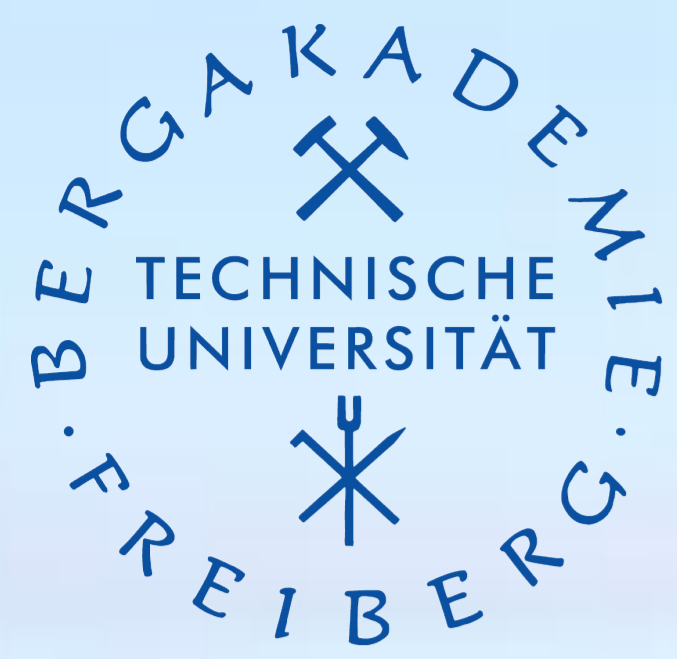


Accessing the Genesis of Lithium-Rich Salt Pan Brines by the Study of Chemical and Isotopic Compositions

