Chemical micro-environments and mineral species richness in the Emmons pegmatite, Greenwood, Oxford Co., Maine

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The Emmons pegmatite (Falster et al., 2019) on Uncle Tom Mountain, Greenwood, Oxford Co., Maine, is Maine's most mineral species-rich pegmatite, with 243 confirmed species (Fig. 1). The early Triassic pegmatite occurs in the Oxford pegmatite field in Oxford Co., Maine and is an example of a highly evolved boron-beryllium-lithium-cesium-tantalum enriched pegmatite. The complexly zoned pegmatite is exposed over an area of 120 m × 18 m. The wall zone in the hanging wall of the pegmatite is characterized by comb-texture schorl. Over 20 distinct geochemical micro-environments have been identified in the pegmatite, and they suggest that in the later parts of the pegmatite crystallization, these small domains remained essentially isolated with virtually no detectable movement of fluids. These isolated environments resulted in the formation of widely ranging chemical compositions that led to the species richness. Alteration processes of earlier formed minerals such as schorl, primary phosphates and others, also show location variations. Among these microenvironments, the following are the principal examples:

1. Beryl that has been partially or completely dissolved leaves an assemblage of fluorapatite, bertrandite and cookeite behind, sometimes also hydroxylherderite.
2. Replaced pollucite or possibly petalite has produced an assemblage with muscovite, albite, quartz, orthoclase, cookeite, lepidolite, fluorapatite, goyazite and brazilianite.
3. Altered montebrasite in proximity with lithiophilite has produced lacroixite, berlinite, wavellite, burangaite, bertossaite, rosemaryite, wardite, wyllieite and whiteite.
4. Schorl replacement: muscovite/lepidolite, siderite-rich carbonates which often have altered to goethite and/or hematite, late rossmanite growth, rare anatase.
5. In the albite replacement zone in the footwall- intermediate zone and the hanging wall analogue, small miarolitic cavities abound, which contain albite, quartz, and muscovite as major minerals and accessory bertrandite, fluorapatite, cassiterite, columbite-tantalite, perhamite, goyazite, and zircon.
6. Lithiophilite alteration under oxidizing conditions produced strunzite, rockbridgeite, jahnsite, laueite, stewartite, bermanite, earlshannonite, beraunite, and mitridatite.
7. Lithiophilite alteration under non-oxidizing conditions produced vivianite, phosphoferrite, reddingite, fairfieldite, childrenite-eosphorite, switzerite, hureaulite.
8. Oxidizing environment near phosphate pods plus high Na or K influx forming essentially Fe^{3+} only, alkali-phosphates such as kapundaite, and cyrilovite.
9. Proximity of altering lithiophilite, beryl and pollucite has produced pezzottaite.
10. Tantalowodginite formation instead of cassiterite and columbite-tantalite
11. Formation of colored elbaite in the footwall intermediate zone's schorl-garnet bands, aided by Fe-removing löllingite.
12. High F near altered montebrasite produced carlhintzeite, kiryuite and gunmaite.
13. Lepidolite veins cutting pollucite have a core of analcime from late Na-influx.
14. Altered beryllonite produced hydroxylherderite, apatite and moraesite.
15. Altering lithiophilite with nearby sulfides has produced diadochite.
16. Alteration from löllingite or arsenopyrite: scorodite, arseniosiderite, arsenic.
17. Oxidation of uraninite produced secondary U species such as natro-autunite.

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18. Gravegliaite formed from the interaction of corroding pyrrhotite and tosudite.

The comb structure schorl and the numerous isolated mineral environments of which the 18 most common ones are listed above, demonstrate that the Emmons pegmatite crystallized rapidly under disequilibrium conditions. In the late stages of pegmatite formation, individual domains of small geochemical micro-environments produced an enormous number of mineral species under these isolated conditions.

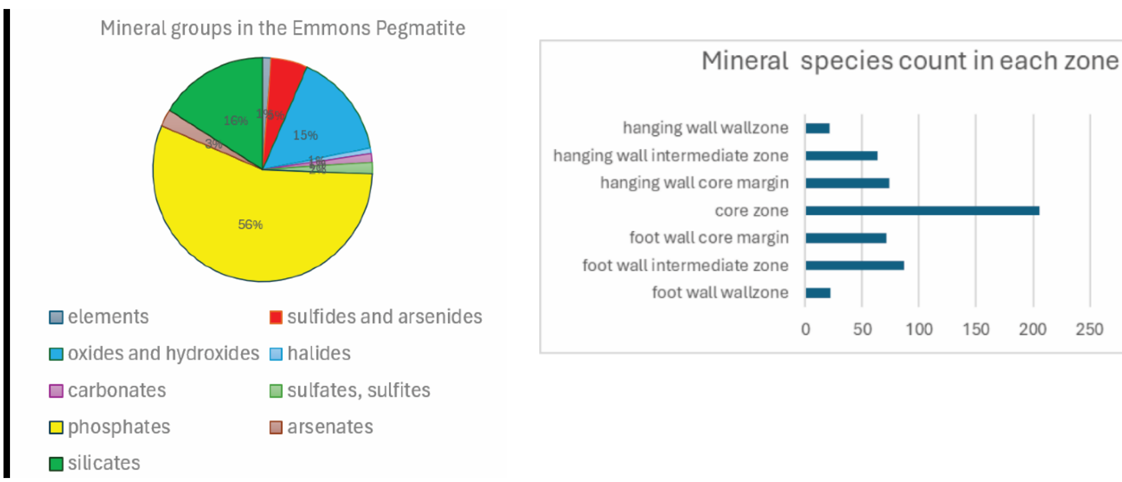

Figure 1: Plot showing the distribution of mineral species in the Emmons pegmatite and species count for the pegmatite zones.

References

Falster, A.U., Simmons, W.B., Webber, K.L., Dallaire, D.A., Nizamoff, J.W., & Sprague, R.A. (2019) The Emmons pegmatite, Greenwood, Oxford Co., Maine. Rocks & Minerals 94(6), 498–519.