Celebrating 175 yrs

Framework for modelling national scale 3D geological models

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GEOLOGICAL SURVEY OF CANADA

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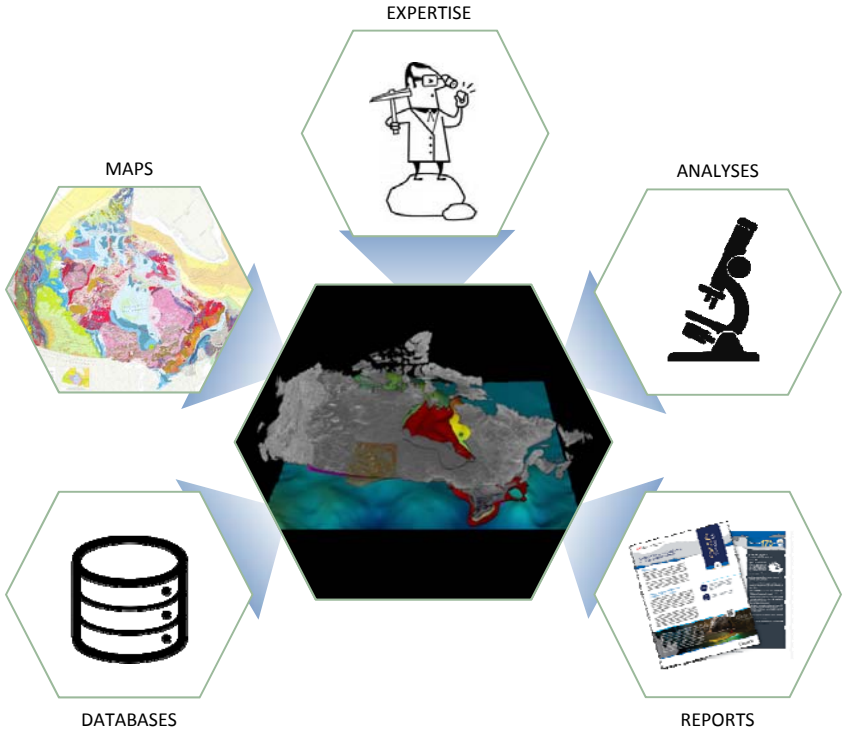
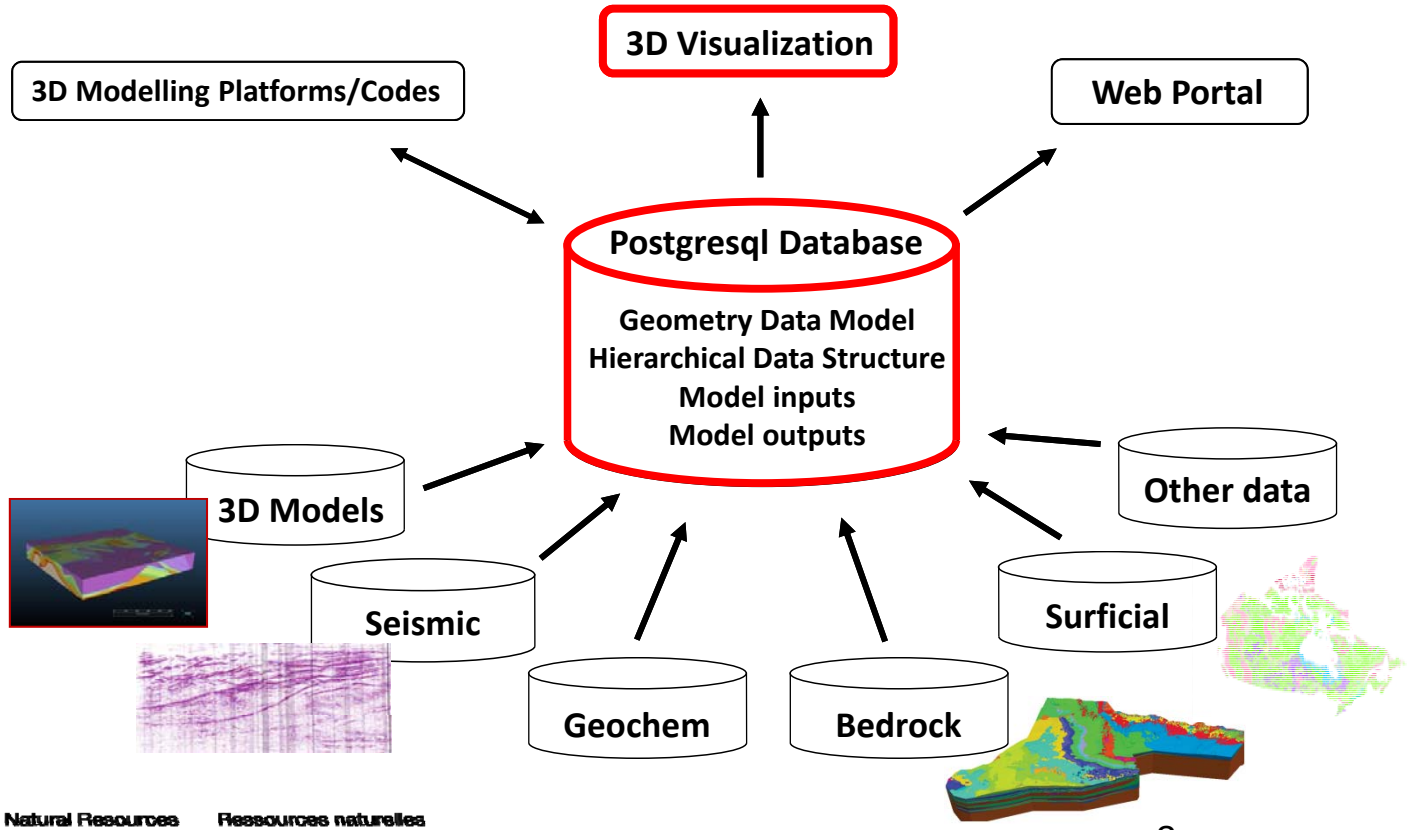
NATURAL RESOURCES CANADA - INVENTIVE BY NATURE

