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Chemical composition and mineralogy of borate from Rio Grande deposit, Uyuni (Bolivia) as raw materials for industrial applications

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Bolivia has large tailings as a result of the historic and present-day Sn mining activity developed extensively in that country. Tailings produced in these mining activities have an appropriate composition to reprocess them and make silicate glass and glass-ceramics, obtaining the valorization of wastes and reducing the visual and chemical impact. Reprocessing the wastes to make glass and glass-ceramics prevents the leaching of heavy metals from those wastes because they are retained in the structure of the glass. Furthermore, an option to increase the economic value of these glasses is the introduction of boron and other additives to produce borosilicate glass.
In this study a characterization of the Rio Grande borate deposit for its use in the manufacture of borosilicate glass is presented. Mineralogy was determined by X-ray diffraction (XRD), and Fourier transforms infrared spectroscopy (FTIR); textures were observed by scanning electron microscopy (SEM) and chemical composition was determined by inductively coupled plasma mass spectrometry (ICP-MS).
The Rio Grande borate deposit is located in an area of about 50 km2 close to the south of the Salar of Uyuni, in the Río Grande de Lípez Delta. Borates occur in the contact between fluvio-deltaic and lacustrine sediments from water raising the surface by capillarity. The borates crop out in an extent area but towards the west they are covered by fluvio-deltaic sediments, which can be up to 2 m thick. These borates occur as lenses 50-100 m in diameter and layers up to 1 m thick. They usually form brittle nodules with a cotton-ball texture.
Chemical composition of the Rio Grande borates is CaO, 11.82-13.83 wt%; Na2O, 13.50-19.35 wt%; K2O, 0.05-1.04 wt%; MgO, 0.42-1.46 wt%; $B2O_3$, 36.21-42.60 wt%; SiO_2, up to 0.53 wt% and SO_2, up to 0.60 wt%. Trace elements are low: Sr content is between 151-786 ppm, Al 12-676 ppm, Mn between 1-17 ppm, As 2-10 ppm and Fe between 9-376 ppm.
The most abundant borate mineral in this deposit is ulexite (NaCaB5.5H20), halite can reach up to 17 wt% and gypsum up to 1.2 wt.%. Calcite occurs in minor contents. Ulexite exhibits a fibrous morphology with fibers oriented parallel each other.
Purity of borates from the Rio Grande deposits makes them suitable for the most restrictive applications. Chemistry of these borates is in accordance with the necessary composition for obtaining borosilicate glasses.

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