STRUCTURAL ANALYSIS AND TECTONIC RECONSTRUCTION OF THE EASTERN MARGIN OF THE THAUMASIA PLATEAU (MARS). F. Borraccini[1], G. Di Achille[2], G. G. Ori[2], F. C. Wezel[1], [1]Istituto di Scienze della Terra, Università di Urbino "Carlo Bo", Urbino, Italy, [2]International Research School of Planetary Sciences, Pescara, Italy.

Introduction: Several studies were previously performed in order to reconstruct the complex geologic history of the whole Thaumasia region [1, 2, 3, 4]. This topic remains still controversial and worth a close investigation. We undertook a detailed structural mapping and tectonic analysis of a 2.400.000-km^2-wide area in the eastern Thaumasia region based on HRSC, Themis and MOC images, and on MOLA data (Fig. 1). Furthermore we investigated the structural associations through time in order to propose a tectonic model which can take into account for the inferred deformational sequences.

Methodology: The digital mapping revealed more than 8000 tectonic features. Their rose diagrams and densities of fault length (with their variation through time, Fig. 2) have been determined for each of the stratigraphic units defined by previous geological maps [3, 5]. Specific interpretations have been proposed for three sub-areas: the central-eastern Valles Marineris (VM in Fig. 1), the Felis Dorsa-Bosporos Planum (FD-BP in Fig. 1), and the Melas Dorsa regions (MD in Fig. 1), taking into account structural associations, cross-cutting relationships, lineaments orientations and density of fault length (Fig. 2). Inferences on kinematics and evolution of the sub-areas were integrated into a tectonic evolutionary model for the overall eastern margin of Thaumasia Plateau (Fig. 3) which is following referred to as EMTP.

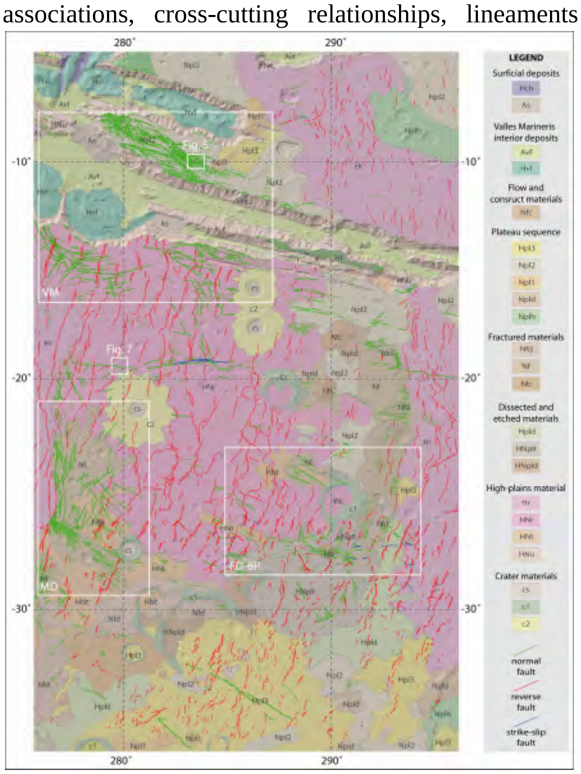

Figure 1. *Geologic-structural map of the EMTP. Geologic contacts and stratigraphic relationships have been redrawn after [2,5] for the areas South of VM and North of VM, respectively. The figure also shows the location of the three areas (VM, FD-BP, and MD).*

Tectonic features: The whole study area is highly deformed and shows structural features with different kinematics, and age (Fig. 1). It represents a key sector for the investigation of the tectonic interaction among the major regional features (i.e. Coprates Rise/Nectaris Fossae, Coprates Chasma/Valles Marineris, Thaumasia Planum). In fact, while the Thaumasia Plateau shows rather regular southern and western margins, its eastern edge appears dissected and complicated by transverse tectonic lineaments. This may reflect a complex evolution in which the reactivation of pre-existing regional structures could have played a major role.

Central-eastern Valles Marineris (VM). In this area (Fig. 1) we recognized an early deformational phase consisting of complex grabens generally NW-SE oriented and dissecting the Noachian Npl2 unit of the plateau sequence. This phase is consistent with a SW-NE extensional stress field. According to our mapping, this stress field was active up to the Late Noachian, since associated faults are sutured by Early Hesperian units. This is also confirmed by the trail off in the density of extensional structure length for the plateau sequence at the boundary between Noachian and Hesperian (Fig. 2).

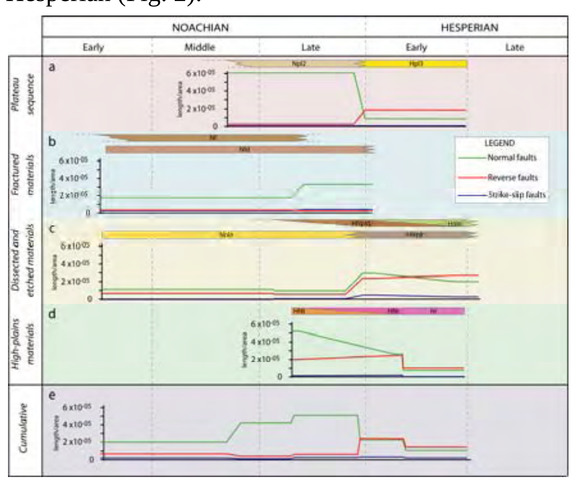

Figure 2. *Areal density of fault length for each stratigraphic unit (cumulative length of structures / area of the outcrop) and its variation through time. The cumulative density graph has been calculated as a mean density for all the units of the same age. The stratigraphic columns have been redrawn from [2].*

A second deformational phase is recorded in the High-plains materials which date from Late Noachian to Early Hesperian. This tectonic event likely produced the formation of wrinkle ridges in Solis Planum and Lunae Planum. Their distribution is likely consistent with a southeastward tectonic transport possibly related to the outward sliding of the whole Thaumasia Plateau from the Syria Planum volcanic centre [4]. This phase could have occurred between the Late Noachian and Early Hesperian as evidenced by the graph related to the density of structure length of High-plains materials (Fig. 2).

