantitative, precise, or accurate than others. When developing a ranking of methods best for any particular use it is necessary to take into account factors which vary between analytical methods. These include weight of sample analyzed, method of decomposition of the sample during the preparation for analysis, sensitivity and accuracy of the instrument used in each method, upper and lower limits of detection for a given element by a given method, the age of the method and stage of its development when a specific analysis was performed, and the exact analytical laboratory and equipment used. Creation of the AGDB2 “best value” subset followed a rubric or decision tree that considered all these factors in ranking the analytical methods in the AGDB2 to determine methods most useful to mineral resource evaluation.

Sample Weight

The amount of sample required for analysis varies widely between methods. On the high end, 15 to 30 grams (g) of sample are needed to determine gold or the platinum group elements by fire assay (FA) methods, and 10 to 15 g for the detection of Au by atomic absorption spectrometry (AA) or direct-current plasma (DCP). On the low end, only 10 milligrams (mg) of sample are needed for direct-current arc emission spectrography (ES), a method that was used to detect concentrations of 33 to 65 elements. In general, larger sample aliquots provide a more accurate assessment of a sample’s chemical makeup, so determinations by ES, for example, are less quantitative than those by analytical methods that require larger sample amounts.

Sample Decomposition

The methods used to decompose a geologic sample to be analyzed vary by material (for example, rock vs. soil) and effectiveness, and are an important factor to consider in determining "best" methods. In general, methods which digest or dissolve a sample vary from near total ("complete") to partial decomposition of a sample. The AGDB2 does not include results from any analytical methods that use passive or weak leaches of geologic material samples. Decomposition methods that result in complete or near complete digestion are herein referred to as "total." Instrumental neutron activation analysis (NA) and energy dispersive X-ray fluorescence spectrometry (EDX), which comprises 3.3 percent of AGDB2 analyses, are non-destructive techniques that analyze the entire sample without requiring digestion, and thus usually represent the best total decomposition of the sample. Wavelength dispersive X-ray fluorescence spectrometry (WDX), inductively coupled plasma-atomic emission spectrometry (AES), inductively coupled plasma-mass spectrometry (MS), atomic absorption (AA), and colorimetric spectrophotometry (CM), which comprise 5.2 percent of AGDB2 analyses, employ various highly effective fusion or sinter digestions that yield near "total" analyses of the elements of interest, but may drive off volatile elements such as As, Hg, S, Sb, or Te in the process. AES, MS, AA, and CM may also employ strong acid digestions that provide for virtually complete decomposition. A common "total" acid digestion technique using a four-acid solution (HF, $HClO_4$, HNO_3, and HCl) is sufficient for many elements of interest, but may not be effective in putting Ba, Cr, Hf, Nb, Sc, Sn, Ta, Ti, W, Zr, and rare-earth elements (REEs) into solution. Decomposition techniques that employ HF account for 10.9 percent of AGDB2 analyses. Partial-digestion acid solution methods and partial fusion methods (9.5 percent of AGDB2 analyses) are moderately effective for some elements but ineffective for others. Most analytical methods are designed for the detection of one or a specific suite of elements and employ decomposition techniques suitable for those elements at the expense of accurate determinations of other elements.

Analytical Instrumentation

The sensitivity and reliability of individual analytic instruments is another factor which affects the method's ranking in the "best values" rubric. The instruments most commonly used for analysis of Alaskan samples are: (1) ES, 69.1 percent of the determinations, (2) AES, 14.7 percent, (3) AA, 6.3 percent, (4) XRF (X-ray fluorescence spectrometry), 3 percent, (5) MS, 2.9 percent, and (6) NA, 2.3 percent. For the determination of most elemental concentrations, NA, AES, MS, and XRF are more sensitive and more quantitative than ES which was usually employed as a semi-quantitative method of determination. In general, newer models of instruments are more sensitive than older ones. For some instruments, spectral interferences, background shifts, matrix effects, and mineralogical and other structural effects cause some element determinations to be less accurate than others. Analytical methods that use WDX spectrometers have developed modifications in sample decomposition, or correction factors that yield more accurate chemical determinations (Taggart and others, 1987).

Limits of Detection

The lower limit of determination (LLD) is the lowest quantity of a substance that can be distinguished from the absence of that substance within a stated confidence limit (Taggart, 2002). As an analytical method becomes more sensitive and can detect lower elemental concentrations, its LLD moves lower. One analytical method may have multiple LLDs for a single element in the database due to preconcentration or dilution of a specific sample, improved sensitivity as newer models of instruments are used, varying dates of analysis for the same method, or different analytical laboratories using varying procedures for the same analytical method. The presence of interfering elements also can affect the LLD. Upper limits of detection are the highest quantity of an analyte that can be determined within a stated confidence limit without further dilution of the digestate. The methods and procedures of USGS laboratories and USGS-contracted laboratories reported in AGDB2 are comparable, since contract laboratories are held to USGS quality assurance and quality control standards.

Review of Analytical Methods

A thorough understanding of all USGS analytical protocols used over the past 50 years was crucial in verifying the chemical analytical data in the AGDB. From 1998 through 2010, analytical method publications from the 1950's to the present were compiled (see table **AnalyticMethodBiblio** in the AGDB2), and chemists knowledgeable in various methods were frequently queried through phone calls, emails, and personal visits. These efforts were continued when developing the AGDB2 in order to capture the details of analytical methods to rank methods on an element by element basis. In December 2011, USGS emeritus chemists James G. Crock, Paul J. Lamothe, and Richard M. O'Leary, representing more than 110 cumulative years of USGS operational and research chemistry (1970 through 2012) along with senior author Matthew Granitto, systematically ranked all the AGDB species and elements by the quality of the analytical methods used. This ranking has since been refined and contributed significantly to the creation of the AGDB2 "best values" subset. Other chemists who have contributed to AGDB efforts over the past 14 years are Philip A. Baedecker, William M. Benzel, Zoe Ann Brown, James R. Budahn, Robert R. Carlson, LaDonna M. Choate, Anthony F. Dorrzapf, Michael W. Doughten, David L. Fey, Philip L. Hageman, Larry L. Jackson, Allen L. Meier, Stephen J. Sutley, Joseph E. Taggart, Jr., and Stephen A. Wilson.

