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Alaska Geochemical Database: Mineral Exploration Tool for the 21st Century—PDF of Presentation

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

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Abstract

The U.S. Geological Survey has created a geochemical database of geologic material samples collected in Alaska. This database is readily accessible to anyone with access to the Internet. Designed as a tool for mineral or environmental assessment, land management, or mineral exploration, the initial version of the Alaska Geochemical Database—U.S. Geological Survey Data Series 637—contains geochemical, geologic, and geospatial data for 264,158 samples collected from 1962–2009: 108,909 rock samples; 92,701 sediment samples; 48,209 heavy-mineral-concentrate samples; 6,869 soil samples; and 7,470 mineral samples. In addition, the Alaska Geochemical Database contains mineralogic data for 18,138 nonmagnetic-fraction heavy mineral concentrates, making it the first U.S. Geological Survey database of this scope that contains both geochemical and mineralogic data. Examples from the Alaska Range will illustrate potential uses of the Alaska Geochemical Database in mineral exploration.

Data from the Alaska Geochemical Database have been extensively checked for accuracy of sample media description, sample site location, and analytical method using U.S. Geological Survey sample-submittal archives and U.S. Geological Survey publications (plus field notebooks and sample site compilation base maps from the Alaska Technical Data Unit in Anchorage, Alaska). The database is also the repository for nearly all previously released U.S. Geological Survey Alaska geochemical datasets. Although the Alaska Geochemical Database is a fully relational database in Microsoft® Access 2003 and 2010 formats, these same data are also provided as a series of spreadsheet files in Microsoft® Excel 2003 and 2010 formats, and as ASCII text files. A DVD version of the Alaska Geochemical Database was released in October 2011, as U.S. Geological Survey Data Series 637, and data downloads are available at *http://pubs.usgs.gov/ds/637/*. Also, all Alaska Geochemical Database data have been incorporated into the interactive U.S. Geological Survey Mineral Resource Data web portal, available at *http://mrdata.usgs.gov/*.

Introduction

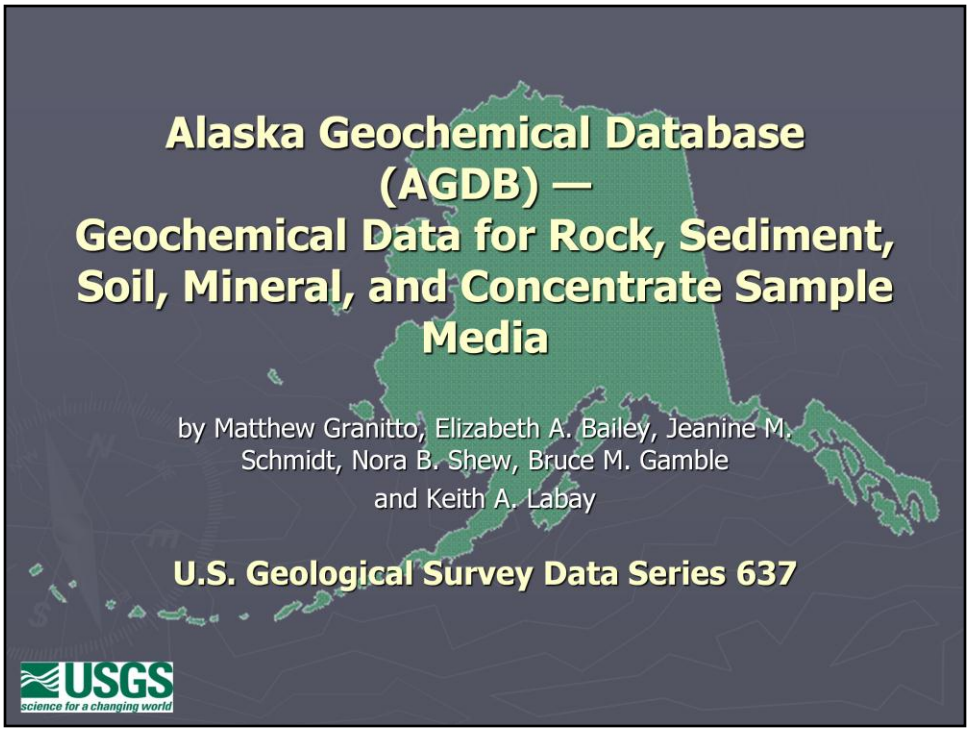
The U.S. Geological Survey (USGS) has recently completed a comprehensive geochemical database for Alaska: the Alaska Geochemical Database (AGDB). The AGDB has been published digitally as a USGS Data Series DVD (Granitto and others, 2011) and information about the AGDB dataset is summarized in a recent USGS Fact Sheet (Schmidt and Granitto, 2011). This report is a record of a presentation prepared by the authors and presented to the Alaska Miners Association Annual Convention in Anchorage, Alaska, on November 9, 2011 by senior author Matthew Granitto. It describes information about the AGDB database and gives examples from two areas of the Alaska Range to illustrate how AGDB data can be sorted, selected, and combined with other geological information (for example, the Alaska Resource Data Files (ARDF)) to provide information and analysis useful for mineral exploration or mineral-assessment purposes.

Alaska Geochemical Database: Mineral Exploration Tool for the 21st Century

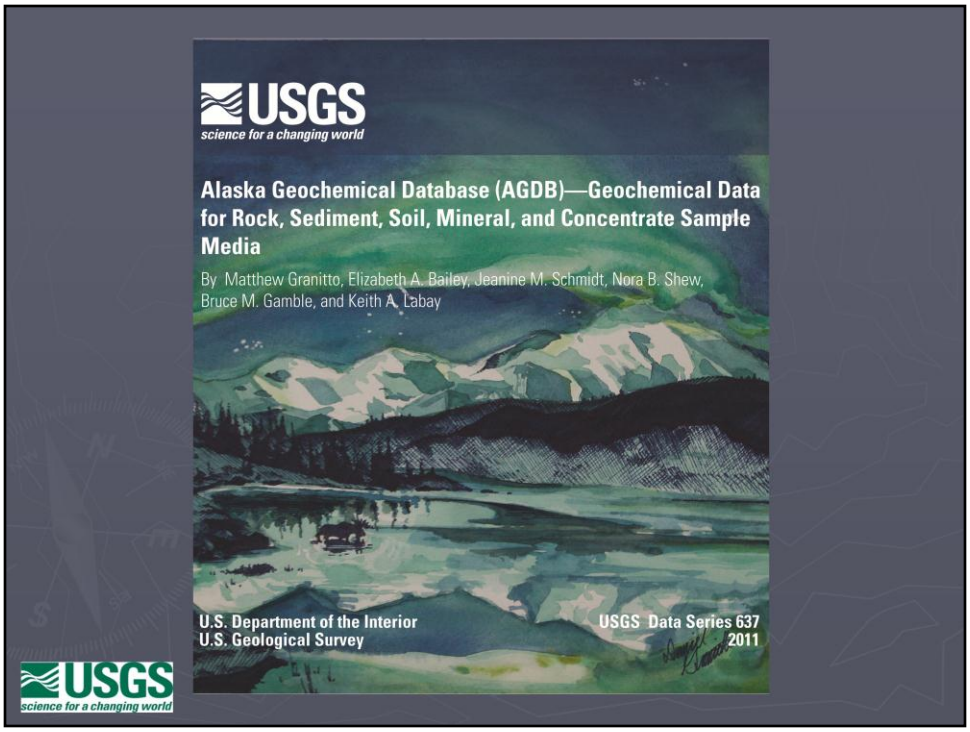
Alaska Miners Association, November 9, 2011

Prepared by: Granitto, Matthew, Schmidt, J.M., Labay, K.A., Shew, N.B., and Gamble, B.M.,
U.S. Geological Survey

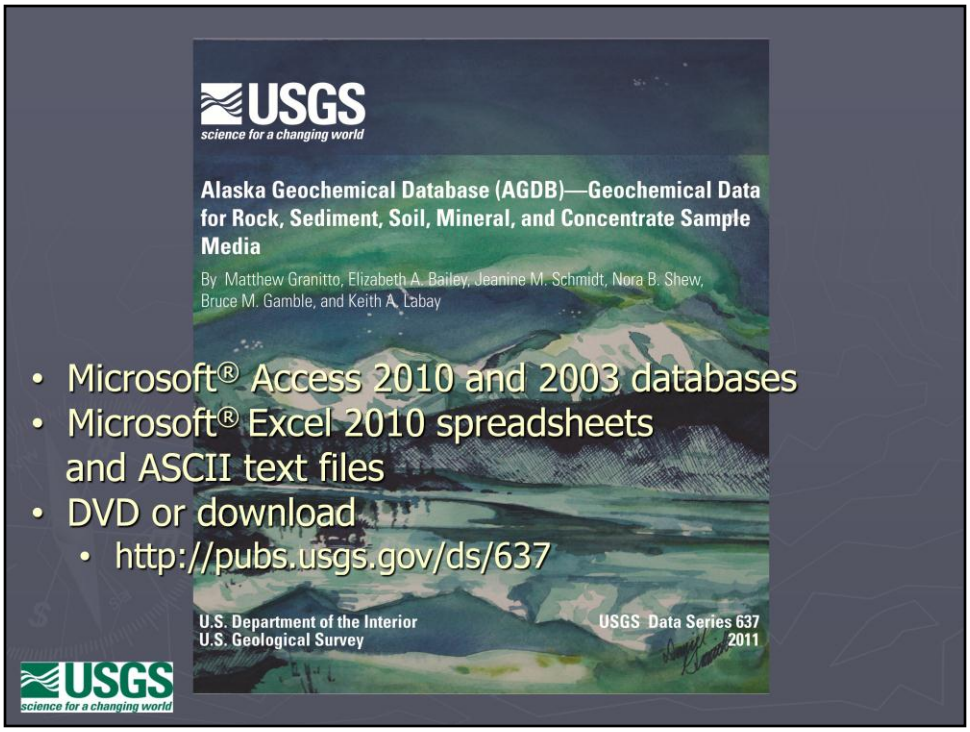
Presented by: Matthew Granitto



USGS geochemical data for geologic material samples collected in Alaska are now readily accessible to anyone with a powerful personal computer and access to the Internet. The Alaska Geochemical Database (AGDB)—Geochemical Data for Rock, Sediment, Soil, Mineral and Concentrate Sample Media was released in October, 2011 as the USGS publication Data Series 637 (*http://pubs.usgs.gov/ds/637*).



