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Imaging magma storage in the Main Ethiopian Rift with 3-D Magnetotellurics

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RIFT VOLC

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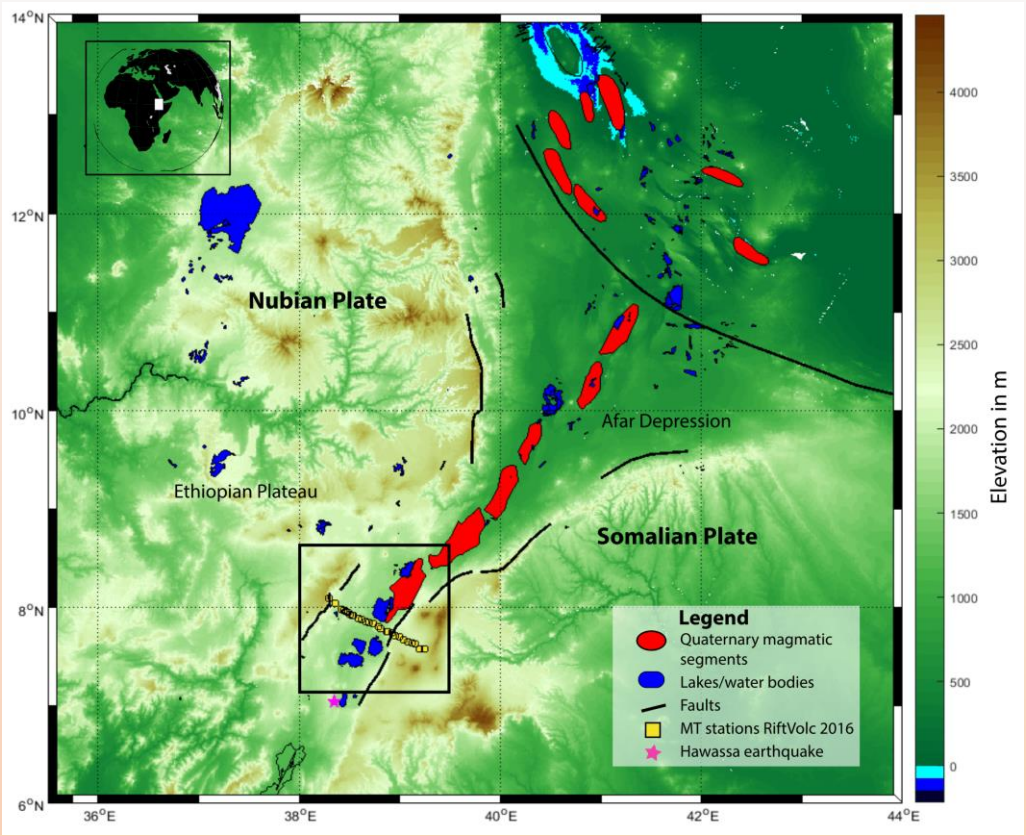
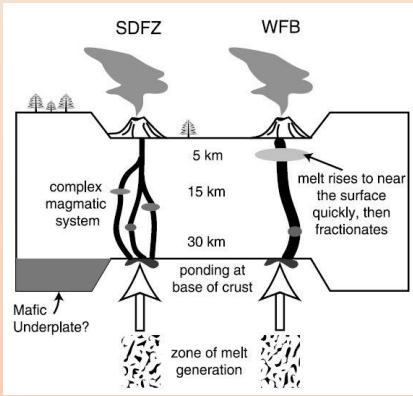
Main Ethiopian Rift (MER)



Number of active volcanoes – geothermal energy is of great interest, but also large hazard for population

Volcanism is greatly variable: silicic calderas, basaltic monogenetic vents etc. (Fontijn et al. 2018)

