Investigating magmatic and hydrothermal systems in the Main Ethiopian Rift

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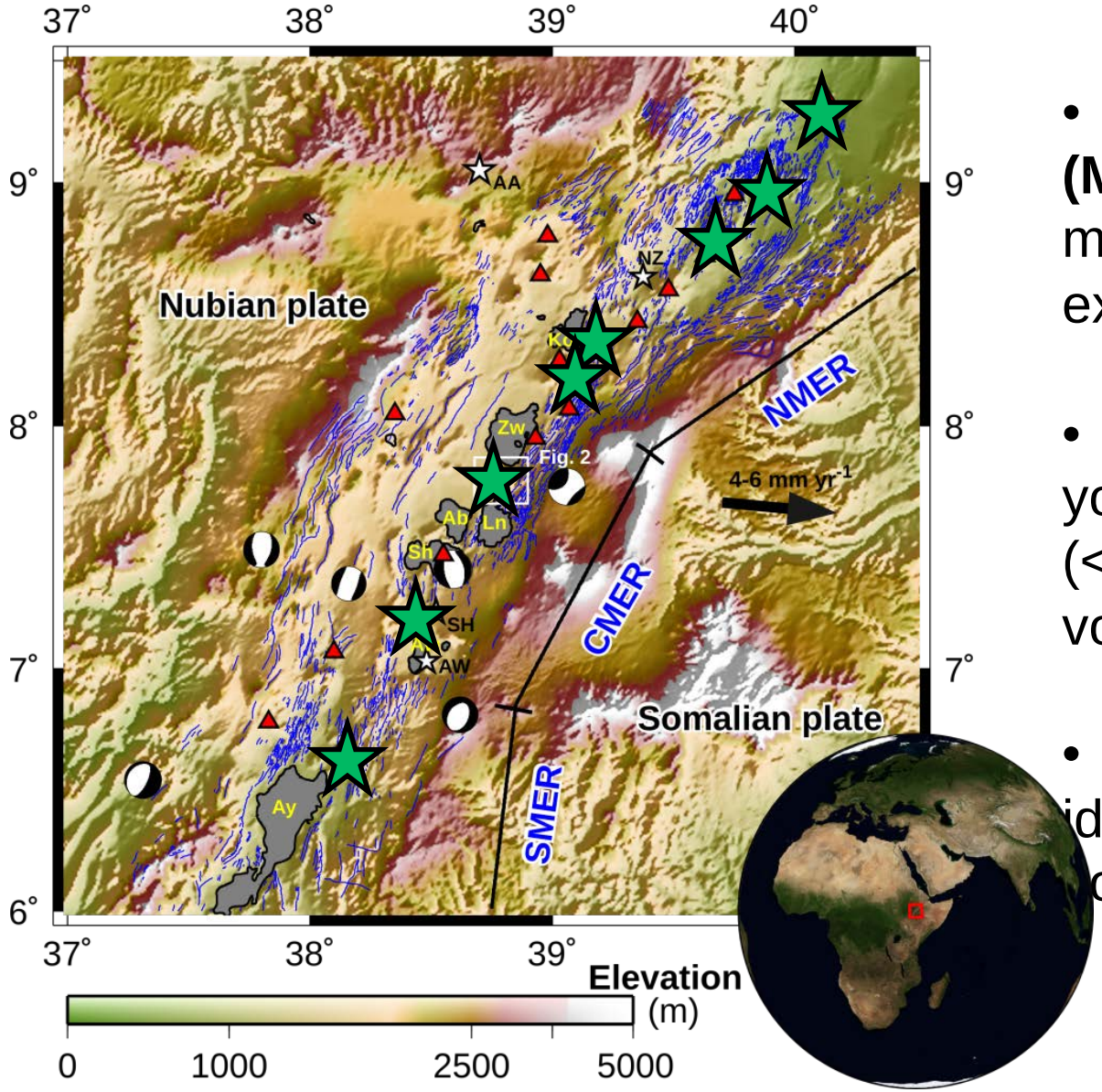
Rifting and volcanism in Ethiopia

