Incorporation of Geologic Data with Soil Survey Information

Harvey Thorleifson, Association of American State Geologists & Dave Soller, US Geological Survey

Asheville, North Carolina
May 22-26, 2011
“Soil Survey — Interpreting the Inventory in a Digital World”
The Association of American State Geologists (AASG) represents the State Geologists of the 50 United States and Puerto Rico. Founded in 1908, AASG seeks to advance the science and practical application of geology and related earth sciences in the United States and its territories, commonwealths, and possessions.

Click on each state to go to its geological survey!

Other selection options...
National Cooperative Geologic Mapping Program
U.S. National Geologic Map Database Project
Dave Soller, USGS, Project Chief

http://ngmdb.usgs.gov
The U.S. Geologic Mapping Act of 1992:

“...The Survey shall establish a national geologic map database. Such database shall be a national archive ...”

Geologic maps contributed to the national archives should have standardized format, symbols, and technical attributes... ”
NGMDB responsibilities

Standards:
- FGDC Symbols and Colors
- Terminologies and Nomenclature
- Publication Formats
- NCGMP ArcGIS 9.3 Map Template

Database contents:
- Geoscience Catalog
- Geologic Names Lexicon
- NCGMP Mapping In Progress
- Geologic Names Comm. Archives
- USGS Paleo & Strat Archives (in prep.)

http://ngmdb.usgs.gov
NGMDB Geoscience Map Catalog

We provide bibliographies and links to buy, borrow, and download these products.

- 87,000+ products
- 630+ publishers
- 43,500+ are “digital”
- 13,000+ scanned maps in our image library. New system will provide images as:
  - Full and low resolution PDFs
  - Full resolution geoTIFFs
  - Browse JPEGs, MrSIDs

http://ngmdb.usgs.gov
New technologies, new options -- A Window to the NGMDB Map Catalog via ArcGIS Image Server

2011 plan:

• Georeference Catalog holdings (20,000+ geologic maps)
• Create composite bedrock, surficial, and “newest available” geologic basemaps
• Make accessible to users via web interface (thin clients) and GIS software (thick clients)
• Link service to the Map Catalog (discovery)

(CO – UT area, showing 250K maps, and footprints of larger-scale maps)
Appendix. Geochemistry of the <63 micron fraction

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Digital till surface points

F51 cross-section and digitized points of Otter Tail River group top -- GoCAD
Digital till surface points

F51 cross-section and all points in West Fargo Area of Otter Tail River group top -- GoCAD
F51 cross-section, points of Otter Tail River group top and surface of Otter Tail River River group top -- GoCAD
F51 cross-section, points of Otter Tail River group top and volume of Otter Tail River group -- GoCAD
Cross-sections of solid model of Quaternary in West Fargo area

Sherack Formation
Brenna/Argusville Fms.
Red Lake River group

Buffalo aquifer
Goose River group
All aquifers in West Fargo area
Red Lake River group aquifers in West Fargo area

- West Fargo North aquifer
- Eastern Edge aquifer
- Buffalo aquifer
- Mapleton aquifer
- Ponderosa aquifer
- Davenport aquifer
- West Pleasant aquifer
- Horace aquifer
All aquifers in West Fargo area
All aquifers in West Fargo area
All aquifers in West Fargo area
Geologic Model with the Lake Agassiz Beaches and Sherack Fm. removed

Forest River gp.

Brenna & Argusville Fms.

undifferentiated surface outwash
Model with Forest River gp., surficial sand and Brenna & Argusville Fms. removed

Red Lake River gp.

Hillsboro aquifer
Geologic Model with Sheyenne delta sediments and Upper Goose River I gp. removed

Upper Goose River II gp. sand
Geologic Model with the Upper Goose River II gp. removed

Lower Goose River gp. sand
Geologic Model with the Lower Goose River gp. removed

Otter Tail River gp. sand
Geologic Model with the Otter Tail River gp. removed
Model with Buffalo River gp., Lake Tawauken gp and Crow Wing River gps. removed

Browerville fm. sand
Geologic Model with the Browerville fm. removed

Older Till
Geologic Model with the Cretaceous Fms. removed

Ordovician Red River Fm.

