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

or….

I made a model!!! Now what?

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Meet the team

Abigail Burt

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Our clients

Internal (OGS geoscientists)

Other government ministries (Ministry of Environment and Climate Change)

Conservation authorities

Industry / Consultants

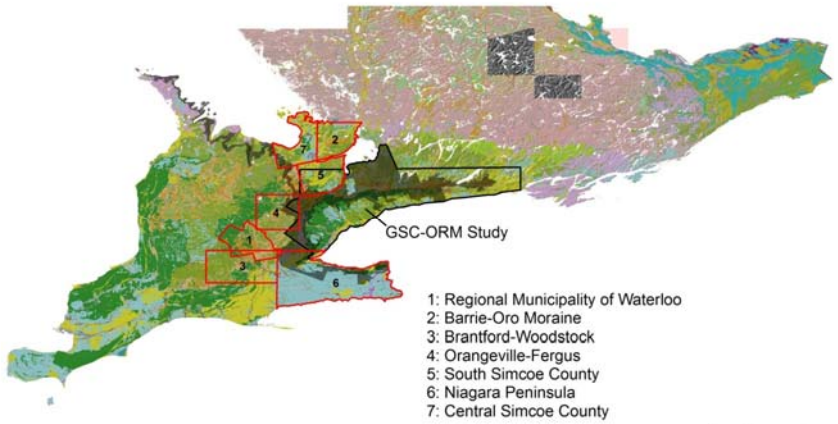
Academia

Ontario

3-D Workshop 2015

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



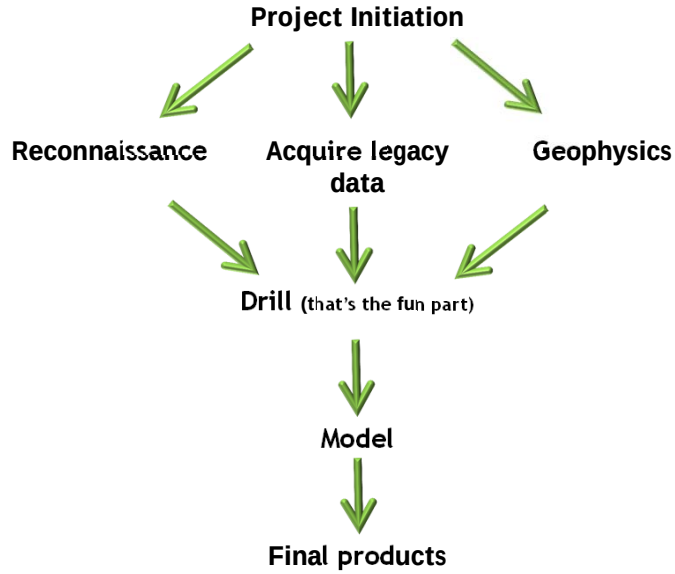
Ontar

p 2015

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



Reconnaissance

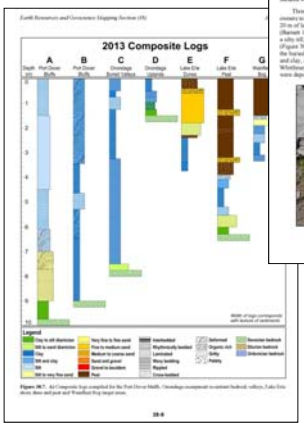
- Improve our understanding of late-glacial history
- Verify existing surficial mapping (identify problem areas)
- Log exposures
- Auger and probe….
- Meet potential partners

Product: Summary Report

- Field descriptions
- Preliminary interpretation of landform-sediment assemblages
- Compilation of existing mapping
- Summary logs


38. Project Unit 13-018. The Niagara Peninsula Study: A New Three-Dimensional Quaternary Geology Mapping Project

INTRODUCTION




Port Dover Bluffs

Usage and Feedback…

Traditional view is that nobody reads them.

