

KNOB FIELDS IN THE TERRA CIMMERIA/TERRA SIRENUM REGION OF MARS: STRATIGRAPHY, MINERALOGY AND MORPHOLOGY.

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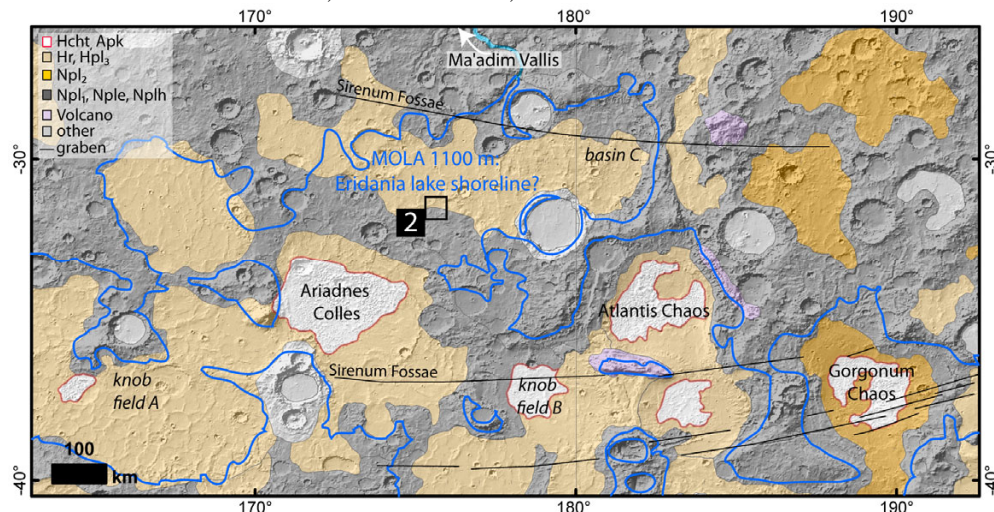


Figure 1: Overview of the knob fields near the head of Ma'adim Vallis, simplified from [1,2]. They have been mapped as Hesperian or Amazonian units [1,2] and lie within the suggested shoreline of the Eridania lake at 1100 m [3]. They contain Mg/Fe clays, yet would have been formed *after* the "phyllosian period" of Bibring et al., 2006 [4], following the stratigraphic interpretation of [1,2,6].

This study of textural and mineralogical features of light-toned exposures at the knob fields around Ariadnes Colles produced a new stratigraphy that integrates past conflicting models of the region.

Introduction: The region between Terra Cimmeria and Terra Sirenum contains several fields of enigmatic knobs, including Ariadnes Colles, Atlantis Chaos and Gorgonum Chaos (fig. 1). They have been mapped as Hesperian or Amazonian units [1,2] and are located within the shoreline of the Eridania Lake, which might have formed Ma'adim Vallis [3]. The knob fields contain Mg/Fe-rich and locally Al-rich phyllosilicates [5,6, this study]. Following the stratigraphic placement by [1,2], the knobs are a location on Mars, where clay-bearing deposits are younger than the Noachian, in a possible disagreement to [4]. The region also features chloride deposits [7] and valley networks younger than the Hesperian ridged plains (Hr unit [1,2]), named Mid-Latitude Valleys (MLV) by [8], and has been proposed as an MSL landing site by [9].

A slightly different stratigraphic interpretation is presented by [10]. They describe the knob fields as "surface type 4" of a possible airfall deposit informally named "Electris deposit", which covers the Hesperian ridged plains and cratered uplands. This has been revised by [6], suggesting that the knob fields are not

part of, but postdate the "Electris deposit", but possibly contain reworked "Electris" material.

Methods: We use imagery from HRSC, MOC, and HiRISE together with hyperspectral data from CRISM to produce geological/geomorphological maps of the light-toned knobs and light-toned patches and the surrounding material based on morphology, stratigraphy and composition in order to decipher the aqueous history of this region of Mars.

Discussion and Conclusions: Our geological mapping of the light-toned knobs and patches forming small outcrops of only a few km² found in the entire region shows that the knob fields are indeed one morphological expression consistent with the "Electris deposit" model [10]. However, the "Electris" deposit does not stratigraphically overlay the ridged plains and is eroded back to the level of the ridged plains, as proposed by [6,10]. Instead, the "Electris" deposit, including the knob fields, is covered or embayed by the ridged plains, and thus is older (fig. 2). Because the ridged plains (Hr) are defined as forming in the Hesperian, this results in a late Noachian age for the "Electris deposit", in agreement with [11]. This also reconciles the apparent contradiction of the stratigraphy suggested by [1,2,6,10] to [4], as the clays would then indeed have formed in the "phyllosian" period, as "sedimentary clays" of [12].

Wide valley networks cut into the "Electris" deposit and may have filled the Eridania lake. However, the knob fields and clays within are observed at varying total elevations, suggesting separated local basins rather than a single large lake at the time of their formation.

