Crust vs mantle origin of granitic rocks: current views on an old debate

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Granitic rocks have a composition close to eutectic. This implies that they correspond to the lowest possible temperature melts in silicate systems. Therefore, a granitic composition can be reached by several pathways. Two models are particularily relevant: (1) melting of a feldspar-bearing lithology (i.e. crust) and (2) fractionation of a mafic (basaltic) liquid. Both processes lead to the same granitic minimum.

Second-order differences between granitic types may, in principle, allow to identify the source from which granites derive. However, this information is difficult to use for most volumetrically dominant rock type (including the crust-forming Archaean granitoids).

Isotopes are a powerful tool, but they are overly influenced by minor crustal contamination, or by crustal residence times. Trace elements are poor tracers, as the trace element contents of a liquid is largely influenced by the composition of its source, itself the result of all previous events that eventually lead to its formation. It is therefore very difficult to unravel the multiple processes that led to a granitic composition. Petrology, phase equilibria and major elements chemistry (all the manifestation of the same, underlying thermodynamics) appear as powerful tools. However, the best they can do is point to a specific source -- but not to a specific process. It is essentially impossible to decide between melting of a source, or differentiation of the same. Whereas this leaves little doubt in some cases (e.g. in the case of a source with a sediment composition, hard to reconcile with a liquid), other situations are more ambiguous (e.g. a mafic source could equally be a melting metabasaltic rock, or a fractionating basalt).

Such limitations are probably intrinsic to petrology and geochemistry, and it seems unlikely that a globally relevant model can be proposed -- each case must be judged on its own merits. Alternately, some answers may be supplied by other approaches, such as modelling of the thermal state of the crust, or the consideration of preserved disequilibrium features within a rock.