CORE 79001/2: AN EXAMPLE OF EXTREME MIXING IN THE LUNAR REGOLITH.

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INTRODUCTION: Double drive tube 79001/2 was collected near the southeast rim of Van Serg crater, a 90 m diameter crater on the floor of the Taurus-Littrow valley. Station 9 is interpreted to be entirely within the ejecta blanket of Van Serg crater [1]. Arguments based on morphology and exposure age of rocks at Station 9 suggest that Van Serg Crater may be as young as 1.5 million years [1]. This core was dissected in 1986 and 1987 [2,3,4], and results of ferromagnetic analysis show that the upper 8.5 cm part of this core is mature and includes the highest maturity soils found in the Apollo collection [5]. Below this level, the core soils are generally submature. As pointed out by [5], the young age of Van Serg as well as the nitrogen isotope data of [6] on soil 79221 preclude the possibility that these high maturity soils near the top were made by in situ reworking. We are investigating this core to try to determine the origin of the high maturity soils and to try to understand the anomalous nitrogen isotopes reported for the nearby trench soils.

METHOD: We have sieved 12 samples from representative locations along this core into seven size fractions and have determined the grain size distribution for the soil finer than 1 mm. We have combined these data with data collected during dissection by C. Schwarz on the coarser fragments [2] which ranged up to about 2 cm in diameter. We have also made polished grain mounts of the 90-150 micrometer grain size and have determined the agglutinate abundance in each of these mounts.

AGGLUTINATES: The agglutinate abundances in this core range from 15% (immature) to 44% (mature); most are in the submature range (Fig. 1). The general pattern is very similar to that of the I_s/FeO profile of [4], except that the range of variation is not nearly as extreme and the upper samples do not show very high agglutinates values which might be predicted from the extremely high I_s/FeO values. For comparison, the nearby trench soils contain 44% agglutinates in the upper dark sample (79221) and 22% agglutinates in the lower light sample (79261) [7].

GRAIN SIZE: The submillimeter size distribution of the core samples is approximately log-normal (as are most lunar soils) with a median grain size of 48 micrometers for the upper dark zone. These soils are moderately fine-grained, consistent with their moderate to high maturity. However, if the material greater than 1 mm is added, the distribution becomes clearly bimodal as shown in a composite size-distribution histogram of the upper 9.5 cm (Fig. 2). Coarse material, about 60% of which is regolith breccia fragments, makes up a high proportion of the total mass of the core; even excluding the fragments larger than 1 cm, about 41% of the mass in the upper dark layer consists of fragments larger than 1 mm [2]. Median grain size in this interval becomes 237 micrometers which is quite coarse. This is in the interval of high maturity [5]. Typical mature soils seldom contain more than 5% material coarser than 1 mm and do not exceed about 75 micrometers in median grain size. For the lower part of the core (79001), about 21% is coarser than 1 mm but finer than 1 cm. This value is closer to those of the trench soils 79221 and 79261 which contained before sieving 13.2% and 17.2% of their mass respectively in the size interval 1 mm to 1 cm. These values are fairly typical for submature to immature soils.

Normally, mature soils are fine grained, even when using the full grain size distrubution from 1 mm to 1 cm [8]. However, for 79001/2 a reversal exists. When the distribution including 1 cm to 1 mm is included, the more mature soils (based on I_s/FeO and agglutinates) are much coarser than any mature soil. This is the most extreme case of disagreement between grain size and other maturity parameters in the lunar collection (excepting volcanic soils 74220 and 74001/2 which are are fine-grained and immature because of their volcanic origin).

MIXING: The properties of these soils can be interpreted as reflecting extreme mixing of an immature or submature coarse-grained component (mainly regolith breccia fragments) with a mature fine component.

The high I_s/FeO index in comparison to the relatively low agglutinate content for the upper mature soils may be explained in part because the abundant regolith breccia fragments contribute to the I_s/FeO signature but not to the petrographically identified agglutinate abundance. Regolith breccia 79115 has an I_s/FeO index of 56 (D. Morris, pers. com.) and would contribute a significant amount to the I_s/FeO maturity if mixed in as fragments but would only dilute the agglutinates. It is also possible that the agglutinates do not reach extreme values because they are starting to saturate compared to the I_s/FeO index as discussed by [9,10].

ORIGIN OF MATURE SOIL: Where did the very high maturity end member soil come from? Nitrogen isotope data indicate that for the trench soil 79261, the finer grained fraction contains a higher $^{15}N/^{14}N$ ratio [6], suggesting that this finer fraction acquired its solar wind earlier than did the coarser fraction. If this relationship is also true for the core soils, it would mean that at some earlier time, a very mature regolith was formed and was subsequently mixed with a coarser, less mature, but younger regolith. Both of these regoliths had to be buried prior to the Van Serg impact because both preserve nitrogen isotopic values which are much older than values for recent soils [6]. One way to get extremely mature soils is to form them on an extremely thick regolith [10,11]. The high-maturity soil in this core is consistent with the proposal that the regolith in the Van Serg area is anomalously thick, at 11 m [1] compared to 4-6 m for mare regolith at Apollo 11, 12, and 15 [11]. This thick regolith would produce very mature soils when exposed to micrometeorite reworking because of the reduced dilution by fresh ejecta from the subfloor basalt. The exposure which produced this very mature soil could have occurred a long time ago in accordance with the nitrogen data. This old regolith was then excavated and mixed with somewhat younger regolith (now represented by the regolith breccias?) and basalt fragments by the Van Serg event.

REFERENCES: [1] Wolfe et al. (1981) USGS Prof. Paper 1080, 280 pp.; [2] Lunar News 47, Fall, 1986; [3] Lunar News 48, Spring, 1987; [4] Lunar News 49, Summer, 1987; [5] Korotev and Morris (1987) LPSC XVIII, 509-510; [6] Clayton and Thiemens (1980) Proc. Conf. Ancient Sun, 463-473; [7] Heiken and McKay (1974) Proc. Lunar Sci. Conf. 5th, 843-860; [8] McKay et al. (1974) Proc. Lunar Sci. Conf. 5th, 887-906; [9] Morris (1976) Proc. Lunar Sci. Conf. 7th, 315-335; [10] McKay and Basu (1983) Proc. Lunar Planet. Sci. Conf. 14th, B193-B199; [11] McKay et al. (1980) Proc. Lunar Planet. Conf. 11th, 1531-1550.

Figure 1: Core 79001/2

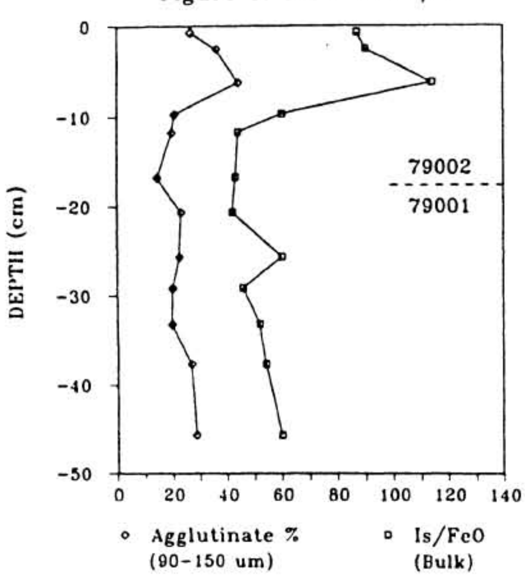

Figure 2