

3D geological modelling in Canada

Challenges and opportunities for academic research

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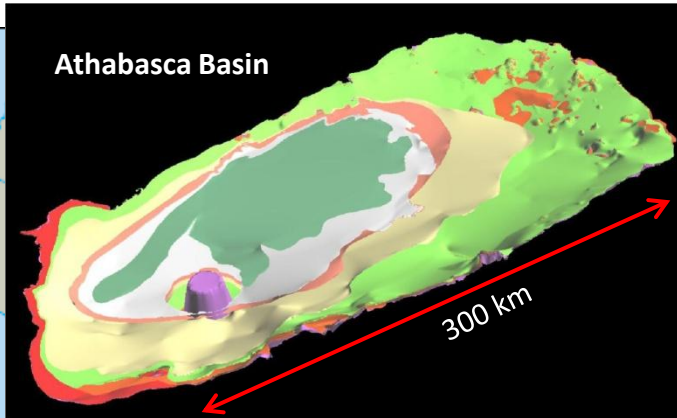
Geological 3-D Modelling in Canada

- Bedrock Geology
 - Economic Geology
 - Structural geology, ore deposits
 - Sedimentary Basins
 - Hydrocarbons, uranium, geothermal energy
 - Nuclear waste repository studies
- Surficial sediments (Quaternary)
 - Groundwater resources (extraction, protection, remediation)
 - Land use management (e.g. planning growth)
 - Seismic hazards (e.g. ground shaking amplification)

Many opportunities exist for government-academic or industry-academic collaboration to investigate and address 3D geology related issues in Canada

Government mapping programs, R&D programs, partnership programs (funding)

3D geology needs by provinces...

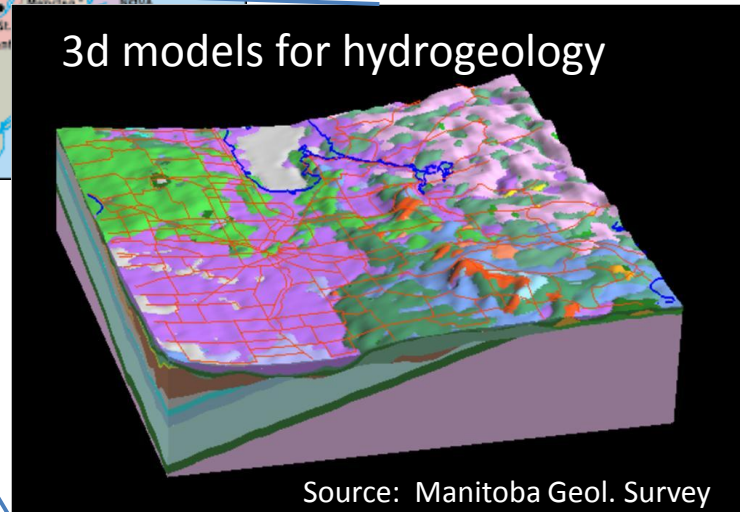
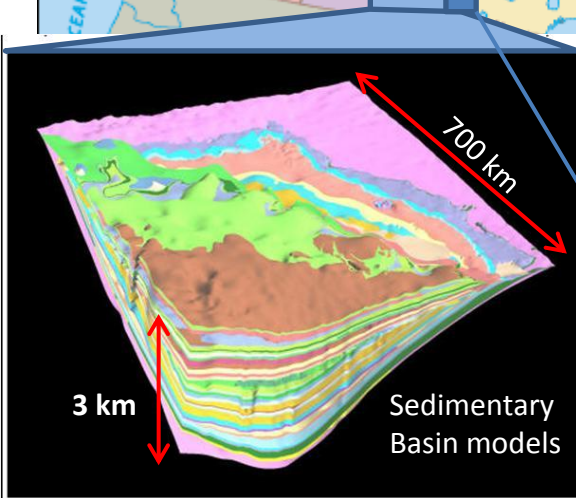


PRAIRIE provinces

Pop. about 5.9M

Largest city: Calgary (pop. 1M)

