AN INVESTIGATION OF MORPHOLOGIES IN NORTH TYRRHENA TERRA, MARS. G. Caprarelli[1], M. Pondrelli[2], S. Di Lorenzo[2], L. Marinangeli[2], G.G. Ori[2], [1]Department of Environmental Sciences, University of Technology, Sydney, PO Box 123, Broadway, NSW 2007, Australia, Graziella.Caprarelli@uts.edu.au, [2]IRSPS, Università d'Annunzio, Italy.

Introduction: North Tyrrhena Terra is an eastern hemisphere sub-equatorial area on Mars's Southern Highlands. It straddles the Amenthes and Mare Tyrrhenum quadrangles, and is located south of the crustal dichotomy (Fig. 1), which in this region is not as sharp and well defined as it is in the western hemisphere.

A broad NW-SE depression known as Amenthes Planum bounds the study area to its west. The distal reaches of Amenthes Planum are included in the study area. Amenthes Planum is surrounded by highly cratered ancient ridged highlands terrains, that are also studied in this work.

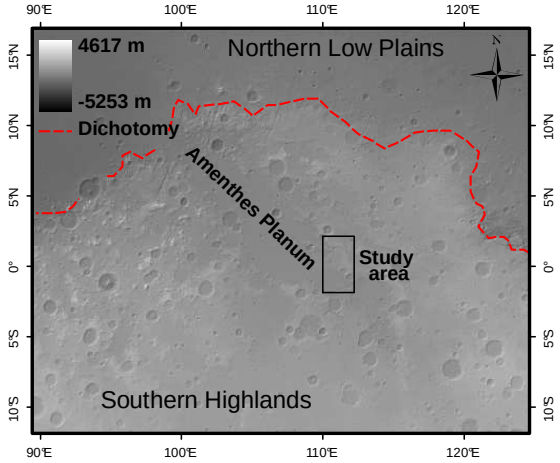

Fig. 1 – Geographic context of study area, showing the main geographical elements of the region. The map is based on equidistant cylindrical projected MOLA DEM data, and comprises a partially transparent grey-scale map of MOLA DEM at resolution ~ 430 m/pxl, overlying a shaded relief raster calculated from the MOLA data. The red dashed line represents the approximate position of the crustal dichotomy.

Data from Mars Express High Resolution Stereo Camera (HRSC) provide us with high resolution imagery (~25 m /pxl), digital terrain model elevation data (~ 50-100 m/pxl; [2]) and large area coverage, and are thus instrumental in geo-morphological studies of martian surface features. MOLA DEM data give contextual information and, where available, MOC NA images (resolution ~ 3-7 m/pxl) provide additional detail.

Studies of this area were undertaken to characterize in detail surface features in a relatively flat and otherwise poorly investigated region of Mars, and to draw inferences about the geological processes that have shaped the region [1].

Data analysis and discussion: Flat morphologies on Mars are common in the southern hemisphere, where ancient terrains are characterized by Noachian degraded large impact craters encapsulated in intensely dissected ridged terrains. Understanding the nature of the geological processes that shaped the ancient ridged terrains is substantially aided by high resolution - high quality imagery, that reveals diagnostic details.

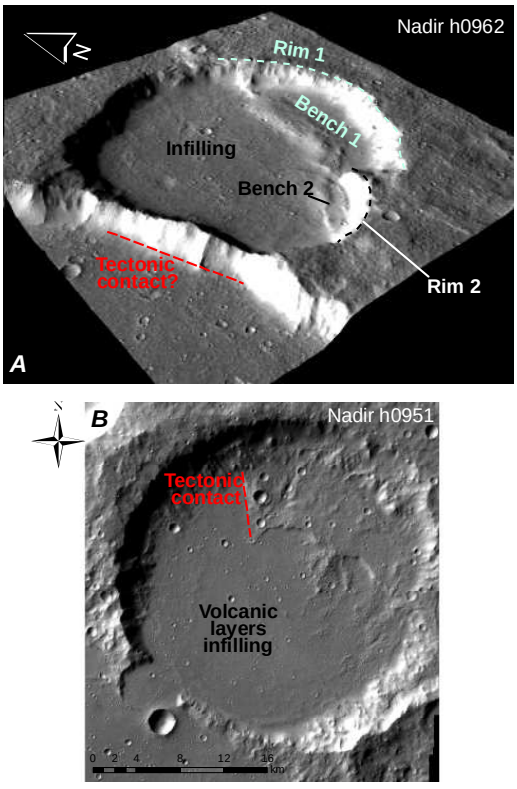

Fig. 2 – Two types of craters identified in north Tyrrhena Terra. (A) 3-D view of putative caldera obtained by draping HRSC nadir image from tracts of orbit h0962 onto h0962 elevation data. Vertical exaggeration: 2. (B) Large impact crater (~ 31 km in diameter) modified by tectonism and infilled by volcanic layers.

