

# Investigating magmatic and hydrothermal systems in the Main Ethiopian Rift

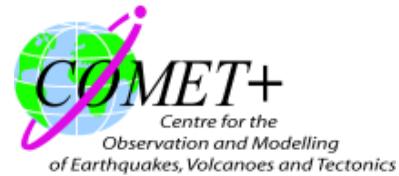
Aluto caldera



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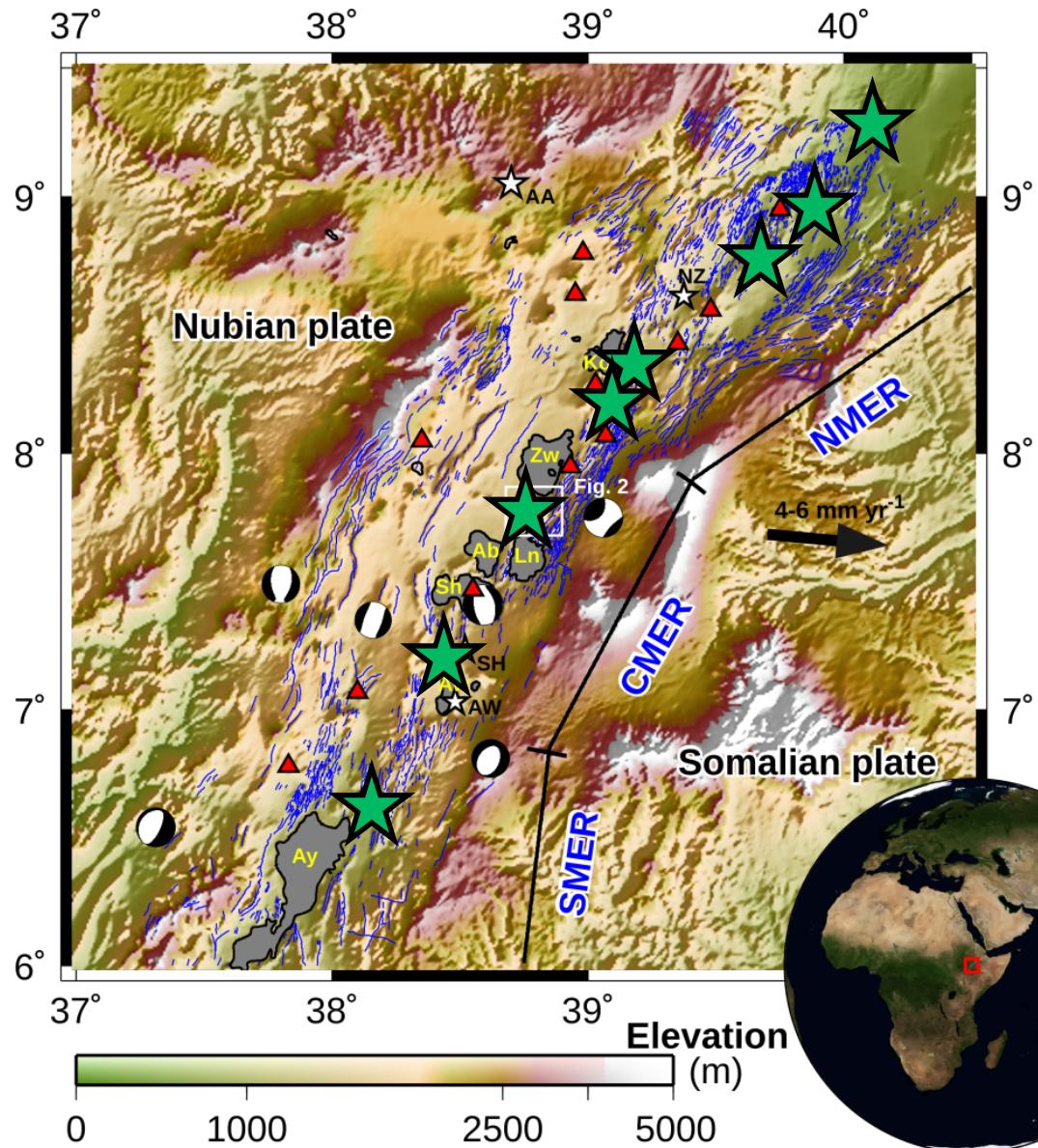
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**National Centre for  
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NATIONAL ENVIRONMENT RESEARCH COUNCIL



