ALHA 81005 METEORITE: CHEMICAL EVIDENCE FOR LUNAR HIGHLAND ORIGIN.

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Summary: Based on the well-established characteristic lunar and meteoritic ratios of FeO/MnO, Cr_2O_3/V and K/La, and REE patterns, ALHA 81005 meteorite is undoubtedly of lunar origin. Our conclusion is confirmed by oxygen isotopic (1), noble gas (2), and petrologic (3, 4) studies. The ALHA 81005 meteorite is an anorthositic gabbro (72 % Pl) and matches closely in chemical composition to Apollo 15 15418 (5) and Luna 16 21013 (6) highland rocks. The high content of siderophiles, Ni, Ir and Au (1-2% meteoritic component) in ALHA 81005 is similar to the siderophiles content in other lunar highland breccias, which strongly suggests that this rock was also subjected to a meteoritic impact on the moon. The terrestial ages of meteorites collected at the Antarctica including ALHA 81005 are relatively young 0.01 - 0.7 m.y (7, 8). Assuming a short space residence time, the young terrestrial ages indicate recent excavation of the rock by a cratering event on the moon. This implies that if a recent cratering event by a meteoritic impact can send lunar debris on the earth, then when major lunar basins were formed by planatesimal bodies during early (∿4 B.y) cataclysmic bombardment, the earth must have received enormous amounts of lunar material which is now mixed in the crust. The finding of a meteorite of lunar origin is the first documented case which further lends credibility to the suggestion (9, 10) that SNC achondrites may come from Mars.

Discussion on the bulk, matrix and clast: The bulk, matrix (dark) and clast (white) were analyzed for 30 elements by INAA. The petrology work on the same sample split was done by Papike's group (4). The chemical data are shown in Table 1. For comparison the data for 15418 and 21013 highland rocks are also included. The chondritic normalized REE patterns of these samples are shown in Fig. 1. The clast is low by ∿20% in REE and other trace elements relative to the matrix and bulk. The chemistry of the bulk is governed by the matrix. The strong element correlations of FeO/MnO and Cr_2O_3/V first noted by Laul et al (11) and K/La (12), and later found to be typical ratios for the moon is used to distinguish ALHA 81005 from other Ca-rich achondrite planetary bodies such as Eucrites, Howardites, Shergotittes, Nakhlites and Chassignites. These correlations are shown in Figs. 2-4. ALHA 81005 samples fall on the lunar line, whereas the other achondrites fall distinctly away from the lunar line. The FeO/MnO ratio of 80 provides the strongest evidence in favor of the lunar origin. The rock is reported as a regolith breccia (3, 4) indicating that the observed chemical signatures represent various lithic components similar to 15418 which is also a melt rock.

References: (1) Mayeda, T. K. and R. N. Clayton (1983) this volume. (2) Bogard, D. and P. Johnson, (1983) this volume. (3) Warren, P. H. et al. (1983) this volume. (4) Simon, S. B. and J. J. Papike (1983) this volume. (5) Laul, J. C. and R. A. Schmitt (1973) LPSC 4, 1348. (6) Smith, M. R., et al (1983) this volume. (7) Nishiizumi, K and J. R. Arnold (1983) LPI Tech. report 82-03. (8) Evans, J. C. and J. H. Reeves (1983) this volume. (9) Steel, I. M. and J. V. Smith (1982) JGR 87 ,375. (10)Grimm, R. E. and H. Y. McSween, Jr. (1982) JGR 87, 385. (11) Laul, J. C., et al (1972) LPSC 3, 1181. (12) Wanke, et al (1973) LPSC 4, 1461.

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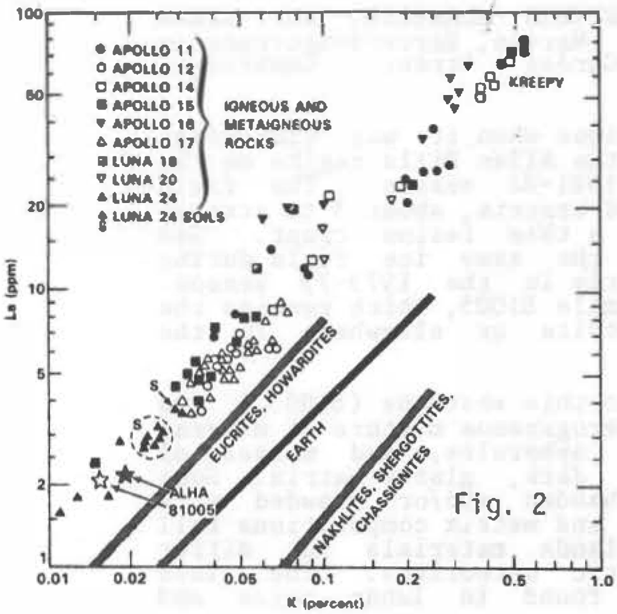

