RARE EARTH ELEMENTS (REE) IN THE UNIQUE ACHONDRITE LEW 86010; Ghislaine Crozaz and Laura L. Lundberg, Department of Earth and Planetary Sciences and McDonnell Center for the Space Sciences, Washington University, St. Louis, MO 63130 and Gordon McKay, SN4, NASA Johnson Space Center, Houston, TX 77058.

The Antarctic meteorite LEW 86010 was described by Mason [1] as a unique achondrite. Its major minerals, present in subequal amounts, are pyroxene, olivine and plagioclase; accessory minerals include kirschsteinite, merrillite, troilite, hercynite and celsian. The mineral compositions of LEW 86010 are similar to those of the ultramafic pyroxenite Angra dos Reis (ADOR) (which in contrast, however, contains only minor olivine and very rare plagioclase). Since LEW 86010 has a weight of only 6.9 g, we were asked to make a preliminary ion probe investigation of this meteorite; the results, as well as results of similar measurements on the ADOR Ca-rich achondrite, are presented here.

REE and selected trace element concentrations were measured in individual grains of pyroxene, olivine, kirschsteinite, plagioclase and merrillite from LEW 86010. The REE results are summarized in Fig. 1.

Merrillite - As expected, REE are most concentrated in merrillite, which is found only in one area of the thin section. Results for five grains are identical within errors. The REE pattern shows a LREE enrichment (La ~ 3,300 x CI, Tm ~ 100 x CI, Yb and Lu are too low to be measured reliably) and a small negative Eu anomaly (Eu/Eu* = 0.6). Concentrations in LEW 86010 are higher than in ADOR merrillite and the REE pattern is steeper (Fig. 2).

Pyroxene - In distinction to ADOR pyroxene, LEW 86010 pyroxene is zoned. Great care was taken to analyze 8 spots that cover the range of available compositions. The average of these 8 measurements is shown in Fig. 1, the extreme REE patterns observed in pyroxene are shown in Fig. 3 and a comparison of average patterns in ADOR and LEW 86010 is presented in Fig. 2. Ce concentrations range over a factor of 10 and increase with FeO/FeO+MgO (Fig. 4). The Ce/Ho and Ce/Y ratios also increase with this index of crystallization. On the average, REE concentrations are lower in LEW 86010 pyroxene than in ADOR pyroxene; the REE pattern is not as flat and the negative Eu anomaly is more pronounced. Ca does not vary with increasing FeO/FeO+MgO but Sc and Cr decrease and Al, Ti and Zr increase.

Olivine and Kirschsteinite (Ca-olivine) - These two minerals are intimately associated in LEW 86010 (exsolution lamellae of each are found in the other); the olivine is unusually rich in CaO (~ 2% vs ~ 29% in kirschsteinite). REE concentrations are lower in the "normal" olivine than in kirschsteinite (Fig. 1); REE patterns in these two minerals show an increase from LREE to HREE with a small negative Eu anomaly. Ce concentrations differ by more than a factor of 10 and Ho concentrations by ~ 2.5. The results are consistent with the limited INAA data available for these minerals in ADOR [2]. Kirschsteinite contains less Sc, V, Cr, Mn and Zr than olivine but more P, Ti and Y.

Plagioclase - Because there is no major element zoning of this mineral in LEW 86010 and because REE concentrations in this phase are very low, only two measurements were made. The REE patterns are similar but the REE concentrations differ by a factor of ~ 2.7. The chondrite-normalized REE abundances decrease by a factor of ~ 10 between La and Tm; there is a pronounced positive Eu anomaly (Eu/Eu* = 40).

In conclusion, the REE data substantialize a magmatic origin for LEW86010. The strong correlations among Fe/Mg, Ce/Ho ratios, and REE, Al, and Ti abundances in clinopyroxenes are as expected for magmatic crystallization and inconsistent with metamorphic processes.
The close relationship of LEW86010 and ADOR [1] is supported by the similarity of relative REE abundance patterns for merrillite, clinopyroxene and also (not shown here) for olivine and kirschsteinite. However, the much higher REE content of ADOR pyroxenes, at similar Fe/Mg ratio, indicates separate and distinct magmatic evolutions for these two meteorites. The large range of major and trace elements compositions of LEW86010 pyroxenes suggests that modelling the initial magma from average pyroxene compositions would not be appropriate.

References: