**LEW88516: A NEW SHERGOTTITE FROM ANTARCTICA.** M.M. Lindstrom¹, D.W. Mittlefehldt², A.H. Treiman¹, S.J. Wentworth², J.L. Gooding¹, R.V. Morris¹, L.P. Keller¹, and G.A. McKay¹, 1) NASA Johnson Space Center, Houston, TX 77058; 2) Lockheed ESC, Houston, TX 77058.

**Introduction.** The SNC meteorites are a group of rare meteorites that appear to have come from a planetary rather than asteroidal parent body, probably from Mars. Recently LEW88516, a 13 g stone from Antarctica, was classified as a shergottite [1], the ninth member of the SNC group. We report here the preliminary results of a coordinated petrologic, mineralogic and bulk compositional study of LEW88516 aimed at evaluating the igneous petrogenesis and subsequent shock metamorphism and weathering of the meteorite.

**Petrography.** In thin section LEW88516 is substantially identical to ALHA77005 [2,3,4], as noted by [1]. LEW88516 consists of approximately equal proportions of olivine and pyroxene (grain diameter to 2 mm), with lesser chromite, maskelynite (shocked plagioclase), ilmenite, and whitlockite. In part of the thin section, euhedra of olivine and spinel are enclosed in large (mm-sized) pigeonite oikocrysts. Elsewhere, the texture is more equigranular, consisting of olivine subhedra with anhedral pyroxenes and maskelynite. All olivines are pleochroic from clear to variable intensities of brown. Commonly, the pleochroism is strongest along fractures, where it is associated with minute opaque spots. Other olivines have alternating darker and lighter pleochroic patches in a "perthitic" texture. Magmatic inclusions in olivine are like those in olivine in ALHA77005 [3,4]. Magmatic inclusions in pyroxene are like those in Shergotty [5], and contain amphibole(?). LEW88516 is cut by veins of glass and vitrophyre. Some thin cracks contain brown vesicular glass, which physically connects with larger vitrophyric veins. The vitrophyre consists of dendritic olivine crystals, olivine spherulites, and euclidean oxide grains in transparent glass. The veinlets contain fragments of intensely mosaicked pyroxene and olivine, identical to the rock adjacent to the veinlets. Commonly, olivine dendrites have grown perpendicular to the vein edges and to surfaces of included rock fragments. The vitrophyre also contains common vesicles, into which project olivine dendrites.

Shock effects are ubiquitous and extreme, including the presence of: maskelynite, vitrophyres of olivine and plagioclase compositions, mosaicked olivine and pyroxene, and pleochroic brown "staining" of olivine. Adjacent to the vitrophyre veinlets, mosaicism is intense and all trace of original crystal orientation may be lost.

An untreated whole-rock chip containing fusion crust was examined by scanning electron microscopy (SEM) and energy-dispersive X-ray spectrometry (EDS), including direct analysis for carbon and oxygen. The fusion crust appears generally clean and uncontaminated but is definitely weathered. Fractures and vugs in fusion crust are filled with ultrafine-grained (< 1 micrometer size) sulfates and aluminosilicate clays resembling those previously documented for Antarctic achondrites [6]; carbonates are either absent or rare. Compared with other Antarctic weathering products, those in LEW88516 are distinguished by a separate Na-rich sulfate (crystal system not yet known). Monoclinic habits suggest that the Ca-sulfate is gypsum while the incipient sheet-like partings and elemental compositions of the clays are consistent with smectites or illites. Based on superposition on fusion crust, the sulfates and clays are clearly of terrestrial origin. Their depth of penetration into the meteorite's interior is not yet known. In at least one case, however, separate grains of Ca- and Na-sulfate occur along a fracture at a few tens of micrometers below fusion crust. Nonetheless, the occurrence of such weathering products in Antarctic shergottites is well known from previous work [6, 7] and should not prohibit further detailed studies of LEW88516. Trace-element and isotopic analyses must be prepared to accommodate the fact that aqueous alteration of Antarctic origin has affected the meteorite to some degree. Further SEM/EDS work in progress will determine whether products of pre-terrestrial (shergottite parent body) aqueous alteration also occur in LEW88516.

**Mossbauer Spectroscopy.** The Mossbauer spectrum of a whole-rock powder of LEW88516 is characterized by two doublets resulting from ferrous iron in pyroxene (IS = 1.15 mm/s; QS = 2.09 mm/s) and olivine (IS = 1.15 mm/s; QS = 2.90 mm/s). The percentage spectral area resulting from olivine is 63%, so that most of the ferrous iron is associated with that phase. There is no evidence for either ilmenite or magnetite above the 2% detection limit. Because of overlapping pyroxene lines and potential low abundance of ferric iron, it will be necessary to obtain a Mossbauer spectrum of a pure olivine separate to determine if there is ferric iron associated with olivine similar to that in ALHA77005 [8].

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**Bulk Composition.** We were allocated two splits of LEW88516; 100 mg of homogenized whole-rock powder and 20 mg of glass. We analyzed the glass and 2 subsamples of the powder by INAA. At present only preliminary results, based on two short count sets, are available. Final data will include additional elements and provide more precise analyses of current elements. Major element analyses will also be determined by both modal recombination and chemical analysis. Existing data show that the two powder samples are essentially identical, while the glass is enriched by about a factor of two in incompatible elements (except K). Comparison to the average compositions of SNC meteorites [9] shows that LEW88516 is very similar to ALHA77005 in composition and distinct from the other SNC meteorites. LEW88516 analyses are plotted normalized to average ALHA77005 [9] in Figure 1. The whole-rock powders are generally within one sigma analytical uncertainties of the ALHA77005 average, except for a few well-determined elements (Na, Sc, Cr) which differ by only 10-20% from the other shergottite. There is a hint that LEW88516 is slightly enriched in plagioclase and depleted in mafic minerals relative to ALHA77005, but more complete analyses are required to evaluate this. The glass is markedly enriched in incompatible elements and may also show LREE enrichment. Glass petrography indicates that it is produced by shock. The fact that it is enriched in incompatible elements suggests that melting may have taken place along grain boundaries and preferentially incorporated minerals rich in late-stage incompatible elements.

**Discussion.** All aspects of the petrography and bulk composition of LEW88516 are remarkably similar to those of ALHA77005. The 20% maximum deviation in LEW88516 whole rock composition from the average ALHA77005 composition is only slightly greater than the 10% variation in composition observed in different splits of ALHA77005. These 10-20% variations in composition are not unusual for analyses of separate samples of a coarse-grained igneous rock. ALHA77005 is an unusual meteorite, a feldspathic hartzburgite that is closely related to the shergottites [2,9]. The two rocks are so similar, and so unusual, that we would certainly consider them to be paired meteorites from the same fall, if they had not been collected at locations about 500 miles apart! Studies of their exposure histories and terrestrial ages (currently being done by other investigators) are essential to evaluate whether the two meteorites might be related to the same fall. If exposure histories are consistent with pairing, we will evaluate mechanisms for producing widely dispersed fragments of a single meteorite. These might include disintegration high in the atmosphere, or transportation by divergent iceflows, or even deposition at different times by a meteorite stream. If LEW88516 and ALHA77005 are distinct meteorites, one would conclude that this cumulate shergottite is not so unusual afterall.


**Figure 1.** LEW88516 normalized to mean ALHA77005 [9].