

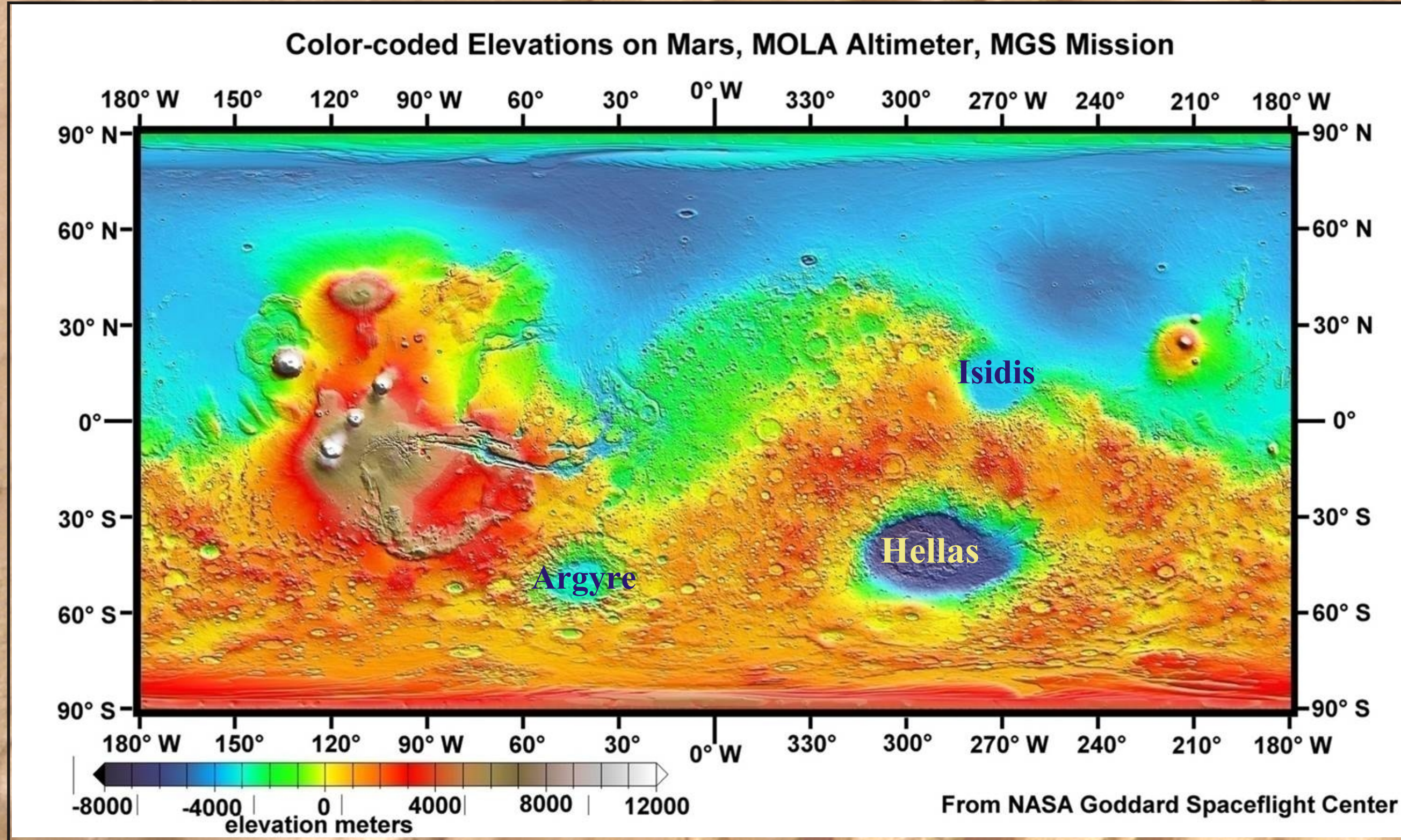
# EVIDENCE OF WATER FROM LHB ON THE LARGEST MARTIAN CRATER HELLAS IN COMPARISON TO OTHER CRATERS FROM OF THE SAME PERIOD.