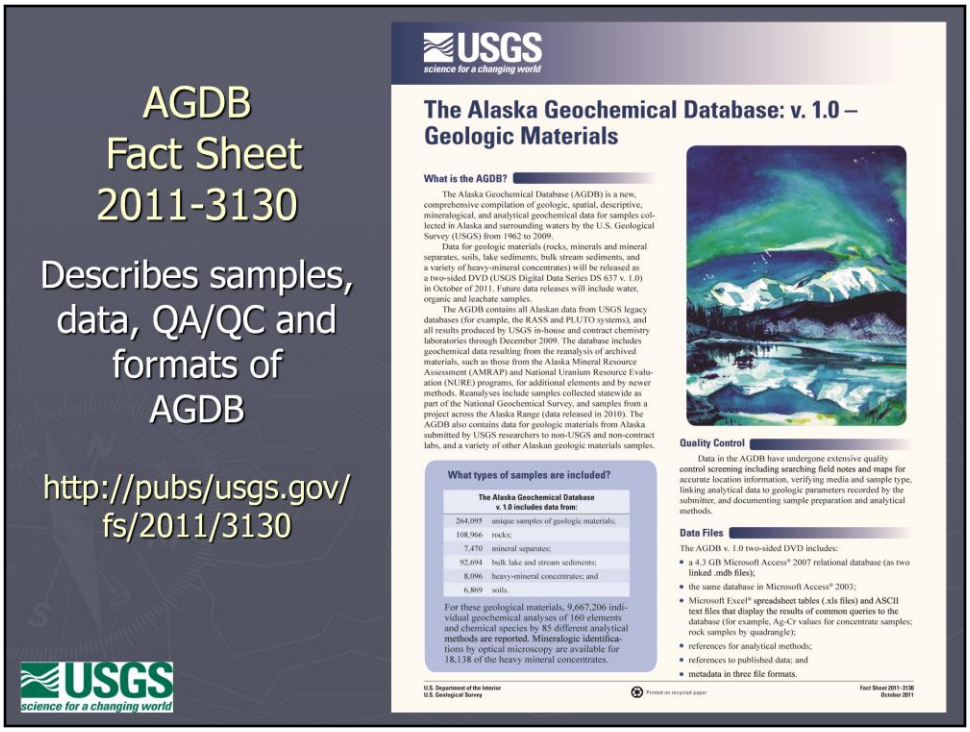
The AGDB DVD contains geochemical, geological, and mineralogical data for geologic material samples collected in Alaska and from its adjacent marine waters; all have geographic coordinates. For ease of use, the data have been grouped by sample-media type. For example, rock data are kept separate from data for other sample-media types.



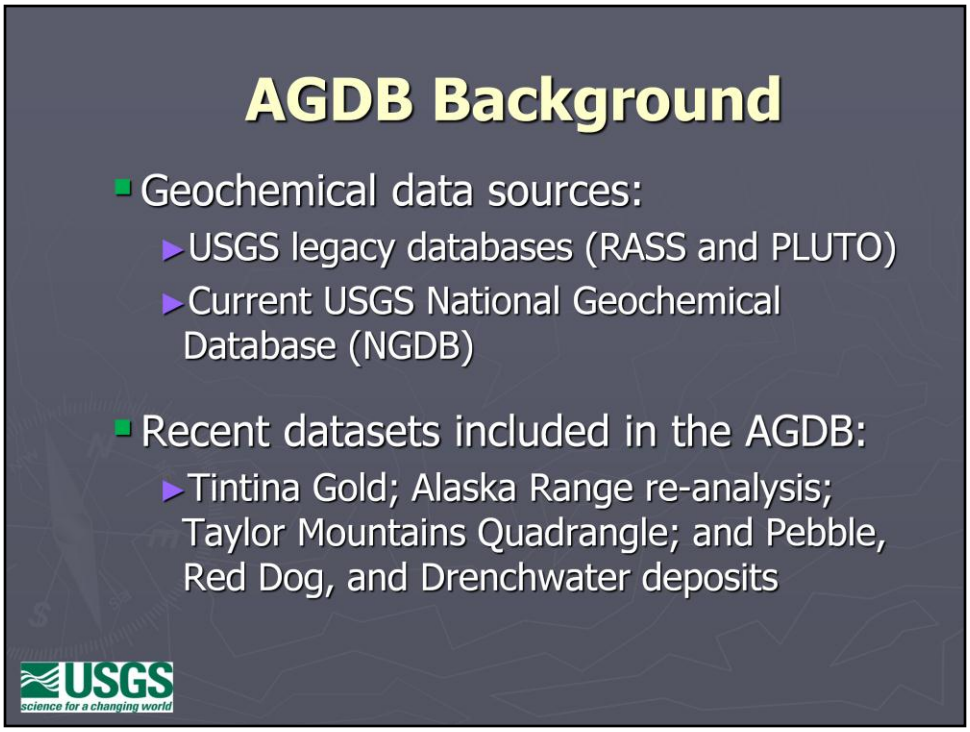
A Microsoft® Access relational database, constructed in both 2010 and 2003 versions, is the primary repository of this data. This DVD also provides the data as Access® "flat file" or spreadsheet tables, which is useful for those who are not familiar with relational databases.

The data are also provided as Microsoft® Excel 2010 spreadsheets, and as ASCII text files.

The AGDB DVD is available from the authors (*granitto@usgs.gov* or *jschmidt@usgs.gov*). The data, pamphlet, and metadata files can also be downloaded from the USGS Publications Warehouse website (*http://pubs.usgs.gov/ds/637*).



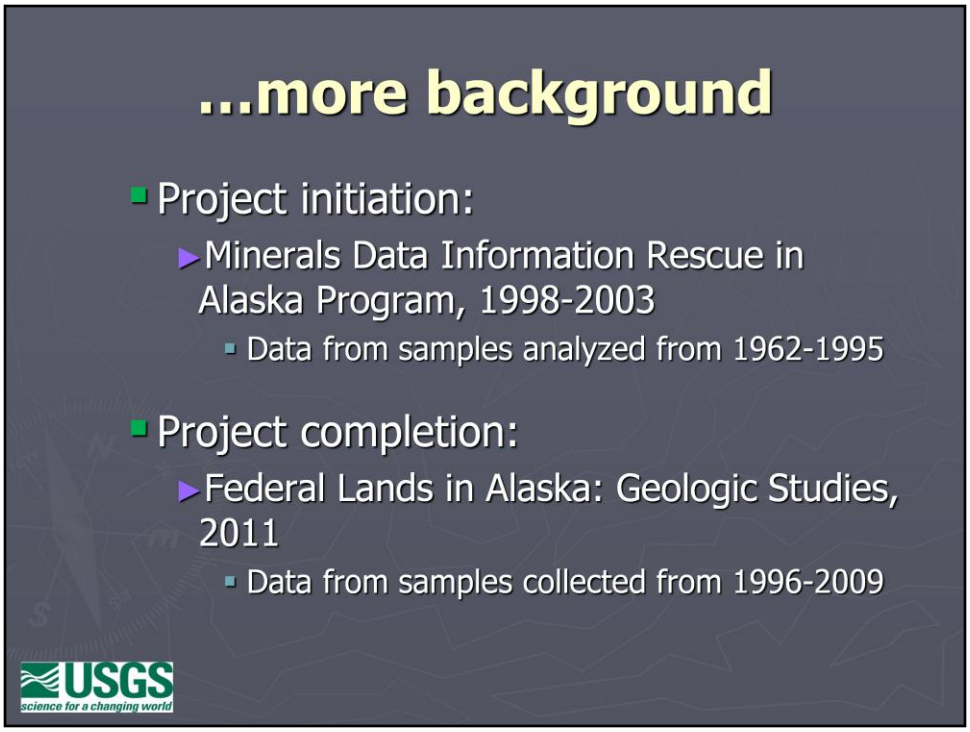
The data types, sample media, Quality Assurance/Quality Control procedures, metadata, and references of the AGDB are summarized in a 2-page Fact Sheet which is available in hard copy from the authors (*granitto@usgs.gov* or *jschmidt@usgs.gov*) or online at the USGS Publications Warehouse (*http://pubs.usgs.gov/fs/2011/3130*).



The data in the AGDB consist of both recent and legacy geochemical data. The USGS legacy databases RASS (Rock Archival Storage System) and PLUTO contributed more than 75 percent of all the AGDB data. Most of the remainder is from the current USGS National Geochemical Database (NGDB). The NGDB is the data warehouse for all USGS geochemical data from all 50 states and from foreign countries.

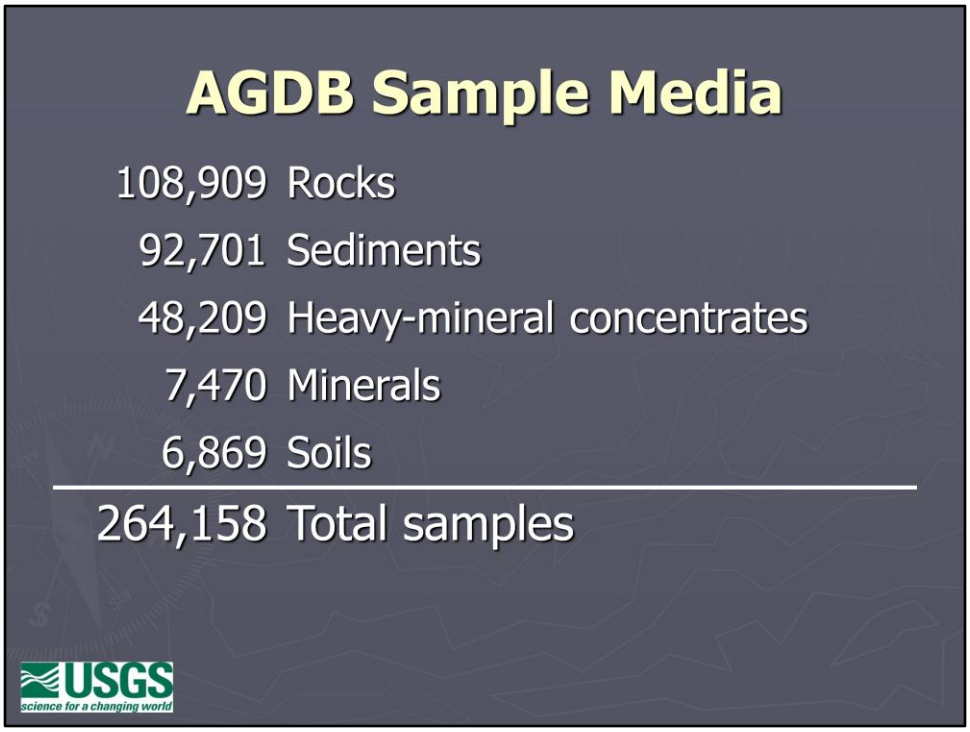
Most of the AGDB data has been released over the past 45 years as datasets of varying size in paper or digital publications. For the first time, these and other data have been compiled to produce an exhaustive geochemical database for geologic media samples collected in Alaska in support of USGS programs.

The AGDB contains Alaskan datasets more recently released to the public, including datasets from projects such as the Tintina Gold Province, Federal Lands in Alaska—Geologic Studies (reanalysis of Alaska Range stream sediments), the Taylor Mountains quadrangle, the Pebble Cu-Mo-Au deposit, and the Red Dog and Drenchwater Creek Zn-Pb-Ag deposits. All of the Alaskan sample data from the National Geochemical Survey (which includes the reanalysis of National Uranium Resource Evaluation program archival samples) are also included in the AGDB.



