Electromagnetic Measurements on Volcanic Islands

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SUMMARY

Volcanic islands develop in the geodynamic context ranging from mid-ocean ridges (e.g., Azores Archipelago) to intraplate (such as the Hawaiian Islands, Cabo Verde) and to volcanic arcs (e.g., the Aeolian Islands, the Antilles). They are one of the most vulnerable environments on Earth not only because of their high exposure to the impact of multi-hazards (e.g., volcanic eruptions, landslides, tsunamis etc.) but also because of their isolation from the mainland. Many volcanic islands are densely inhabited, hence given the growing population and changing climate, the need to identify, monitor, and mitigate geohazards has been increasingly important to protect the public. Additionally, identifying and de-risking natural resources such as geothermal energy and freshwater are also essential to economies and societies. This review provides an overview of electromagnetic studies aimed at understanding and characterising the activity, dynamics and hazards of volcanoes on volcanic islands. These studies include passive and active electromagnetic data acquisition in the atmospheric, terrestrial, and marine (i.e., near-shore) realms. The review also addresses challenges related to survey planning, data acquisition, modelling, and interpretation. The particular challenges posed on volcanic islands include the following:

1. A potentially complicated internal structure of the volcanic edifice, which usually extends spatially below the ocean. Deep investigations thus will require marine measurements.
2. Depending on different tectonic and environmental settings, the subsurface can be extremely heterogeneous. The diversity of rocks present in and around the edifice is large, and often displays the work of multiple episodes of growth and collapse.
3. The presence of the ocean, where the near-shore bathymetry is often not well known, as well as the distribution of high-porosity sediments around the island, which are derived from the growth and collapse of the volcanic edifice.
4. Volcanic islands often have strong and steep topography, which poses not only considerable logistical problems, but also challenges for the model discretisation.
5. The ubiquitous presence of hydrothermal systems, which represent geochemically aggressive environments, and have the potential of interacting with the original rock, leading to considerable volumes of high-conductivity minerals and additional secondary heterogeneity.

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