GIS AND GPS UTILITY IN THE GEOLOGIC MAPPING OF COMPLEX GEOLOGIC TERRANE ON THE MASCOT, TENNESSEE 7.5' QUADRANGLE

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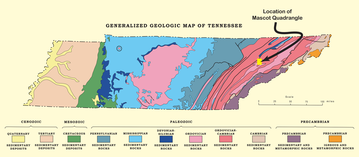
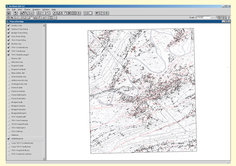
INTRODUCTION



Trimble GeoExplorer® 3 Global Positioning System

The Mascot, Tennessee 7.5' Quadrangle was selected as one of the candidates for geologic mapping under a STATEMAP cooperative agreement with the U.S. Geological Survey and the Tennessee Division of Geology. The Mascot Quadrangle is located in the Valley and Ridge Province of East Tennessee and the bedrock of the area consists of folded and faulted Cambrian and Ordovician strata. The Tennessee Division of Geology purchased two Trimble GeoExplorer® 3 Global Positioning Systems (GPS) prior to the start of geologic mapping on the Mascot Quadrangle. It was decided that the GPS units would be used in conjunction with ESRI ArcView® 3.2 Geographic Information System (GIS) software to compile geologic field information and present the results of the geologic mapping.



ESRI ArcView® 3.2 Geographic Information System

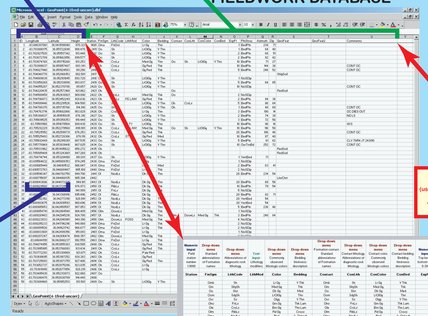
USING THE TRIMBLE GEOEXPLORER® 3 GPS AND DATA DICTIONARY FOR GEOLOGIC FIELD DATA COLLECTION

Using the Trimble GPS data dictionary, a geologic data spreadsheet was set up which contained attribute fields such as lithology, rock color, bedding thickness, formation contacts, etc. This GPS spreadsheet was designed for rapid data input by predefining many of the geologic attributes (e.g., fine-grained limestone, coarsely crystalline dolomite, dark gray, light gray, etc.) in dropdown menus. Numerical fields were included in the database for azimuth degree attitudes of bedding, joints, cleavage, fold axes, etc. Additional pertinent geologic information on soil, chert, karst, mining, etc. could also be input in the database by menu or text fields. These geologic attributes were usually input while the GPS unit collected the satellite-based coordinate information. After returning to the office, the coordinates were differentially corrected to a local base station to improve accuracy. Additional values were added to attributes with the data dictionary as needed while the field season progressed. The fieldwork database was transferred into a compilation database to produce the geologic map using the ESRI ArcView® 3.2 Geographic Information System (GIS) software.

Longitude, latitude, ID, and elevation: geographic information collected by GPS unit at geologic field stations.

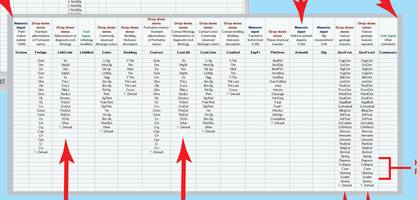
Data input by geologist at geologic field stations.

FIELDWORK DATABASE



Latitude and longitude coordinates are collected by the GPS unit in decimal degree format in order to plot field station locations in ArcView.

The strike is taken in azimuth degrees (using the right hand rule) for correct rotation of geologic symbols in ArcView.



THE GPS DATA DICTIONARY

contains a description of the features and attributes relevant to a project. It is used in the field to control the data collection of a feature (e.g., object, rock outcrop, etc.) and its attributes (e.g., object information, rock lithology, etc.). This particular data dictionary is structured toward the geology of the Mascot Quadrangle in that it contains features and attributes that should be observed in that quadrangle.

