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

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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

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 δD/δ18O in the brines.

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: δD, δ18O, δ34S, δLi
- Modeling of drainage basin by GIS
- Measurement of porosity (CT) and permeability (pumping tests, permeameter)

Results
The brines are of NaCl type with mineralisations of ~300 g/L (half 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. δD/δ18O 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.

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.

References

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