PRELIMINARY REPORT ON GEOCHEMICAL STUDY OF LUNAR METEORITES MAC88104 AND MAC88105; Randy L. Korotev, Bradley L. Jolliff, and Larry A. Haskin, Dept. of Earth & Planetary Sciences and the McDonnell Center for the Space Sciences, Washington University, St. Louis, MO, 63130.

Anecdotal. MAC88105, a 662 g stone, was discovered near the MacAlpine Hills, Antarctica on (Friday) January 13, 1989. MAC88104 (61g) was found shortly thereafter less than 0.5 km away. The specimens were not immediately recognized as lunar meteorites. Because they were found in an area of the icefield that was populated primarily by terrestrial rocks, which they more closely resembled than they did the occasional ordinary chondrites also found in the area, members of the field party (including RLK) suspected that they were probably unusual terrestrial rocks. However, enough doubt existed to collect the specimens. The sample location is about 850 km south of the Allan Hills, from which the first meteorite recognized to be of lunar origin was returned [1], and about 30 km west of the Lewis Cliff ice tongue, from which a large number of meteorites have been collected in recent years by field teams of the Antarctic Search for Meteorites led by W. C. Cassidy.

Analytical. We report here lithophile element data for MAC88104 and MAC88105 based on preliminary results of instrumental neutron activation analysis (two radioassays, 4-5 days and 7-10 days following irradiation). We also report new data for YAM86032, a lunar meteorite from the Japanese collection [2].

Samples. We were allocated four samples for bulk chemical analysis. (1) 0.2 g of 88105,41 - We have not yet studied this sample, which was received as a powder. (2) 1.0 g of MAC88105,35 - This sample was received as two pieces with no large clasts. Thirteen subsamples consisting primarily of matrix were analyzed (M01-M13, 4-10 mg) along with two subsamples of a fine-grained tan clast (C1A and C1B, 3 and <1 mg). (3) 0.07 g of MAC88105,51 - This sample consists primarily of the large whitish clast known as W2 in the JSC documentation. Five subsamples were analyzed (C2A-C2E, 1-5 mg). A thin section of the clast was also received [2]. (4) 0.24 g of MAC88104,15 - This sample was received as several large pieces and fines. Four matrix-rich subsamples were analyzed (M14-M17, 6-11 mg) along with a white clast (C3, 1.4 mg), and three subsamples of gray clast (C4-C6, 4-9 mg; these may not each be samples the **same** gray clast).

We also have completed INAA of 11 chips of YAM86032 (Table 1) and have preliminary results for 8 additional chips analyzed along with the MAC81004/5 samples (1-11 mg). Five of the YAM86032 chips are rich in white clast material; the rest appear to be primarily matrix.

Bulk/matrix samples of MAC88104/5. Matrix-rich subsamples of MAC88104 and MAC88105 are indistinguishable from each other in composition (Table 1, Fig. 1), thus there is no compositional evidence that the two specimens are not paired. MAC81004/5 is compositionally similar to other lunar meteorites found in Antarctica, ALH81005, YAM791197, YAM82192/3, and YAM86032. The three principle aspects of this similarity are (1) similar concentrations of elements associated with major mineral phases (e.g., Ca, Fe, Sc, Eu, and, by inference, Al), indicating similarly high ratios of felsic to mafic mineral phases, (2) low concentrations of ITEs (incompatible trace elements, e.g., Sm) compared to most Apollo samples, indicating a virtual absence of a KREEP component, and (3) concentrations of siderophile elements that are generally on the low end of the range for lunar breccias composed of regolith material [3].

Although MAC88104/5 is compositionally similar to other lunar meteorites, subtle differences do exist. The ratio of Sm (and other ITEs) to Sc is slightly greater for MAC88104/5 than for the other lunar meteorites (Fig. 1a). The MAC88104/5 samples form a distinct field that does not overlap the fields for the other lunar meteorites on the Fe-Na plot of Fig. 1b.

Clasts from MAC88104/5. Petrography of two thin sections of MAC88105 is discussed in accompanying abstracts [4,5]. The most interesting clast studied is a troctolitic anorthosite from MAC88105 (JSC clast W2, INAA clast C2) [5]. We do not yet have petrographic information on the other clasts discussed here. The three samples of gray clast (C4-C6) are unremarkable; they are generally similar to the matrix but have lower concentrations of ITEs (Figs. 3 and 4) and slightly "flatter" chondrite-normalized REE patterns (not shown). The whitish clast from MAC88104 (C3) appears to be more feldspathic than the matrix in having lower concentrations of Fe, Sc, and Cr as well as ITEs (Fig. 2). It is similar in composition to whitish clasts from ALH81005 [6].

