HIRISE VIEWS AN ENIGMATIC DEPOSIT IN THE ELECTRIS REGION OF MARS.

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Introduction: The Electris region of Mars defines a broadly distributed, unconformable deposit near the western end of Sirenum Fossae (Fig. 1) from 30ºS to 45ºS between 160ºE to 200ºE [1] that is mostly distributed between 1 and 3 km relative to the MOLA datum. This Electris deposit covers an area exceeding 1.8×10^6 km^2 and crater statistics constrain the emplacement and subsequent modification of the deposit to the middle to late Hesperian [1]. Electris materials include outcrops that grade gradually from mantled to unmantled areas or are relatively flat-topped and display abrupt, steep margins (Fig. 1). Some materials characterized by flat-topped chaos-like material in Gorgonum chaos and other regional basins were originally included in the Electris deposit [1], but are probably distinct [1-7].

The Electris deposit is 150-200 m thick, but local thicknesses exceed 300 m, and yields an estimated volume of 300,000 km^3. Outcrops are locally incised and are characterized by relatively flat-lying strata at varying scales that include some meter-scale beds displaying truncating relationships over tens of meters (Fig. 2). Electris materials are variably blocky (diameters typically ~1-2 m), but many outcrops lack boulders. Talus bounding blocky outcrops typically display a relative deficiency of blocks.

Most surfaces possess a TES albedo of 0.12 to 0.16 [8] and a dust cover index of 0.96 to 0.99 [9]. The Electris deposit has thermal inertia (TI) values of ~200 $\mathrm{Jm^{-2}K^{-1}s^{-1/2}}$ (range 185-290 $\mathrm{Jm^{-2}K^{-1}s^{-1/2}}$) that may relate to surfaces of well-sorted sub-millimeter-scale particles (sand-sized), finer-grained, indurated materials, or surfaces with a few percent cover of blocks (e.g., [10]). Compositional data from CRISM is limited by a debris mantle [11] and the paucity of targets. One noisy CRISM observation (HRL000063D1) of the deposit at 188°23'E, 35°07'S, suggests saponite (Mg-smectite) and vermiculite (Mg-phyllosilicate) are the best candidate minerals for any hydrated phase.

Origin of the Electris Deposit: Processes considered for emplacement of the Electris deposit include eolian, volcanic, fluvial, and impact [12-15], lacustrine [6], relict polar deposits [4], and eolian airfall [1, 16, 17]. Newly resolved details of the deposit, however, confirm that the bulk is probably not related to fluvial, volcanic, impact, or lacustrine origins.

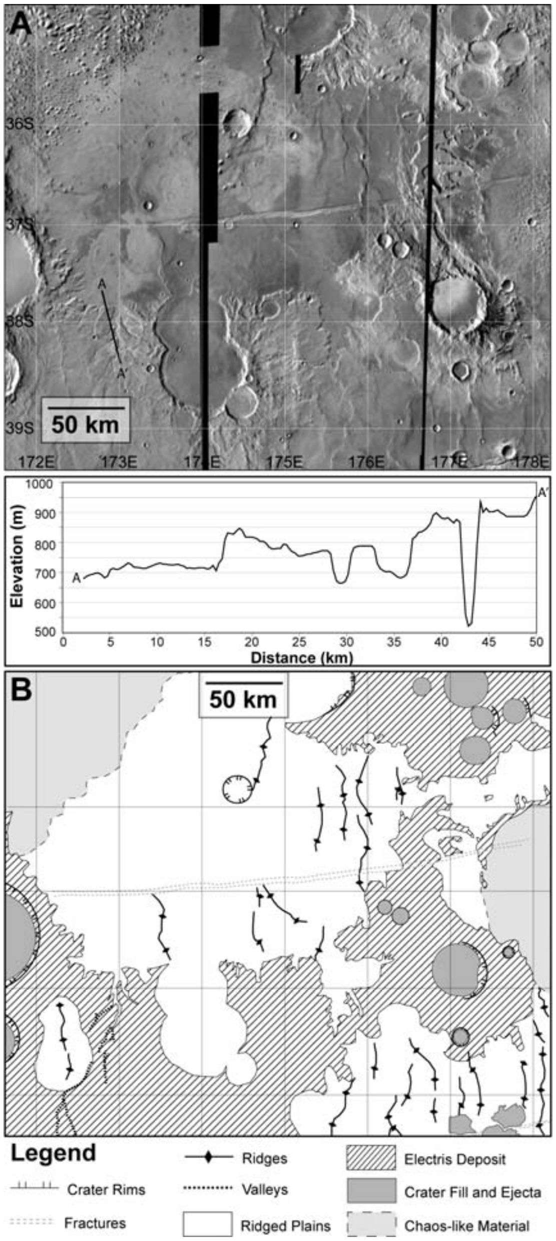

Figure 1. THEMIS Day IR mosaic (A) and geomorphic map (B) of typical Electris deposit, underlying ridged plains, and younger chaos-like material. Deposit thickness in this location ranges between ~150-200 m (profile A-A').

