Intrusive Rock Database for the Digital Geologic Map of Utah

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Introduction and Background

Digital geologic maps offer the promise of rapid and powerful answers to geologic questions using Geographic Information System software (GIS). Using modern GIS and database methods, a specialized derivative map can be easily prepared. An important limitation can be shortcomings in the information provided in the database associated with the digital map, a database which is often based on the legend of the original map. The purpose of this report is to show how the compilation of additional information can, when prepared as a database that can be used with the digital map, be used to create some types of derivative maps that are not possible with the original digital map and database.

This Open-file Report consists of computer files with information about intrusive rocks in Utah that can be linked to the Digital Geologic Map of Utah (Hintze et al., 2000), an explanation of how to link the databases and map, and a list of references for the databases. The digital map, which represents the 1:500,000-scale Geologic Map of Utah (Hintze, 1980), can be obtained from the Utah Geological Survey (Map 179DM). Each polygon in the map has a unique identification number. We selected the polygons identified on the geologic map as intrusive rock, and constructed a database (UT_PLUT.xls) that classifies the polygons into plutonic map units (see tables). These plutonic map units are the key information that is used to relate the compiled information to the polygons on the map.

The map includes a few polygons that were coded as intrusive on the state map but are largely volcanic rock; in these cases we note the volcanic rock names (rhyolite and latite) as used in the original sources Some polygons identified on the digital state map as intrusive rock were misidentified; these polygons are noted in a separate table of the database, along with some information about their true character.

Fields may be empty because of lack of information from references used or difficulty in finding information. The information in the database is from a variety of sources, including geologic maps at scales ranging from 1:500,000 to 1:24,000, and thesis monographs. The references are shown twice: alphabetically and by region.

The digital geologic map of Utah (Hintze and others, 2000) classifies intrusive rocks into only 3 categories, distinguished by age. They are: Ti, Tertiary intrusive rock; Ji, Upper to Middle

Jurassic granite to quartz monzonite; and pCi, Early Proterozoic to Late Archean intrusive rock. Use of the tables provided in this report will permit selection and classification of those rocks by lithology and age.

This database is a pilot study by the Survey and Analysis Project of the U.S. Geological Survey to characterize igneous rocks and link them to a digital map. The database, and others like it, will evolve as the project continues and other states are completed. We release this version now as an example, as a reference, and for those interested in Utah plutonic rocks.

CLICK ON THE LINKS BELOW TO VIEW THIS REPORT

Data characteristics

The The workbook, UTAH_PLUT.XLS, contains 9 worksheets, TITLE, CORRELATE, LITHOLOGY, AGE_SUM, RAD_AGE, DEPOSITS, ERRORS, DOCUMENTATION, and CLASSIFICATION. The first is the title page, and the last three provide supplementary information. Each of the rest is a table of attributes that applies to plutonic rock map polygons; these are also provided as tab-delimited .txt files suitable for use directly in GIS applications.

The CORRELATE table is the master table that relates quasi-stratigraphic units (*plut_name*) to the specific individual polygons of the digital geologic map of Utah. The *plut_name* was chosen to refer to a nearby geographic feature, or other commonly used name, tempered by the goal that each *plut_name* would represent a coherent group of lithologies, textures, and other attributes. In a very few cases where no appropriate name was apparent, a serial number was appended to the name of the 1:250,000 scale topographic quadrangle.

The LITHOLOGY table is the largest, with the largest number of fields. It contains information about lithology, mineralogy, texture, structure, geochemistry, hydrothermal alteration, and data quality, all related to the units (*plut_name*) in the CORRELATE table. There are as many records for each *plut_name* as are necessary to adequately describe the unit. Any unique combination of *lith_class* and *lith_form* requires an additional record. The maximum in the table is 8 records, which were required to describe Mineral_Mts_02. The numbers compiled in the percent field are percentages for each unique lithology; they add to 100 percent for each *plut_name*. We make no claim these figures are accurate to the two significant figures we use; they are estimates only.

The AGE_SUM table combines information about stratigraphic ages reflected by geologic setting of each *plut_name*, along with a best numerical estimate for the age of each unit. The quality of this estimate varies widely, but it permits the plotting and selection of the units mathematically and logically.

The RAD_AGE table compiles information about radiometric ages that were encountered during the research to complete the other tables. We make no claim that it is comprehensive. It serves as a reference for many of the age estimates in the AGE_SUMMARY table.

The DEPOSITS table contains information about associated mineral deposits, including mining districts, commodities, and mineral deposit types.

The DOCUMENTATION worksheet contains a description of the fields in the other worksheets, in the form of instructions for compilers.

The ERRORS worksheet lists 24 polygons that are coded as intrusive in the digital map database that, when examined on larger scale maps, prove not to be intrusive rocks. We did not try to determine if these were errors in the original map (Hintze, 1980) or introduced during production of the digital map (Hintze and others, 2000).

