Petrogenesis of fayalite granitoids: New insights from metapelitic xenoliths

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Fayalite-bearing granites are fairly uncommon granitoids, related mainly to alkaline and evolved magmatism usually associated with intraplate settings or anorogenic magmatism. Fayalite granitoids have recently been reported from the Cobquecura Pluton of Central Chile, SW margin of Triassic Gondwana. We discuss their petrogenesis in the light of their geochemical and isotopic characteristics. The Cobquecura Pluton is an epizonal, partly fayalite-bearing intrusive suite, composed mainly of gabbro and granite. Both fayalite-granitoids and gabbros contain hercynite-rich metapelitic xenoliths with a composition different to the metamorphic basement in the area, but similar to that expected for the (restitic) lower crust.

The Cobquecura rocks (SiO_2 = 48 - 76 wt.-%) are sub-alkaline, with high FeO*/(FeO*+MgO) ratios. REE patterns are fairly flat (La_N/Sm_N = 1.12 - 3.39; Lu_N/Gd_N = 0.59 - 0.76). Patterns are nearly parallel, with steeper slopes for the LREE as typical for fractional crystallization processes. However, the fayalite-granitoids are richer in REE-content than the fayalite-free granites despite the higher SiO_2-content of the latter. The trace element signature of metapelitic xenoliths in gabbros and fayalite-granitoids differs from the metapelitic basement in the area. The xenoliths are richer in compatible elements, and their overall chemical signature is very similar to that of the fayalite-granitoids. Fayalite granites have high $^{87}Sr/^{86}Sr_i$ (~0.707) for their corresponding εNd values (-0.6 to -0.7). Pb-isotopic fingerprints of the fayalite granite ($^{206}Pb/^{204}Pb$ = 18.22 - 18.25, $^{207}Pb/^{204}Pb$ = 15.64 - 15.62 and $^{208}Pb/^{204}Pb$ = 38.13 - 37.8) are similar to those of the metapelitic xenoliths ($^{206}Pb/^{204}Pb$ =18.22 – 18.39, $^{207}Pb/^{204}Pb$ = ~ 15.6 and $^{208}Pb/^{204}Pb$ = 37.62 – 38.25).

The origin of fayalite granites is been discussed in terms of (i) fractionation from a mafic magma and (ii) partial melting of a dehydrated source, like granulites of the lower continental crust. The restitic nature of the pelitic xenoliths suggests that they come from the middle or lower crust. The major element behaviour suggests that the fayalite granites are a product of fractionation from the gabbros of this suite. However, close similarities between xenoliths and fayalite granites in terms of Pb isotope and trace element signatures point to Fe- rich medium or lower continental crust assimilation as an important process in fayalite granitoid petrogenesis.

A reassessment of prebiotic sources of carbon in the early Earth

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A major reassessment of the sources of carbon is required to explain a range of anomalies associated with carbon distribution in the early earth and in the post Hadean periods.

Among these we might list:-

A. The early earth crust whether sub-continental:-acidic or granitic, or sub-oceanic:-basic or basaltic contains avery small concentration of carbon, less than 100 ppm. The sedimentary rocks which are assumed to be directly or indirectly derived from these materials contain well over 5% of carbon.

B. The earliest sources of carbon can not be assumed to have been derived from living matter and a prebiotic source of carbon must have existed in realistic quantities. Even if the micro-structural and isotopic evidence for the existence of life around 3.8Ga is assumed, which is an open question, a source of carbon must be established.

C. The large deposits of methane hydrates as well as the more recent sources of methane (Lake Kivu) cannot be explained as purely to organic sources.

To explain the above anomalies we wish to propose the concept of ‘reactive minerals’. We believe that a considerable number of reactive minerals exist well below the earths surface. Such minerals would react with water, water vapour and/or oxygen when approaching the surface. We could cite carbides and sulphides as examples, more specifically calcium and aluminium carbide. It is well known that these compounds are stable at high temperatures but react if exposed to water or oxygen. In the former case they would initially yield methane or acetylene if confined to a neutral or reducing environment, or under oxidising conditions they would yield CO_2. this in turn would form carbonates and at higher temperatures result in the formation of oxides and silicates.

The existence of such reactive minerals would explain how pre-biotic sources existed from which living matter could have developed. It will also show that our present figures regarding the actual carbon content of the earth are low and true values would now be in line with the carbon content of other planets and interstellar materials.