Investigation of Ni isotopic anomalies in carbonaceous chondrites at the mineral scale

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Nickel isotope has been the focus of many studies over the past several years because the decay of ^{60}Fe ($T_{1/2}$=2.62 Myr) to one of its isotope (^{60}Ni) can potentially be used as a chronometer to constrain the ages of the early solar system objects. In addition, other isotopes such as ^{62}Ni and ^{64}Ni have shown to be a powerful tool to investigate the nucleosynthetic sources of the materials that make up the solar system. Recently, high precision Ni isotopic data have been reported from a variety of meteorites [1-3], and through these studies the presence of small but important isotopic heterogeneities in bulk meteorites is now apparent. Here, we selected two carbonaceous chondrites Allende and Murchison to explore the possible existence of Ni isotopic heterogeneities at the mineralogical scale.

The powdered samples of Allende and Murchison were sequentially dissolved in acetic acid (L1), 0.2N HNO_3 (L2), 1N HCl (L3), 6N HCl (L4), and HF-HNO_3 mixture (L5). Ni was purified using the method modified from Yamakawa et al [4]. The isotopic composition was measured using a Neptune MC-ICPMS, with a typical sample precision of ~0.1ε and ~0.2ε for ε^{60}Ni and ε^{62}Ni, respectively (normalized to ^{61}Ni/^{58}Ni).

The whole rock samples of Allende and Murchison gave ε^{60}Ni and ε^{62}Ni values consistent with those reported previously [2, 3]. The L1 to L5 fractions of Allende showed ^{56}Fe/^{58}Ni ranging from 0.9 to 48. However, no obvious correlation with ε^{60}Ni was observed. Deviation in ε^{62}Ni from the whole rock value was also absent in these fractions. The leachates of Murchison measured so far also showed no evidence of isotopic variations in ε^{60}Ni and ε^{62}Ni beyond the level of sample precision. These observation imply that the major carriers of Ni in these meteorites had a uniform Ni isotopic signature, or the Ni isotopic heterogeneity that was originally present at the mineral scale was homogenized during the parent body processes.

[1] Steele *et al* (2011) *GCA*, **75**, 7906 [2] Steele *et al* (2012) *ApJ*, **758**, 59 [3] Tang *et al* (2012) *EPSL*, **359-360**, 248 [4] Yamakawa *et al* (2009) *Anal. Chem.,* **81**, 9787