METAL-SILICATE RELATIONSHIPS IN 2 APOLLO 17 SOILS, J. I. Goldstein*, R. H. Hewins* and H. J. Axon** - *Metallurgy and Materials Science Dept., Lehigh University, Bethlehem, Pa. 18015, **Met. Dept., University of Manchester, Manchester, England.

Over 220 of the most magnetic particles in 20g of <1mm Apollo 17 soil have been studied in pol-thin and polished sections. The samples, 75081,9 and 75081,54 from station 5 at Camelot crater in the valley floor and 78501,48 from station 8 at the base of the Sculptured Hills, are from sites covered by dark mantle material. The magnetic, metal-bearing particles in 78501 consist of 31% metal (free-standing or with minor peripheral silicate), 17% "anorthosite", 15% agglutinate, 13% basalt, 7% glassy matrix breccia and 17% other categories. "Anorthosite" is a series of fine-grained plagioclase-rich rocks classified as breccias with various metaclastic textures, hornfels (or granulite) with granoblastic textures and partly to wholly melted rocks with lathy plagioclase. These resemble Apollo 16 (1) and Luna 20 (2) anorthositic soil particles and are interpreted as secondary products of the original anorthositic crust. The Sculptured Hills may well be composed largely of the fine-grained plagioclase-rich material. The proportion of metal particles with little or no adhering silicate was 0.07 wt% in 75081 and 0.03 wt% in 78501.

Almost 20% of the 78501 metal particles contain two or more phases (α,γ, FeS, $(FeNi)_3P$, $(FeNi)_3C$) and many of these show evidence of re-equilibration at metamorphic temperatures. Two phase particles are most abundant in anorthositic fragments and the fine scale of precipitates in some of the metal indicates rapid cooling of these rocks. On the other hand less than 5% of 75081 metal contains two or more phases. Metallic spheroids, globules and remelted metal form 3% of the 75081 particles and 8% of 78501. Most of these probably formed by selective melting of meteorites on impact (3). Metal with clearly preserved meteoritic structure was not observed.

The bulk Co and Ni analyses of one and two phase metal particles (circles) and of remelted metal (crosses) are plotted in Fig. 1a (75081) and Fig. 1b (78501). The meteoritic and basaltic (high Fe and high Co) metal composition ranges (2) are outlined in Fig. 1. The field between meteoritic and high Co may be designated super-meteoritic and that between 1-4% Ni below and the high Co line sub-meteoritic. Most of the metal from soil 75081 falls in the high Fe range (59%) with 22% meteoritic, 11% high Co, 3% super-meteoritic and 5% sub-meteoritic (Fig. 1a). This is consistent with exposure by Camelot crater of subfloor mare basalt metal intermediate in composition between Apollo 11 (high Fe) metal and the more Ni-poor Co-rich Apollo 12 basalt metal, e.g., 12022 (4). Most of the 78501 metal (44%) falls in the meteoritic range, along with 23% high Fe, 15% high Co, 13% super-meteoritic and 5% sub-meteoritic. 78501 metal compositions may be better understood by considering separate Ni-Co plots for metal in basalt, anorthosite, agglutinates and with little or no adhering silicate (Fig. 2a-d).

The Co-Ni distribution of metal in basalt is quite similar to that of the metal of Camelot crater soil 75081 after the meteoritic component is subtracted. A similar basalt component is present in the metal of 78501 (Fig.1b) but it is more clearly bimodal, suggesting derivation from two types of basalt (compare 5) with the more common type similar to Apollo 11 basalts.

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The anorthositic fragments contain metal largely of meteoritic (69%) and super-meteoritic (23%) composition. When these analyses are subdivided into breccia, hornfels and melted subgroups they do not plot in different composition fields, suggesting that the metal compositions have remained essentially unchanged during their incorporation in this fine-grained suite. The meteoritic composition metal may be derived from meteoritic metal fragments incorporated when these anorthositic rocks were formed and/or from a liquid with a high initial Ni Co ratio, e.g., the primary lunar crustal melt containing metal from condensate or building-block planetismals. Crystallization of metal from such a melt would produce super-meteoritic compositions.

The free standing metal category has a distribution of metal compositions similar to a combination of basaltic and anorthositic metal. It is therefore likely that this metal was derived mechanically from these two source bedrocks. By contrast the agglutinates have an unusual distribution of high Co, meteoritic and super-meteoritic particles. They lack a basaltic component and possibly were generated during impact events directly on the Sculptured Hills rock.

A composite 78501 soil can be constructed by a simple two component mixing model involving the metal particles in basalt and anorthositic rock fragments in the measured ratios (45% basalt + 55% anorthosite). A third component in the form of meteoritic metal contributed from local cratering events would make a complete agreement with the measured Co-Ni distribution and allow for the increase in Ni content of soil 78501 of approximately 100ppm over the local anorthositic rocks.

A similar composite, but with basalt in excess of anorthosite, might be proposed for the 75081 soil. However, the aluminous component is less abundant in this soil (5) than in 78501 and anorthositic fragments are less than 2%. In addition, the meteoritic to super-meteoritic ratio is so much higher in 75081 than in the anorthositic category that very little of the metal in the meteoritic range could be derived from anorthosite. The major Ni enrichment in dark mantle soils such as 75081 must therefore be due to a local meteoritic source.