Magma storage and supply is debated

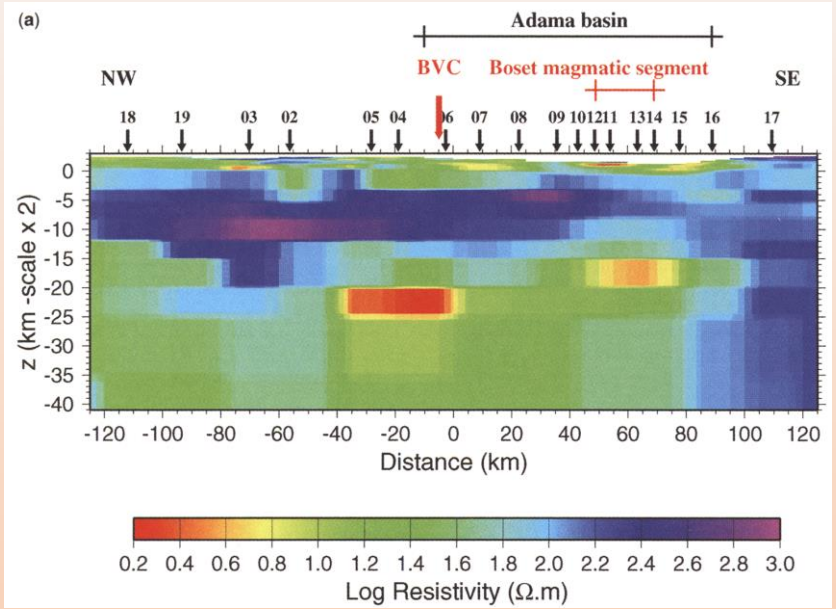


MER is located at transition between continental rifting and seafloor spreading in Afar

Rooney et al. (2007)

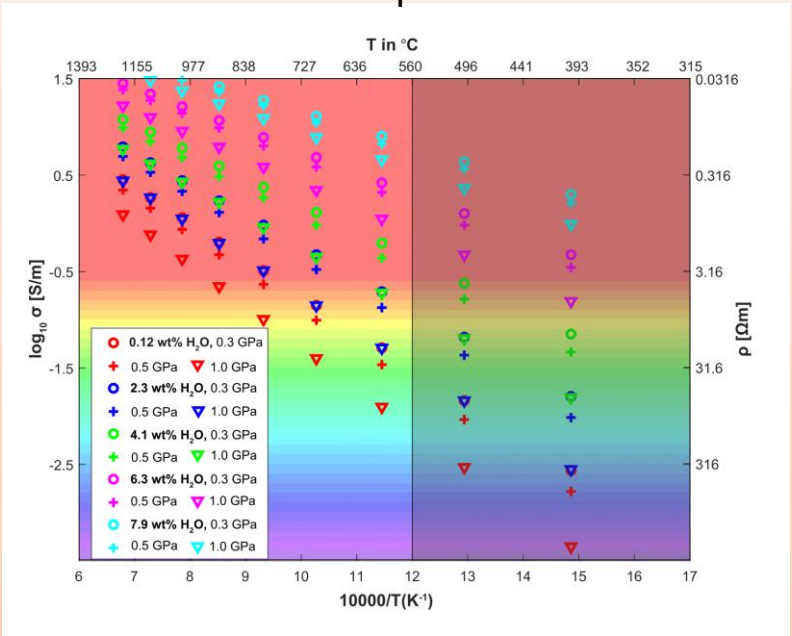
Imaging magmatic processes with magnetotellurics (MT)

MT images the bulk electrical conductivity/resistivity of the Earth
-> highly sensitive to presence of magma/fluid

