REGOLITH BRECCIAS AS PRECURSORS OF PRESENT DAY REGOLITH ON THE MOON

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INTRODUCTION. Mineralogical and compositional similarities between regolith breccias and local soils have led to the inference and an implicit consensus that regolith breccias, which obviously formed from existing local soils, generally reside in the vicinity of their origin [8-10,13,19 etc.]. However, it is also possible that the similarity of composition between regolith breccias and local soils is because the present day soils are derived from regolith breccias. Any regolith breccia compositionally different from local soils is considered exotic e.g. breccia 15205 at the Apollo 15 site, [1,21]. Or, the soil itself might have been emplaced as a blanket from some other place either in response to an impact or by creep [4,12,14]. Exposure ages from neutron fluence modelling may resolve the issue in specific cases. The ultimate origin of lunar soils is the disintegration of pristine rocks and breccias. Large impacts may also produce enough "dust" to contribute to the regolith; Apollo 16 fragmental felspathic breccias represent some such ancient regolith. Some boulders of rocks and breccias may even be recognized as direct sources of some soils. For example, House Rock at the Apollo 16 site is recognized as the parent of soil 67941 [7]. In response to the present day micrometeoritic flux, all exposed boulders including regolith breccias chip and disintegrate to contribute to soil formation.

PROBLEM. We are investigating (i) the hypothesis that a part of the present day soil may have been derived from the disintegration of regolith breccias, and (ii) if so, what may be inferred about the history of breccia formation on the moon.

EVIDENCE. Many lunar soils contain significant amounts of regolith breccia fragments. Despite the strong correlation between agglutinate abundance and FMR values of lunar soils [16] agglutinates are depleted relative to FMR in several soils, e.g. core soils in 79001/2 [15]. The excess FMR signals may come from hidden agglutinates in regolith breccia fragments in the soils. We are currently in the process of matching regolith breccia fragments in soils with large specimens of regolith breccias found in the locality to estimate the proportion of locally derived regolith breccia fragments. Lunar soils are generally more mature than local regolith breccias suggesting that present day soils cannot be parents of the breccias and that since the emplacement of the breccias a period of soil maturation has followed. Many crystalline soil particles are coated in part with brown glass that represents either agglutinitic glass or regolith breccia matrix. A statistical estimate shows that about 80% of crystalline particles in the soils of the double drive tube 64001/2 may be recycled [2]. Clearly, a part of the present soils owe their origin to the disintegration of regolith breccias.

REGOLITH BRECCIAS IN LUNAR HISTORY. Regolith breccias are absent in the large samples from the ejecta blanket of Cone Crater at the Apollo 14 site [3,6,24]. If sampling is representative, this suggests that since the emplacement of the Cone Crater ejecta blanket some 25 m.y. ago [5,23], there has been no sizeable impact to produce a coherent regolith breccia in this area. It is likely that events leading to the formation of regolith breccias are rare at the present, and have become fewer and fewer with time. The cratering record of the moon shows that sizeable impacts (e.g. those producing > 1 km craters) have logarithmically dwindled both in magnitude and in frequency with time perhaps with a spike of cataclysmic bombardment at about 3.9 b.y [e.g. 17,18,25,26].

We assume that (i) all impact events may produce fine dust similar to lunar soils, (ii) high energy events produce crystalline and melt matrix breccias, (iii) low energy events produce regolith breccias, and (iv) very low energy events like micrometeoritic bombardment can only produce and garden soil. If so, formation of crystalline matrix breccias, regolith breccias, and soil has sequentially dominated the products of surficial processes on the moon (fig. 1).

SCENARIO. We envisage a scenario in which at about the time the cratering curve (fig. 1) attained an approximately steady state, formation of regolith breccias was pervasive on the moon because low energy impacts (both primary and secondary) was the order of the day. This allowed large expanses on the surface of the moon to be covered by sintered material [20,22] i.e regolith breccias. Much of the present day soils may have been derived from the disintegration of these regolith breccias with some addition from bed rocks below. If so, (i) many lunar soils should show evidence of pre-irradiation (neutron fluence models of many drill core soils do), and, (ii) regolith evolution models should *a priori* contain a large population of recycled grains in the end product.

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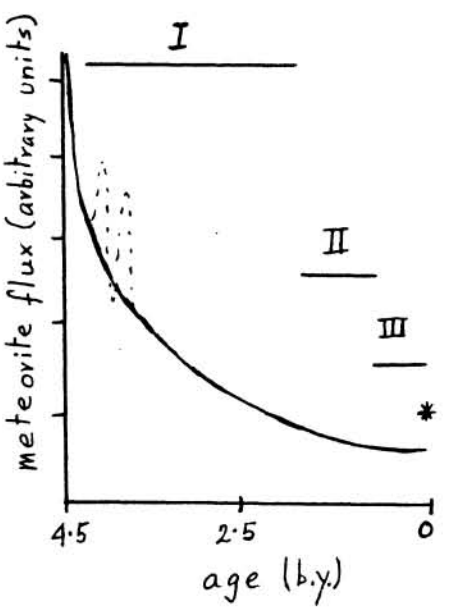

Figure 1. A schematic curve for the meteoritic flux over time in the vicinity of the moon on which we have arbitrarily marked three stages. Stage I :- Crystalline/Melt matrix breccias > Soil formation >> regolith breccia formation. Stage II :- Regolith breccia formation > Soil formation > crystalline/melt matrix breccia. Stage III :- Soil formation > regolith breccia formation >> crystalline-/melt matrix breccia. *(Present Day) :- Soil formation >> regolith breccia formation >>> crystalline/melt matrix breccia.