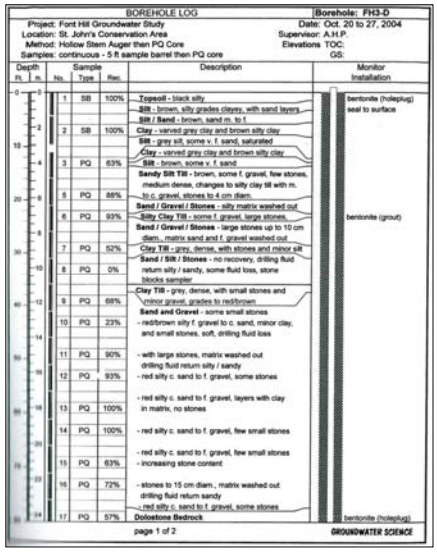
Consultants and Conservation Authorities

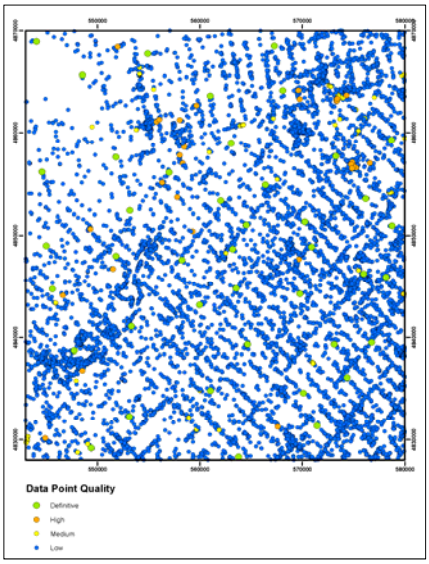
- See where we are starting new projects and get routine updates.
- Used as a source for baseline understanding of the geology in a given area.
- In recent years these reports have been completed on a finer-scale than the regional Quaternary geology reports previously used to understand glacial history.
- 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!

Legacy Data





Dealing with data

- Acquire data
- Standardize
- QUALITY!!!!

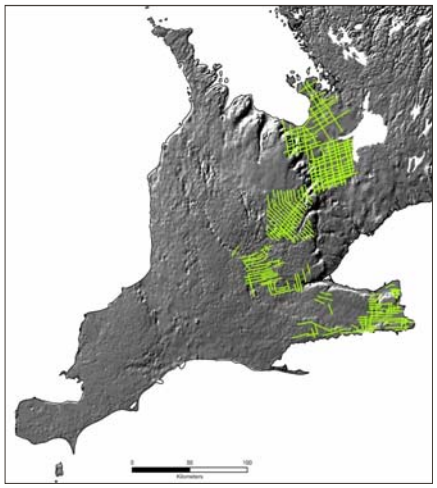
Subsurface database is released as part of the final groundwater resources study

Geophysics

Reconnaissance | Legacy Data | Geophysics | Drill | Model | Final products

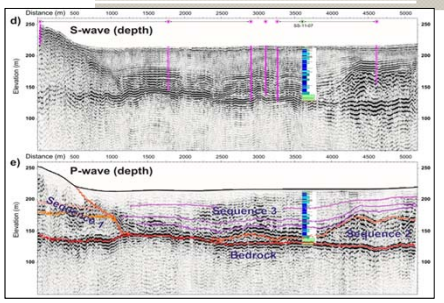
Ground-based gravity surveys

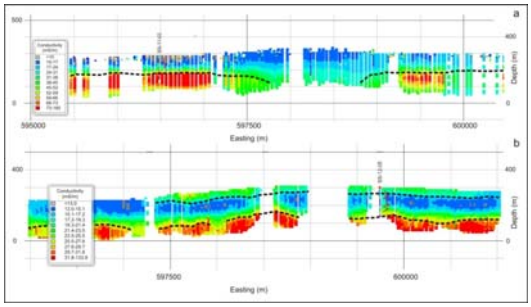
- Target areas with known or suspected buried bedrock valleys
- Guide drilling and monitoring well targets



Seismic surveys

- Collaboration with the GSC
- Continuous data
- Mixed results
- Up to 200 m depth penetration





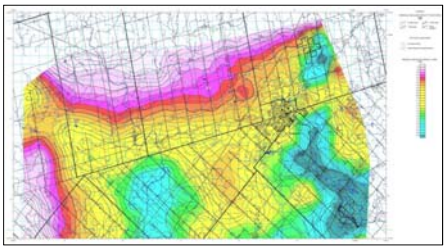
Airborne Time-Domain Electromagnetics

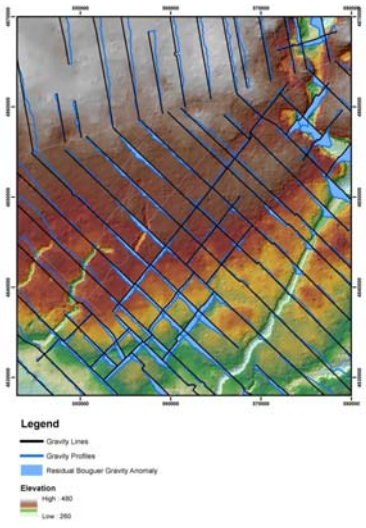
- Continuous data
- Transmitter flown 30-40m above ground (prepare for phone calls!)
- Depth penetration of up to 200 m
- Cultural interference is a huge problem