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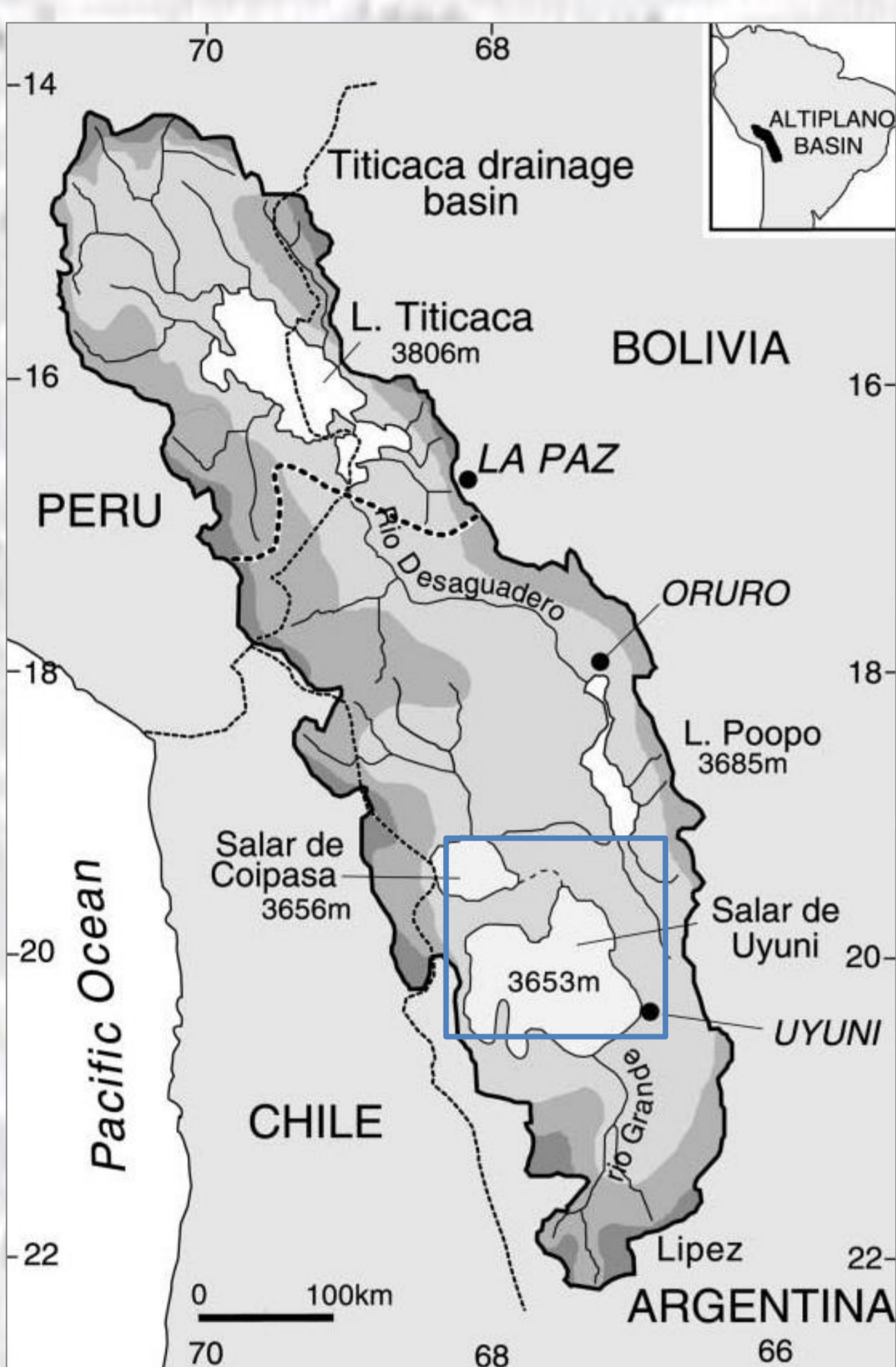
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Introduction

