State-of-stress (fault and dike kinematics) around volcanoes

In the absence of tectonic stress, the stress field caused by volcano load and magma chamber load at depth = radial.

If in extension, two wedges preferred fault and fissure/dike direction

Benoit Smets, PhD 2016 – Vrije U. Brussels
Resistivity structure of the Western rift – Rungwe example

Kate Selway LDEO, Khalfan Mtelela UDSM; Paul Bedrosian, USGS
Lithospheric thickness from surface wave analyses (prior to CRAFTI, SEGMeNT, PRIDE)

Red = positive FAA; Blue = negative FAA

Small Tanzania craton outside resolution of study

Xenoliths – heavily metasomatised mantle

TANGA14, CRAFTI, SEGMENTS – formed in or near boundary of thick cratonic lithosphere

Fishwick and Bastow, 2011
FIGURE 5.14 Effect on apparent resistivity as electrode spacing is increased. Dashed black lines represent current flow line distribution for homogeneous subsurface. Solid gray lines represent actual current flow lines due to horizontal interface. As the distance between current electrodes is increased, $\rho_a$ approaches the value of $\rho_2$. 
So what are the good conductors (i.e. low resistivity)?

Metals (Cu, Au, Ag....) 10⁻⁷ to 10⁻⁸ ohm m
Also sulphides (chalcopyrite, pyrrhotite, pyrite) and Fe oxides (magnetite) 10³ to 10⁻⁵ ohm m

In comparison, most rocks and silicate minerals have low conductivities (high resistivity):

Shale, clay and graphite have the lowest values
Higher values for Quartz, calcite, sandstone, limestone, igneous rocks, metamorphic rocks 10² to 10⁸ ohm m

Good for mineral exploration
Can also quantify the measurements:
Plot the values against increased spacing
Relate curve obtained to master curves
Use values to obtain thicknesses and resistivity values

Resistivity 1 < resistivity 2

Resistivity 1 > resistivity 2

Electrode spacing \( a \) (m)
SEGMeNT Project
http://www.ldeo.columbia.edu/~djs/segment/main.html
MT stations in relation to total magnetic field strength anomaly over the region. The latter suggests a complex inherited structure.
A pilot study in 2013 focused on the Rungwe Volcanic Province between the Rukwa and Malawi rift segments and the Usangu Basin. Wideband MT data were collected at 24 sites, 14 of which were complemented by long-period data. Data quality were compromised by a conductive crustal section and very low signal levels.

The data set is strongly 3D based on phase tensors and polar diagrams. Within a quasi-2D coordinate system (N30W), prominent mode splits are observed at almost all sites, often beginning at periods < 1s. Induction vectors are large at all but a few sites, and suggest a strong crustal conductor centered beneath the Rungwe volcanic center. Neighboring sites with large (~0.5) opposing IVs suggest resistive blocks separated by highly conductive crustal channels.
ANT, Natalie Accardo, in prep. SW, 20-80 s

Moho Depth (km)

David Borrego, PSU – RF - in progress
Sample data fits for the model of Fig. 2. Solid line is the model prediction of the TE mode, dashed line of the TM mode.
Rift to breakup
Evolution
– Magma-rich

Ebinger and Scholz, submitted