National 3D Modelling – Canada-3D

- Authoritative synthesis of knowledge of the geology of Canada
- One-stop web access to knowledge of the geology of Canada

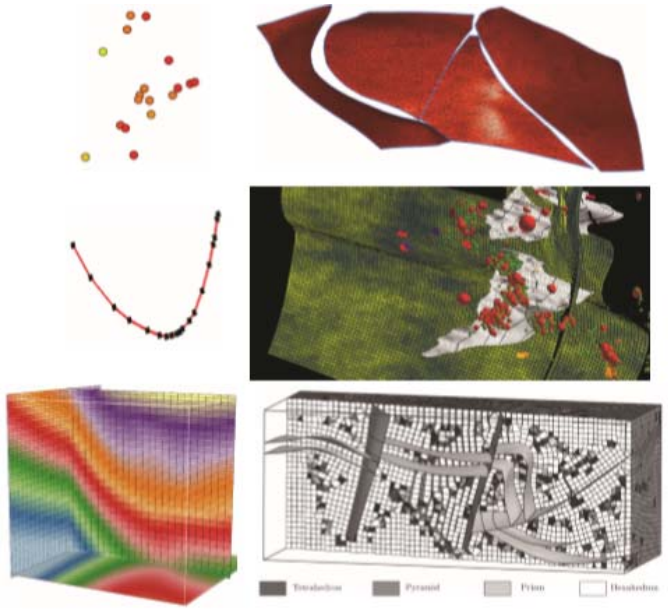


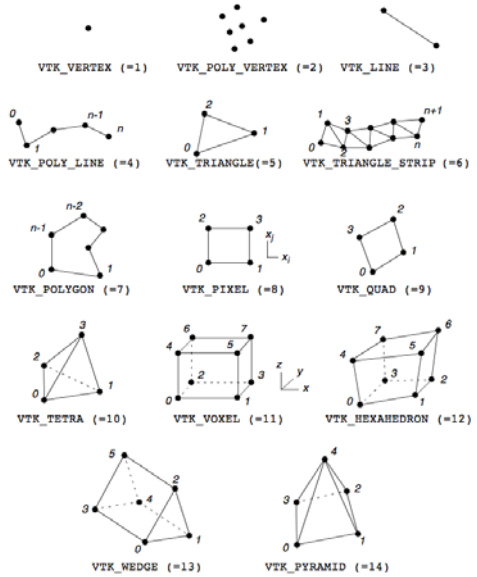
Modelling Infrastructure



Geometry Data Model + 3D visualization

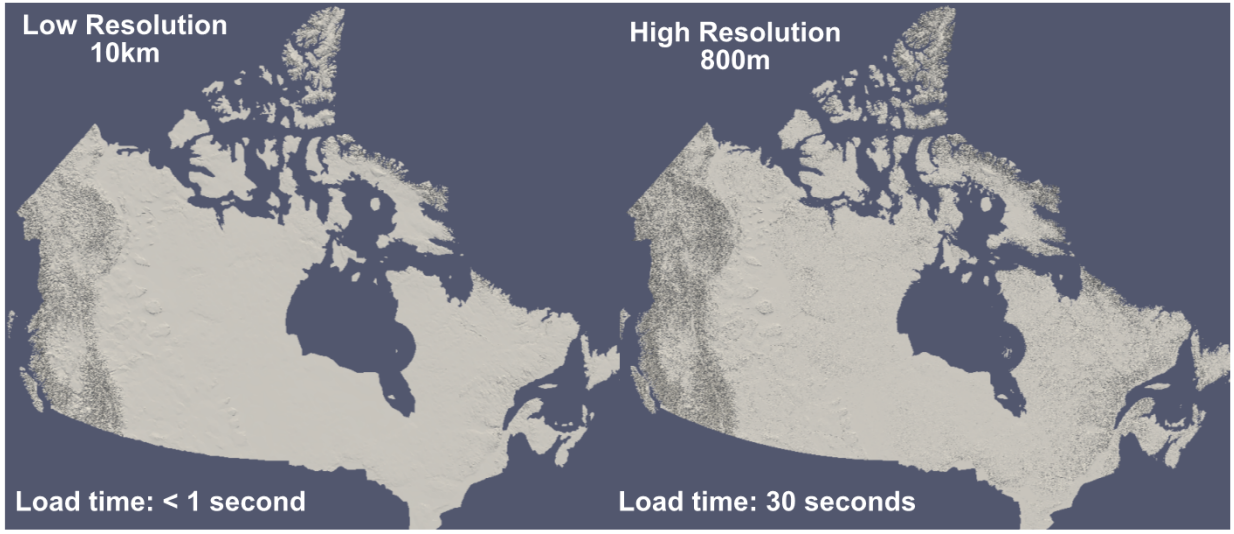
- Biggest constraint for visualization is the geometry data model
  - Tested 34 different software packages (geometry type, db connection, open source)
- Chose vtk model and ParaView or visualization

