3D geophysical inversions to characterize carbon sequestration potential of ultramafic rocks

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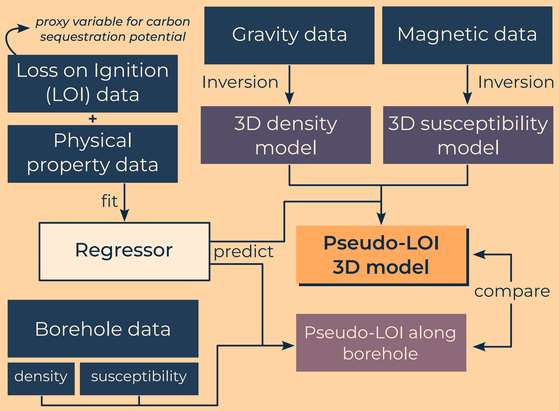
Goals

- Apply **geophysical inversions** to estimate the carbon **sequestration potential** of buried altered ultramafic rocks.
- Generate a **workflow** that can be applied to other areas of interest.

Workflow



Conclusions

- Applied **geophysical inversions** to **gravity** and **magnetic** data over ultramafic complex in Timmins, ON, Canada.
- Estimated carbon **sequestration potential** from the inverted models.
- **Compared** estimations with **borehole** samples.
- **Geophysical inversions** are a valuable technique to characterize carbon **sequestration potential** of buried ultramafic rocks.

CO_2 sequestration in ultramafic rocks

Serpentinization:

olivine + orthopyroxene + **H_2O** → **serpentine** + talc + **brucite** + Ni-Fe alloys and Ni-Fe sulphide

Carbonation:

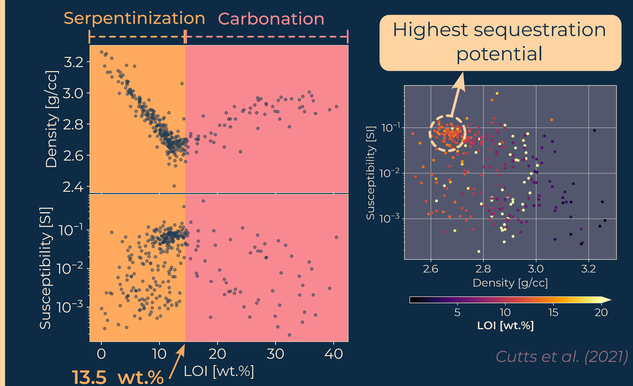
olivine + brucite + **CO_2** + H_2O → serpentine + **magnesite** + H_2O

serpentine + magnetite + **CO_2** → **magnesite** + talc + H_2O

talc + **CO_2** → **magnesite** + quartz

Physical Properties

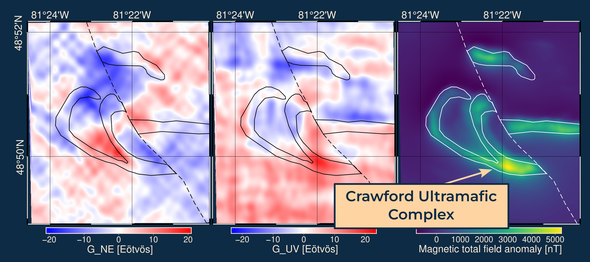
- Loss on Ignition (**LOI**) as a proxy variable for level of **alteration**.
- **Density** and magnetic **susceptibility** vary with LOI.
- **Highest sequestration potential** at LOI of **13.5 wt.%**.



Cutts et al. (2021)

Geophysical Inversions

- Airborne **gravity gradiometry** and **magnetic** data.