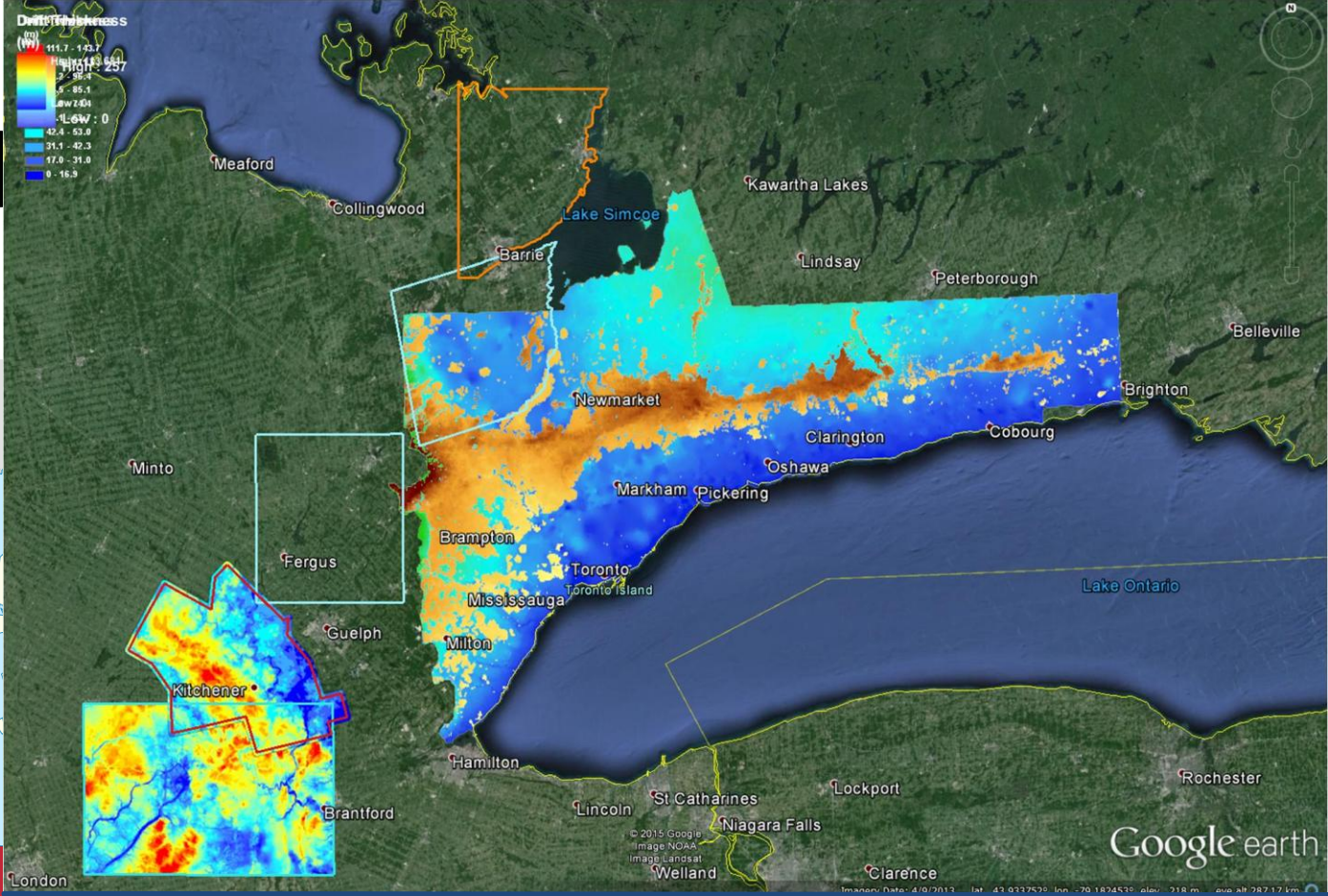
- Rapid growth (pop. + industry)
- Hydrocarbon resources
 - Conv., oil sands
 - Pipeline infrastructures
- Agriculture (southern parts)
- Mining activity (northern parts)



... on groundwater
... ried valley aquifer

Source: Manitoba Geol. Survey

3D geol



Land use; road salt, pesticides, fertilizers

e.g. Ottawa

-pop. 2.8M

-Seismic risk

-Thick clay deposits (ground motion amplification)

-microzonation studies

3D geology needs by provinces...



QUEBEC

Pop. 8M

Largest City: Montreal (metro pop. 4.3M)

- Mining and exploration activity (mid-north)
- Agriculture (St. Lawrence valley)
- Shale gas resources (St. Lawrence valley)
- Groundwater needs
- Seismic risk (St. Lawrence valley)
 - Seismic zone and thick clay deposits