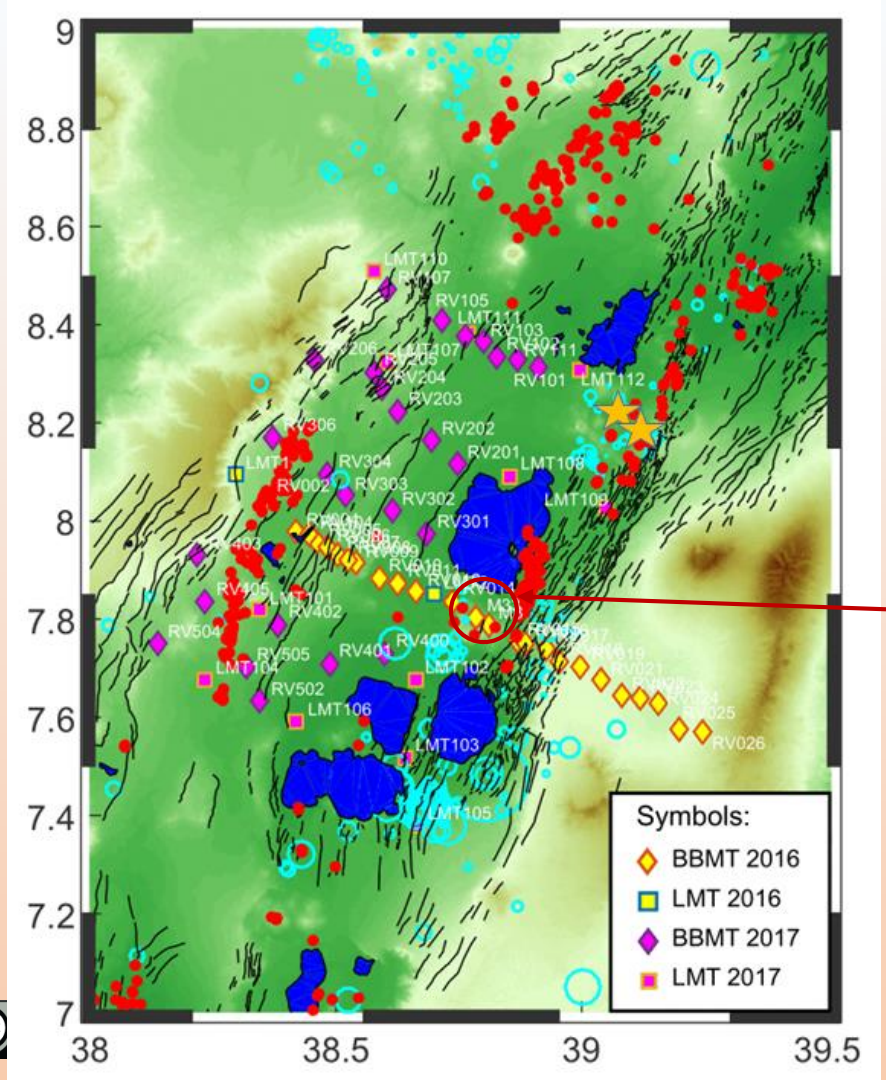


Whaler&Hautot (2006) EAGLE profile in the northern main Ethiopian rift, deeper conductor related to magmatic segment

Electrical conductivity can be interpreted in terms of **temperature**, **pressure**, **water** and **melt** content using petrological models and lab experiments



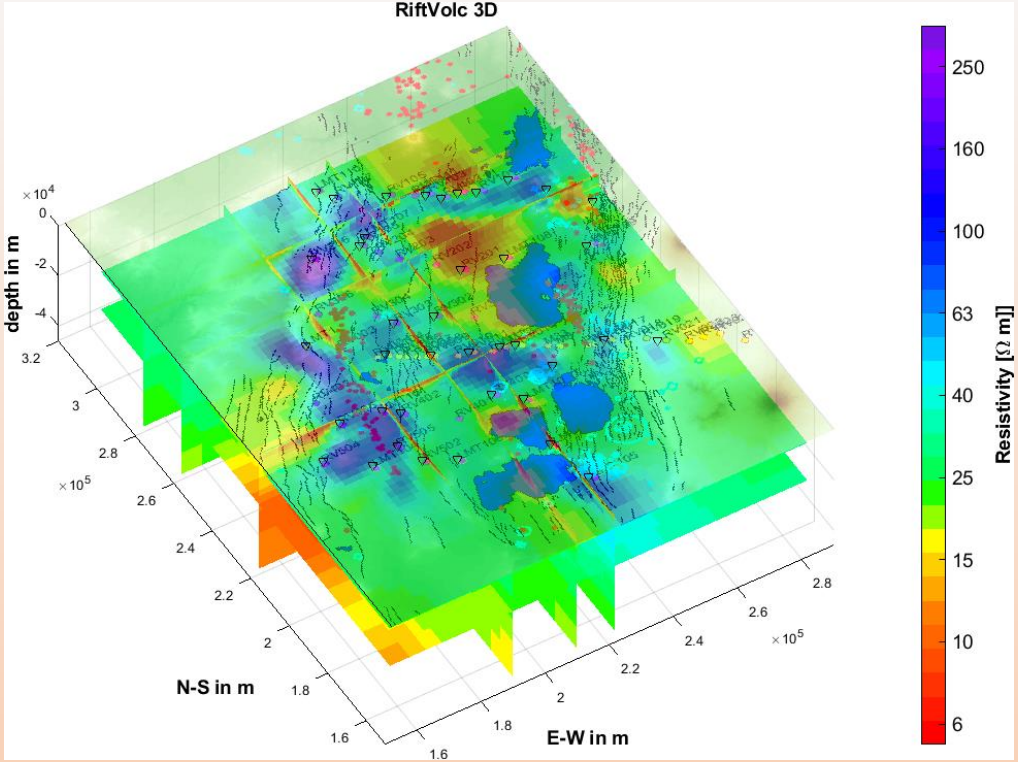
After Guo et al. (2016)



