Jungo 001, Jungo 002, Jungo 003, and Big Horn Mountains: Four New Chondrites from Nevada and Arizona which contain a variety of unusual petrographic features

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Introduction

Four chondritic finds from the Nevada and Arizona deserts in the southwestern United States were classified by the Cascadia Meteorite Laboratory. At a first glance, each uncut hand specimen appeared to be an unremarkable, fairly weathered chondrite. Upon closer examination, each had one or more unusual petrographic features.

Jungo 001 – Conjugate Fractures and a Complexly-Textured Olivine-Rich Clast

This 70.7 g meteorite was found in Humboldt County Nevada by Roger Dyer in October 2007. It is an L6 chondrite based on fayalite content (24.3±0.2), the paucity of well-defined chondrules, and the integration of chondrules and matrix [1]. Olivine displays undulose to mosaic extinction, with the latter predominant, only one shock vein and no melt pockets were observed, and feldspar is deformed but not isotropic, indicating a shock stage of S4 [2]. Approximately 40% of the opaques have been replaced, consistent with a weathering grade of W2 [3].

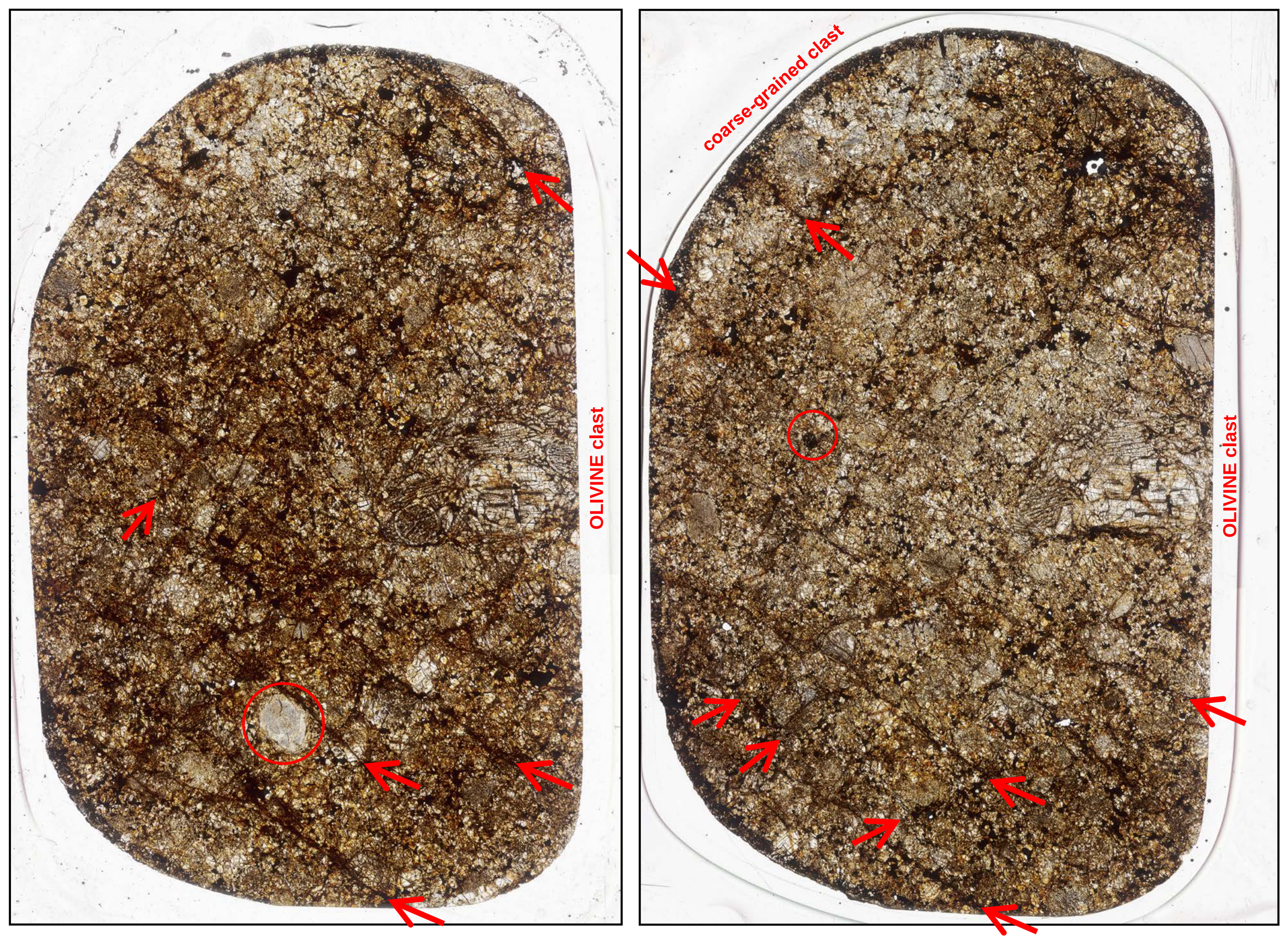

Figure 1. Two thin sections of Jungo 001. Arrows mark some of the fractures visible in both sections. A coarse-grained clast is visible in the upper left of the right-hand section. A coarse-grained olivine-rich clast is visible on the right edge of both sections . Two interesting chondrules are circled (one in each section) and discussed below.

Two thin sections adjacent to each other were prepared (Fig. 1). This meteorite is clearly a breccia with a number of coarse-grained clasts. One clast (~8-9 mm across and visible in both sections--see Fig. 2) consists almost entirely of olivine and contains one extremely large olivine grain (~3-4 mm across—see Fig. 3). The large olivine grain in surrounded by olivine bars and clasts with olivine grains (Fig. 2 right). A well-defined barred olivine chondrule and a partial barred olivine chondrule are also part of this clast (left side of Fig. 2 and Fig. 3). We speculate that this object is an olivine-rich impact-melt breccia clast.