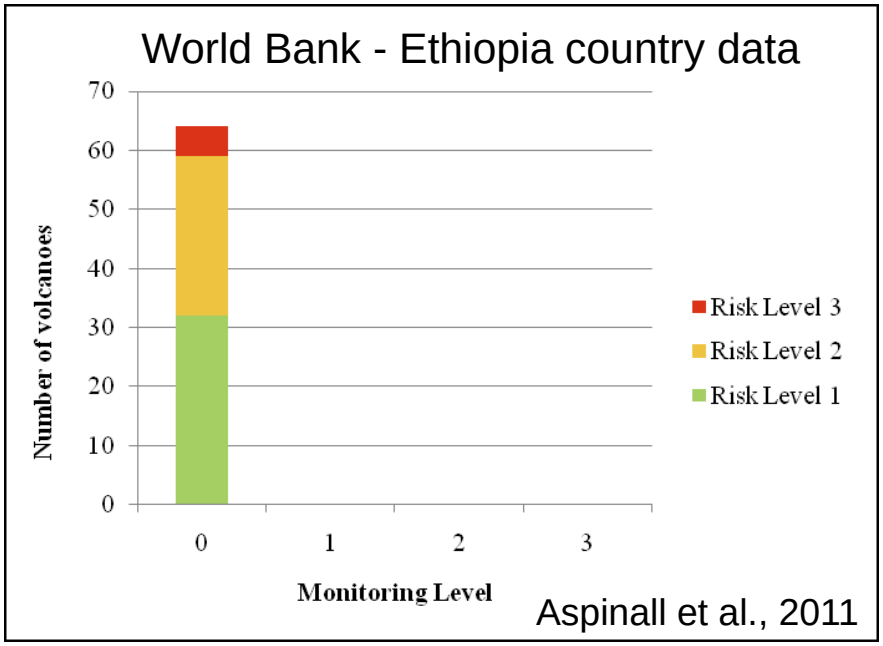


- **Main Ethiopian Rift (MER) –** zone of active magmatic-tectonic extension

- Hosts geologically young ▲ (< 500 ka) caldera-forming volcanoes

- Geothermal resources ★ identified at many of these volcanoes

Geothermal potential and volcanic hazard



http://thinkgeoenergy.com

Aspinall et al., 2011

- Ethiopia has a rapidly growing economy but power sector not meeting demands, shortfall is a major impediment to continued growth
- Combined geothermal resources at these volcanoes may be vast (>> 10 GW_e), yet to be effectively exploited

