British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Applied geoscience for our changing Earth

Development of central volcanoes and rift axial volcanism in the Manda-Hararo rift segment, Afar, Ethiopia

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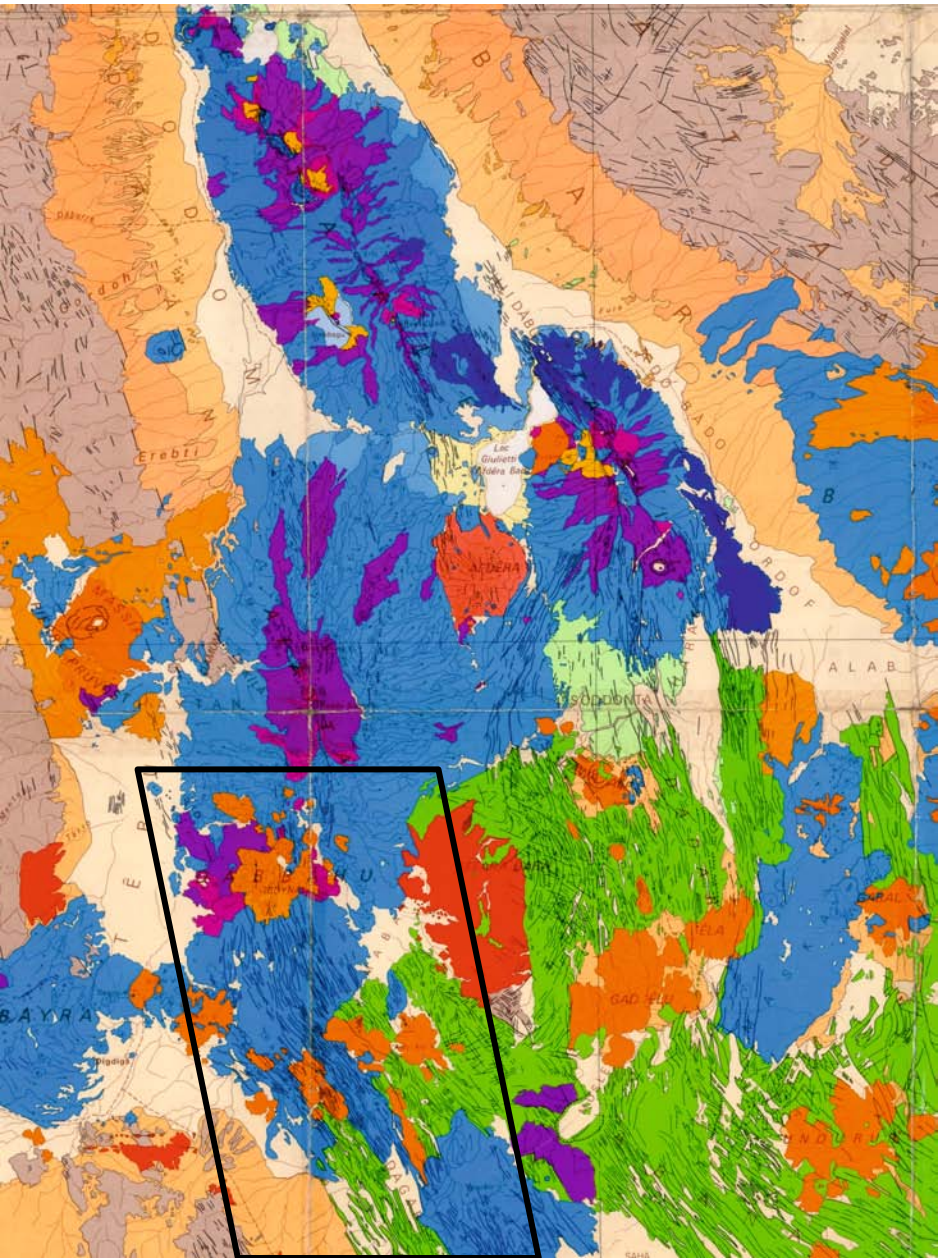
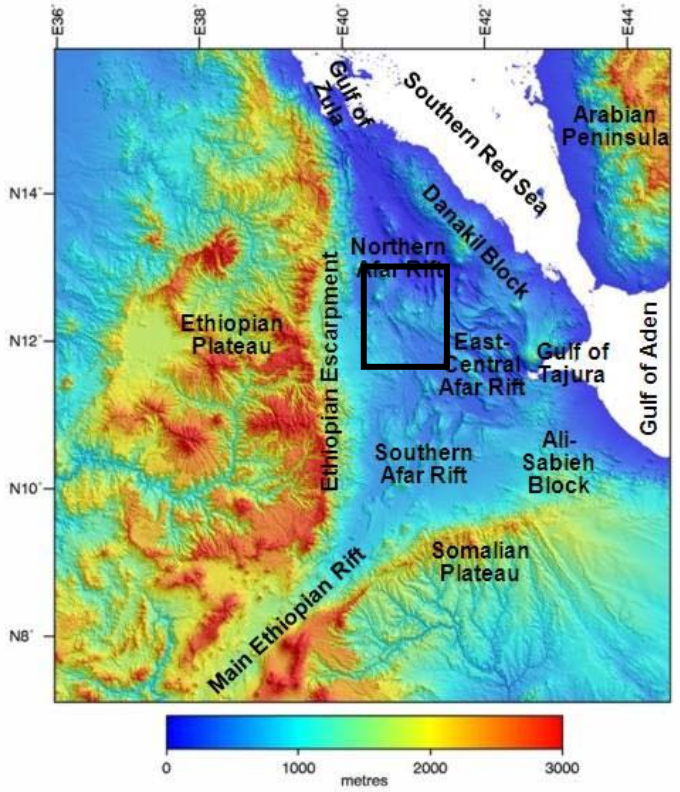
Afar Rift Consortium