Work on the AGDB was initiated by the Minerals Data Information Rescue in Alaska Program from 1998 to 2003 in an effort to make USGS Alaskan geochemical data readily available to the public. Data from samples analyzed between 1962 and 1995 were first released as spreadsheets accessible at USGS websites.

The AGDB was completed under the Federal Lands in Alaska—Geologic Studies project as a fully relational geochemical database. Data from samples collected and analyzed from 1996 to 2009 have been included, which brings Alaskan geochemical data up to date for the user.

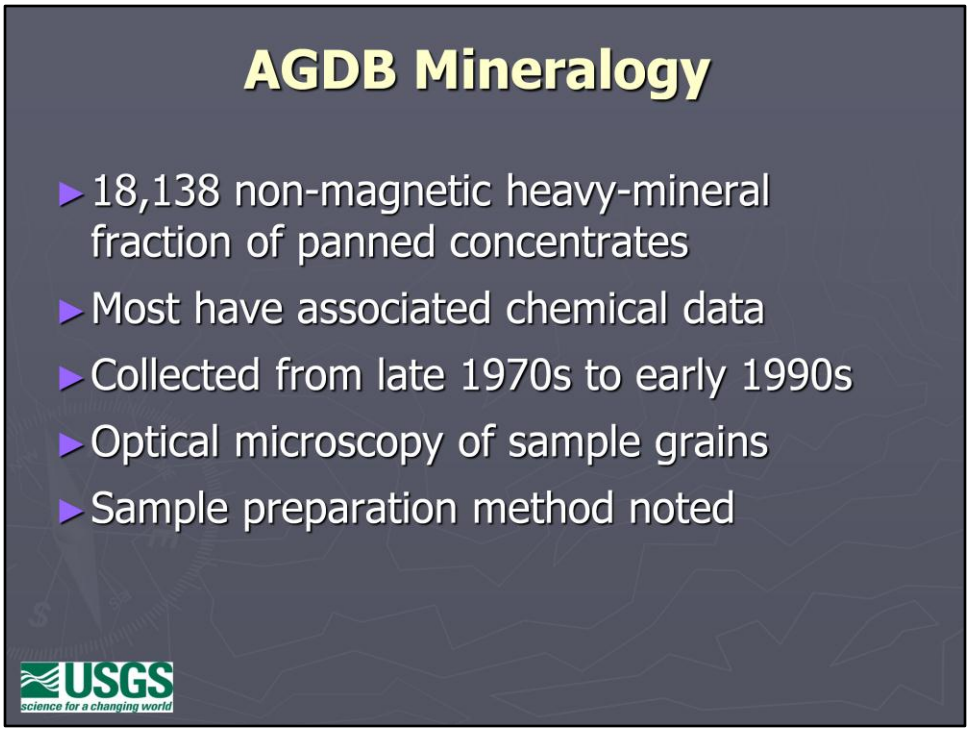


The majority of the analytical data in the AGDB is from rock and stream-sediment samples, most of which were collected by the Alaska Mineral Resource Assessment Program (AMRAP) during the 1970s and 1980s. Most AGDB materials were collected by USGS field parties between 1962 and 2009, although the database includes samples collected by the Alaska Division of Geologic and Geophysical Surveys, the U.S. Bureau of Mines, and by the National Uranium Resource Evaluation (NURE) program. The data from 6,686 reanalyzed NURE sediment and soil samples (that is, the National Geochemical Survey) are included in the AGDB.

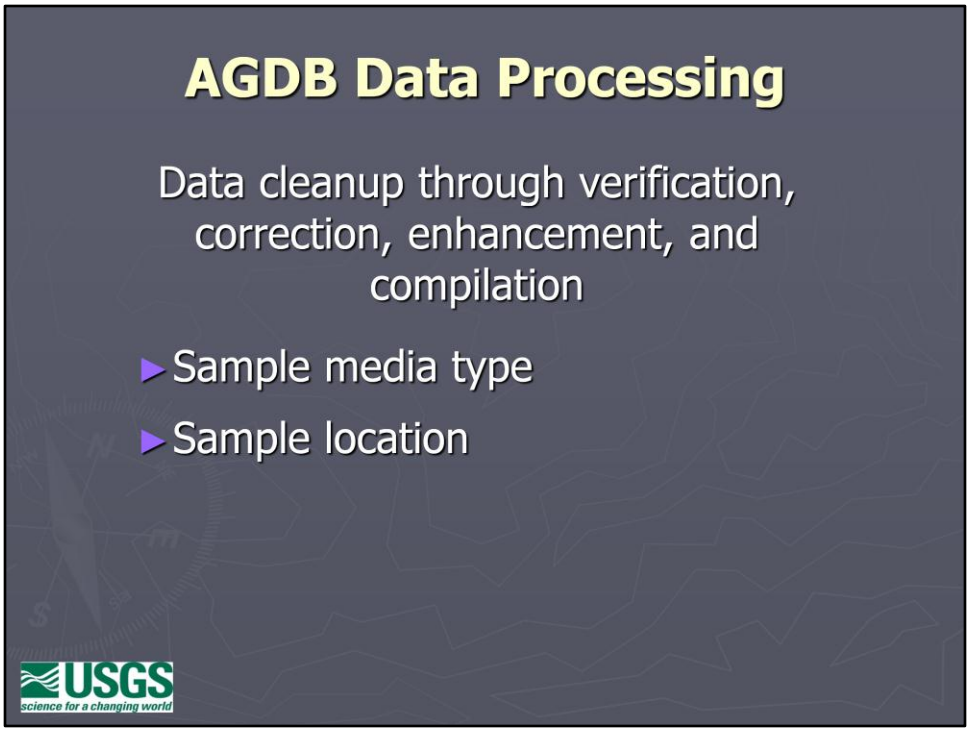
In the AGDB, heavy-mineral concentrates, primarily derived from the panning of bulk stream sediment in the field, have been given their own media type which keeps their data easily separate from that of other sample media. Detailed sample-preparation information is included in the concentrate dataset.

Data for mineral and soil samples are also included in the AGDB. Although most of the mineral data are derived from samples for geochronology, the geologic ages and dating analyses are not included in the AGDB.

The AGDB is an enormous database—it contains data for more than 264,000 geologic material samples.



The AGDB also contains all known USGS Alaskan panned-concentrate mineralogy data. This represents more than 18,000 samples—most of which also have chemical data for the same non-magnetic sample fraction. Most of these samples were collected for AMRAP projects, but mineralogical data from the recent Taylor Mountains quadrangle project are included here as well. Mineralogical identifications were derived from optical-microscopy observations of sample grains—most of which was done by Richard B. Tripp of the USGS, a fact that provides continuity of analysis and consistency of data reporting.

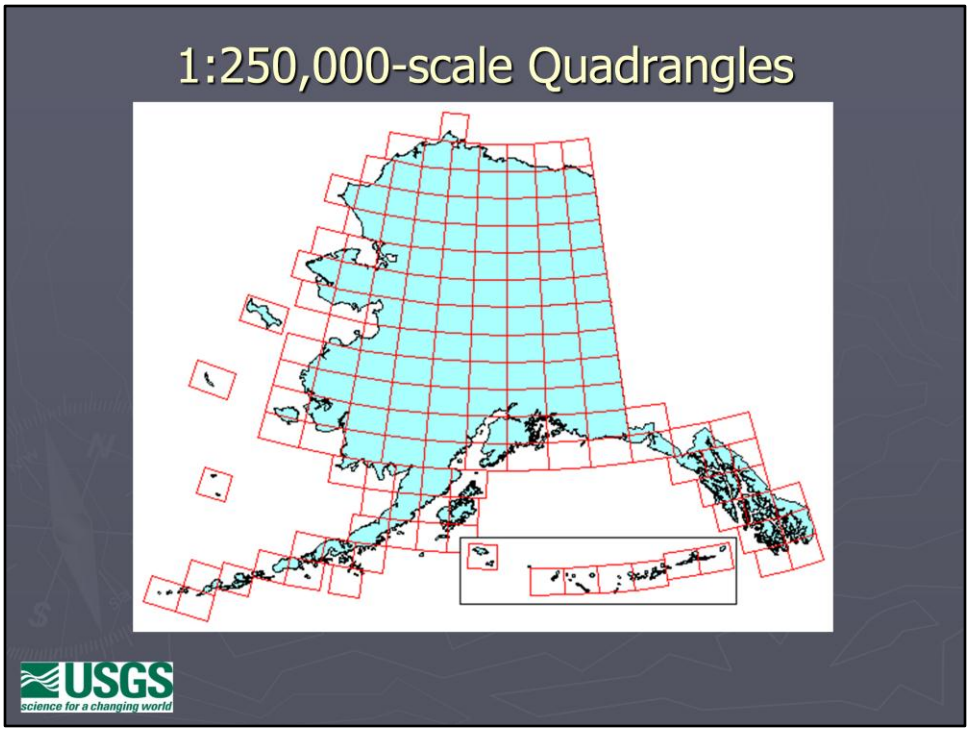


Over the years, USGS scientists recognized several problems with legacy databases. Three primary issues were: location coordinates (either incorrect or lacking), sample media (not precisely identified), and analytical method of detection (also not precisely identified, or actually missing from the early PLUTO database structure).

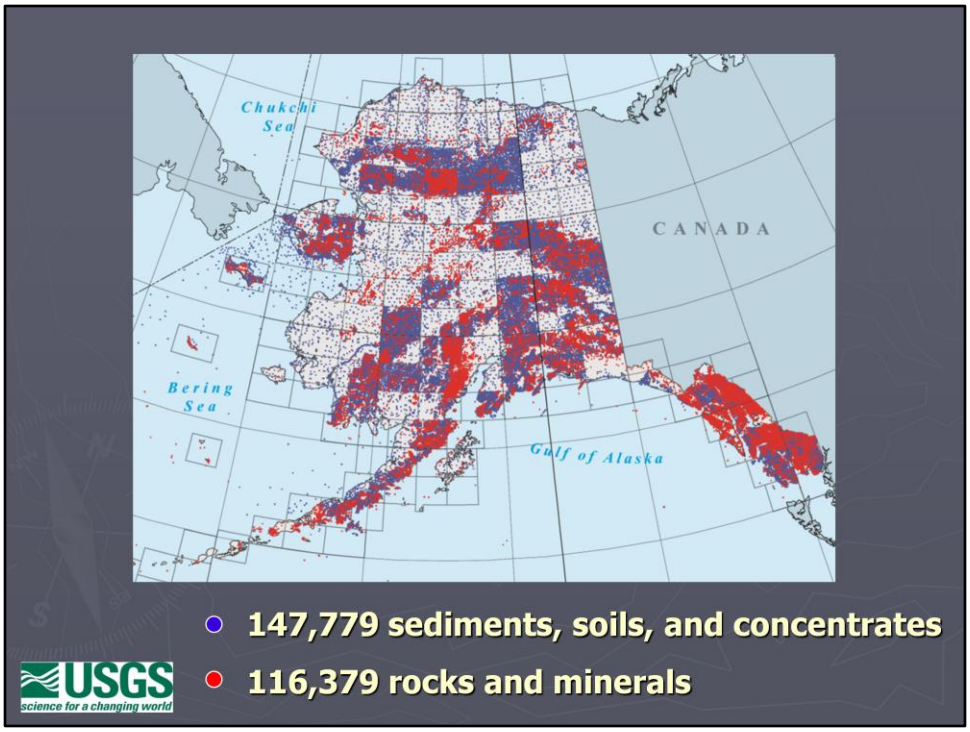
In 1998, re-processing of Alaskan data from these databases was initiated to correct errors in sample locations, to add sample locations when missing, and to correctly identify the sample media and analytical protocol of each record. This re-processing consisted of checking the information on sample media, location, and analytical method against the original sample submittal forms, the original laboratory reports, published reports, field notebooks and sample location base maps, and discussions with sample submitters and analysts. As necessary, fields were added to the original data to more fully describe the sample-preparation methods used and sample media analyzed. Sample records that could have been entered in RASS and PLUTO, but were not, have been included, resulting in the addition of tens of thousands of sample data records to the AGDB.