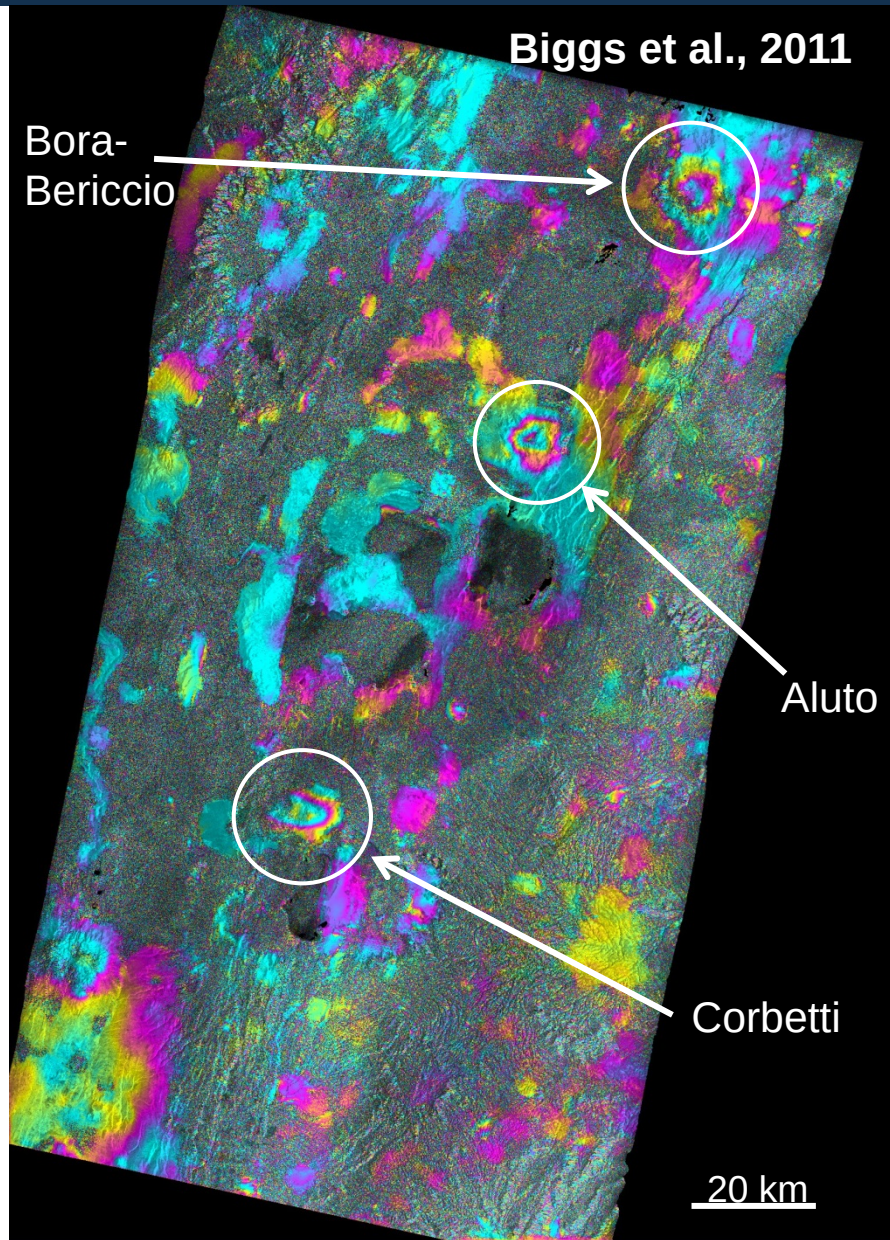
Volcanic deformation in Ethiopia

- InSAR technique enables ground deformation to be mapped remotely

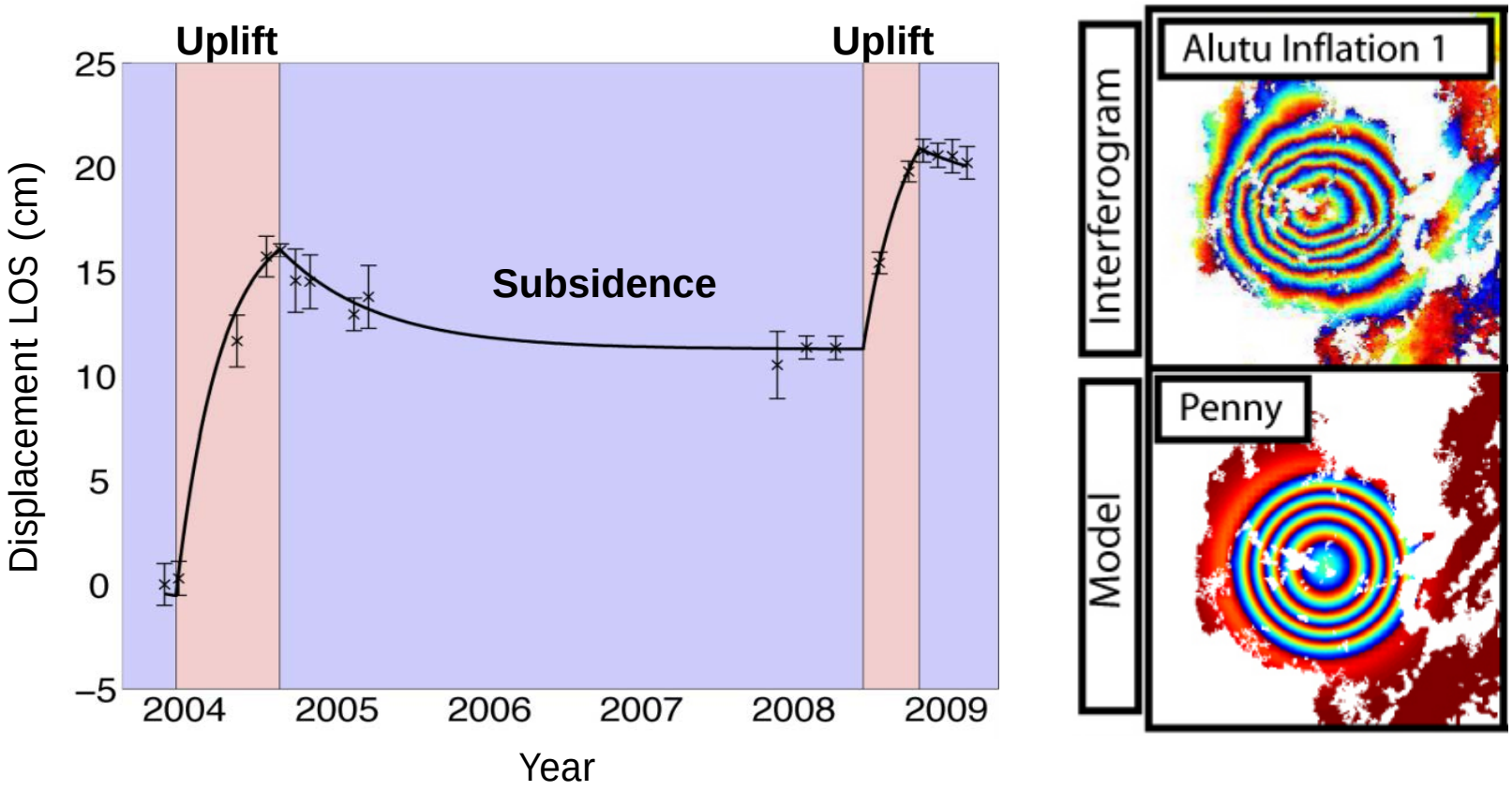
- 4 volcanoes in the Main Ethiopian Rift deforming between 1993-2010

- Deformation seen at volcanoes previously believed to be quiescent, in all cases there was no eruption

- All of these volcanoes host geothermal resources



Volcanic deformation at Aluto



- Aluto shows uplift pulses (10-15cm) separated by gradual deflation
- Source models support a shallow (2.5km depth) radially symmetric source
- But exact cause is uncertain (magmatic, geothermal or