In north Tyrrhena Terra two types of craters were identified: large impact craters modified by erosion, mass wasting and geological processes, and craters with features resembling terrestrial calderas (Fig. 2).

The latter display diagnostic features including multiple rims and internal benches. In Fig. 2A an example of a putative caldera (~ 13 km in diameter) is shown: the shapes of at least two crater rims (Rim 1 and Rim 2 in figure) are identified, and within each a bench (Bench 1 and Bench 2, respectively), clearly standing out from the rest of the material infilling the crater. Multiple rims and benches are common on terrestrial calderas associated to basaltic volcanism, such as those on the island of Hawaii [3]. Caldera craters are ponded by magma. The putative caldera shown in Fig. 2A has been modified by post-caldera processes, as testified by the incomplete rims and shallow crater floor (depth ~ 500 m): however, it is plausible that the smallest (and more central) rim (Rim 2) represents a younger collapse event than the one represented by the outermost larger rim (Rim 1). Consistently, the scarp of Bench 1 is 100 m above the crater floor level, while the scarp of Bench 2 is 50 m above crater floor level. Infilling material is probably mostly composed of ponded lava, although material due to degradation and blown within the cavity by aeolian activity may count for a portion of the infilling. The straight and narrow ridge bounding the SW portion of the caldera is straight, and separates the caldera from a larger crater (not shown in the figure). Terrestrial calderas may be composed of separate collapse features, usually at different depths within a volcanic complex [3]. The floor of the crater to the SW of the putative caldera shown in Fig. 2A is 100 m lower than the caldera floor, which might suggest that the larger crater is a younger component of a volcanic complex comprising also the putative caldera. However, the height of the ridge separating the two depressions runs counter to this interpretation. It is possible that the ridge is a tectonic element, deserving of further investigation.

The large impact crater shown in Fig. 2B displays a straight tectonic contact between a rough surface located in the NE sector of the crater, and a very smooth younger horizontal surface, separated from the other surface by a ~ 150 m tall scarp. The scarp is interpreted to be a normal fault, whose NNW-SSE strike is coherent with other tectonic features observed in the study area [1]. The younger surface is the topmost layer of the material infilling the crater, and it looks similar to the material infilling the valley that opens to the SW of the crater, and that represents the terminal SE portion of Amenthes Planum. In the valley small wrinkle ridges are visible [1]. These indicate that the rocks infilling the valley are stratified. In addition, based on studies on Mars and other terrestrial planets, where wrinkle ridges were found to be associated to volcanic rocks [4], it is possible to speculate that the rocks are volcanic. These extensive lava layers are not associated to any visible volcanic construct.

The analysis of the surface features observed in the study area suggests that various styles of volcanism occurred. In the case of flood volcanism, that cannot be correlated to any specific volcanic construct, it is speculated that some of the tectonic features identified in the study area [1] are related to extension of the crust, leading to the formation of dilational features from which flood lavas extruded.

Conclusions: Detailed investigation of surface features in north Tyrrhena Terra revealed complex morphologies, not apparent in earlier images of Mars. The morphologies are associated to an equally complex geologic history of the study area, whose reconstruction is consistent with tectonic and volcanic activity [1]. The most recent volcanic activity was probably associated to extensional tectonics. Further investigations in adjacent areas will provide information on the spatial extent of these processes and their role in shaping this region of Mars.

References: [1] Caprarelli G. et al. (submitted). [2] Gwinner K. et al. (2005) *Photogrammetrie, Fernerkundung, Geoinformation, 5*, 384-387. [3] Mouginis-Mark P. J. and Rowland S. K. (2001) *Geomorphology, 37*, 201-223. [4] Leverington D. W. (2006) *JGR, E11002*, doi: 10.1029/2004JE002382.