For sample media, details regarding media type, mineralization, alteration, stratigraphy, geologic age, sample source, collection method, and sample preparation have been checked, corrected when in error, and added when absent but later found.

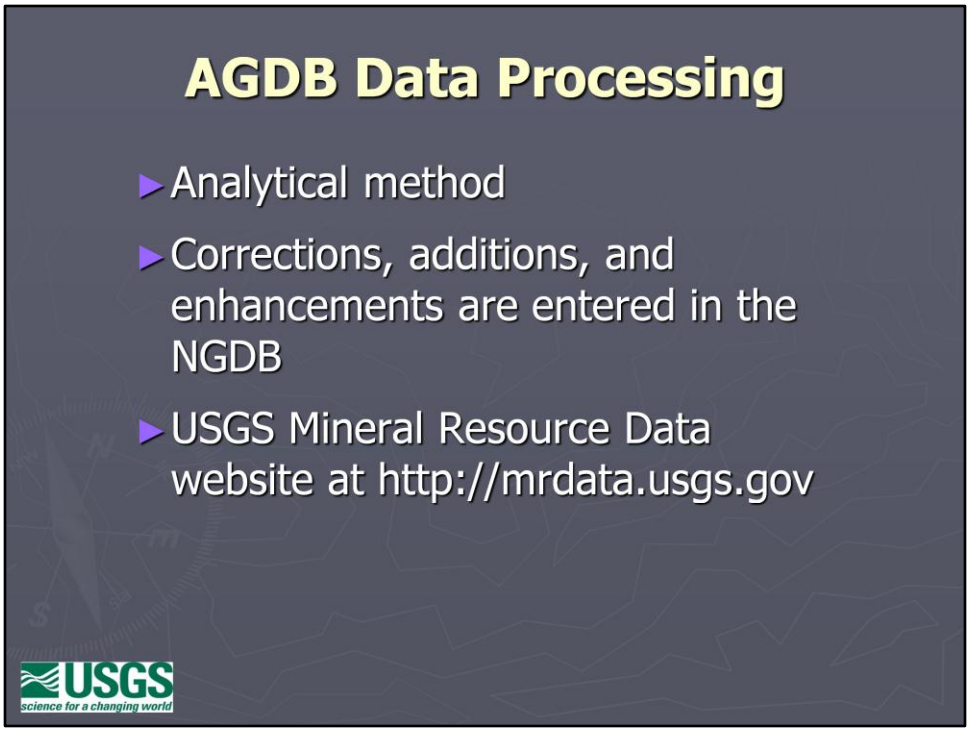
For sample location, many archive sample-site maps were digitized and sites plotted to gain new or more accurate coordinates. The use of geographic information systems has been a great assistance in this effort. Detailed information regarding sample locations was also added to the AGDB.



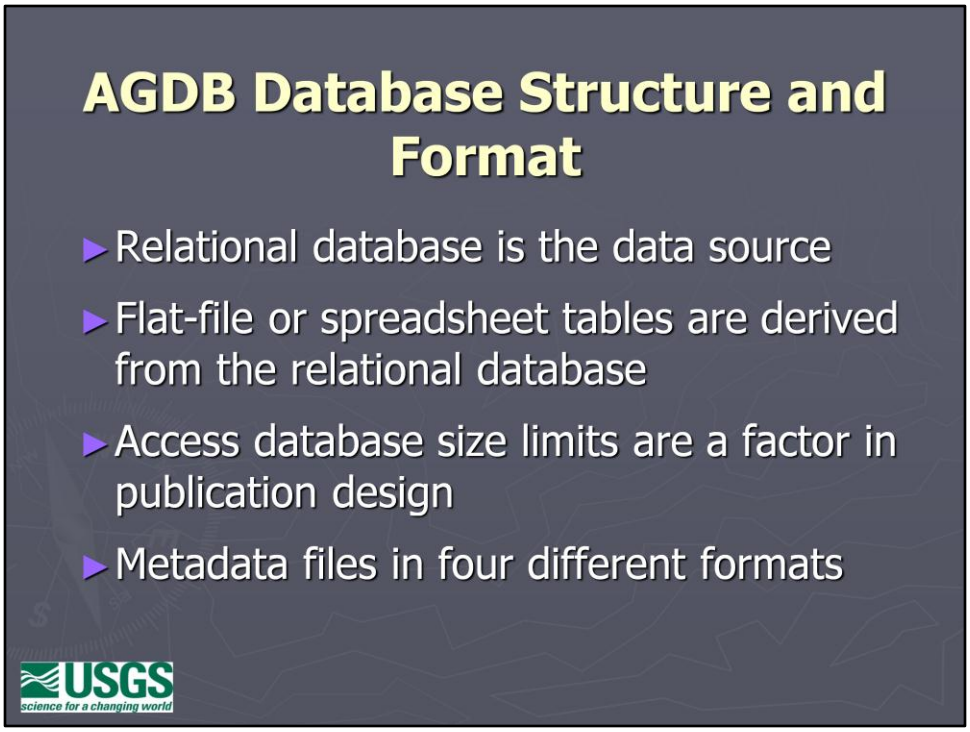
1:250,000-scale quadrangles are often used to group Alaskan sample data, so the names of these quadrangles were added as attributes to the AGDB.



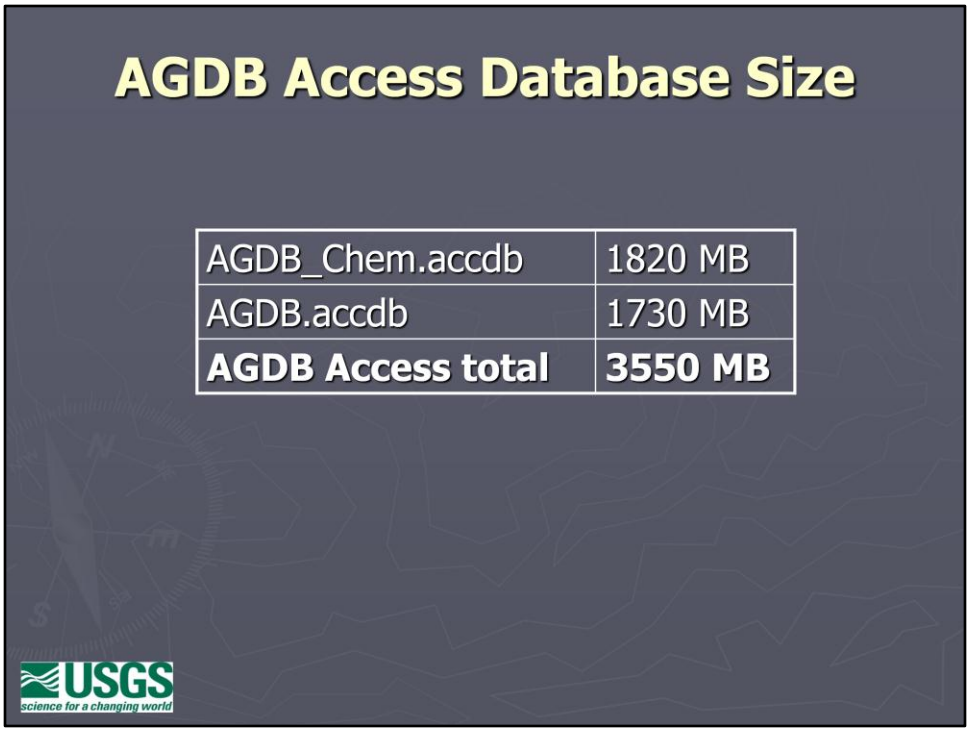
These are the sample localities of the current version of the AGDB. The blue dots are sediment, soil, and heavy-mineral concentrate sample localities. The red dots are rock and mineral sample localities. The red dots often overlie, and in some cases obscure, the blue dots. Not shown on this map are a few sample localities in the western Aleutian Islands. Most of the quadrangles with heavy sample density represent USGS AMRAP study areas.



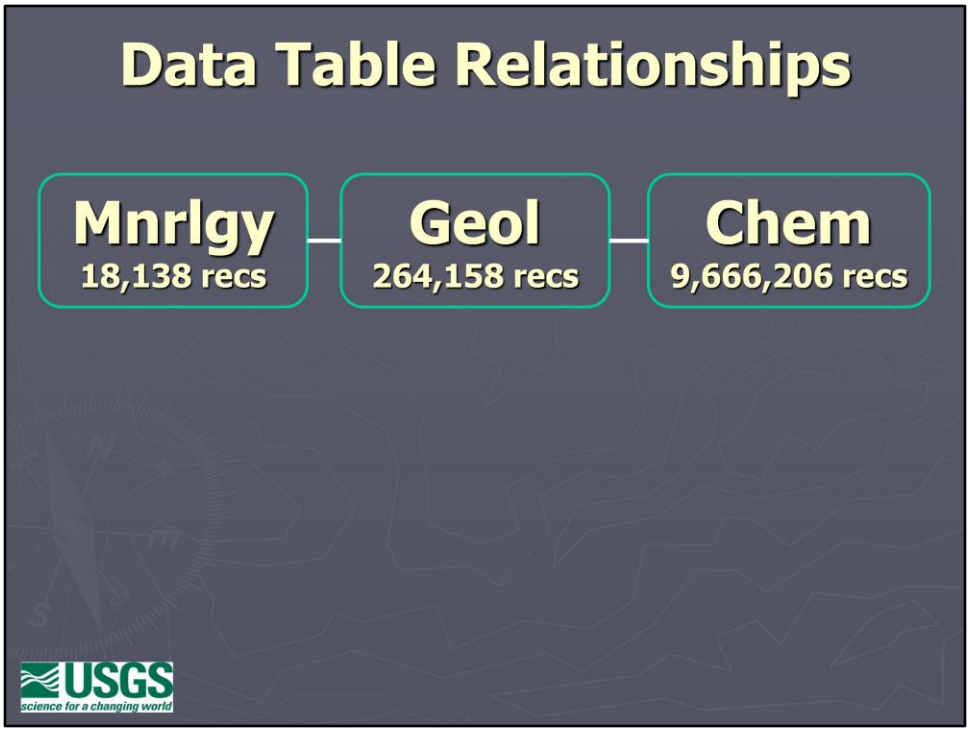
Details of the analytical methods, such as sample digestion and decomposition, were added as the method types were researched, documented, and referenced in the AGDB. The actual analytical data were not checked in great detail, but obvious errors were corrected. All corrections, additions, and enhancements will be entered into the NGDB. In January, 2012, an enhanced interface to search, select, and retrieve AGDB data by various criteria (for example, hydrologic unit) was made available at the USGS Mineral Resource Data website. The refined data in the AGDB will also be input in the national databases already at this site.