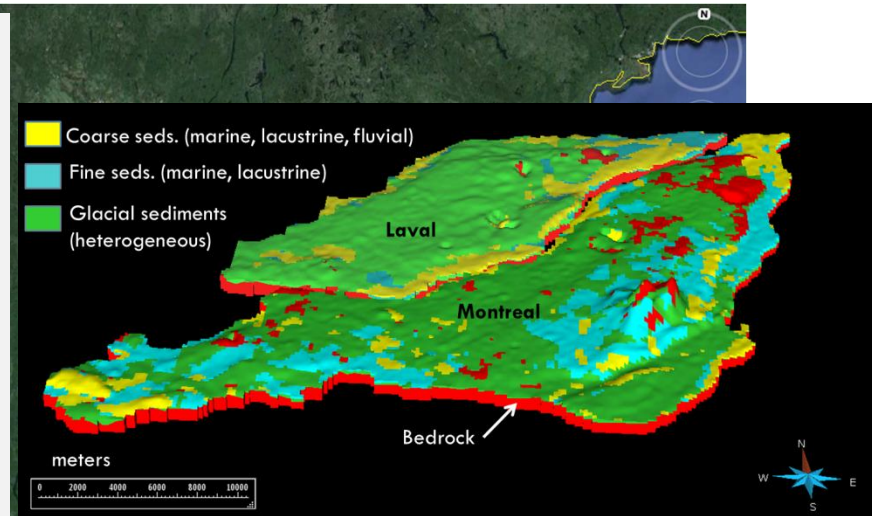
Models for various applications

Government (federal, provincial, municipal) and university collaborations

Regional models for hydrogeology and land use planning/management

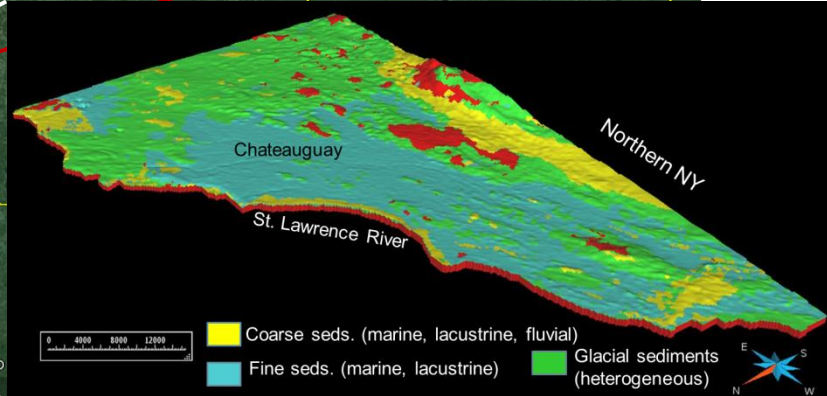
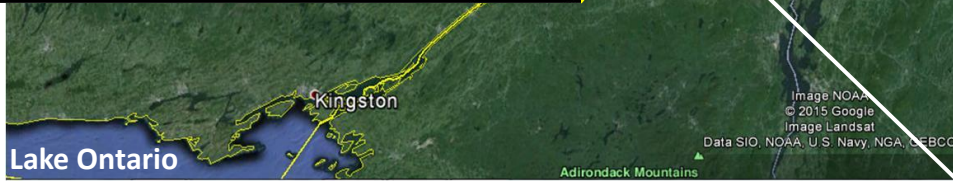
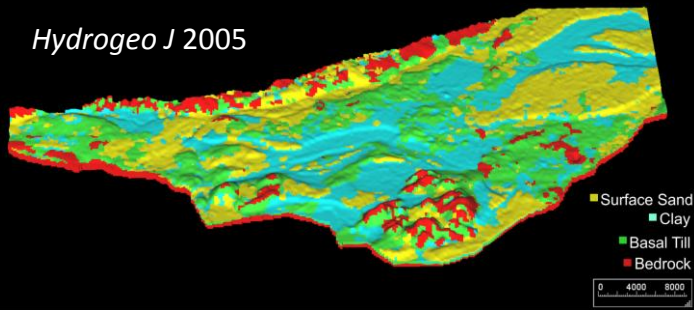
Urban geology models

