AMPHITRITES PATERA STUDIED FROM THE MARS EXPRESS HRSC DATA. Aittola, M.[1], V.-P. Kostama[1], J. Raitala[1], J. Korteniemi[1], R. Greeley[2], D. Williams[2], E. Hauber[3], G. Neukum[4] and the HRSC Co-Investigator Team. [1]Planetology group, Univ. of Oulu, P.O. Box 3000, Oulu, Finland, <marko.aittola@oulu.fi>, [2] Dep. of Geological Sciences, ASU, USA [3] Inst. of Planetary Research, German Aerospace Center (DLR), Berlin, Germany [4] Inst. of Geosciences, Freie Universitaet Berlin, Germany.

Introduction. Amphitrites Patera is located on the ridged plains of Malea Planum, to the south of the Hellas basin [1,2] and was interpreted to be of volcanic origin on the basis of the Viking and Mariner 9 data [3,4], which has been established further by the later data sets [5,6]. It has been suggested that the shield of Amphitrites Patera is mainly made up of pyroclastic rock [1]. Amphitrites Patera - as well as the other highland paterae - has a low relief and unique flank morphology, which is why they all have been considered a distinct group of volcanoes [7-9]. The Patera is 120 - 130 km across and the elevations around its margin are ~1.7 km [5,6]. The nearby Peneus Patera is locating just 250 km west from the center of Amphitrites Patera. These two features compose a volcanic complex, which is surrounded by ridged plains and the channels of the Axius valles in the north. The ridges have a relief of several hundred meters relief and in general they appear to be oriented radially to Amphitrites [5,6].

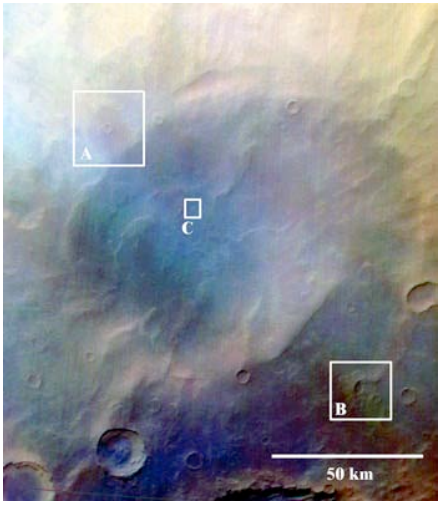

Fig. 1. The Mars Express HRSC stretched RGB color image of the Amphitrites Patera. The area of the studied features are shown with white boxes. A - volcanic edifice; B - lava flows in connection with impact crater; C - volcanic plug or neck structure.

The new data from ESA's Mars Express mission, which is used also in this study, provide us advanced – more versatile – tools to study the geology of Mars. The HRSC camera produces 10-50 m/pix multi-spectral orthoimages which are complimented by high resolution stereo images. Due to the different channels, the mission gives us a possibility also to gather the information about the properties and divergences of surface materials. Therefore, the strength of the Mars Express, and especially the HRSC camera, is its versatility. It enables the studies of the planet's geology with many methods of remote sensing and will open new possibilities to solve the problems of the old paterae within the Hellas region. This study has been made by using the Mars Express HRSC data from orbit 30.

Observations from the HRSC data. Different color channels of the Mars Express HRSC camera offer a possibility to define and add more detail to the surface materials and geological units. Using red- and infra-red channels we recognized two different material units within the caldera of Amphitrites Patera (Fig. 2). Of these, the darker material (*df*) is located in the western part of the caldera. The MOLA, as well as HRSC stereo data, shows that the area of this dark deposit is the deepest part of the caldera. Therefore, it may reflect to the deposit accumulated to the caldera floor and could be for example of aeolian origin, although there is no clear evidence of large scale aeolian activity, e.g., dune fields. The other caldera unit (*bf*) is seen as somewhat brighter in the red channel and it covers the eastern part of the caldera floor. This unit differs from the material of the caldera rim and the flank in the red- and infra-red channels. The material of the unit intrudes into the fractures and the canyons of the rim (*brf*) thus superposing the rim of the patera. The two described caldera floor units cannot be identified in the blue or green channel images. Also the northern and southern flanks of the patera show very different characteristics in the red channel, the northern flank (*brf*) being bright and southern (*drf*) dark. Some of this characteristic may be mixed with the illumination geometry. Still, in the green channel the area to the south of caldera seem to differ notably from the materials of the caldera and of the northern caldera flank. The blue channel image is mostly featureless, showing a white NW-SE trending stripe on the top of caldera indicating most probably the existence of a thin cloud layer. It also has to be taken into account that the Barnard crater just south of Amphitrites may significantly affected to the characteristics of the visible units.