The AGDB is a Microsoft® Access relational database. Because of the scope and complexity of geologic-materials data collected by diverse Alaskan geochemical-assessment projects, a relational database structure was designed for data storage. It is both a tool to be used for data synthesis and analysis, and an archive of data collected during these projects. The database structure and format are a modification of that used by the NGDB because more than 85 percent of the data were retrieved from the NGDB. These data are also provided as Access "flat file" or spreadsheet tables, as a series of spreadsheet files in Microsoft® Excel, and as ASCII text files.



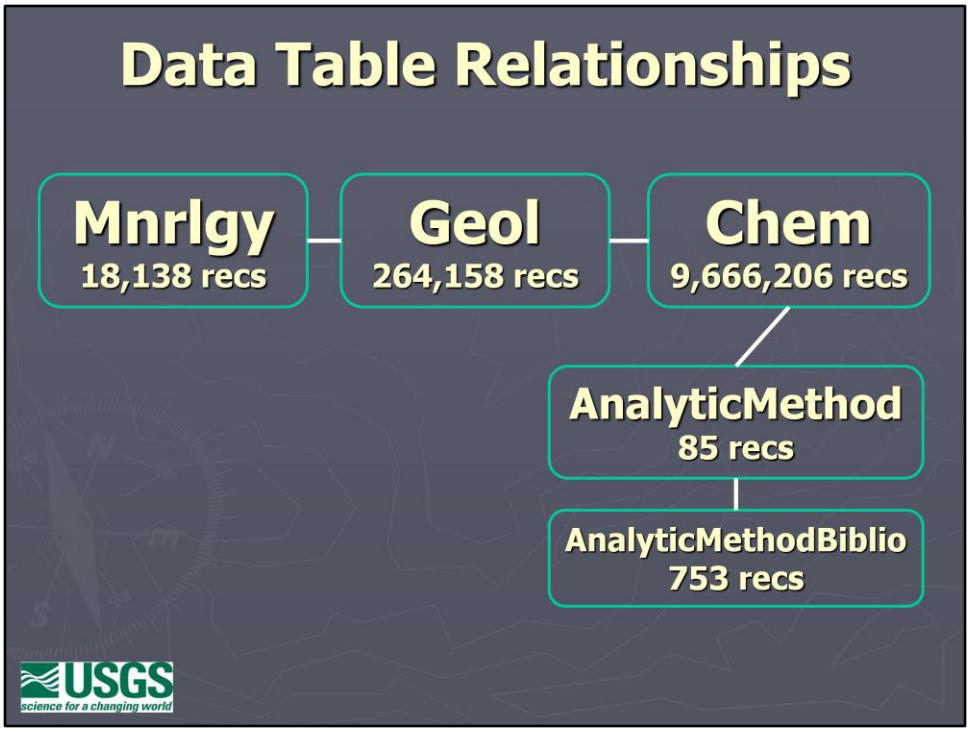
Microsoft® Access has programmatic size limitations that needed to be addressed during the creation of the AGDB. The AGDB actually consists of two databases. All of the data are contained in the split relational database that is **AGDB** and **AGDB_Chem**. As these databases are linked by the common field LAB_ID, they can reside on a computer hard drive as if they were one entity. Together, they greatly exceed 2 GB, which is the maximum allowable database size limit set by Access. When linked, they operate very well together.



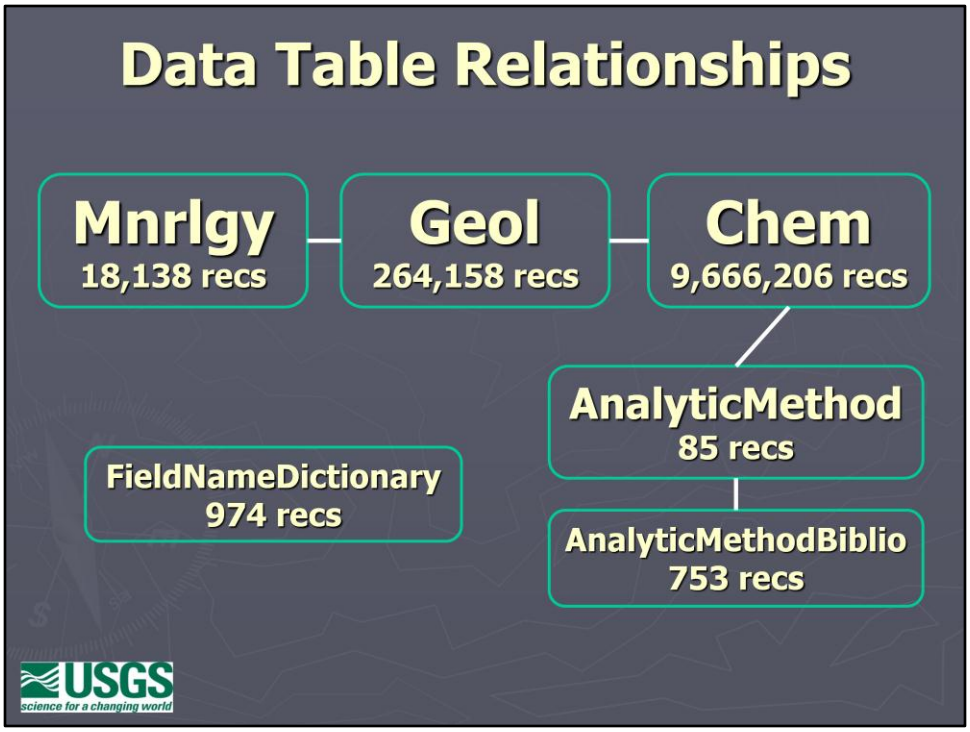
The beauty of relational databases is illustrated by the relationships of data tables to one another. The **Geol** table contains geospatial, geologic, and descriptive attributes for all sample records (recs) in the AGDB with chemical and mineralogical data.

Related to the **Geol** table is the **Mnrlgy** table that contains all the mineralogical data found in the AGDB. All "mnrlgy" records are linked to "geol" records in a one-to-one relationship, where each "mnrlgy" record is also found in the **Geol** table.

Also related to the **Geol** table is the **Chem** table that contains all the chemical determination data found in the AGDB. All "chem" records are linked to "geol" records in a one-to-many relationship, where one "geol" record may have one or more "chem" records associated with it. The relationship diagram shows the three core tables: **Geol**, **Chem**, and **Mnrlrgy**. Note the size of the **Chem** table—it records nearly 9.7 million chemical determinations as unique individual records.

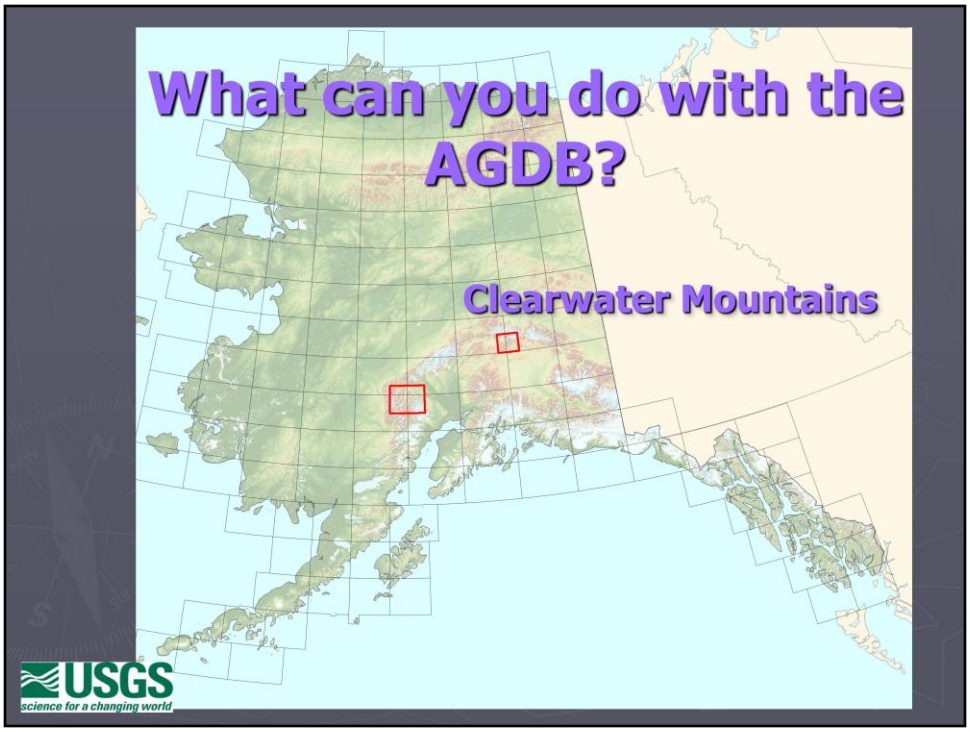


The reference or "lookup" tables provide definitions and descriptions for all of the data fields in the AGDB and function as "on-board" metadata within the database. Information regarding the method of analysis or measurement used to obtain data is found in the **AnalyticMethod** table—a look-up table that provides additional information on the 85 field and laboratory techniques used for analysis of the various geologic materials. The table includes a description of the analytical methods and relevant published references and is linked to bibliographic reference information in the table **AnalyticMethodBiblio**—a table of references for analytical methods used to obtain chemical data.