- Seismic hazards assessment
- Urban planning

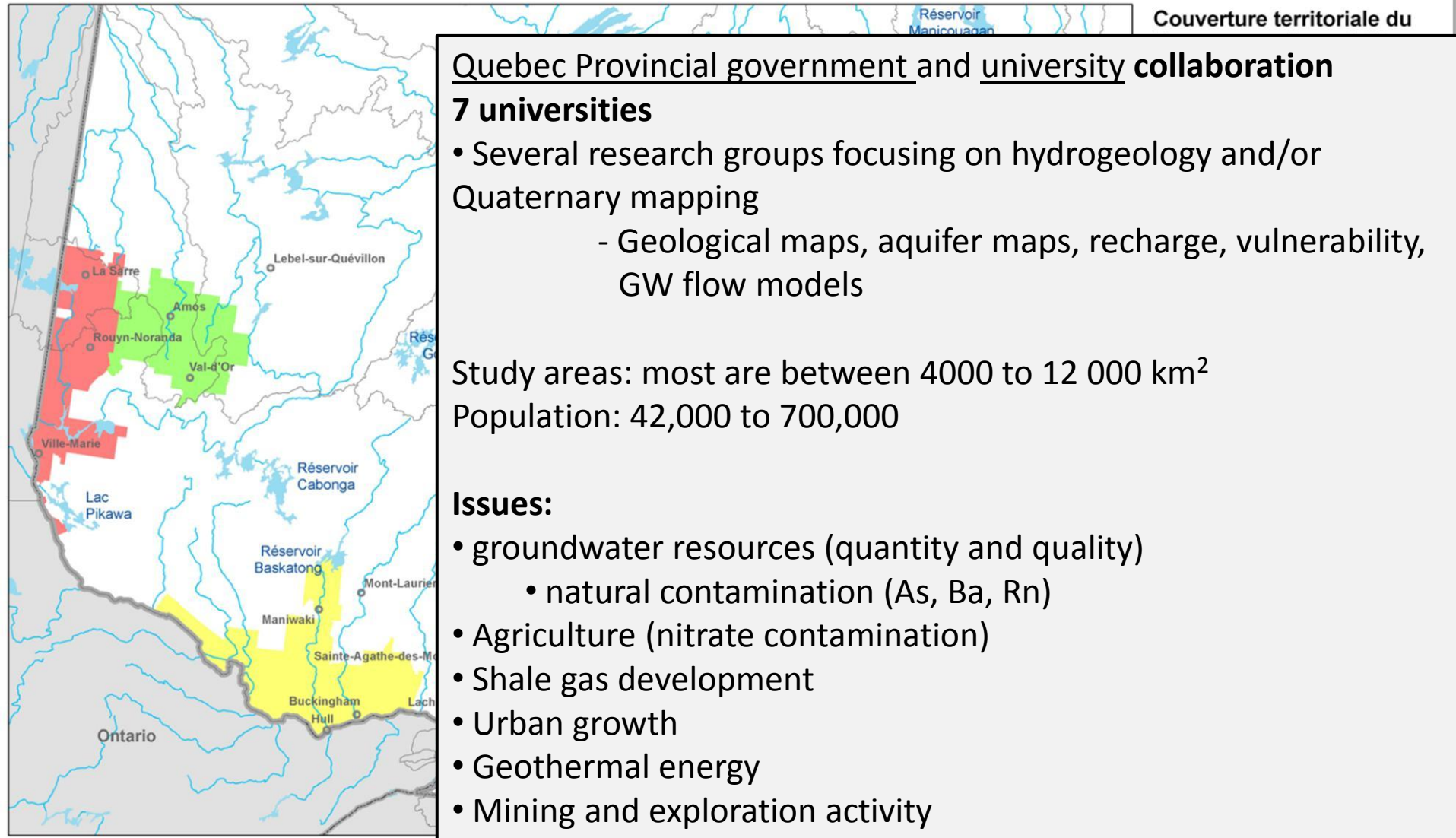


Lower Laurentians model

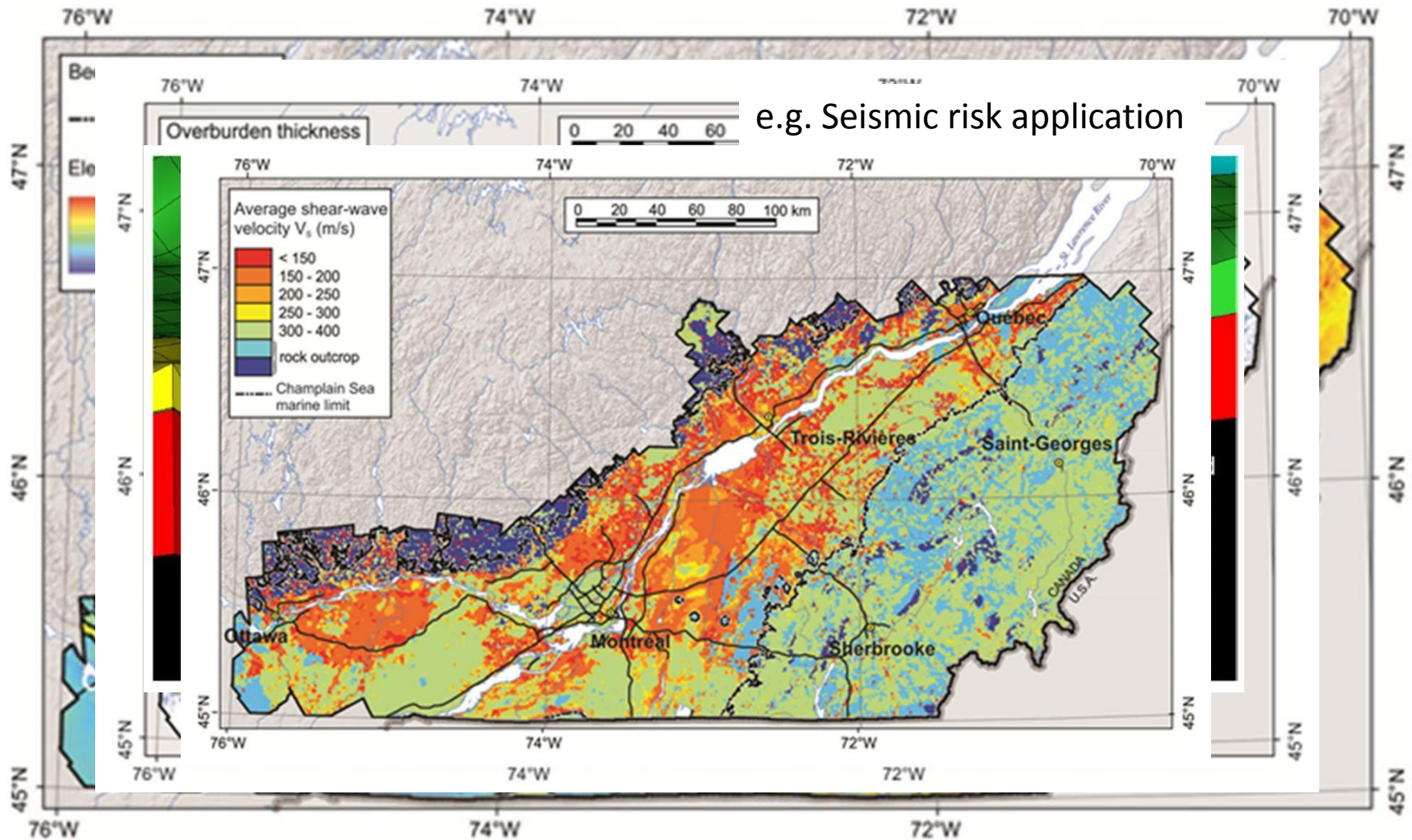
Hydrogeo J 2005



Recent hydrogeology studies with 3D mapping components



Towards seamless 3D geological models of populated regions



3D geology needs by provinces...



Atlantic Canada:

Pop.: 2.4M

Largest City: Halifax (pop. 0.4M)

- Agriculture
- Mining and exploration
- Offshore hydrocarbon resources
- Groundwater needs
- Few targeted 3d mapping



British Columbia:

Pop: 4.6M

Largest City: Vancouver (Metro pop. 2.3M)

