Feasibility study based on the sensitivity of EM fields in the exploration of Ol Doinyo Lengai volcano using magnetotellurics

M. K. Diaz[1, *], A. Junge[1], C. Castro[1], M. C. Reiss[2]

[1]Goethe-Universität Frankfurt
[2]Johannes Gutenberg Universität Mainz
*Corresponding author: mdiazna@geophysik.uni-frankfurt.de

SUMMARY

Ol Doinyo Lengai is the only active volcano on Earth that experiences both effusive and explosive eruptions of two immiscible magma types: alkaline silicate and unusual alkali-rich natrocarbonatites. It is located in the southern Natron Basin, within the eastern branch of the East African Rift System, the longest continental rift in the world.

While extensive geological research has been conducted on Ol Doinyo Lengai, geophysical studies, particularly those using electromagnetic methods, are limited. A recent seismological investigation in the region revealed a complex, highly interconnected lateral and vertical plumbing system. However, magnetotellurics has proven to be more effective in imaging magmatic systems by mapping electrical resistivity distributions at depth. Therefore, applying MT to infer the subsurface structure of Ol Doinyo Lengai is highly promising.

This study assesses the feasibility of using MT to detect the magmatic system of Ol Doinyo Lengai volcano by analyzing the distribution of electromagnetic fields. We considered previous seismological results to model the shallow and deep electrical conductivity structures. Our analysis focuses on: a) evaluating the resolving capacity of MT to identify changes in conductive features that resemble magmatic reservoirs; b) examining the spatial distribution and frequency behavior of EM fields responding to equivalent conductivity models; c) determining a strategy for the optimum site setup and the most sensitive MT components influenced by the conductivity structure; and d) recovering the 3-D conductivity distribution beneath Ol Doinyo Lengai using non-conventional MT station deployments.

By simulating EM fields in a context analogous to Ol Doinyo Lengai's plumbing system, we aim to develop a more accurate and efficient fieldwork strategy that targets the main conductivity features of the volcano.

Keywords: Ol Doinyo Lengai volcano, natrocarbonatites, magnetotellurics, sensitivity, electromagnetic fields.