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Titanium: A key to the processes that shape granite chemistry

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TiO2 and FeO+MgO (maficity) in most granitic (sensu lato) rocks are strongly positively correlated. This characteristic is not inherited from granitic melts, which display a weaker correlation between these parameters, and a far more restricted range of maficity than the granites. Nor does it appear to be a product acquired through mixing with mafic melts, as these show no correlation between Ti and maficity. Ti is a crucial component in the genesis of most granites because they arise through the incongruent melting of biotite and/or hornblende, in reactions that produce peritectic mineral assemblages that always contain at least one ferromagnesian mineral and a titanium-rich mineral (typically ilmenite), in addition to a leucogranitic melt. Here we use the tight Ti-maficity link in granites to demonstrate that their magma compositions represent mixtures of leuco-granitic melt and up to 35%, of the peritectic assemblage produced in the source. Consequently, Ti:maficity ratios in granites reflect the stoichiometry of the titaniferous reactant in the melting reaction. In general, the compositional arrays defined by S-type granitic suites can be explained by peritectic assemblage entrainment. Compositions in I-type suites follow identical trends with increasing maficity, until intermediate compositions are reached, they then fan out toward the uncorrelated mafic rock cluster. This indicates that magma mixing is only evident in I-type granitic suites and, even here, it does not account for the compositions of the granites and granodiorites, but only of some diorites and more mafic rocks. Tracking back along the inferred entrainment vector allows natural melt compositions in the protoliths of granitic magmas to be identified. They are very felsic, with very low Ti contents and their major elements vary principally in terms of peraluminosity and the ratios of dissolved feldspar components (reflecting source composition). Thus, the compositions of granites and granodiorites reflect processes that occur in the source. Dissolution of different proportions of the melting reactants, coupled with entrainment of varying proportions of the solid products of this reaction.