# 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

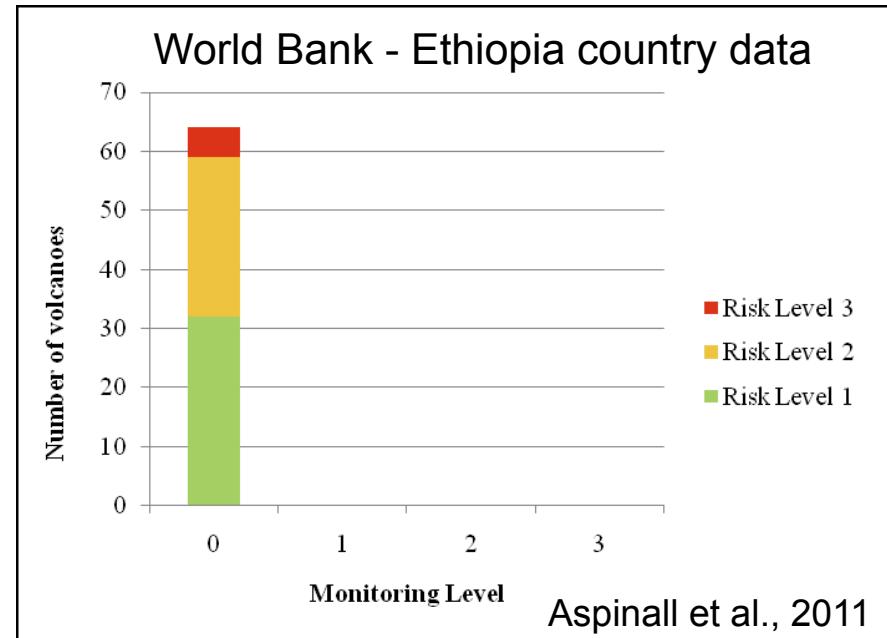


# Geothermal potential and volcanic hazard



**Reykjavik Geothermal signs deal for large Ethiopian