

DO LARGE IMPACT BASINS IN THE SOUTHERN HEMISPHERE OF MARS CONTROL THE DISTRIBUTION OF POLAR STRUCTURES AND DEPOSITS?

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Introduction

Among the outstanding problems in martian geology are the cause of the off-axis and asymmetric distribution of the southern polar layered terrain and residual ice deposits and the cause of the orientation of scarps, valleys and re-entrant canyons which occur there. A perhaps related problem region is the apparently small number of large ($D > 500$ km) impact basins seen in the relatively well-preserved cratered terrain of the south polar region. Previously only the 850 km wide South Polar Basin was easily recognized [1,2,3,4]. We have been mapping the south polar region in detail, searching for evidence of ancient, highly degraded impact basins that may have escaped earlier notice, for two reasons: (a) To determine whether the apparent absence of large impact basins is due to incomplete mapping and recognition or a fundamental characteristic of the martian crust related to the origin of the martian crustal dichotomy [5, 6], and (b) To determine whether ancient impact basins, if they exist, exert some control on the distribution of volcanic and polar deposits in the southern hemisphere and on the topography on which these deposits lie. We previously described [7] several promising candidates, including a large pre-Hellas basin in the Malea Planum region and an older but comparably sized basin overlapping South Polar [8, 9]. In this paper we concentrate on the possible influence of the candidate basins in localizing the asymmetric distribution of polar deposits and in controlling the orientation of structures found within these deposits.

Candidate Basins in the South Polar Region

There is very good structural evidence for a multi-ring basin (Malea B) to the southwest of Malea Planum, centered at about 340°W, 75°S, near the fresh crater South. Three reasonably well-defined but incomplete rings, marked by massifs, isolated peaks and outcrops of knobby and degraded Noachian terrain bounded by scarps, have diameters 740, 950 and 1155 km. Evidence for two inner rings is weaker. Overlap of this smaller basin with South Polar Basin appears to influence the distribution of polar ice and perhaps the layered terrain deposits (see below).

South Polar Basin is the most obvious impact basin in the southern polar region, but its single recognized ring - the disjointed scarp-like Promethei Rupes - is unusual. It is impossible to fit all the segments of the exposed scarp with a single circular arc. We suggest that influence from other basins, including Malea B, South Polar B (see below), and even the distant but larger Hellas Basin, has affected the structure of the South Polar rim. As in the case of Malea B, the distribution of ridged plains, outcrops of ancient terrain, ridges, scarps, and other features suggests the *influence* of South Polar Basin greatly exceeds its variable 850-900 km diameter. We found rare individual peaks, scarps, and some ridges in spotty, sometimes concentric distribution at "diameters" of 700, 1220, 1420, 1745 and 2050 km about the center of South Polar Basin. It appears the influence of this basin extends to more than twice the diameter of the obvious ring, as does that from the much larger Hellas Basin.

Evidence exists for an overlapping basin we call South Polar B [9]. A variety of features including straightened crater rims, a subtle 45 km long scarp, a 200 km long knobby ridge, a group of massifs and mountainous peaks, a 300 km long concentric ridge, an inward-facing, 85 km long scarp 505 km from the center, and a series of short ridges, scattered knobs and small massifs all suggest a partially buried ring 1010 km wide centered at 206°W, 73°S. A possible second ring ($D \sim 1375$ km) is suggested by a break in the rim of South Polar Basin, deflection of an 85 km NW trending ridge, a 50 km long straightened crater rim, small (10-20 km long) sinuous but concentric ridges, a small 10 km long massif, and similar features.

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The 1000 km diameter of the most prominent (middle?) ring makes South Polar B slightly larger than South Polar, but its highly degraded state and obvious overprinting by the Promethei Rupes suggest it formed earlier.

Influence of Large Basins on Polar Structures and Deposits

It appears the location and overlap of Malea B, South Polar, and South Polar B control the location of important polar terrain units. Nearly all the *Hdu* and *Hdl* units in the eastern portion of the south polar region lie within the Malea B and South Polar Basins. Likewise, the polar layered terrain (*Apl*) appears to lie mostly within South Polar and South Polar B, even though there is no obvious rim preserved on the northwestern edge of the unit. The extended distribution of *Apl* northward about 180° W longitude appears directly related to the overlap between South Polar and South Polar B.

The off-axis location of the residual ice deposits (*Api*) is more difficult to explain, being located far from the center of South Polar B and only lying within overlap of the more distant Malea B rings with South Polar. The *Api* units are located at the approximate center of a large, roughly circular region in which large craters are nearly absent. Perhaps there remains to be found a very ancient basin whose overlap with South Polar and Malea B provides the proper topographic trap not only for *Apl* units but for *Api* as well. A basin centered at 85°W, 78°S in the Cavi Agusti region would not only provide the proper overlap but also help explain the distribution of *Hdu* and *Hdl* units in the western south polar region and many of the structures found there.

Malea B, South Polar and South Polar B may influence the orientation of structures (scarps, valleys, Chasma Australe) within the layered terrains. Many of these occur along proposed rings of these basins, as arcs concentric to basin centers, or along lines radial to a basin center (sometimes where combinations of these conditions exist). Malea B appears to be particularly important in this regard. Ridges in the *Nplr* and *Hr* units of Malea Planum as well as valleys and scarps in the layered terrain *Apl* all lie on arcs concentric to the Malea B center. Chasma Australe lies within the overlap region of all three basins described, along an arc roughly concentric about the center of Malea B which may control several narrow valleys within *Api*, marks the boundary between cratered terrain and *Nplr* ridged plains that run northward from South Polar Basin rim between 280 and 290°W, and lies along several prominent ridges with Malea Planum. Several long valleys within the residual ice *Api* are oriented towards the center of either South Polar or South Polar B; shorter cross-cutting valleys in the same unit seem more aligned with the center of Malea B. Within the layered terrain away from the residual ice deposits, several long ridges at about 150°W are also radially oriented toward South Polar B. By contrast, the prominent facing scarps at 300°W, 85°S are not so obviously associated with any of these basins, and may reflect still additional influences not yet recognized.

While not explaining everything seen in the south polar region, there is intriguing but at the present time only circumstantial evidence that the three basins described above did exert substantial influence on the distribution of polar deposits (*Hdu*, *Hdl*, *Apl*, *Api*) and on the orientation of many of the structures found within these deposits. Both radial and concentric directions appear important, and in many places the combination of these from different basins may have contributed to the localization of structures.

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