Reconnaissance | Legacy Data | Geophysics | Drill | Model | Final products

Products

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





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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.

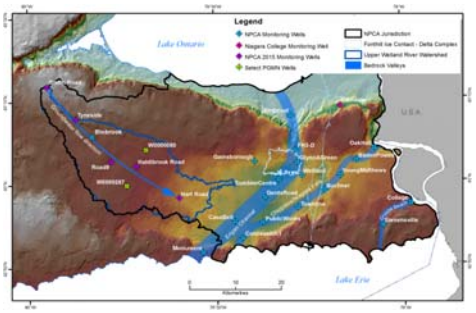
Drill

Monitoring wells

- Collaboration with municipal and conservation authority partners
- We provide the hole, they install the well

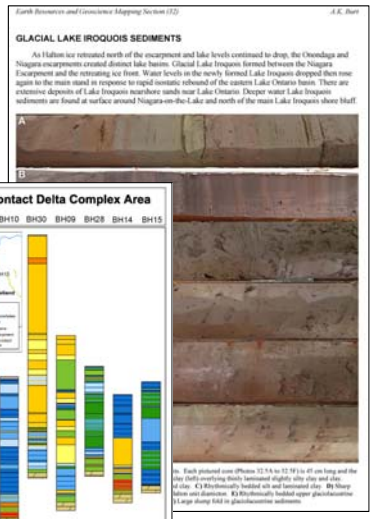
Downhole geophysics

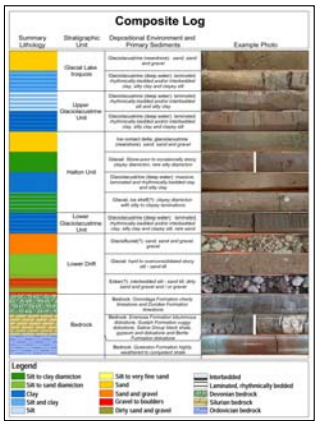
- Collaboration with the GSC
- Determine seismic velocities of lithological units (convert profiles to true depths)
- Fingerprint tills

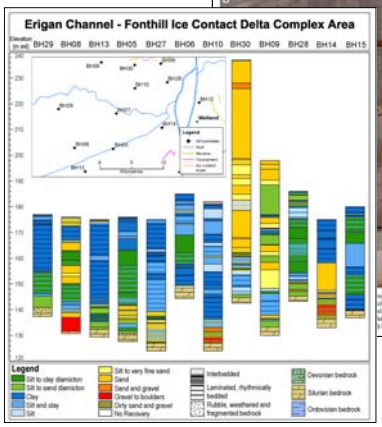


Product: Summary Report

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


GLACIAL LAKE IROQUOIS SEDIMENTS





Usage and Feedback…

Conservation Authorities

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

Consulting Companies

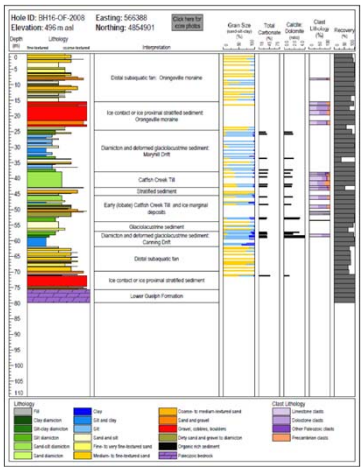
- Good morning Abigail. I just downloaded your latest summary and wondered if I could run something by you…..