The two samples of tan clast in MAC88105 (C1) are unusual in being slightly enriched in ITEs and considerably enriched in siderophile elements (weighted mean Co: 35 $\mu g/g$, Ni: 515 $\mu g/g$, Ir: 36 ng/g; Au: 6.6 ng/g). The relative proportions of siderophile elements are consistent with (nonlunar) meteoritic derivation, so we can infer that about 1.1 cg/g (%) of the FeO is of extralunar origin, which accounts for most the FeO enrichment observed for these two particles compared to bulk samples in Fig. 2b. Ratios of Ir to other siderophile elements in clast C1 (Ir/Au = 5.5) are high compared to CI chondrites (Ir/Au = 3.2), bulk samples of lunar meteorites (Ir/Au = 2.5-3.1 [3]), and Apollo 16 soils (Ir/Au~1.5 [3]). A few of the matrix-rich samples of MAC88105 analyzed here (M01-M13) contain a portion of this clast, which leads to the larger siderophile element concentrations and Ir/Au ratio for MAC88105 compared to MAC88104 in Table 1.

YAM86032. The small chips of YAM86032 analyzed here are generally similar in composition to bulk samples reported by others [7]. There is considerably more compositional variability among the chips then among similarly-sized chips of MAC88104/5 (Figs. 1 and 2). This is also true of YAM82192/3, which are paired with YAM86032 [3,8]. The whitish clast-rich samples all tend to be enriched in Na (Fig. 2b) and Eu, indicating the presence of a feldspar component that is more albitic than that in the matrix. Two of the chips not observed to be enriched in white material are also richer in Na and Eu than the others; data for these were included in the mean listed in Table 1.

Conclusions. MAC88104 and MAC88105 are paired meteorites of lunar origin. Although generally similar to other lunar meteorites in composition, the MacAlpine Hills specimens are distinctly different from the others. There are no compositional (or geographical) reasons to strongly suspect that they are paired with any of the other known lunar meteorites (although exposure data to be obtained by others may provide such suspicions.) Warren *et al.* argue that the five previously studied lunar meteorites discussed here probably represent three impacts on the lunar surface [3]. By the same arguments, MAC88104/5 probably represents a fourth. If the lunar meteorites represent four truly *random* locations on the lunar surface, then their general similarity to each other (and to certain Apollo and Luna samples [6,9]) is remarkable and provides a strong constraint on models of lunar crustal formation.

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Table 1. Preliminary results of INAA. Values in cg/g (%) for oxides, ng/g (ppb) for Ir and Au, and μg/g (ppm) for all others. Weighted mean concentrations of matrix-rich, clast poor chips. Total mass: 85 mg YAM86032, 30 mg MAC88104; and 80 mg MAC88105.

	YAM 86032	MAC 88104	MAC 88105		YAM 86032	MAC 88104	MAC 88105		YAM 86032	MAC 88104	MAC 88105
Na_2O	0.455	0.335	0.342	Zr	16	44	50	Hf	0.45	0.84	0.90
CaO	16.2	16.5	16.5	Ba	24	31	32	Ta	0.06	0.10	0.11
Sc	7.79	8.64	8.37	La	1.21	2.32	2.39	Ir	4.7	6.4	9.4
Cr	634.	626.	627.	Sm	0.62	1.11	1.16	Au	1.6	1.6	1.8
FeO	3.93	4.31	4.35	Eu	0.92	0.77	0.78	Th	0.18	0.42	0.41
Co	13.1	13.8	15.1	Tb	0.13	0.23	0.23	U	0.05	0.12	0.10
Ni	106	130	160	Yb	0.57	0.94	0.95				
Sr	170	150	145	Lu	0.081	0.130	0.132				

Figure 1. Bulk samples (matrix-rich, clast-poor chips) of MAC88104 (open square), MAC88105 (closed square), and YAM86032 (closed circle) from this work compared with matrix/bulk samples of ALH81005, YAM791197, and YAM82192/3 (various literature sources).

Figure 2. Clasts and clast-rich chips compared with bulk samples. Data for clast C2 (troctolitic anorthosite) are presented elsewhere [4,5].