“Best Value” Ranking Tables

The review of analytical methods discussed above resulted in a series of tables (**BestValue_Rank.xlsx**) which rank, from best to least preferred, the analytical methods that produced the “best values” for each element within the AGDB2. The ranking for each element contains two subsets—methods that employ “total” decomposition techniques (for example, rated as “01”) are listed above, and separate from methods that use partial decomposition techniques (for example, “P01”). The method ranking tables are compiled in the AGDB2 as the table **Parameter_Rank**, and as the Excel spreadsheet Parameter_Rank.xlsx.

The method ranking tables for each element contain the same field names (column headers). *SPECIES* is the chemical entity for which samples have been analyzed. *PARAMETER* is a concatenation of the fields *SPECIES*, *UNITS*, *TECHNIQUE*, *DIGESTION*, and sometimes *DECOMPOSITION* from the AGDB2. *ANALYTIC_METHOD* contains the short name of the analytical method as used in the AGDB. *BESTVALUE_RANK* is the numeric ranking of the analytical methods used in the determination of each species. *NONDETECT_RANGE* contains the range of non-detect values for the analytical method. Wherever the species concentration is lower than the LLDs of the method used, yielding a negative value entry in the *QUALIFIED_VALUE* field of the **Chem2** table in the AGDB2, the *NONDETECT_RANGE* value equals the LLD for that method. Non-detect values of a method vary due to sample preconcentration or dilution, instrumental sensitivity, the laboratory performing analyses, or the date of analysis. Non-detect ranges in parentheses represent approximately 90 percent of the non-detects in the AGDB2 for that analytical method species combination. Non-detect ranges such as “< 0.28” indicate that no non-detects were encountered, and that 0.28 was the lowest detected value in the AGDB2 for that particular analytical method and species. The field *LLD_RANGE* is the range of LLDs reported in USGS publications or in-house laboratory manuals, and does not represent actual analytical determinations in the AGDB2. The entry “na” indicates that no published LLD was found for the analytical method and species. *NONDETECT_RANK* is the ranking of LLD entries in *LLD_RANGE.* No distinction is made between methods employing total or partial digestion, and *NONDETECT_RANK* reflects only the sensitivity of the method in recognizing the presence of the species. The field *RANK_COUNT* contains the total number of determinations of each species in the AGDB2 by the analytical method listed. Further method information is available in the field *ANALYTIC_METHOD_DESC* of the **AnalyticMethod** table.

Characteristics of the Relational Database

Because of the scope and complexity of the Alaskan geologic materials analyzed, a tabular relational database which records both field site and sample observations and laboratory analyses was designed for data storage. The AGDB2 was constructed in Microsoft Access 2010 as an archive and a tool to be used for data synthesis and analysis. The database structure and format are a modification of that used by the National Geochemical Database (NGDB) because more than 85 percent of the data were originally retrieved from the NGDB (Smith and others, 2003).

Contents

The AGDB2 (2.34 gigabytes) comprises two linked databases, AGDB2.accdb and AGDB2_Chem.accdb, to accommodate the Microsoft Access limitation of 2 gigabytes for a single database. Data are contained in 12 tables, which are described in table 1of this report pamphlet. The six primary database tables contain quantitative analytical results, sample data, field site information, geologic and mineralogic data. Analytical method information and analytical method bibliography core-lookup tables provide references for quantitative results. A reference table of field name definitions assists the user in understanding the names and content of database fields. In this report, names of tables cited are in boldface; field names within tables are italicized.

Structure

AGDB2 data are contained in six primary tables, **Geol2, Chem2**, **BestValue_Ag_Mo**, **BestValue_Na_Zr**, **BestValue_WholeRock**, and **Mnrlgy**, and relationships are defined to link these tables (fig. 2). This structure provides for efficient storage of information and for data verification. Relationships between these tables are depicted as lines in figure 2. **Geol2** is linked to **Chem2** by the common field (*LAB_ID*). Therefore, all chemical values have corresponding sample information in **Geol2**. This is a one-to-many relationship; that is, a single sample may have many analytical results (for example, different elements, same element by multiple methods, and so forth). **Geol2** is also linked to **BestValue_Ag_Mo** by the common field *LAB_ID* since chemical values cannot exist without corresponding sample information in **Geol2**. This is a one-to-one relationship; that is, a single sample record in **Geol2** has one or more analytical results

Table 1. Tables of **Alaska Geochemical Database Version 2.0.**

Table name	Type	Description	Primary key field	Fields	Records
Geol2	Primary	Spatial, geologic, and descriptive attributes for heavy mineral concentrate, mineral, rock, bulk sediment, and soil samples	LAB_ID	42	264,095
Chem2	Primary	All chemical data compiled for heavy mineral concentrate, mineral, rock, bulk sediment, and soil samples	CHEM_ID	13	9,699,962
BestValue_Ag_Mo	Primary	"Best value" chemical data - silver through molybdenum - for heavy mineral concentrate, mineral, rock, bulk sediment, and soil samples	LAB_ID	130	264,095
BestValue_Na_Zr	Primary	"Best value" chemical data - sodium through zirconium - for heavy mineral concentrate, mineral, rock, bulk sediment, and soil samples	LAB_ID	118	264,095
BestValue_WholeRock	Primary	"Best value" chemical "whole rock" data for heavy mineral concentrate, mineral, rock, bulk sediment, and soil samples	LAB_ID	145	264,095
Mnrlgy	Primary	Mineralogy data for non-magnetic heavy mineral concentrate samples	LAB_ID	28	18,138
AnalyticMethod	Primary-lookup	Analytic methods used to obtain chemical and physical data	ANALYTIC_METHOD	4	85
AnalyticMethodBiblio	Primary-lookup	References for analytic methods used to obtain chemical data	ANALYTIC_METHOD_PUB_ID	9	753
MnrlName	Primary-lookup	Mineral name abbreviations used in Mnrlgy table	MNRL_ABBRV	2	126
Parameter	Primary-lookup	Analytical method parameters used to obtain chemical and physical data	PARAMETER	3	989
Parameter_Rank	Primary-lookup	Analytical method parameters ranked by species	PARAMETER	11	847
FieldNameDictionary	Reference	Field name descriptions for all tables in the database	FIELD_NAME	5	496

in the chemical data tables. **Geol2** is also linked to **Mnrlgy** by the common field *LAB_ID* in a one-to-one relationship; that is, every sample with mineralogical data has geospatial and sample media data in **Geol2**. Data may be extracted from the AGDB2 to meet specific user needs by constructing user-defined queries.