project**

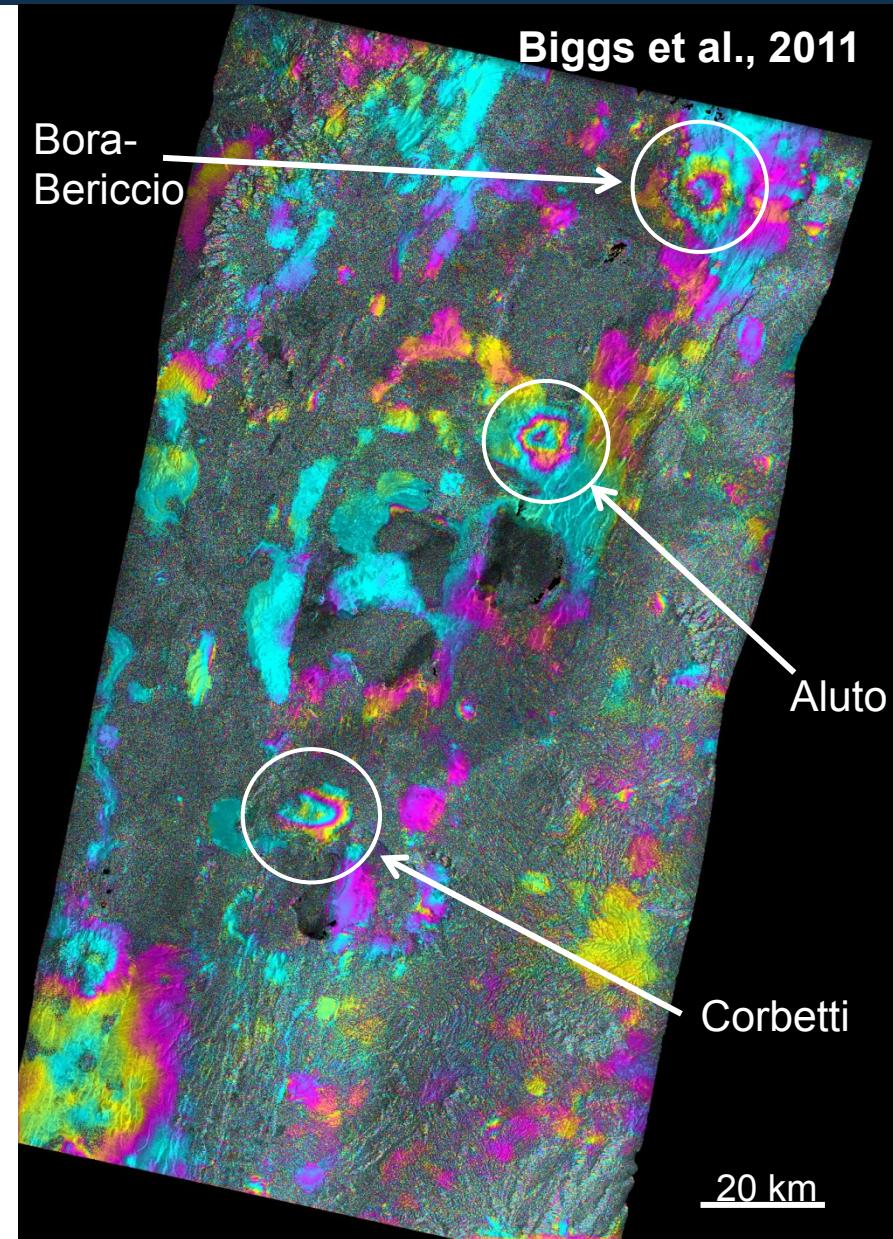
<http://thinkgeoenergy.com>



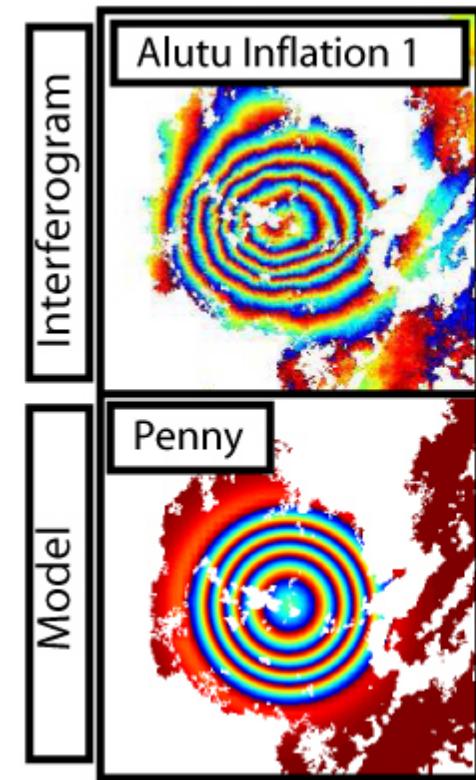
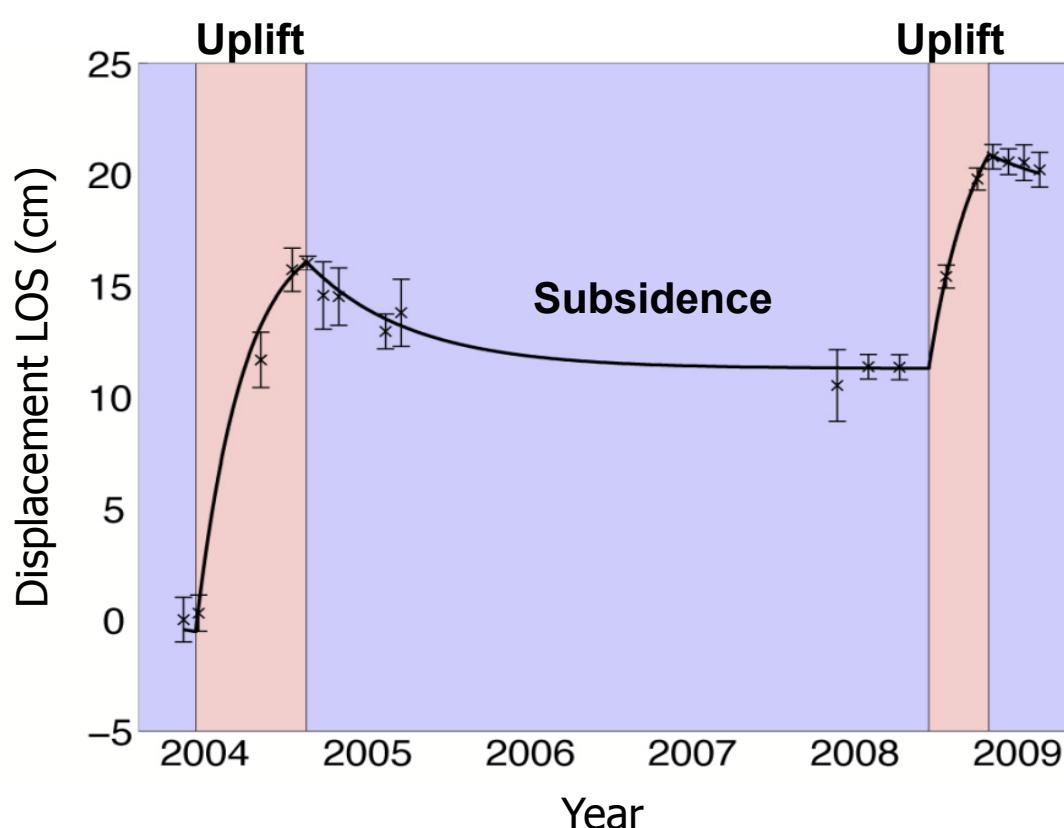
- Ethiopia has a rapidly growing economy but power sector not meeting demands, shortfall is a major impediment to continued growth
- Combined geothermal resources at these volcanoes may be vast (>> 10 GW<sub>e</sub>), yet to be effectively exploited