Regional context





Map extract from Barberi, Giglia, Marinelli, Santacroce, Tazieff and Varet, Geological map of the Danakil Depression

BGS working in collaboration with ARC

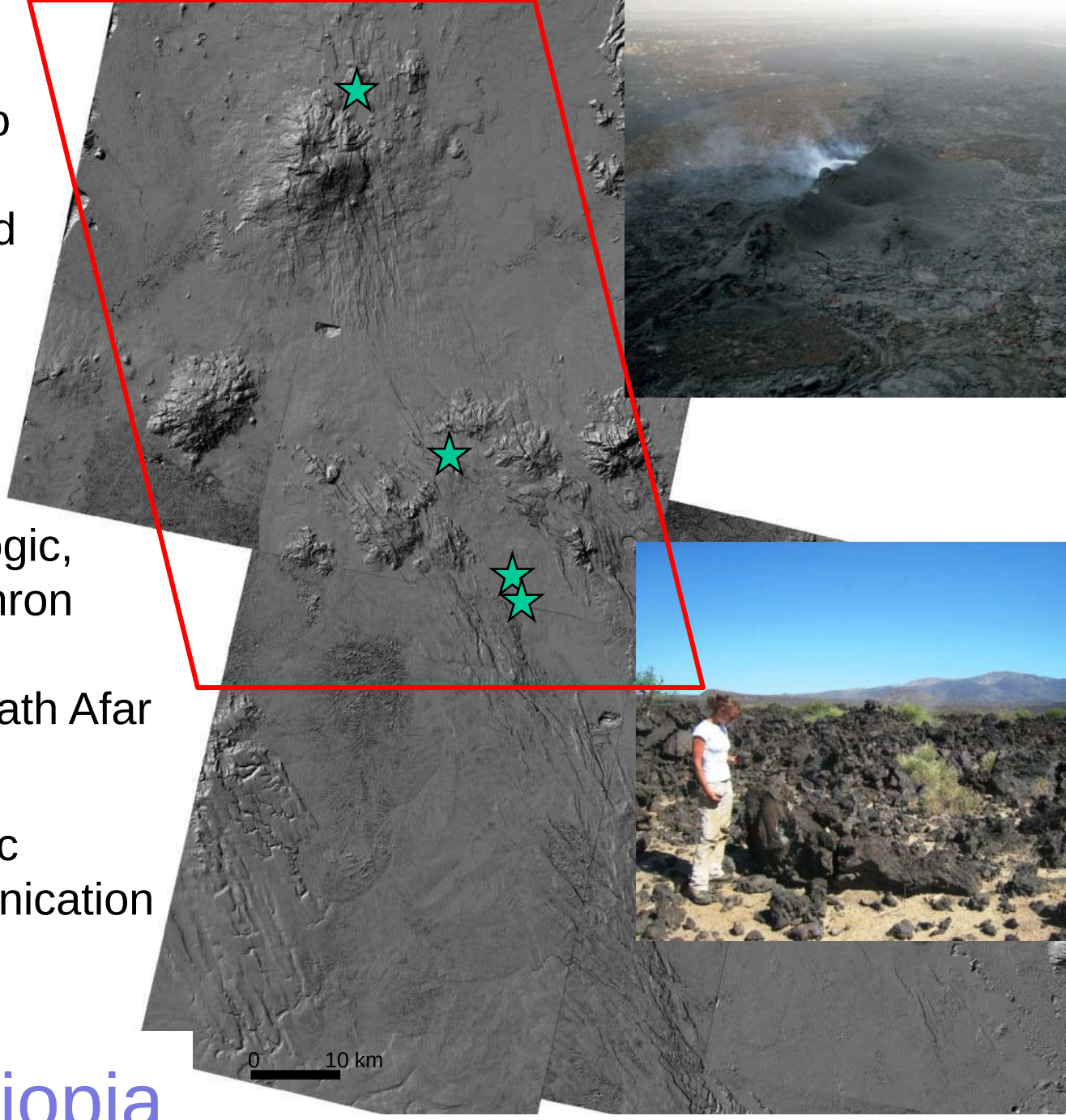
Mapping central volcanic complexes, extensive plains-style basaltic lavas, fault networks, fissures and pyroclastic deposits.