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**Introduction:** The age of the largest craters on Mars suggests that they have been formed during the LHB (Late Heavy Bombardment) period. The formation of craters Hellas, Isidis and Argyre happened during that period. Age of Hellas is determined on 3.99 +/- 0.01 billion years, Isidis to 3.96 +/- 0.01 and Argyre 3.85 +/- 0.01 which is already at the end of the LHB. The layer of clay minerals in each of the craters originates from Noachian age, but in Hellas crater those layers are converted by the glacier and may appear in subsequent ages. Clay minerals are unshakable proof of the existence of water. One can draw conclusions, that large amounts of water appeared at an early Noachian. In subsequent ages, there is no large amounts of these minerals. Formations of Hellas and in comparison of Isidis crater are associated with the ingress of water on these terrains, in contrast Argyre formed after water left because the impact revealed layers of clay minerals.

A good indicator of the presence of water is the occurrence of clay minerals and other hydrated minerals. Geomorphology of craters also indicates a degree of erosion. Hellas has a lot more features of erosion than Argyre. Channels which are on the east side of Hellas could have been water flows at some point in the history of Mars. Such a significant erosion of the inside of Hellas crater could have been caused by the huge flows of water, where accumulation of clay minerals and hydrated silica in the interior of the crater and on the north side is observed. Glaciation that probably occurred in the Amazonian era clearly exaggerated the erosion of the crater.

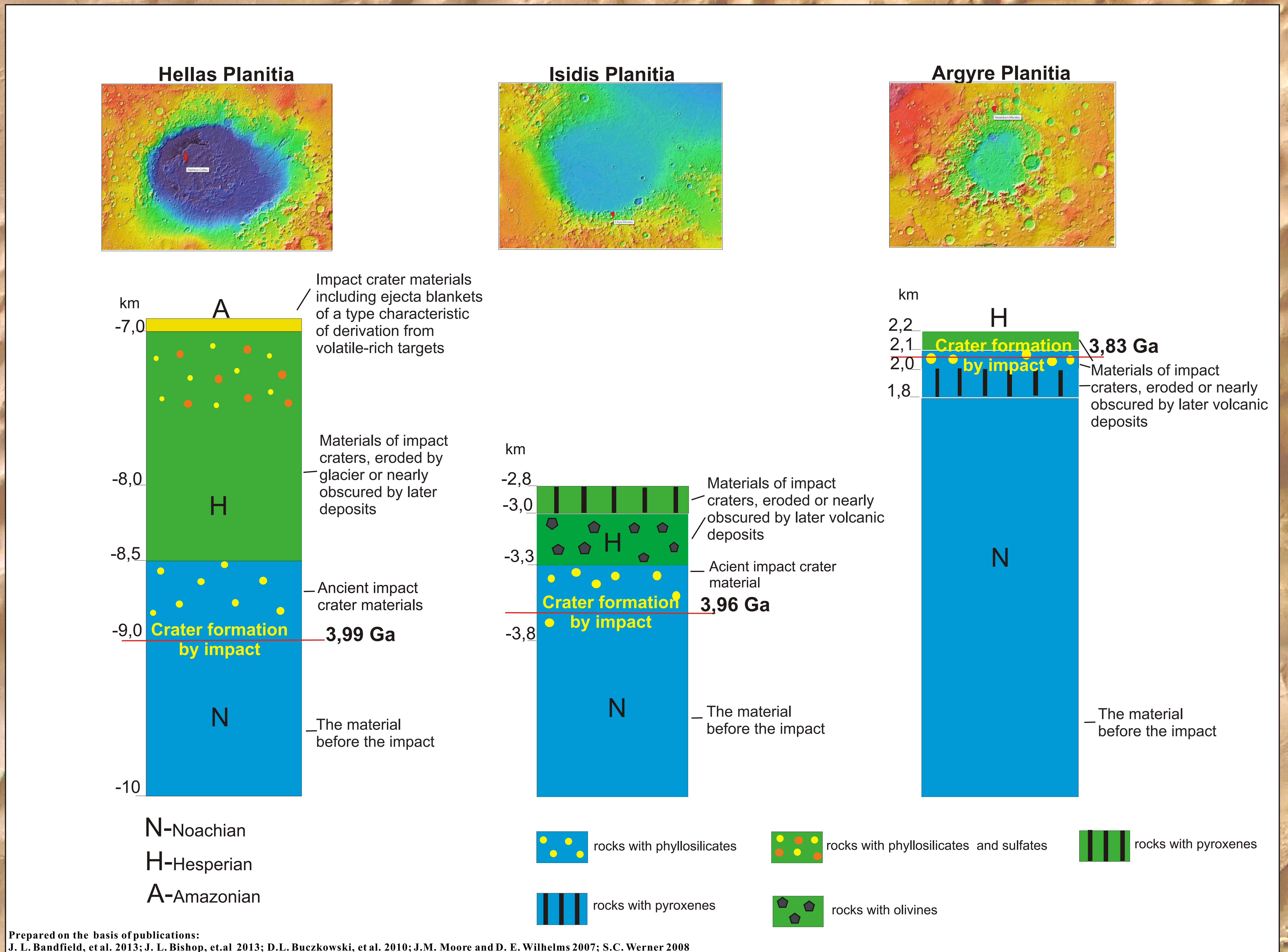
It is estimated that the clay minerals in the area were formed mainly in the Noachian era when Hellas could have been filled with water forming a kind of sea or lake. The appearance of clay minerals in areas from Hesperian and Amazonian suggests rework of the material by the glacier. Runoff water appeared not only in the Noachian era but also in the late Hesperian and early Amazonian, from the melting of subsurface ice layer and/or lingering ice caps due to episodes of late volcanism. It is when great Harmakhis, Dao, Reull and Niger Vallis channels were formed.



