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Mineralogy and Petrology of the Murrili Meteorite

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Introduction: Murrili (pronounced moo-RRil-y) is the 3rd meteorite recovered by the Desert Fireball Network (for details of the fall and orbit see [1]). It fell as a single, heart-shaped, 1.68 kg stone, measuring ~13 × 7 × 6 cm, and was entirely fusion crusted. Two small wedges and a thin slab were cut from the main mass for examination and analyses. Cut surfaces reveal pervasive alteration with rusty staining heterogeneously distributed in a wormy pattern. Chips and powders of both altered and unaltered sample were sent for oxygen isotope, bulk composition, cosmogenic nuclide, porosity/density, and Mössbauer analyses.

Analytical techniques: Mineral compositions were determined on a thick section with a JEOL 8530F electron microprobe (20kV, 20nA). Modal mineralogy was determined using a Tescan Integrated Mineral Analyzer. Oxygen isotopes were measured using the method described in [2]. Bulk trace and major element compositions were determined using the method described in [3,4]. Cosmogenic nuclides were measured as described in [5,6].

Results: Mössbauer and porosity/density results are reported elsewhere in this volume [7,8]. We focus here on the classification, mineralogy and a preliminary petrologic description of the meteorite.

Physical characteristics: Distinct chondrule (barred olivine, the remnants of porphyritic olivine, and possible radiating pyroxene) outlines, as well as large single mineral crystal clasts, are set in a relatively coarse-grained matrix. The section is dominated (all in vol%) by olivine (32%) and orthopyroxene (32%), with smaller amounts of plagioclase (7%), metal and Fe-oxides (10%) and sulfides (6.5%). Phosphate and chromite make up < 1% of the section. The overall texture of the sample indicates that the meteorite is a type 5 ordinary chondrite, which is consistent with the chromite [10] and OPX Wo values [11]. The average olivine, orthopyroxene and oxygen isotope compositions indicate the meteorite is chemically classified as an H chondrite [12,13]. The cosmic ray exposure (CRE) age of ~7 Ma coincides with the main CRE age cluster for H-chondrites. Cosmogenic nuclide ratios are compatible with a small pre-atmospheric size (few 10 cm).

Discussion: The overall texture of the sample indicates that the meteorite is a type 5 ordinary chondrite, which is consistent with the chromite [10] and OPX Wo values [11]. The average olivine, orthopyroxene and oxygen isotope compositions indicate the meteorite is chemically classified as an H chondrite [12,13]. The cosmic ray exposure (CRE) age of ~7 Ma coincides with the main CRE age cluster for H-chondrites. Cosmogenic nuclide ratios are compatible with a small pre-atmospheric size (few 10 cm).

Conclusions: The Murrili meteorite is classified as an H5 chondrite, based on olivine, orthopyroxene and oxygen isotope compositions, as well as textural features. It has a shock stage of S1. It is weathered due to exposure to the lake bed mud, but the alteration has not completely pervaded the rock.