TESTS FOR ANCIENT POLAR DEPOSITS ON MARS: MORPHOLOGY AND TOPOGRAPHIC RELATIONSHIPS OF ESKER-LIKE SINUOUS RIDGES (DORSA ARGENTEA) USING MOLA DATA.
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Abstract: MOLA data are used to characterize the Hesperian-aged Dorsa Argentea sinuous ridges near the South Pole in order to assess their origin.

Introduction: The process of glaciation has been proposed to account for a number of features and units on Mars [1-5]. Among the most distinctive of these features are sinuous, braided, kilometer-wide ridges as long as 150 km which occur in a number of places on Mars, preferentially at middle to high latitudes. These sinuous ridges occur singly and in groups or systems up to 800 km long, and display a variety of patterns including cross-cutting, braided and dendritic. Among the most prominent locations of ridge systems are near the South Pole (Dorsa Argentea) [4], on the floor of the Argyre Basin, and in Hellas Planitia [7]. On the basis of their similarities to terrestrial eskers, these sinuous ridges have been interpreted by several workers [2,6,7-11] to be martian eskers associated with glacial processes, but this interpretation has not been widely accepted, and other candidate origins have been proposed [2,4,8-10]. We here use MOLA data to examine the nature of these features and to assess their topographic environment. We focus here on the Dorsa Argentea area near the South Pole (Fig. 1, 2). Elsewhere [12] we use these observations to attempt to distinguish among the several hypotheses.

Dorsa Argentea form a NW-SE trending sinuous ridge system about 50-250 km wide, 850 km long, and located at about 70-80$^\circ$S and 0-60$^\circ$W. The ridges are located exclusively in the Hesperian-aged Dorsa Argentea Formation (Hd) [4], which forms polar plains near Augusti and Sisphi Cavi, embays older highland rocks and ridged plains material, and underlies Amazonian-aged polar layered deposits (ApI). The Dorsa Argentea Formation is interpreted as eolian mantle or lava flows, with a possible role of ground ice [4]. We mapped the nature and distribution of these ridges in the central part of their occurrence (Fig. 1a, b) and constructed a MOLA topographic map of the same area. Using these maps, and individual MOLA profiles (Fig. 2), we analyzed the morphology of these features and assessed their regional topographic setting. In this region, the Dorsa Argentea Formation occurs in a shallow linear depression about 1250 km long and about 250 km wide; the ridges of Dorsa Argentea generally parallel the trend of this valley. At the polar end of the linear depression, it divides into two valleys and rises to the layered terrain (ApI) and to HNu (undivided terrain of Hesperian/Noachian age). At its northward end, the valley ends in a circular arc (portion of an old crater rim about 450 km in diameter). The floor of the valley lies at about 900 m elevation at the northern end, at about 1200 m in the area of Fig. 1, and rises toward 1500 m and above as it approaches HNu and ApI. A series of individual profiles across the valley in the area of Fig. 1 illustrates the setting and details of the individual ridges (Fig. 2). The individual ridges of Dorsa Argentea lie within and along the margins of a broad concave low about 140 km wide and 200-250 m deep. To the east (at about -76.5), units of the older Noachian highlands outcrop. To the west (-78.5 and to the south) higher topography of Hd occurs.

The individual profiles show that the ridges have a variety of cross-sectional shapes (simple symmetrical inverted-v, flat topped, median trough, asymmetrical, complex), that they are typically 50-100 m in height but range up to 120 meters, have widths typically about 2-4 km but are up to 6 km. The more prominent individual ridges can be traced laterally in map view for typically several hundreds of km; less prominent ridges can be traced 50-100 km. Comparison to topography shows that the individual ridges typically maintain similar heights for tens of km, but migrate up and down in elevation several tens of meters. In addition, ridges run generally parallel to the strike of the valley, but do not show a dendritic pattern converging on the lowest point in the valley, as might be expected from surface flow of streams. Instead, the ridges generally parallel contours and when they are sinuous, tend to wind back and forth across the valley irrespective of slope (Fig. 2). The ridges often fork or branch downslope, and show a variety of intersection relationships: some merge or branch to and from one another, while some appear to cross and be superposed on others.

An important contribution of the new topography data is the ability to assess the relationship of these ridges to other units. Figure 1a, b shows that the ridges are prominent in the northeast part of the image but are absent or obscure in the southwest. The unit to the southwest is part of Hd, but is characterized by a variety of textures different from those in the area of the sinuous ridges, including lineated, braided, smooth, and pitted. Detailed examination of the contact between these units shows that the boundary is transitional in some places (central region), but sharp and scarp-like in others (southeast and northwest). In the northeast, the scarp-like contact is accompanied by pits on the southern side of the contact, and on the northern side of the contact several small plateau-like outliers of similar terrain are seen. Taken together, these observations (remnant plateau outliers and pits near the contact) suggest that the unit to the southwest overlies the unit to the northeast, and that it is being stripped back toward the south. This observation is supported by the altimetric profiles (Fig. 2) which show that the surface of the unit to the southwest lies at a higher elevation than the sinuous ridge-bearing unit to the northeast. These data also provide evidence for the relationship of the sinuous ridges to this unit; the sinuous ridges can be traced up to this boundary and show two types of relationships: 1) they disappear rather abruptly, 2) they tend to become progressively more mantled until they disappear completely within the overlying unit. These data further support the idea of the unit to the southwest as mantling the sinuous-ridged plains. In addition, within the overlying unit there are occasional sinuous ridge segments.
exposed and other evidence (albedo streaks and subtle topography) that suggest that the sinuous ridges lie within or under this mantling unit. These new MOLA data provide information to permit an assessment of the several hypotheses proposed for the origin of sinuous ridges [12].


Figure 1. a. Viking Orbiter image 421B53. b. Sketch map of this region. Tick marks indicate top and bottom profile locations.

Figure 2. MOLA altimetric profiles across region in Figure 1.