Relationships between **Geol2** and other tables in the AGDB2 are shown in figure 2. **Geol2** contains 264,095 records, and has 42 fields describing sample sites and the sample material collected at each site. Each analyzed sample has a unique *LAB_ID*, as well as a *FIELD_ID* provided by the sample collector. *LAB_ID* is a unique identifier assigned to each submitted sample by the analytical laboratory that received the sample. It is a key field that links the sample to its chemical and physical data found in the chemical data tables. Dates of sample submission and collection are stored in the *DATE_SUBMITTED* and *DATE_COLLECT* fields; less than 10 percent of samples have a collection date recorded. *LATITUDE* and *LONGITUDE* contain the geographic coordinates, whose precision is set at 0.00001 degree, although in many cases, location information collected by the sampler is accurate to only 2 or 3-digit precision by global positioning system (GPS) (Granitto and others, 2011). Associated *SPHEROID* and *DATUM* information is sometimes provided. *PRIMARY_CLASS* defines the sample material; *SECONDARY_CLASS* and *SPECIFIC_NAME* provide more detail about

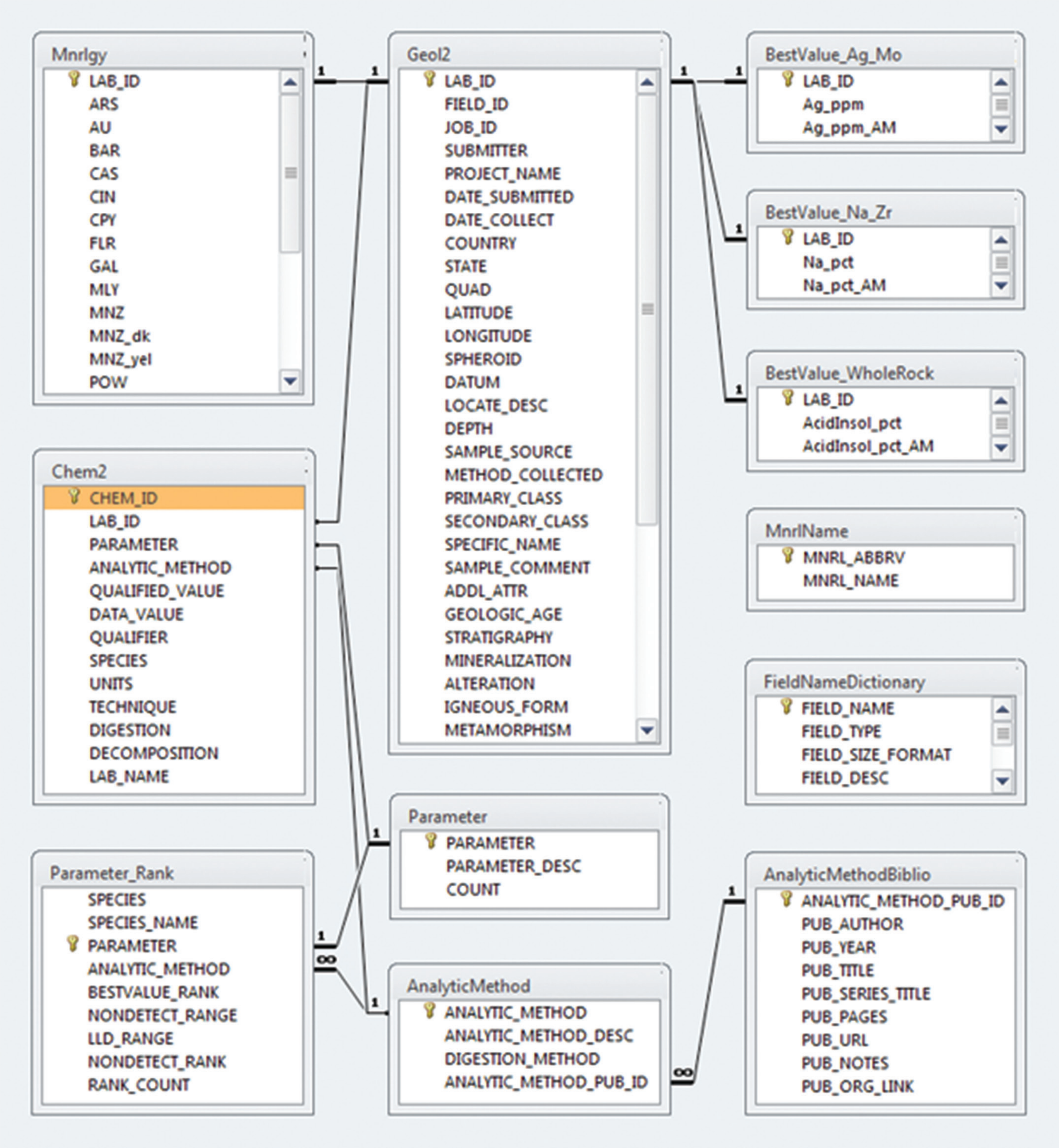


Figure 2. Table relationships in the **Alaska Geochemical Database Version 2.0.**

the sample medium. Media type should be carefully noted so that data from different sample types are not mistakenly equated. For example, AGDB2 contains copper analyses for multiple subsamples (described in *SPECIFIC_NAME)* derived from one sediment sample site (for example, bulk sediment of various size-fractions, and their panned concentrate fractions of various magnetic susceptibilities). Information regarding the collection and preparation of the sample are found in *METHOD_COLLECTED*, *PREP*, and *MESH_PORE_SIZE*. Most of the *LAB_ID* entries are samples entered in the USGS laboratory information management system, archived in the NGDB (Smith and others, 2003).

The **Chem2** table contains 9,699,962 records in 13 fields with laboratory and field analytical measurements, expressed as numeric values. *CHEM_ID* is a unique identifier assigned to each measurement in the table and is a key field of software-assigned integers. Measurements in **Chem2** consist of a numeric *DATA_VALUE* and an optional *QUALIFIER*, which is used to describe results such as those that were not detectable or that were estimates based on limits of instrumental detection (for example, "less than" values, such as < 2). *QUALIFIER* entries include "<" or "N," meaning that the element was not detected at concentrations above the lower limit of determination for the method; "L," meaning that the element was detected, but at concentrations below the lower limit of determination for the method; and ">" or "G," meaning that the element was measured at a concentration greater than the upper limit of determination for the method. *QUALIFIED_VALUE* was populated by combining the data in *DATA_VALUE* with its complement in *QUALIFIER*, according to the following conventions: *DATA_VALUE* entries that are accompanied by "<," "N," or "L" entries in *QUALIFIER* are represented in *QUALIFIED_VALUE* as negative numbers (for example, "-2"); and *DATA_VALUE* entries that are accompanied by ">" or "G" entries in *QUALIFIER* are represented in *QUALIFIED_VALUE* as values with 0.00111, 0.01111 or 0.11111 added to them (for example, >0.25 becomes 0.25111, >0.5 becomes 0.51111, and >10 becomes 10.11111).

