The East Kemptville tin-base metal deposit, Nova Scotia: documentation of the magmatic to hydrothermal transition in a highly-fractionated, F-rich environment

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The East Kemptville tin-base metal deposit, in operation from 1985–1992 as the only primary producer of tin in North America, is hosted by a 376 Ma topaz-muscovite leucogranite (EKlcgr). Mineralization (i.e., 56 Mt @ 1.65% Sn) occurred as structurally controlled, zoned- and massive-, tin-topaz-sulphide greisens. Geochronological (Rb-Sr, $^{40}Ar/^{39}Ar$, Pb-Pb, U-Pb, Re-Os) and petrological studies indicate that the EKlcgr represented the end product of crystal (Plg-Bt-Kfs)-fluid fractionation of a zoned, peraluminous magma. This zoned magmatic complex, referred to as the Davis Lake Pluton, is one of several plutonic centres comprising the large (7800 km^2), 380 Ma South Mountain Batholith. The EKlcgr (ca. 1 km^2) was emplaced at ca. 3.5–4 kbar and represents the apical portion of a zoned, F-rich magma within which occurred periodic cycling of fluid pressure. The preserved textures and petrological features that reflect this once dominant process include: (1) gradation and heterogeneity of granitic textures inwards from the contact (i.e., roof); (2) a variety of miaroles near the roof zone, some of which contain primary cassiterite; (3) distribution of paired aplite-pegmatite sheets; (3) crenulate layering and USTs marginal to the contact; (4) abundant stockscheider; and (5) an unfractionated chemistry (e.g., whole rock and Kfs)for pegmatite versus the host EKlcgr. Related to the cyclicity of fluid pressure was emplacement of the EKlcgr into an active shear-zone environment, evidence of which includes: (1) the elongate outline of the intrusion; (2) orientation of quartz grains in the EKlcgr and endogenic pegmatites; (3) stockscheider alignment; and (4) the structural control of mineralized greisens and veins (e.g., fibre veins on growth faults). Stable isotopic data (O, D, S) and fluid inclusion studies indicate that the magma evolved as a closed system with no evidence of second boiling (i.e., fluid unmixing), the latter feature of which is commensurate with the depth of formation. The above observations are interpreted to suggest that the mineralized environment evolved due to injection of a volatile-rich, chemically-evolved (i.e., Sn-, Cu-, Zn-, F-rich) magma into a fault zone within which periodic pressure release related to seismic events facilitated exsolution of a mineralizing fluid. Migration of this fluid into structural sites (i.e., fractures) and its subsequent interaction with and neutralization by the wallrock EKlcgr resulted in the formation of zoned- and massive greisens.