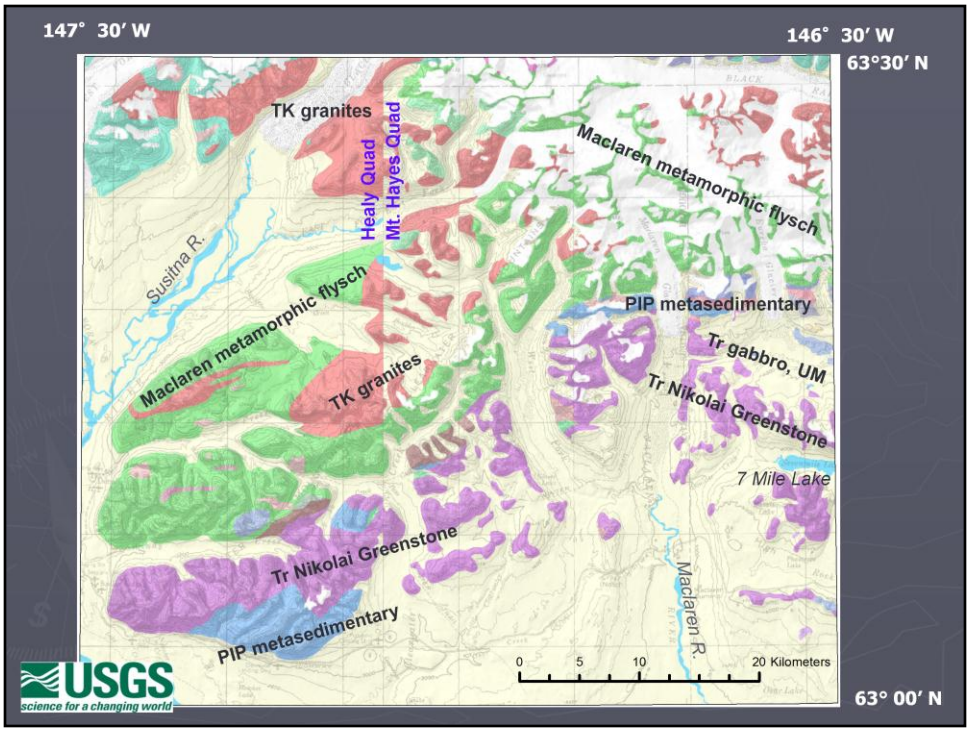


The table **FieldNameDictionary** is also a reference table. It contains the field name, size, definition, and general data type of the 974 fields that are used in the tables of the AGDB, as well identifying the table or tables in which these fields appear. **FieldNameDictionary** is a lookup table that is not directly linked (white line) to other tables in the relational database. It is of particular importance for the non-database user as it also contains the descriptions of field names used in the Excel and ASCII text data tables.

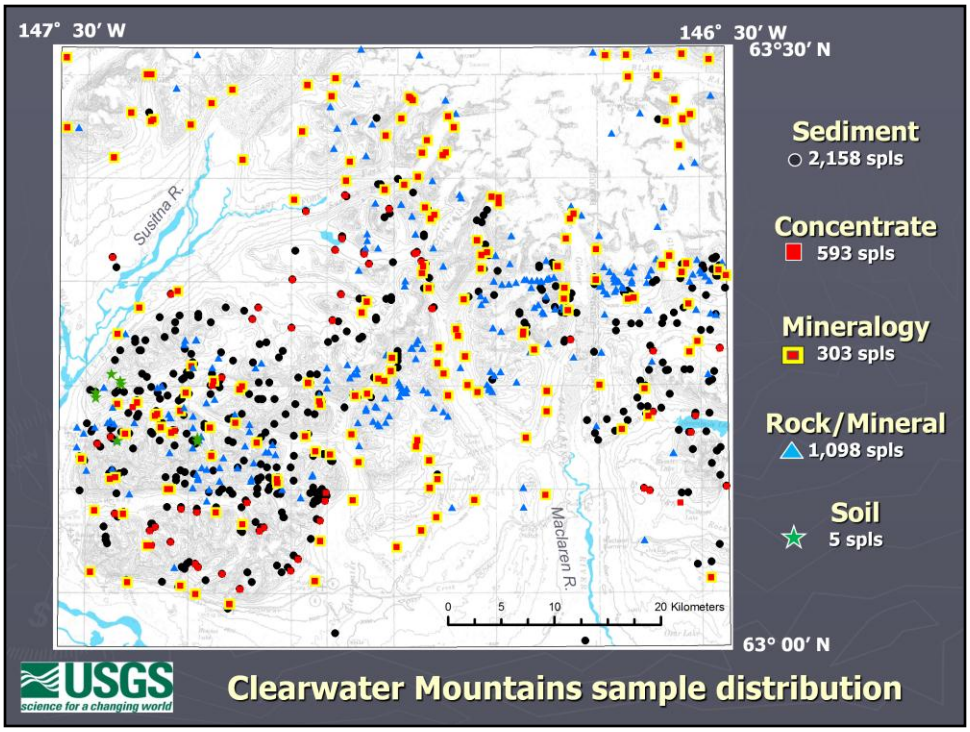
This relational database structure provides for efficient storage of information and built-in data-verification checks. For example, all valid chemistry results must have corresponding geologic sample information. Relations between these tables are depicted as lines. **Geol** is linked to **Chem** by including a common field (LAB_ID) in both tables. Therefore, a chemical value cannot exist without having a corresponding sample in **Geol**. Data may be extracted from the AGDB to meet specific user needs by constructing user-defined queries. USGS Data Series 637 (*http://pubs.usgs.gov/ds/637*) contains a number of completed sample queries to help the user take advantage of the relational nature of the AGDB (Granitto and others, 2011).



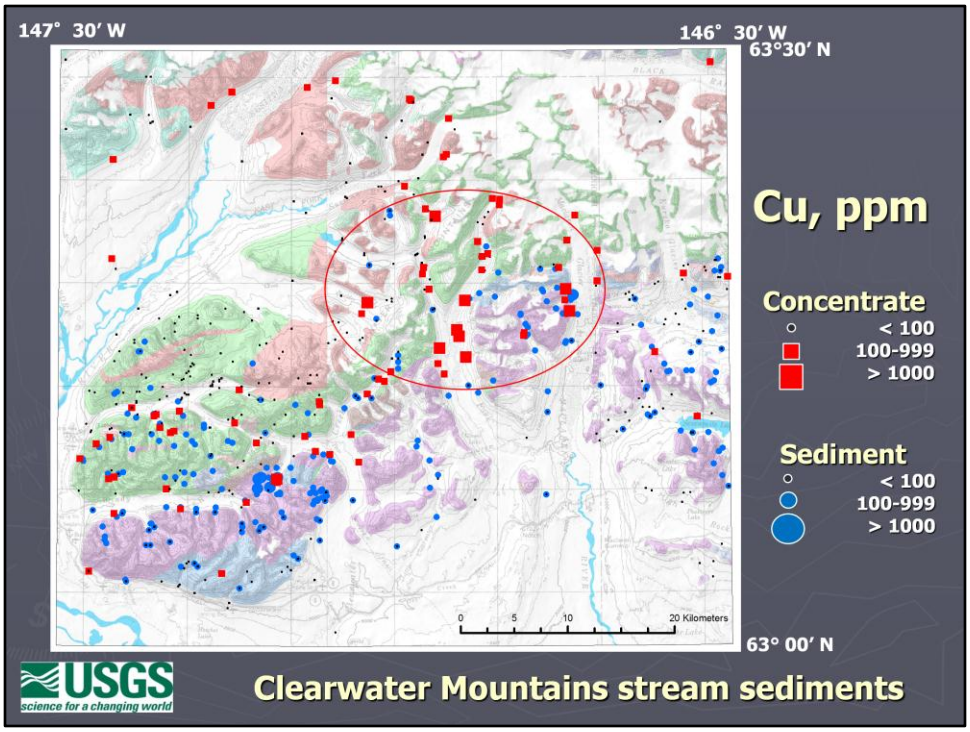
Let's look at some of the types of data included in the AGDB and what you can do with it. We will start with the Clearwater Mountains area in the central Alaska Range, spanning the Healy and Mt. Hayes quadrangle boundary.



Exploration for nickel, copper, and platinum-group-element sulfide deposits is currently underway in the Amphitheatre Mountains, which straddle the east boundary of this map, east of the Maclaren River. The geologic units of primary interest, the Triassic (Tr) Nikolai Greenstone and related gabbro and ultramafic (UM) sills (in purple), continue westward into the Clearwater Mountains, which take up the central and western part of this map, west of the Maclaren River. Other geologic units represented on this map are Permian-Pennsylvanian (PIP) metasediments (in blue), the Mesozoic Maclaren metamorphic flysch (in green), and Tertiary-Cretaceous (TK) granites. Note that the Healy/Mt. Hayes quadrangle boundary is indicated by a change in the style of mapping of Quaternary units (in tan), as this slide shows a compilation of two geologic maps (Wilson and others, 1998).



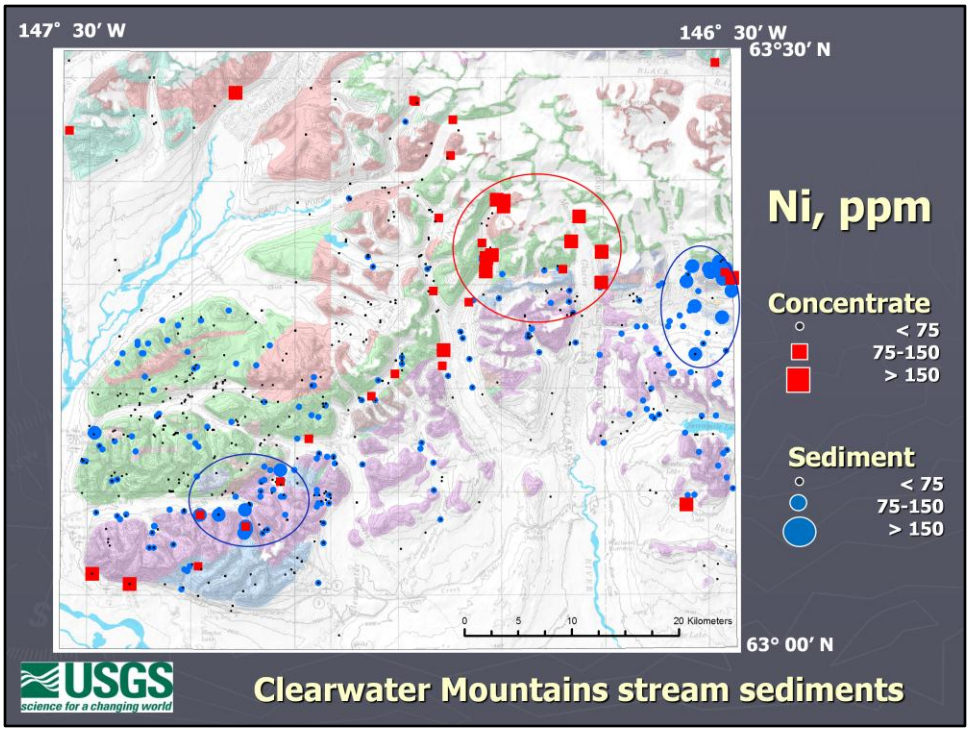
This map of the same area shows that analytical geochemistry or mineralogy data are available for 1,616 samples (spls) of geologic materials from this 1,350 square mile area. Heavy-mineral-concentrate sample localities are a subset of sediment localities, because the concentrates were derived from the panning of bulk sediments in the field. All mineralogy localities are also concentrate localities. In the next few slides, we will illustrate how the AGDB data can be used to identify areas of exploration interest.