Measurement characteristics such as units and analytical techniques are identified using a *PARAMETER* code, which is a concatenation of data from the fields *SPECIES*, *UNITS*, *TECHNIQUE*, and *DIGESTION*. For example, the parameter "Sb_ppm_AA_F_HNO3_P" represents the concentration of antimony, expressed in parts per million, as detected by flame atomic absorption spectrometry after a partial digestion (dissolution) with HNO_3. *PARAMETER* is a 25-character-length field that contains a method summary that can be used as a column name in a data report or spreadsheet.

The chemical data have been split into tables **BestValue_Ag_Mo**, **BestValue_Na_Zr** and **BestValue_WholeRock** due to the 255-field limit of Access software. These data are derived from all of the determinations in the **Chem2** table of the AGDB2 and are presented in "best value" format. In **BestValue_Ag_Mo** data for trace-elements Ag through Mo are reported for all samples. For non-rock samples (sediment, soil, mineral and heavy-metal concentrates), data for major elements Al, Ca, Fe, K, Mg, and Mn are reported in this table as elemental concentrations. **BestValue_Na_Zr** includes data for trace-elements Nb through Zr for all samples. For non-rock samples (sediment, soil, mineral and heavy-metal concentrates), data for major elements Na, P, Si, and Ti are reported in this table as elemental concentrations. **BestValue_WholeRock** contains whole-rock data for all samples. For rock samples, major element chemical determinations are expressed as oxide concentrations and fields are named accordingly (for example, *Al2O3_pct_WDX* rather than *Al_pct_WDX). LAB_ID*, the key field of the chemical data tables, is described in the "BestValue" Ranking Tables section of this report.

The chemical data tables **BestValue_Ag_Mo**, **BestValue_Na_Zr,** and **BestValue_WholeRock** contain fields of the type "*Species_ppm*" (for example, *Ag_ppm*) that contain the "best value" for the species entered as qualified values from the *QUALIFIED_VALUE* field of the **Chem2** table. The chemical data tables contain fields of the type "*Species_ppm_AM*" (for example, *Ag_ppm_AM*) which include the abbreviated name of the analytical method used to determine the "best value" for the species. These are the same methods and names found in the AGDB2. The chemical data tables also contain fields of the type "*Species_ppm_SUM*" (for example, *Ag_ppm_SUM*) that concatenate in order from best method to least, all available values and their respective analytical methods for the species and sample. For example, sample LAB_ID C286881 has a *Ag_ppm_SUM* entry "0.4, AES_AZ; -1, MS_ST; -1, MS_HF". This indicates that the best value for Ag in this sample is "0.4 ppm" by AES_AZ, the second best value is "<1 ppm" by MS_ST, and the third best value is "<1 ppm" by MS_HF. Descriptions of all analytical methods are found in the **AnalyticMethod** table. All determinations in the **Chem2** table of the AGDB are contained in these "*Species_ppm_SUM*" fields of the AGDB2.

The **Mnrlgy** table contains 28 fields with optical mineralogical data for 18,138 nonmagnetic heavy-mineral concentrate samples. The 18 fields record the occurrence of 18 discrete ore-related minerals; *NORM* field indicates that no ore-related minerals were observed. Details and ore-related minerals beyond the 18 are recorded in *OreRelatedMnrl_Comment*; data regarding rock-forming minerals are in *RockFormingMnrl_Comment*. Appendix 2 lists the mineral name abbreviations in **Mnrlgy**. The relationship between **Mnrlgy** and **Geol2** is shown in figure 2. More than 75 percent of these data were generated by Richard B. Tripp (retired, USGS) from1975 through 2009 in support of various USGS mineral resource assessment projects. Mineralogic data were originally recorded in hardcopy with mineral abundances variously reported as: (1) "present" or "not present", (2) "abundant" or "moderate" or "trace" or "absent", (3) as a percentage or as a percentage range, or (4) as numbers of mineral particles. The field *Inferred_Comment* contains R.B. Tripp's comments based on chemical analyses and previous USGS map publications, and those that were noted during the Federal Lands in Alaska–Geologic Studies project (2007–2009) for samples that had been hand ground or consumed during analysis. Appendix 3 contains a bibliographic list of these USGS map publications as well as other USGS publications containing relevant mineralogical information.

AnalyticMethod, **Parameter**, **Parameter_Rank**, and **AnalyticMethodBiblio** are reference tables in the AGDB2. **AnalyticMethod** is a look-up table with additional information on the 85 field and laboratory techniques used for analysis of the various geologic materials. It is linked by *ANALYTIC_METHOD* to the **Chem2** table. **AnalyticMethod** includes a description of the methods and relevant published references, and is linked by *ANALYTIC_METHOD_PUB_ID* to references in **AnalyticMethodBiblio**. In the **Chem2** table, details of sample preparation methods are found in *DECOMPOSITION,* and *LAB_NAME* indicates the laboratory or work group responsible for the analysis. **Parameter** is a look-up table of analytical method parameters used to describe measurement characteristics of chemical and physical data, and is linked by *PARAMETER* to the **Chem2** table. There are 989 unique parameters in the AGDB2. The **Parameter_Rank** table contains the analytical method parameters of the AGDB2 ranked by species, and is linked by *ANALYTIC_METHOD* to the **AnalyticMethod** table, and by *PARAMETER* to the **Parameter** table. The **FieldNameDictionary** table contains the field name, size, definition, and general data type of the 496 fields used in the AGDB2 tables as well as the names of tables in which these fields appear. Relationships between chemical data tables and all other tables in the AGDB2 are shown in figure 2.

