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Geophysical imaging of the lacustrine sediments deposited in the La Calderilla Volcanic Caldera (Gran Canaria Island, Spain) for paleoclimate research

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The discovery of well-preserved maar structures is important not only for studying the eruptive activity and formation of volcanoes, but also for paleoclimate research, since laminated maar lake sediments may contain very detailed archives of climate and environmental history. Maars are a singular type of volcanic structure generated by explosive phreatomagmatic eruptions as a result of interaction between rising magma and groundwater. This kind of structures are characterised by circular craters, often filled with water and/or lacustrine sediments and surrounded by a ring of pyroclastic deposits.Recently a borehole was drilled at the bottom of La Calderilla volcanic complex which penetrated about 8.7 m in its sedimentary sequence and paleobotanical study has supplied the first evidence of paleoenvironmental evolution during the Holocene on the Gran Canaria Island.

This survey, however, did not penetrate into the substrate because the total thickness of the sedimentary fill was unknown. Since the age of formation of La Calderilla volcanic complex based on K/Ar dating is about 85,000 years (Upper Pleistocene), the possibility of its sedimentary fill extends beyond of the Holocene is extremely attractive, since, for example, there are few paleoenvironmental data regarding how much the last glaciation that affected the Canary Islands.
In these circumstances, the knowledge of the total thickness of the lacustrine sediments is crucial to design a deeper borehole in the next future. Therefore, the subsurface characterisation provided by geophysics is essential for determining thickness and geometry of the sedimentary filling.

Multielectrode ERT method was used to obtain five 2-D resistivity cross-sections into La Calderilla volcanic caldera. An Iris Syscal Pro resistivity system with 48 electrodes connected to a 94 m long cable (2m electrode spacing) in Wenner-Schlumberger configuration for an investigation depth of about 20 m. Data quality (q <2 %).was assessed by averaging or stacking several measurements. Also, very low contact resistances were found because of the high moisture of the soils and the special design of the stainless steel electrodes directly in contact with the multicore cable (R values <3 kΩ). Current injected was automatically adjusted by the system to optimize the input voltage and to ensure the best signal-to-noise ratio.

All inverted ERT cross-sections show typical three layer models with very high resistivity contrast. The upper layer with intermediate to high resistivity values (1000 Ω.m to 2500 Ω.m) thin and quit heterogeneous can be correlated with the recent coarse deposits. An intermediate low resistivity layer (200 Ω.m to 400 Ω.m) with a thickness increasing to the NW where reach more than 14 meters and that can be associated to the laminated lacustrine sediments. A lower layer of very high resistivity (> 8000 Ω.m) that can be associated with be volcanic rocks that were the basement of the lake.

Sedimentation rate is certainly not homogeneous. A very high rate has been obtained from the first four meters, giving all ages around 2,200 years. Nevertheless, for the rest of the geological log the sedimentation rate is lower and in our opinion more realistic: about 0.5 m for 1,000 years. Extrapolating this rate up to 14 m, the oldest age of lacustrine sedimentary record should be about 19,000 years, far away from the 85,000 years of the formation of La Calderilla volcanic complex following K/Ar dating.