Several lithologies are diagnostic, but not exclusive to certain formations.

CrsLs = coarsely crystalline limestone ~ Holston Formation
RibLs = ribboned limestone ~ Consasauga Group limestones
NodLs = nodular limestone ~ Lenoir Limestone
DoveLs = dove gray limestone ~ Mosheim Limestone Member
PotDol = petroliferous dolomite ~ Copper Ridge Dolomite

Several geologic occurrences are diagnostic, but not exclusive to certain formations.

CrypChrt = cryptocoan chert ~ Copper Ridge Dolomite
MoldChrt = dolomoldic chert ~ Chepultepec Dolomite
ChrtMxSs = chert matrix sandstone ~ Mascot Dolomite

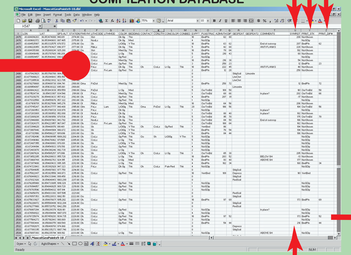
THE COMPILATION DATABASE WAS ADDED TO AN ARCVIEW PROJECT IN ORDER TO PLOT AND MANIPULATE THE GEOLOGIC FIELD DATA

USING ESRI ARCVIEW® 3.2 GIS SOFTWARE AND THE GPS DATABASE TO PRODUCE THE MASCOT QUADRANGLE GEOLOGIC MAP

The geologic field information was exported as a dBase file and transferred into a compilation database that was used in ArcView® to produce a preliminary geologic compilation map. This map included separate point themes for lithology, bedding attitudes, formation contact points and other geologic features recorded in the database. These point themes were used to draw in contacts and faults as line themes to produce a final compilation map.

To produce the "final" version of the geologic map, the line themes are converted to polygon themes with appropriate fill colors and displayed beneath the topographic base map. Contacts and faults are divided into solid, dashed, and dotted line segments. Lithologic and geologic point themes are not displayed.

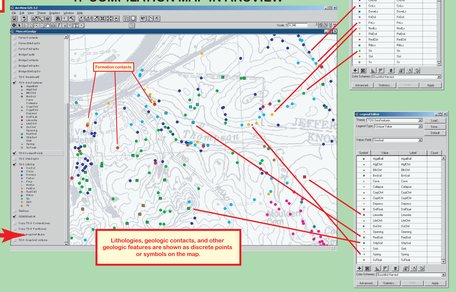
COMPILATION DATABASE



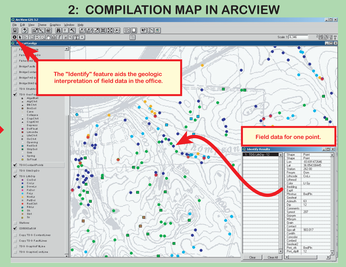
Columns were added to the compilation database for geologic symbol rotation (SYMROT), print geologic symbol (PRINT_STR), print dip number (PRINT_DIP#) in ArcView.

The compilation database was used to construct preliminary geologic maps. Point, line, and polygon themes are used to represent various geologic aspects.

