Quantification of H in olivine: Direct calibration of FTIR and SIMS by ERDA

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Experimental studies show that varying the H content of olivine has a marked effect on rheology and electrical conductivity, such that the H content of olivine can be said to control tectonic processes and to affect the observable properties of the mantle [1,2]. In order to apply experimental results to the Earth, we need to be able to measure accurately the H content of olivines in experiments. Calibrations for the commonly used infrared (FTIR) and ion probe (SIMS) techniques rely on just a handful of truly independent measurements of natural olivines by ^{15}N nuclear reaction analysis [3]. Moreover, it has been suggested, on the basis of comparative SIMS measurements, that the infrared absorption coefficient (k) for OH stretching bands in high pressure olivines could be greater by as much as a factor of 3 than that derived from natural samples [4], implying that H contents have been underestimated in many experimental studies.

We used elastic recoil detection analysis (ERDA) to determine k for OH bands in Fo_{90} olivines with 240-2000 ppm H_2O, synthesised at 3-10 GPa in multianvil experiments that were optimised for growth of large, homogeneous crystals. On the basis of 20 ERDA and >200 FTIR analyses of olivines from 7 experiments, the H content (in ppm H_2O) is given by 0.120±0.008×total integral absorption, corresponding to an integral extinction coefficient of 45,000 L/(mol·cm^2), i.e. k is ~35% *smaller* than the value previously derived for natural olivines. This implies that the H contents of experimental olivines have in fact been generally *overestimated*.

The samples that were analysed using ERDA are used as SIMS standards, thereby providing a direct calibration that avoids the baseline uncertainties that are inherent to FTIR. Direct calibration of SIMS using high pressure experimental samples allows for improved high accuracy analysis at high spatial resolution.

[1] Hirth & Kohlstedt (1996) *EPSL* **144**, 93-108 [2] Karato (1990) *Nature* **347**, 272-273 [3] Bell *et al.* (2003) *JGR* **108**, 2105 [4] Kovács *et al.* (2010) *Am Min* **95**, 292-299

W-Os isotope systematics in IVB iron meteorites

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^{182}Hf-^{182}W dating implies contemporaneous condensation of the earliest solar system solids (CAIs) and magmatic differentiation of planetesimals (i.e., iron meteorite groups) [1]. IVB iron meteorites exhibit ε^{182}W (-3.56±0.1) lower than CAIs (ε^{182}W -3.28±0.2). The initial W isotope signature of CAIs may have been reset by metamorphism of chondrites [2] while IVB irons need to be corrected for thermal neutron capture due to galactic cosmic ray (GCR) exposure. Although GCR corrections have become more sophisticated, determining the true ^{182}W deficit remains problematic [3].

Using Os isotopes as *in situ* neutron dosimeters [4], we re-evaluated the degree of GCR modification of ε^{182}W. Our IVB ε^{182}W data is derived from a more complete sampling of the IVB group (including Iquique, Weaver, Kokomo), but using smaller samples than [4-5]. MC-ICP-MS measurements (NEPTUNE™) of W isotopes were performed on 10-20ng aliquots using an Apex™ introduction system and Jet Ni sampler and X skimmer cones. The reproducibility of ε^{182}W for NIST SRM 3163 is ±0.14ε (2σ, n=142) and ±0.32ε (2σ, n=19, 10-25ng) if a smaller, random standard population is considered to capture the analytical uncertainty expected from our IVB set. Since Tlacotepec has systematically lower ε^{182}W, the average ε^{182}W (-3.31±0.22, 2σ) of IVBs is calculated for n=9 samples, excluding Tlacotepec. Our IVB average ε^{182}W is more radiogenic than previously reported [1-3,5-6] but with larger analytical uncertainty. Importantly, our ε^{182}W IVB average is identical to the most recent CAI value [1].

By using Tlacotepec with its large GCR-induced ^{182}W-^{190}Os shift as an anchor point, the Os-W isotope data of this group can be projected towards ε^{190}Os of 0 [4] to yield a pre-irradiation ε^{182}W of -2.95. This ε^{182}W allows for ~4 Myr of accretion and planetesimal differentiation for IVBs and reconciles current models of solar system formation with the W isotope record. A follow-up higher-precision W-Os isotope study from the same digestions is underway.

[1] Kleine *et al.* (2009), *GCA* **73**, 5150–5188. [2] Humayun *et al.* (2007), GCA 71, 4609-4627. [3] Markowski *et al.* (2006), *EPSL* **250**, 104–115. [4] Huang & Humayun (2008), *LPSC XXXIX* (**1168**). [5] Qin *et al.* (2008), *EPSL* **273** 94-104. [6] Markowski *et al.* (2006), *EPSL* **242** 1-15.