Spatial temporal distribution of volcanic products and rift history.

Mapping in the Afar Depression, Ethiopia to identify **individual eruptive episodes** and understand character, extent, timing and causes of past volcanism.

Combining with petrologic, seismic, MT and geochron research to investigate plumbing system beneath Afar in this active rift.

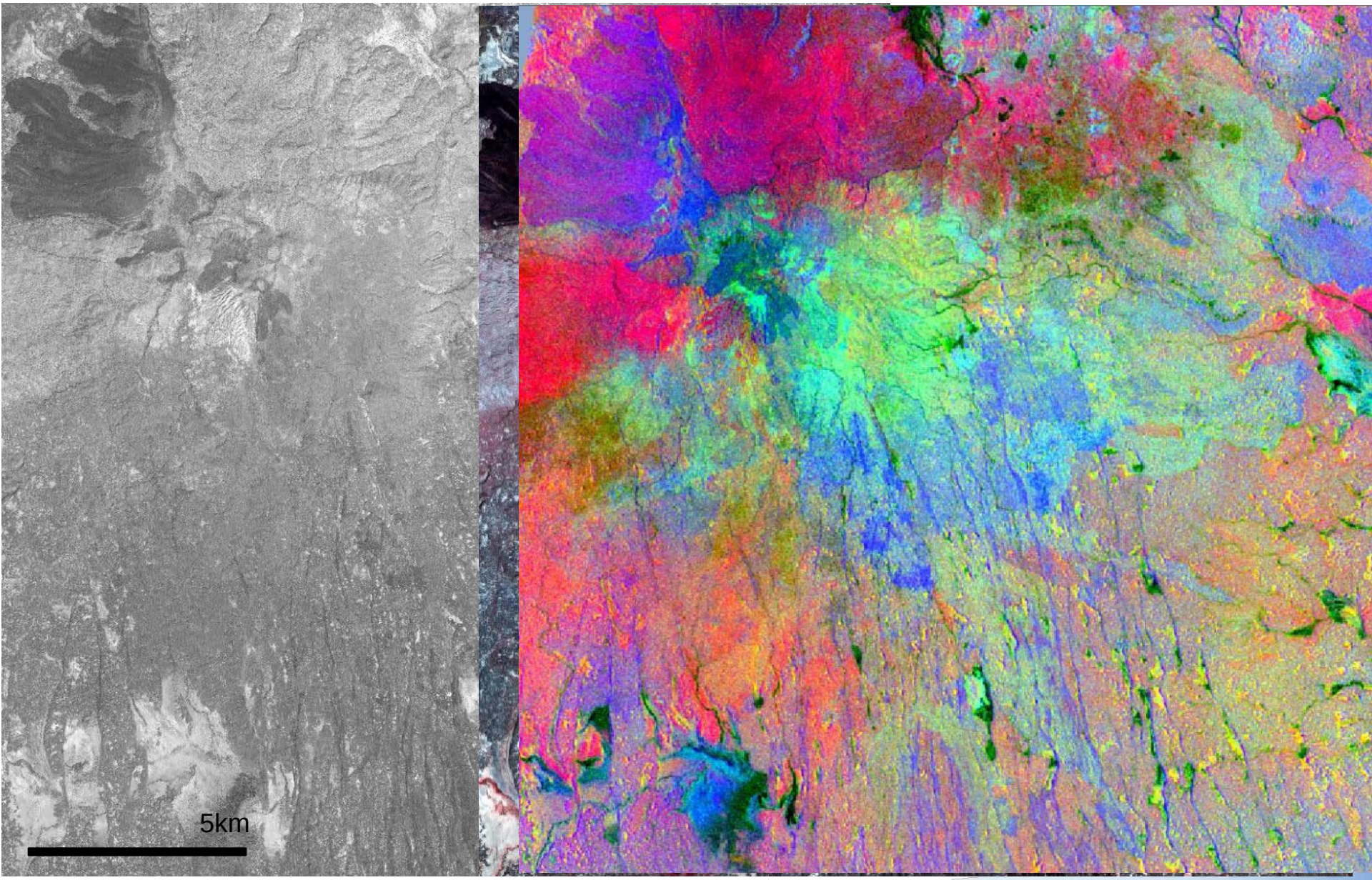
Integrating the scientific objectives with communication of hazards and risk.