References

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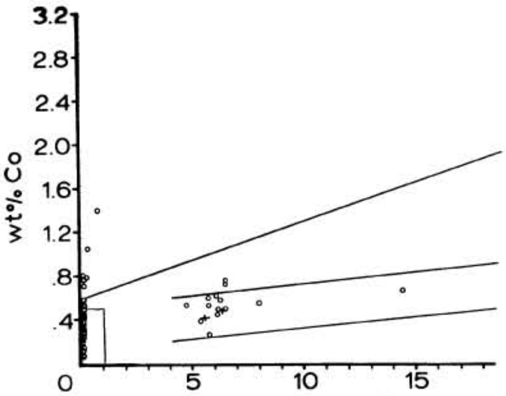

Fig. 1a - 75081

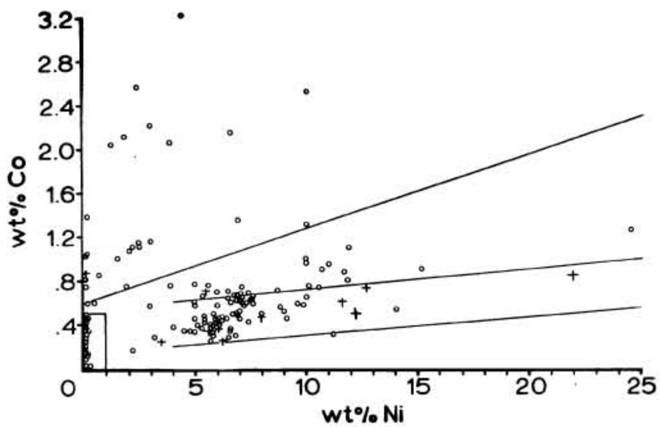

Fig. 1b - 78501

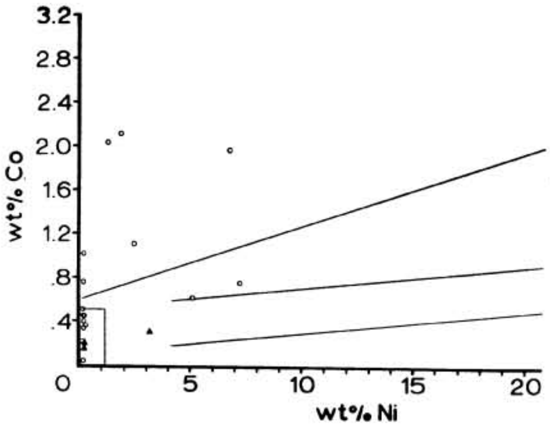

Fig. 2a - 78501 Basalt

▲ - Shocked basalt

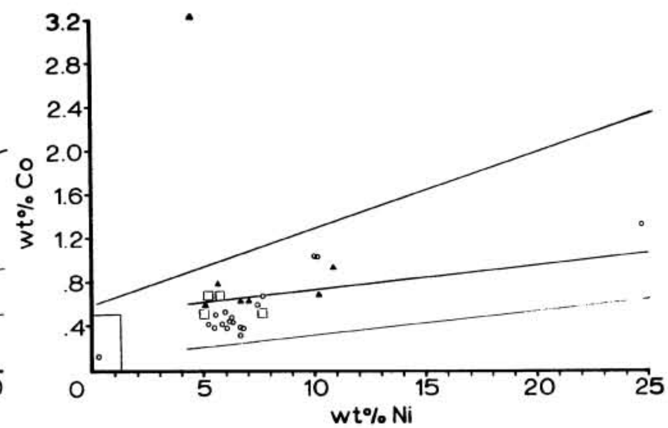

Fig. 2b - 78501 Anorthosite

▲ - Shocked anorthosite

□ - Luna 20 anorthosite (2)

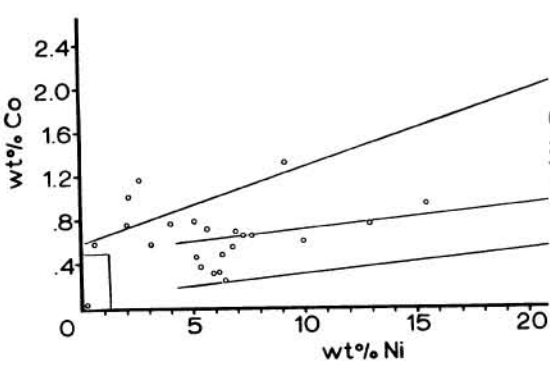

Fig. 2c - 78501 Agglutinates

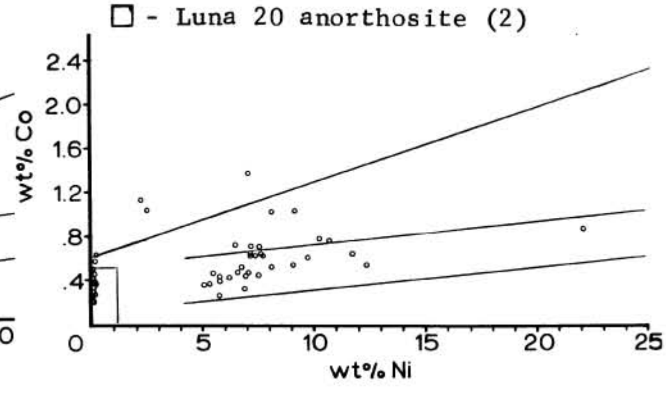

Fig. 2d-78501 Little or no adhering silicates