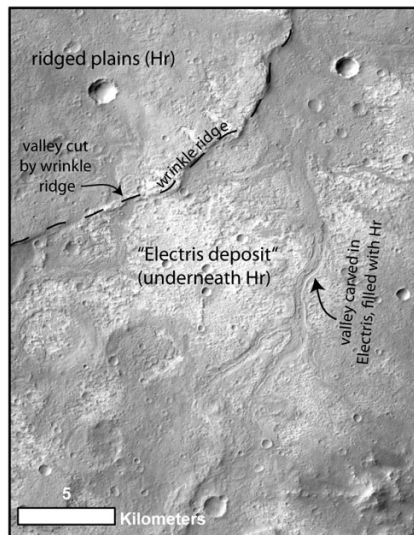


Figure 2: Valleys cut into "Electris deposit", are overlain by Hr material and crosscut by wrinkle ridge. CTX P14_006590_1474_XN 32S184W. See fig. 1 for location.

A second generation of valley networks crosscut the light-toned mounds, knobs and patches as well as the ridged plains. They correspond to the MLV described in the Gorgonum and nearby Newton basins by [8]. The water forming the valleys locally ponded and formed chlorides in "basin C" (fig. 1). In all knob fields except Gorgonum, the aqueous activities predate the formation of Sirenum Fossae. In the Gorgonum basin, valleys fed a lake [8], which postdates Sirenum Fossae.

Our geological and mineralogical mapping and previous studies let us reconstruct the succession of events shown in fig. 3. (1) Deposition of "Electris" airfall deposit on top of Noachian rocks. (2) Valleys carve into "Electris" and form lake. (3) Water level drops to form individual basins, clays form. (4) "Electris" breaks up into individual knobs. (5) A harder outer layer develops. (6) Ridged plains material covers/embays knobs. (7) Wrinkle ridges form by pressure from Tharsis. (8) Localized, precipitation-fed valleys (MLV) form. Water ponds and leaves chlorides. (9) The region is crosscut by Sirenum Fossae (not shown).

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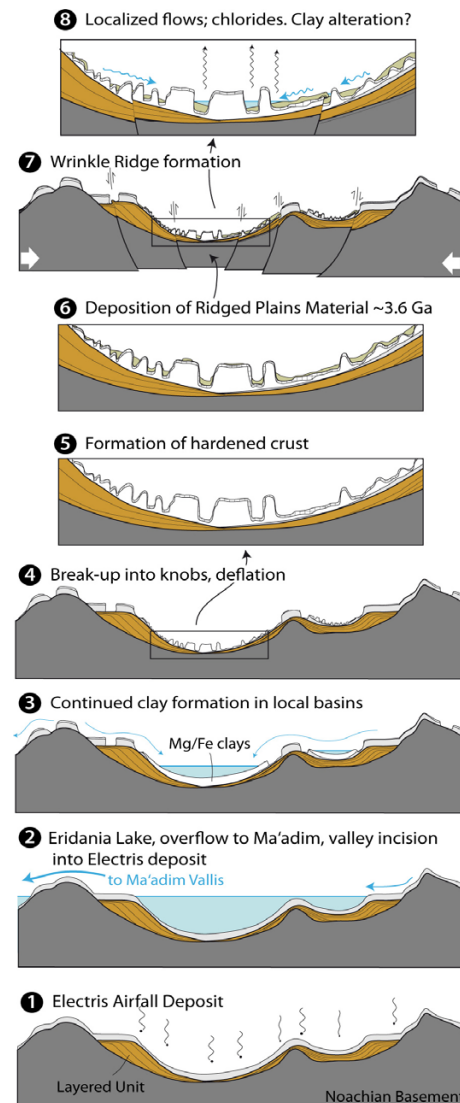


Figure 3: Reconstructed succession of events. See text for further explanation.

References: [1] Scott, D. H. and Tanaka, K. L. (1986) *USGS map I-1802-A*. [2] Greeley, R. and Guest, J. E. (1987) *USGS map I-1802-B*. [3] Irwin, R. P. III et al. (2004) *JGR*, E12, E12009. [4] Bibring, J.-P. et al. (2006) *Science*, 312, 400-404. [5] Annex, A. M. and Howard, A. D. (2011) *LPS XLII*, Abstract #1577. [6] Grant, J. A. et al. (2010) *Icarus*, 205,1, 53-63. [7] Osterloo, M. M. et al. (2010) *JGR*, 115, E10, E10012. [8] Howard, A. D and Moore, J. M. (2011) *JGR*, 116, E5, E05003. [9] Noe Dobrea, E. Z. (2007) *2nd MSL Landing site workshop*. [10] Grant, J. A. and Schultz, P. H. (1990) *Icarus*, 84, 166-195. [11] Baker, D. M. and Head, J. W. III (2009) *LPS XL*, abstract #1835. [12] Ehlmann, B. L. et al. (2011) *nature*, 479, 53-60.