GEOLOGICAL EVOLUTION OF THE TYRAS VALLIS PALEOLACUSTRINE SYSTEM, MARS. G. Di Achille[1], L. Marinangeli[1], G.G. Ori[1], E. Hauber[2], K. Gwinner[2], D. Reiss[2], G. Neukum[3] and HRSC Co-Investigator Team. [1]International Research School of Planetary Sciences, Pescara, Italy (gadiachi@irsps.unich.it), [2]Institute of Planetary Research, DLR, Berlin, Germany, [3]Remote Sensing of the Earth and Planets, Freie Universität, Berlin, Germany

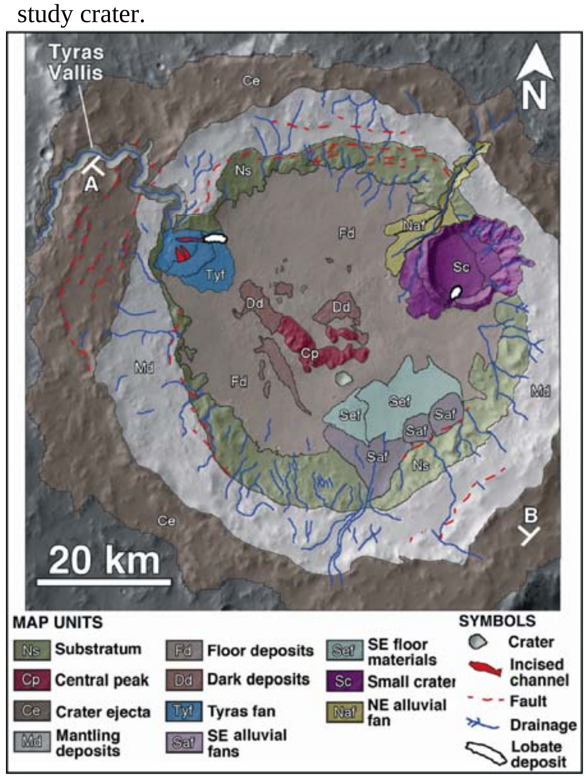
Introduction: Compelling evidence of past and sustained hydrological activity have been described in the intercrater plains of the Xanthe Terra region, based on Viking and MOC images [1, 2]. In order to detect past depositional environments we undertook a new regional geomorphological/geological mapping of the Xanthe Terra using High Resolution Stereo Camera (HRSC) data [3] in addition to previously released Martian imagery. High resolution topography derived by HRSC stereo images supports the morphometric analysis of the deposits which aids to reconstruct the overall sedimentary history of the basins. Several fan-shaped deposits, revealing a wide morphological variety, are visible within the study area [4, 5]. We present a geological analysis of a potential lacustrine system formed by the Tyras Vallis channel and an as yet unnamed complex crater (70-km-diameter, Fig. 1), in which the former channel flowed and formed a fan-shaped distributary feature (here-after referred to as the Tyras fan). To investigate the geology of the paleolacustrine system, we considered the geomorphologic characteristics of the mapped units (Fig. 1) and determined their relative ages based on stratigraphic relationships.

Study area: The complex crater (49°30' W, 8°20' N) is located southward of the Chryse Planitia basin, close to the crustal dichotomy boundary, and it has been dated to the Noachian [6]. Local hydrography is largely dominated by the two branches of the northeast oriented Nanedi Valles network and by several secondary valleys: Tyras, Hypanis and Sabrina Valles. The regional groundwater system was probably recharged by a combination of precipitation and infiltration of water during warmer terrestrial-like conditions [2], or by local mechanisms of recharge, such as hydrothermally induced circulation driven by volcanic heat or residual heat from impacts [7, 8].

Tyras fan description: The fan is confined in its proximal part by the crater wall slope morphology and covers an area of about 83 km^2, with a 13 km radial length and an average slope gradient of about 3.5°. The apex of the fan lies about 900 m above the crater floor, and based on the detailed topography derived by HRSC (Fig. 2), we divided the fan into an upper (I), a central (II), and a lower (III) parts. The upper portion (Fig. 2-3) extends from the apex to the first scarp (10-30 m in height), which occurs at a radial distance of about 4.5 km. The MOC imagery of the upper fan shows (Fig. 3) a continuous horizontal layering pitted by many small impact craters, filled with aeolian deposits. This portion is also carved by two eroded radial features that terminate at the first scarp position. The central terrace (Fig. 3) starts just below the first scarp and extends for about 2 km. It is covered by smooth materials and does not present visible layers, apart from those within some erosional windows. This rather flat plane interrupts the radial profile of the fan (Fig. 2) and marks the transition from the convex-upward shape of the upper fan part (I) to the almost straight segment of the lower fan portion (III). This terminal part extends from the second scarp (approximate height is 30-50 m) which occurs at about 7 km from the fan apex and wanes towards the crater floor. The distal fan portion has a smoother morphology than the upper part (Fig. 3). Its surface does not display bedding and is mantled by smooth deposits, the continuity of which is interrupted by a sequence of randomly spaced contouring bands observable only over this part of the fan.

