Technetium-97 and *p*-radionuclides

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The *p*-nuclide ^{97}Tc decays to ^{97}Mo with a mean life of 3.8 Ma. Technetium-97 is absent from solar system material but it might have been alive when the first solids formed. Evidence for its presence in the early solar system would have profound implications for a variety of fields.

Of the four *p*-nuclides that could have been present in the early solar system but have now decayed below detection levels (^{97}Tc, ^{98}Tc, ^{92}Nb, and ^{146}Sm), ^{97}Tc has the shortest mean life. Thus, evidence for the presence of live ^{97}Tc would provide stringent constraints on the stochastic chemical evolution of the Galaxy. Technetium-97 could also be used to study the timing of metal-silicate segregation. Indeed, technetium is highly siderophile while molybdenum is moderately siderophile, giving rise to a large fractionation of the Tc/Mo ratio. Two recent studies [1,2] have questioned the timing of core formation inferred from the Hf/W chronometer. Both studies have suggested that the terrestrial core differentiated early, while ^{182}Hf was still alive. If evidence for live ^{97}Tc were found, then the timing of core formation could be constrained using the ^{97}Tc-^{97}Mo chronometer.

We have measured the molybdenum isotopic composition in iron meteorites [3] because some of these objects exhibit high Tc/Mo ratios due to differences in liquid/solid metal partition coefficients. After correction for the presence of nucleosynthetic anomalies [3,4], we could find no evidence of ^{97}Mo excess derived from decay of ^{97}Tc. Instead, we derive an upper-limit on the ^{97}Tc abundance at the time of solar system formation.

We have developed an open non-linear model of the chemical evolution of the Galaxy that allows prediction of the abundance of short-lived *p*-nuclides in the early solar system using stellar yields derived from detailed modelling of nucleosynthesis in supernovae [5]. It is concluded that the observed abundances of short-lived *p*-nuclides in the early solar system are consistent with nucleosynthesis in supernovae and reflect the continuous chemical evolution of the Galaxy. All extinct radioactivities were probably not synthetized by a single event in the molecular cloud where the sun was born.

References

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Magmatic fluids coexisting with felsic melts: An example from Rio Blanco rhyolite, Chile

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The existence and composition of aqueous fluids exsolved from felsic melts, although not well documented at present, is a matter of wide geological interest. Examples of primary magmatic fluids can be found in magmatic inclusions in quartz and feldspar phenocrysts from intrusive and extrusive rhyolites spatially associated with the Rio Blanco Cu-Mo deposit, Chile. The host rocks belong to the La Copa Volcanic complex (4.9-3.9 Ma), which was the final phase of volcanism at Rio Blanco. Several types of coexisting inclusions in phenocrysts represent a range of magmatic phases present at the time of crystallisation. These include glass melt inclusions with shrinkage bubble(s), inhomogeneous crystalline melt inclusions, consisting of felted masses of silicate crystals and interstitial aqueous fluid, and composite inclusions may contain glass, crystals and fluids in variable proportions (details in Davidson, & Kamenetsky (2001)). Fluid-rich phases occur as fluid-filled bubbles in composite inclusions, or as individual primary fluid inclusions. Bubbles are usually single phase and may be dark or clear in appearance with or without translucent crystals, and often coexist in the same inclusion. Thermometric experiments show that clear bubbles can be completely frozen, and final ice melting temperatures indicate salinities up to at least 15 wt% NaCl equiv. Dark bubbles either show no freezing behaviour, or only the formation of thin ice films.

The contention that fluid-rich bubbles in glass were the result of inhomogeneous trapping of aqueous phases, coexisting with silicate melt is supported by several observations. The existence of fluid-only magmatic inclusions implies an independent aqueous fluid phase in the magma. Phase ratios within composite inclusions containing fluid bubbles are variable, and composite inclusions contain too much aqueous fluid for it to have exsolved post-trapping. The elevated salinities of fluid bubbles also imply magmatic origin.

The droplets of primary magmatic aqueous liquid preserved in studied magmatic inclusions provide strong evidence for the existence of exsolved aqueous phases in felsic melts, and the opportunity to constrain the parameters of exsolution and compositions of immiscible phases.

References

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