Tungsten self-diffusion: Constraints on the core formation timescale

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We are conducting a series of W diffusion experiments to study the kinetics of isotope exchange between metal-silicate during planetary accretion and core formation. Knowing the W self-diffusivity is essential when trying to assign a meaningful age for the Hf-W chronometer. Our simple diffusion couple experiment provides constraints on the intrinsic mobility of W in silicate liquids, which is not complicated by the interdiffusion of chemical species. The experiment gives us a first order approximation of the W isotopic exchange and re-equilibration in a magma ocean scenario. Given the huge energies involved during the late giant impact stage of the planet formation, terrestrial magma ocean is an inescapable consequence. Very slow solid-state diffusion is unlikely applicable.

In our experiment we used natural basalt doped with isotopically enriched and normal WO_3. Cylinders of the isotopically distinct basalt are juxtaposed to form a simple diffusion couple and run in the multi-anvil apparatus. The resulting W-isotope diffusion profiles (Fig. 1) are analyzed by LA-ICP-MS. For example, the W self-diffusion coefficient (D*) at 3GPa and 1500ºC is $5X10^{-7}$ cm^2/s.

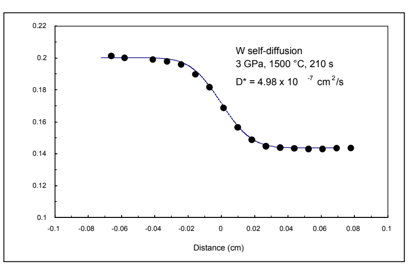

Figure 1. Isotopic profile for ^{183}W ($^{183}W/\Sigma W$) across the diffusion couple.

The mafic composition and the modest P and T in the experiment assure the determined W diffusivity is a minimum estimate. We assume the equilibration is rate-limited by diffusion in the silicate liquid. Assuming the D* given above and taking a reasonable estimate of viscosity for silicate liquids from the literature, we conclude that the core of the impactor, dispersed as small metallic droplets in the magma ocean, would have reached W isotopic equilibrium within the timescale of metal-silicate segregation.

Geochemistry of the granite intrusion in the Madurai block, South of Palghat – Cauvery shear zone

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The Southern Granulite Terrain lying south of the Palghat-Cauvery shear system, abound in a number of granite bodies that are younger to main 550 Ma granulite event exhibit high to Ultra-High Temperature (UHT) metamorphism. These post collisional granitoids thus preserve evidences for a prominent Pan African magmatic event.

Discussion

The granites belong to the 'A-type' as evidenced by field, petrological and geochemical studies and have intruded along prominent shear zones. The granulite lithologies comprises of garnet- cordierite- orthopyroxene- sillimanite- spinel- quartz ± sapphirine bearing pelitic and wollastonite-scapolite-clinopyroxene bearing calc-silicate associations. The temperatures of metamorphism are around 650° to 1050°C at pressures of 6-10 Kbars. It is significant that these associations are at the contacts of the pelites with the granite sheets, implying that the metamorphism took place at high pressure and temperatures.

Conclusion

In the Y-Nb-Zr/4 trilinear diagram, the granites plot in the field of granites derived from re-working of the deep continental crust or under-plated crust (charnokite/granultic lower crust).