Internal

- Take a deep breath and THINK

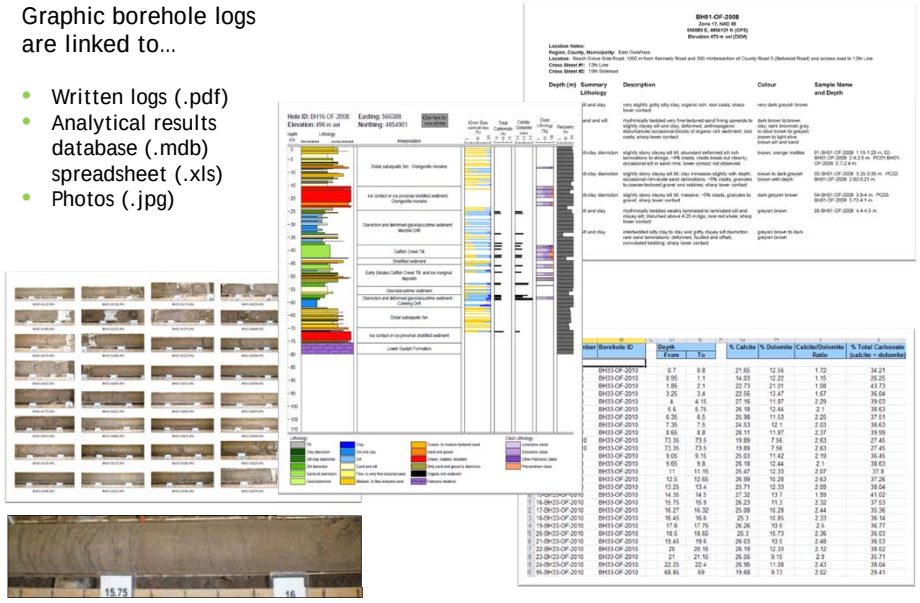
Product: Interactive Borehole Data Release

- 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!

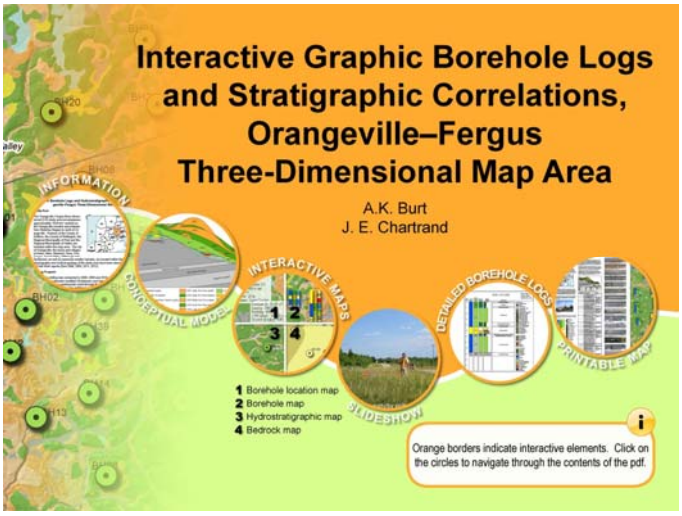
Consulting Companies
- I like to see the detailed logs so I can be confident in your interpretations (and summary logs).
- We use the boreholes as golden spikes to extrapolate the geologic units outwards.
- Particularly useful as you drill in areas with little or only poor quality data.
- Saves us (clients) 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.

