Fission track analysis applied to mineral deposits and exploration

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Apatite fission track (FT) analysis is a rock-dating technique that, in addition to an age, provides a time-temperature cooling history for the rocks sampled. The technique is particularly sensitive and well-calibrated between 60°C and 120°C, which coincides with the range of temperatures of carbonate hosted base metal deposits, some epithermal precious metal deposits, active geothermal fields, and thermal halos around unexposed intrusions and salt structures. This is also the domain of rocks approaching the surface of the earth during exhumation due to tectonic processes such as crustal thickening, thrusting, block faulting and continental rifting, or to lowering of the base level. Fission track dating of minerals with suitable uranium in solid solution, such as zircon (blocking temperature ca. 200°C), epidote (ca. 200-400°C), titanite (ca. 300°C), promise applications in the realm of epithermal to mesothermal ore deposits.

The Gays River zinc-lead deposit, Nova Scotia, and similar deposits, hosted in Mississippian carbonates, were formed in the late Pennsylvanian-Early Permian during rapid basin dewatering of hot overpressured fluids (ca. 300 Ma), coinciding with FT dates on zircon, but apatite FT dates are much younger (ca. 200 Ma) representing post-ore exhumation through the 100°C isotherm in the Mesozoic.

In the Central Andes, apatite FT analyses in the giant Eocene-Oligocene Chuquicamata porphyry copper deposit and surrounding basement rocks indicate that the mineralized porphyries were intruded immediately following a period of rapid exhumation, that cooling of the intrusions was

fairly rapid indicating shallow emplacement, and that post-ore exhumation proceeded at a pace conducive to optimal supergene enrichment and concentration of exotic copper ores.

It is probable that northern Labrador has seen significant post-Precambrian exhumation into the Mesozoic, possibly related to rifting of the margin. Apatite FT analysis will be used to test whether there has been differential uplift and exhumation in distinct tectonic blocks. Kimberlite or lamproite complexes may exist in Labrador; for the diamondiferous tops of these complexes to be preserved, erosion must be limited after their emplacement. If the uplands erosion surface (and gossans over sulphide bodies) developed during deep lateritic weathering in the mid-Cretaceous warm event, as we propose, any younger kimberlite/lamproite complexes have a chance of being preserved.