Afar Rift, Ethiopia

Hill-shaded DEM from SPOT5 (supplied by S.Hautot)

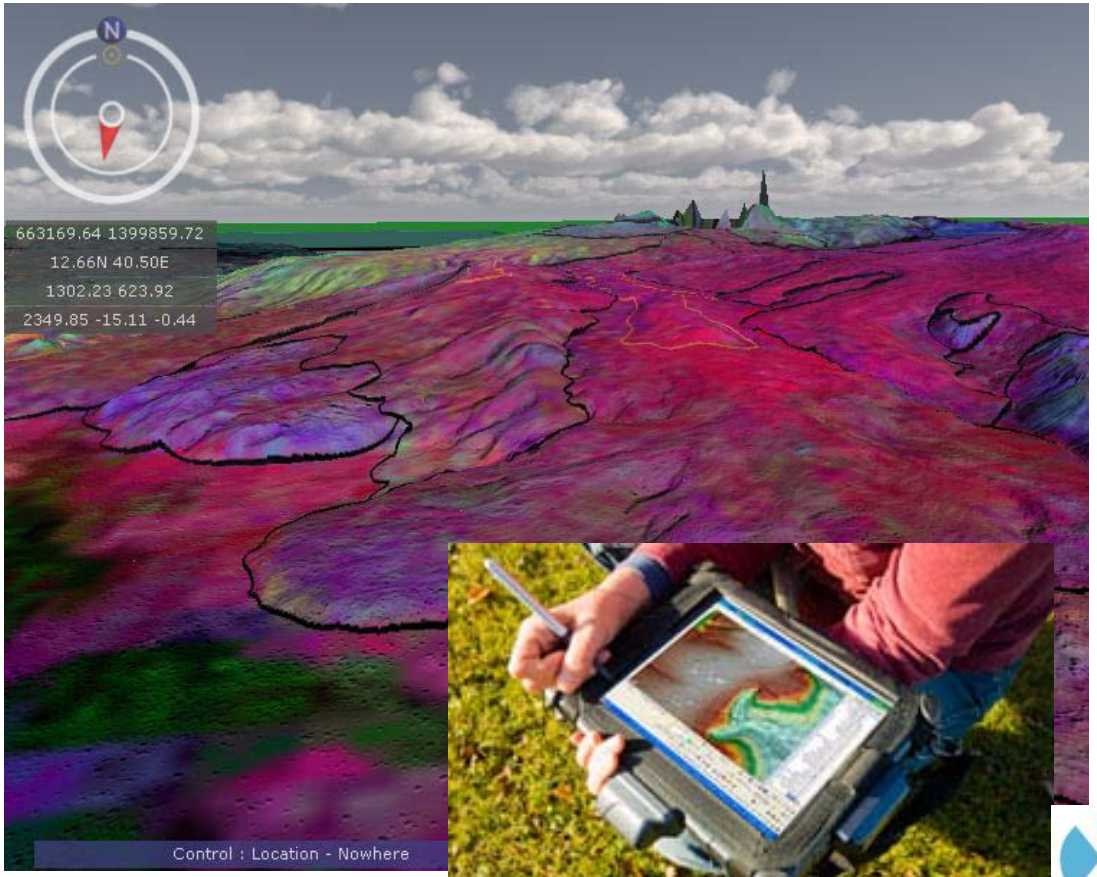
Mapping and modelling development



3-D visualisation

GEOVISIONARY

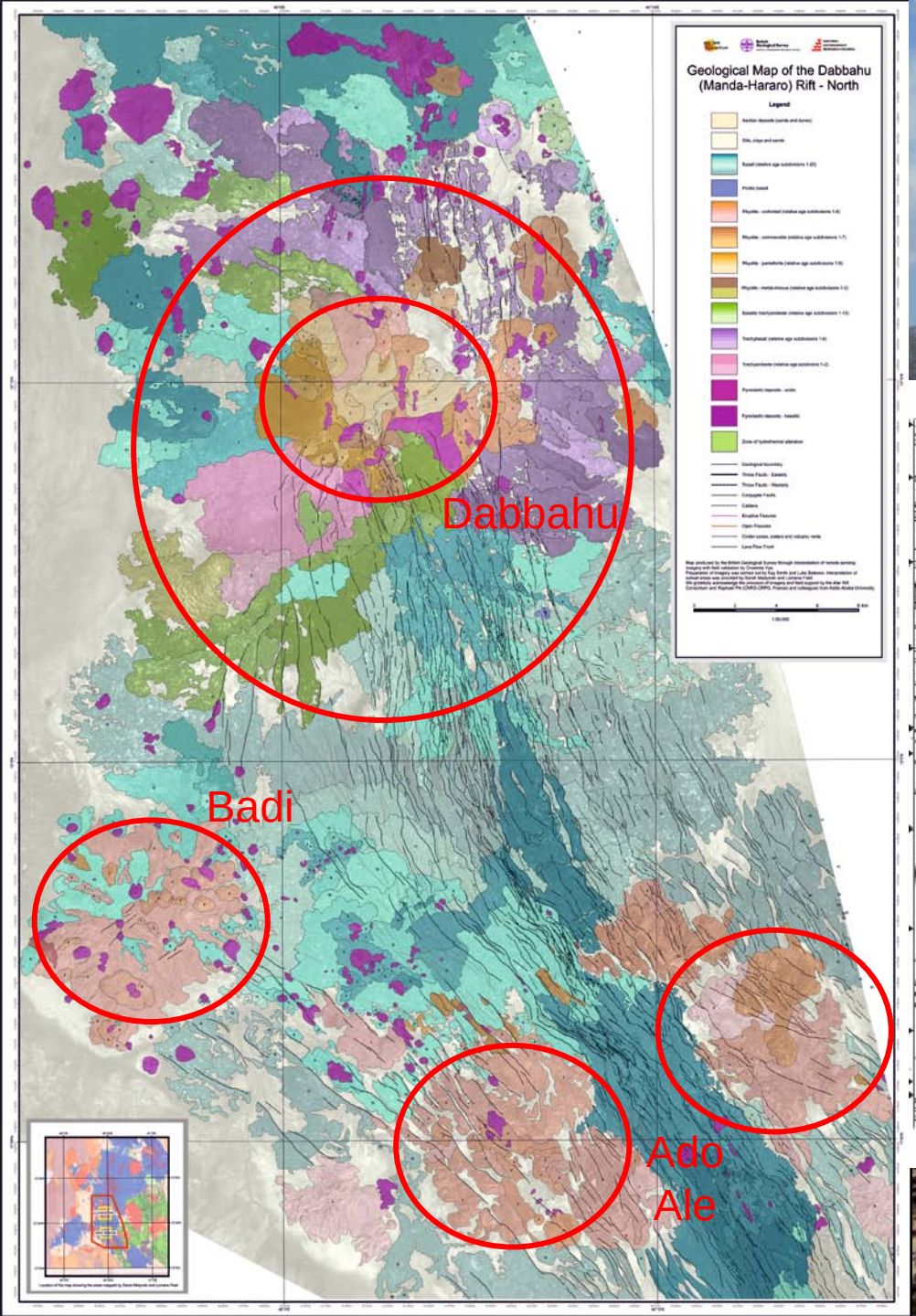
- Combined in Geovisionary™ to provide a full stereoscopic 3-D environment in which to simulate field investigation.
- Essential for establishing relationships between geological units.