The DOCUMENTATION worksheet contains guidelines for the format of the individual fields in the data tables, and can serve as a guide to future compilers, as well.

The CLASSIFICATION worksheet portrays the hierarchical classification of plutonic rock names used in the *lith_class* field of LITHOLOGY. This hierarchy is very close to the recommendations of Streckeisen (1976).

Data

Download database files

UT_PLUT.xls (Microsoft Excel, 876 KB)

correlate.txt (tab-separated value, 16 KB)

lithology.txt (tab-separated value, 96 KB)

age_sum.txt (tab-separated value, 16 KB)

rad_age.txt (tab-separated value, 36 KB)

How to use the database

By linking the tables in this database to the Digital Map of Utah (Hintze et al., 2000), those polygons that are plutonic will acquire additional attributes that can be used to construct complex topical maps. This database must be joined to an existing copy of the Digital Map of Utah (Hintze and others, 2000). We made tests with ArcMap 8.2, and describe how to use it with that system, although similar methods will apply to other GIS software.

The first step is to add the tables CORRELATE.txt, LITHOLOGY.txt, AGE_SUM.txt, RAD_AGE.txt, and DEPOSITS.txt to your ArcMap document. Then join the CORRELATE.txt table to the attribute table of the Utah map, using the field *UTGEOMAP_* in the UTGEOMAP attribute table, and *spatobj_id* in the CORRELATE table as keys. Once this is successful, the other tables LITHOLOGY.txt, AGE_SUM.txt, and RAD_AGE.txt, and can be related (linked) to the UTGEOMAP attribute table, using *plut_name* as the relate field. Relates in ArcMap 8.x are termed links in ArcView 3.x. Figure 1 shows the structure of the resulting database.

To join two tables means to append the attributes in one table to those in the first, using a field common to both tables. This, of course, is only possible when there is a one-to-one relationship between the records in the two tables to be joined. This requirement is met by the CORRELATE table, which has one (and only one) entry for each polygon in the spatial database that refers to intrusive rock. However, note that a few polygons that are coded Ti in the spatial database do not have corresponding records in CORRELATE, because they were found to be errors, i.e. they do not refer to polygons that actually represent intrusive rock.

To relate, or link, two tables means, in this case, to define the relationship between some attributes about intrusive rocks in a table and the related records in the spatial database being used. This relationship can be defined even when the relationship between the two tables is not one-to-one. Using the data in this report, the single polygon represented by the *plut_name* Abajo_Mtns_East_01 consists of both diorite and monzodiorite, and part of the polygon represents a laccolith, part a stock. Thus, there are 4 entities in the LITHOLOGY table that relate to Abajo_Mtns_East_01. Selecting for either diorite, monzodiorite, sill, or laccolith will identify the Abajo_Mtns_East_01 polygon.

Because many of the polygons in the Utah digital geologic map contain multiple lithologies, it