MT data collected within RiftVolc:

14 Long period MT + Broadband stations, 45 Broadband stations in array in Western part of MER, mixed data quality (high population density) + 2 Sites from Reykjavik Geothermal's Tulu Moye prospect ☆
-> roughly 6 parallel profiles Crossing Central volcano Aluto (silicic caldera with active hydrothermal system), focus of many more detailed studies

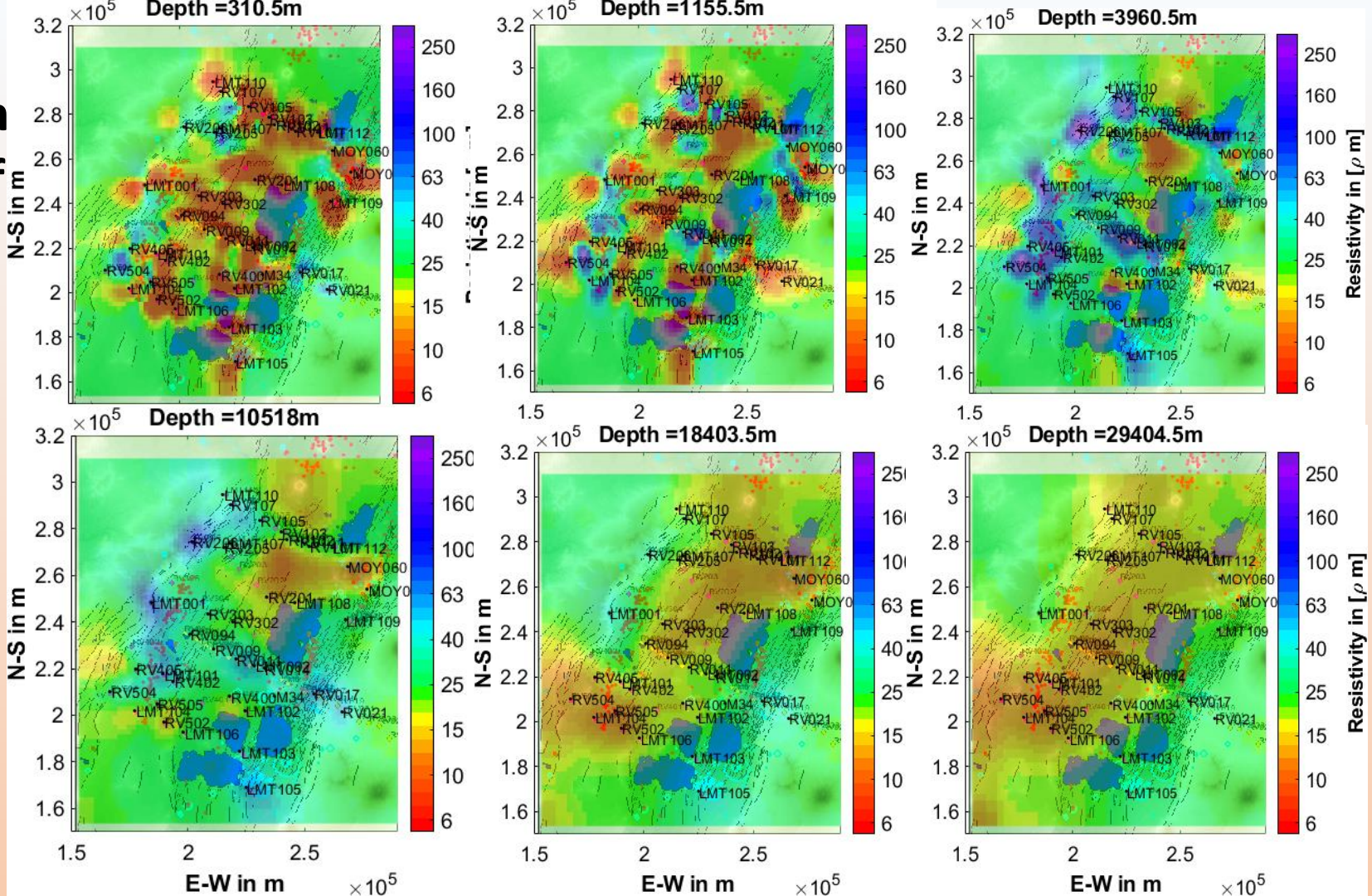
A new full 3-D inversion model of electrical resistivity in the MER