Ordovician Winnipeg Group
Mapping, not maps
Threats to groundwater quality

Vulnerability and fate of contaminants are governed by geology
PART ONE
REPORT OF THE WALKERTON INQUIRY
The Events of May 1998 and Related Issues

Walkerton
Water Treatment Plant

ONTARIO

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Minnesota Geological Survey Databases

- Geological Survey Publications
- Geological Mapping; 1:1M & 1:100K
- Geological data
- Geological collections
- Geophysical data
- Geochemical data
Publications

• Publications index
• Maps
• Reports
road cut shows a mixture of Cretaceous clay with the Cambrian, the top of the whole being thiny and irregularly covered over and chinked up with coarse drift. The Cambrian is more or less broken and tilted; at least the bedding seems to have been cut out into huge blocks by divisional planes, which, either by weathering or water-weathering, were widened, the blocks themselves being subsequently thrown to some extent from their horizontality, tipping in all directions. The opened cracks and seams were then filled with the Cretaceous clay, which is deposited between these loosed masses, and sometimes even to the depth of twenty feet below the general surface of the top of the rock. The clay sometimes occupies rocks and rounded angles, sometimes sheltered below heavy masses of the Cambrian beds. The clay is uniformly bedded, about horizontally, with some slope in accordance with the surface on which the sedimentation took place. But the most interesting and important feature is the condition of these old Cambrian surfaces. They are rounded by the action of water, evidently waves. The cavities and porous spots are more deeply eroded, making little pits on the face of the rock; and along the lines of section of the sedimentation planes with the eroded surface, there are furrows due to the greater effect of water. The rounded surface of these huge masses of limestone is coated with a thickness of about a half inch, or an inch and a half, of iron ore, which scales off easily, and is easily broken by the hammer. While this scale of iron ore is thicker near the top and on the upper surface of the blocks, yet it forms down between the Cretaceous clay and the body of the rock."

Another deposit of greenish clay (Fig. 25) similar to the two last described, enclosed in a cavity of the Shakopee limestone and in part appearing to be a stratum overlain by it, was noted beside the carriage road from South Bend to Mankato close east of its bridge over the Blue Earth river.

**FIG 25. CRETACEOUS CLAY BENEATH THE SHAKOPEE LIMESTONE, MANKATO.**


In the S. W. 1 of section 30, Lime, the quarry of J. R. Beatty & Co. exhibits a thickness of twenty to twenty-five feet of the Shakopee limestones. The top of this ledge is waterworn and hollowed in shallow potholes. Near the middle of the quarry face, as it was at the time of examination, these water-worn cavities reach to a depth of fifteen feet, their sides being in part encrusted with an iron-rusty scale, an eighth to an inch thick. They are filled with very coarse ferruginous gravel, much waterworn, so that sometimes its pebbles up to three or four inches in diameter are almost perfectly spherical. In some of these crevices scanty traces of white clay occur with the gravel, the former being probably Cretaceous, while the latter seems to be older than the glacial drift, and may be Cretaceous or of earlier date, possibly representing the period in which these hollows were eroded. Close west of this quarry is found a thick bed of whitish, very fine earth (analyzed 2, page 438), containing too little clay for brick-making.

Professor Winchell writes as follows respecting these probably Cretaceous deposits at localities recently examined by him near Mankato. "At the quarry of the Standard Cement company, lately opened in the east bank of the Blue Earth river about a third of a mile south of the railroad bridge, the Shakopee limestones is separated from the Jordan sandstone by a course of light green or often nearly white shale or clay, highly silicious and aluminous, having a thickness of about three feet. The hydraulic qualities of the Shakopee limestone seem to be associated with the occurrence of this bed of shale, and to be altogether an accidental and local character. The formation has before been known to be somewhat hydraulic, but here this quality is so far extended as to make a valuable source of hydraulic lime. In the Shakopee limestones here are also numerous pits and gorges, rounded off with age and creased over with a ferruginous scale
Publications

• 650 maps published since 1872
• 100% scanned and web accessible
Geological Mapping; 1:1M & 1:100K
Geological data

- Geological observations
- Geotechnical data
- Hydrogeological data
- Images
- Karst database
- Mineral exploration document archive
- Sediment texture and lithology
- Water well data
Databases

- Water well data
Geological data
• Hydrogeological data
Geological data

- **Karst database**
- **12,164 sites**
Geological data

- Sediment texture and lithology
- 12,000 analyses
Geological data

• Geological observations
  ➢ MGS – 40,000 sites
  ➢ DNR Aggregate
Geological data

- Geotechnical data
Geological data

- Images
Geological collections

- Cuttings
- Drill core
- Fossils
- Geochemical samples
- Hand samples
- Sediment samples
- Thin sections
Collecting:
- Drill core
- 3 million feet
Collections

- Cuttings
- 4900 sites
Collections

• Hand samples
Collections

• Thin sections
Collections

- Fossils
- 16,242 specimens
Collections

• Geochemical samples
Collections

• Sediment samples
  ➢ ~25,000 samples
Geophysical data

- Aeromagnetic data
- Airborne gamma ray spectrometry
- Borehole geophysics index
- Gravity
- Rock Properties
Geophysical data

- Aeromagnetic data
Geophysical data

- Gravity
Databases

- Rock Properties
- 4000 values
Geophysical data

- Borehole geophysical log index
- 5500 logs
- Average depth 336’
Geophysical data

- Soundings

Seismic reflection profiling

- Recording truck
- Geophones
- Drilling rig
- Explosive seismic source
- Reflected seismic waves
- Geological structure
- Velocity 1
- Velocity 2
Geophysical data

• Airborne gamma ray spectrometry
Geochemical data

- Soil geochemical data
- Till geochemical data
- Groundwater geochemical data

The chemistry of soil and well water in Minnesota reflects a combination of natural history and cumulative human impacts, and presumably has an influence on biodiversity and human health.