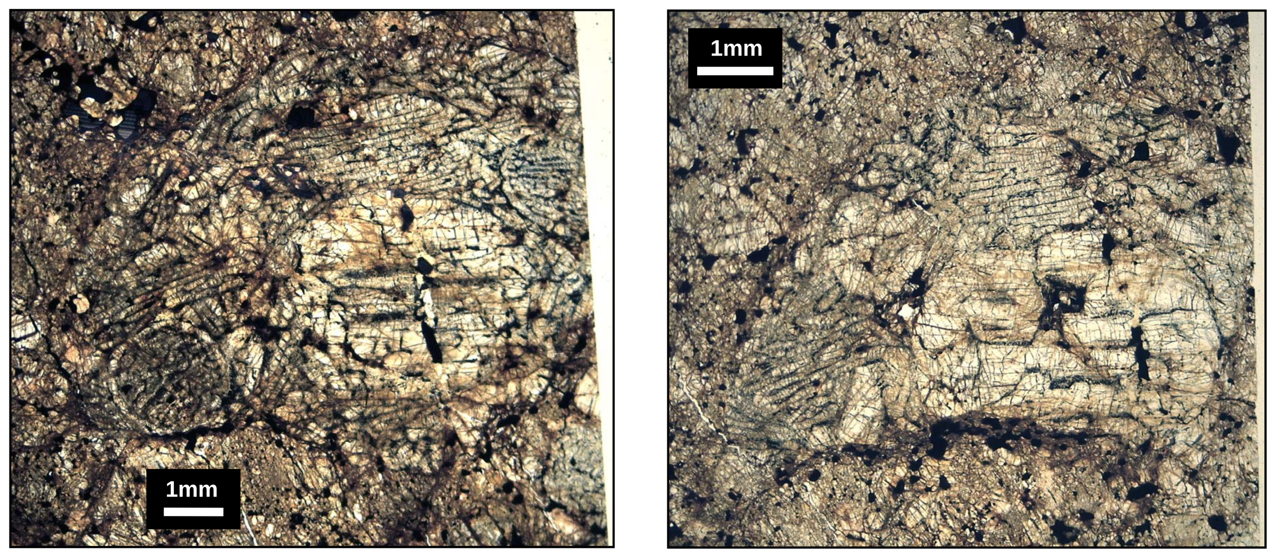

Figure 2. A coarse-grained olivine-rich clast as it appears in the two thin sections shown in Fig. 1. Images taken with a binocular microscope.

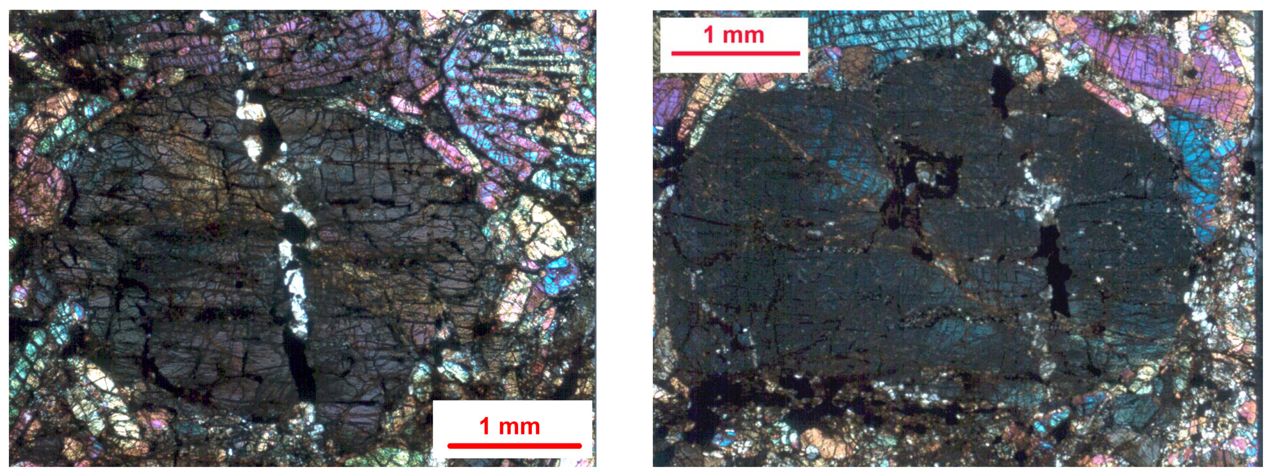

Figure 3. A view taken in cross-polarized light of the largest olivine grain in each section in the clast shown in Fig. 2. Each grain is optically continuous allowing for strain due to shock. A partial barred olivine chondrule is visible in the upper right of the image.

Both sections of Jungo 001 contain numerous chromite-plagioclase areas, which fill spaces between other grains. One exception is a single chromite-plagioclase rich chondrule shown in Fig. 4 and circled in the right-hand section of Fig. 1.