Topography of Mars- MOLA (Mars Orbiter Laser Altimeter)

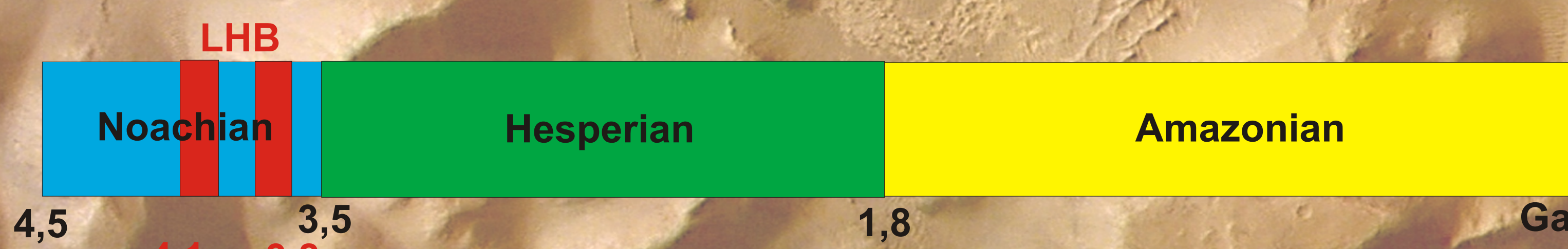
On the basis of the spectra from Themis / TES, OMEGA and CRISM was separated the three different layers of different origin in Isidis area. The first oldest basalt that formed before the formation of the crater, containing layers of clay minerals formed already inside crater, Fe / Mg-smectite, Fe / Mg-smectite mixed with carbonate and/or other Fe/Mg-rich phyllosilicates, and Al-smectite. Above this layer the unit with olivines was separated that developed by the ejection of volcanic material from the area of Syrtis Major, or the influence of basaltic lava rich in olivines. Cover layer is the youngest lava basalt volcanic ash contains no clay minerals, which is probably derived from the adjacent land of Syrtis Major. Layer of clay minerals present in the form of outcrops in many places on Libya Montes, especially in its central part. The clay minerals come from the period when in the Isidis a network of river channels was developed already from a 3.45 to 3.98 Ga.

On the basis of spectra from CRISM is observed the northern rim of the Argyre crater and the Hale Crater in particular. There distinguished the layer of clay minerals that formed apparently even before the formation of Argyre crater. So it looks like impact that created this crater cut layers from the early Noachian and revealed the surface layer of clay minerals lying on the basalt.



Prepared on the basis of publications: J. L. Bandfield, et al. 2013; J. L. Bishop, et al. 2013; D.L. Buczkowski, et al. 2010; J.M. Moore and D. E. Wilhelms 2007; S.C. Werner 2008

Geological cross-sections of selected points of three largest Martian craters -Hellas, Isidis and Argyre. Red dot indicates the location of cross-section



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