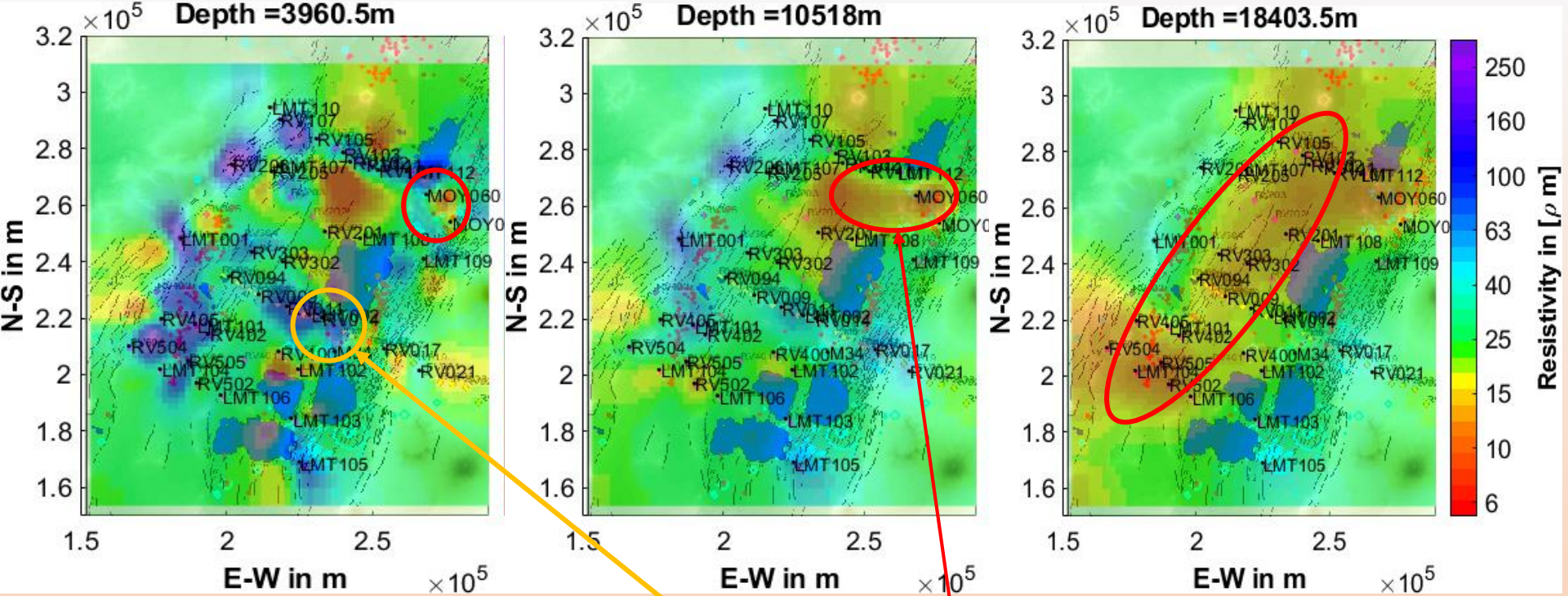
Inversion parameters and details:

- ModEM (Egbert&Kelbert 2012)
- Starting model is homogeneous half space with 25 Ωm (average of all apparent resistivity curves)
- Covariance set to 0.4 (after testing)
- start with full impedance data (>1s), then all impedance data plus LMT tipper (BB tipper is very small and noisy)
- RMS of preferred model is 2.7

