LEWIS CLIFF 87057: A NEW METAL-RICH E3 CHONDRITE WITH SIMILARITIES TO MT. EGERTON, SHALLOWATER AND HAPPY CANYON.

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The Antarctic meteorites LEW87057, LEW87220, LEW87223, LEW87234, LEW87237, and LEW87285 were described as paired E3 chondrites by Brian Mason (*Antarctic Meteorite Newsletters*, 12(1) and 15(1,2)). LEW87223 is texturally unusual, containing abundant chondrules and jagged troilite grains which are enclosed in metal. Our INAA data show that the siderophile element abundance in two splits of LEW87223 are higher than the EH range, while chalcophile elements (Cr excepted) are highly depleted. Mineral compositions are unlike those normally found in EH or EL chondrites or aubites, and in some respects resemble those of several anomalous enstatite meteorites such as Shallowater, Mt. Egerton and Happy Canyon. The bulk and mineral compositions are consistent with the addition of EL chondrite metal to an EL3 chondrite with the removal of sulfides other than troilite which is now Cr-rich. We suggest that this meteorite is an EL3 chondrite into which metal was introduced and sulfides redistributed during an event involving impact melting and brecciation.

INTRODUCTION

Enstatite meteorites consist of the EH and EL classes (which are chondritic in composition but with complex and poorly understood thermal histories)[1,2], the igneous aubrites[3,4] the Mt. Egerton stony-iron[5], the Horse Creek iron[6], the metal-rich aubrite Shallowater and a number of impact melts such as Happy Canyon (EL6)[7] and Ilafegh 009 (EL6)[8,9]. They probably originated on a number of distinct parent-bodies[7]. Shallowater, unlike other aubrites, is unbrecciated, metal-bearing (9 wt%), diopside-free, and shows a positive Eu anomaly[10]. It probably experienced a complex cooling history associated with impact mixing and repeated break-up[10]. Mt. Egerton consists of Fe-free, low-Ca pyroxene and Si-bearing metal similar to enstatite chondrites, but in very different proportions probably also due to mixing during impact[5]. Here, we present the results of our study of LEW87223 (part of the LEW87057 pairing group[11]), another unusual enstatite meteorite which is a metal-rich E3 chondrite in some respects similar to the unusual enstatite meteorites.

RESULTS

Mineralogy and petrography. The LEW87223 hand-specimen is highly weathered although our thin section looked fresh. It contains a closely-packed aggregate of fractured and otherwise altered chondrules surrounded by abundant metal, which encloses large masses of irregular-shaped troilite. A modal analysis of a small thin section (~0.7 x 0.5 cm, 509 points) shows clinoenstatite (61wt%), metal (23%), sulfides (12%) and other phases (4%). By comparison, EH and EL chondrites are typically 22 and 19 wt% metal, and 11 and 8.0 wt% sulfide, respectively[12]. A small xenolith of plagioclase was also observed in our section (LEW87223, 18).

Bulk chemistry. Using our previous INAA methods[13], we analyzed two splits (150 mg and 100 mg) of LEW87223 in two separate irradiations (Fig.1). While the Fe/Mg ratio (1.2) corresponds to the normal EH value[13]; Ir, Ni and Co are much higher than the EH range; chalcophiles are much lower than the EH and EL ranges (although Cr is less depleted than the others); Al, Sc, Ca, V and Mg are intermediate between EH and EL values. The Ni/Ir weight ratio (23.9), which is an important parameter for distinguishing EH and EL chondrites, is lower than EH chondrite (31.0) and comparable to EL (24.8) and Shallowater (24.5)[10,14]. Like Shallowater and Mt. Egerton, the REE display a strong Eu enrichment, although our REE data are preliminary[10,15]. While 10 other E chondrites analyzed in the same two irradiations had compositions similar to EH or EL group averages, the composition of LEW87223 corresponds to no known enstatite meteorite class.