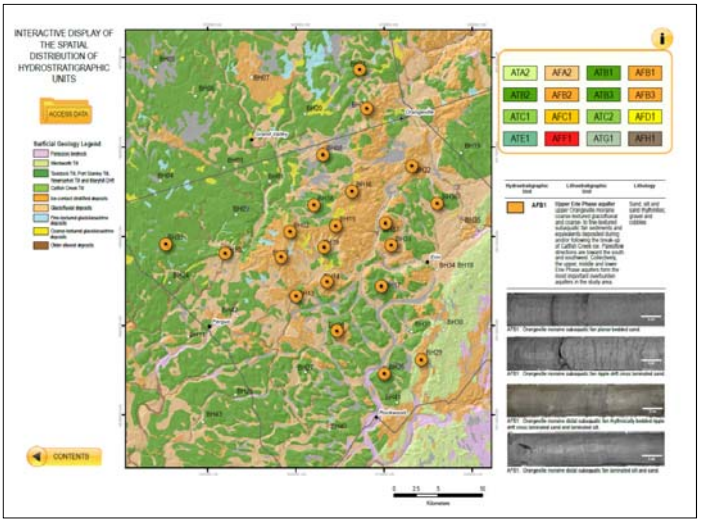
Product: New Interactive Borehole Map

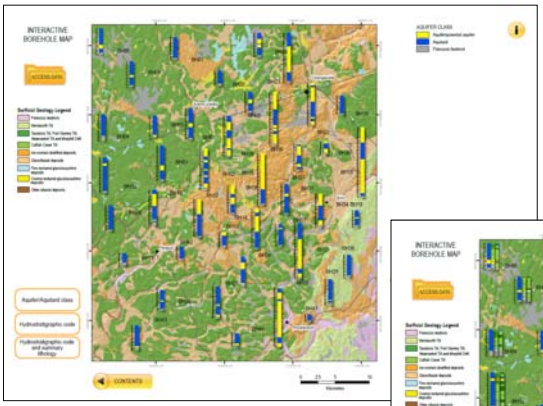
- Project information
- Conceptual model
- Maps
- Slideshow
- Graphic logs
- Printable maps

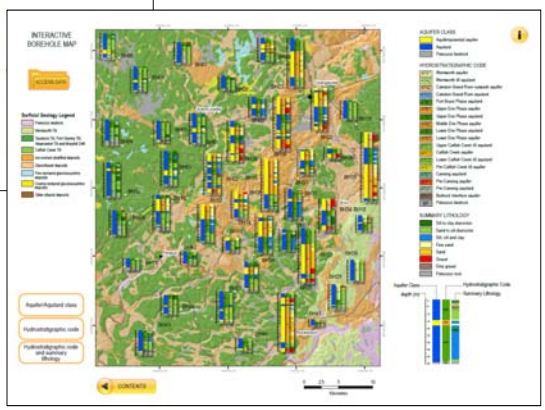


Distribution of hydrostratigraphic units

- Clickable map (.pdf)
- Links to database (.mdb, .xls)
- GIS project (.mxd)







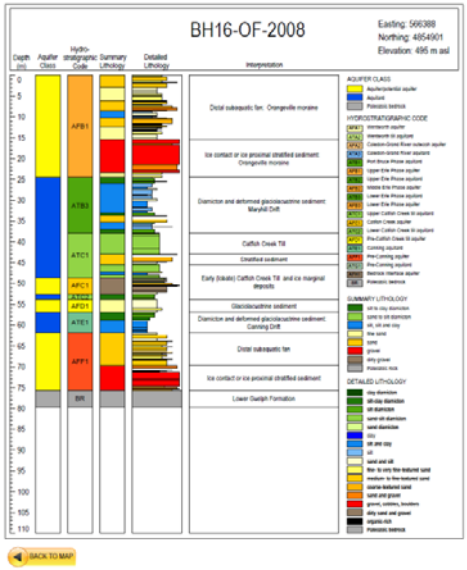
Borehole map

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

Reconnaissance | Legacy Data | Geophysics | Drill | Model | Final products

Graphic logs

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



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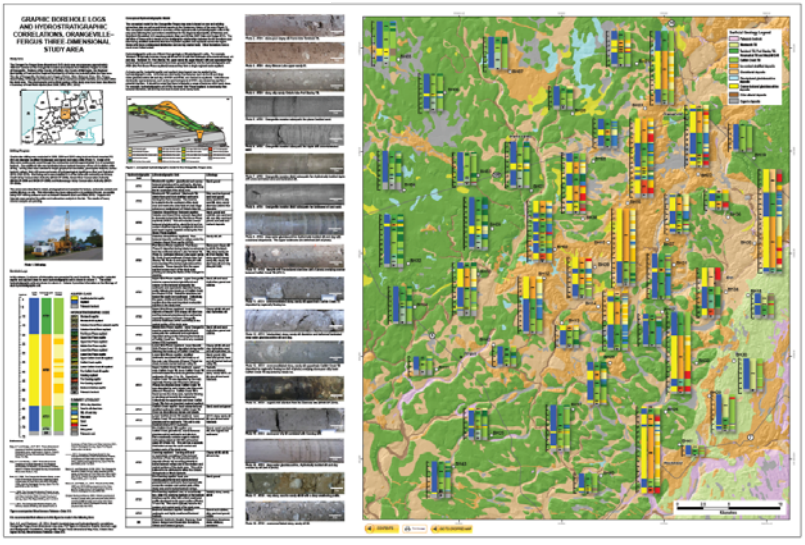
Reconnaissance | Legacy Data | Geophysics | Drill | Model | Final products

