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Novel implementation of U-series dating of gypsum: A case study on the hyperarid Atacama Desert, Chile

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The Atacama Desert of northern Chile is the driest non-polar desert, with hyperarid conditions lasting until the Pliocene. The high salinity, UV, and aridity of the Atacama Desert contributed to extreme adaptations within endemic flora and fauna. These same environmental properties make the Atacama a key Martian analogue and site of significant nitrate deposits.

Uranium-series chronometry provides a method for accurately dating environmental changes up to ~500 ka, typically utilising carbonate samples. Recent methodological developments now allow for accurate U-series dating of gypsum [1]. We employ this new method to date gypsum samples from across the Atacama Desert and present results for two key sites (Salar de Pajonales, Ria Loa) to identify periods of relative humidity and drought. Salar de Pajonales is a hydrologically and volcanically active playa situated at ~3500 m in the altiplano featuring geomorphological evidence for wetter and drier periods, but lacking dates for these features. The Ria Loa is Chile's longest river, forming a deeply incised canyon that in places reaches over 450 m in depth. The timing and rate of canyon incision are key for understanding reduction in water table depth across much of the Atacama Desert during the late Quaternary.

At Salar de Pajonales, we dated mounds of selenite gypsum in the centre of the salar. The top ridges of these mounds were 181±13.3 ka, younging to 56±2.2 ka at the base of the salar. Within the mounds, localised topographic lows yielded older ages (336±77.6 ka and 224±26.9 ka), indicating the salar was fed by overland flow and groundwater, rather than precipitation. Consistent downward younging of the gypsum salar deposits indicates increasingly shallow water and may reflect a continued drying over the last ~200 ka in this region. Our preliminary data from the Ria Loa canyon indicates incision near the top of the canyon at 228±65.0 ka, correlating to MIS-7 and in agreement with drainage ages of the nearby paleo-lake Soledad [2]. Our study shows that gypsum is an excellent geochronological tool, persisting in environments that otherwise lack datable archives.

[1] Obert *et al.,* (2022), *Chem.Geol.,* 607

[2] Ritter *et al.,* (2018), *Quat.Geochron.* 44