Geophysical Research Abstracts
Vol. 20, EGU2018-19626-1, 2018
EGU General Assembly 2018

A floating transient electromagnetic system to acquire dense data on volcanic lakes

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Often geophysical surveys leave out water covered areas due to inaccessibility, leading to a lack of resolution in derived subsurface images and consequently leading to interpretation uncertainty. For measurements on volcanic lakes a floating transient electromagnetic system (floatTEM) was developed composing an in-loop TEM configuration. The current floatTEM system allows for earth exploration down to approximately 200 m depth but, however, can be modified for deep exploration down to 1000 m depth. The floatTEM system was successfully applied to image sedimentary deposits of a volcanic Maar lake in the Eifel/Germany. Recently, the floatTEM system was successfully used to image the hydrothermal system and CO_2 outgassing areas of the Furnas volcanic lake on the Azores islands.

The floating measurement system is built of a frame of conventional plastic drain pipes. The outer construction forms an 18 m x 18 m square frame holding the transmitter cable. The inner 6 m x 6 m square frame holds a receiver cable. While on water, the TEM construction is pulled by a boat also containing the measurement equipment. The pipes are tight together using several tow ropes with adjustable tension belts to ensure stability on water. Additional fenders and floats are used to ensure sufficient buoyancy. To allow for enhanced survey speed and dense data acquisition the floatTEM system was continuously pulled with a maximum speed of 0.2 m/s. These measurements resulted in a very dense data set with around 500 soundings and between one and 20 m site spacing near the Furnas fumarolic fields. The soundings were well applicable to image the shallow hydrothermal system and the outgassing area down to around 180 m depth.

Recent Audio-magnetotelluric (AMT) geophysical data revealed a 500 m deep conductor which is interpreted as related to hot fluids near the boiling point. However, as no data was measured on the lake directly, the spatial dimension of the conductor is not known precisely. Due to the latter and due to the limited depth resolution of the current floatTEM system, we propose a modified TEM setup to image the Furnas volcanic system. The modified system combines two different configurations: (1) a large fixed-loop configuration around the lake with 1 km x 1 km loop side and floating multi-component magnetic field receivers. The receivers can be easily mounted on the existing pipe construction; (2) Several extended grounded dipole sources with approximately one km length installed around the lake and floating electric field receivers. A high power transmitter can be used to ensure source moment and sufficient exploration depth. Water proof pressure cases, marine electrodes and other marine equipment which is available from recent offshore projects can be adopted to the new system. Dense and deep TEM data can be acquired along numerous tow lines on a three-dimensional grid using continuously floating receivers and anchored soundings with improved signal-to-noise ratio. The original floating and modified semi-floating TEM systems, are a new approach to look into the depth of a volcano.