Other Data Formats

To serve a wider audience of potential users of the AGDB2, all of the geospatial and chemical data have been exported from Access tables into five Excel spreadsheets with data on rock, sediment, concentrate, mineral, and soil samples. The reference tables are also provided as Excel spreadsheets. Table 2 lists the spreadsheet files included in the data release. In addition, these spreadsheets and tables are also included as tab-delimited ASCII flat files (.txt) that may be used by various applications.

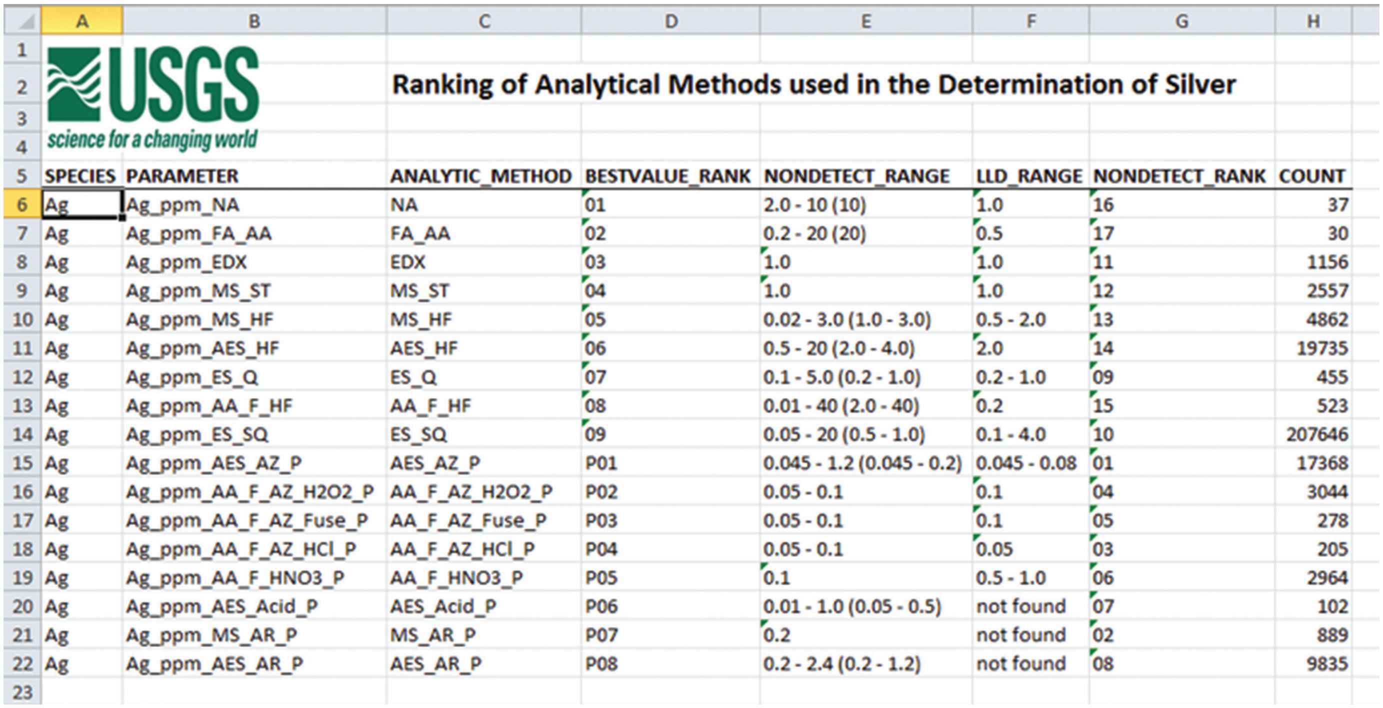
Relational databases can be implemented using a variety of proprietary or nonproprietary software packages. AGDB2 data are reported here in proprietary (Microsoft Office Access 2010 and Excel 2010) and nonproprietary (ASCII tab-delimited) formats.

“Best Value” Data Population

The AGDB2 “best value” chemical data tables were populated element by element with chemical determinations and corresponding analytical method data from the **Chem2** table of the AGDB2 by the use of Microsoft Access select and update queries. Though an analytical method may determine multiple species concentrations, each species in the AGDB2 was ranked individually to consider the many factors that have been mentioned in the section Determining “Best Value”

Table 2. List of spreadsheets containing data from **Alaska Geochemical Database Version 2.0.**

Spreadsheet name	Information contained in spreadsheet
AnalyticMethod.xlsx	Analytical methods used to obtain chemical and physical data
AnalyticMethodBiblio.xlsx	References for analytical methods used to obtain chemical data
BestValue_HMC.xlsx	“Best value” chemical data for heavy-mineral concentrate samples
BestValue_Mnrl.xlsx	“Best value” chemical data for mineral samples
BestValue_Rank.xlsx	Workbook with tables for each species of analytical method parameters ranked by species
BestValue_Rock.xlsx	“Best value” chemical data for rock samples
BestValue_Sed.xlsx	“Best value” chemical data for bulk sediment samples
BestValue_Soil.xlsx	“Best value” chemical data for soil samples
FieldNameDictionary.xlsx	Description of field names used for all tables in the database
Mnrlgy.xlsx	Mineralogy data for non-magnetic heavy-mineral concentrate samples
MnrlName	Mineral name abbreviations used in Mnrlgy table
Parameter.xlsx	Analytical method parameters used to obtain chemical and physical data
Parameter_Rank.xlsx	Analytical method parameters ranked by species