Fig. 2

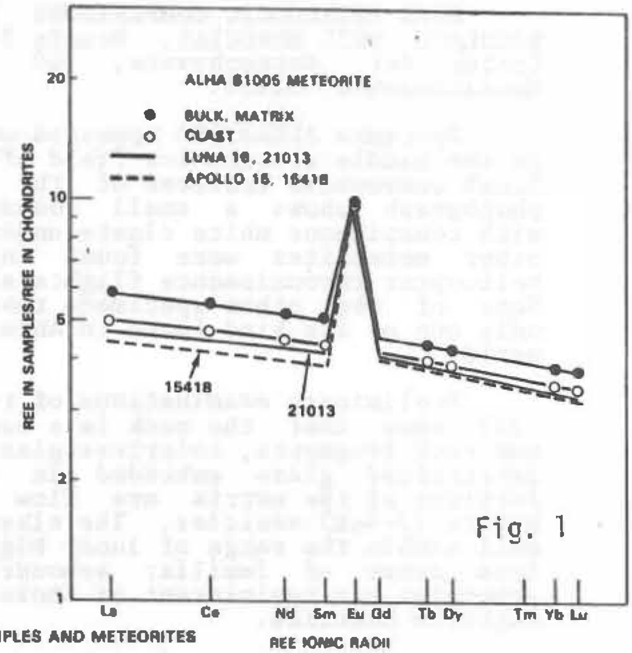

Fig. 1

MnO-FeO CORRELATION IN MOON SAMPLES AND METEORITES

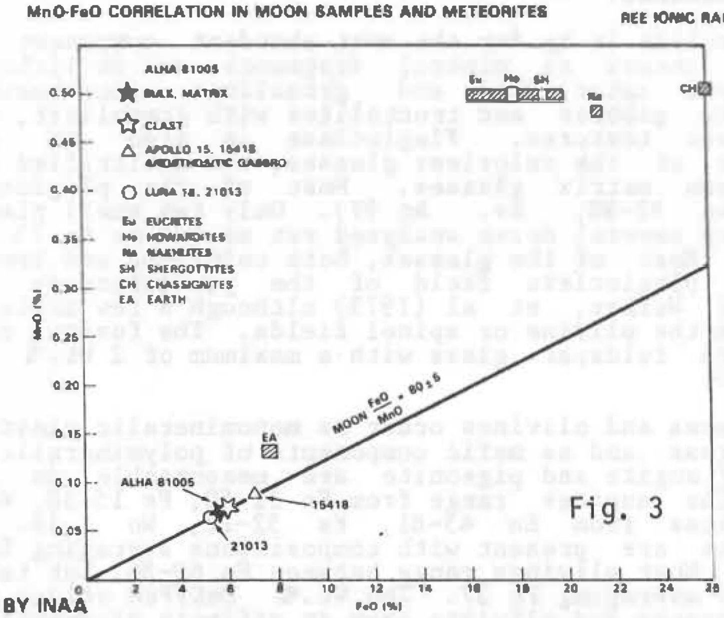

Fig. 3

CHEMICAL ABUNDANCES BY INAA

SAMPLE		ALHA 81005 METEORITE			APOLLO 15 15418 HIGHLAND ROCK	LUNA 16 21013 HIGHLAND ROCK Smith, et al (1983)
		CLAST	MATRIX	BULK		
WT (mg)		0.3	23.0	20.5	22.0	
ELEMENT						
(%)	TiO_2	0.30	0.30	0.30	0.30	0.2
	Al_2O_3	25.9	25.8	26.3	25.4	27.0
	FeO	5.9	5.6	5.8	7.0	5.2
	MgO	8.0	8.0	8.0	6.0	7.8
	CaO	16.7	15.2	16.0	15.7	15.0
	Na_2O	0.31	0.31	0.31	0.29	0.31
	K_2O	0.020	0.025	0.025	0.011	0.021
	MnO	0.074	0.070	0.069	0.084	0.088
	Cr_2O_3	0.12	0.12	0.12	(0.28)	0.11
(ppm)	Sc	8.7	8.7	8.8	12.0	10.7
	V	25	26	25	25	28
	Co	17.0	19.0	19.0	(70)	10
	La	1.7	2.0	2.0	1.5	1.6
	Ce	4.0	4.8	5.0	4.0	4
	Nd	2.8	3.5	3.3	3.0	<8
	Sm	0.85	1.0	1.0	0.75	0.82
	Eu	0.70	0.73	0.75	0.73	0.78
	Tb	0.19	0.21	0.20	0.18	0.20
	Dy	1.2	1.3	1.3	1.2	1.3
	Yb	0.74	0.84	0.86	0.81	0.79
	Lu	0.11	0.13	0.13	0.12	0.11
	Hf	0.84	0.86	0.85	0.70	0.85
	Ta	0.050	0.10	0.080	0.08	0.042
	Th	0.26	0.30	0.32	0.25	0.19

*VALUES IN PARENTHESIS ARE SUSPECT OF CONTAMINATION.

V-Cr_2O_3 CORRELATION IN MOON SAMPLES AND METEORITES

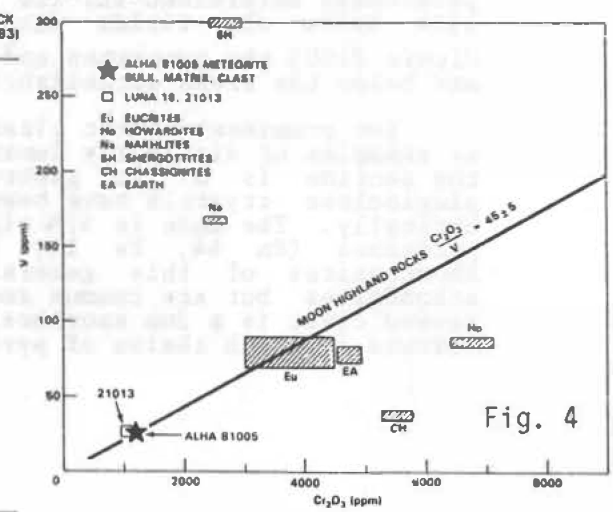

Fig. 4