The observed volcanic constructs and structures. The high resolution nadir image of the MEX-HRSC reveals a few examples of small interesting features – possible evidence of volcanic activity post-dating the formation of the central caldera(s) of Amphitrites and the pyroclastic deposits of the area.

Fig. 3 displays a small volcanic edifice on the NW rim of the patera. The diameter of its caldera is 2.9 kilometer and the diameter of the whole structure is ~16 kilometers. The flank around the central caldera is well identifiable in the HRSC green channel image but can be seen also in red and infra-red channels as well as THEMIS IR image, by showing darker material around the caldera (Fig. 3). The HRSC data indicates that the material of this volcanic edifice differs notably from the surrounding plains as well as from the ejecta blankets of the craters of the same size. Moreover, it is evidently different material than that on the floor of the patera. These facts indicate that the material has to be rather unique in the area of Amphitrites Patera. When looking HRSC nadir image (Fig. 4), we can see two ring-like features on the elevated area to the SW-W from the caldera of the edifice. The westernmost ring is evidently cut by the ring-structure to the east of it, which, in turn, is older than the "main caldera". These two elevated ring structures being volcanic in origin, the activity of the area has been moved from west to east. In conclusion, this structure represents most probably the relative young volcanism on the rim area of the Amphitrites Patera, which establishes that the area has been active after the formation of the patera.

Besides the volcano, there are two other possible examples of small-scale volcanism on the patera area: The depression and associated lava flows in connection with impact crater and the possible volcanic plug or neck structure inside the caldera. The depression is located on the western side of the crater floor on the south-eastern rim of the caldera of Amphitrites. The flow-feature is originating from the crater from the side of collapse, which suggests that the flow could be of volcanic origin, driven by the impact event.

Conclusions: In the case of Amphitrites Patera, the study of the multi-channel data of the HRSC reveals several surface units with different properties within the caldera as well on the flanks of the caldera. Also the high resolution nadir image has shown its usability by displaying evidences of small scale volcanic activity postdating the formation of the patera, e.g. a possible small volcanic edifice, the depression and associated lava flows in connection with impact crater and the possible volcanic plug or neck structure inside the caldera. These examples suggest that the volcanic activity continued well after the formation of the main Amphitrites Patera. This has to be taken into account when determining the evolution of the Malea Planum as well as the evolution of the whole Hellas basin area. The future studies will include the comparative study of nearby Peneus Patera by using the available data sets, which will give us even better understanding of the evolution of Malea Planum.

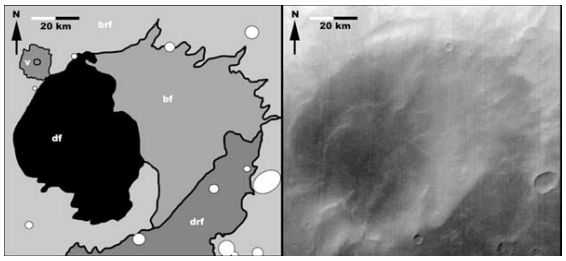

Fig. 2. The HRSC red channel image of the patera (right) and the geological map based on the red channel (left). Abbreviations: Bf - bright floor material, Df - dark floor material, Brf - bright rim/flank material, Drf - dark rim/flank material, V - volcano.

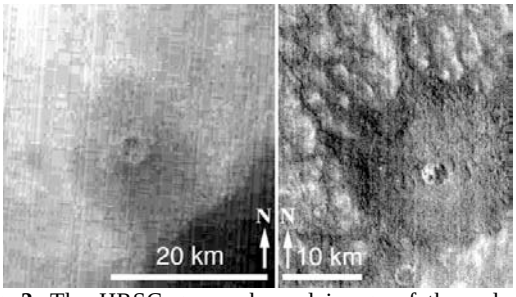

Fig. 3. The HRSC green channel image of the volcano (left), displaying the difference between the flank material and the surroundings. THEMIS IR image (I07682003) of the volcano (right).

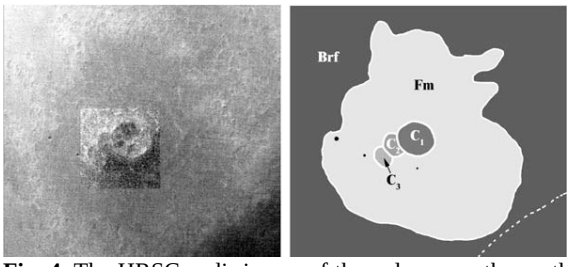

Fig. 4. The HRSC nadir image of the volcano on the north-western part of the patera (left). Geological map (right) of the area shows three distinct calderas (C_1-C_3), three small impact craters (black dots), flank material (Fm) and the material of the Amphitrites rim/flank (Brf).

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