The TI, blocks, and composition may be consistent with a fluvial origin. However, fluvial materials typically show greater variability in expression. Although the large blocks and deposit composition (if weathered in place) may be consistent with volcanics, the inferred fine-grained nature of the bulk of the material (from erosion and TI) is not. Distribution across kilometers of relief, absence of flow features, steep outcrops, extent and scale of bedding, and lack of source vents make a fluvial or volcanic origin unlikely [1, 17].

The lateral extent, thickness, occurrence over kilometers of relief, and steep outcrops may be consistent with impact ejecta, but there is no well-preserved large basin in the vicinity. Moreover, the scale and extent of bedding and inferred fine-grained nature of the bulk of the deposit interbedded with blocks is unlike ejecta.

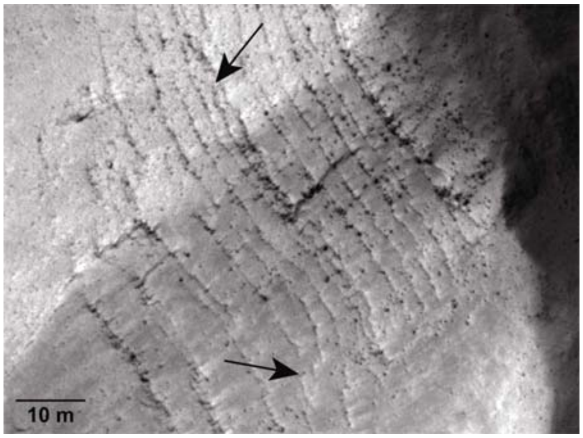

Figure 2. Meter-scale, truncating beds (arrows) in the Electris deposit at 33.9°S, 181.0°E. Varying expression of the layers indicates little contrast in strength. HiRISE image PSP_006247_1460_RED. North is up.

A lacustrine origin might be consistent with the lateral extent, inferred fine-grained nature of the deposit, and scale of some beds. But the blocks, meter-scale truncating beds, and lack of a confining basin [18] argue against this process.

Airfall deposition is broadly consistent with emplacement of a regional deposit blanketing kilometers of relief [1] and the lack of basin-encompassing topography. The overall thickness and uniform appearance of the deposit may also be consistent with airfall processes. Airfall deposition could produce beds whose regional extent, vertical distribution, and scale are consistent with observations, with apparently blocky beds relating to induration or pedogenic activity.

Comparison between the Electris deposit and polar materials reveals significant differences including a paucity of incorporated ice, continuity of bedding, and distance from other polar materials. Deposition of volcanic ash or tuff can mantle pre-existing topography, but fine-scale, continuous beds are lacking and the deposit is not adjacent to a large volcanic source. Although activity in Tharsis is a candidate source for the deposit, no intervening deposits are present.

Emplacement of the Electris deposit as loess is consistent with a regional deposit hundreds of meters thick that mantles considerable relief [19]. Loess is often unstratified at fine scales [19], consistent with the absence of sub-meter beds in Electris. Erosion and pedogenic activity between depositional events could produce the truncating stratigraphy and apparently blocky beds. Shedding of blocks from outcrops and their rapid downslope breakdown is observed in some terrestrial loess, which are typically comprised of silt-sized grains and are commonly exposed in vertical outcrops [19] that may be analogous to Electris. Accumulation of weathered sediments as loess is also consistent with limited compositional information.

Source of Sediment: If the Electris deposit is loess, its emplacement reflects deposition of fines deflated from distant source regions. One source of fine sediment includes weathered ash from Tharsis. Major eruptive phases at Tharsis could yield the large-scale, more continuous stratigraphy versus sediments from individual eruptions and/or short-term climate driven changes responsible for meter-scale beds. Alluvial, periglacial or polar, impact terrains represent other potential sources. Many valleys predate Electris [20], however, and are not associated with comparable deposits. It is also unclear why deflation of sediments from polar regions, which is ongoing, would result in only a single deposit in the southern hemisphere. Finally, Electris-like deposits are not found around impact basins. If loess, distribution of the Electris deposit may help constrain sediment transport and prevailing winds in the middle to late Hesperian.

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