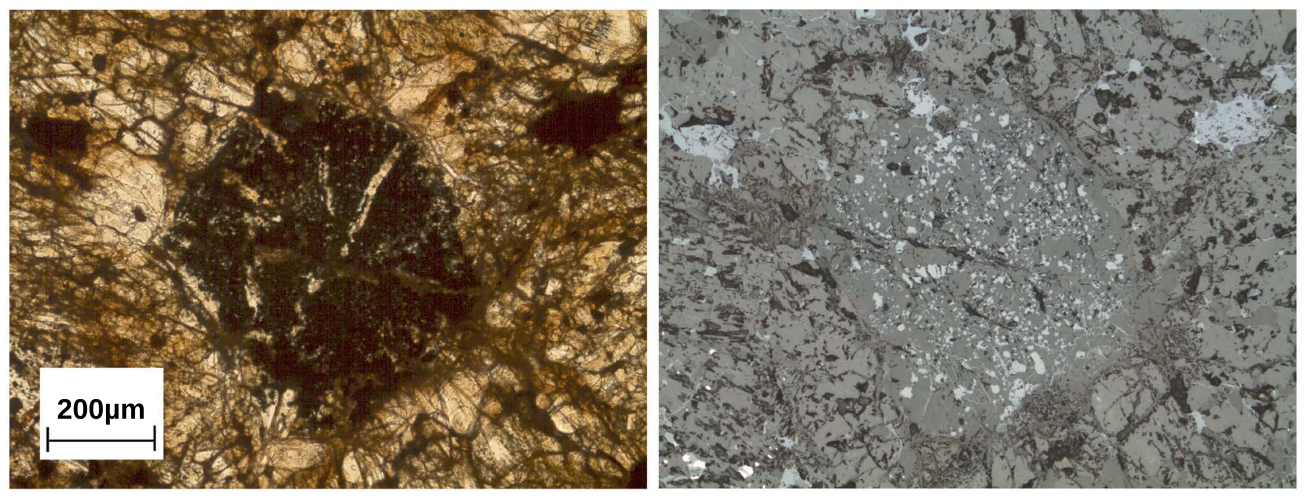

Figure 4. Transmitted light (left) and reflected light (right) photomicrographs of a chromite-plagioclase-rich chondrule in Jungo 001.

A light-colored chondrule is obvious in the left-hand thin section in Fig. 1, where it is circled. This chondrule displays a heavily recrystallized texture with a complex pattern of coarser and finer grains (see Fig. 5).

