EXPERIMENTAL REGOLITH STUDIES: THE EFFECTS OF INITIAL FRAGMENT SIZE ON COMMINUTION BEHAVIOR. Friedrich Hörz+, Thomas H. See++, Mark J. Cintala+, and Francisco Cardenas++ (+NASA, ++Lockheed EMSCO; Johnson Space Center, Houston, Texas 77058)

INTRODUCTION: We continue our efforts to understand the evolution of planetary regoliths *via* multiple impacts into fragmental targets. Our initial experiments demonstrated the process of mineral fractionation during *in situ* gardening of a fragmental gabbro target [1]. Additional studies quantified mineral-specific comminution behavior for feldspar, pyroxene, and olivine relative to gabbro [2]. Other parameters that affect the comminution process include absolute impact velocity and the initial fragment size of the target, the topics of our most recent experiments. This report addresses the effects of fragment size, while [3] investigates the effects of velocity.

EXPERIMENTAL CONDITIONS: In contrast to the previous experiments that employed a heterogeneous fragment-size distribution (*i.e.*, >2-32 mm; simulating fresh crater ejecta), the present study utilized fragmental targets with restricted fragment-size intervals (*i.e.*, >16-32 mm, >2-4 mm, and >0.25-0.5 mm; termed "coarse", "intermediate", and "fine", respectively). Projectiles were stainless-steel spheres 6.35 mm in diameter (D_P). The mean fragment-sizes of the targets employed in the three series spanned almost two orders of magnitude and were approximately 4 D_P, 0.5 D_P, and 0.05 D_P, respectively. All other parameters, including the average impact velocity of 1.4 km/s, were identical to those described in [1]. Gabbro and single-crystal feldspar chunks from the same sources as those in [1] and [2] were used as target materials, with the gabbro simulating competent "rock" and the feldspar representing the most readily comminuted major rock-forming mineral [2]. A total of six experimental series were conducted: two different materials and three fragment sizes of each. Each series consisted of 25 impact events, and sieve analyses were performed after shots 1, 5, 10, 15, 20, and 25.

RESULTS: The principal results of these experiments are illustrated in Figure 1, which simply depicts the total amount of material comminuted as a function of cumulative energy and, by implication, as a function of "time". Each impact delivered $\sim 10^{10}$ ergs to the target, which initially weighed 4000 g. It is readily apparent in Figure 1 that the initial fragment size is a crucial parameter, with the coarse targets yielding ~2300 g of comminuted material after 25 impacts, while the fine charges produced only some 500 g (*i.e.*, ~58% and 13% of the initial target mass was comminuted, respectively). The behavior of the intermediate target is consistent with these trends. Feldspar comminutes with somewhat greater ease than gabbro, consistent with [2], regardless of the initial fragment size. The datum for the coarse gabbro after shot 5 is higher than the ensuing trend, an observation that is ascribed to the vagaries of a small number of impacts into a coarse-grained surface. It is clear from Figure 1 that the initial fragment-size dominates material-specific comminution behavior, at least for the gabbro and feldspar utilized in our experiments. Figure 2 illustrates the specific energies required (A) to generate fresh surfaces, and (B) to comminute some unit mass. Similar amounts of surface area are being generated per unit kinetic energy for all three fragment sizes of feldspar; the gabbro necessitates consistently higher specific energies, but the coarse target deviates somewhat from the intermediate and fine targets. Relative to feldspar, the >16-32 mm gabbro target seems to have comminuted preferentially into >8-16 mm fragments and was thus relatively depleted in fine-grained detritus. If a material's comminution behavior were defined in terms of target mass destroyed per unit kinetic energy (Figure 2B), however, initial fragment size becomes more important. Over the fragment-size range simulated, the mass-specific kinetic energy varies from $\sim 10^8$ ergs/g for the >16-32 mm targets to values some 4 times higher for the >0.25-0.5 mm initial fragment size. This size-specific comminution effect most likely relates directly to projectile dimensions, because more material is comminuted during the interaction between the projectile and a few large fragments in the coarse target than during *bona fide* cratering in the finer-grained media.