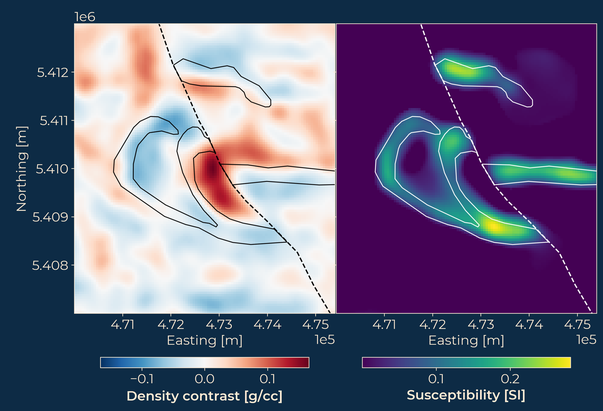


- Independent **inversions** of **gravity** gradiometry and **magnetic** data with SimPEG.

$$\min_{\mathbf{m}} \phi(\mathbf{m}) = \underbrace{\phi_{\mathrm{d}}(\mathbf{m})}_{\text{data misfit}} + \beta \underbrace{\phi_{\mathrm{m}}(\mathbf{m})}_{\text{regularization}}$$

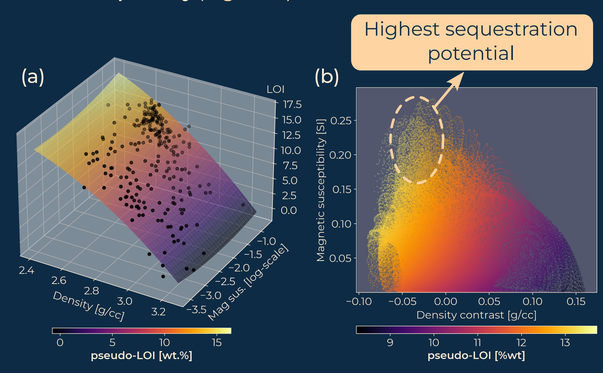
simpeg

- Recovered models (slices at 12.5m of elevation):



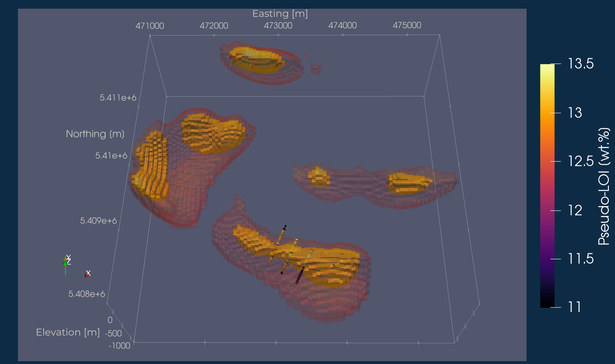
Estimating carbon sequestration potential

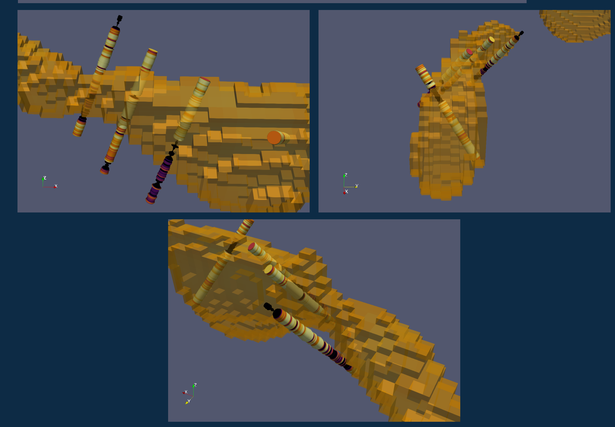
- Fit a **polynomial regressor** on **LOI data** from Cutts et al. (2021) *(Figure a)*.
- Used the **regressor** to predict **pseudo-LOI** values from inverted models of **density** and **magnetic susceptibility** *(Figure b)*.



3D Representation and Comparison with Borehole data

- **Pseudo-LOI** values close to **13.5 wt.%** are interpreted as rocks with **high sequestration pontential**.
- **Borehole data** measurements of **density** and **magnetic susceptibility**.
- Used the **regressor** to predict **pseudo-LOI** values from **borehole data**, to compare estimated pseudo-LOI from inversion results.
- **Good agreement** between estimated sequestration potential and borehole data.





References

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- Cutts et al. (2021), doi: 10.1029/2021GC009989
- Mitchinson et al. (2020), ISBN: 978-0-88865-470-0

Abstract
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