Aluto volcano project motivation

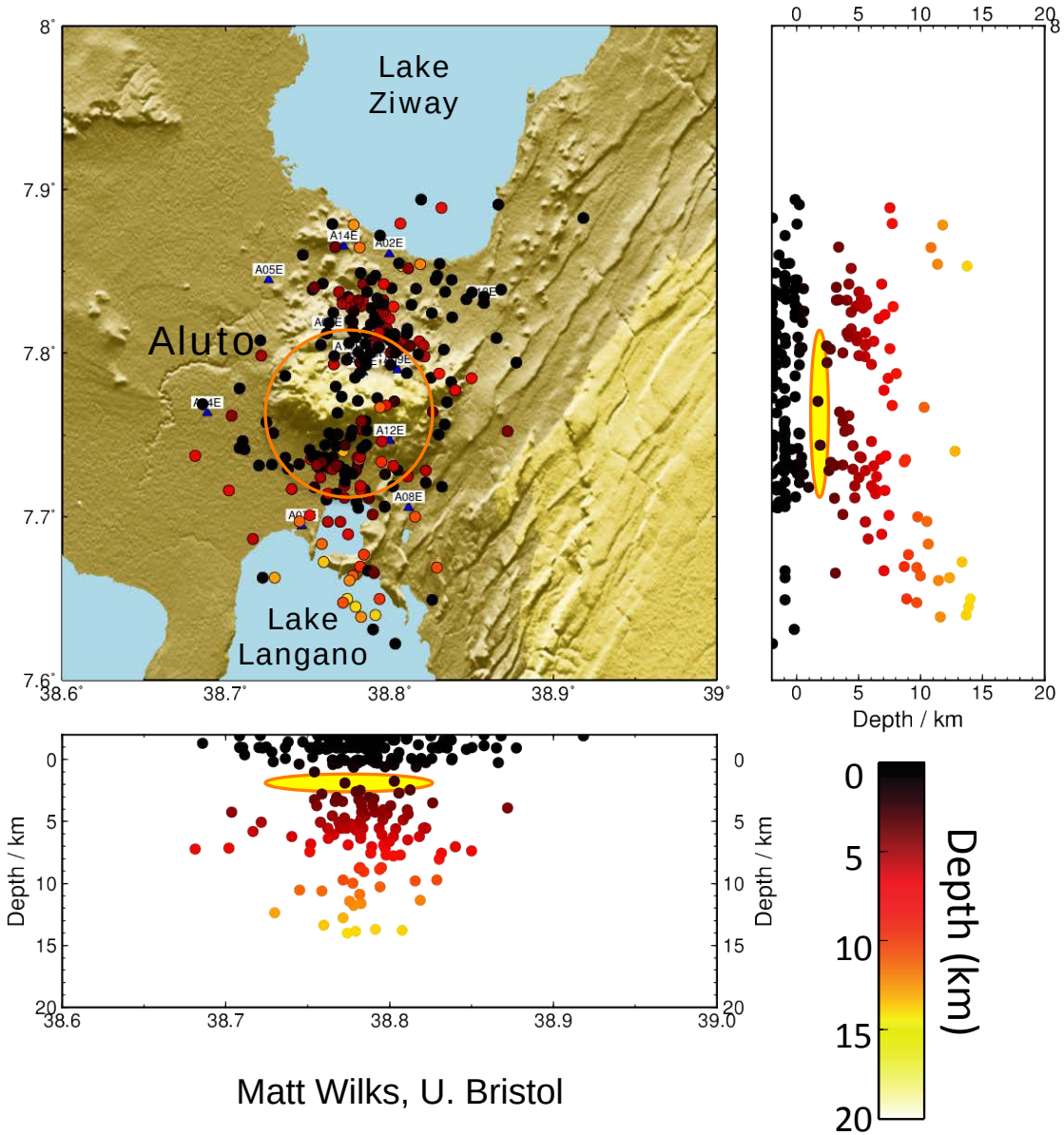
1) Ground deformation identified at volcanoes previously believed to be quiescent

2) Volcanoes [illegible] ure development

- How active are these volcanoes at present? How active have they been in the past? Can these tools also be implemented for geothermal characterisation?

