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Appendix
Analytical Methods

Two thin section of this pair meteorite were studied (GRA 06129,23 and GRA 06128,55) along with a sample mass of approximately 6 grams. Samples were initially inspected using backscattered electron imaging (BSE), from which false colored maps were created. These maps aided in the identification of major phases, namely plagioclases, olivine, orthopyroxene and clinopyroxene, as well as less abundant phases such as phosphates (apatite and merrillite), spinel, pentlandite, troilite and Fe,Ni metal. Following phase identification, quantitative point analyses were conducted on the phases of interest, using an accelerating voltage of 15 kV, a beam current of 20 nA and a ~1 μm spot size. Phosphate analyses were conducted using a defocused, 10 μm spot in order to minimize beam volatilization. Analyses were standardized using Taylor brand mineral and metal standards; ferric Fe was calculated using the equation of Droop (1987). Stoichiometric constraints used to determine the quality of the datasets, and detection limits were calculated at the 3δ level.

Major and trace element contents of GRA06129-128/129 were determined in duplicate. Approximately 1 g of GRA was powdered in a clean agate pestle and mortar. Two ~0.25 g aliquots were fused using a LiBO3 flux and analyzed using ICP-AES using the method described by Shafer et al. (2004). Two ~50 mg aliquots were dissolved using HF/HNO3 digestions and analyzed for trace elements following the procedure described by Neal (2001). The reference material BIR-1 was analyzed with both the major element and trace element analyses.

Oxygen isotope measurements were made on bulk material that was pre-cleaned with dilute HCl. 1-2 mg samples were fluorinated using BrF_5 as an oxidant, following the procedure described in Sharp (1990; 1995). O_2 gas generated from laser fluorination was cleaned by passage over a heated NaCl trap to remove any excess F_2 gas produced by breakdown of the BrF_5. The O_2 was adsorbed on two successive cold traps filled with 14X mol sieve to remove any traces of NF_3. Gore Mountain garnet and San Carlos olivine were used as standards, both plotting on the terrestrial fractionation line.

Initial sample processing was conducted in a clean laboratory at Lawrence Livermore National Laboratory. Several interior fragments weighing a total of ~185 mg were lightly crushed and leached for ~1 hour in 1N HCl at room temperature. The sample was then rinsed in ultrapure water and dried on a hotplate. All subsequent processing for the ^{26}Al-^{26}Mg isotopic analyses was conducted under clean laboratory conditions in the Isotope Cosmochemistry and Geochronology Laboratory (ICGL) in the School of Earth and Space Exploration at Arizona State University. A ~30 mg fraction from the whole rock sample was digested using a 3:1 mixture of HF:HNO_3, followed by concentrated nitric acid and

was finally brought into solution in 1N nitric acid. A ~5% aliquot was reserved for Al/Mg ratio measurements and ~3-4 mg equivalent aliquot was subjected to column chromatography for separating Mg for high precision Mg isotope ratio measurements. Mg isotope ratio analyses were conducted with a Thermo Neptune multicollector inductively coupled plasma mass spectrometer (MC-ICPMS) in the ICGL. Magnesium isotope ratios are expressed as per mil (‰) deviations from the mean Mg isotopic composition measured in the bracketing standards, where $\delta^{x}Mg = ([^{x}Mg/^{24}Mg]_{sample}/[^{x}Mg/^{24}Mg]_{standard} - 1) \times 10^{3}$, and x is either 25 or 26. Mass-independent excesses in ^{26}Mg from the decay of ^{26}Al ($\Delta^{26}Mg$) were calculated by normalizing all measured $^{26}Mg/^{24}Mg$ ratios to a $^{25}Mg/^{24}Mg$ ratio of 0.12663 using the exponential law and comparing the normalized $^{26}Mg/^{24}Mg$ ratio in the sample to the mean of the normalized $^{26}Mg/^{24}Mg$ ratios of the bracketing standards.

Droop, G.T.R. (1997) A general equation for estimating Fe^{3+} concentration in ferromagnesian silicates and oxides from microprobe analyses, using stoichiometric criteria. Mineralogical Magazine, 51. 431-435.

Neal C.R. (2001) The interior of the Moon: The presence of garnet in the primitive, deep lunar mantle. *J. Geophys. Res*. **106**, 27,865-27,885.

Shafer, J., **Neal C.R.,** and Castillo P. (2004) Compositional variability in lavas from the Ontong Java Plateau: Results from basalt clasts within the volcaniclastic sequence of Ocean Drilling Program Leg 192 Site 1184 In *Origin and Evolution of the Ontong Java Plateau* (Fitton J.G., Mahoney J.J., Wallace P.J., and Saunders A.D., eds.). *J. Geol. Soc. London Spec. Pub*. **229**, 333-351

Sharp Z. D. (1990) A laser-based microanalytical method for the *in situ* determination of oxygen isotope ratios of silicates and oxides. *Geochimica et Cosmochimica Acta* **54**, 1353-1357.

Sharp Z. D. (1995) Oxygen isotope geochemistry of the Al_2SiO_5 polymorphs. *American Journal of Science* **295**, 1058-1076.