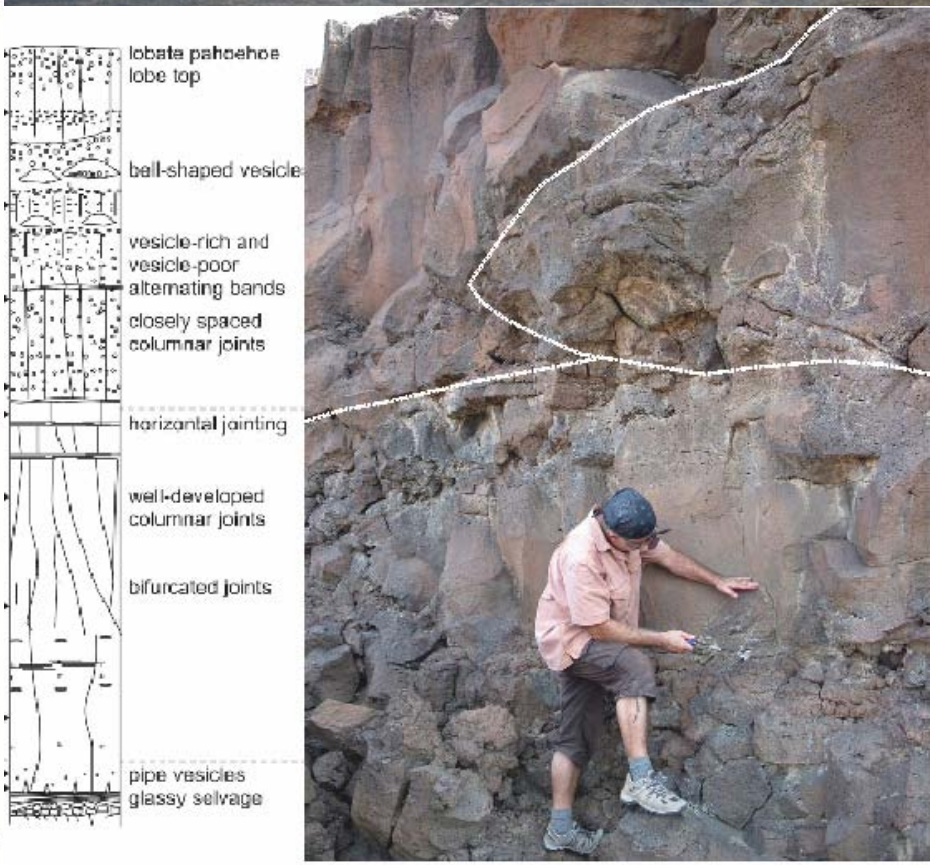


- Provides a remote mapping methodology to combine datasets and link to Arc GIS.
- Opportunity to easily identify fault throw and subtle conjugate fault sets.
- Capability to stack and manipulate multiple high-resolution datasets e.g. RS imagery.

