

SEG 2026 Conference in Salt Lake City, United States

Direct Lithium Extraction in High Mg/Li Brine System. Geological Challenges at Salar De Uyuni, Bolivia

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The Salar de Uyuni is the world's largest lithium brine deposit, with estimated resources of between 21 and 23 million tons of lithium carbonate equivalent (LCE) according to the USGS (2026). This system formed in a closed basin on the Bolivian Altiplano after the paleo-lake Minchin dried up about 40,000 years ago. The lithium in the brine comes primarily from the leaching of volcanic ignimbrites rich in this element and from hydrothermal contributions. Over time, in a very arid environment with high evaporation rates, lithium and other elements became concentrated, although water recharge is only seasonal and quite limited. The Uyuni brine has a complex geochemistry: it features a Mg/Li ratio of around 20 to 1, much higher than in other salt flats of the Lithium Triangle, as well as significant amounts of potassium and boron. It also exhibits significant vertical and lateral variability, caused by past climatic changes and by the halite layers covering the aquifers. All of this makes traditional evaporation a very slow and inefficient process. Direct Lithium Extraction (DLE) offers a better alternative. It allows for increased recovery rates, significantly reduces water use, and facilitates the reinjection of the remaining brine. For it to work effectively, it is necessary to study the geochemistry, geophysics, and three-dimensional structure of the deposit in detail, understanding how the brine varies at depth and on the surface. A thorough understanding of this geological complexity in 3D will be essential to harnessing this important Bolivian resource more efficiently and sustainably as part of the global energy transition.