A POSSIBLE VOLATILE-RICH AIR-FALL DEPOSIT IN THE ELECTRIS REGION OF MARS; J.A. Grant and P.H. Schultz, Geological Sciences, Brown University, Providence, RI 02912

INTRODUCTION: A regional, unconformable, mantled and etched deposit occurs in the Electris region at the western end of Sirenum Fossae. This deposit has been interpreted as lava filling volcano-tectonic depressions (1) and as fluvial deposits filling large degraded craters (2); however, both studies considered only the thickest deposits. Examination of all occurrences indicates it is more likely the result of air-fall deposition. Evidence favoring rapid emplacement and short duration suggests that it resulted from a sudden, short-lived, climate change.

OBSERVATIONS: The deposit is unconformable and occurs as an irregular unit on both highlands and plains where it partially to completely buries surfaces and landforms. The deposit attains a thickness of over 700 m, with the thickest occurring in degraded 50 to 200 km impact craters. Deposits in craters range in thickness from 450+ m in eastern areas to 700+ m to the west. Both the deposit and exhumed surfaces display similar, low, crater densities. Although displaying no regular, thin layering, the deposit does appear to consist of several thick layers (10s to 100s of m) in some craters.

The deposit covers approximately 1.8×10^6 km^2 (from about 160^{o}W to 200^{o}W and 30^{o}S to 47^{o}S). It appears to be undergoing active removal which has progressed farthest on low relief plains. Although the original extent is not known, partially filled craters to the immediate south suggests this area was also covered. The surface of the deposit is partially dissected by valley networks which head within the unit, but seldom incise underlying surfaces. A heavily eroded dome is located at 179^{o}W, 36.5^{o}S (Fig. 1) in the northeast portion of the deposit.

The deposit occurs in four distinct classes of differing thicknesses. In some locations (A in Figs. 1, 2), it thins gradually, thereby resulting in an obscure contact between mantled and unmantled areas. Slightly thicker deposits adjacent to these areas resemble gullied cuestas (B in Figs. 1, 2) commonly forming partial rings around degraded craters at constant elevation. These deposits are bounded by low, serrated scarps, usually facing away from the impact center on one side and thinning on the other. A third class of deposits form irregular promontories and mesas about 300 to 400 m thick that are bounded by scarps without basal talus (C in Figs. 1, 2). Such deposits isolated by adjacent valley networks thin in the down-valley direction, whereas other examples are completely ringed by a scarp of near constant relief. The fourth class represents the thickest deposits and occurs in large degraded craters (2) as irregular, angular, flat topped and rounded blocks resembling chaotic terrain (D in Figs. 1, 2). These blocks are from 400 to over 700 m thick and grade into uncovered or thinly buried plains.

DISCUSSION: The fourth class of deposits has been interpreted as lava filled volcano-tectonic depressions (1) and as collapsed fluvial deposits, resulting in the present chaotic appearance (2). We feel the deposit is likely a volatile-rich (ice?) air-fall deposit based on: A) consideration of all four classes of deposits; B) its occurrence over both uplands and lower plains; and C) patterns of removal.

Evidence favoring air-fall accumulation comes from the observation that the deposit covers both high relief uplands and low relief plains. Emplacement over this range of terrain by flood basalts, fluvial processes, or other processes, is unlikely. The deposit appears more easily eroded on plains than in the highlands, probably due to differences in surface roughness. The low density of valley networks/area exhumed and an absence of flow-related features indicates that fluvial erosion is secondary. Efficient eolian erosion of large areas across the deposit argues for the presence of fairly uniform fine-grained material, consistent with an air-fall deposit.

Relatively young valley networks incising the deposit indicate at least local volatile concentrations. This is consistent with observed atmospheric water concentrations over the deposit even in winter (3). The daily winter occurrence of Electris clouds over the most dissected portion of the deposit also suggests a locally high volatile content. These clouds are presumed to be composed of CO_2 (4), but may be water ice.

MARTIAN DEPOSITS
Grant, J.A. and Schultz, P.H.

It is not known if current disparities in thickness reflect original depths and/or variations in rate of removal. Deposits that gradually thin may denote relatively low strength volatile poor zones and/or zones not thick enough for overburden welding, that are undergoing direct eolian deflation. Deposits occurring as scarp-bounded promontories, mesas, and irregular flat-topped and angular blocks may be higher strength volatile-rich areas thick enough to have undergone overburden welding and are dominated by mass-wasting and scarp retreat. The eroded cuesta-like appearance of some intermediate thickness deposits and the chaotic appearance of the thickest may require additional processes.