# 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

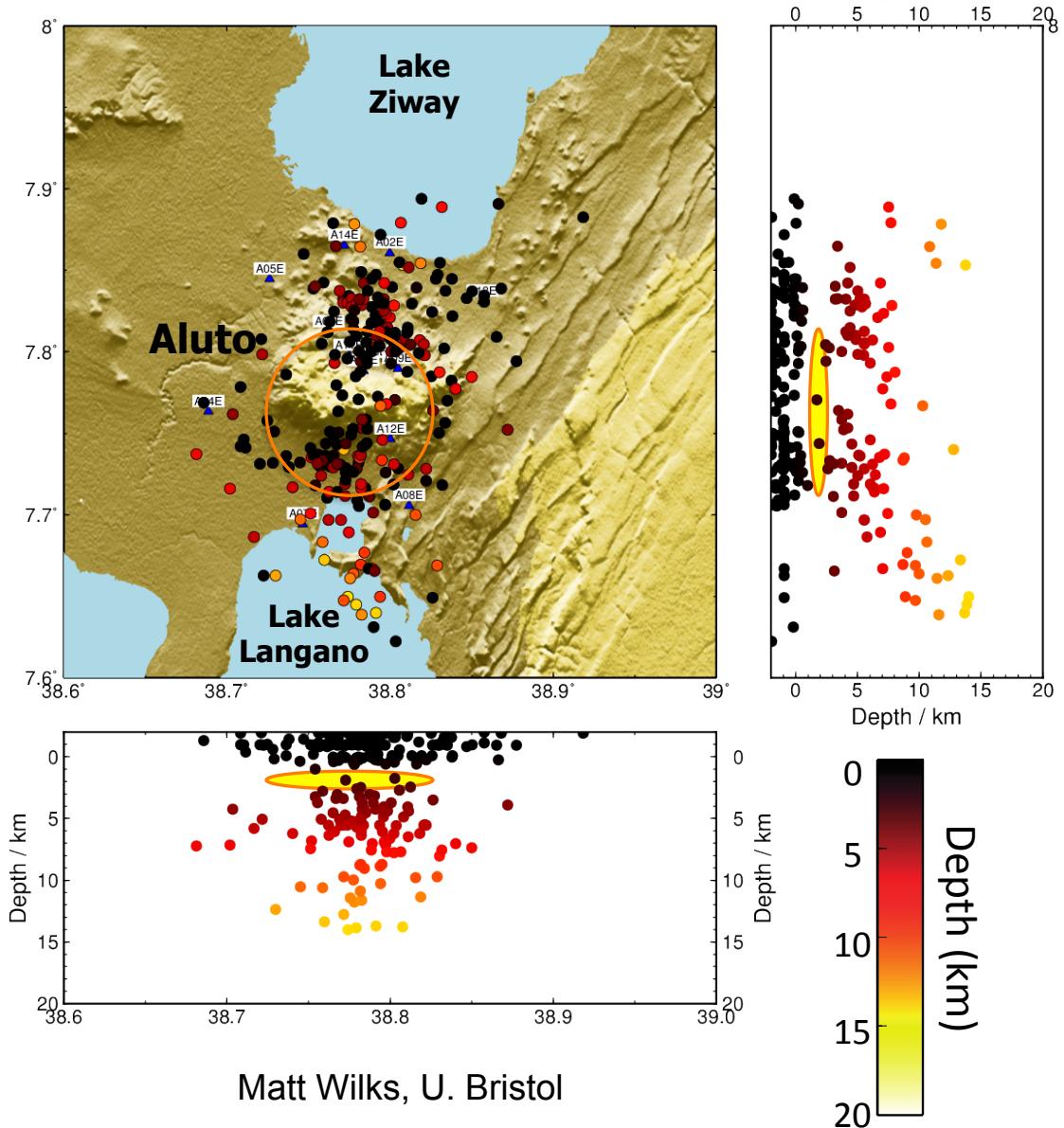
- 1) Ground deformation identified at volcanoes previously believed to be quiescent
- 2) Volcanoes previously believed to be quiescent now show signs of future development