Ranking of Analytical Methods used in the Determination of Silver

SPECIES	PARAMETER	ANALYTIC_METHOD	BESTVALUE_RANK	NONDETECT_RANGE	LLD_RANGE	NONDETECT_RANK	COUNT
Ag	Ag_ppm_NA	NA	01	2.0 - 10 (10)	1.0	16	37
Ag	Ag_ppm_FA_AA	FA_AA	02	0.2 - 20 (20)	0.5	17	30
Ag	Ag_ppm_EDX	EDX	03	1.0	1.0	11	1156
Ag	Ag_ppm_MS_ST	MS_ST	04	1.0	1.0	12	2557
Ag	Ag_ppm_MS_HF	MS_HF	05	0.02 - 3.0 (1.0 - 3.0)	0.5 - 2.0	13	4862
Ag	Ag_ppm_AES_HF	AES_HF	06	0.5 - 20 (2.0 - 4.0)	2.0	14	19735
Ag	Ag_ppm_ES_Q	ES_Q	07	0.1 - 5.0 (0.2 - 1.0)	0.2 - 1.0	09	455
Ag	Ag_ppm_AA_F_HF	AA_F_HF	08	0.01 - 40 (2.0 - 40)	0.2	15	523
Ag	Ag_ppm_ES_SQ	ES_SQ	09	0.05 - 20 (0.5 - 1.0)	0.1 - 4.0	10	207646
Ag	Ag_ppm_AES_AZ_P	AES_AZ_P	P01	0.045 - 1.2 (0.045 - 0.2)	0.045 - 0.08	01	17368
Ag	Ag_ppm_AA_F_AZ_H2O2_P	AA_F_AZ_H2O2_P	P02	0.05 - 0.1	0.1	04	3044
Ag	Ag_ppm_AA_F_AZ_Fuse_P	AA_F_AZ_Fuse_P	P03	0.05 - 0.1	0.1	05	278
Ag	Ag_ppm_AA_F_AZ_HCl_P	AA_F_AZ_HCl_P	P04	0.05 - 0.1	0.05	03	205
Ag	Ag_ppm_AA_F_HNO3_P	AA_F_HNO3_P	P05	0.1	0.5 - 1.0	06	2964
Ag	Ag_ppm_AES_Acid_P	AES_Acid_P	P06	0.01 - 1.0 (0.05 - 0.5)	not found	07	102
Ag	Ag_ppm_MS_AR_P	MS_AR_P	P07	0.2	not found	02	889
Ag	Ag_ppm_AES_AR_P	AES_AR_P	P08	0.2 - 2.4 (0.2 - 1.2)	not found	08	9835

Figure 3. “Best value” analytical method ranking table for silver used in the **Alaska Geochemical Database Version 2.0.**

Rankings (sample size, decomposition, instrument used, limits of detection, interferences, method complexity, and so forth). Using Ag (silver) as an example, the process of “best value” data population is described here. The “best value” analytical method ranking table for Ag (worksheet AGDB_AnalMethRank_Silver in the workbook table BestValue_Rank.xlsx) was used for reference (fig. 3). The AGDB2 fields to be populated with Ag data in the table **BestValue_Ag_Mo** are *Ag_ppm*, *Ag_ppm_AM*, and *Ag_ppm_SUM*.

Detected Values

The first set of values to be populated is detected values (*QUALIFIED_VALUE* >0) by analytical methods using “total” digestion techniques. These methods correspond to “best value” rank 01 through 09 in the *BESTVALUE_RANK* field of the ranking table for silver. Rank 01 corresponds to 37 NA determinations for Ag in the **Chem2** table. The detected values of this data set were populated from *QUALIFIED_VALUE* to *Ag_ppm*, the corresponding analytical method from *ANALYTIC_METHOD* to *Ag_ppm_AM*, and the concatenations of the value and method populated in *Ag_ppm_SUM*. Ranks 02 through 09 were then populated in ascending order but each in the following order: (1) if *Ag_ppm* is not null (has already been populated) then populate *Ag_ppm_SUM* with its existing concatenation entry followed by a semi-colon and the new concatenation, and (2) if *Ag_ppm* is null (has yet to be populated) the population scheme of rank 01 is repeated. In this way the “best value” is reported and all other values are entered as well. The second set of values to be populated contains detected values by analytical methods employing partial digestion techniques, and was executed in the same manner as ranks 01 through 09. These partial digestion methods correspond to “best value” rank P01 through P08 in the *BESTVALUE_RANK* field of the ranking table for silver. This second step was skipped for species that didn’t employ partial digestion techniques.

Non-detected Values

The third set of values to be populated contains non-detect values (*QUALIFIED_VALUE* <0). The analytical methods for these values correspond to non-detect rank 01 through 17 in the *NONDETECT_RANK* field of the ranking table for silver. Rank 01 corresponds to 17,368 AES_AZ_P determinations for Ag in the **Chem2** table. The non-detect values in this data set were populated from *QUALIFIED_VALUE* to *Ag_ppm*, the analytical method from *ANALYTIC_METHOD* to *Ag_ppm_AM*, and the concatenations of the value and method populated in *Ag_ppm_SUM*. Ranks 02 through 17 were then populated in ascending order, but each in the following order, 1) if *Ag_ppm* is not null (has already been populated) then populate *Ag_ppm_SUM* with its existing concatenation entry followed by a semi-colon and the new concatenation, and 2) if *Ag_ppm* is null (has yet to be populated) the population scheme of rank 01 is repeated.

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Database References

Within the database, references are cited for analytical methods that were used to determine elemental concentrations in the chemical data tables. Information regarding the method of analysis or measurement used to obtain data is found in **AnalyticMethodBiblio** (table 1). Refer to the *ANALYTIC_METHOD_PUB_ID*—in most cases the USGS Library call number—when researching the analytical method in question.

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Appendix 1

Analytical Methods

Appendix 1 contains a table of analytical method names and descriptions of the analytical techniques that provided the chemical data of the Alaska Geochemical Database Version 2.0.

Table A1. Analytical methods.

