Rift Volcanism: Past, Present and Future
What controls volcanism in a continental rift?

1. How does rifting influence magma generation, storage, migration and eruption?
2. What drives unrest at volcanoes?
3. What are the potential volcanic threats?
What controls volcanism in a continental rift?

1) First dated catalogue of eruptions and deposits at a continental rift
2) Integrated models of the ascent and storage of melts through a rift
3) Characterisation of the source(s) of volcanic unrest
4) Novel probabilistic analysis of volcanic hazards
5) Improved local & global resilience over NERC’s 3 key impact areas
Why Ethiopia (1): THE classic mature continental rift

- Basaltic Fissures, East Zway
- Silicic Caldera, O’a
- Obsidian Flows, Chabbi

Maars, Butajira
Specific Objectives

O1: Constrain the timing and magnitude of Holocene to Recent volcanism.
O2: Understand magmatic controls on eruption style at the central volcanoes.
O3: Determine the links between eruption style and climate/hydrology.
O4: Define the role active rifting plays on magmatic plumbing systems and volcanism.
O5: Characterise the spatial and temporal variations in stress and strain associated with magmatic, hydrothermal and fault-related processes at the silicic volcanic centres.
O6: Quantify the state of unrest from geophysical data.
O7: Develop probabilistic assessment methods to fully characterise key volcanic hazards at a high risk central volcano.
O8: Develop a regional analysis of ash fall hazard and assess the long-term volcanic threat, incorporating the inherent uncertainty.
**PAST: What has driven eruptions over geological timescales?**

**Objectives:**
- Frequency/Magnitude of past eruptions
- Controls on eruption style
- Links to hydrology
**PRESENT:** What controls the active magmatic system and volcanic unrest?

**Objectives:**
- Influence of rifting
- Magmatic, hydrothermal and fault processes

**Regional Monitoring**

- Stress & Strain
- Sources, Seismic Sources, Deformation
- Mass & Fluid
- Seismic Imaging, Resistivity, Gravity, Gas

**Magma Storage and Migration**
- Resistivity, Seismicity, Seismic Imaging, Geodesy, Petrology
FUTURE: What are the potential threats from future volcanic activity?

Objectives:
- Alert criteria
- Probabilistic tools for sparse datasets
- Regional/long-term volcanic threat
RiftVolc Team

Bristol, Cambridge, Edinburgh, Leeds, Oxford, Southampton, BGS

Bristol
Juliet Biggs; Jon Blundy; Kathy Cashman; Jo Gottsmann; Michael Kendall; Alison Rust; Fiona Whittaker

Addis Ababa University
Atalay Ayele; Elias Lewi; Getnet Mewa, Shimeles Wodemichael, Gezahegn Yirgu

Cambridge
Marie Edmonds

British Geological Survey
Brian Baptie; Julia Crummy; Murray Lark; Sue Loughlin; Richard Luckett; Kay Smith; Charlotte Vye-Brown

Edinburgh
Kathy Whaler; Andrew Bell; Eliza Calder; Ian Main

Oxford
Tamsin Mather; David Pyle; Victoria Smith

Leeds
Andy Hooper; Graham Stuart; Tim Wright

Southampton
Derek Keir

+ PDRAs and PhD students (see later)
Progress (1): Science Highlights

- WP1 field season (Fontijn et al)
- ~25 ash layers from the Holocene deposited in lake cores near Aluto (McNamara)
- WP2 field season: 36 seismic stations deployed (Keir et al) & cross-rift MT profile measured (Hübert, Whaler & Fisseha)
- Processed 3-year GPS & InSAR archive – ~7 cm/yr uplift at Corbetti, ~2cm/yr subsidence at Aluto (Birhanu & Lloyd)
- Repeat dynamic gravity survey show magma input at Corbetti (Birhanu & Gottsmann)
- World-bank funded expert elicitation on the characteristics and frequencies of explosive eruptions in Ethiopia and Kenya (Vye-Brown et al)
Progress (1): Science Highlights

- Most seismic stations serviced (Birhanu)
- 2-D model of MT profile (Hübert, Whaler & Fisseha)
- Data from January 2016 Hawassa earthquake analysed and published (Wilks et al)
- Field campaigns suspended when state of emergency imposed
  - action supported by AAU colleagues and Advisory Board
  - situation seems easier now, and AAU advice is we can consider resuming
- FCO travel advisory to our region lifted, but other alerting services still recommending against travel
Progress (2): Personnel

Postdoctoral Researchers:
- PDRA1 (Oxf) – Karen Fontijn
- PDRA2 (Sot) – Tim Greenfield
- PDRA3 (Bristol) – Yelebe Birhanu
- PDRA4 (Edin) – Juliane Hübert
- PDRA5 (BGS) – ad out soon
- PDRA6 (Data) – TBA

Tied Studentships:
- PhD1 (Bristol) – Keri McNamara
- PhD2 (Edin) – Rachel Wilcock
- PhD3 (Leeds) – Chris Moore
- PhD4 (Cambridge) – Fiona Iddon

Associated Studentships:
- Ryan Lloyd (Bristol)
- Jon Hunt (Oxford)
- Ben Clarke (Edinburgh)
- Melanie, Aude & Finn (Southampton)
- Emma Chambers (Sot)
- Tesfaye Temtime (Bristol)

Exchange visits with AAU:
- Elias Lewi (Bristol, 2015);
- Amde Zafu (Oxford, 2016)
Peer-reviewed publications:


- Plus plenty of conference presentations, including at the meeting following this
Next Science Meeting

Dovedale House, Ilam, South Peaks
www.dovedalehouse.org

July 2017
These are the Project Outputs:
1) the first integrated eruption catalogue for a continental rift, detailing dates, magnitudes, mechanism and chemical characterization of major eruptions and associated flows and cones;
2) combined geophysical and geochemical models of the ascent and storage of melts through an active rift and the influence of along-rift variations in magma supply and tectonic setting;
3) characterisation and statistical analysis of the evolving stress, strain and fluid flow fields around actively-deforming volcanic systems, and comparison with quiescent volcanoes;
4) novel probabilistic analysis of the hazards associated with rift volcanism at both volcano-specific and regional scales, and new statistical methods to assess regional volcanic threat
Breakout questions

• What is required to produce an *integrated* eruption catalogue?
• What dating is required? Is it going to be a limitation?
• How is the chemical characterization proceeding?

• What geophysical and geochemical data will we have and how will they be combined to model magma ascent and storage?
• What along-rift variations in magma supply and tectonic setting have been documented to date?
• What about across-rift variations e.g. Silte-Debra Zeit Fault Zone versus Wonji Fault Belt?

• Characterization of some actively-deforming volcanic centres is proceeding well, but what about the evolving stress, strain and fluid flow fields around volcanic systems? And statistical analysis?
• How will we undertake comparison with quiescent volcanoes?

• What information is required to undertake novel probabilistic analysis of the hazards associated with rift volcanism at both volcano-specific and regional scales, and new statistical methods to assess regional volcanic threat?