The relationship of Fe oxide-P-REE mineralisation to magmatism: the Pea Ridge deposit, Missouri

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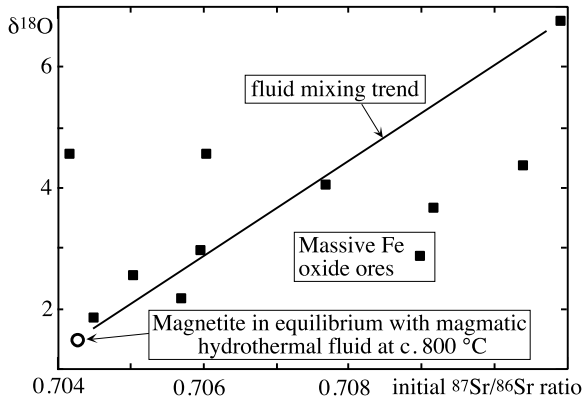
Fe oxide-P-REE mineral deposits of the St Francois Terrane are contemporaneous with their c. 1.48 Ga old, predominantly metaluminous rhyolitic host rocks. At Pea Ridge mine, replacive massive magnetite grades outwards through massive hematite to hydrothermally altered rhyolitic tuffs veined with, and replaced by, Fe oxides.

Formation of the Fe oxide ores by magmatic liquid immiscibility can be ruled out on a variety of textural and geochemical evidence. A hydrothermal origin is therefore favoured. REE concentrations, Nd, Sr and O isotopic compositions of Fe oxide samples are compatible with derivation of the bulk of their budgets of these elements from local rhyolitic rocks. The mineralising fluid then evolved by admixture with a more oxidized fluid of higher $^{87}Sr/^{86}Sr$ ratio and $\delta^{18}O$ as shown in the figure below. The predominant, low $\delta^{18}O$, low $^{87}Sr/^{86}Sr$, hot, hypersaline (Sidder et al. 1993) component of the hydrothermal fluid is most simply explained as having separated from magma, though the alternative of thorough equilibration of another fluid with hot rock cannot as yet be ruled out.



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Geochemical Measurements of ^{130}Te Half-life: Present Status

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Geochemically determined ^{130}Te half-lives have yielded two clusters of values at $2.5 \pm 0.4 \times 10^{21}$ y and $8 \pm 1 \times 10^{20}$ y. Mechanisms of Xe loss and Xe inheritance have both been suggested in attempts to explain this dichotomy. If some ^{130*}Xe was inherited from pre-existing minerals inferred ^{130}Te half-lives would be too short; if Xe losses occurred the values would be too long. Both are subject to experimental test.

Tellurides which yield "short" ^{130}Te half-life are the best candidates for inherited ^{130}Xe. The shortest, Kalgoorlie krennerite ($T_{\frac{1}{2}} = 3.3\times10^{20}$y, Bernatowicz et al, 1993) and Kochbulak native Te ($T_{\frac{1}{2}} \approx 3\times10^{20}$y, Meshik et al, 2002), however, yield mixing lines between unique radiogenic and trapped Xe components with no evidence for ^{130*}Xe excess.

The best samples to look for Xe losses are those that have "long" inferred ^{130}Te half-lives. Native Te from Good Hope and American mines, Colorado, with the longest ^{130}Te half-lives ever observed (2.99 and 3.22×10^{21} y, Bernatowicz et al, 1993), were neutron irradiated to convert ^{130}Te into ^{131*}Xe. The ^{130*}Xe/^{131*}Xe ratios were constant in all step-wise extrac-tions, even the lowest, which leads us to conclude that ^{130*}Xe has not been partially lost by diffusion (Meshik et al, 2002).

Neither Xe inheritance nor partial loss seems to be responsible for disagreement among measured ^{130}Te half-lives. However the constant ^{130*}Xe/^{131*}Xe observed in diffusion experiments on irradiated samples only indicates the absence of *partial* diffusion losses. *Total* loss of the ^{130*}Xe would be undetectable by this method. The long ^{130}Te half-lives were derived assuming that the Colorado Te samples were undisturbed since their formation 1.7 Ga ago. However recent thermochronological studies of the Colorado Front Range (Shaw et al, 1999) reveal several additional thermal episodes, one of them at ~1.4 Ga with associated peak temperatures of 550°C, well above melting point of native Te. Model Pb-Pb age (1.7 Ga) for Colorado samples seem not to have been affected by that event. Even a more gentle, ~300°C, thermal episode may cause complete loss of ^{130*}Xe that is difficult to detect. Evidence for this possibility is that the older samples tend to give longer ^{130}Te half-lives. Younger samples usually have better documented thermal history, and in that context, may provide the more reliable ^{130}Te half-life. Supported by NASA grant NAG594424.

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