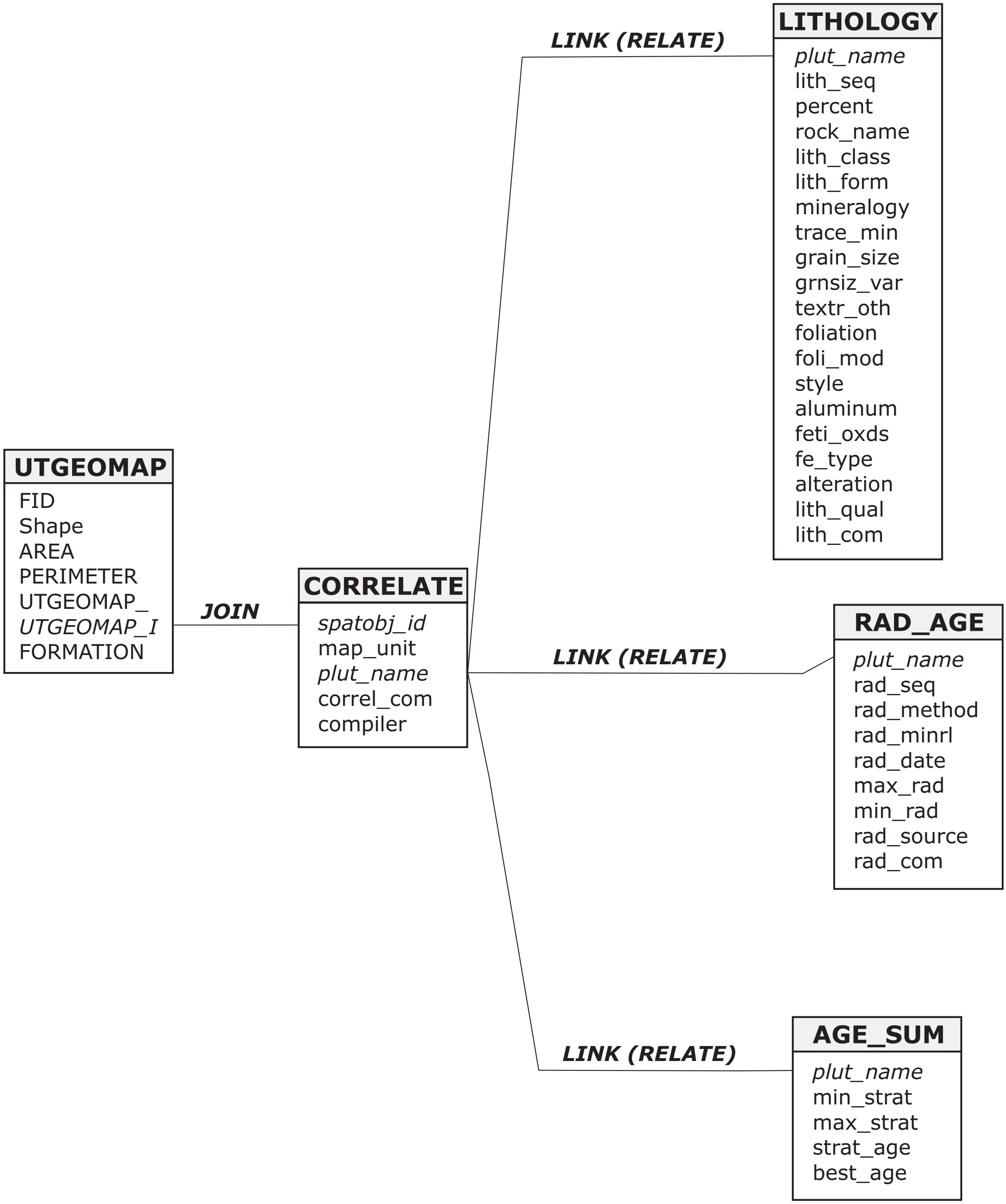

Figure 1. — Diagram showing structure of UT_PLUT database.

is conceptually impossible to make a map symbolized by rock type. It is, however, possible to make a map showing all polygons that contain some granite. This would be done by selecting all the polygons that contain granite, and making a new spatial file with them. But because many of them also contain granodiorite, it is not possible to directly construct a symbolization scheme based on lithology.

The *plut_name* field

During development of this database, some questions have arisen over the use and nature of the *plut_name* field. The names used in this field are for the convenience of the compiler, and should be chosen to both minimize extraneous detail, and to maximize information availability.

The complexity of this database is due to both the complexity of nature, and to the varied ways geologic map units are defined and illustrated. In nature, a pluton may consist of several lithologies, either separated by specific boundaries (contacts) or in a continuous, gradational relationship. It may also consist of only one lithology. Conversely, the body, that consists of one or more lithologies, may be exposed at the earth's surface in one continuous outcrop, or in a number of outcrops separated by surficial materials. Likewise, such a body may be portrayed on a geologic map as a single polygon, or as a number of polygons. On a small-scale map like the Utah map, an individual polygon is more likely to represent a number of different lithologies (or ages) than on a large-scale map like a 1:24,000-scale quadrangle. Nevertheless, many of the plutons portrayed on the Utah map consist of several polygons and are relatively homogenuous.

The polygon or polygons that are designated with a single *plut_name* should generally be as simple as possible, petrologically and temporally. Whenever possible, we assign a geographic name, in some cases, one that has been used informally in the literature. When an appropriate name is not apparent, we used the name of the 1 degree x 2 degree quadrangle, concatenated with a serial number (as in SALINA_01); names of this nature are in all caps. If, during compilation, a group of polygons is found to contain radically dissimilar rocks, or rocks of distinctly different ages, every attempt should be made to use multiple *plut_name*s. We have done this in the cases in the CORRELATE table where the serial number part of the *plut_name* is greater than one. In theory, one could even apply multiple *plut_name*s to a single polygon, but we have not done this.

Data compilation

Maps were prepared that portrayed all the polygons coded as intrusive rock (map units Ti, Ji, and PCi) on the digital representation of the Utah state geologic map (Hintze and others, 2000). Then, in order to assign *plut_name*s and to fill out the tables in UT_PLUT, geologic maps at 1:250,000 to 1:24,000 scales were consulted, as well as selected scientific articles that described the rocks in question. The starting point was available 1:250,000 and 1:100,000 scale maps and the GEOREF database. Using references from these maps and database, more detailed information was obtained about the attribute fields in LITHOLOGY and RAD_AGE. In some cases, the 1:250,000 and 1:100,000 maps were the only source of information. The reference list, which is shown both alphabetically and by region, is included to identify the sources of data.

The naming of igneous rocks is always contentious. In these tables, we have used the field *rock_name* for the name as used in reference publications. Entries in the *lith_class* field are limited to the hierarchy of names listed in the last worksheet of the spreadsheet, CLASSIFICATION. This hierarchy is closely similar to the one published by Streckeisen (1976).

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