EFFECTS OF FORMATION OF LARGE CRATERS AND BASINS ON EMPLACEMENT OF SMOOTH PLAINS MATERIALS. Verne R. Oberbeck, NASA-Ames Research Center, Moffett Field CA 94035, Fred Hörz, NASA-Johnson Space Center, Houston TX 77058, Robert H. Morrison, LFE Corp., Richmond CA 94804, William L. Quaide and Donald E. Gault, NASA-Ames Research Center, Moffett Field CA 94035.

Formation of laboratory impact craters, laboratory explosion craters and larger N.T.S. explosion craters have been studied to determine the effects of ejection of material from large lunar impact craters on distant terrain. High-speed motion pictures of large explosion craters formed at scaled depths of burst that simulate impact crater formation (Baldwin, 1963 and Oberbeck, 1971) show that most of the material is ejected from large craters at angles that are similar to those for material ejected from small impact craters. Impact, break-up, and mixture of this material with secondary crater ejecta are responsible for formation of the dust aerosol that produces base surges. Primary crater ejecta and the ejecta of secondary craters mix with the expanding air cloud. Because there is no lunar atmosphere, lunar base surges of this type will not occur. Instead material ejected from large lunar craters produces a combined radial depositional and cratering regime that mixes pre-existing materials with basin or crater ejecta.

Study of the herringbone pattern associated with lunar secondary craters has shown that fragments producing them were ejected from craters like Copernicus at angles less than 30° measured from the horizontal. This knowledge together with knowledge of range of the secondary from the primary crater permits one to estimate the part of the emplaced deposit that is mass ejected from the local terrain relative to the part that is primary crater ejecta. This estimate is obtained both by direct simulation of secondary craters and by computation.

Simulation of secondary crater formation and calculations based on measurements of secondary craters and energy-size scaling relationships for crater formation indicate that the proportion of primary crater ejecta in secondary crater deposits decreases with the distance of the deposit from the primary crater or basin. For example, if secondaries of Orientale basin are present near the Apollo 16 landing site, any deposits associated with the Orientale event would be scattered in a discontinuous manner about the isolated secondaries and the material from Orientale basin would be at most about 12% of the deposit. The remainder is local material. On the other hand, the proportion of primary crater ejecta in that part of the Cayley Formation emplaced by a nearby highland crater can be much higher. These findings support the interpretations that local and regional craters had an important effect on the history and petrology of the Apollo 16 site (Head, 1973; Oberbeck _et al._, 1973).

Additional calculations show that the total mass ejected by all secondaries of a primary crater can be a significant fraction or multiple of the total mass ejected from the primary crater. The cratering mechanics analysis predicts large mass wasting deposits produced by formation of secondary craters in or near depressions of the highlands and in intercrater areas that are the sites of intense bombardment by material ejected from the

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primary craters. This material, however, will consist of rather high proportions of ejecta of pre-existing local and regional highland craters. So, in addition to fallback breccia and ejecta blankets of local craters secondaries of local and distant craters have eroded the rims of local craters and the highland materials into depressions to contribute to the Cayley Formation.

Smooth plains materials in a depression northeast of crater Tycho are shown to be adjacent to and downrange from saturated fields of Tycho secondaries on the highlands. The secondaries must have ejected material of the highlands into these smooth plains areas and contributed a significant amount of material of highland composition to this smooth plains unit during Copernican time. Calculations show that approximately 1/2 of the mass emplaced in this smooth plains unit by Tycho is material from the highlands and 1/2 is Tycho ejecta. This smooth plains unit adjacent to a zone of saturated secondary craters suggests that, if larger continuous units of smooth plains are to be related to the formation of a single crater or basin, they must occur near the zone of saturated secondary craters of that primary crater or basin. Secondary craters at greater distances from the source could produce only discontinuous deposits because the secondary craters are separated outside the saturated zone.

The association of saturated secondaries of crater Tycho with adjacent smooth plains is used as a possible explanation of the observed relationships between the lineated pre-Imbrium terrain and the adjacent, much larger patches of smooth plains units in the southern highlands. The lineated terrain has been considered by previous investigators to be a result of either faulting associated with formation of the Imbrium basin or Imbrium secondary cratering. If the lineated terrain is produced by secondaries of Imbrium, these craters could have ejected large quantities of highland material into depressions like Ptolemaeus crater and at the Apollo 16 landing site. If so, the part of the Cayley Formation emplaced by the Imbrium event would be at most about 20% Imbrium ejecta and at least 80% ejecta from the local highlands. Other post Ptolemaeus local highland craters have also eroded the highlands and crater rims and added this material and primary crater ejecta to the Apollo 16 site. The percentage of primary crater ejecta in material contributed by local craters is considerably higher. Some smooth plains units might also consist partially of fallback breccias, impact melts or volcanic deposits.

Applications of the cratering theory to consideration of origin of materials of the Fra Mauro Formation are discussed. It is concluded that much of the material of this formation is also derived from the local terrain and it has been mixed with ejecta from the Imbrium basin. These conclusions are supported by observations of the nature of the basal units of the continuous deposits of the Ries crater. They contain significant deposits of local material that were cratered by Ries ejecta.

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