

Fe and Ni isotope fractionation in magmatic and non-magmatic iron meteorites

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The Widmanstätten pattern of iron meteorites forms due to subsolidus ingrowth of kamacite (α iron, bcc) out of taenite (γ iron, fcc) in the presence of P during cooling of the meteorite parent body in the early Solar System. Concentration profiles of Ni across lamellae serve as a tool to determine cooling rates. The mineral growth is accompanied by mass-dependent isotope fractionation of the constituting Fe and Ni. Thermodynamic considerations predict enrichment in the heavier isotopes in the kamacite phase at equilibrium. Formation temperatures can be extracted from the equilibrium isotope fractionation of adjusted mineral phases [1]. However, the Ni and Fe isotopic compositions in the Widmanstätten pattern are controlled by subsolidus diffusion kinetics. Isotope ratios of these two alloy-constituting elements are negatively correlated with less pronounced effects for δFe , a result of its higher concentration [2]. Being relatively well studied, the Fe-Ni isotope system is attractive to elucidate core formation stages. Magmatic iron meteorite groups exhibit element trends compatible with fractional crystallization, initiated by cooling of molten asteroid cores. Non-magmatic groups (IAB, IIE, IIICD) are believed to have formed through impact melting and as such experienced a different crystallization history potentially recorded in Fe and Ni isotope ratio profiles [3]. In this work, high precision multi-collector-ICP-MS analysis of the Fe and Ni isotopic composition for several magmatic and non-magmatic iron meteorites was performed. Samples were taken via micro-drilling with a 300 μm lateral resolution. The results of Fe and Ni isotope partitioning are in agreement with the theoretical predictions of Richter *et al.* [2]. The presented Fe and Ni isotopic compositions of iron meteorites are compared to those of terrestrial rocks, where mass-dependent isotope fractionation is governed by magmatic processes under superposition of equilibrium (*e.g.*, crystallochemistry) and kinetic (*e.g.*, diffusion) isotope fractionation controls [1, 2].

[1] Young *et al.* (2015), *Chem. Geol.* **395**, 176-195. [2] Richter *et al.* (2009), *Chem. Geol.* **258**, 92-103. [3] Goldstein *et al.* (2009), *Chemie der Erde* **69**, 293-325.