EVOLUTIONARY HISTORY OF GUSEV – THE MER LANDING SITE – SEEN BY MEX-HRSC. S. C. Werner[1], B. A. Ivanov[2], G. Neukum[1], M. van Kan[3], T. E. Zegers[3], B. Foing[3], R. Greeley[4], D. Williams[4], and the HRSC Co-Investigator Team, [1] Institut fuer Geologische Wissenschaften, Freie Universitaet Berlin, Malteserstr. 74-100, Bldg. D, 12249 Berlin, Germany. (swerner@zedat.fu-berlin.de), [2] Insitute for Dynamics of Geospheres-RAS, Moscow, Russia, [3] ESA-ESTEC, Noordwijk, The Netherlands, [4] Deapartment of Geological Sciences, ASU, Tempe, Arizona .

Introduction: One of the larger Martian impact basins is the Gusev Crater and the landing site of one of the two robot rovers of the American Mars Exploration Rover (MER) mission, which landed in January 2004. At the same time, the European Mars Express mission arrived at Mars. The High Resolution Stereo Camera, a multiple line scanner instrument, has been acquiring high-resolution colour and stereo images of the surface of Mars [1]. During the first Mars Express mission year parts of the Gusev Crater (about 165 km in diameter) was imaged several times.

Gusev crater is situated at the dichotomy boundary (14.7°S and 175.3°E). At the northern rim, a volcanic construct named Apollinaris Patera is located. To the south a valley named Ma'adim Vallis incises the crater rim. The MER mission scientists hoped to find indications of a former lake inside Gusev crater and sediments deposited by the Ma'adim Vallis' fluvial activity [2]. Other origins of the deposits representing the crater floor were also proposed [2,3,4,5]. Most of the instruments onboard of the MER lander Spirit indicate the dominance of basaltic lava composition of the rocks found on the Gusev floor, no evidence for rocks of primary sedimentary origin is found, eventually rocks are altered by weathering involving liquid water. Features inside Gusev crater resemble "mare-type" wrinkle ridges, which are typically of deformation of basaltic lava flows (for detailed discussion see [6]). It is suggested based on morphologic data that Gusev is flooded by lavas [6] and this is supported by the chemical and mineralogical findings of the MER lander instruments.

Age and geology: To determine absolute ages on Mars we measure the crater size frequency distribution for a geomorphologically mapped unit and fit the crater production function [7,8] to the data set, extract a size-frequency value for craters of one kilometer and larger, and apply the Hartmann/Neukum chronology model [9] for the derivation of an absolute age. Using imagery of the HRSC, Themis and MOC experiments, a geologic mapping effort of Gusev crater and its vicinity has been performed by [10]. Selected areas with simplyfied unit boundaries representing the geologically mapped units were used to determine ages. These ages, based on crater frequencies measured on images gained during the first year, can be used to reconstruct the sequence of events of the Gusev region.

Martian highland large crater infilling: To estimate the infilling thickness we use MOLA data to study craters with diameters similar to Gusev (~150 km) but located in different areas and with visibly different geologic history. They are wide spread in the Martian highlands. MOLA tracks are used to construct a local topographic map for each crater of interest. We find that most of craters with diameters >150 km look partially filled. However many of them have a distinct central feature (central peak or central peak ring) above the level of possible floor sedimentary infilling. Gusev has a flat visible floor. It means that the Gusev infilling has a larger thickness than infillings in other impact craters of similar size. For three studied Gusev-like craters (43°S343°E, 23°S15.5°E, 5°S138°E; data for 2 of them are presented in Figs. 1 and 2) the visible rim-to-floor depth is about 2.5 to 3 km. For Gusev the same parameter is in the range of 1 to 1.5 km. Hence we estimate that post-impact infilling of Gusev crater has a thickness of **no less than 1 to 1.5 km** (Fig. 2). This is an important constraint for any interpretation of the geological history of Gusev and the area around.

Results: Based on the determined ages the following picture of the geologic history of the Gusev region can be drawn: The Gusev surrounding plain, belonging to the heavily cratered highland unit, has a surface age of about 4.1 Ga. Gusev itself was most likely formed at about that time [11]. Later the plains unit as well as Gusev's interior suffered a resufacing event which filled inter-crater depressions and Gusev at about 3.65 Ga ago. The surface unit of the Gusev infill is as discussed above dominated by volcanic material [6] and fits well with the period of mare volcanism on the Moon. Later resurfacing of the Gusev interior and its vicinity produced the wrinkled and etched units in the eastern part of Gusev at about 3.45 Ga ago. The volcanic activity belonging to Apollinaris Patera seems to be independent for morphologic reasons and ended already about 3.75 Ga ago. The possible fluvial activity of Ma'adim Vallis started very early in the Martian geologic history (about 3.8 Ga ago or prior) and appears to have ended

about 2 Ga ago. This is the period in which landforms whose origin is possibly water related have formed all over the planet. Based on the resurfacing ages the discharge of the later-stage fluvial activity in Ma'adim Vallis cannot be of large scales and did not in any major way contribute to the filling of Gusev's interior. A comparison of Gusev--sized impact craters on Mars show that the level of infill of Gusev is about 1 -- 1.5 km more than the other highland craters of about the same size. This might be the contribution of the early stage fluvial activity of Ma'adim Vallis (under the later stage basaltic cover).

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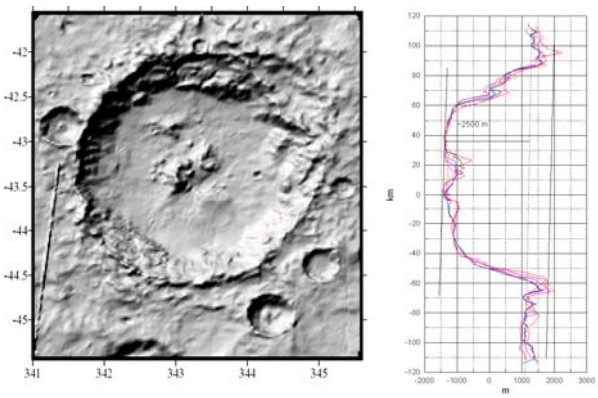

Fig. 1. MOLA-based shaded relief and central MOLA tracks for Crater-1 (43°S, 343°E). The rim-to-floor depth is ~2.5 km, the central feature (central peak ?) is about 2 km below the pre-impact level.

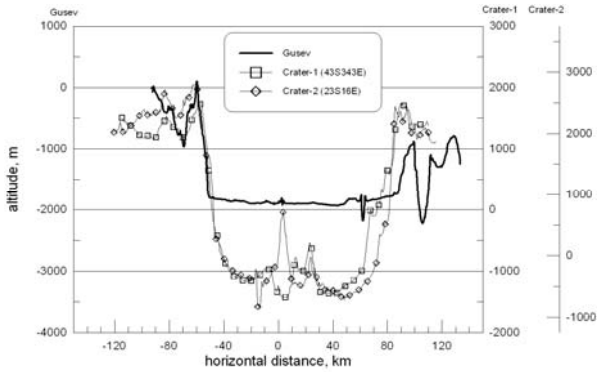

Fig. 2. Comparison of central MOLA profiles for Gusev crater and 2 other craters of comparable size. Crater-1 is presented in Fig. 1, coordinates for a similar Crater-2 are presented in the legend insert.