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RB - SR and U - TH - PB SYSTEMATICS OF ALKALINE ROCKS:
THE ALKALINE ROCKS FROM ITALY

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ABSTRACT

The isotopic composition of Pb and Sr and the abundances of Rb, Sr, U, Th, and Pb were determined for whole rock samples from all major volcanic centres of the Cenozoic alkaline volcanism of Central and South Italy, together with some samples from the contemporaneous anatectic Tuscan volcanism. The Pb and Sr isotopic compositions of the alkaline rocks show a regional trend: the \(^{87}\)Sr/\(^{86}\)Sr ratios decrease from 0.711 in the north-west to 0.704 in the south-east, while the \(^{206}\)Pb/\(^{204}\)Pb ratios increase from 18.7 to 20.0. The variation in both isotopic compositions is generally small for each eruption centre and within a volcanic centre no correlation with any major element nor with any measured trace element abundance could be observed.

All variations in the isotopic abundances of lead and strontium for a suite of igneous rocks for which a common origin can be assumed can be interpreted as the cause of two physical processes, which in turn correspond to two groups of geological processes: (i) they can result from a time dependent development in subsystems with different Rb/Sr or U (Th)/Pb ratios or, (ii) they can result from mixing of Sr or Pb with different isotopic compositions. Combining both, lead and strontium isotopic compositions, it is possible to exclude the first of the two alternative models for the Italian alkaline rocks; also none of the observations are in contradiction to the second model.

It is shown that the source of each volcanic centre is formed by various degrees of mixing between two components which differ in their Sr and Pb isotopic composition. The one component and the most southern Tuscan anatectic rocks most likely have a common source, whereas the other component of the mixing process is suggested to be a liquid fraction derived from a small degree of partial fusion of a hydrous mantle. Thus at least a two stage process for the origin of the Italian alkaline rocks is indicated: first a mixing process leading to the formation of the parental material with subsequent differentiation processes leading to the formation of the rock series.

The geodynamic model, which explains the data best, is that of a lateral inhomogeneous mantle. In this model the actual mixing of the two components occurred not during the volcanic activity, but some time before, so that the lateral inhomogeneities are the result of the mixing. A feasible process could be the fusion of the crust by a rising mantle plume.