GEOCHEMISTRY OF LEW87051 AND COMPARISON OF THE ANGRITES; David W. Mittlefehldt, Lockheed ESC, C23, 2400 Nasa Rd 1, Houston, TX 77058, and Marilyn M. Lindstrom, SN2, NASA/Johnson Space Center, Houston, TX 77058.

We have continued our studies on the origin of angrites by performing INAA and electron microprobe-fused bead analysis on LEW87051; the third member of this achondrite group. Our investigation is part of extensive consortium efforts organized by G. McKay. Previous petrological work on LEW86010 and Angra dos Reis suggested that these meteorites possibly represent liquid compositions (1,2) although the geochemistry of the angrites (3) and other petrological studies (4) suggested that substantial cumulus material might be present. One important question we hoped to resolve with LEW87051 is whether this third angrite represents a quenched liquid composition or is a cumulate.

LEW87051 is the smallest member of the angrite trio. The recovered sample was a completely fusion-crusted individual 0.6 grams in weight (5). We received a ~22 mg split from 122 mg of coarsely crushed and homogenized material. About 13 mg of material was used for INAA and the remainder was finely ground and fused to glass for major element analysis by electron microprobe. After counting was complete, the INAA sample was transferred to M.E. Lipschutz for further activation and RNAA.

Like the other angrites, LEW87051 is highly depleted in Na with a CI normalized abundance of 0.035 and has a high FeO/MnO ratio of ~84. For comparison, the CI normalized Na abundances for LEW86010 and Angra dos Reis are 0.032 and 0.045 respectively, and their FeO/MnO ratios are 89 and 94 (3). LEW87051 has fractionated Ca/Al (~1.4x CI) and Ti/Al (~1.8x CI) ratios similar to those of LEW86010 (~1.6x and ~1.8x CI) and substantially less than those of Angra dos Reis (~3.1x and ~5.0x CI). The Mg/Si ratio for LEW87051 (0.66x CI) is considerably higher than the ratios for LEW86010 and Angra dos Reis (0.24x and 0.20x CI). The high Mg/Si ratio of LEW87051 is compatible with petrographic observation of abundant olivine phenocrysts in this rock that might indicate olivine accumulation (6). The mg# of LEW87051 (64) is higher than that of LEW86010 (41) but slightly less than for Angra dos Reis (67) (3).

Unlike the other angrites, LEW87051 shows a flat REE pattern with much lower REE abundances (Fig. 1). The LREE depletions observed in LEW86010 and especially Angra dos Reis (3) are absent in LEW87051. The REE pattern for LEW87051 is very similar to typical basaltic eucrites, such as Juvinas (Fig. 1). Figure 2 shows the refractory element abundances in the angrites normalized to mean Juvinas; an example of melts formed by low pressure processes on asteroids. It is apparent from Fig. 2 that LEW87051 is similar to LEW86010, and that Angra dos Reis is the odd man out of the angrite trio. LEW87051 exhibits the least fractionated refractory element pattern of any of the angrites (Figs. 1, 2). Depletions in Al, Th and Ta, and enrichments in Sc and Ti relative to Juvinas are apparent (Fig. 2). The overall lower trace element abundances in LEW87051 compared to LEW86010 may be due to accumulation of olivine phenocrysts in LEW87051 causing dilution of the trace element content. We have attempted to correct for this by comparing the normative mineralogies of the two samples and correcting the LEW87051 data for excess olivine. The line labeled "LEW87 (-ol)" shows the LEW87051 data corrected for dilution by a calculated 30% excess olivine. The olivine corrected data are still at lower abundance than are the LEW86010 data and indicate that LEW87051 derives from a more primitive melt than does LEW86010.

The quench texture (6) and the relatively unfractionated trace element pattern of LEW87051 strongly indicate that it represents a liquid composition, perhaps with moderate olivine accumulation (6). The overall

