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Origin of 87Sr/86Sr isotope variability in granitic magmas by fluid-absent melting of compositionally heterogeneous protoliths

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Experimental studies on crustal rocks and analogues as well as geochemical studies on migmatites suggest that, if heating during the metamorphic event and extraction of the melt are rapid enough, equilibration between the liquid and the residual phases is not likely to be achieved. When disequilibrium prevails the melt does not inherit the same isotopic ratio as its bulk source and the isotopic composition of the melt depends primarily on: i) the extent of isotopic re-equilibration before melt segregation ii) the composition of the reactant phases, iii) the stoichiometry of the melting reaction and iv) the entrainment of restitic material. Thus, a variety of isotopically distinct melts can arise from progressive melting of a single heterogeneous source rock volume.

The compositional variability exhibited by natural sediments is taken into account to produce a theoretical model showing the relationship between age and composition of the protolith and 87Sr/86Sr composition of the melt formed by fluid-absent melting. The model demonstrate that the Sr isotopic variability observed in granitic suites as well as the isotopic heterogeneity at the grain and sub-grain scale in a single magmatic body can be primary, and therefore reflect the magma composition that ascended directly from the source.