Σigma • MOBILE
System for integrated Geoscience Mapping

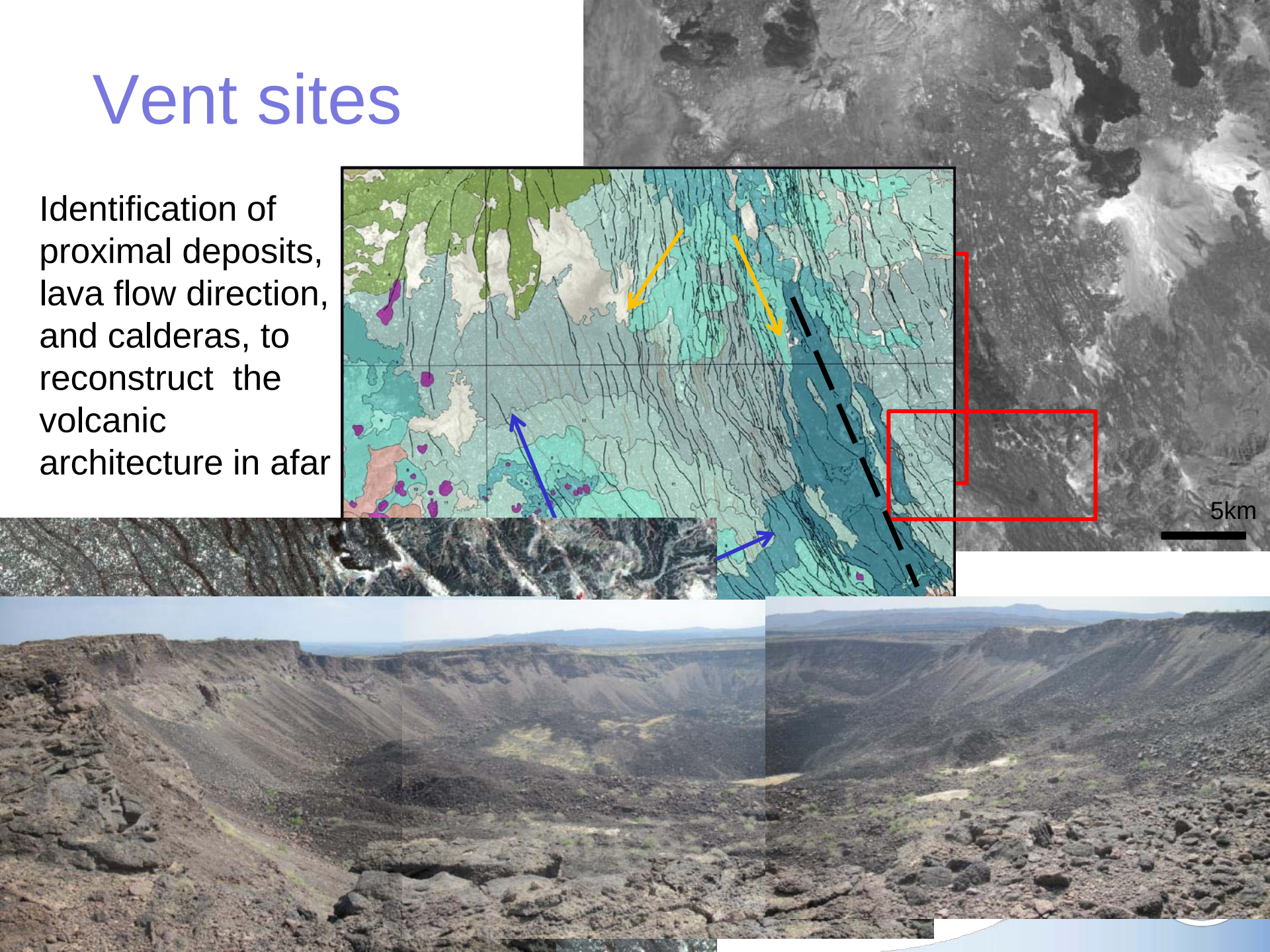
Dabbahu (M-H) Rift fly-through


Geological Map of the Dabbahu
(Manda-Hararo) Rift - North
Legend
Dabbahu
Badi
Ado
Ale

