

Age of magnetite–apatite deposits and geochemistry of host rocks, Bafq District, Central Iran

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Major hydrothermal/metasomatic Kiruna-type REE-apatite-magnetite ores (2×10^9 t) of the Bafq district in East Central Iran are hosted by Early Cambrian rhyolitic rocks and occur locally also in late spilitic basalts. This intimate association within a 150 km N–S striking structural zone, bordered by crustal faults, suggests a genetic link between magma generation and ore formation. The exact age of the mineralization, however, has not yet been determined. The tectonic setting of granitoids and rhyolites has been controversially discussed (rift setting versus magmatic arc environment) with Ramezani and Tucker (2003) favoring a collisional setting based on the chemical signature of the felsic magmatic rocks and paleogeographic reconstructions.

Our current study deals with the age of the mineralization and the geochemistry of the host rocks.

Petrographic investigations indicate that the rhyolites have been subjected to a broad-scale alkali metasomatism and an ore-related metasomatism that have modified their original composition, thus complicating the interpretation of geochemical data. Indeed, our major and trace element data do not yet permit an unambiguous interpretation of the geotectonic environment. However, we note that volcanism in the southern sector of the Bafq district is essentially bimodal with intermediate (andesitic) rocks being rarely encountered and mafic rocks being subordinate to felsic ones.

Clear apatite crystals were separated from three apatite–magnetite deposits. The nine analyzed samples yield apparent $^{206}\text{Pb}/^{238}\text{U}$ ages between about 527 and 539 Ma and thus fall entirely within the age range of the felsic magmatic rocks dated by Ramezani and Tucker (2003) [525–547 Ma]. This confirms field evidence that the ore formation was closely related to the Early Cambrian magmatic event (Daliran, 2002).

References

- Ramezani, J. & Tucker, R. D. (2003) *Am. J. Sci.* **303**, 622–665
 Daliran, F. (2002) In: *Hydrothermal Iron Oxide Copper–Gold and related deposits, Volume 2*, T. M. Porter [Editor], PGC Publishing, Linden Park, South Australia, 303–320

Tracing the mineralogy of oceanic basalt sources

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Subduction of oceanic crust has introduced considerable quantities of basalt into the Earth's mantle, which, in the form of eclogite or pyroxenite, have often been proposed to constitute part of oceanic basalt sources. Isotopic evidence for mafic constituents in oceanic basalt sources remains ambiguous because their inferred isotopic composition is highly model dependent. Identification of pyroxenite derived melts on the basis of their major element composition is complicated by second order processes, i.e. fractional crystallization. Incompatible trace element compositions, however, are less affected by small extents of fractional crystallization. In addition, the higher modal abundance and different composition of garnet and clinopyroxene in pyroxenite compared to peridotite can lead to different partitioning behavior of the incompatible trace elements, which may be a useful tracer of pyroxenite versus peridotite derived melts. On the basis of recent partitioning experiments, bulk D values for pyroxenite are, on average, about a factor of 3–6 higher than for garnet peridotite. The relative compatibility of the lithophile trace elements, however, is broadly similar. The main differences are an order of magnitude higher Ba/(Th, U, Nb, La), and about a factor of 2–3 lower Nb/(Th, U, La) and Sr/(Nd, Hf, Zr, Pb) bulk D ratios in pyroxenite compared to peridotite. Owing to the extremely low bulk D values of the most incompatible elements Ba, Th, U, Nb and La, however, even large differences in their bulk D ratios result in no resolvable differences in derivative melt compositions at melt fractions $\geq 5\%$. For the more compatible elements Sr, Nd, Hf, and Zr, partition coefficient induced differences (higher Sr/(Nd, Hf, Zr) and Nd/Hf ratios) persist up to melt fractions of 20–30%. Whether differences in melt composition owing to the different partitioning behavior of garnet-peridotite and pyroxenite can be identified therefore depends largely on the style of melting and melt aggregation, i.e. how do melts form, what degree of melting is reached before separation from the solid (melt extraction) and how and to what extent do melts pool to form the aggregate melts erupted on the surface. Owing to its lower solidus temperature, pyroxenite starts melting deeper than peridotite. Key parameters for being able to resolve partitioning induced differences in melt compositions are therefore the extent of melting of pyroxenite before the onset of peridotite melting and the extent to which early pyroxenite melts can be extracted, if at all, without being significantly mixed with melts from the ambient peridotite. Regardless of the exact melt extraction scenario, the large extents of melting expected for pyroxenite ($>20\%$) suggest that any partition coefficient induced differences between peridotite and pyroxenite melts are likely to be subordinate to initial compositional differences.