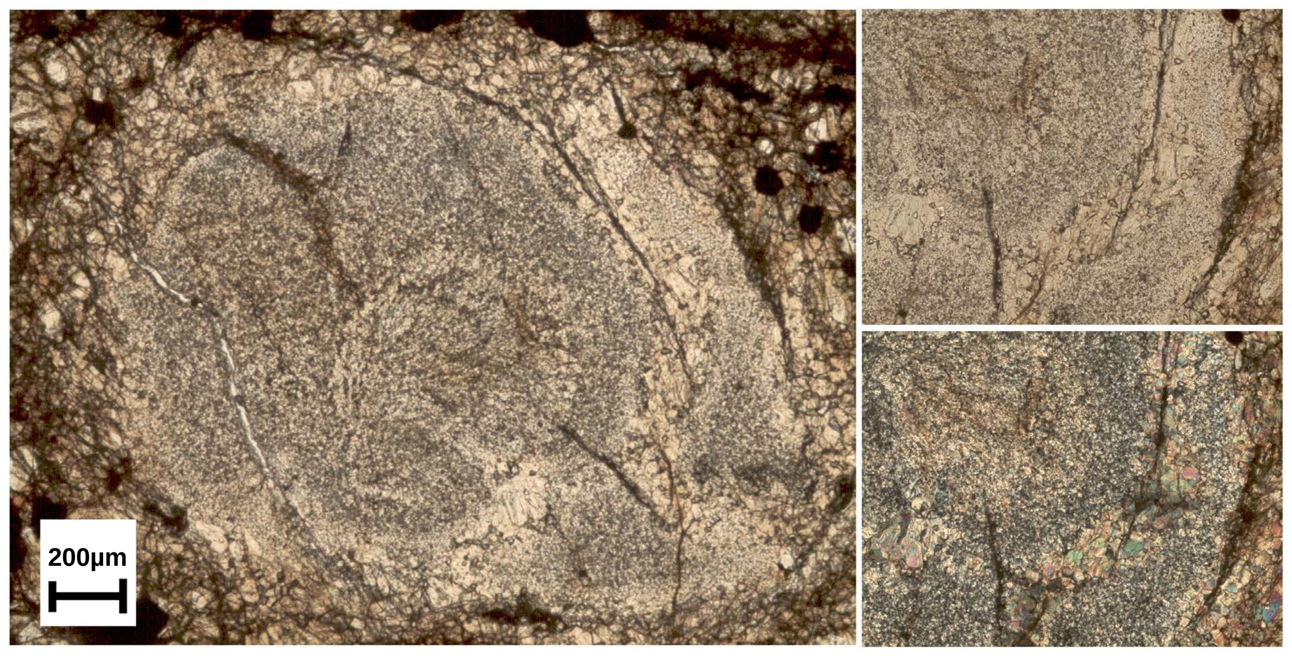

Figure 5. A light-colored chondrule displaying a recrystallized texture (circled in the section on the left side of Fig. 1). The image on the left is a transmitted light photomicrograph. On the right is an enlarged view of a portion of the chondrule in transmitted (top) and cross-porlarized (bottom) light.

Another interesting feature in Jungo 001 are the numerous fractures which cut across both thin sections (some are indicated by arrows in Fig. 1). There are two dominant sets of fractures, which meet at angles of approximately 60° and 120°. The fractures appear dark in transmitted light (Fig. 1 and Fig. 6), but for the most part do not contain opaque minerals or significant weathering