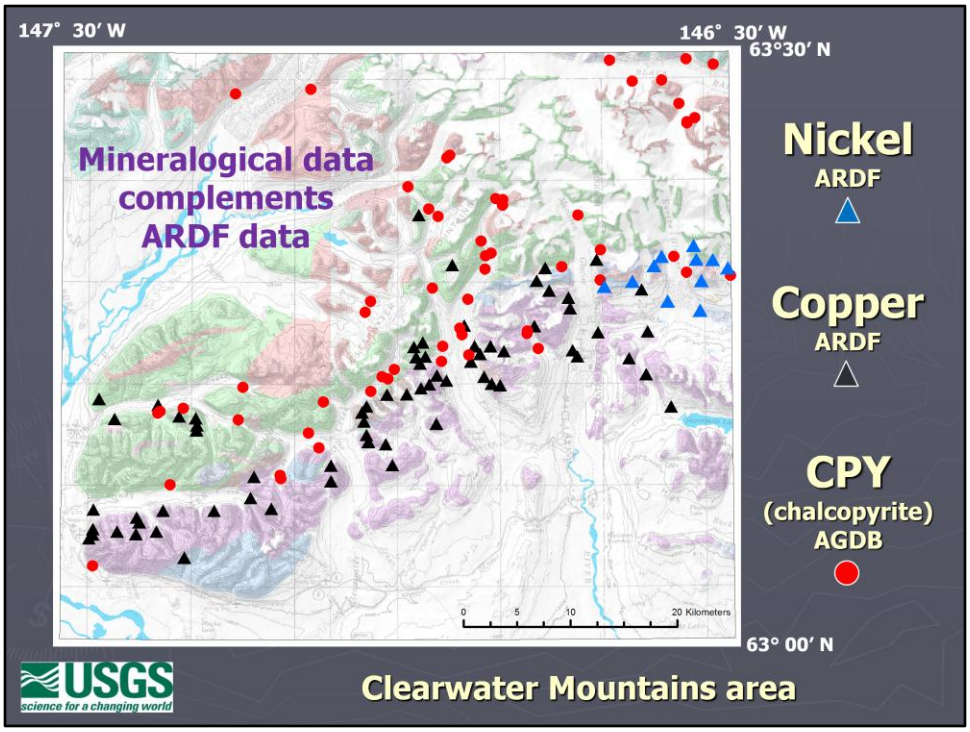
We plotted the distribution of copper in bulk stream sediments versus that in panned concentrates and can compare those distributions to the bedrock geology. Copper values in stream sediments (blue circles) are uniformly high in areas underlain by the Nikolai Greenstone (in purple) with a cluster of very high values in the Pass Creek area (lower left) of the southern Clearwater Mountains.

Copper in concentrate samples (red squares), in contrast, is elevated in several areas underlain by Cretaceous metamorphic rocks and Tertiary granites (in the greens and reds in the upper central part of the map).

One area indicated as of possible exploration interest is the central ridge of the Clearwater Mountains (inside the red oval in this map), where both sediment and concentrate samples are consistently elevated in copper, and where geophysical data suggest that the Maclaren metamorphic rocks may form a relatively thin sheet thrust southward over Nikolai and related magnetic rocks.

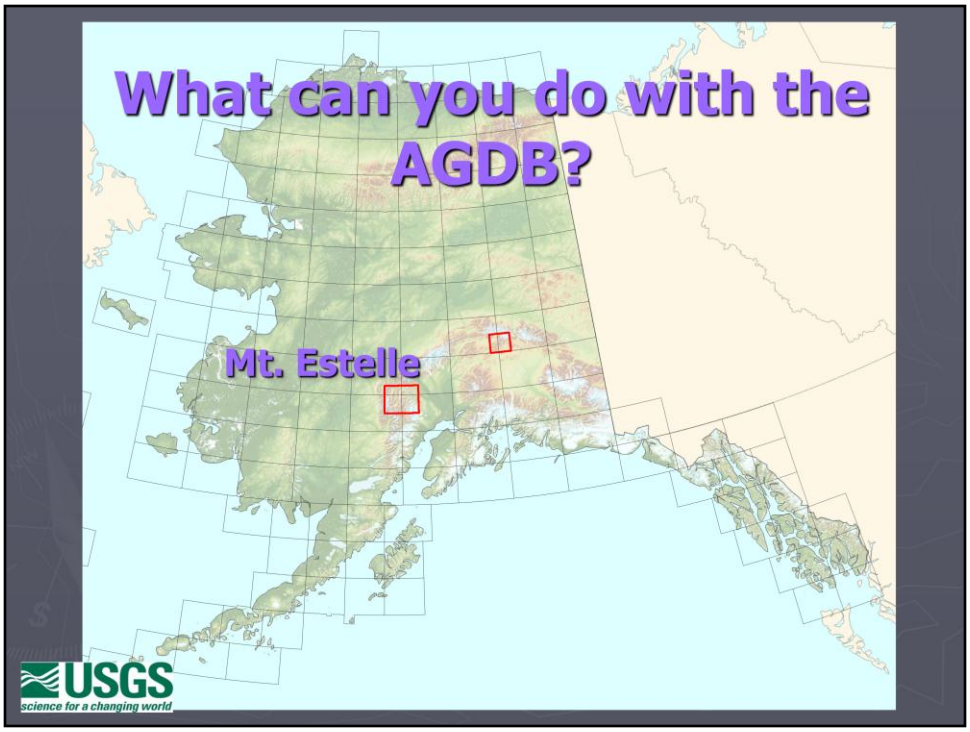


If we look at the distribution of nickel, we find that the high nickel concentration in stream sediments (blue circles) are clustered in two areas (inside the blue ovals in this map): Pass Creek area on the southern ridge of the Clearwater Mountains (in the lower left corner of the map), and in the northwestern Amphitheatre Mountains (at the right edge of the map). Heavy-mineral concentrates (red squares) show a completely different distribution of high nickel values (inside the red oval in this map), located in the Maclaren metamorphic belt and Tertiary granitic rocks north of the region underlain by Nikolai Greenstone.

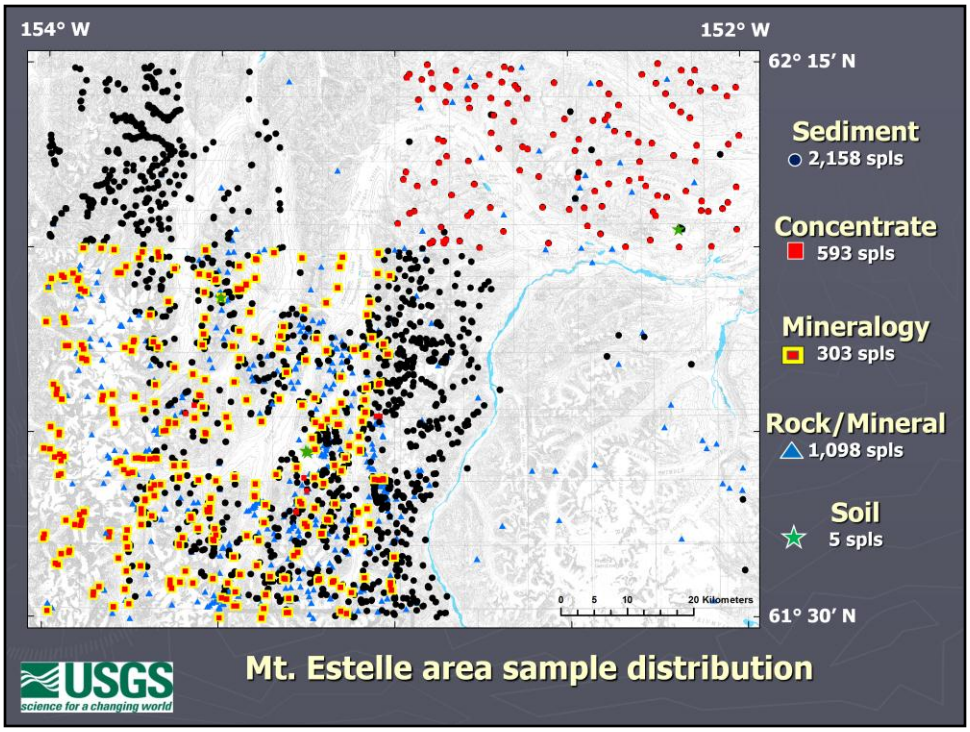


Data from the AGDB can also be combined with other types of geologic information to further develop and refine exploration targets. The Alaska Resource Data File (ARDF) is the USGS database of mines, prospects, and mineral occurrences for Alaska. In this example, we have plotted from the ARDF occurrences in which either nickel (blue triangles) or copper (black triangles) were the primary or secondary commodities present. Known nickel-bearing occurrences cluster at the east end of the map area, unlike a much broader distribution of copper-bearing prospects, the majority of which are underlain by Nikolai Greenstone (in purple).

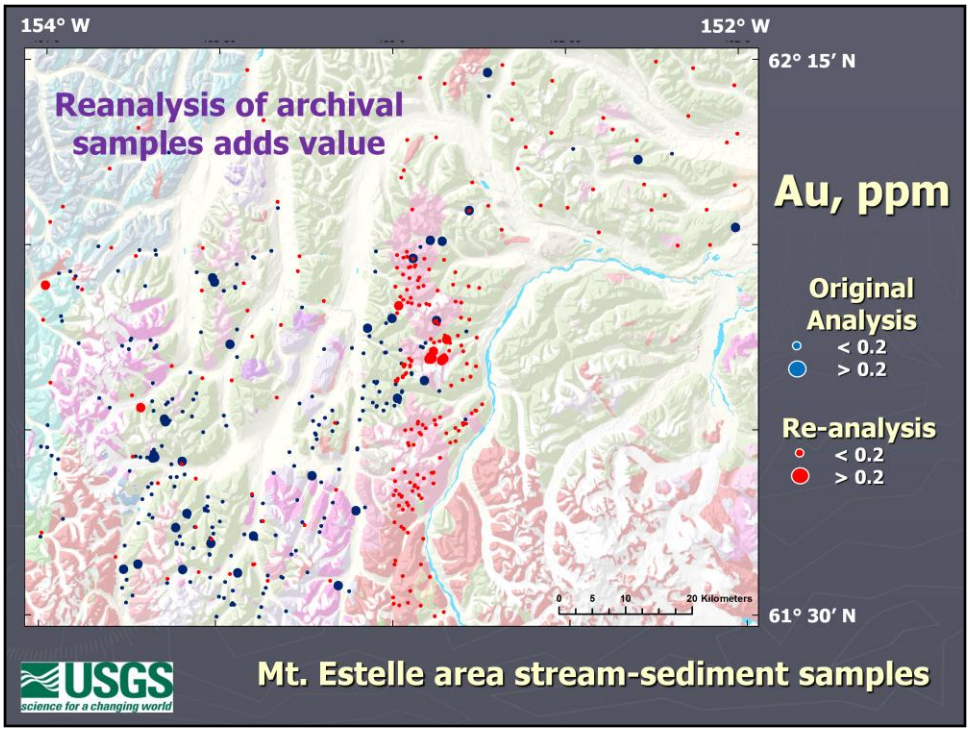
However, the AGDB includes mineralogical observations as well as analytical data. A search of AGDB mineralogic data for heavy-mineral-concentrate samples in which chalcopyrite was optically identified shows a distribution (red circles) significantly different than that of the known copper occurrences. This suggests that copper-sulfide minerals (such as chalcopyrite) have been derived from sources much more widely distributed than the known prospects.