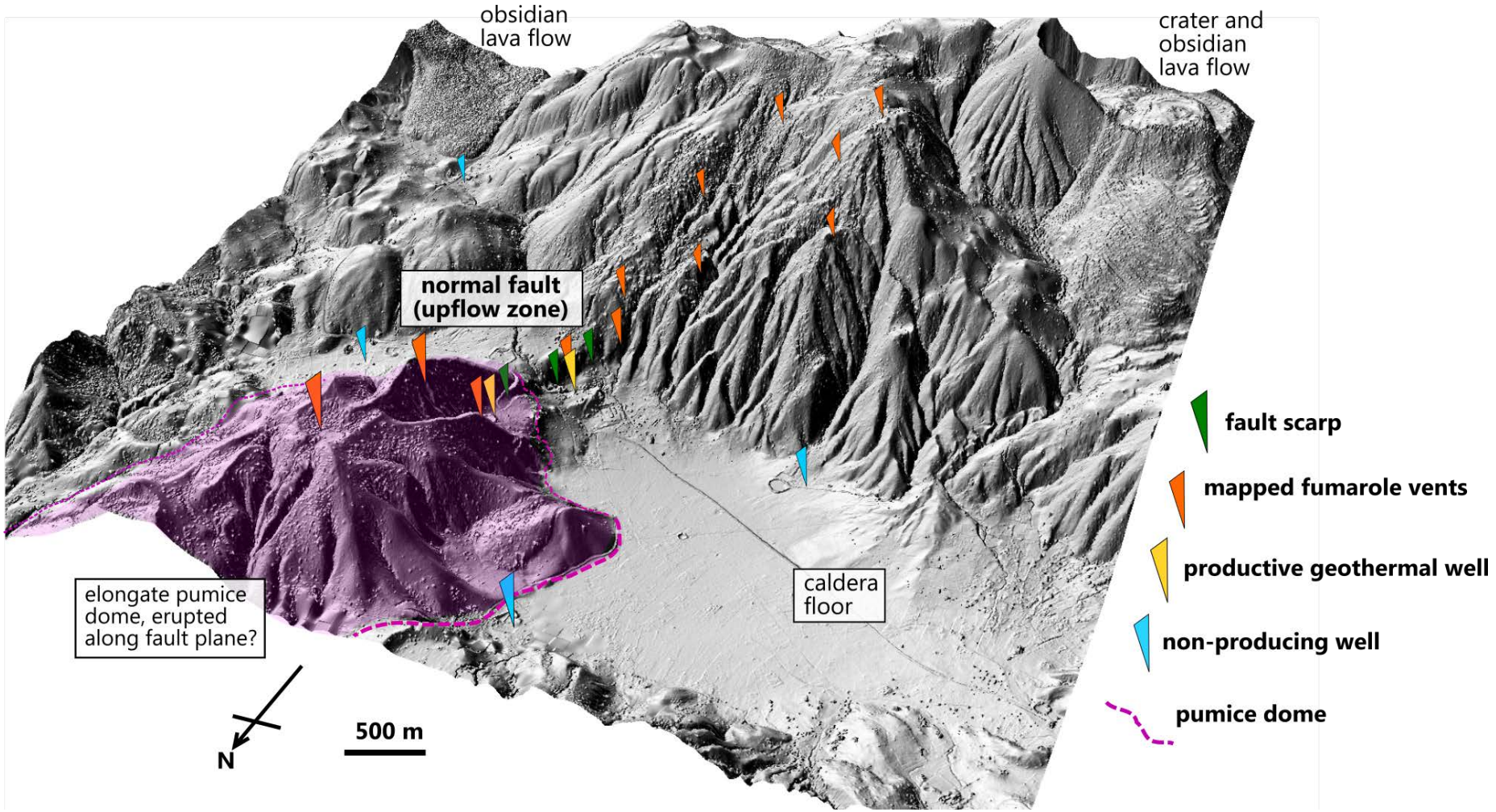
Aluto seismicity

- Network deployed between January 2012 and February 2014
- Aluto is seismically active
- Seismic gap at around 3 km depth
- Roughly corresponds with interface between magma-hydrothermal



Matt Wilks, U. Bristol

Structural mapping (LiDAR)