Understanding this landscape requires geochemical mapping. The Minnesota Geological Survey (MGS) and the Minnesota Pollution Control Agency (MPCA), in cooperation with the United States Geological Survey (USGS), have assembled the Minnesota Geochemical Database, a comprehensive collection of chemical properties of selected statewide geochemical data. Construction of this dataset was funded by the Minnesota Minerals Coordinating Committee (MMCC).

Soil, soil parent material, and well water were analyzed following USGS Environmental Protection Agency (EPA), and Geological Survey of Canada protocols. The 1,360 points on the soil map show combined results from soil in the top 0.2 meters and at about 0.5 meters depth, as well as stream sediments. Soil and some stream sediments were sampled in 2004 and 2005. Most stream sediments were collected in 1979, mainly from western Minnesota under the National Uranium Resource Evaluation program, and were remanaged in 2013. Soil data were averaged; values below detection were set to half the detection limit. The soil parent material map shows the weighted arithmetic mean of the sample values for the map area, and the fraction for soil <15 millimeters and for soil parent material was <0.5%. The well water map shows results from MPCA sampling and analysis from 854 water wells that sampled 71 selected aquifers between 1965 and 1996. Map classes are based on natural groupings in the data using the natural breaks method. Class boundaries were established by the mapping software at relatively large jumps in the data values.

The geochemical database is both state-wide and multi-level, providing a regional context for exploration and environmental management effects. Additional geochemical information is available for specific areas. Users of this map are referred to an accompanying report for more detailed information about data collection and limitations.

This and other maps, plus associated data, are available from the Minnesota Geological Survey. Additional information may be obtained from the MPCA and USGS.
1992 PRAIRIE ULTRA–LOW DENSITY GEOCHEMICAL RECONNAISSANCE
Cd (AAS) in <63μm Tills
Soil Geochemical and Indicator Mineral Reconnaissance Survey of Till in Minnesota

**Magnesium**

- Year of collection: 2004
- Material sampled: C horizon till
- Number of samples: 250
- Analytical method: Total leach/ICP-AES/IMS
- Analyzed fraction: <63 μ

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University of Minnesota

Minnesota Geological Survey, Harvey Thorkelson, Director
Soil Geochemical and Indicator Mineral Reconnaissance Survey of Till in Minnesota

**Aluminum**

- Year of collection: 2004
- Material sampled: C horizon till
- Number of samples: 250
- Analytical method: Total leach/ICP-AES/IMS
- Analyzed fraction: <63 μ

---

**Percentile Aluminum percent**

- 25 5.2
- 50 5.8
- 75 6.7
- 90 7.6
- 95 7.9
- 98 8.2
- 99 8.3
- 100 9.3
Soil Geochemical and Indicator Mineral Reconnaissance
Survey of Till in Minnesota

**Cadmium**

- Year of collection: 2004
- Material sampled: C horizon till
- Number of samples: 250
- Analytical method: Total leach/ICP-AES/IMS
- Analyzed fraction: <63 μm

**Map of Cadmium Distribution**

- **Percentiles and Concentrations**
  - 25th percentile: 0.12 ppm
  - 50th percentile: 0.27 ppm
  - 75th percentile: 0.37 ppm
  - 90th percentile: 0.54 ppm
  - 95th percentile: 0.69 ppm
  - 98th percentile: 0.89 ppm
  - 99th percentile: 1.06 ppm
  - 100th percentile: 1.13 ppm

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University of Minnesota
Minnesota Geological Survey, Harvey Thorleifson, Director
Soil Geochemical and Indicator Mineral Reconnaissance Survey of Till in Minnesota

Barium

Year of collection: 2004
Material sampled: C horizon till
Number of samples: 250
Analytical method: Total leach/ICP-AES/IMS
Analyzed fraction: ~63 µ

Kilometers

Percentile Barium ppm
25 420
50 470
75 520
90 560
95 610
98 660
99 670
100 690
Databases

• Geological Survey Publications
• Geological Mapping; 1:1M & 1:100K
• Geological data
• Geological collections
• Geophysical data
• Geochemical data
Uppermost layer of subsurface information

Bathymetry
Web Soil Survey

Version 1.1

Maintenance Schedule
Supported Browsers
New features in version 1.1
Release Notes
"Web Soil Survey—How To Use It" (PDF)

Third, click on the Soil Data Explorer tab to...
Discretized physical properties
Drillhole forecasts
<table>
<thead>
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<th>Day</th>
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Incorporation of Geologic Data with Soil Survey Information

Harvey Thorleifson, Association of American State Geologists &
Dave Soller, US Geological Survey