products. Similar, but far less pervasive fractures were described in CAI rim layers in the Leoville (CV3) chondrite and attributed to shock [4]. The fractures clearly postdate the assembly of the meteorite, as they crosscut clasts, chondrules, and individual grains throughout the chondrite.

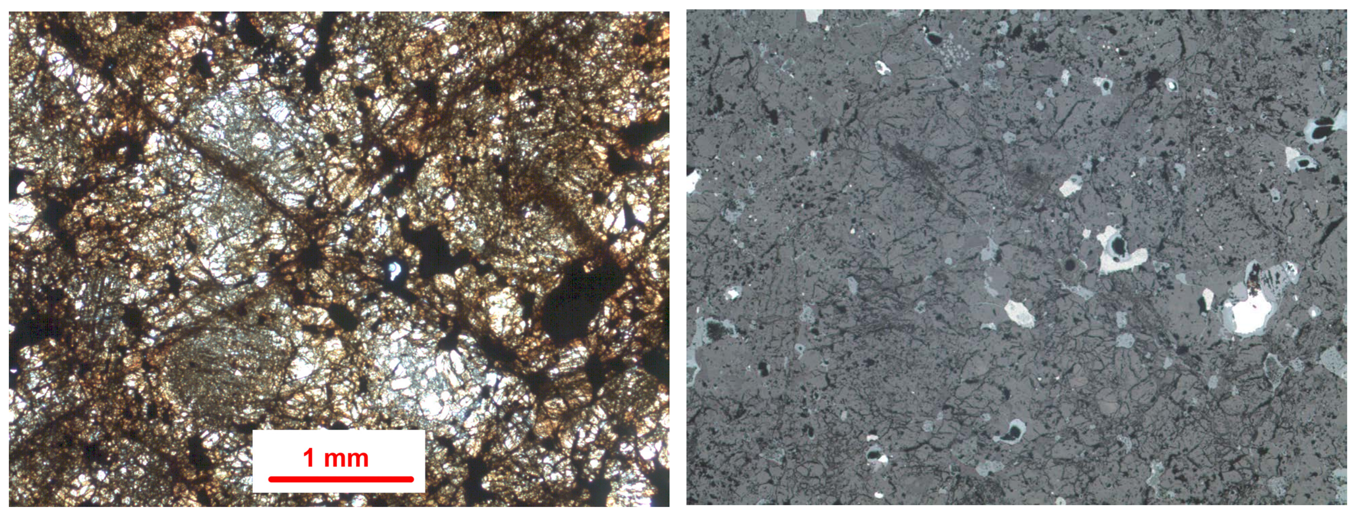

Figure 6. Transmitted light (left) and corresponding reflected light (right) photomicrographs showing two sets of fractures which meet in the center of the image. Additional fractures are visible in the lower left, upper left, and middle right edges of the left-hand image. It is clear from the reflected light image (right) that the fractures are neither opaque-rich shock veins nor weathering veins.