3-D inversion model of CMER

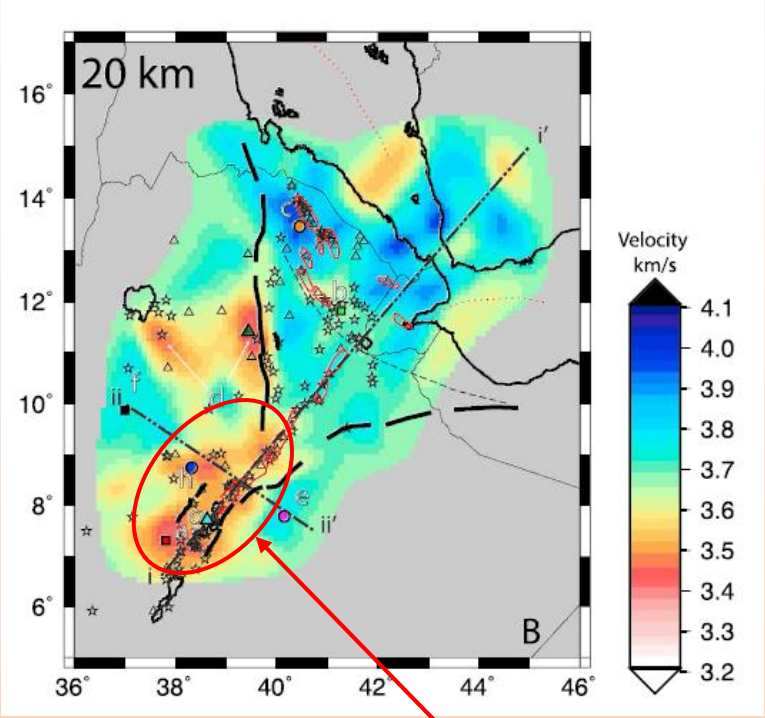


3-D inversion model of CMER – some details

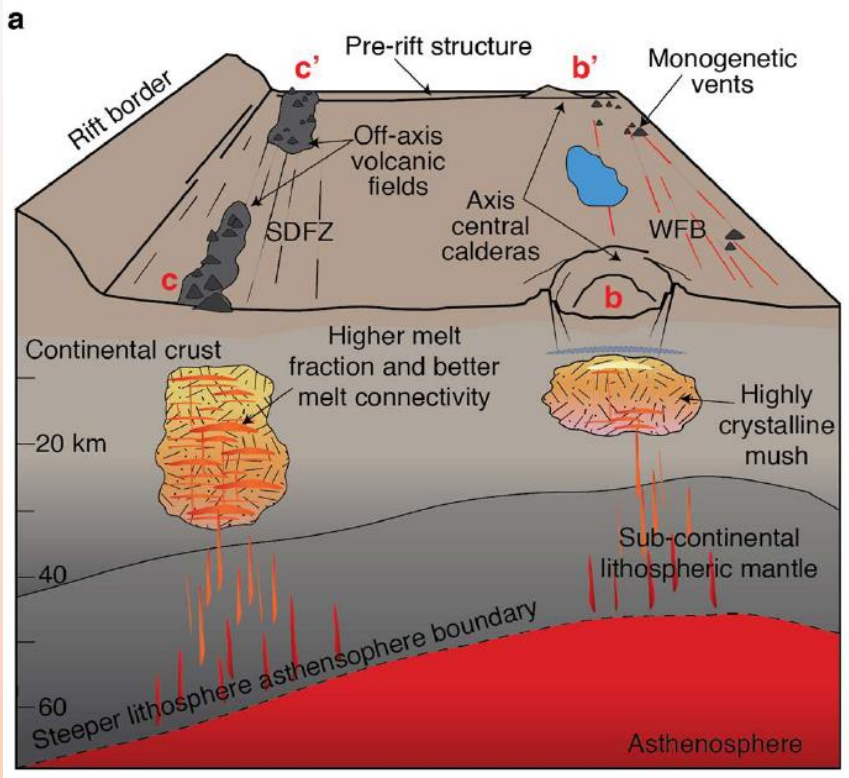


- No big conductor at 5km under central volcano
- Large deeper conductor in the northern part with connection to Tulu Moye hydrothermal prospect deep reservoir at ~5km)
- Large zone of higher conductivity in the lower crust in the Western part of the rift
- Asymmetric shoulders

Structural interpretation of melt storage in the MER supported by MT model



Chambers et al. (2019), 3-D slow shear wave velocity anomaly roughly 200-km by 100-km wide positioned 20km beneath the MER axis



Iddon (2019), model of melt storage in the MER

Summary

- Broadband and long period MT data from an array in the CMER yield new 3-D model of electrical conductivity of the crust (<40km)
- Electrical conductivity observed/modelled can constraint water and partial melt content of current storage conditions
- Magma is stored below the rift centre and off-axis
- Zone of higher conductivity in the lower crust coincides with low shear-wave velocity

Acknowledgements:

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