Interpretation and evolution: The Tyras deposit presents the typical morphological features (e.g. fan-head incision, downslope terrace and segmented radial

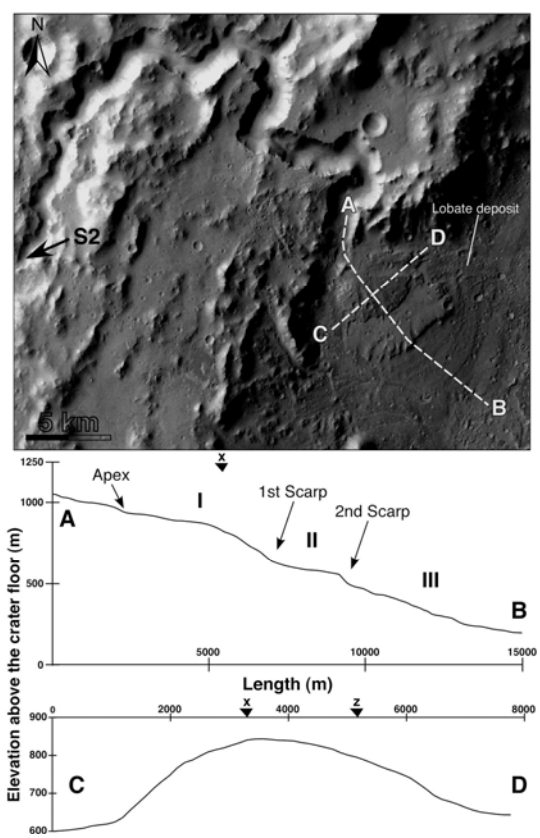
Fig. 1 – Geological/geomorphological map of the study crater.



profile) of a fan-delta which underwent a complex depositional/erosional evolution. The longitudinal scarps, the evident central terrace and the contouring bands in the distal portion of the fan, were interpreted as a result of wave erosion occurring during the main stationary water levels of the basin before the definitive retreat of the lake. The distributary feature was likely formed as a complex fan-delta produced by a main depositional phase and simultaneously affected by at least two main erosional stages. The fan has been used as sedimentary recorder of the crater lake history and allowed to assess the overall hydrological evolution. Two major stands of the water level have been inferred (700 m and 550 m above the crater floor), based on the correlation between the morphology and topography of the fan and the crater floor deposits. Wave height analysis in fetch-limited settings and morphological comparison with terrestrial analogues [9] support this hypothesis [4].

Paleoclimate and water sources. Although the formation of the Tyras Vallis system could be explained by water releases provided by the local groundwater system in presence of favourable climatic conditions [2], we believe that the overall Tyras Vallis physiographic settings (characterized by a sharp downstream steepening) and the local hydrology strongly suggest a causal relationship with the study impact crater. Therefore, we think that the reactivation of the local subsurface water system could have been triggered by the heating effect of the impact or by impact-related hydrothermal activity [7, 8] that might have accelerated the replenishment of the aquifer largely through melting of ground ice/permafrost. Quantitative analysis, based on the available impact heat and the subsequent water releases, is compatible with this hypothesis [4].

Fig. 2- Overall view of the Tyras fan from HRSC orbit 927 with longitudinal and transversal topographic profiles.



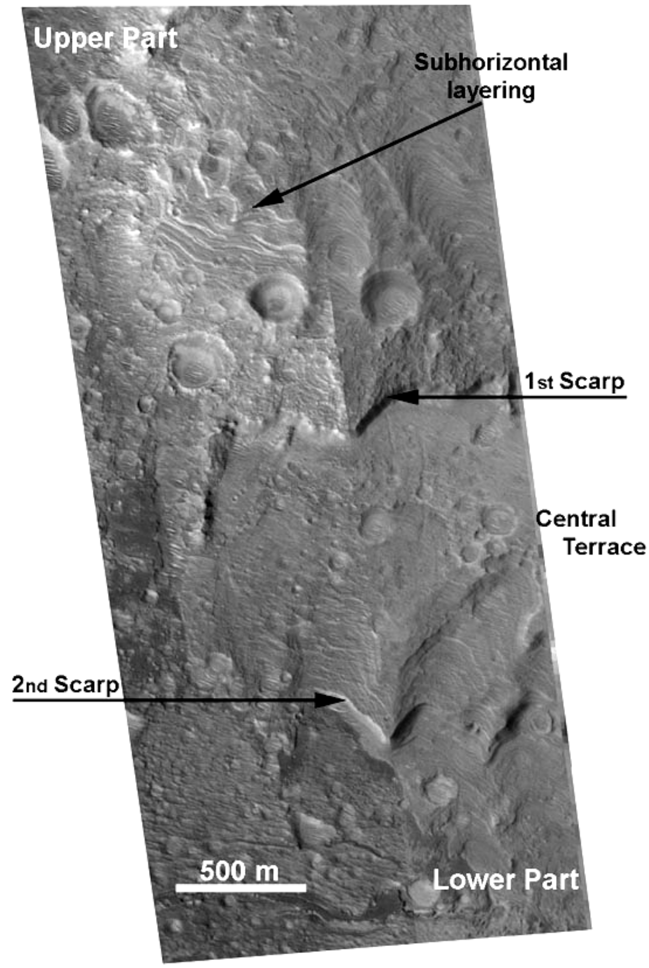


Fig. 3- MOC narrow angle mosaic of the Tyras fan showing the sub-horizontal thin-layered upper portion, the first scarp separating the upper fan from the central terrace, and the lower part of the fan below the second scarp.

References: [1] Nelson and Greeley (1999), *JGR*,104; [2] Carr and Malin (2000) *Icarus, 146;* [3] Neukum et al., (2004), *ESA Spec. Pub.*, 1240; [4] Di Achille et al., *JGR* (in press); [5] Hauber et al. (2005), *XXXVI LPSC*, #1661; [6] Scott and Tanaka (1986), *USGS Map*, I-1802-A; [7] Newsom et al. (1996), *JGR, 101*; [8] Brakenridge et al. (1985) *Geology*, 13; [9] Nava-Sanchez et al. (1995), *Sedimentary Geology*, 98.