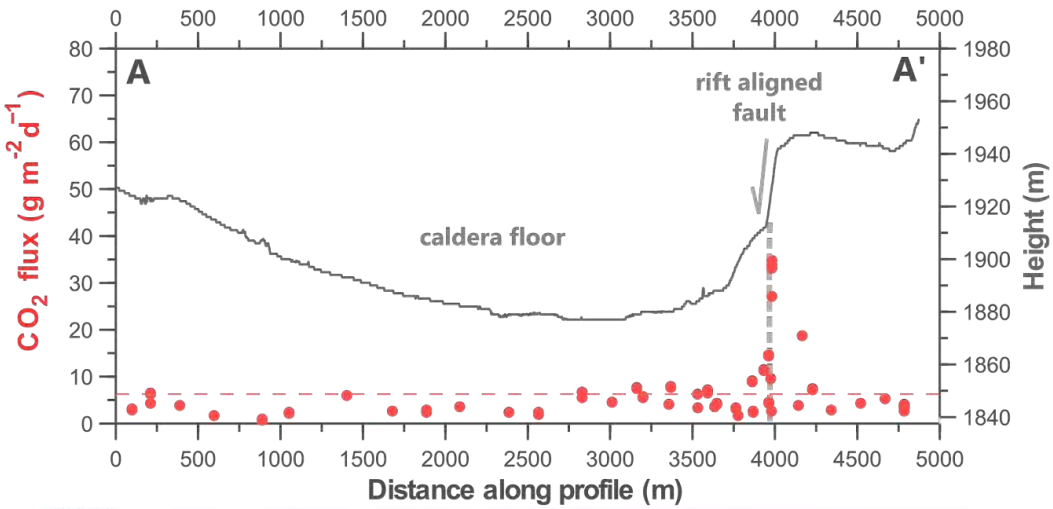


W. Hutchison, U. Oxford

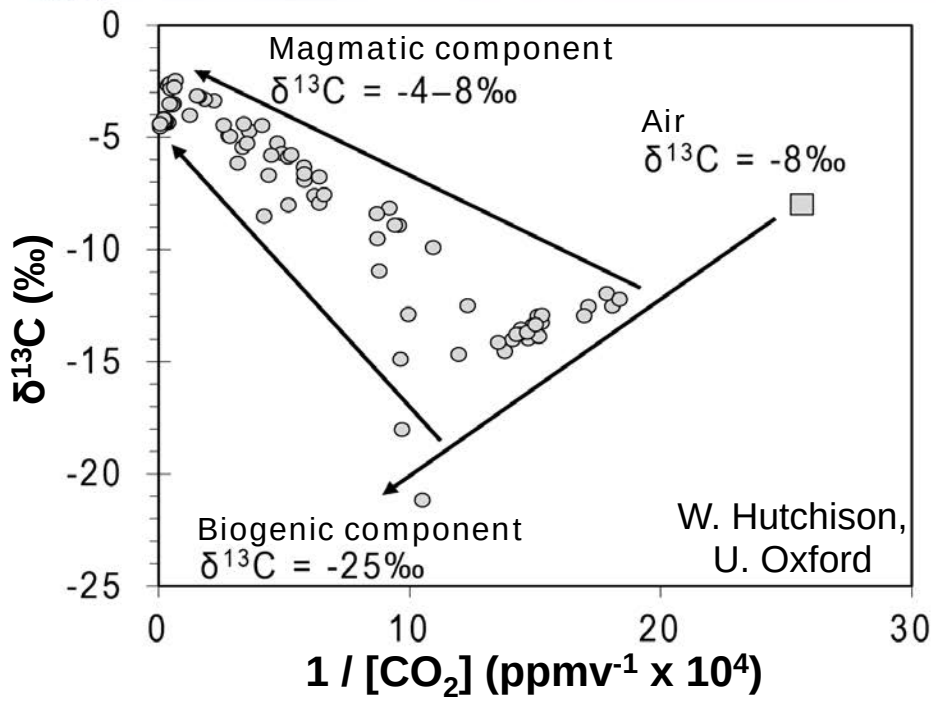
- Surface faulting identified with new LiDAR DEM
- Faults control steam and magma ascent – represent pathway between deep geothermal and magmatic reservoirs and surface

Volcanic degassing

LiCOR CO_2 gas analyzer



- CO_2 flux peaks along mapped fault structures
- Isotopic analysis ($\delta^{13}C$) confirms magmatic contribution to degassing
- Heat source driving geothermal circulation must be a magma body



Summary

- Geothermal industry in Ethiopia set for rapid expansion, however the potential for future unrest at host volcanoes is unknown

- Tools routinely used by volcanologists are also suited for geothermal industry, e.g.,
  - InSAR (prospecting)
  - Seismic (reservoir characterisation)
  - LiDAR (structural mapping)
  - Degassing (magmatic source)

- Huge scope for collaborative research projects in rift geothermal

- Recently funded RiftVolc project to investigate these systems further

RiftVolc - 5 year NERC funded large grant to work in Ethiopia

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http://www.bgs.ac.uk/research/volcanoes/RiftVolc.html

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