similarity in trace element pattern between LEW87051 and LEW86010 supports earlier suggestions that LEW86010 represents a liquid composition and is not a cumulate rock (1). The trace and major element data permit LEW87051 and LEW86010 to be genetically related melts, either as two members of a fractionation sequence from a common parent melt, or as partial melts from very similar source regions. The high olivine content and Mg/Si ratio suggests that LEW87051 may be a more primitive melt than LEW86010. The flat REE pattern shown by LEW87051 (Fig. 1) suggests that olivine is the major residual phase in the source region for this melt; consistent with the petrologic information (6). However, LEW87051 shows fractionated Ca/Al and Ti/Al ratios, and the aforementioned depletions in Ta and Th. The high Ca/Al and Ti/Al are likely due to depletion of Al (Fig. 2) and suggest that the melt equilibrated with an aluminous phase, perhaps spinel. The depletions in Th and Ta are not understood at present. Potentially, a melt similar to LEW87051 could evolve to a melt like LEW86010 via fractionation of olivine. Detailed petrologic experiments are required to evaluate this scenario. By contrast, the trace element pattern exhibited by Angra dos Reis is difficult to relate to either of the LEW meteorites. Angra dos Reis appears to be a more distant relation of the LEW samples, and we cannot state whether it is a cumulate or a melt.

References: 1. McKay et al. (1989) LPS XX, 675; 2. Treiman (1989) PLPSC 19th, 443; 3. Mittlefehldt et al. (1989) LPS XX, 701; 4. Prinz et al. (1977) EPSL 35, 317; 5. Antarctic Meteorite Newsletter (1989) 12(1), p. 15; 6. McKay et al. (1990) LPS XXI, somewhere in this volume.

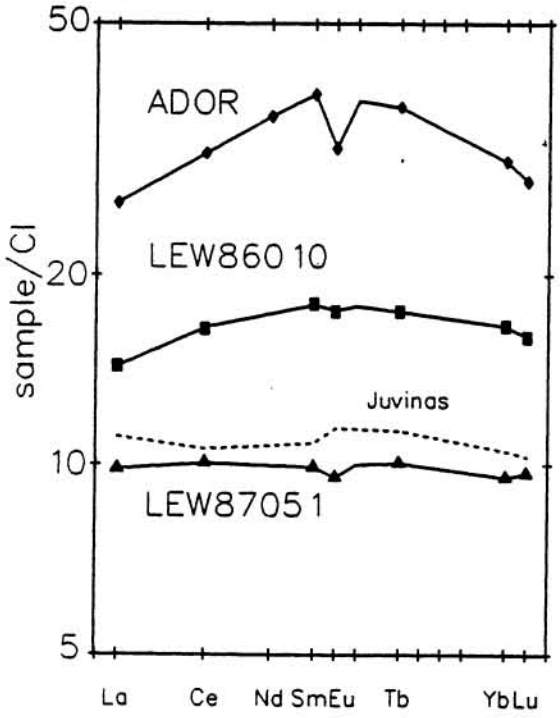

Figure 1. REE data for the angrites normalized to CI. Data for mean Juvinas are shown for comparison.

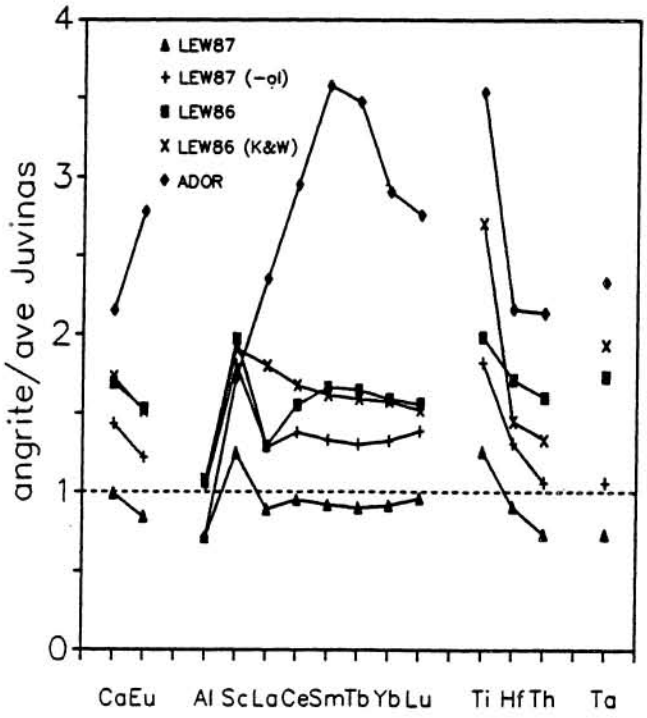

Figure 2. Refractory elements normalized to mean Juvinas plotted by increasing charge and in order of atomic number. LEW86 (K&W) are the data of Kallemeyn and Warren (1989) LPS XX, 496.