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Quantifying the mechanical response of the Izaña area (Tenerife) to sustained groundwater withdrawal

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Surface water resources on volcanic islands with moderate rainfall and relatively high permeability are usually scarce or non-existent. As such, life and local economies of these islands mostly relies on groundwater exploitation. It is therefore important to characterise the sustainability of volcanic aquifer systems. In short, an aquifer is deemed in equilibrium when the recharge rate equals or exceeds the exploitation rate. The Izaña area in Tenerife Island (Canary Islands, Spain) has been exploited since the 1900s via a series of ~30 horizontal drilling or water galleries coming from both flanks of the NE-Ridge. Since exploitation began, the water table has dropped continuously, in some area even more than 200 m. Since the 2000s, aquifer dynamics (compaction) have been observed using InSAR indicating a subsidence rate of up to 2 cm per year.

Here, we investigate a suite of rock samples collected. The samples were collected at several water galleries aiming to be representative of the aquifer materials from the Izaña area. We first characterise the basic physical properties of each samples (porosity, permeability, solid density) before quantifying the elastic parameters (Young's modulus, Poisson ratio) and uniaxial strength of the lithologies collected. We also measure V_p under dry and wet conditions (i.e. different saturation levels) to assess whether water saturation can alter the velocity of P-waves passing through those rocks.

Preliminary results show that connected porosities range from 0.16 to 45%, conferring a wide range of mechanical response to increasing effective pressure, with strength ranging from 18 – 315 MPa and Young's moduli ranging from 3 – 57 GPa. In a similar fashion, results for V_p measurements also exhibit a range of values (~1.5 – 4.5 km/s). These data show that materials present in the aquifer are extremely varied, suggesting that both fluid flow and observed deformation are likely to be controlled by the weakest, most porous lithologies.

These results will further be integrated with the lithostratigraphic record of the aquifer in order to model the mechanical response of the aquifer to changes in effective pressures, and specifically pore pressure reduction with water extraction. Additionally, chemical and textural analysis will provide insights on the evolution of the porous network at different alteration levels, here serving

as a proxy for time at saturation in the aquifer. Finally, we aim to compare the experimental results from laboratory measurements to those of hydro-geophysical measurements that will be collected in the field starting in mid-2021.