Analytical Method	Description
AA_CV	mercury by cold vapor-atomic absorption spectrometry after multi-acid digestion and solution.
AA_F_AZ_Fuse_P	silver, arsenic, bismuth, cadmium, copper, lead, antimony and zinc by flame atomic absorption spectrometry after partial digestion by K2S2O7 fusion, HCl-KI, ascorbic acid, and selective organic extraction with Aliquat 336-MIBK.
AA_F_AZ_H2O2_P	silver, arsenic, bismuth, cadmium, copper, lead, antimony and zinc by flame atomic absorption spectrometry after partial digestion with HCl-H2O2-KI, ascorbic acid and selective organic extraction with Aliquat 336-MIBK.
AA_F_AZ_HCl_P	silver, arsenic, bismuth, cadmium, copper, lead, antimony and zinc by flame atomic absorption spectrometry after partial digestion with HCl-KI, and selective organic extraction with Aliquat 336-MIBK.
AA_F_CX_P	calcium, magnesium, sodium, potassium and cation exchange capability in soil by flame atomic absorption spectrometry after solution extraction and cation exchange.
AA_F_DTPA_P	cadmium, cobalt, copper, iron, manganese, nickel, lead and zinc by flame atomic absorption spectrometry after DTPA extraction and cation exchange.
AA_F_Fuse	major and minor elements by flame atomic absorption spectrometry after fusion digestion.
AA_F_Fuse_P	molybdenum and antimony by flame atomic absorption spectrometry after K2S2O7 fusion, partial acid digestion, and selective organic extraction with Aliquat 336-MIBK.
AA_F_H2O_P	calcium, magnesium, manganese and arsenic in saturation paste of soil by flame atomic absorption spectrometry after solution extraction.
AA_F_HBr	silver, gold and tellurium by flame atomic absorption spectrometry after HBr-Br2 digestion and selective organic extraction with Aliquat 336-MIBK.
AA_F_HCl_OE_P	antimony by flame atomic absorption spectrometry after partial digestion with HCl and selective organic extraction with Aliquat 336-MIBK.
AA_F_HCl_P	copper and manganese by flame atomic absorption spectrometry after partial digestion with HCl.
AA_F_HF	major and minor elements by flame atomic absorption spectrometry after multi-acid digestion with HF.
AA_F_HNO3_P	silver, cadmium, copper, lead and zinc by flame atomic absorption spectrometry after partial digestion with hot HNO3.
AA_FE	sodium and potassium by flame emission spectrometry (flame photometry) after HF-HClO4 dissolution or LiBO2 fusion.
AA_GF_HBr	gold and tellurium by graphite furnace atomic absorption spectrometry after HBr-Br2 digestion and selective organic extraction with Aliquat 336-MIBK.
AA_GF_HF	arsenic, gold, bismuth and tellurium by graphite furnace atomic absorption spectrometry after multi-acid digestion with HF and selective organic extraction with Aliquat 336-MIBK.
AA_GF_ST	thallium by graphite furnace atomic absorption spectrometry after Na2O2 sinter, HCl-HNO3 dissolution, and selective organic extraction with DIBK.
AA_HG_Acid	selenium by flow injection or continuous flow-hydride generation-atomic absorption spectrometry after digestion with HNO3-HCl-H2SO4-KMnO4.
AA_HG_HF	arsenic, antimony, selenium and tellurium by flow injection or continuous flow-hydride generation-atomic absorption spectrometry after multi-acid digestion with HF.
AA_HG_ST	arsenic and antimony by flow injection or continuous flow-hydride generation-atomic absorption spectrometry after Na2O2 sinter digestion.

Table A1. Analytical methods.—Continued

Analytical Method	Description
AA_TR	mercury by thermal release and atomic absorption spectrometry after heating (Vaughn-McCarthy method).
AA_TR_W	mercury by thermal release and atomic absorption spectrometry after heating (Vaughn-McCarthy method) and use of a willemite screen.
AES_Acid_P	major and minor elements by inductively coupled plasma-atomic emission spectrometry after unknown partial acid digestion.
AES_AR_P	major and minor elements by inductively coupled plasma-atomic emission spectrometry after partial digestion with aqua regia.
AES_AZ_P	silver, arsenic, gold, bismuth, cadmium, copper, molybdenum, lead, antimony and zinc by inductively coupled plasma-atomic emission spectrometry after partial digestion with HCl-H2O2.
AES_Fuse	major and minor elements by inductively coupled plasma-atomic emission spectrometry after fusion digestion.
AES_HF	major and minor elements by inductively coupled plasma-atomic emission spectrometry after digestion with HF-HCl-HNO3-HClO4.
AES_HF_REE	rare earth elements by ion exchange and inductively coupled plasma-atomic emission quantitative spectrometry after HF-HCl-HNO3-HClO4 digestion.
AES_IE	molybdenum, niobium and tungsten by inductively coupled plasma-atomic emission quantitative spectrometry after HF-HCl-HNO3-HClO4 digestion and ion exchange separation.
AES_ST	major and minor elements by inductively coupled plasma-atomic emission spectrometry after sinter digestion.
AFS_CV	mercury in aqueous media by flow injection-cold vapor-atomic fluorescence spectrometry.
CB_CHN	carbon, hydrogen and nitrogen by gas chromatography/thermal conductivity (CHN elemental) analyzer after combustion.
CB_IRC	carbon and sulfur by infrared detection after combustion.
CB_TC	total carbon and organic carbon by thermal conductivity detection after combustion.
CB_TT	sulfur by iodometric titration after combustion.
CM_Acid	bromine by colorimetry after acid digestion.
CM_Acid_P	arsenic by modified Gutzeit apparatus confined-spot method colorimetry after partial digestion in KOH-HCl and chemical separation.
CM_CX_P	heavy metal elements by colorimetry after partial extraction in aqueous ammonium citrate solution.
CM_Fuse	major and minor elements by colorimetric spectrophotometry after fusion digestion.
CM_Fuse_P	molybdenum and antimony by colorimetry after partial digestion by K2S2O7 fusion (Mo) or NaHSO4 fusion-HCl digestion (Sb, rhodamine B).
CM_H2O_P	sulfate in saturation paste of soil by colorimetric titration after solution extraction.
CM_HF	major and minor elements by colorimetric spectrophotometry after multi-acid digestion with HF.
CM_HFS	fluorine by colorimetric spectrophotometry after H2SiF6 digestion and chemical separation.
CM_HNO3_P	copper, lead and zinc by colorimetry after partial digestion with HNO3.
CM_PC_P	uranium by paper chromatography after partial digestion with HNO3.
CM_ST	chlorine by colorimetric spectrophotometry after Na2CO3 and ZnO sinter digestion.
CM_ST_P	tungsten by colorimetry after partial digestion with carbonate sinter.
CP	organic carbon, carbonate carbon and totals by computation.
DN	uranium and thorium by delayed neutron activation counting.
EDX	minor elements by energy dispersive X-ray fluorescence spectrometry.
ES_H2O_P	boron by semi-quantitative direct-current arc emission spectrography after solution extraction.
ES_Q	major and minor elements by quantitative direct-current arc emission spectrography.
ES_SQ	major and minor elements by semi-quantitative direct-current arc emission spectrography.
FA_AA	gold, silver and platinum group elements by graphite furnace atomic absorption spectrometry after PbO fire assay chemical separation.

