RARE EARTH ELEMENT FRACTIONATION IN PHASES CRYSTALLIZING FROM LUNAR LATE-STAGE MAGMATIC LIQUIDS, J.F. Lovering and D.A. Wark, School of Geology, Univ. of Melbourne, Parkville, Victoria, Australia 3052.

The late-stage liquids produced during lunar magmatic processes are highly enriched in the rare earth elements (REE). A characteristic suite of REE-rich phases (including apatite, whitlockite, monazite, zirconolite, tranquillityite, baddeleyite and zircon [1] crystallize from these liquids and may cause modification of the REE fractionation patterns within these liquids. Up till now REE fractionation patterns have been determined for co-existing REE-rich phases of only 3 of the 7 petrographically defined lunar rock groups defined from clasts in Apollo 14 and 15 breccias [2]:

Group 2: Mare basalts 10047 and 14072. [Figs. 1 & 2].

Group 4: Monzonite clasts (numbers 1 and 2) in breccia 14305. [Fig. 3].

Group 6: Recrystallized breccias 14305 and KREEP-rich 65015.[Figs.4 & 5].

Apatites and Whitlockites: For rocks with co-existing apatites and whitlockites (i.e. 14072; monzonite clast and matrix of breccia 14305;65015) both have similar and relatively flat REE fractionation patterns which are also parallel to the patterns of the host total rock. The major difference between co-existing apatite and whitlockite patterns is the very marked negative Eu anomaly found in whitlockites while the apatites show either a very small or virtually zero Eu anomaly. A different set of conditions has apparently operated during the crystallization of 10047. In this rock virtually all the calcium phosphate present is apatite in which the REE fractionation pattern is different from all other apatites studied (which co-existed with major whitlockite), having a centrally humped pattern and a marked negative Eu anomaly. Apatite shows the most variation of any REE-rich phase studied.

Zirconolite: Zirconolites were studied in 10047, matrix of 14305 and KREEP-rich 65015. All show REE fractionation patterns which rise steeply from La to Sm, have a marked negative Eu anomaly and then remain virtually flat from Gd to Lu.

Tranquillityite: Only one grain was measured from 10047. The basic pattern is like that for zirconolite, plus a positive Pr anomaly.

Baddeleyite: Baddeleyite grains were analysed in 10047, 14072 and 65015. The accuracy is limited by the low abundance of the light REE's but the general pattern indicates a continued enrichment from the lightest to the heaviest REE's. Baddeleyite in 65015 seems to have a positive Eu anomaly.

Zircon: Zircons have been analysed from the monzonite (clast 1) and the recrystallized matrix in 14305. Both zircons show REE fractionation patterns which are rather similar to baddeleyite patterns.

Monazite: Monazite is a rare constituent of the mesostasis areas of the 10047[1]. It shows a REE fractionation pattern which is grossly different from the trend of most other REE-rich phases in that the light REE's are

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highly enriched relative to the heavy REE's while a distinctly negative Eu anomaly is also observed.

The limited data available show differences in REE fractionation patterns observed for the REE-rich phases present in the lunar rocks and these differences suggest possible mechanisms for deriving either late-stage crystallizing liquids, or early-stage partial melt liquids exhibiting a variety of REE fractionation trends.

REFERENCES

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(2) Gleadow, A.J.W., Le Maitre, R.W., Sewell, D.K.B. and Lovering, J.F., "Chemical discrimination of petrographically defined clast groups in Apollo 14 and 15 lunar breccias" in Lunar Science IV, pp.289-291, The Lunar Science Institute, Houston, 1973.

