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How Seismology can help to know the origin of gases at Lastarria Volcano, Chile-Argentina?

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Gases at Lastarria volcano have a double origin: hydrothermal and magmatic, as revealed by geochemistry analysis. Nevertheless, the exact location (especially the depth) of degassing is not well known. We show here how seismology may help to answer this question. Hydrothermal and magmatic reservoirs have been revealed by a 3-D high-resolution S-wave velocity tomography deduced from a ambient seismic noise technique at Lazufre (an acronym for Lastarria and Cordón del Azufre), one of the largest worldwide volcanic uplift, both in space and amplitude, located in the Altiplano-Puna Plateau in the central Andes (Chile, Argentine). Past deformation data (InSAR and GPS) and geochemical gas analysis showed a double-wide uplift region and a double-hydrothermal/magmatic source respectively. Nevertheless the location and shape of these sources were not well defined. In this study, we defined them better using seismological data. Three very low S-wave velocity zones are identified. Two of them (with S-wave velocity of about 1.2-1.3 km/s) are located below the Lastarria volcano. One is located between 0 and 1 km below its base. It has a funnel-like shape, and suggests a hydrothermal reservoir. The other one is located between 3 and 6 km depth. Its dyke-shape and depth suggest a magma reservoir that is supposed to feed the shallow hydrothermal system. This double hydrothermal and magmatic source is in agreement with the double-origin found by previous geochemical and magneto-telluric studies. Both anomalies can explain the small uplift deformation of about 1 cm/yr deduced from InSAR data at Lastarria volcano. The third low-velocity zone (with S-wave velocity of about 2.7 km/s) located below 6 km depth, is located beneath the center of the main uplift deformation of about 3 cm/yr at Lazufre zone. We suggest it is the top of a large magma chamber that has been previously modeled by InSAR/GPS data to explain this uplift. We show here for the first time the exact geometry and location of the hydrothermal and magmatic reservoirs at Lazufre volcanic area, helping understanding the origin of one of the largest worldwide uplift, revealed by past InSAR/GPS, magneto-telluric and geochemical data.