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Significant contribution of helicopter-borne resistivity surveys to the hydrogeological characterisation of volcanic islands: review of the recent researches

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The demographic explosion of many volcanic islands, with associated increasing drinking water needs, requires detailed investigation of their subsurface in order to provide sustainable solutions and for an adapted management of groundwater resources. In this context, hydrogeological studies are challenging due to difficulties in accessing the study sites (steep slopes, dense vegetation and a limited access), and to the geological complexity of volcanic deposits (lateral and vertical lithological variability with superimposed intense weathering). Furthermore, there are often few boreholes enabling detailed hydrogeological characterizations, which limit the detailed validation of the different approaches and methods.

The SkyTEM dual-moment Time Domain Electromagnetic system was used for the first time in a volcanic context in 2006 over the Galapagos Islands by UPMC-Sorbonne University and Aarhus University, then by BRGM in 2009 over Mayotte Island (with Aarhus University as partner), in 2013 over Martinique and Guadeloupe Islands (Lesser Antilles) and in 2014 over Reunion Island. The SkyTEM helicopter-borne TDEM system allows detailed mapping of the internal geological structure of the upper 200 m of these volcanic islands, through a quasi-3D resistivity model.

Based on a literature review, the main contribution of this SkyTEM method to volcanic island hydrogeology will be presented. In this context, this method: (i) could help to highlight the main geological structures, playing key roles on the hydrogeological functioning of such islands even on a complex geologic context, and (ii) allows identification of seawater intrusions and depth of saltwater interface. For instance, the presence of a perched aquifer, potentially strategic for the island water supply, is suspected on Santa Cruz Island and confirmed on San Cristobal (Galapagos Archipelago). On these islands, seawater intrusions are typical of Hawaiian model basal aquifer. On Mayotte Island, influences of successive phases of volcanic construction and erosion, and consequently structural controls on groundwater flows have been highlighted. At a smaller scale a buried valley also clearly plays a key role on the hydrogeological functioning in the south of the island. Seawater intrusions here are clearly different from Galapagos Island and don't penetrate far inland. In Martinique islands, preliminary results are also promising.