Printable maps

- Full and cropped versions (.pdf)



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Usage and Feedback…

Conservation Authorities

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

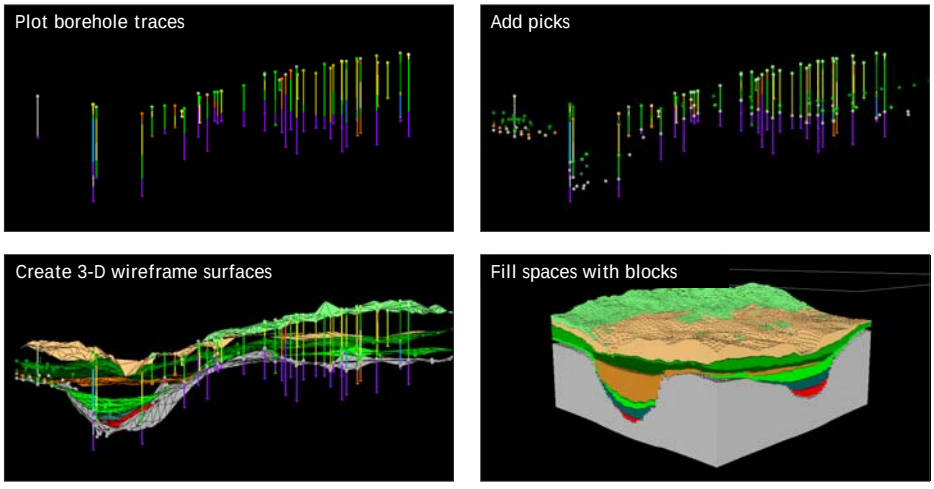
Other ministries

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

Internal

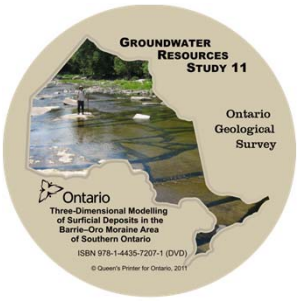
- I used the borehole map as a quick reference tool while modelling.
- I used spatial distribution map to quickly see which boreholes to reference during the report writing stage.

Model



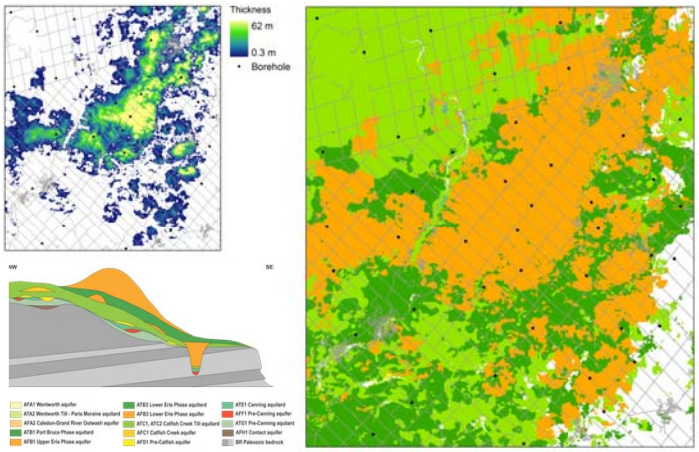
Report

- 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



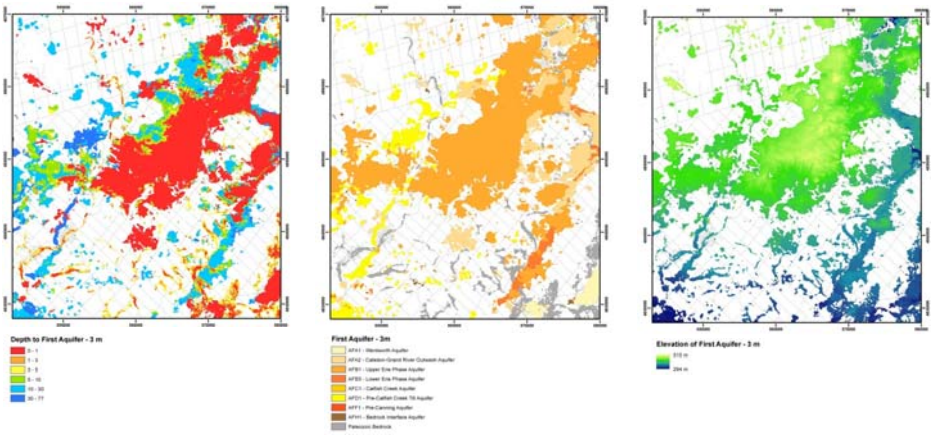
Synthesis and interpretation - discussion of modelled units