- Mining and exploration
- Agriculture (Fraser and Okanagan valleys)
- Natural hazards (e.g. seismic, landslides)
- Few targeted 3d mapping (e.g. Vancouver Island)

3D geology needs by provinces...



Northern Canada:

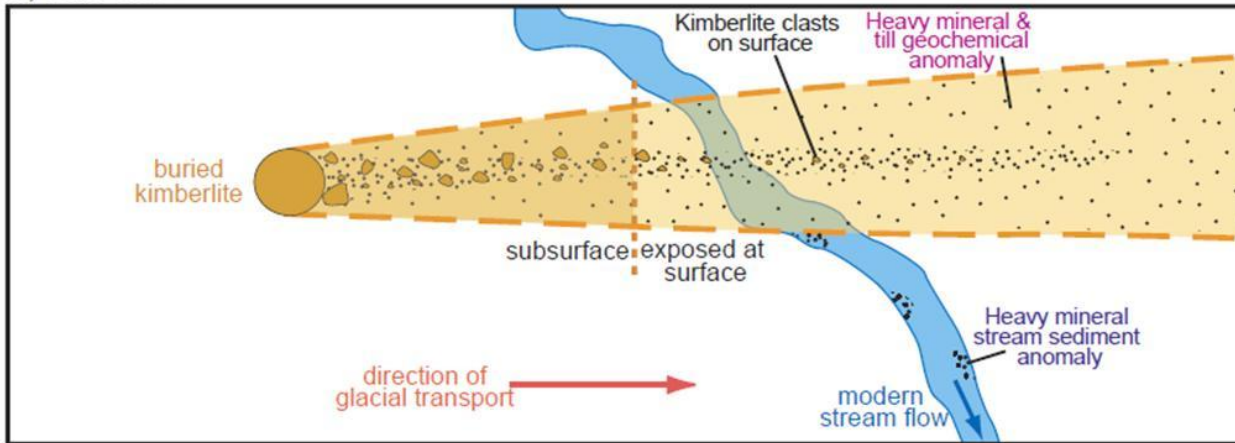
Pop: about 0.1M

0.03 inhabitants per square km

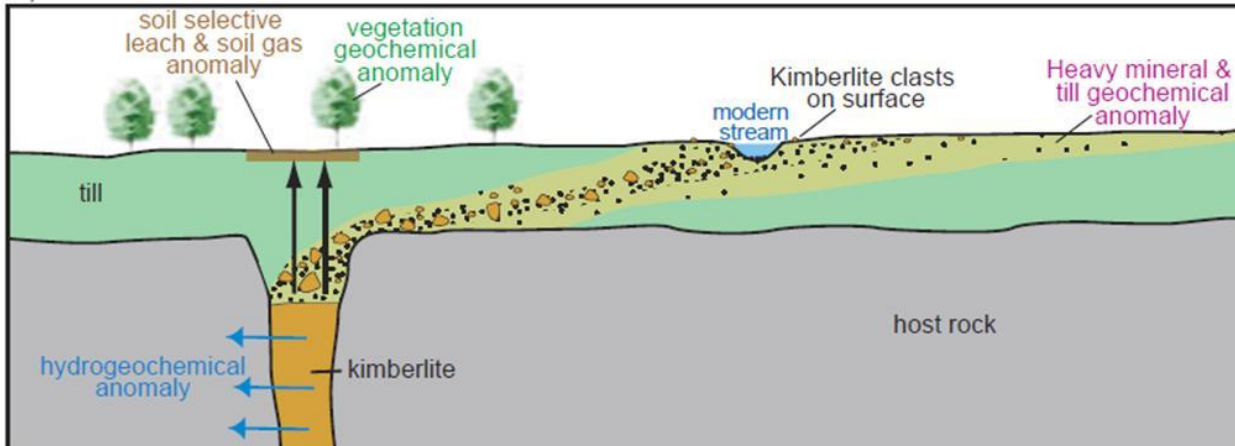
- Natural resources
 - Mining and exploration
 - Hydrocarbon (offshore)
- 3D modelling is very focused
 - Ore deposits and mines
 - e.g. diamond mines (Yellowknife)
 - Recent 3D Quaternary mapping
 - Prospective areas
 - Local permafrost studies