Conclusions

We have classified four new stones from Nevada and Arizona. None of these stones looked particularly notable in hand specimen. However, all four of these chondrites display interesting petrographic features. Jungo 001 in particular has experienced a complex history and is worth further study. Additionally, variable weathering of two obviously paired meteorites (Jungo 002 and Jungo 003) and of differing portions of Big Horn Mountains makes it clear that the amount of weathering visible in a meteorite thin section may not be a reliable means for pairing meteorites.

References:

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[4] Ruzicka A. and Boynton W. V. (1992). Microfaulting of CAI-rim layers and relationship to the fabric of the Leoville (CV3) chondrite. *LPS XXIII,* 1191–1192.

Jungo 002 and Jungo 003 – Silicate-bearing Troilite

Both of these meteorites were found by Roger Dyer in October 2007. Both were single stones, with Jungo 002 weighing 27.8g and Jungo 003 weighing 29.1g. Both chondrites are weathering grade W3 [3], with about 70% of the opaques in Jungo 002 and about 90% of the opaques in Jungo 003 having been replaced. Extensive weathering veins crosscut thin sections of both meteorites. Fayalite contents (19.3±0.4 for Jungo 002 and 19.1±0.5 for Jungo 003) indicate that both are H chondrites [1]. Chondrules are not well-defined and matrix is coarse-grained, with some feldspar grains exceeding 50µm in size, indicating that both meteorites are petrographic type 6 [1]. Olivine grains in both meteorites show undulose to mosaic extinction, with the latter predominant. The few large feldspar grains in each meteorite that were examined are heavily deformed, but not isotropic, indicating a shock stage of S4 [2]. Two small (<50µm across) melt pockets were seen in Jungo 002. None were observed in Jungo 003. Both meteorites contain distinctively-textured troilite grains, which is the main reason for believing these two stones to be paired. In both meteorites, troilite grains contain angular silicates, mostly concentrated near the edges of the grains (Fig. 7 and 8). A few of the troilite grains in Jungo 002 also contain irregularly-shaped metal grains (Fig. 7). It is possible that troilite in Jungo 003 also have contained metal, but most of the opaques in that meteorite were completely replaced by terrestrial weathering. Many of the troilite grains have irregular margins, suggesting that the troilite was fluid and molded itself around adjacent silicate grains.

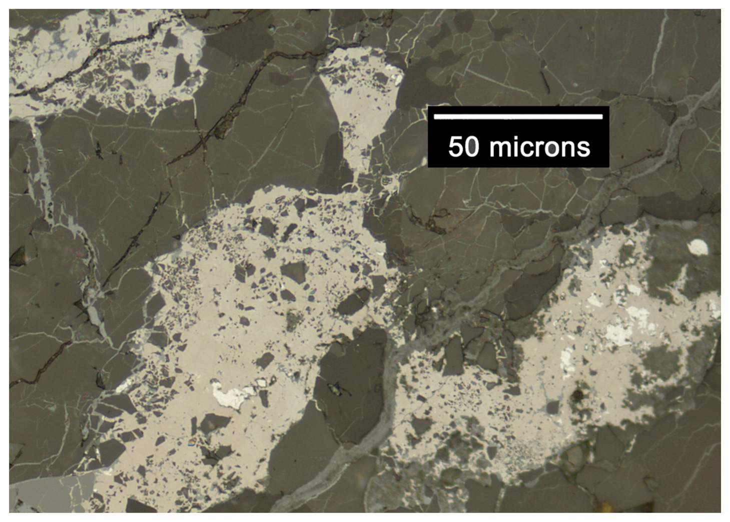
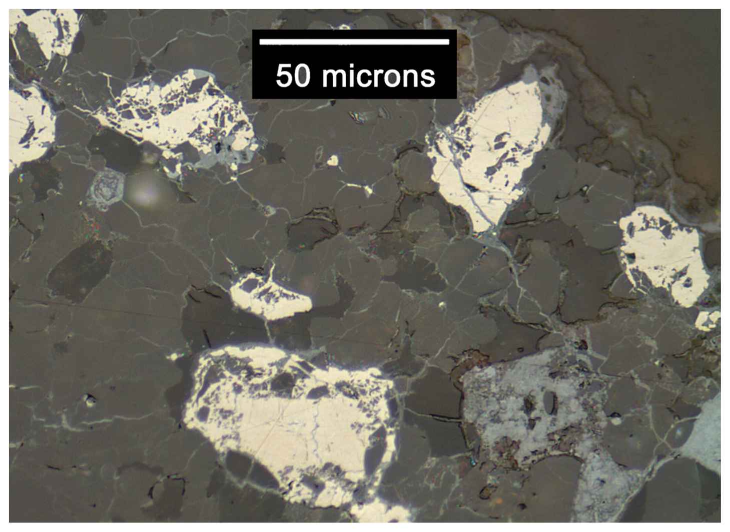


