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Transient electromagnetic measurements using a floating setup: Investigation of the hydrothermal system below the Furnas volcanic lake, Azores Islands

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The Furnas Volcano is located in the eastern part of São Miguel island (Azores). Volcanic activity is nowadays mostly prominent in the northern part of the caldera, where fumarolic fields, thermal springs and intense CO_2 outgassing are the main hydrothermal manifestations. The Furnas lake is roundly shaped and has a diameter of around 1.5 - 2 km. As there were no previous geophysical measurements conducted on the lake, the structures below the lake as well as the extent of the hydrothermal system were unknown.
For measurements on the lake, a floating TEM setup was used consisting of a frame of plastic drain pipes, composing an 18 m x 18 m in-loop configuration. While on water, the TEM construction is pulled by a boat also containing the measurement equipment. During the field survey 52 stations were measured while the boat and the pipe construction were anchored on the lake. In order to provide a dense data coverage in the northern lake area where intense CO_2 outgassing was detected, measurements were conducted in continuous mode while the boat was slowly pulling the floatTEM system. The continuous driven measurements resulted in around 500 soundings near the fumarolic fields. The exploration depth of the continuous measurements is around 80 m, whereas the anchored soundings provide depth information down to approximately 180 m. This mobile measurements are a new approach for TEM surveys on water, that proved to be a success with respect to survey speed and data coverage.
We achieved to collect a large and very dense data set, consisting of more than 650 TEM soundings in total on the lake and six land based reference stations. The data is inverted one-dimensionally using conventional inversion schemes. In order to derive quasi 2D/3D subsurface models and to improve deep target resolution by incorporating the anchored soundings, laterally and spatially constrained inversion techniques are used. The results show a well conducting anomaly in approximately 50 m below the water level in the northern part of the lake, that correlates well to the already known CO_2 outgassing anomalies and the hydrothermal system. Towards the main lake in the southern part, the good conductor dips downwards to approximately 120 m depth. This well conducting structure is currently interpreted as a shallow aquifer that feeds the surface hydrothermal manifestations.