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Melting granites to make granites

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Large-scale partial melting in the continental crust is widely attributed to fluid-absent incongruent breakdown of hydrous minerals in the case of pelites, greywackes and meta-mafic rocks. Granite is a far more common rock in the continental crust, but fluid-absent hydrate-breakdown melting is unlikely to result in significant melting in granites because of their low modal abundance of mica or amphibole. Experiments show that fluid-present melting can produce ~30% melt at low temperatures (690°C). Thus, granites and leucogranites can be very fertile if H_2O-present melting occurs via reactions such as plagioclase + quartz + K-feldspar + H_2O = melt, because of their high modal proportions of the reactant phases.
Our study investigates the Kinawa Migmatite in the São Francisco Craton, southeastern Brazil. This migmatite is derived from an Archaean TTG sequence and can be divided into; 1) pink diatexites, 2) leucosomes, 3) grey gneisses and 4) amphibolites. The migmatite records upper-amphibolite to beginning of granulite facies metamorphism in a P-T range from 5.1-6.6 kbar and ~650-780°C.
Pink diatexites are the most abundant rocks, and their appearance varies depending on the amount of melt they contained. Three types are recognised: residual diatexites (low melt fraction (Mf)), schlieren diatexites (moderate Mf) and homogeneous diatexites (high Mf). They are very closely related spatially in the field, with mostly transitional contacts. There is a sequence with progressive loss of ferromagnesian minerals, schollen and schlieren through the sequence to the most melt-rich parts of the diatexites as magmatic flow became more intense. There are fewer ferromagnesian minerals, thus the melt becomes cleaner (more leucocratic) and, because the schlieren have disaggregated the aspect is more homogeneous. These parts are texturally similar to leucogranites in which the biotite is randomly distributed and pre-melting structures are completely destroyed.
The likely protolith for the migmatites was a leucocratic granodiorite (with modal K-feldspar up to 30% and biotite up to 5%), and from geochemical modelling the degree of partial melting ranged from 0.21 to 0.25. Furthermore, the residual diatexites show a complementary low modal proportion, or even absence, of K-feldspar, but an increase in modal plagioclase, quartz (up to 56 and 37% respectively) and biotite (5-16%). This suggests that the melting reaction did not involve biotite and that plagioclase and quartz were in excess. As result the melt generated is fairly leucocratic, and most of the mafic phases in it are inherited.
Anatectic melts in the Kinawa Migmatite were mildly metaluminous and distinctly leucocratic (A/CNK from 0.97 to 1.01; SiO_2 from 72.8 to 75.65%; ($FeOT+MgO+TiO_2$) from 0.49 to 2.3%). Since most granites have a higher ($FeOT+MgO+TiO_2$), additional processes must add the “mafic component” to these melts before they form plutons.