Salt pans are composed of evaporite layers, which can reach several 100 meters in thickness. Pores in the salt crust are filled with a highly saline brine significantly enriched in lithium. The formation of salt pans with such characteristics is controlled by various processes including:

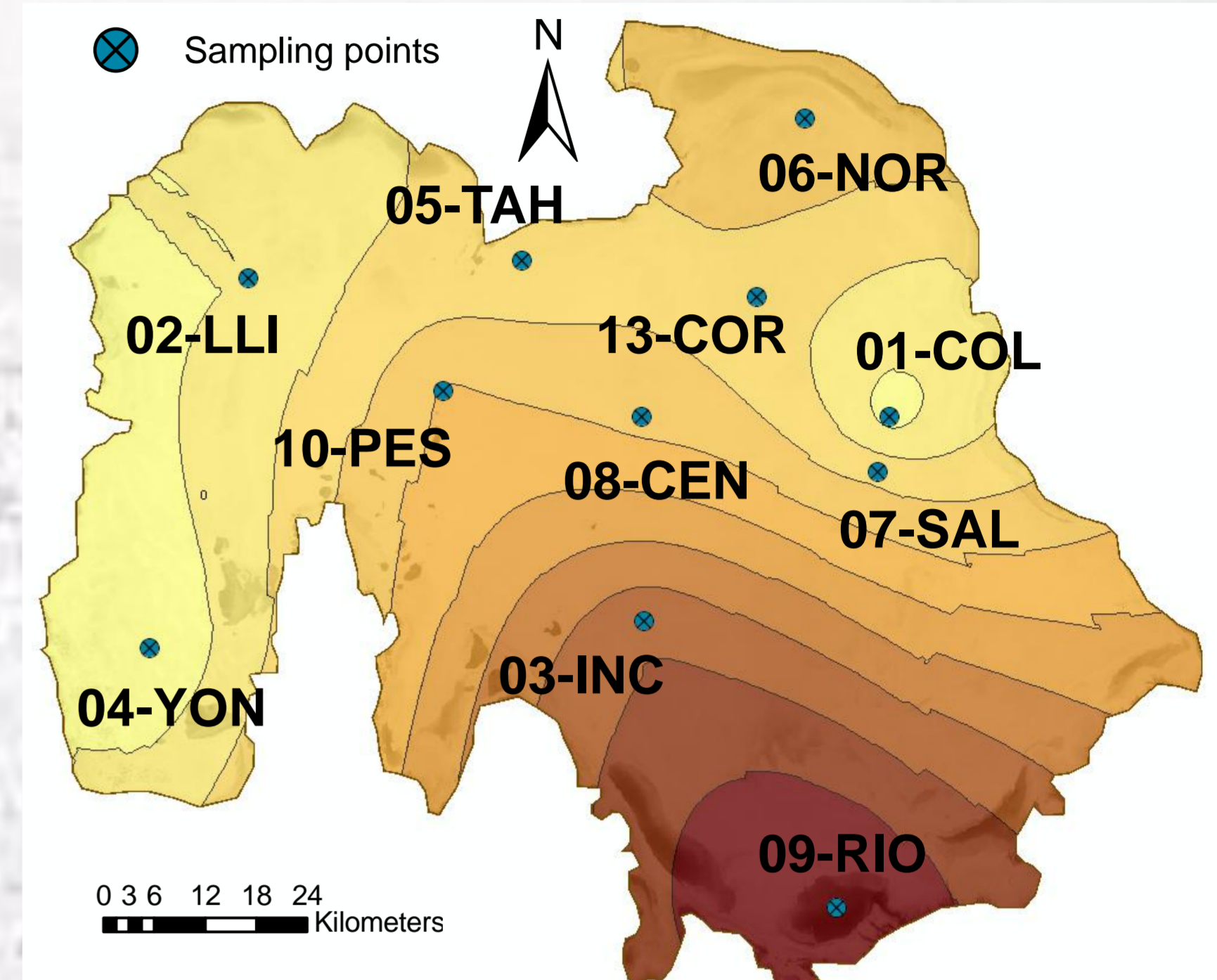
- Leaching of surrounding rocks and older underlying evaporites
- Rise of volcanic fluids
- Arid or semi arid climate



