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TITLE: Detecting Mantle Heterogeneity at a Grain Scale with Improvements in High Precision Neodymium Isotope (NdO+) Analysis

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ABSTRACT BODY: Recent advances in the analysis of Nd isotopes by thermal ionization mass spectrometry (TIMS) as an oxide[1,2] have led to significant improvements in our ability to measure small aliquots of Nd (e.g. 4 ng) to high levels of precision (10 ppm, 2 RSD). In one resulting application, the age precision achievable in garnet geochronology has been significantly improved, allowing the dating of multiple zones of an individual garnet to a resolution of ± 0.5 Ma [2]. More recently, the methods described in [1] have been further improved upon, allowing 400 pg loads of Nd to be run at 25-50 ppm (2 RSE) precision. The ability to precisely analyse sub-ng aliquots of Nd opens up a whole new range of possible applications for this method.

Chemical and isotopic heterogeneity in the Earth's mantle has been identified at a number of scales[3] [4]. In particular, Nd isotope heterogeneity in abyssal peridotites has been recorded at a cm to km scale, revealing refractory domains of mantle Nd that are not readily observable in the basalts that they produce[5]. Here we present the preliminary results of experiments to determine the viability of single-grain (sub-mg) clinopyroxene analyses of Nd isotope measurements, with the goal of applying this method to the search for Nd isotope heterogeneity in mantle rocks on a cm scale.

Optically pure clinopyroxene grains from a single peridotite xenolith from Kilbourne Hole, New Mexico[6] were hand-picked under a binocular microscope prior to purification for Nd isotope analyses using methods described in [1]. The internal reproducibility of unleached batches of 16, 8, 4 and 2 grains of clinopyroxene (<23 ppm, 2 RSE) is smaller than the degree of heterogeneity observed between the different populations of grains (>145 ppm). When single grains of clinopyroxene (0.4 - 1.2 mg) were leached in 1.5M HCl for 30 minutes at 80 degrees C and analysed, the degree of heterogeneity observed between grains was even greater (≤303 ppm) compared to the internal reproducibility of the measurements (<57 ppm, 2 sigma). This suggests that (i) a significant degree of Nd isotope heterogeneity is present at a 1 cm to 1 m scale at this locality; (ii) this heterogeneity is easily resolvable using the methods developed in [1]; (iii) when large aggregates of 10s to 100s of grains are used for Nd isotope analyses, the observation of small-scale heterogeneity may be lost as compositional differences are averaged out.

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