If the eroded dome to the northeast (Fig. 1) is a volcanic edifice (1, 5) it may have provided a source for the deposit. The major structural fabrics of the area are large ridges/scarps (compression) oriented NNW-SSE (6) and fractures (extension) oriented ENE-WSW (7). If the dome is volcano-tectonic in origin, it is oriented obliquely to both, perhaps due to redirection of the principal local stress field. However, several characteristics of the dome suggest it was not a source of the deposit: A) its isolated nature; B) large deposit volume (about 900,000 km^3) compared to the dome size; C) apparent singular history; D) eroded style compared to adjacent deposits; and E) morphological similarity with other types of terrestrial domes. Other modes of formation (diapirism or sub-deposit basaltic eruptions?) may be required.

Origin by long-term seasonal accumulation during periods of high obliquity (8) is unlikely because of: A) low crater densities on both the deposit and exhumed surfaces favoring rapid emplacement and a short lifetime; B) an absence of thin layering; and C) limited regional extent. Based on gross estimates of the crater density on the deposit, accumulation occurred near the time of formation of Hesperia Planum. This suggests emplacement of the deposit may have been due to a sudden, but significant, short-lived change in climate and erosion rates occurring at that time (9). Similarity of this deposit in age and appearance to other transient deposits in the Isidis, Hellas, and Argyre Basins (10) implies they may be related. The thick layered appearance of the deposit in some large craters may indicate several earlier episodes of burial.

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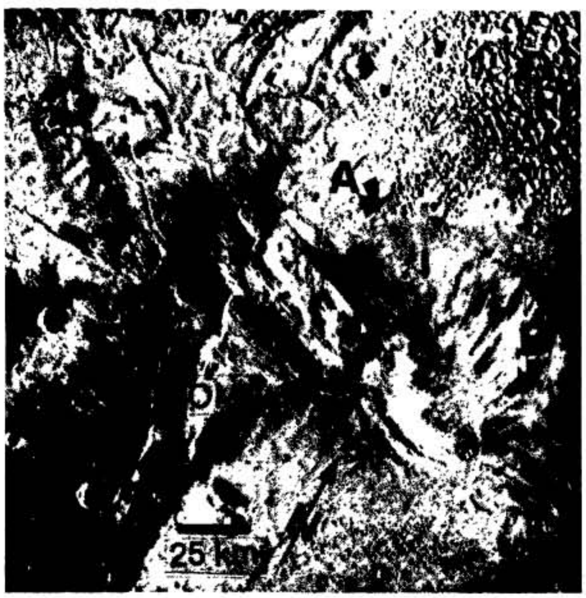

Figure 1. Eroded dome at 179°W, 36.5°S. All four classes of unconformable deposit are shown (A,B,C,D). See text for discussion. Image 597A85.

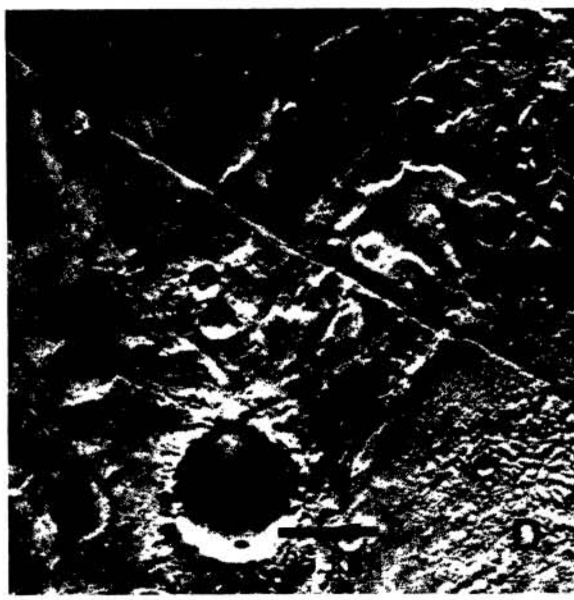

Figure 2. Exhumed (E) and buried topography at 184°W, 37°S, just west of Figure 1. All four classes of unconformable deposits are shown (A,B,C,D). See text for discussion. Image 372S09.