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Segregation and re-segregation of melt in granulite facies migmatites

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Not all the granitic melt produced in the lower or middle crust ascended to form plutons in the upper crust (∼12 km). In some cases ascent was arrested at the solidus and formed injection complexes in the middle crust. In other cases melt segregated from its residuum, but failed to leave its source. Quantifying the amount of melt in these two cases is a necessary step in understanding the effectiveness of crustal differentiation. Identifying all the melt that remained in its source region can be difficult. Melt that segregated into ductile fractures can be readily identified by its form, leucosomes or dykes. However, in the deep, deforming crust supra-solidus temperatures can exist for >107 years and complication arise because; 1) melt can be moved more than once (re-segregated) as transient pressure gradients develop, 2) melt becomes contaminated as it moves, and 3) melt can react with the residuum and is then no longer obvious.

In the field changes in grain size and mineralogy together with the loss of pre-anatectectic structures and the development of new flow structures can be used identify the products of former melt. The type of framework microstructure and the whole rock composition of individual samples indicate which processes the melt has undergone, and provides a mass balance for these. Examples of these occur in the Ashuanipi Subprovince in Canada which experienced granulite facies anatexis. The melt retained occurs as secondary diatexite migmatite formed by the injection of segregated melt into very large (structurally controlled) sheets. This melt was contaminated with the adjacent residual metagreywackes, but also metamafic rocks. The diatexite underwent flow during crystallisation and subsequent re-segregation of the remaining, fractionated, melt. In places where deformation was sufficiently weak and re-segregation did not occur, local, in situ fractional crystallisation produced patches of monzogranite in the diatexite.

The majority of diatexite migmatites in the Ashuanipi subprovince are tonalite or granodiorite in composition and have a microstructure dominated by a plagioclase framework. In many cases K-feldspar is interstitial to the plagioclase framework; the bulk composition of these rocks can be modelled by loss of a fractionated melt. A small proportion of diatexite migmatites have compositions corresponding to this re-segregated, fractionated, monzogranite melt. Widespread replacement of peritectic orthopyroxene by biotite indicates that not all the melt component was re-segregated, some reacted with the residual phases. Overall, a large fraction of the anatectic melt produced and segregated from the residual metagreywackes in the Ashuanipi subprovince remained in the source region as diatexite with a plagioclase-cumulate microstructure and tonalite bulk composition. The volume of fractionated melt that remained is small, thus the melt that escaped to higher crustal levels had a fractionated composition. Leucogranite with such a composition forms an injection complex in the adjacent and slightly shallower Opinaca Subprovince.