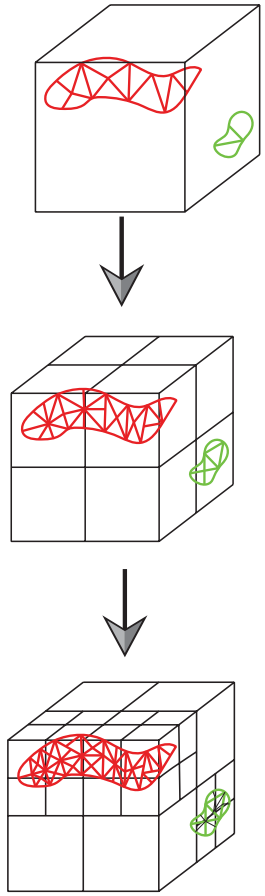




Hierarchical data structure

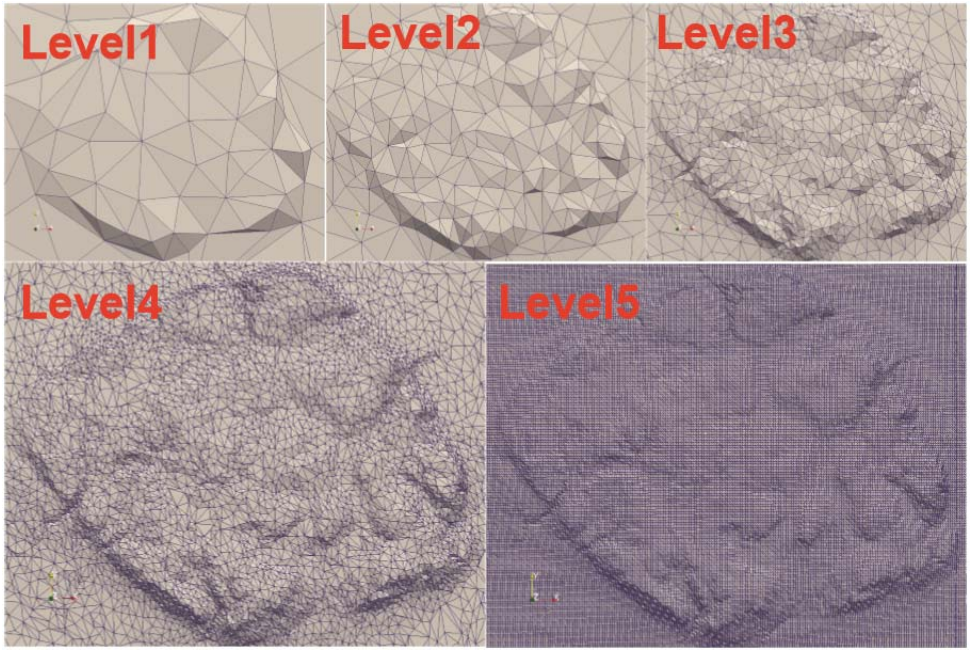
- Visualization of national scale 3D geomodels is intractable with current commercial geological 3D modelling software
  - Requires 3D tiling: visualization at multiple resolutions (octree hierarchy)





Algorithm development: Building Hierarchical Model

- 3D geological models inserted into base of octree and pushed to the database
  - 6 columns - id, process data, render data, feature name, object name, spatial index
- Generalization algorithm
  - Recursively iterate through database's stored octree
  - Generalize each octree block's process data to the appropriate amount to ensure an interactive experience in the visualization (1 million triangle total) IF triangle limits exceeded
    - Set the block's render data
  - IF an block's process data is generalized, subdivide and push those new blocks to the database



Database Storage

Model Feature	#Δ's of Original Model	#Δ's stored in DB (process)
Topography	32M	183M
Bedrock	29M	177M
PC	0.09M	0.09M
Moho	0.05M	0.05M
Provincial	62M	692M

Table 1: Process data storage increase from hierarchy

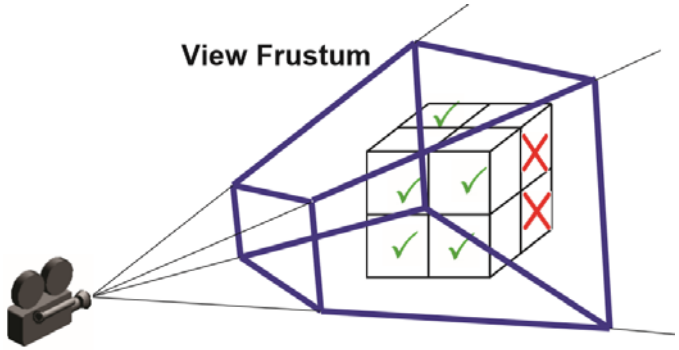
Hierarchy Level	Maximum #Δ's stored in DB (render)	Resolution of Topography (meters)	Maximum db records
1	1M	4800	80
2	8M	1700	640
3	64M	600	5120
4	512M	212	40960
8	2T	3.4	167 M
12	8×10^{15}	0.05	687 B