Left: Location of the Salar de Uyuni in Bolivia (Fornari et al. 2001); Up: Satellite image of the Tuz Gölü in Turkey (salt production plants in grey scale)

Investigations

- Drillings to depths of <30 m performed at:
 - Salar de Uyuni in the Bolivian Altiplano (high plateau between Andean cordilleras)
 - Tuz Gölü, central Anatolia, Turkey
- Depth-dependant brine sampling
- Determination of
 - on-site parameters: pH, electrical conductivity, O₂, redox potential
 - main ions (IC), trace elements (ICP-MS)
 - stable isotopes: ²H, ¹⁸O, ³⁴S, ⁶Li
- Modeling of drainage basin by GIS
- Measurement of porosity (CT) and permeability (pumping tests, permeameter)



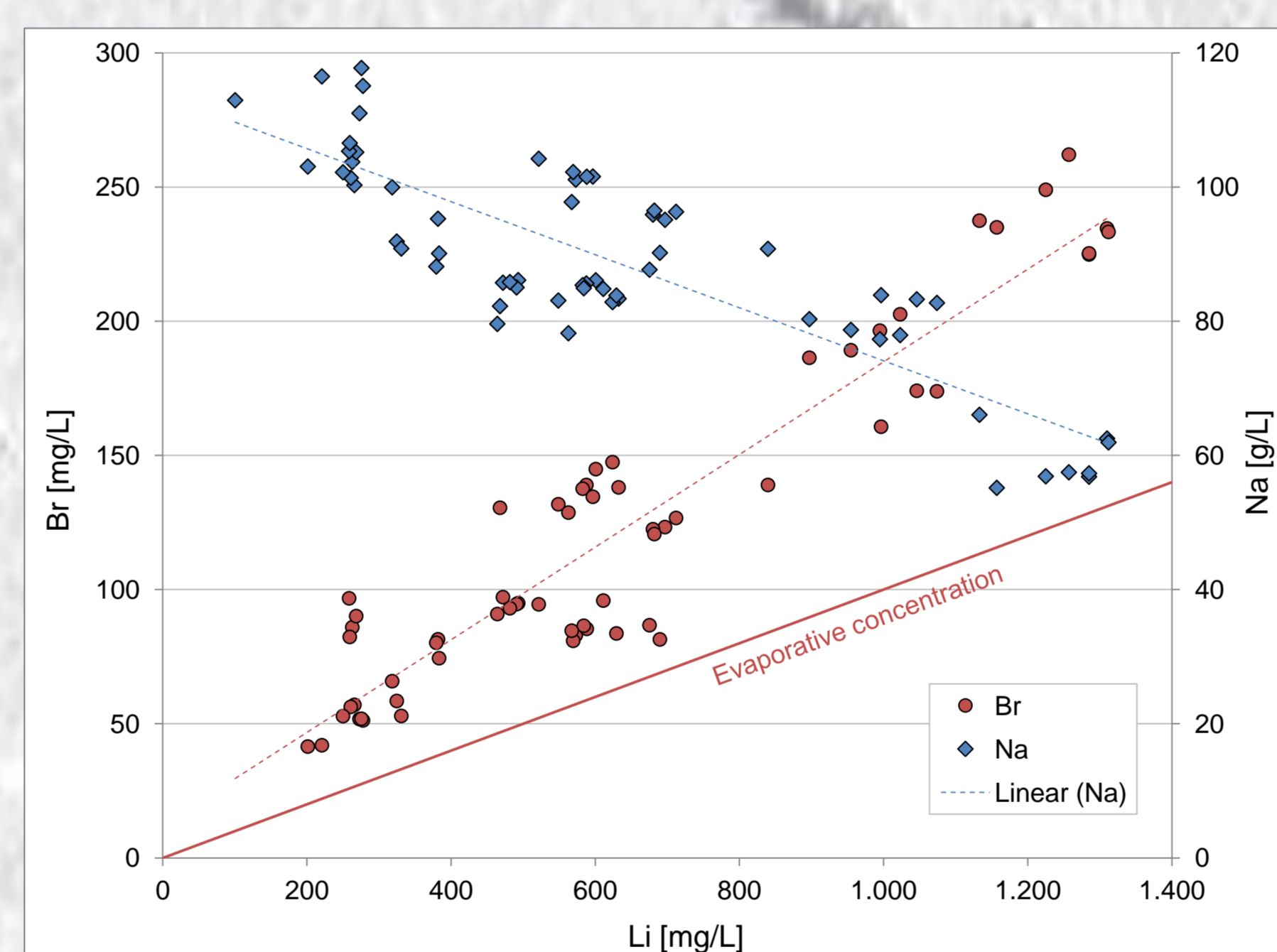
Distribution of lithium in the interstitial brine of the upper 10 m (modeled by ArcGIS using Kriging)



Analysis of on-site parameters in the field

Mechanisms of enrichment

The high lithium load in tributaries of the Salar de Uyuni points to the intensive weathering processes in Andean rocks. Ion exchange processes in extensive floodplains lead to the release of lithium from clay minerals and the enrichment in the delta area of the Rio Grande. Wind transport contributes to the distribution of the enriched brine on the surface. The intensive solar insolation during the dry season leads to the evaporative concentration of the surface water, and thus, to the specific isotopic signature of $\delta D/\delta^{18}O$ in the brines.