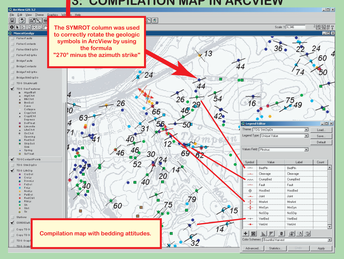
1: COMPILATION MAP IN ARCVIEW



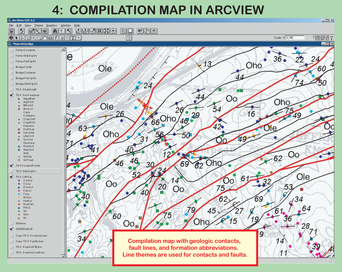
2: COMPILATION MAP IN ARCVIEW



3: COMPILATION MAP IN ARCVIEW

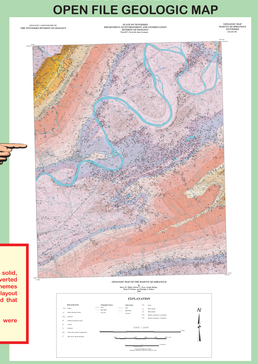


4: COMPILATION MAP IN ARCVIEW



5: COMPILATION MAP IN ARCVIEW

REDUCED VIEW OF OPEN FILE GEOLOGIC MAP

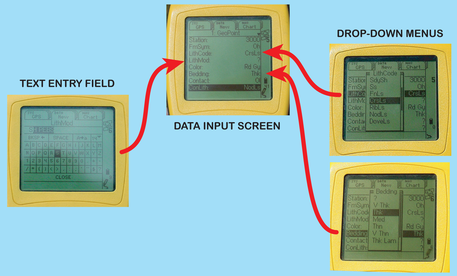


GEOLOGIC MAP CONSTRUCTION

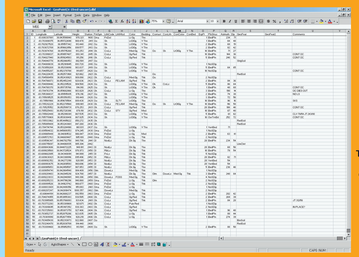
In the ArcView map view, stratigraphic contact and fault contact lines were divided into solid, dashed, and dotted line segments based on contact reliability. The line themes were converted to polygon themes with appropriate geologic fill colors. Lithologic and geologic point themes were not displayed. The geologic cross-section location line was added. In the ArcView layout view, titles and labels were produced and a geologic symbol legend was constructed that included a written scale, bar scales and a north arrow.

The geologic cross-section, stratigraphic section and stratigraphic description were constructed separately using Adobe Illustrator 8.0 software.

GPS SCREEN DISPLAY OF DATA DICTIONARY FILE



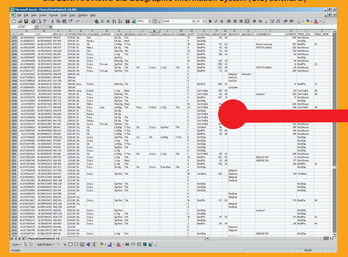
FIELDWORK DATABASE



FIELD DATA TRANSFERRED TO COMPILATION DATABASE

COMPILATION DATABASE

(used to produce the geologic map using the ESRI ArcView® 3.2 Geographic Information System (GIS) software.)



CONCLUSIONS

The Trimble GeoExplorer® 3 Global Positioning System and the ESRI ArcView® 3.2 Geographic Information System were invaluable tools to complete the geologic map of the Mascot Quadrangle. The GPS unit facilitated accurate location of station points in complex geologic areas where formation units were repeated within short distances due to imbricate faulting as well as station location in areas with few useful landmarks. The GPS data dictionary permitted relatively rapid data entry into the database while the GPS unit collected coordinate information. The GIS software enabled accurate plotting of the GPS coordinate information and manipulation and display of the database attribute information.

PROBLEMS:

-The need for a *paper copy* of the topographic map in the field for navigation and station point location.

-The need to plot the data in the field to determine where the geologic traverse needs to proceed.

-Field books were necessary for lengthy geologic descriptions, sketches, or other information.

-Time consuming to convert line themes to polygon themes in GIS.

-GPS acquisition of coordinate information was occasionally time consuming particularly under heavy forest canopy or when satellites were not in proper array. Station point locations were sometimes plotted on topographic map paper copies and later converted into GIS locations.

Many of these problems may be overcome by the acquisition of ESRI ArcPad® 7.0 and ESRI ArcGIS® 9.1. Despite the minor GPS and GIS problems in the field and office, the two systems worked well in unison to complete the task of geologic mapping in the Mascot Quadrangle.