Development of a Virtual Geotechnical Database System to Store and Retrieve Subsurface Information

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Agenda

◆ Overview

◆ Process

  ● Acquiring Geodata
  ● Formatting Geodata

◆ Applications: Manipulations of database information

◆ Conclusions
Why have a VGDB?

- Need for easy access of existing geologic and geotechnical data useful for assessing vulnerability of underground facilities, groundwater, and environmental conditions.
- Need for up-to-date information, such as expected subsurface conditions, physical properties, depth-to-groundwater, which can easily be updated and shared with end users.
Broader Motivation

Department of Defense agencies need accurate geodata for:

- navigation
- target evaluation
- environmental sustainability
- resource assessment
- prediction of site conditions
Compile raw geological & geotechnical data

Convert to GIS layers

Digital

Compil

GIS

Bedrock Geology
Mines
Rivers
Shapefiles

Coded in XML

Analog

Borehole Logs
ACQUIRING GEODATA
BEDROCK GEOLOGY & SURFICIAL MATERIALS
Bedrock Geology

1. Harrison (1997), scale 1:100,000
2. Whitfield (2002), scale 1:24,000
3. Stincomb and Fellows (2002), scale 1:24,000
4. Middendorf and Brill (2002), scale 1:24,000
5. Kolata (2005), scale 1:500,000
Surficial Materials
Composite Soils Map

Data from USDA; 1:12,000 scale
### Engineering Properties

**St Clair County, Illinois**

[Abundance of an entry indicates that the data were not estimated]

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<th>USDA Texture</th>
<th>Classification</th>
<th>Fragments</th>
<th>Percent passing sieve number (4, 10, 40, 200)</th>
<th>Liquid limit</th>
<th>Plasticity index</th>
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HISTORIC MAPS
1796 map of St Louis area; note large oxbow lakes in flood plain
Overlay information on historic maps – in this case, old oxbow lakes and cutoffs that have since been infilled.
Lakes identified on 1908 map have been filled in and covered by development.
CROSS SECTIONS
GEOTECHNICAL BORINGS
**Borehole data in Excel spreadsheet**

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KARST FEATURES
Sinkholes
GEOPHYSICAL INFORMATION
Shear Wave Velocity (Vs) and Surficial Geology
Peak Horizontal Accelerations from New Madrid Seismic Zone

Legend
Earthquakes
OTHER_MAG1
-9999.000 - 0.000
0.001 - 2.000
2.001 - 3.000
3.001 - 4.000
4.001 - 5.000
Peak Horiz. Acceleration (%g)
<all other values>
ACC_VAL
0
1
2
3
4
5
6
7
8
9
10
15
20
25
30
40
60
80
100

Historic earthquakes, showing epicenters and magnitudes
HUMAN ACTIVITY
Mines

Grey areas underlain by coal; pink areas underlain by mines on IL side

Circles with X’s indicate abandoned mines on MO side
Pipelines

Pipelines shown carry crude oil, natural gas and/or refined products.
FORMATTING

GEODATA
Formatting: ArcGIS

- **File type**
  - ArcInfo: .e00
  - Google Earth: .kml
  - Shapefile: .shp

- **Projection** - NAD 1983 Datum
- **Attribute tables**
Formatting: XML

- Data Interchange for Geotechnical and Geoenvironmental Specialists (DIGGS) Standard
- Used by:

  - USGS
  - U.S. Department of Transportation
  - Federal Highway Administration
  - 12 state DOTs
Metadata

- Data about data
  - Source
  - Map scale
  - Method of acquiring data
- Must follow Federal Geographic Data Committee standards
## Data Dictionary

### MoDOT
- Struc_Id
- BH_Id
- FHoleElev
- FDepth
- FSampEl
- Blows_2
- Blows_3
- Nm
- Em
- Ne_N60
- PP
- Torvane
- Qu_psf
- c_psf
- phi_angle
- Cc
- Cv_e
- P1_e
- Pc_e
- P2_e
- e0
- ec
- e2
- LL
- PI
- ASTM_class
- Wm_percent
- EDryWt
- DryWtMeth
- Comment
- Xutm_point
- Yutm_point

### MEGA
- **ID**
- **WELL_TYPE**
- **OWNER**
- **DRLDATE**
- **DRILLDEPTH**
- **DEPTHTOBED**
- **SWLA**
- **ELEVATION**
- **TOP**
- **BASE**
- **NAME**
- **UNIT_1**
- **TOP**
- **BASE**
- **NAME**

### ISGS
- **api**
- **UTM 15_N83_X**
- **UTM15_N83_Y**
- **elev**
- **elevref**
- **cdate**
- **st**
- **fname**
- **fnum**
- **cname**
- **permitnum**
- **permitdate**

### Heading | Description | Example
--- | --- | ---
base | Measured depth or distance to the base of Layer. If the depth is unknown because it occurs below the depth of investigation, set to the base of the hole. If Layer is a point depthBase should be set equal to depthTop, or depthBase may be left blank. | 1.6
baseBoundary | A description of the Boundary at the bottom of this layer | A
reference | Stratum Reference | A
classifications | Classification of this Layer | |
components | Components of this Layer | |
descriptions | A description of the Layer within the context of the descriptive system | |
Manipulation of Database Information
to Enhance Quality Control of Predictive and/or Hybrid Map Products
Cokriging Map of **Groundwater Elevations**

**Data Sources:**

1. ) 1069 well logs from **MoDNR and ISGS**

2. ) 469 inferred points from **topo maps (1:24,000)**

3. ) 2100 points along rivers & streams from **USGS**
Predicted **Standard Error of Groundwater Elevation using Cokriging**

The larger value, the more error (the less accurate)

Thus, more dataset of well logs are necessary for these areas for better estimation.
Cokriging Map of **Bedrock Elevation** and showing data points (geotechnical borings)

**Data Sources:**

1. 2637 boring logs from MoDNR
2. 3997 boring logs from ISGS
Map of Liquefaction Potential Index
Conclusions

- Data from disparate sources:

  - USGS
  - USDA
  - Missouri Environmental Geology Atlas
  - Missouri Department of Natural Resources
  - Environmental Protection Agency
  - MoDOT
  - Illinois State Geological Survey
  - VGDB
Conclusions

- **Result:** comprehensive & unique source for geospatial analysis of the St. Louis area
- Many applications of data use
- Other areas can use this as a template
Questions?