Mobility of elements from cesium formate residue emplaced on pegmatite tailings

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A unique Cesium Products Facility (CPF) manufactures a cesium-formate drilling mud from pollucite ore at a pegmatite mine in SE Manitoba, Canada. The CPF is a closed system, with the waste slurry discharged to containment cells. When a cell is full, the Cs-rich slurry is dewatered, and the residue is dry-stacked on neutral tailings in a hydrogeologically closed tailings management area. This study concentrated on the geochemical and mineralogical reactions occurring within the residue pile and the underlying tailings to determine the mobility of Cs and other residue-related elements including Rb, Sr, Ba and Li.

Drill cores were extracted from the residue and tailings. The mobility of residue-related elements was examined through mineralogical observations, sequential extraction and porewater analysis.

The residue contains an order of magnitude more Cs (up to 2 wt. %) than the tailings (up to 0.3 wt. %). Sequential extraction results showed that 47% of the total Cs in the residue is mobile under natural conditions, compared with only 24% in the tailings. The stable forms of Cs in the residue are pollucite, feldspar and formate with sulphate and carbonate being the mobile forms. The Cs being released into the tailings does not appear to be re-precipitating in secondary phases. Cesium is predominantly in pollucite in the tailings. Rb, Sr, Ba and Li are all immobile in both the residue and the tailings in feldspar, lepidolite and barite.

Earth's early atmospheric density revealed from Archaean raindrop imprints

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The Archaean atmosphere has been investigated dominantly by numerical models that typically assume a total atmospheric pressure of ~1 atm [1-3]. However, barometric pressure may have been different, owing to the negligible presence of oxygen in the atmosphere [4], and the resulting difference in the redox-sensitive cycling of the other major gas, nitrogen.

We have developed a new method that uses lithified raindrop imprints as a proxy for atmospheric density. We consider the physics that determine the morphology of raindrop imprints preserved in tuff of the ~2.7 billion year old Ventersdorp Supergroup of South Africa [5]. Volume and surface area of raindrop imprints are a function of raindrop size and terminal velocity, the latter being dependent upon air density, whereas maximum raindrop size is not.

We experimentally determine the relationship between imprint volume and surface area as a function of raindrop size in wet ash (10% moisture by weight) from the 2010 Eyjafjallajokull event (Iceland) and Pahala (Hawaii), as modern analogs to the Ventersdorp tuff. We are then able to place an upper bound on the late Archaean atmospheric density, which has previously had no such observational constraint.

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