Subcropping deposits (thick till)

A) Plan View



B) Cross-section



Simple conceptual models:

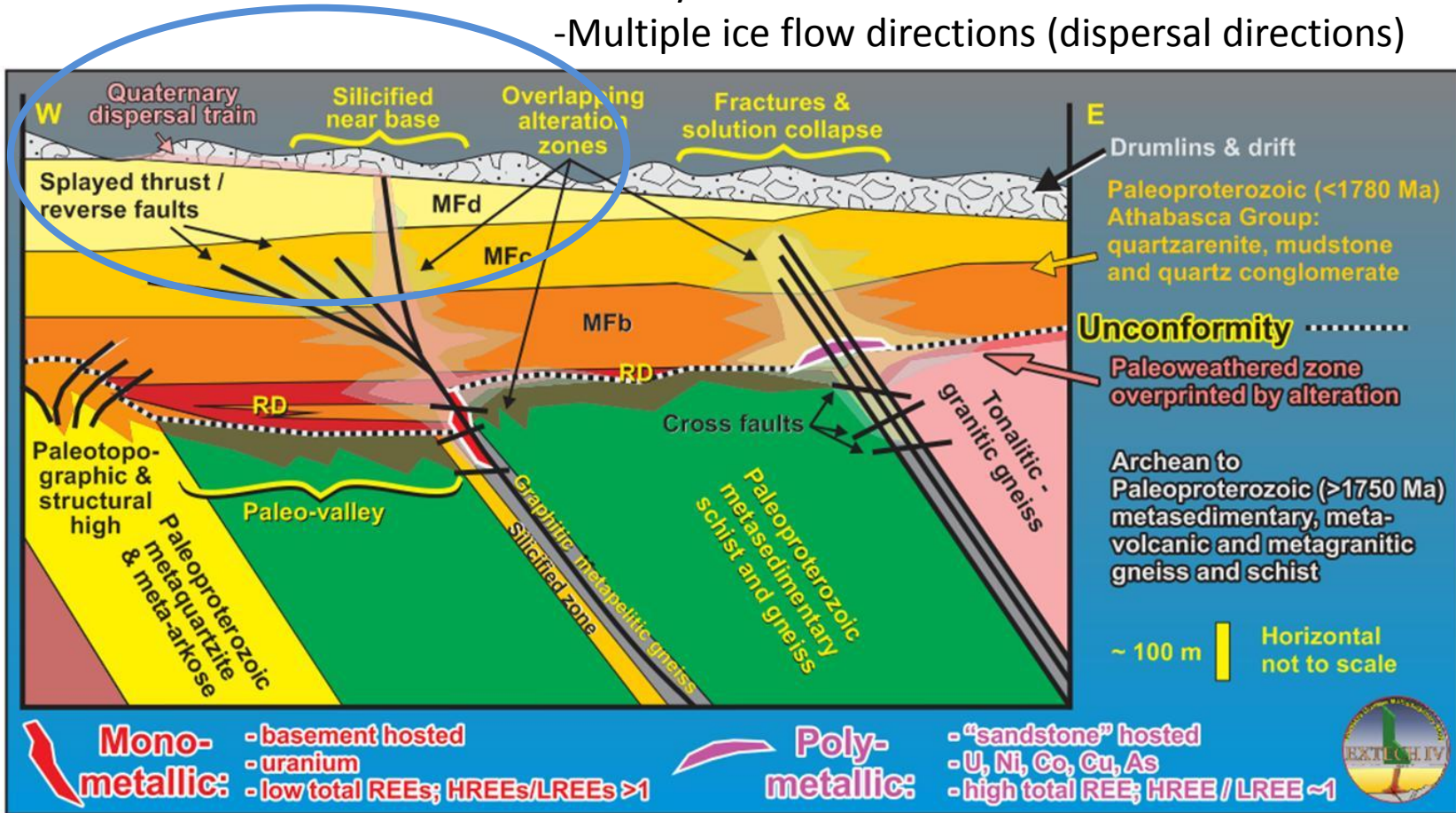
- One dispersal direction
- Subcropping mineralization available to glacial erosion
- Relatively flat bedrock
- Simple stratigraphy (one unit)

FIGURE 4. Schematic plan and cross-section views of clastic dispersal and chemical dispersion patterns in various media around a kimberlite in glaciated terrain.

