3-D Geological Modelling at the OGS - Products and Applications

or....

I made a model!!! Now what?

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Meet the team

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Our clients

- Internal (OGS geoscientists)
- Conservation authorities
- Industry / Consultants
- Other government ministries (Ministry of Environment and Climate Change)
- Academia

What and Where

- Reconstruct the regional Quaternary history
- Construct a 3-D model of key sediment packages
- Characterize the properties of the modelled sediment packages
Products: Guiding Principles

- Standardized from one project area to the next
- Terminology and geologic conceptualizations need to be standardized to allow for merging of models
- Products need to be useable by a wide range of clients
- Need to release products that eliminate the need for high-end computers or software to use the data.

Life-cycle of a 3-D Project

Project Initiation  
Reconnaissance  
Acquire legacy data  
Geophysics  
Drill (that's the fun part)  
Model  
Final products
Reconnaissance

- Improve our understanding of late-glacial history
- Verify existing surficial mapping (identify problem areas)
- Log exposures
- Auger and probe....
- Meet potential partners
Usage and Feedback...

Traditional view is that nobody reads them.

Consultants and Conservation Authorities
- See where we are starting new projects and get routine updates.
- Used as a source for baseline understanding of the geology in a given area.
- In recent years these reports have been completed on a finer-scale than the regional Quaternary geology reports previously used to understand glacial history.
- No one has much knowledge of summary articles. Their existence is poorly known and are generally viewed as a flag that work is on-going.

Internal
- Get it down before you forget!
Dealing with data
- Acquire data
- Standardize
- QUALITY!!!!!

Subsurface database is released as part of the final groundwater resources study
Geophysics

Ground-based gravity surveys
- Target areas with known or suspected buried bedrock valleys
- Guide drilling and monitoring well targets
Seismic surveys
- Collaboration with the GSC
- Continuous data
- Mixed results
- Up to 200 m depth penetration

Airborne Time-Domain Electromagnetics
- Continuous data
- Transmitter flown 30-40m above ground (prepare for phone calls!)
- Depth penetration of up to 200 m
- Cultural interference is a huge problem

Products
- Lots of maps (.pdf)
- Geophysical datasets
  - Databases
  - Grids
  - Survey lines and/or stations
  - Images
  - Contours
  - Logistics and processing reports
Usage and Feedback...

Consulting Companies
- Data is seen as contributing to the overall understanding of the area.
- Geophysical data outlining the buried valleys is very useful in modelling studies.

Conservation Authorities
- I don’t think we have the computing power to use the geophysical tools.

Internal
- Most of the geophysical surveys are designed to help find buried bedrock valleys before we drill (gravity surveys) or improve our understanding of surfaces.

Municipal Engineers
- Used results of a gravity survey to check on some dodgy drill logs.

Drill

![Drill Image]
Monitoring wells
• Collaboration with municipal and conservation authority partners
• We provide the hole, they install the well

Downhole geophysics
• Collaboration with the GSC
• Determine seismic velocities of lithological units (convert profiles to true depths)
• Fingerprint tills
Product: Summary Report

- Hot off the drill field descriptions
- Preliminary interpretations
- Summary logs
- Text and graphics (.pdf)

Usage and Feedback...

Conservation Authorities
- Great, thank you. When do we get your interpretations?
- Do you keep track of fractures?

Consulting Companies
- Good morning Abigail. I just downloaded your latest summary and wondered if I could run something by you.....

Internal
- Take a deep breath and THINK
**Product:** Interactive Borehole Data Release

- Index map (.pdf)
- Graphic borehole log (.pdf)

Graphic borehole logs are linked to...

- Written logs (.pdf)
- Analytical results database (.mdb)
- Spreadsheet (.xls)
- Photos (.jpg)
**Usage and Feedback...**

Conservation Authorities
- We use the logs for holes with monitoring wells.
- I don’t need the details, just show me the aquifers!

Consulting Companies
- I like to see the detailed logs so I can be confident in your interpretations (and summary logs).
- We use the boreholes as golden spikes to extrapolate the geologic units outwards.
- Particularly useful as you drill in areas with little or only poor quality data.
- Saves us (clients) money as we don’t have to drill.
- Only useful if boreholes are close to a site or area of interest – this rarely appears to be the case.
- Downhole geophysics isn’t of much interest

Engineer
- Asked for additional parameters (numbers make them happy)

Other ministries
- Soil scientists like the way the drill data is displayed.

**Product: New Interactive Borehole Map**

- Project information
- Conceptual model
- Maps
- Slideshow
- Graphic logs
- Printable maps
Distribution of hydrostratigraphic units
- Clickable map (.pdf)
- Links to database (.mdb, .xls)
- GIS project (.mxd)

Borehole map
- Interactive (clickable) map (.pdf)
- Links to database (.mdb, .xls)
- Link to printable borehole log (.pdf)
Graphic logs

- View on screen or print
- Not everyone needs / wants the detailed version
- Database (.mdb) and spreadsheet (.xls) contain depth information

Printable maps

- Full and cropped versions (.pdf)
Usage and Feedback...