Fig. 1

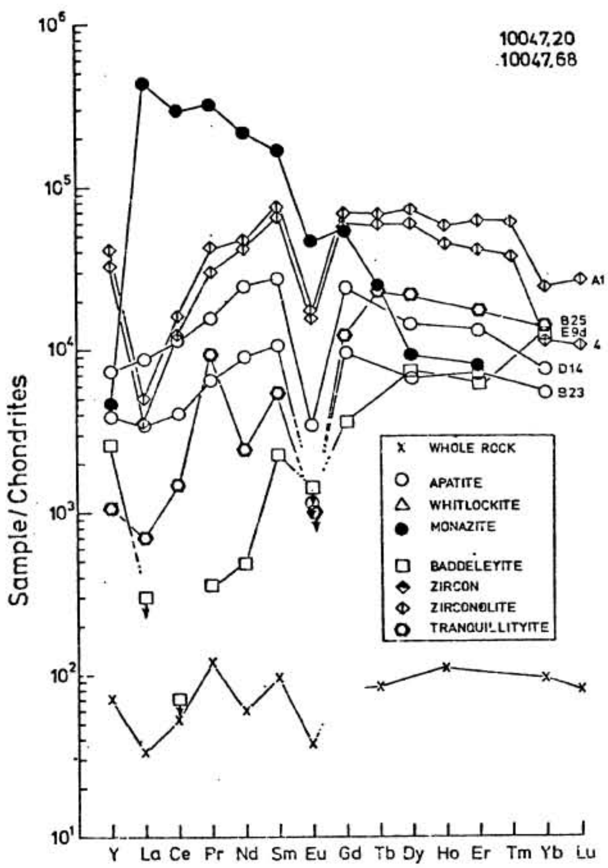
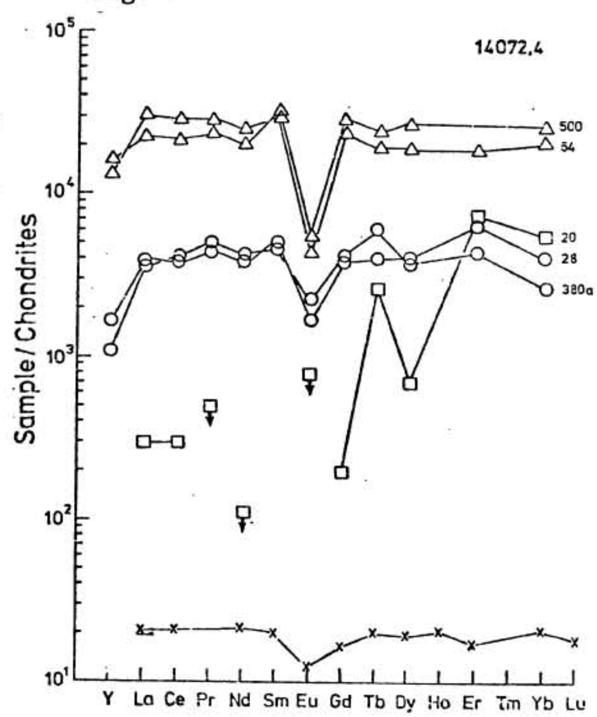


Fig. 2



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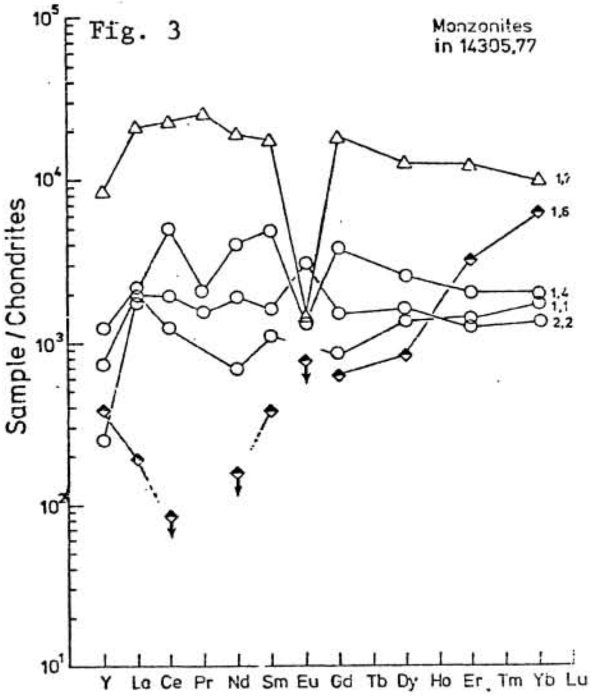

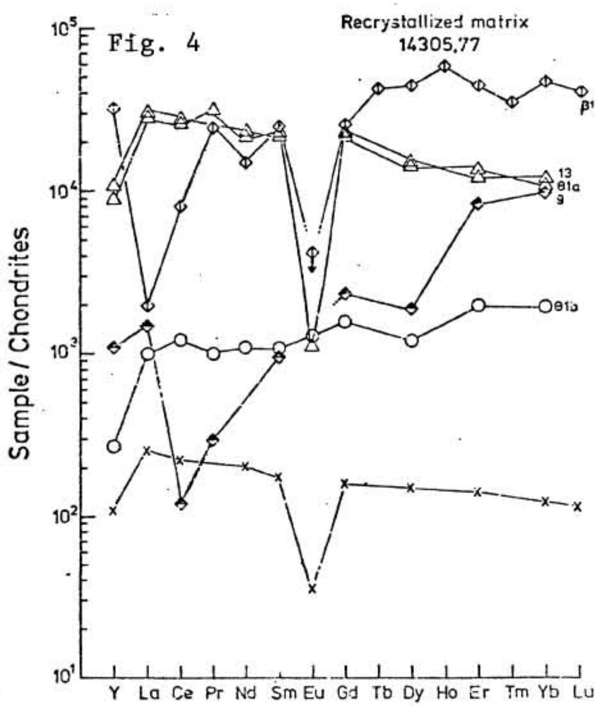

Fig. 5