Figure 7. Left: Reflected light photomicrograph of troilite (pale yellow) in Jungo 002 containing both angular silicate grains (brown) and irregularly-shaped metal grains (white). Light gray veins are weathering products. The overall texture suggests that silicate fragments were embedded in fluidized troilite.

Figure 8. Right: Reflected light photomicrograph of troilite grains in Jungo 003, containing angular silicate grains. The blue-gray material in the lower right is an opaque mineral that has been replaced by terrestrial weathering products. The dark gray grains outside of the troilite are feldspars.



Big Horn Mountains – Bimodal Weathering

This 91.9g stone was found by Larry Sloan in Maricopa County, Arizona in March 2006. It was obvious immediately after cutting the stone that the meteorite had bimodal weathering, with an extremely weathered zone completely devoid of metal and troilite (weathering grade W4) occurring between two fractures that are roughly parallel to one exterior surface. Approximately 40% of the opaque minerals in the rest of the meteorite have been replaced, indicating a weathering grade of W2 [3]. The contact between the two regions is sharp in thin section. No region in thin section was observed that could be considered weathering grade 3. Olivine and pyroxene analyses (Fa=18.5±0.3; Fs=16.3±0.4) are consistent with an H-chondrite [1]. Fairly well-defined chondrules containing devitrified glass suggest this is a type 4 chondrite [1]. Olivine grains show sharp to slight undulatory extinction, with the latter predominant, consistent with a shock stage of S2 [2].

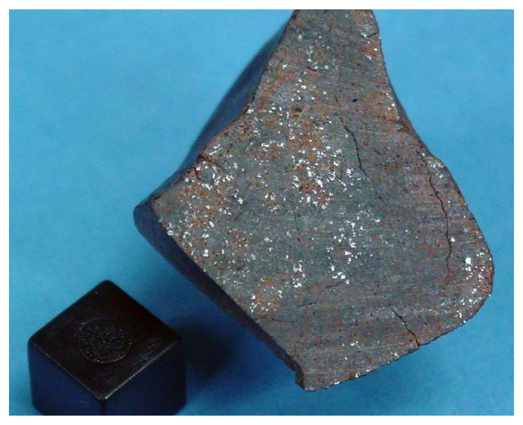


Figure 9. Left: Photograph showing the cut face of a piece of the Big Horn Mountains chondrite. A second cut surface is at the lower left near the 1 cm cube. All other edges are original exterior surfaces. Below left: Reflected light photomicrograph of an area in the less weathered portion of the meteorite. Metal is white, troilite is gold, weathering products/ oxides are blue-grey, and silicate minerals are gray. Below right: Reflected light photomicrograph of a region in the heavily weathered area.