HERSCHEL BASIN EJECTA AND SOME IMPLICATIONS FOR DECIPHERING THE GEOLOGIC HISTORY OF THE MARTIAN CRATERED HIGHLANDS.

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The recognition of basin ejecta deposits is an important key to the interpretation of cratered highlands geology [1]. Such deposits are also important because the ejecta may preserve a record of local erosional history [2,3] and because basin ejecta contains a stratigraphic sampling of crustal rock, a potentially important source for a Mars sample return project [2,4]. Mouginis-Mark *et al.* [1] described the tectonic evolution, infilling history, and style of ejecta emplacement around Schiaparelli Basin (3°S, 343°W). On Mars, however, the ejecta materials associated with large (>100 km diameter) ancient (Early-Middle Noachian) impact basins are difficult to recognize [eg. 1,5]. This paper examines the materials associated with Herschel Basin (15°S, 230°W) in an attempt to identify the basin ejecta deposits.

Herschel Basin (300 km. diameter) is in the cratered highlands about 1,000 km east of northern Hesperia Planum. It is a large central peak-peak ring basin [6] surrounded by heavily cratered and channeled materials of Mid-Noachian age [7,8]. The basin rim stands about 1.5 km above the present floor [9,10]. Although the southern rim has been modified by impact craters, the rest of the rim is largely preserved. The peak ring and central peak complex form mountainous materials located at the center and about 60 km east and west of the center. In the south and east, hilly and rough-textured materials surround the peak ring and probably consist of slumped and brecciated basin wall and floor materials, mixed with aeolian sediments. Wrinkle-ridged plains occur in the northern third of the basin and are Lower Hesperian in age [7], considerably younger than most of the other basin materials. The plains are presumed to be volcanic, although wrinkle ridges cannot be taken as sole indicators of a volcanic origin [11,12]. The NW-SE orientation of the ridges corresponds with predicted regional compressional stresses [13], but some ridges also may reflect buried peak ring topography.

Within the vicinity outside the basin, there are three main types of material: (1) heavily cratered and channeled materials, (2) isolated smooth and ridged materials, and (3) relatively fresh, sharp-rimmed crater materials which lie unconformably on top of all other units. Smooth and ridged materials occupy low areas and depressions and lie unconformably on top of the heavily cratered and channeled materials. These materials may be volcanic and/or sedimentary in origin, similar to the ridged materials within Herschel Basin.

There are four morphological units of cratered and channeled material surrounding the basin, interpreted to be the eroded remnants of Herschel's continuous ejecta. Directly outside the basin, to a distance of 1 to 1.5 Herschel radii from the rim, lies terrain characterized by small valley networks in the northwest and northeast, and trough and groove-like depressions in the north, east, and southeast, all of which are generally oriented radial to Herschel basin. At least 10 depressions >25 km in diameter occur near Herschel whose edges or rims are partly buried or encroached by this material. The material appears to be thickest toward the basin rim, thinning outward; and is considered to be the remains of the thickest portion of Herschel's continuous ejecta. Beyond this material lies a flatter, cratered, dissected plain which contains valley networks which are not radial to Herschel Basin. The most apparent contact between these two units is located in the northwest and northeast, where the small valley networks radial to Herschel Basin either debouch onto the plain or join with small valleys which are not radial to Herschel Basin. This unit probably consists of remnants of Herschel's outer continuous ejecta, similar to the "smooth continuous ejecta" units mapped at Lyot (50°N,330°W) and Lowell (52°S,81°W) Basins [14]. Linear troughs and aligned elliptical depressions which radiate outward to the north and to the southeast from Herschel are interpreted to be secondary impact crater chains. Several of these chains extend as far as 450 km (~3 Herschel radii) from the rim. Two other types of terrain occur near the basin in the proposed ejecta complex. One is a smooth material which generally lacks valleys, troughs, and other features radial to Herschel. The other is a plain characterized by a complex surface of small valley networks or undulating hill patterns. The proposed ejecta material from Herschel Basin has been dissected, particularly in the north, by deep valley network-type troughs. Most of these valleys probably formed in depressions and grooves which were part of the original ejecta morphology. The majority of these valleys could have formed by sapping due to water entrained within the ejecta of Herschel Basin, as was suggested for similar valleys at Schiaparelli [1,15].

The two sets of high resolution Viking images of the region, 759A11-22, 31-46 and 448A1-26, show that the most recent modifications of Herschel Basin were by aeolian processes. Images which cover the northern rim area of Herschel show some unusual linear, subparallel ridges oriented WSW-ENE, which are probably yardangs; and NNW-SSE-oriented dunes are present within some craters around Herschel Basin and might comprise the dark materials within the basin.

In the region around Herschel Basin, up to ~1.5 radii from the rim, there are 58±6 craters >16 km in diameter which probably pre-date the Herschel Basin impact. (The uncertainty represents the number of depressions which are so degraded or buried that there is some question as to whether they are impact craters.) These craters include (1) those which probably predate Herschel, and (2) those which *might* predate Herschel. Type 1 craters are partly buried by the proposed Herschel ejecta within 1.5 radii of the rim, intersected by crater chains radial to Herschel, or are superposed by another crater which exhibits one of these characteristics. Type 2 craters are in contact with the proposed ejecta but do not appear to be superimposed *on* it. There are 38±4 Type 1 craters and 20±2 Type 2 craters. Using Tanaka's stratigraphic scheme [7], the crater density for *all* of these craters [N(16)= $183/10^6$ km^2] and the density for only Type 1 craters [N(16)= $120/10^6$ km^2] give an age of Middle Noachian, suggesting that the basin formed no earlier than that epoch.

Herschel Basin is similar to Schiaparelli Basin, as both have experienced a long history of modification. Their interiors were partly filled by volcanic and sedimentary materials, and both have wrinkle-ridged floors reflecting regional stress patterns. When compared with the ejecta from Herschel Basin, ejecta materials around Schiaparelli were difficult to recognize [1,16], in part because of more extreme modification by volcanic, aeolian, and fluvial or sapping processes. Ejecta modification is probably a function of local conditions (volcanism, erosion) as well as age. Radial valleys, troughs, grooves, and secondary impact crater chains, in addition to the occurrence of buried or partially buried craters within 1.5 basin diameters of the rim, can be used as criteria to identify old, eroded basin ejecta deposits. Mapping the location, extent, and superposition relationships of presumed ejecta facies around martian basins may provide a reasonable means for further understanding the geology heavily cratered highlands.

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