- 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)

	A	B	C	D	E	F
1	XC	YC	ZTOP	SEQNUM	STRATUM	
2	509700	4815900	316.9727	19	Bedrock	
3	509700	4815900	326.0116	16	ATE1	
4	509700	4815900	335.6006	12	ATC1	
5	509700	4815900	373.055	6	ATB1	
6	509700	4816100	316.4268	19	Bedrock	
7	509700	4816100	326.007	16	ATE1	
8	509700	4816100	331.9896	12	ATC1	
9	509700	4816100	373.17	6	ATB1	
10	509700	4816300	316.0366	19	Bedrock	
11	509700	4816300	326.0701	16	ATE1	
12	509700	4816300	329.1664	12	ATC1	
13	509700	4816300	373.8627	6	ATB1	
14	509700	4816500	318.1646	19	Bedrock	
15	509700	4816500	326.9261	16	ATE1	
16	509700	4816500	339.0816	12	ATC1	
17	509700	4816500	373	6	ATB1	
18	509900	4815500	317.9073	19	Bedrock	
19	509900	4815500	342.2944	12	ATC1	
20	509900	4815500	373.105	6	ATB1	
21	509900	4815700	317.6195	19	Bedrock	

Zzzzzzzzzz.....

Subsurface database

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

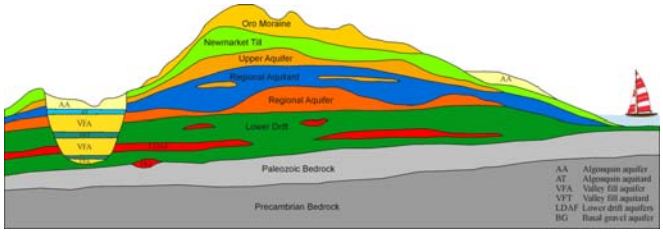
Usage and Feedback…

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…

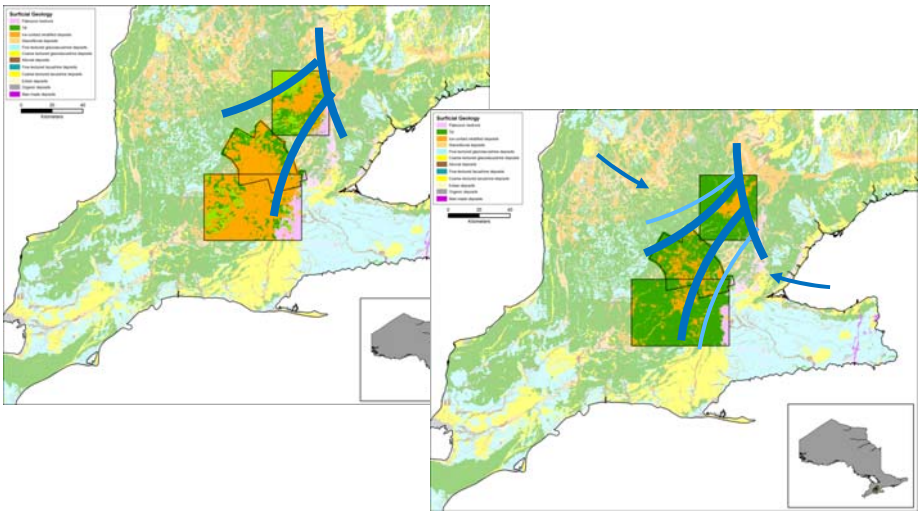
- Was very difficult to use as an input for flow models
- Required extra processing
- Providing the clipping surface would have resolved most of the problems

