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Supercooled melt inclusions in lower-crustal granulites and rapid exhumation by channel flow

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We found unexpected felsic (granitic) inclusions with quench textures such as spherulite and dendrite (felsite inclusions), similar to some volcanic rocks, within garnet in presumably slowly cooled lower-crustal granulites of various geologic ages ranging from Early Proterozoic to Middle Paleozoic and wide global distribution (the Limpopo Belt, the Grenville Province, the Lutzow-Holm Complex of East Antarctica, the Highland Complex of Sri Lanka, and the southern Bohemian Massif). The well-preserved textures of felsite inclusions are indicative of melts formed by anatexis during high-pressure and high-temperature metamorphism, crystallization under far-from-equilibrium conditions (at $>$50 degree undercooling) and subsequent rapid cooling. The occurrence of felsite inclusions in granulites in restricted tectonostratigraphic zones in Sri Lanka, among others examples, may be the first geologic evidence for fast exhumation of lower-crustal rocks to andalusite-stable upper-crustal conditions by channel flow in a continental collision orogen. We hypothesize that granulites ascend episodically along discrete high-strain zones and cool as fast as some felsic magmas. This conclusion sheds new light on the debate regarding the deep crustal processes and necessitates changes to fundamental beliefs about exhumation rates based on rates of plate convergence (1-10 cm/year).

Keywords: felsic melt inclusions, granulite exhumation, supercooling, channel flow