OVAL STRUCTURES ON THE FLOOR OF HELLAS BASIN, MARS. L.I. Leppänen[1] , V.-P. Kostama[1] and J. Raitala[1], [1]Astronomy Division, Department of Physics, Univ. Oulu, FIN-90014 Finland, leena.leppanen@oulu.fi.

Introduction: To the NW of Alpheus Colles, the floor of Hellas has a number of oval structures [1,2] with their long axis in the NE-SW direction [3,4]. The oval area is 6 to 7 km deep (Fig. 1). A few impact craters show that the area may be young [1,2] or lately exposed [4].

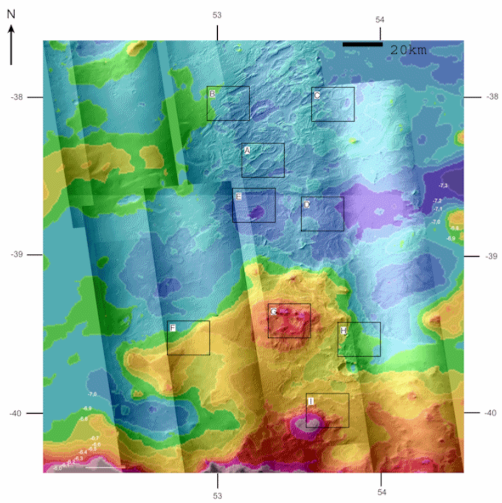

Figure 1. Topography of the area shows a northern depression and an elevated south part. The boxed areas were studied in details.

Characteristics of the ovals: Most ovals are large, oblong and single structures. The NE area has, however, smaller roundish ovals in close connection to each other. The central parts of the ovals are smooth with some indications of layered materials. Just inside of the oval edge there is generally a belt that consists of densely-spaced narrow set of ridges and valleys (Figs. 2b-e). The ridge-valley set may be continuous but, in cases, forms a spiral. The edge varies from a distinct one to a broken one. Closely-spaced ovals may share the edge for some distance. The edge may be missing or may be a depression.

The area between two connected ovals displays usually sets of parallel lineaments (Fig. 2a). These lineaments vary in their characteristics. In the southern part of the study area, the lineaments are clearly visible and they border rather featureless oval interiors that display some layering only. In places the lineaments form complex structures with multiple layers (Fig. 2d), bending or folding structures (Figs. 2b,d,e), and deep contouring canyons possibly indicative of easily eroded materials (Fig. 2d).

Observed lineaments vary in their appearance and may have different origins. Some of them are bands with different colors. Others are prominent ridges and valleys or distinct canyons reflecting differences in resistance against erosion. In places they resemble folded dome structures exposed by later erosion (Fig. 2f). Dust that covers most of the area may have been deposited and removed related to topography thus possibly enhancing differences that relate to color, layering and erosion. Dark stripes may be originally dark or they are seen darker in relation to their dust-covered surroundings [5]. Some structures display such a 3D lineament arrangements that can be explained by doming of a layered material by diapir or raising plume [3].

Oval formation: A dome rise can be explained by convection where a buried less-dense material rises upward and the denser covering material moves away from the top and sinks down aroud the rising dome. Variables that relate to the effectivity of convection are related to temperature, and differences in density and viscosity. The rising mass assumes different shapes based on the tectonic stress field and pre-existing faults and other structures.

Terrestrial diapirs may also relate to magma plutons that produce dome-like batholiths and laccoliths. Mangold and Allemand (2003) claim that the origin of the Hellas' ovals is due to a magma rise from the lower crust. Similar convection may also take plase in a deep impact melt body or in a basaltic lava lake [3]. The main difference between the cases is that the deep magma rise produces larger oval structures than the more shallow impact melt body or a lava lake.

The size of the observed ovals in Hellas resembles certain terrestrial salt domes in their appearance. This explanation was adopted for the Martian ovals located in Candor Chasma [6]. The near by ridge network may fit to this hypothesis [7]. The vertical scale of the salt domes in Iran is 1 to 10 kilometers. The size is related to the depth, thickness and composition of the evaporite layer [8]. A gypsum-rich composition, for example, might make a good dome-forming material.