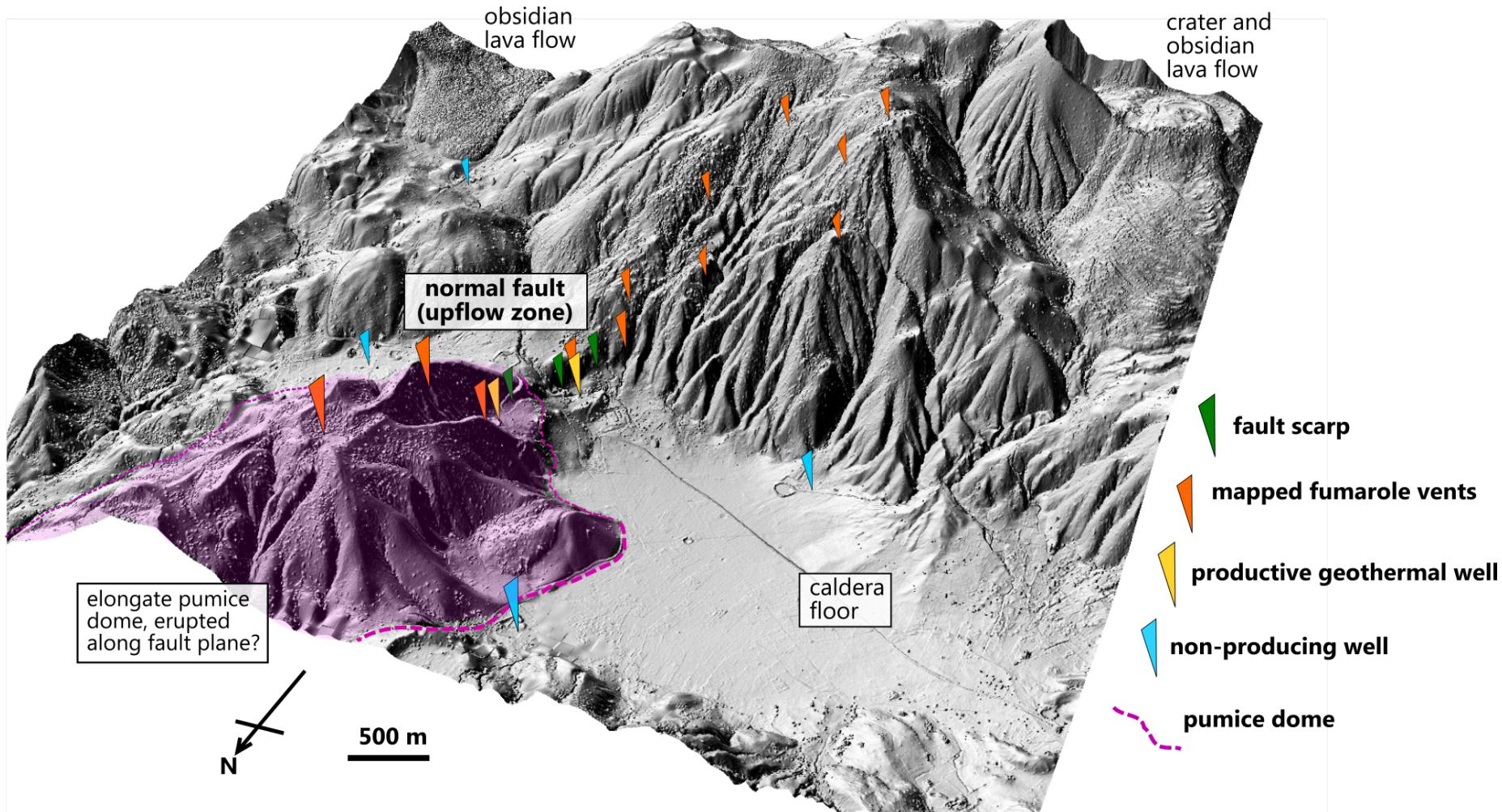
- How active are these volcanoes at present? How active have they been in the past? Can these tools also be implemented for geothermal characterisation?