Mineral chemistry. The mineral compositions of LEW87223 also defy simple assignment to the EH or EL class. Like EL chondrites, LEW87223 contains alabandite but it is unusually Fe-rich (42 %FeS), Si in the kamacite and Ni in the metal are in the EL3 range, phosphide compositions are in the EH5,6 range, and Cr and Ti in the troilite have much higher values than typical of the EH and EL classes and resemble Shallowater, Mt. Egerton and Happy Canyon (Fig.2)[3,4]. The CaO in enstatite is intermediate to EH and EL chondrites.

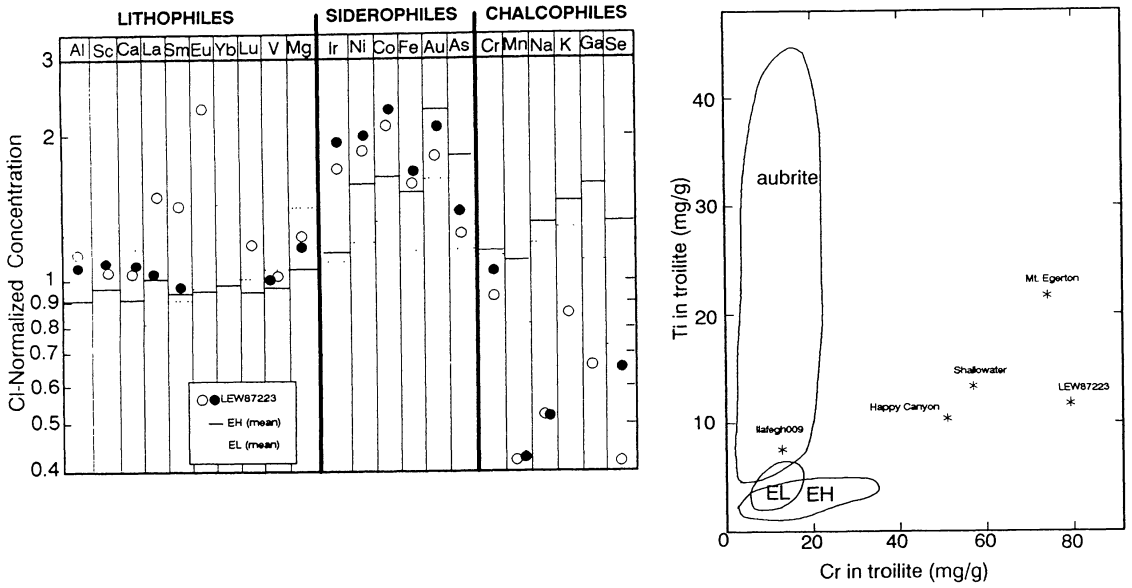

Fig. 1. (Left) CI-normalized concentration ratios for two splits of LEW87223 analyzed by INAA. The data suggest that the meteorite is an EL chondrite to which metal has been added and sulfides, other than Cr-bearing troilite, were removed.

Fig. 2. (Right) Titanium and Cr concentrations in the troilite of enstatite meteorites. Like Shallowater, Happy Canyon and Mt. Egerton, troilite in LEW87223 has high concentrations of these minor elements.

DISCUSSION

In terms of bulk composition LEW87223 is highly anomalous. These compositional properties are not due to weathering (which might leach Na and K but could not increase siderophiles while lowering lithophiles) or sample heterogeneity, which produces much smaller effects. The bulk composition can be explained by the addition of about 12% metal with EL proportions of siderophiles to starting material of EL composition, with the removal of the sulfides, other than troilite, to explain the depletion in chalcophiles. At the same time, the Cr content of the FeS was increased and the FeS content of the residual alabandite was increased. A positive Eu anomaly was produced, although experimental details of how REE behave in sulfide systems is not available; REE are known to be located in the sulfides in E chondrites[16]. The unusual sulfide-metal structures were presumably produced, and the xenolith introduced, by this process. The meteorite may be described as a metal-rich EL3 chondrite showing several signs of an igneous event, such as the Eu anomaly, the low abundance of sulfides other than troilite and the metal-sulfide structures. Mineral compositions are also highly unusual and unlike the EH or EL group. They most closely resemble those of Shallowater, Mt. Egerton and Happy Canyon. We suggest that LEW87223 is an EL3 chondrite to which considerable metal and the xenolith were added by impact and brecciation which was accompanied by a small amount of partial melting.

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