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CONCLUSIONS: The initial fragment-size distribution is an important parameter for the evolution of planetary regoliths. Fragments and boulders that are large relative to the dominant projectile population require substantially less specific energy to comminute a given mass (*i.e.*, ergs/g) than do "small" surface components. Absolute fragment size appears to be more important than differences in the physical properties of common, igneous rocks and minerals. In contrast, the cumulative surface area generated during impact-induced comminution (ergs/cm^2) appears to be relatively insensitive to the initial fragment size.

REFERENCES: [1] Hörz *et al.*, 1984, *PLPSC 15, JGR, 89*, C183; [2] Hörz *et al.*, 1985, *LPS XVI*, 362; [3] Cintala *et al.*, 1987, *LPS XVIII*, this volume.

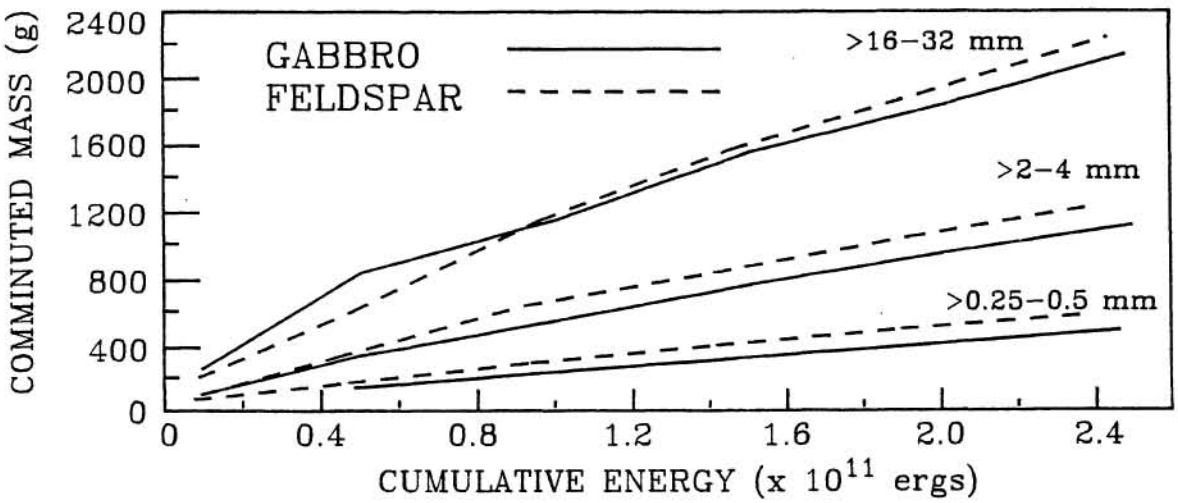

FIGURE 1. Total comminuted mass as a function of cumulative impact energy showing the susceptibility of the various size fractions of gabbro and feldspar to impact-induced comminution.

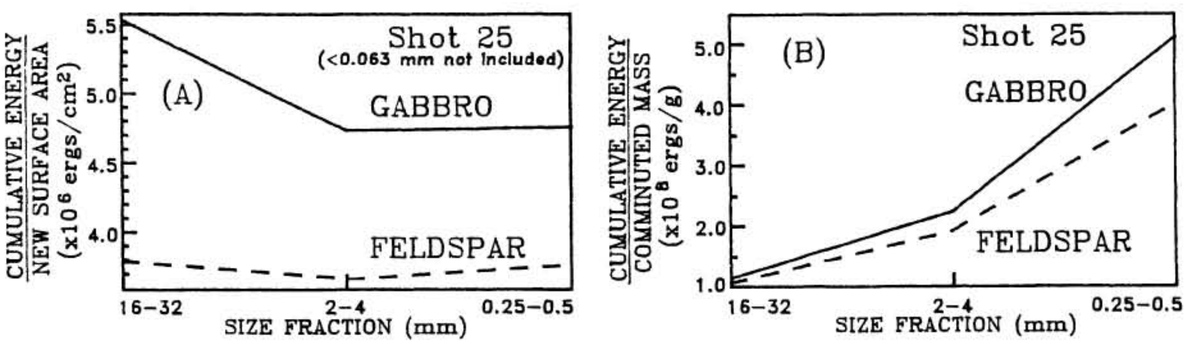

FIGURE 2. Specific energy required (A) to generate a given amount of surface area and (B) to produce a unit mass of comminuted material.