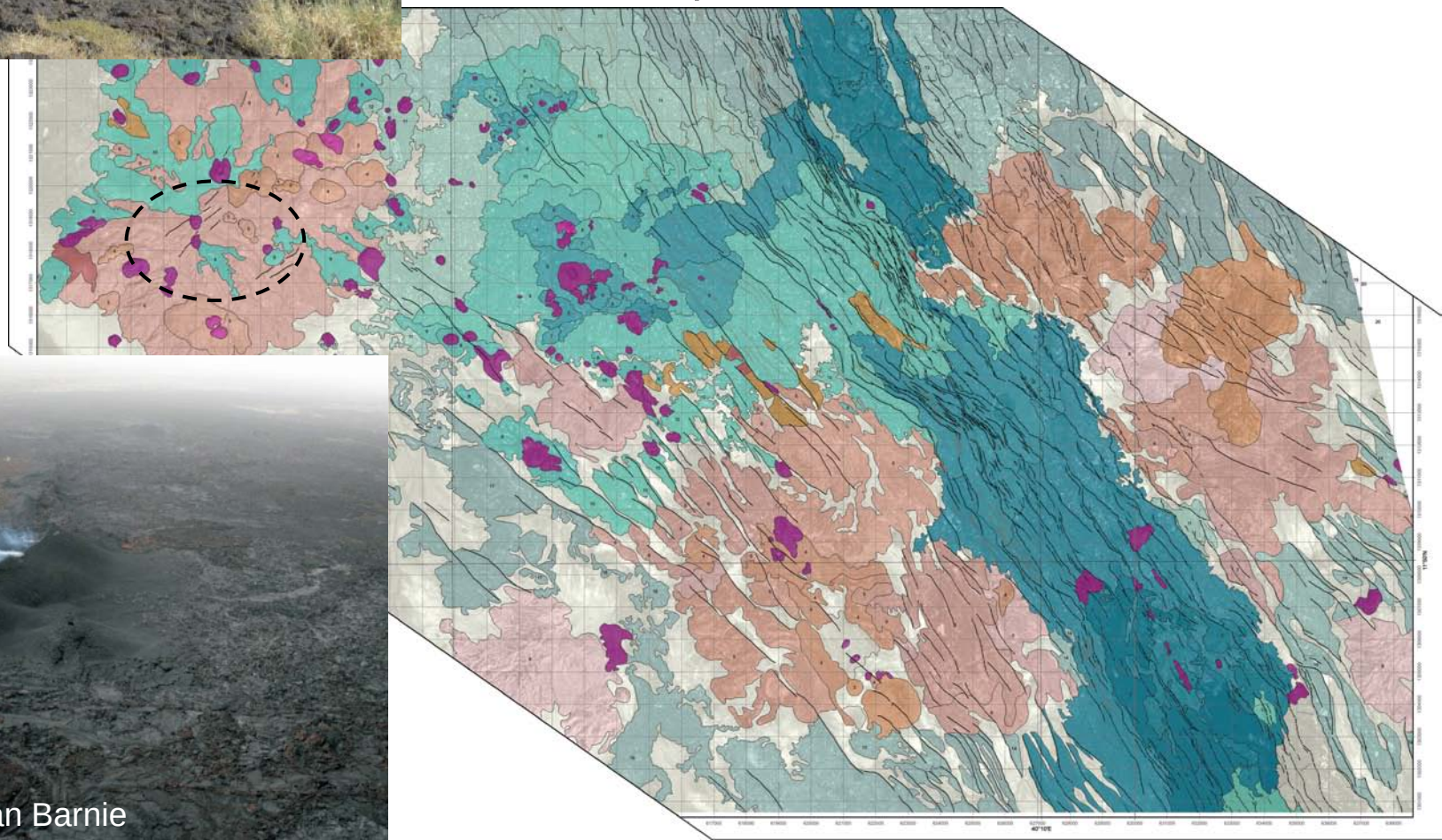

lobate pahoehoe
lobe top
ball-shaped vesicle
vesicle-rich and
vesicle-poor
alternating bands
closely spaced
columnar joints
horizontal jointing
well-developed
columnar joints
bifurcated joints
pipe vesicles
glassy selvage

Vent sites

Identification of proximal deposits, lava flow direction, and calderas, to reconstruct the volcanic architecture in afar



- Linear basaltic fissure vents dominate the topographic rift axis whilst point source basaltic vents are located up to 7 km away from the rift axis. Off axis central volcanic complexes host the products of young eruptions that are up to 12 km from the centre.