Another and strikingly different explanation involved buried ice [8,9]. This is based on the existence of ice and water-containing minerals on the floor of the Hellas Basin. Icy diapir is formed ten times faster than a diapir made of gypsum. The co-existing brine may also increase any salt diapir growth in a way that depends on temperature, pressure and the amount and type of salt in brine. The most extreme is the proposal that involves a convection diapir formation within a glacial ice [3].

The diapir size vs. the formation depth: The simplest estimate is that the diapir diameter equals the formation depth [8]. Terrestrial salt domes are 100s to 1000s meters apart and reach the surface in 10^4–10^6 years [10] if both depth and thickness of the salt layer is at least 6 km [7]. The 5-10 km wide diapirs have a 2-3 km thick salt layer [11]. Hellas' impact melt layer may have been 2 km [12]. The alternative salt layer may have formed during the lacustric phase of the Hellas Basin [3].

The use of the two equations for the terrestial salt domes by Jackson et al. (1990) and Turcotte and Schubert (1982) gave following values:

Area	Wavelength	Depth
A	7955 m	3098 m
C	5069 m	1974 m
D	3684 m	1435 m
E	5160 m	2009 m

The diapir depth is thus 1,5 to 3 km. If the depth relates to the diameter [8] the depth of Hellas' diapirs is 2 to 12 km. Both values fit to the convection in the impact melt [3] and in the sediment stack. Plutonic diapirs, in contrary, should produce much larger structures than what is observed in Hellas.

The location of the ovals just beside Alpheus Colles may support the convection-in-the-sediment-layer alternative. The structures and their erosion- and fold-like details in the interiors of the ovals also support the idea of the existence of layered sediments within the Hellas basin.

The young appearance has to reflect a period of time of sheltering the area by a protecting layer (possibly related to the smooth terrain in to the north). Some of the studied ovals still have a partial cover. Variations in the observed oval properties reflect differences in their formation, burial depth, depth of the active layer, and in differences in their age, time being covered, exposure age and thus in their deformation.

References:

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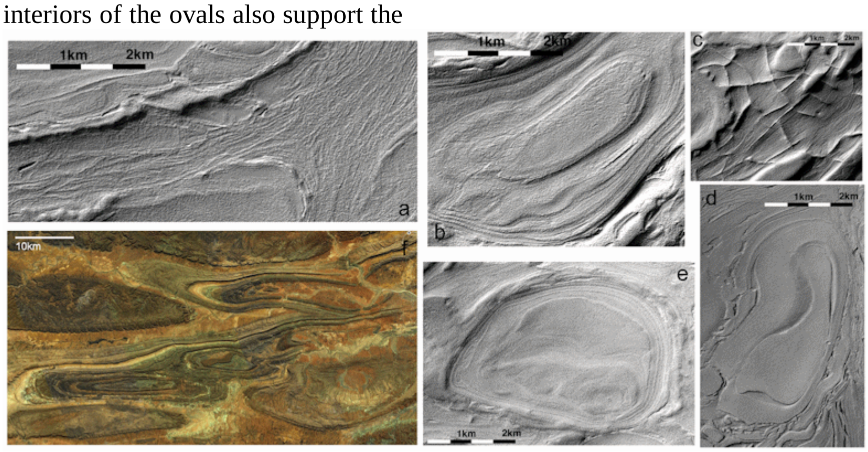

Figure 2. a. The triple junction area between three ovals shows sets of ridge-valley lineaments (Fig. 1, area E). **b.** The elevated oblong oval center (Fig. 1, area A) is surrounded by oblong set of ridges and valleys. These have similar ovoid-centered dips that indicate the existence layered and folded material exposed by erosional processes. **c.** The distance between parallel network ridges is 1 km if close to ovals but diminishes to 0.5 km in the north and west (B in Fig. 1). A smooth terrain that covers ridges increases in coverage in the north. Deformed impact craters show that the smooth terrain is easily eroded. **d.** Distinct troughs contour the smooth interior (Fig. 1, area F). This and the eroded outskirts indicates layers which resist erosion in a different way. The elevated central part is elevated, possibly due to folding or convection. **e.** The rounded oval (area C in Fig. 1) has an elevated edge against the surrounding terrain. The ridge-valley belt surrounds the gentle sloping interior. **f.** Deeply eroded structures of an old folded belt in central Australia are seen as ovals that closely resemble ovals on the Hellas' floor. Coordinates of the centre of the Google Earth image are 24˚23"S, 132˚8"E.