Our second example of AGDB data use is in the area near Mt. Estelle in the western Alaska Range, situated at the junction of the Lime Hills, McGrath, Talkeetna, and Tyonek quadrangles.

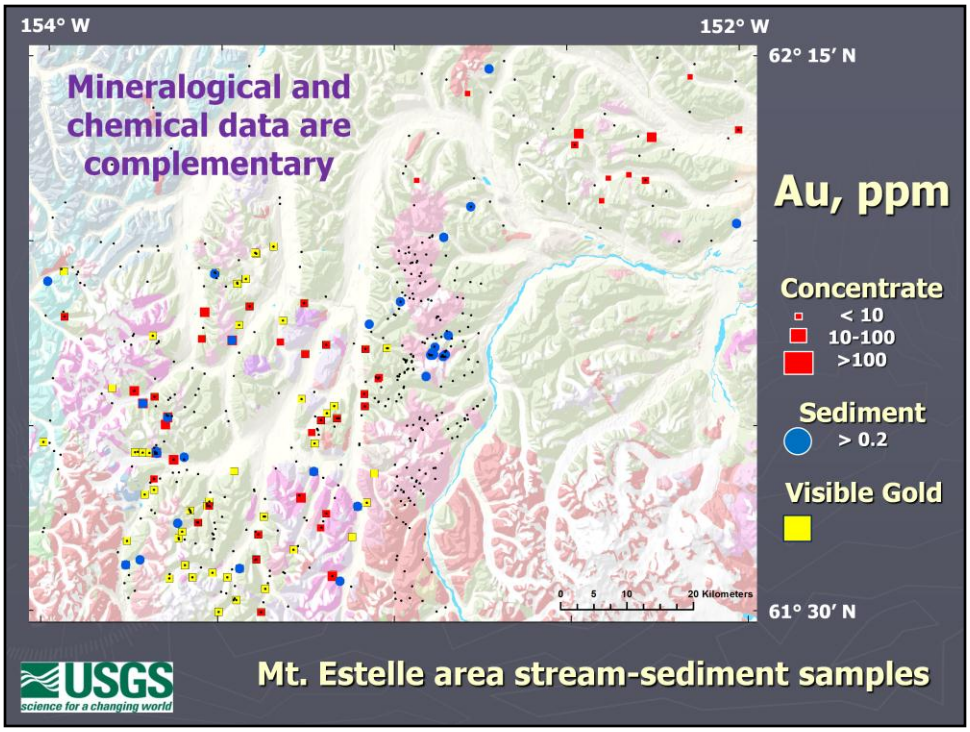


The 3,390-square-mile area around Mt. Estelle includes 4,157 samples (spls) for which analytical geochemistry or mineralogy data are available. This plot shows the variation in sample media types, sample density, and sample distribution within our area of interest. Note that the McGrath quadrangle (upper left) and the Tyonek quadrangle (lower right) show limited sample distribution and only a single sample media type—sediment samples (black circles). Distribution plots such as this identify target regions where additional sampling of one or more media is needed.

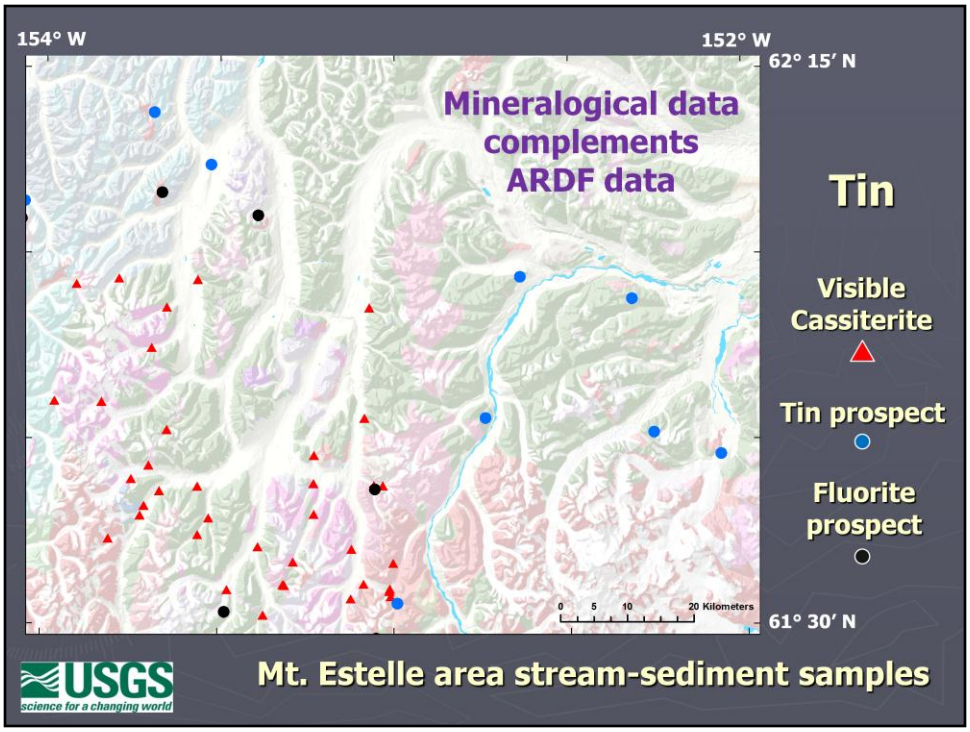


Between 2007 and 2009, stream-sediment samples collected during the Heavy Metals Program (1966-1970) and the Alaska Mineral Resource Assessment Program (AMRAP, 1970s-1980s) were retrieved from the USGS sample archives and reanalyzed for additional elements. In this case, sample points in red are those for which no gold determinations existed prior to this reanalysis program. These new data identified new areas with anomalous gold values. Both the old and new chemical data for these and similarly reanalyzed samples are included in the AGDB and are linked by field IDs so that reanalyzed samples can be clearly identified.

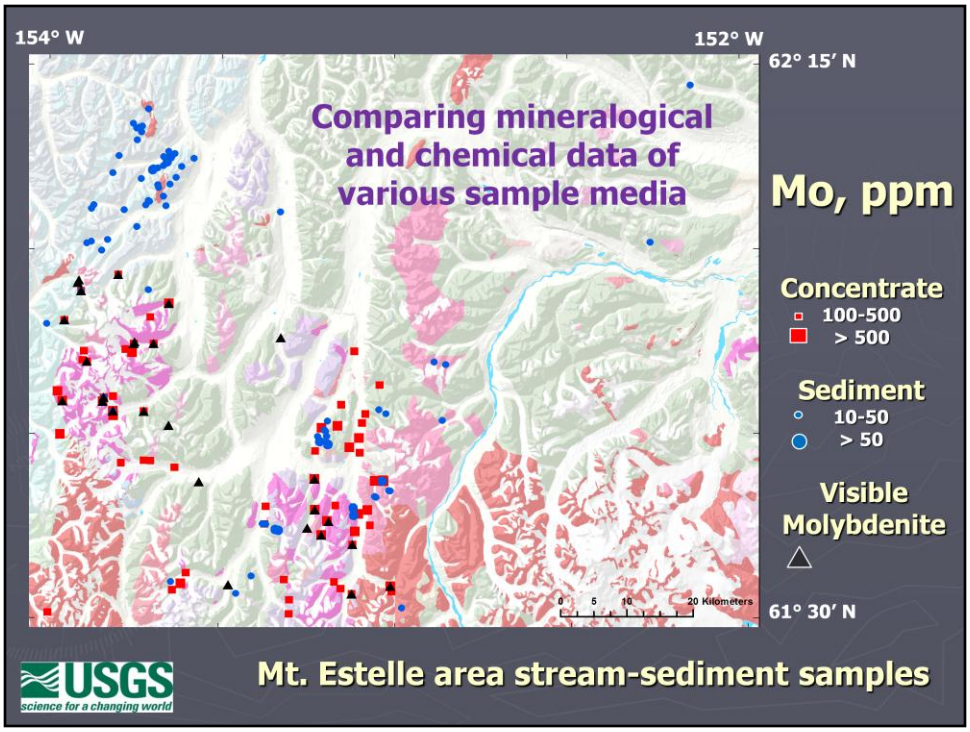
The map background shown here (from Wilson and others, 1998) indicates Cretaceous flysch of the Kahiltna assemblage and the Kuskokwim Group in pale green, Tertiary plutonic and volcanic rocks in various shades of red and purple, and pre-Mesozoic sedimentary rocks in blue.



The mineralogy data included in the AGDB provides yet another type of exploration information. Here in the Mt. Estelle area high values of gold analyzed from heavy-mineral-concentrate samples (red squares) and bulk stream sediments (blue circles) do not indicate all of the areas in which visible gold has been identified by optical microscopy (yellow squares).



AGDB data can also be combined with geologic information from other sources, such as the Alaska Resource Data Files (ARDF). In this plot, concentrate samples from the AGDB in which cassiterite was identified optically (red triangles), indicate a wide range of potential tin occurrences. Many of these are in regions not previously identified as having mineral occurrences (from the ARDF) in which tin (blue circles) or fluorite (black circles) are the primary commodity.



AGDB mineralogical data also provide information not necessarily available from the analytical data. Comparing the distribution of high molybdenum values in concentrates (red squares) and in stream sediments (blue circles) with the distribution of molybdenite identified optically (black triangles) highlights three distinct regions of potential for molybdenum-bearing mineral occurrences, each associated with a different suite of igneous rocks (shown in the reds and pinks).

Version 1.0 of the AGDB is currently available as a DVD or for download online. It is also available on the USGS Mineral Resource Data website (*http://mrdata.usgs.gov*), where it may be queried interactively and offers a variety of downloadable formats. Version 2.0 of the AGDB, to be released in 2012, will include analytical data for water-, organic-, and leachate-sample media.

For further information on the AGDB, copies of Fact Sheet 2011-3130 are available at the USGS Publications Warehouse (*http://pubs.usgs.gov/fs/2011/3130*).

If you have comments regarding the AGDB format and coverage, or corrections to current data, please send them to Matt Granitto or Jeanine Schmidt.

References Cited

Granitto, Matthew, Bailey, E.A., Schmidt, J.M., Shew, N.B., Gamble, B.M., and Labay, K.A., 2011, Alaska Geochemical Database (AGDB)—Geochemical data for rock, sediment, soil, mineral, and concentrate sample media: U.S. Geological Survey Data Series 637, 31 p. pamphlet and database, 1 DVD. (Available at *http://pubs.usgs.gov/ds/637*.)

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Wilson, F.H., Dover, J.H., Bradley, D.C., Weber, F.R., Bundtzen, T.K., and Haeussler, P.J., 1998, Geologic map of Central (Interior) Alaska: U.S. Geological Survey Open-File Report 98–133-A, v.1.2. (Available at *http://pubs.usgs.gov/of/1998/of98-133-a/*.)