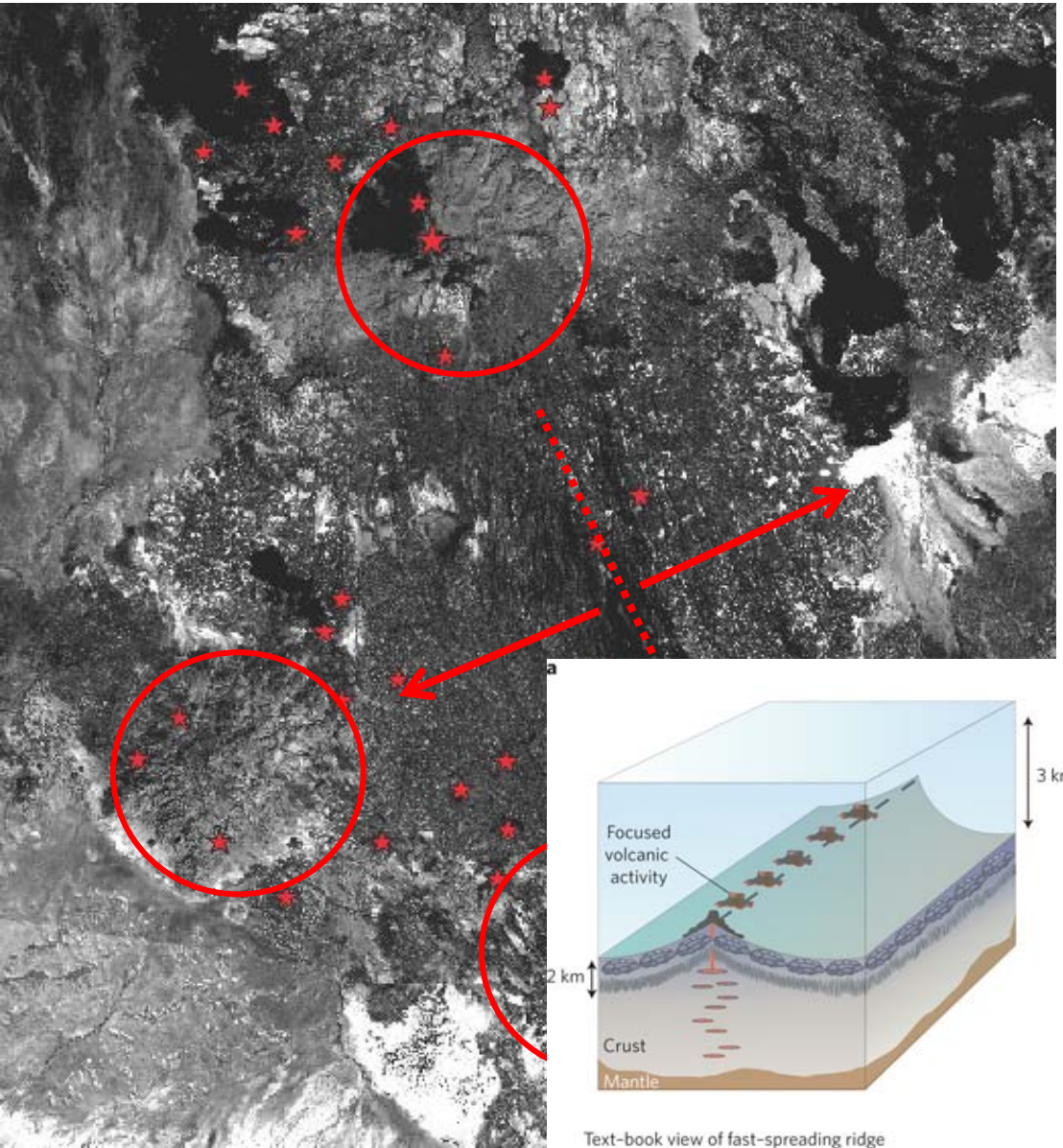
Courtesy of Talfan Barnie

Mid-rift explosive volcanism

- Mid-rift caldera thought previously to be a magma drain-back feature / collapse ~830 m diameter.
- No evidence for ignimbrites, silicic tephras etc found during fieldwork.
- Gabbroic lithics up to 80cm diameter found within 100m of the vent lip.
- = explosive basaltic eruption due to interaction with groundwater / brines / hydrothermal systems.

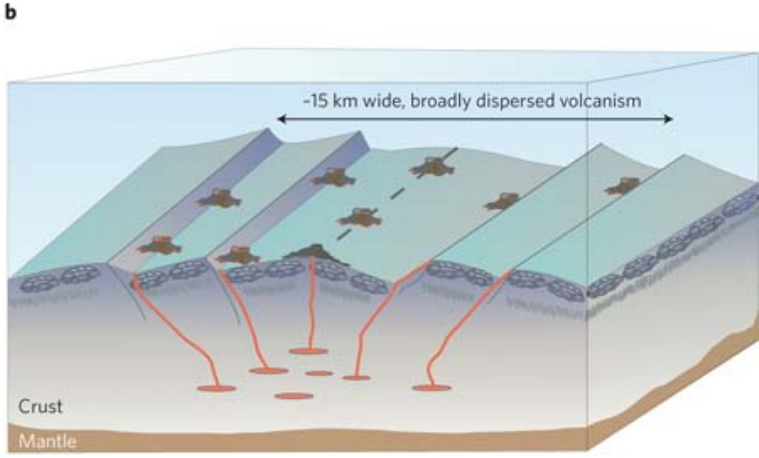
Distribution of vents

- Spread of eruption sites, vent character, and young volcanic ages (<10 ka) dispersed throughout the segment. Similar to models of slow-spreading magmatic mid-ocean ridge (MOR) segments, in contrast to repetitive eruptions from central fissure vents in fast-spreading MORs.



From Maclennan, 2010, Nature Geoscience

Text-book view of fast-spreading ridge



New model of ultraslow-spreading ridge

Conclusions

- Detailed mapping at the scale of individual eruption units achieved through the use of 3D visualisation and remote sensing data with field validation.
- Spread of eruption sites throughout the segment is similar to models of slow-spreading magmatic mid-ocean ridge (MOR) segments, in contrast to repetitive eruptions from central fissure vents in fast-spreading MORs.
- Linear basaltic fissure vents dominate the topographic rift axis whilst point source basaltic vents are located up to 7 km away from the rift axis.
- Off axis central volcanic complexes host the products of young eruptions that are up to 12 km from the centre, supports oblique angle dyke injection to the WNW towards Badi volcano.
- Explosive basaltic eruptions have occurred in the past in this segment, the age and extent of impact of these events are currently unknown.
- Future work for hazard specific work will be conducted in collaboration with the Geological Survey of Ethiopia and colleagues within the IGSSA and Earth Science Dept at AAU.

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