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Origin of the chemical variability of the late Miocene Elba Island granitic complex (Italy) by peritectic phases entrainment and anatexis of an heterogeneous source rock

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The chemical variability exhibited by the granitic rocks of the multiple sheets Elba Island intrusive complex (Italy) has generally been interpreted to reflect the progressive hybridization of an original crustal melt with mantle-derived magma(s). Comparison with experimental melt compositions indicates that rocks of the intrusive system have Fe + Mg, Ti and Ca contents that are too high to represent pure melts. This demands the addition of a ferromagnesian, Ti- and Ca-rich component to the magma. Additionally, both Ti and Ca are highly correlated with Fe + Mg, yet other elements such as Sr, K, Na are not. This challenges a simple mantle-crustal magma mixing hypothesis. Consequently, this contribution focuses on reconsidering the role of mantle-derived magmas in the petrogenesis of the Elba Island intrusive system from the perspective of constraints imposed by crustal melt compositions. Modelling in this study illustrates that the well-defined Ti and Ca vs. Mg + Fe linear trends, characterizing the Elba Island granitic system, can be generated by entrainment of peritectic clinopyroxene and Ilmenite into the melt. Other major and trace element components (e.g. K, Na, Sr, Rb), plotted against Mg + Fe, do not generate linear trends. This observation indicates that their concentration in the magma is not entrainment-dependent, and most likely controlled by compositional variability of the source. On the basis of the major- and trace element geochemical data, we propose that at least part of the compositional variation displayed by the Elba Island intrusive complex is primary, i.e. reflecting the magma composition that ascended directly from the source. Following this hypothesis, the composition of the final magma may be controlled by two main factors: (i) the stoichiometry of the melting reaction and the composition of reactant phases in the source, that control the composition of the anatectic melt; (ii) the degree of entrainment of peritectic mineral phases, whose nature will be dependent by (i), as well as by the P, T conditions of melting. The magma mixing relevant to the great majority of the products of the Elba system occurs between successive magma batches generated by anatexis of heterogeneous source rock volumes. Mantle-derived magmas are only involved in the genesis of the more mafic magma batches.