Conservation Authorities
- We are using your new map to try and figure out which aquifer our monitoring wells are screened in.

Other ministries
- Our GIS staff like the drill log layouts
- Envy! We had a request to train their support staff in creating a similar product.

Internal
- I used the borehole map as a quick reference tool while modelling.
- I used spatial distribution map to quickly see which boreholes to reference during the report writing stage.

Model

- Plot borehole traces
- Add picks
- Create 3-D wireframe surfaces
- Fill spaces with blocks
Report

• Executive summary
• Regional setting
• Construction of a 3-D geologic model (the abbreviated version)
• Synthesis and interpretation of modelled units
• Discussion of aquifer vulnerability and recharge
• Explanatory notes for accompanying datasets and products
• Appendices
  • Detailed discussion of data acquisition
  • Detailed discussion of modelling protocols
  • Outputs and products including links to previous releases

Synthesis and interpretation - discussion of modelled units
• Location, thickness, structural contour
• Stratigraphic context, age
• Sediment characteristics (range in grain sizes, trends)
• Interpreted depositional environment
### Aquifer vulnerability and recharge

- Depth to first aquifer
- Aquifer ID
- Elevation

### Usage and Feedback...

**Consulting Companies**
- A present in a present in a present
- Saved us a lot of time and effort (money)
- Stratigraphic interpretations are used to construct our conceptual model
- We rely on your geologic information and interpretations
- It gives the wrong impression to use the term ‘aquifer’ in the unsaturated zones.
- We don’t need you to focus on hydrogeologic interpretations. That’s our job. Just make sure you give us detailed GEOLOGIC interpretations!

**Conservation Authorities**
- Suspiciously silent on the topic...

**General**
- Work and products are regarded as being of high scientific quality by those in other government agencies and the private sector
Technical Products

Model output files
- Continuous and discontinuous surfaces
- X, Y, and Z coordinates on a 100 m grid
- Designed for easy import into groundwater modelling software
- Comma-delimited data files (.csv)

Subsurface database
- Location, formation and 3-D picks tables
- Database (.mdb)
- Too big for a spreadsheet

Usage and Feedback...

Model Surfaces
- Used as a foundation for our flow models
- Most useful in the deep overburden where our information is lacking.
- We need you to model aquifers where monitoring wells are screened.
- Cost benefits are substantial in both the short and longer terms.
- An excellent starting point. I get really annoyed when people describe early efforts as crap. We just need to be able to tweak the model.
- Use the model, but add local refinement to fit our borehole data.

This highlights a major weakness in the process – we don’t get access to most consultant’s data so our models are inaccurate in the very places they are most important. Obvious???? One would have thought so.
**Classic Example of the ‘Merged Model’**

Geologically accurate and streamlined the modelling process

Unfortunately...

- Was very difficult to use as an input for flow models
- Required extra processing
- Providing the clipping surface would have resolved most of the problems

Even more unfortunately...

- The consultants didn’t pick up the phone and ask for clipping surface, even when another major client suggested it.

**GIS grids**

- GIS Raster datasets
- Structural contours, isopach and aquifer vulnerability maps
Usage and Feedback...

Consulting Companies
- Use the maps and grids to help build our hydrostratigraphic model
- Import the grids into flow modelling software
- Some have used ALL our layers, other merge the layers

Internal
- Display grids from multiple project areas to improve our interpretation of the Quaternary history
- The grids facilitate the report writing process

Non-technical Products

Section viewer
- Displays cross-sections along user defined lines
- Save then view in Google Earth™
- Microsoft® Virtual Earth™ executable (SectionViewer.exe)
Google Earth™ as a viewing platform
- Eliminates need for clients to have expensive software
- Isopach and structural contour maps
- Excerpts from seamless geology maps
- Aquifer vulnerability maps
- Google Earth™ (.kml, .kmz) and graphic (.png) files

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- Query the standardized legacy database
- View new high quality data (perhaps the SUMMARY lithology would be better)
• Import previously saved cross-sections
• Allows user-defined fence diagrams

Usage and Feedback...

Conservation Authorities
• Use the section viewer to determine which aquifer their monitoring wells are screened in.
• I mostly use the online Google Earth OGS tool for hydrostratigraphic and geological purposes along with the various layers associated with it.
• Can you resend me the link?

Other Feedback
• It looks great, but what am I supposed to DO with it?
OVERALL ASSESSMENT

Summary reports and borehole releases
- Mixed reviews – some can’t wait, others barely register their existence.

Geophysics
- Valley delineation is used, the rest is largely ignored.

Final Products
- This is what folks download and use as a reference and employ as a data source.

My take on it
- No one likes ALL of the products!
- This means that we have succeeded in our mission to provide products useable by a wide range of clients.
- Suspect that the auditors like interim products more than our clients do.