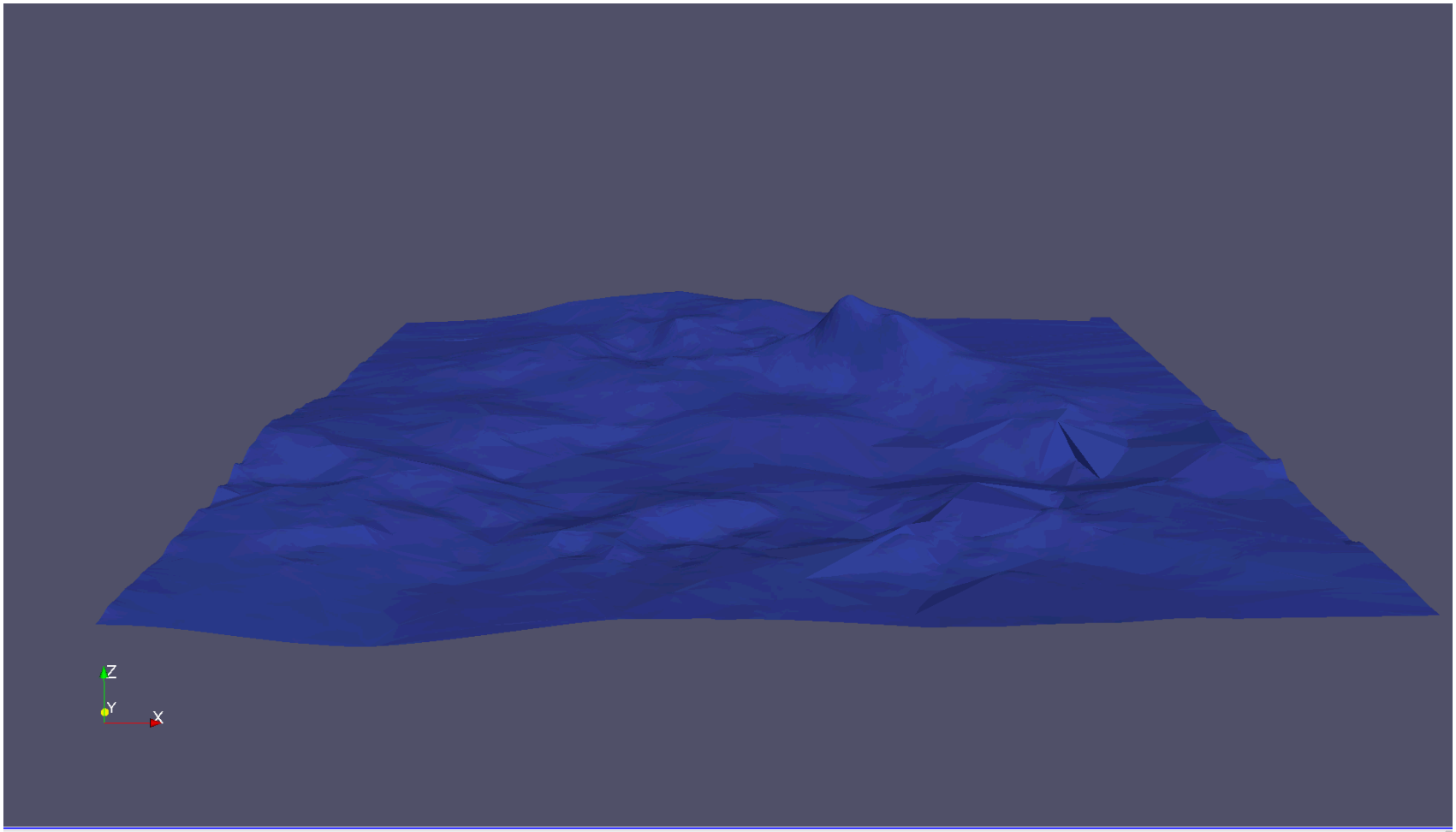
Table 2: Hierarchy's level triangle storage limits and associated resolution

Algorithm development: Visualization

- Custom plugins for Paraview:

1. Data reader
   - makes database queries
   - builds octree
   - assembles/clips data for rendering
2. Streaming visualization algorithm
   - Finds octree blocks intersecting the view frustum at the correct scale
   - Determines which blocks to included for rendering




Z
Y
X

Conclusion + Future Work

- Custom algorithm and tools were developed to facilitate scalable visualization of national 3D geological models in open source software (Paraview)
- Code is not proprietary, could be incorporated into other software
  - Will be added to Paraview open source project
- Web version feasible - preliminary testing completed
- Future work involves the modelling lifecycle
  - Process of including new data constraints and updating existing models stored on the database