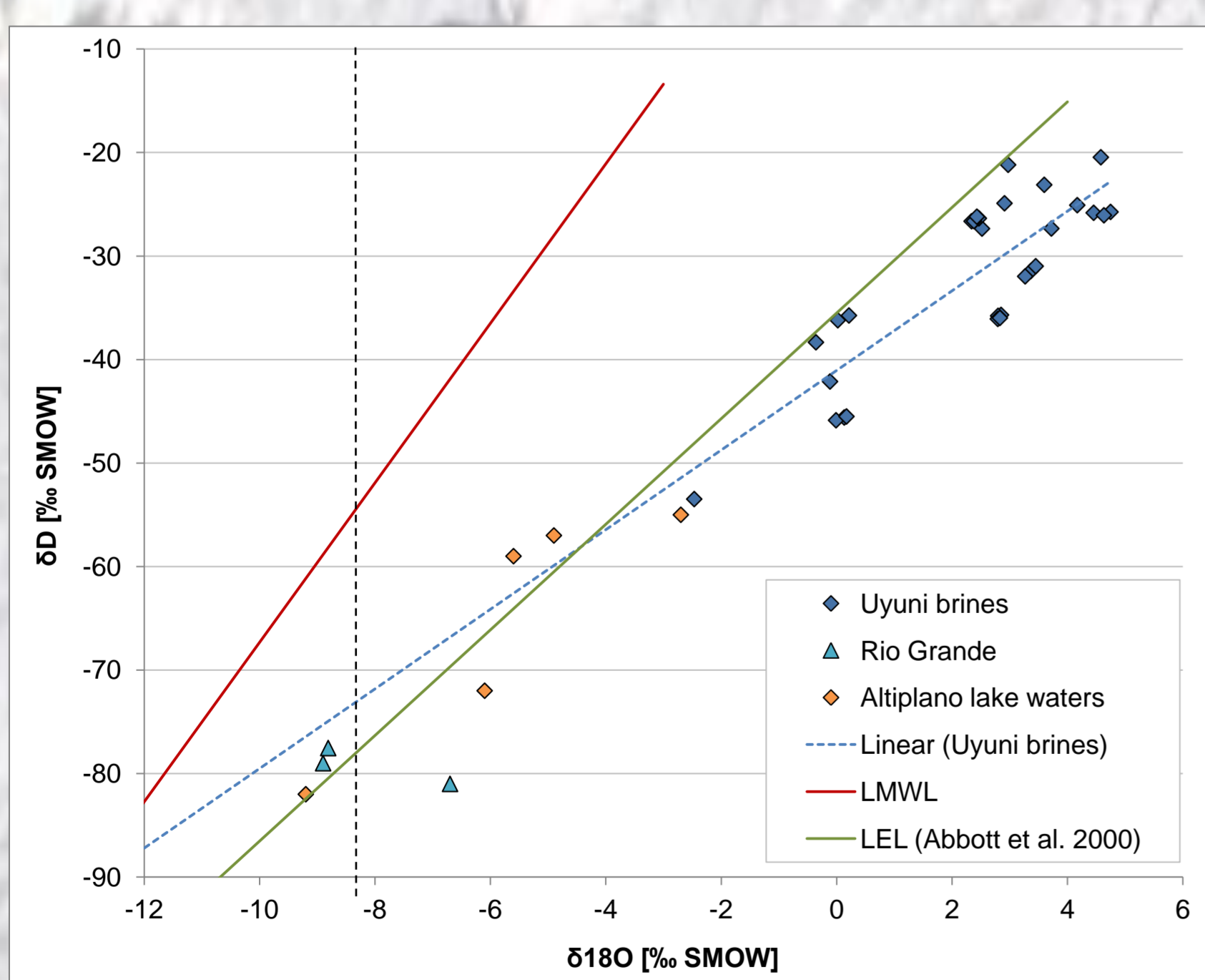
Concentration s of bromine and sodium in the Uyuni brines in comparison to lithium contents

Results

The brines are of NaCl type with mineralisations of ~300 g/L (halite saturation). Lithium behaves conservative (concentration in solution increases with overall salinity).

Salar de Uyuni: Surrounding springs and tributaries are enriched in lithium, high concentrations in the brine occur in the delta area of main inflows. $\delta D/\delta^{18}O$ of interstitial brines plot on the local evaporation line.

Tuz Gölü: A concentration gradient at the surface could not be observed, but content of main ions increases with depth. Tributaries contribute only little to the enrichment of lithium in the salt lake brine.



