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Cryogenic vacuum extraction in soils derived from volcanic ashes

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Upper Andes catchments (UACs) are key components of the hydrological cycle, capturing moisture, storing water, and releasing it for use in productive activities and environmental needs in the Central Valley of Chile. However, our knowledge of the hydrological processes within UAC's is limited, and our understanding of within- catchment processes is far from clear. A common approach to estimate watershed storage is the combined use of environmental isotopes and field monitoring of hydrological and hydro-chemical variables at hillslope scale. Isotopes (δ2H and δ18O) are direct tracers for groundwater and surface water, as they allow constraining the origin, recharge and evolution of surface waters and groundwater. Moreover, analyzing isotopes from different water pools -soil, precipitation, plants- enhances the building process of hydrological models.

The majority of soils in Chilean Andes derive from volcanic ashes – Andosoils- presenting high contents of organic matter and high-water holding capacity. Arenosols are young ash soil, mainly free of clay, while Andosols are clayey older ash soils. Thus, Andosols show a higher total pore volume and a higher field capacity, especially due to an increase in fine pores, than the Arenosols. The site attains strong drying conditions, close to permanent wilting point, during dry seasons. We collected soil samples in the upper catchments of the Itata basin (33º – 38º S) located at 3200 masl. Both soils, Loamy-sand and loam, are representative of the site and close to Arenosols and Andosols.

Cryogenic vacuum extraction is the most commonly used technique for water extractions from unsaturated soil samples, xylem, plant water and cells water. However, there is little evidence of its use in Chilean Andosoils. Here, we set up 7 extraction lines following the instruction given in Koeniger et al. (2011): Soil samples are placed in a 10 mL Vacutainer with plastic-silicon septa, and linked to another Vacutainer by a stainless tube of 1.56 x 0.96 mm. Experiments ewere: (1) minimum extraction times and extraction volume, (2) extracted water at different soil moisture content (from 33 to 1500 kPa), and (3) whether the extracted water maintains its isotopic signature. The results indicate that the minimum extraction time required varied depending on the soil texture, but in the range of 40 and 50 minutes. From loamy-sand soils, the volume of extraction was in the range 0.67 to 0.20 g of water, while loam soil samples the extraction volume in the range 1-3 g of water. After extraction, the difference between the standard and the values after extraction was less than 1 ‰ for deuterium and 18O.