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

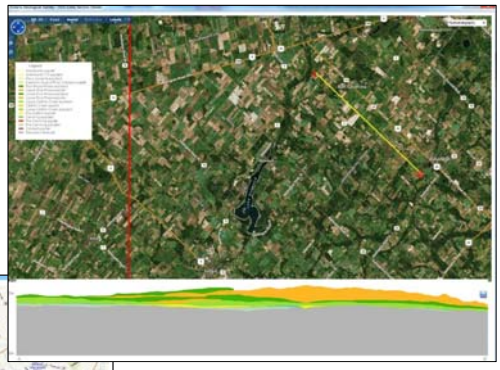
Internal

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

Non-technical Products

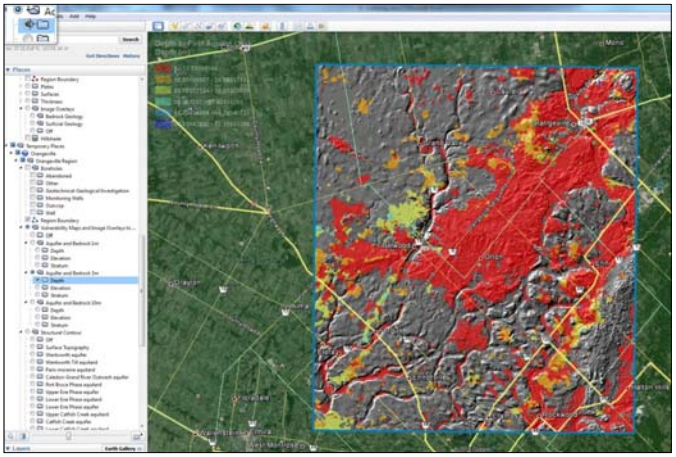
Section viewer

- Displays cross-sections along user defined lines
- Save then view in Google Earth™
- Microsoft® Virtual Earth™ executable (*SectionViewer.exe*)

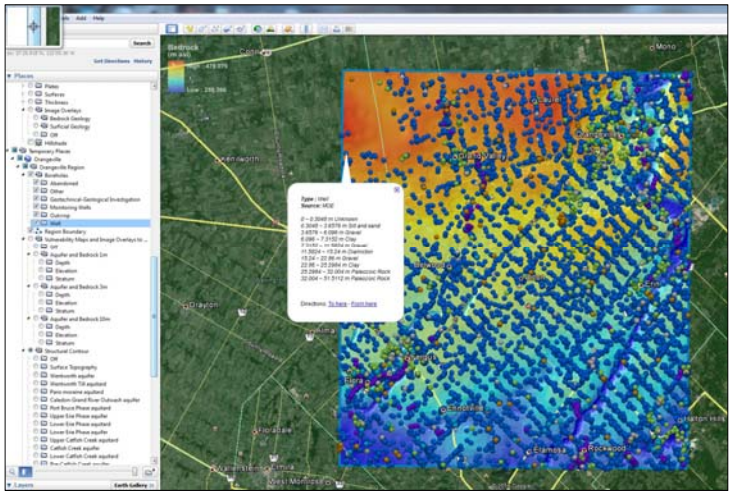


Google Earth™ as a viewing platform

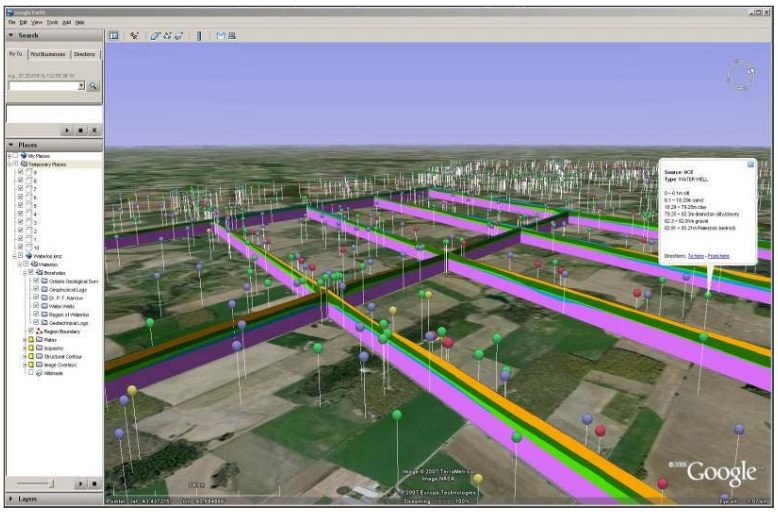
- Eliminates need for clients to have expensive software
- Isopach and structural contour maps
- Excerpts from seamless geology maps
- Aquifer vulnerability maps
- Google Earth™ (.kml, .kmz) and graphic (.png) files



- 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.