Deeper targets...

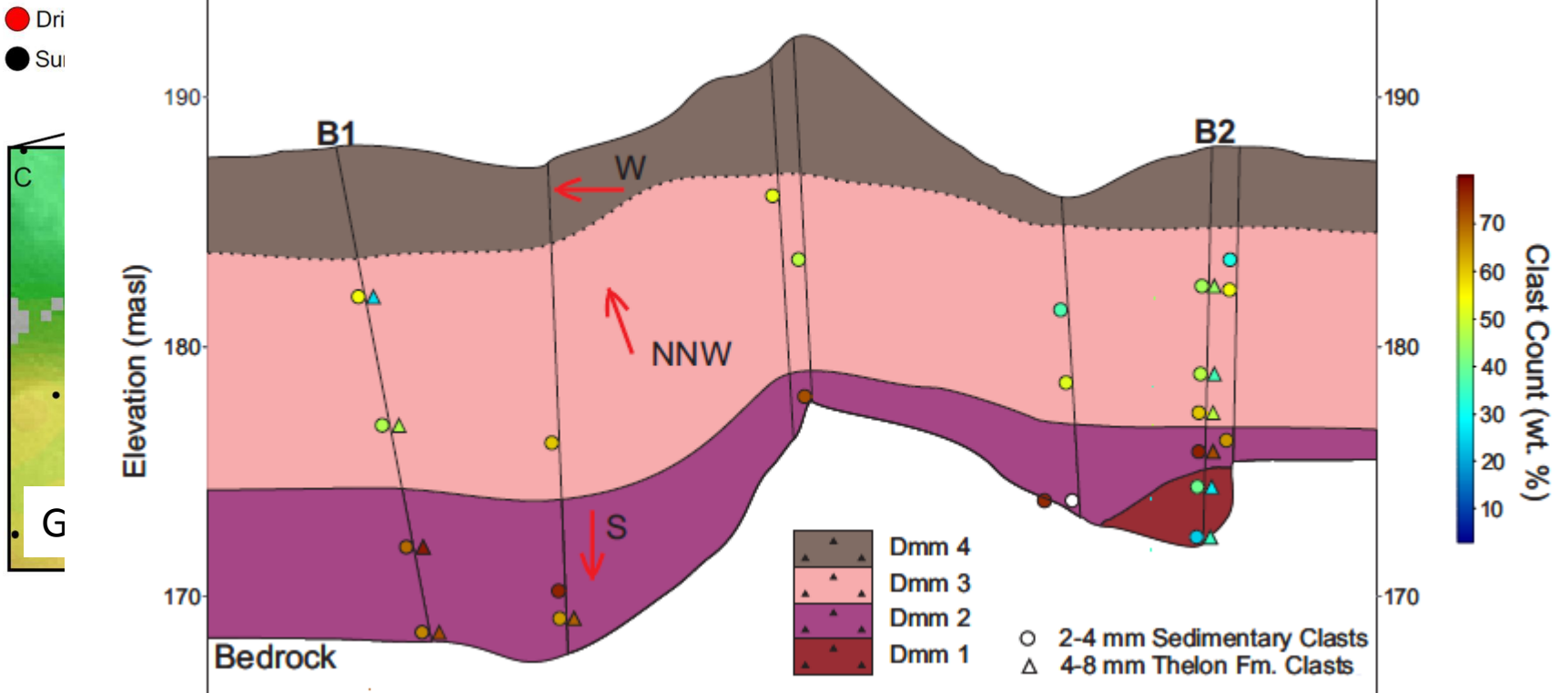
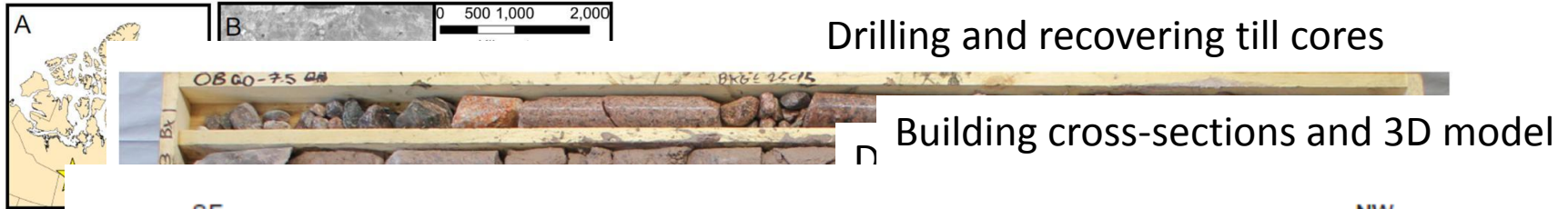
More complex situation...

