Intra-continental uplift and volcanism in the Hangai Mountains (Mongolia)
Insights from a multiscale magnetotelluric 3-D inversion

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See the following preprint for more information:

- Magnetotelluric multiscale 3-D inversion reveals crustal and upper mantle structure beneath the Hangai and Gobi-Altai region in Mongolia
- Johannes Käufl, Alexander V. Grayver, Matthew J. Comeau, Alexey V. Kuvshinov, Michael Becken, Jochen Kamm, Erdenechimeg Batmagnai, Sodnomsambu Demberel
- DOI: 10.31223/osf.io/5zd3n
- https://eartharxiv.org/5zd3n/
Hangai Mountains

- Bogd and Bulnay Faults accommodate deformation
- Large Earthquakes M>8 in the last century
- Mineralization zone along the South Hangai Fault
Cenozoic volcanism in the Hangai

- Young volcanism (~5 ka to 33 Ma)
- Hot springs
- Shallow lithosphere-astenosphere boundary
- Evidence for the presence of melt below the Hangai Dome

The Hangai Magnetotelluric experiment

- Obtain the first 3-D el. resistivity model of the region
- Understand the Hangai Mountains uplift
- Study intra-continental volcanism

- Electrical resistivity:
  - Presence of melt / partial melt fraction
  - Fluid content
  - Composition
  - Temperature
The Hangai Magnetotelluric experiment

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How to bridge the different scales in a single model?

- Large scale geodynamic and tectonic processes
  - Lithospheric & Asthenospheric structure (>100 km)
- Intermediate Scale
  - Crustal structure and geol. terrane boundaries (10 - 100 km)
- Local features and surface observables
  - Surface fault traces, volcanic provinces, geothermal systems (< 10 km)

Data acquisition

- 272 locations on a 650x400 km²
- grid with ~50 km spacing
- 4 profiles with 5-10 km spacing
- Instruments partly provided by GIPP
**Inter-site transfer functions**

- Single-site impedance:
  \[ \bar{E}_H(\vec{r}, \omega) = Z(\vec{r}, \omega) \bar{H}_H(\vec{r}, \omega) \]

- Inter-site impedance:
  \[ \bar{E}_H(\vec{r}, \omega) = \bar{Z}(\vec{r}, \vec{r}_b, \omega) \bar{H}_H(\vec{r}_b, \omega) \]

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**Magnetotelluric 3-D Inversion**

- 3-D finite element forward modelling and inversion code: GoFEM (Grayver, 2015)
Magnetotelluric 3-D Inversion

- 3-D finite element forward modelling and inversion code: GoFEM (Grayver, 2015)
  - Locally refined unstructured meshes

Inversion Mesh

- Nested multi-scale hexahedral mesh with 321000 cells
- Cellsizes: 2.4 km to 350 km
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Inversion Process

Stage II
RMS: 2.7

Stage III
RMS: 2.1

Stage IV
RMS: 1.9

Animation of the final model:
https://osf.io/d9btv/
Asthenospheric Upwelling and Mineralization

P1-3 by M. Comeau

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Asthenospheric Upwelling and Volcanism

Tariat Volcanic Field & Khorgo Volcano

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Conclusions

- First 3-D resistivity model of the Hangai and Gobi-Altai region
  - Complex resistivity structure, from small crustal features to large regional structures
  - Heterogeneously conductive lower crust below the Hangai dome
    ➢ subsequent talk by Matthew
  - Asthenospheric upwelling in the eastern and southern Hangai, linked to volcanism and mineralization
- Remaining questions (WIP):
  - Link between uplift and upwelling?
  - Driving force behind the asthenospheric upwelling?

- Outlook
  - Joint inversion of MT and global induction methods
  - EM-constrained geodynamic modelling
  - Integrated interpretation with seismology

Field Crew:


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