Felis Dorsa-Bosporos Planum (FD-BP). The older family of structures in this area consists of NW-SE trending grabens affecting the Noachian Nf and HNt units. The stress field responsible for the formation of these sets of grabens is similar to that inferred for the first deformational phase in VM area. Hesperian formations (HNr and Hr) are mainly affected by roughly N-S oriented wrinkle ridges and E-W tectonic lineaments. These structures can be associated with the above mentioned southeastward sliding of the Thaumasia Plateau.

Melas Dorsa (MD). The oldest unit (Nf) across the whole study area is affected by two main sets of extensional faults mostly arranged in simple grabens (Fig. 1). The two sets of grabens were active during the end of the Noachian, but they likely became inactive in the early Hesperian since they are sutured by the Hr unit (Fig. 1). The compressional phase, already found in the other two areas, is visible also across the MD study sector whithin both the Noachian (Nf and HNt) and the Hesperian (HNr and Hr) units indicating an as early as Early Hesperian activity.

Remarks on the tectonic evolution: According to our tectonic survey and structural analyses, we found that the deformative phases recognized in each studied areas can be traced in the whole EMTP, outlining this overall evolutionary model (Fig. 3):

- The oldest N-S oriented grabens can be ascribed to a Noachian extensional phase likely related to the activity of the Syria Planum volcano-tectonic province (Fig. 3b).
- A second extensional event whose effects are mainly visible in Npl2 unit, occurred in Late Noachian. This is consistent with a NE-SW extensional stress field which could have been also responsible for the structuring of a proto-Valles Marineris as extensional feature (Fig. 3c).
- At the Noachian-Hesperian boundary a major change in stress regime occurred (Fig. 3d): the Noachian stress field, responsible for the formation of N-S and NW-SE normal faults, decreased. Contrarily, Hesperian units (HNr and Hr) experienced tectonic shortening resulting in the emplacement of roughly N-S wrinkle ridges and regional scale ridges (e.g. Coprates Rise and Melas Dorsa).

During the last phase the active stress field could have been also accommodated along favorably oriented tectonic lineaments inherited from previous extensional phases which could have been reactivated as transfer faults accommodating differential motions among lithospheric blocks within the EMTP. This mechanism could explain the prominent eastward motion of the Coprates Rise front with respect to the Thaumasia Highland front (Fig. 3d).

References: [1] Anguita et al., 2006, *Icarus*, in press; [2] Dohm and Tanaka, 1999, *Planet. Sp. Sci.*, *47*; [3] Dohm et al., 2001, *USGS Inv. Ser. Map I-2650*; [4] Webb and Head, 2002, *LPSC XXXIII*, *#1358*; [5] Scott and Tanaka, 1986, *USGS Inv. Ser., Map I-1802-A*.

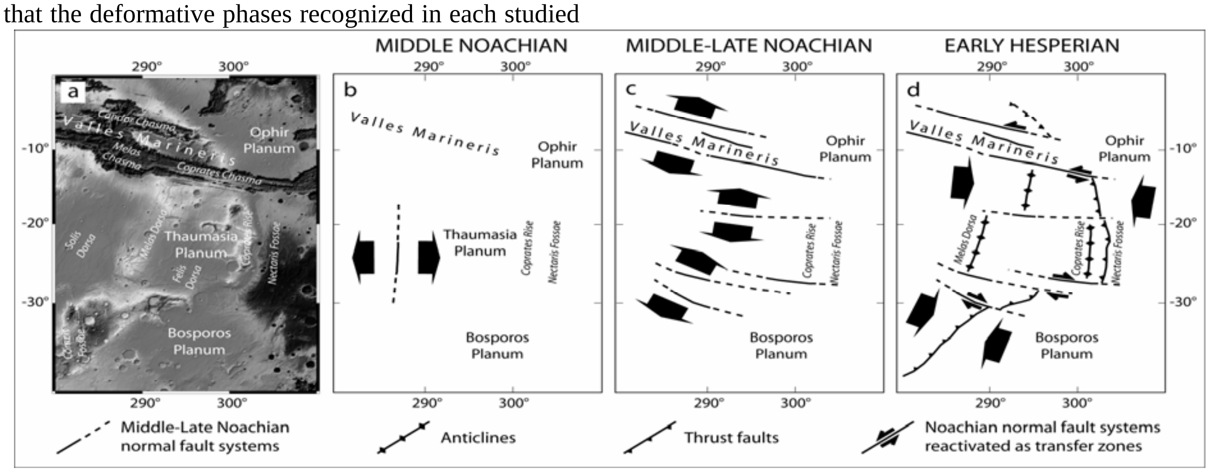

Figure 3. *Tectonic evolution of the EMTP. (a) Shaded relief map of the EMTP; (b) tectonic phase ascribable to the Middle Noachian which produced a N-S striking set of grabens visible at the southern termination of the Melas Dorsa where Noachian units crop out; (c) Formation of WNW-ESE striking normal faults; (d) formation of thrust faults and folds as a result of the eastward motion of the Thaumasia Plateau. Normal faults inherited from previous tectonic phases could have been reactivated as transfer zone accommodating differential movements of the Thaumasia Plateau blocks.*