All Minerals Considered: Burbankite

Out of sight burbankite

Burbankite is a rare sodium carbonate mineral that is easily dissolved away in its host igneous rocks. Its formation and dissolution can help concentrate rare earth elements vital for a low-carbon future, as Sam Broom-Fendley explains.

The sodium-carbonate mineral burbankite is not one an undergraduate mineralogy student would typically encounter. However, the landscape for mineral deposits is changing, with more focus on lesser known 'critical raw materials' - those with a risk of supply interruption but essential for economic development and achieving net zero targets. This includes the rare earth elements (REE), which consist of the lanthanides, plus yttrium, and are important components of the high strength permanent magnets used in most wind turbines and electric vehicles. Understanding how rare earth element deposits form is, therefore, of increasing importance to better locate new deposits and increase processing efficiencies. Burbankite is an important yet often-hidden step in forming these resources needed for a greener future.

Burbankite ($[Na,Ca]_3[Sr,Ca,Ba,REE]_3[CO_3]_5$) is found primarily as an accessory mineral in carbonatites - igneous rocks with greater that 50% carbonate minerals. Carbonatites host the biggest and highest concentration rare earth element deposits and, consequently, make up almost all currently active rare earth mines. Burbankite, however, is a rare mineral and certainly not a rare earth element ore. Its high sodium content means it is soluble and poorly preserved. Often the only evidence of its role are its completely replaced, or pseudomorphed, hexagonal remains[1] (Figure 1). However, once you start looking, burbankite crops up in many carbonatites.

Burbankite provides a link between the intrusive, sub-surface magma system and extrusive carbonatite lavas through the presence of sodium in its mineral structure. Alkali elements like sodium and potassium are major components of the carbonatite lavas erupted at the unique Oldoinyo Lengai volcano in Tanzania. However, alkalis are found in low concentrations in almost all intrusive carbonatites. In part, this is because intrusive carbonatites likely represent crystal cumulates, while sodium and potassium are retained in the liquid phase and subsequently lost to hydrothermal fluids where they form characteristic aureoles of sodium- and potassium-metasomatised rocks, termed fenites. Experimental[2] and melt inclusion evidence[3] demonstrate the link between alkali-rich and alkali-poor carbonatites, but the only carbonate mineral preserving sodium in an intrusive carbonatite is burbankite. In these rocks, burbankite can be found as an early-forming mineral phase along with calcite[4], as well as in inclusions contained within other early-forming minerals[5].

However, the most important petrogenetic aspect of burbankite is its role in understanding carbonatite- hosted rare earth element mineralisation, and the importance of alkalis in this process. Fluid inclusion[6] and experimental results[7] indicate that alkali elements are important agents for transporting rare earth elements, resulting in the formation of burbankite. However, most rare earth deposits are formed of complex assemblages that include fluorcarbonates and/or the phosphate mineral monazite, associated with various strontium-, barium-, and calcium-bearing minerals. These assemblages compositionally represent the products of burbankite dissolution by hydrothermal fluids, as demonstrated in rare circumstances where burbankite is partially preserved[8].

The breakdown and dissolution of burbankite can result in rare earth element enrichments that reach high enough grades such that mining is economically viable, highlighting the importance of alkali-rich fluids in transporting and concentrating these elements in carbonatites. The ubiquity of hydrothermal overprinting in carbonatite-hosted ore deposits destroys burbankite and removes alkalis like sodium, masking their role in transporting rare earth elements. However, the closer we look the more burbankite appears. Although nature has disassembled the pieces, burbankite plays an important role in moving society towards a low-carbon future.

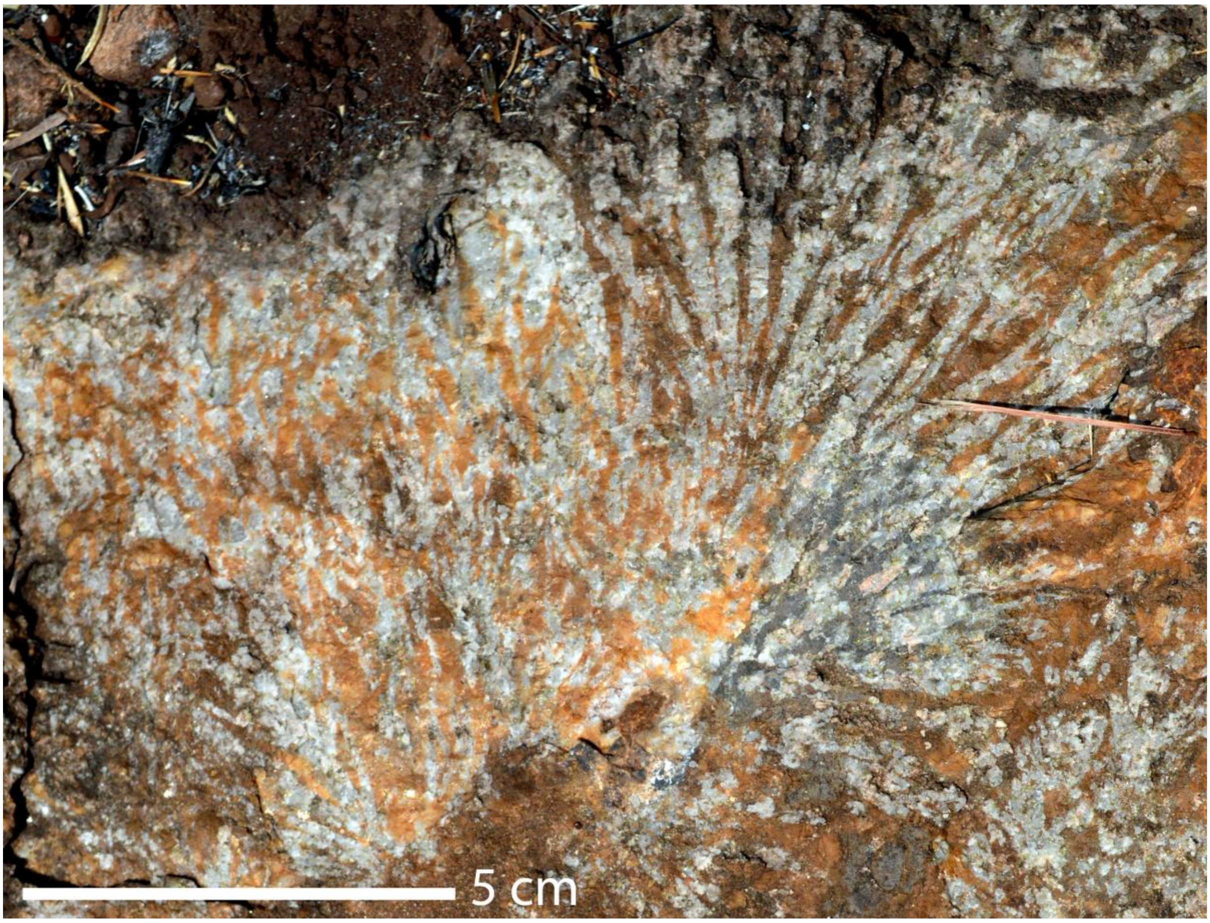

Figure 1. Radiating hexagonal pseudomorphs composed of the minerals monazite, strontianite, barite and dolomite, formed after the dissolution of burbankite. Kangankunde rare earth element deposit, Malawi. Field of view: 15 cm.

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Competing Interests

The author declares no competing interests.

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