# 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



# Structural mapping (LiDAR)



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

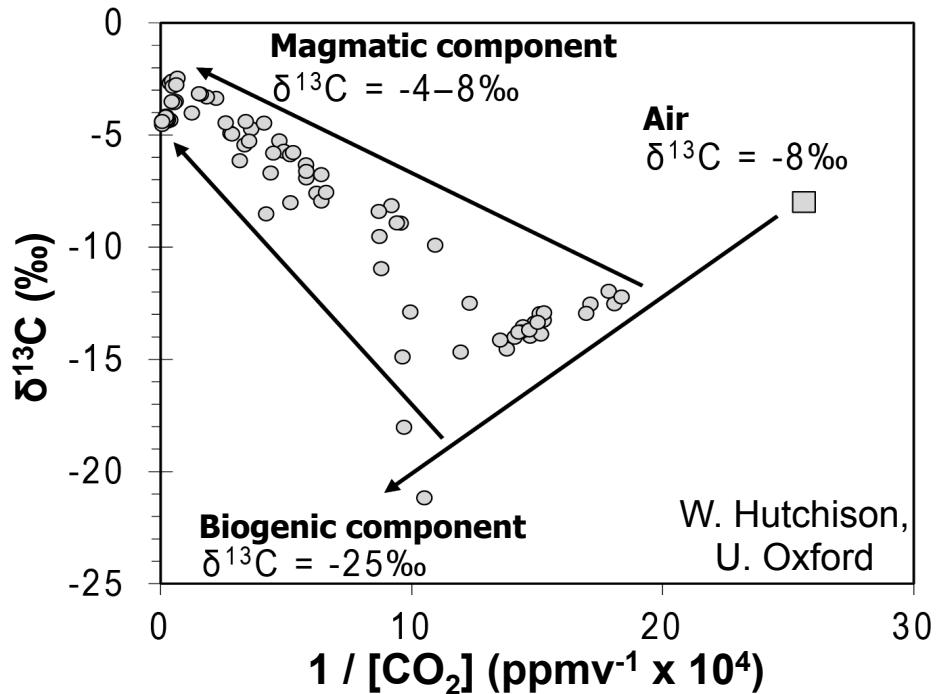
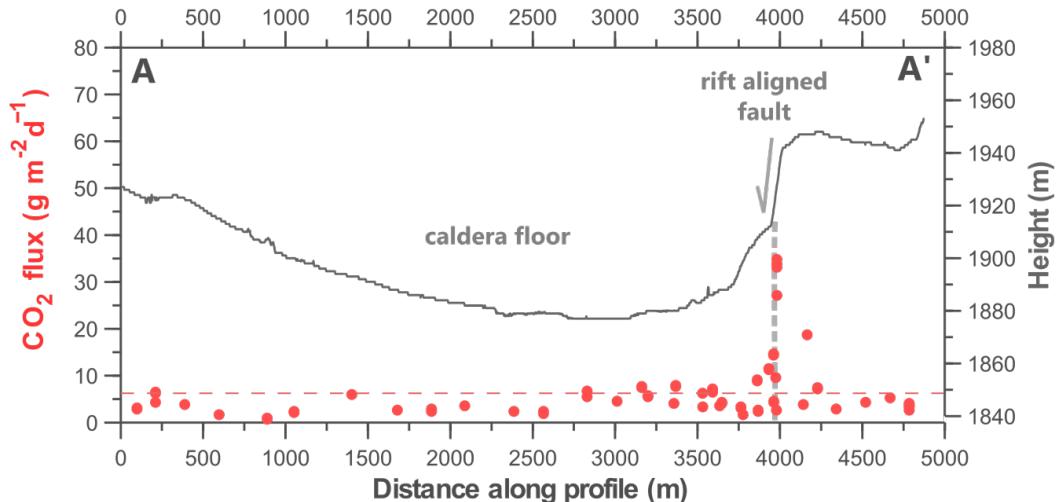
W. Hutchison, U. Oxford

# Volcanic degassing

LiCOR CO<sub>2</sub> gas analyzer



- CO<sub>2</sub> flux peaks along mapped fault structures
- Isotopic analysis ( $\delta^{13}\text{C}$ ) confirms magmatic contribution to degassing
- Heat source driving geothermal circulation must be a magma body



# Summary

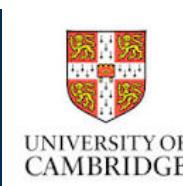
- Geothermal industry in Ethiopia set for rapid expansion, however the potential for future unrest at host volcanoes is unknown
- Tools routinely used by volcanologists are also suited for geothermal industry, e.g.,
  - InSAR (prospecting)
  - Seismic (reservoir characterisation)
  - LiDAR (structural 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



UNIVERSITY OF  
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<http://www.bgs.ac.uk/research/volcanoes/RiftVolc.html>

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