- Only alteration halo may have been eroded and transported
- Multiple Quaternary units (complex 3D dispersal patterns)
- Heavily drumlined terrain
- Multiple ice flow directions (dispersal directions)

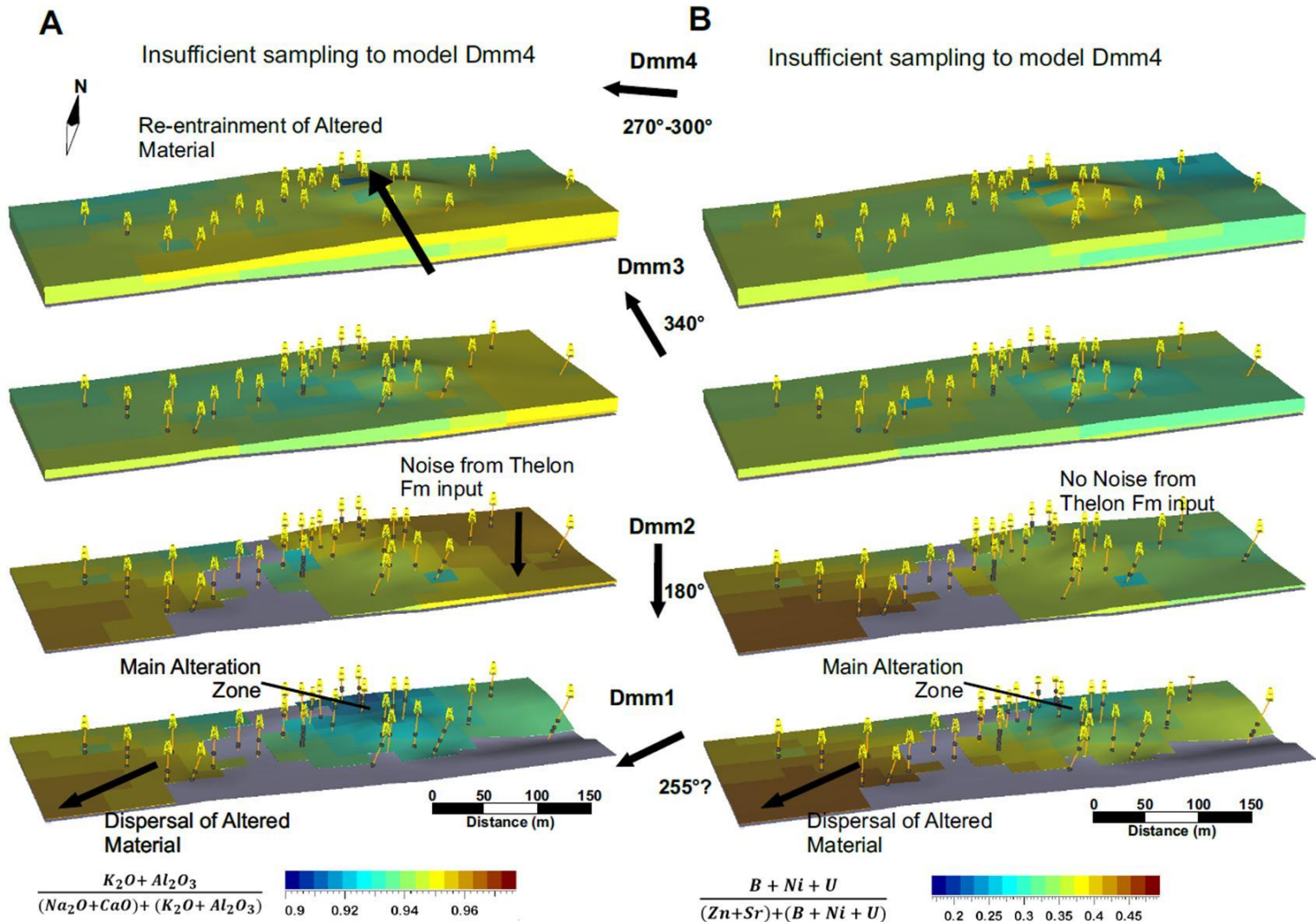


e.g. Eastern Athabasca Basin, northern Saskatchewan

Case example...



3D dispersal patterns



Partnerships in 3D geomodelling

- Increasing needs and more complex problems
 - Need R&D along with 3D geomodelling
- Need training next generation of geoscientists in 3D geomodelling
- **Solution?** Government- or industry-academic partnerships
 - Govt. and university research teams involved in developing the models and their application to various problems
 - Spur innovation
 - Graduate students embedded in collaborative research groups
- **Issues?**
 - A mosaic of models and databases (difficult to integrate, maintain, and update with evolving online technologies for data dissemination, visualization, etc.)
 - Publication media still not well adapted for 3D digital products
 - Few 3D mapping standards
 - Most geological surveys still largely involved in traditional 2D mapping
 - Limited resources for 3D mapping programs
 - Urban geology remains a major challenge...

Acknowledgments



Natural Resources
Canada

Ressources naturelles
Canada

