Iron Isotope Fractionation Factors at High Pressure

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It has been hypothesized that iron isotopes can provide information on high pressure and temperature processes that occurred on Earth and other planetary bodies [1]. Previous work has focused on low pressure experiments [e.g. 2] or on reanalyzing previous ^{57}Fe vibrational density of states spectra determined by nuclear resonant inelastic X-ray scattering (NRIXS) [1]. However the applicability of these experiments and the reanalysis of NRIXS spectra have been questioned [3,4]. Here we present new high presure ^{57}Fe NRIXS spectra obtained at beamline 16 ID-D (HPCAT) of the Advanced Photon Source, Argonne National Laboratory in order to better understand the effect that pressure has on iron isotope fractionation. We will present the force constants and calculated beta factors for Fe in FeO, Fe_3C and FeS at several pressures.

We conducted experiments in a panaromic-type diamond anvil cell using 100% ^{57}Fe enriched samples. NRIXS spectra were collected by tuning the x-ray energy range within ± 120 to 180 meV around the ^{57}Fe nuclear transition energy. The spectra were analyzed using the PHOENIX program [5] to obtain the phonon density of states and the force constants. The iron isotope fractionation factors were then calculated using several methods and compared to previous results [3,6].

There are slight differences in the solutions depending on the method used to calculate the beta factors. However, the data for FeO at 5, 20, 25 and 40 GPa show a clear pressure dependence of the beta factor for Fe. We find that extreme pressure conditions do in fact have an effect on the iron isotope fractionation factors and should be considered in models used to understand planetary scale iron isotope ratios.

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