Composition of $\delta D/\delta^{18}O$ in the Salar de Uyuni brines compared to its tributary and Altiplano lake waters

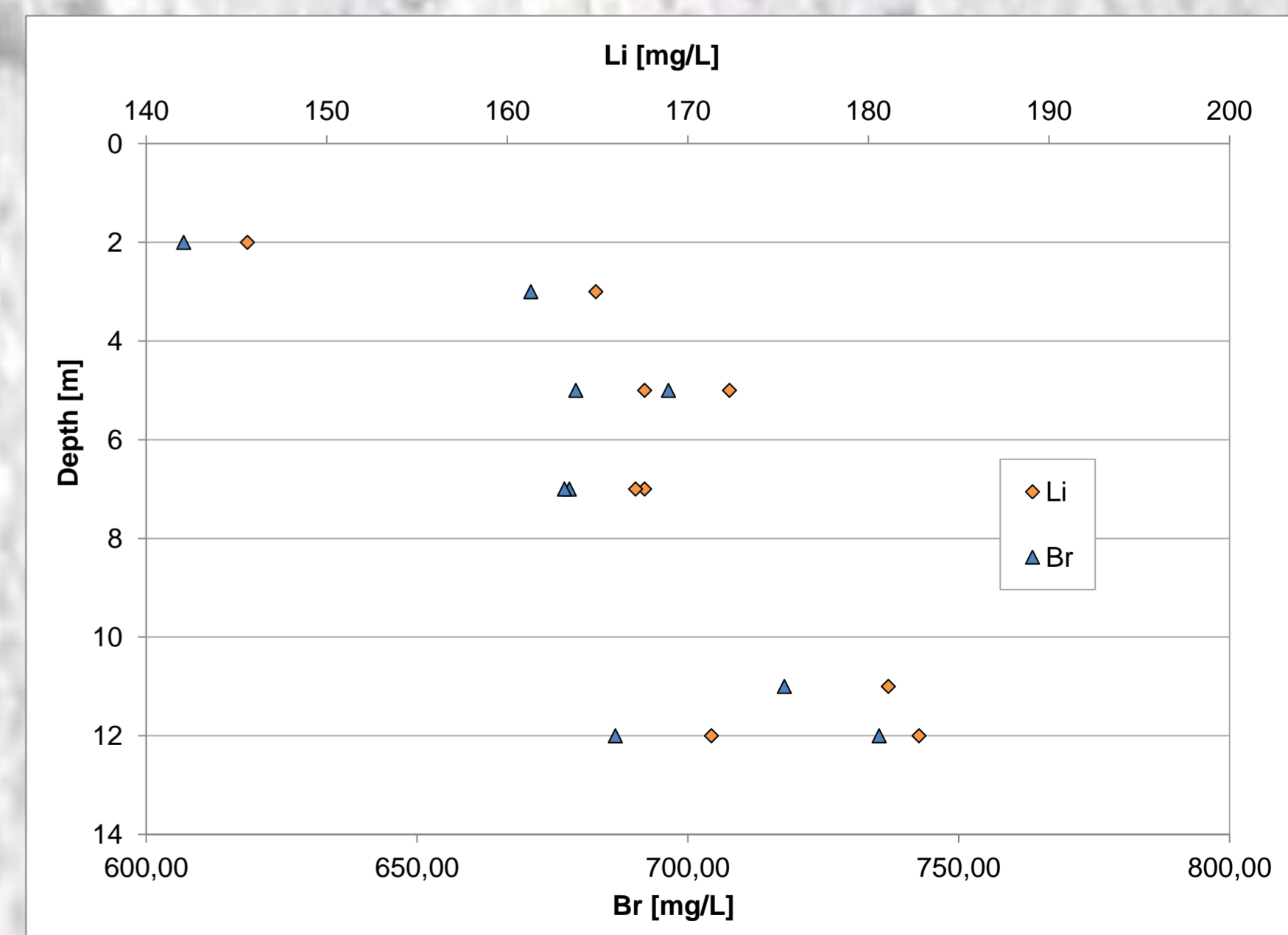
Conclusions & Outlook

The previous investigations show, that various mechanisms determine the enrichment and distribution of lithium in salt lakes located at different climatic and geologic backgrounds.

Further investigations include the precise analysis of lithium isotopes and the extension of sampling at the Tuz Gölü to a larger regional scale and the catchment area.



View of the Salar de Uyuni from the island of Incahuasi



Depth profile of lithium and bromine in the Tuz Gölü brines

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