Table A1. Analytical methods.—Continued

Analytical Method	Description
FA_DC	gold by direct current plasma-atomic emission spectroscopy or atomic absorption spectrophotometry after PbO fire assay chemical separation.
FA_ES	gold and platinum group elements by direct-current arc quantitative emission spectrography after PbO fire assay chemical separation.
FA_MS	platinum group elements by inductively coupled plasma-mass spectrometry after NiS fire assay chemical separation.
FL_HF	beryllium, tin and uranium by fluorometry after multi-acid digestion with HF.
FL_HNO3	selenium by fluorometry after digestion with HNO3-H3PO4.
GRC	uranium by gamma counting.
GV	density, moisture and weight by gravimetry; ash or loss on ignition by weight loss after heating at 900° C.
GV_Acid	major and minor elements by gravimetry after acid digestion.
GV_CR	major and minor elements by gravimetry for Classical Rock Analysis after unknown digestion method.
GV_Flux	moisture, bound water and total water by heating and weight loss with flux.
GV_Fuse	major and minor elements by gravimetry after fusion digestion.
IC	chlorine, fluorine, nitrate, sulfate and phosphate by ion chromatography.
INST	pH by standard method combination pH electrode.
INST_P	specific conductance by standard method conductivity electrode and pH by standard method combination pH electrode after partial digestion.
ISE_Fuse	chlorine, fluorine and iodine by ion specific electrode after fusion digestion.
ISE_H2O	chlorine by ion specific electrode after solution extraction.
ISE_HF	chlorine by ion specific electrode after multi-acid digestion with HF.
MS_AR_P	major and minor elements by inductively coupled plasma-mass spectrometry after partial digestion with aqua regia.
MS_HF	major and minor elements by inductively coupled plasma-mass spectrometry after HF-HCl-HNO3-HClO4 digestion.
MS_ST	major and minor elements by inductively coupled plasma-mass spectrometry after Na2O2 sinter digestion.
MS_ST_REE	rare earth elements by inductively coupled plasma-mass spectrometry after Na2O2 sinter digestion.
NA	major and minor elements by long or short count instrumental neutron activation analysis.
pH	pH by standard method combination pH electrode.
TB_AR	acid-soluble sulfate, sulfur and sulfide by turbidimetry after aqua regia digestion.
TT_Flux	total water by Karl Fischer coulometric titration with flux after combustion.
TT_Fuse	Fe2O3 by titration after fusion, decomposition and precipitation.
TT_HCl	carbonate carbon and carbon dioxide (acid soluble carbon) by coulometric titration after HClO4 digestion and extraction.
TT_HF	ferrous oxide by colorimetric or potentiometric titration after HF-H2SO4 digestion.
VOL	carbon dioxide or carbonate carbon by evolution after acid decomposition; aka “gasometric” or “manometric”.
WDX_Fuse	major and minor elements by wavelength dispersive X-ray fluorescence spectrometry after LiBO2 fusion digestion.
WDX_Raw	chlorine, iodine and bromine by wavelength dispersive X-ray fluorescence spectrometry on raw sample.

Appendix 2

Mineral Name Abbreviations

Appendix 2 contains a table of abbreviations for mineral names used in the **Mnrlgy** table of the Alaska Geochemical Database Version 2.0.

Table A2. Mineral name abbreviations.

Abbreviation	Description
AB	albite
AG	silver
ALN	allanite
AMG	amalgam
AMP	amphibole
AMP/PYX	amphibole/pyroxene
AND	andalusite
ANG	anglesite
ANT	anatase
APT	apatite
ARG	aragonite
ARS	arsenopyrite
AU	gold
AZR	azurite
BAR	barite
BI	bismuth
BIO	biotite
BIS	bismuthinite
BLG	boulangerite
BRK	brookite
CAS	cassiterite
CDT	cordierite
CER	cerussite
CHR	chromite
CIN	cinnabar
CLB	columbite
CLN	clinochlore
CLR	chlorite
CONT	contamination
COR	corundum
CPY	chalcopyrite
CR-D	Cr-diopside
CUP	cuprite
CUS/O	copper sulfide/copper oxide
CYR	cyrtolite
DUM	dumortierite
ENG	enargite
EPD	epidote
FE/MN	iron oxide/manganese oxide
FLR	fluorite
FUC	fuchsite
GAL	galena
GAL/CER	galena/cerussite
GAL/MIN	galena/minium
GAR	garnet
GHN	gahnite
GRP	graphite
HB	hornblende
HMP	hemimorphite
HMT	hematite
ILM	ilmenite
JAM	jamesonite
KYN	kyanite
LCX	leucoxene
LIM	limonite
LTH	litharge
MAL	malachite
MAR	marcasite
MAS	massicot
MGT	magnetite
MIC	mica
MIM	mimetite
MIN	minium
MLY	molybdenite
MNZ	monazite
MTZ	metazeunerite
MUS	muscovite
MUS/CLR	muscovite/chlorite
NORM	no ore-related minerals
OL	olivine
OL/SRP	olivine/serpentine
ORP	orpiment
PHN	phenakite

Table A2. Mineral name abbreviations.—Continued

Abbreviation	Description
POW	powellite
PRS	proustite
PYC	pyrochlore
PYH	pyrrhotite
PYM	pyromorphite
PYR	pyrite
PYR/ARS	pyrite/arsenopyrite
PYR/MAR	pyrite/marcasite
PYX	pyroxene
Q/F	quartz/feldspar
Q_FE	iron stained quartz
QTZ	quartz
R1	rock fragments—graphitic
R2	rock fragments—grey
R3	rock fragments—chloritic
R4	rock fragments—tan
R5	rock fragments—pelitic
R6	rock fragments—pyritic
REE-M	REE-rich minerals
RLG	realgar
RUC	rucklidgeite
RUT	rutile
RUT/ANT	rutile/anatase
RUT/ANT/BRK	rutile/anatase/brookite
RUT/BRK	rutile/brookite
RX	rock fragments
SAF	safflorite
SAP	sapphire
SCH	scheelite
SCH/POW	scheelite/powellite
SIL	sillimanite
SLF	sulfide
SMA	smaltite
SMI	smithsonite
SPH	sphalerite
SPN	sphene
SPN-REE	REE-rich sphene
SPN-TH	thorium-rich sphene
SRC	sericite
SRP	serpentine
STB	stibnite
TET	tetrahedrite
TH-M	Th-rich minerals
THN	thorianite
THR	thorite
TPZ	topaz
TRN	tourmaline
URN	uraninite
UTH	uranothorite
WOL	wolframite
WUL	wulfenite
XEN	xenotime
ZIR	zircon

Appendix 3

Mineralogical Data References

Appendix 3 contains a bibliographic list of USGS map publications containing mineralogical information. Some of these publications have been cited in field *Inferred_Comment* of the **Mnrlgy** table in the AGBD2 database.

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