Geophysical Research Abstracts
Vol. 12, EGU2010-2109, 2010
EGU General Assembly 2010

Ages of plains volcanism on Mars

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Plain-style volcanism [1] is widespread in the Tharsis and Elysium volcanic provinces on Mars, [2,3]. Detailed images and topographic data reveal the morphology and topography of clusters of low shields and associated lava flows. The landforms of plains volcanism on Mars have all well-known terrestrial analogues in basaltic volcanic regions, such as Hawaii, Iceland, and in particular the Snake River Plains [4]. The very gentle flank slopes (<1°) indicate low-viscosity lavas [4-6], and topographic investigations hint at emplacement times for the low shields in the order of a few hundred to a few thousand years [7]. Emplacement itself was characterized by complex interactions between ascending magma bodies and tectonic structures of various ages [8]. Despite these recent studies, the chronology of plains volcanism was only poorly constrained, with a few exceptions of regionally limited studies [e.g., 6]. Here we report on our absolute age determinations of plains volcanism on Mars, as derived from cratering models [9,10] and crater counts that were performed with the software tools CraterTools (crater counting; see [11]) and Craterstats (analysis of crater statistics; see [12]), both developed at FU Berlin. We used images of the Context Camera Investigation (CTX) on Mars Reconnaissance Orbiter [13], which are ideally suited for this purpose due to their good contrast, high resolution (5-6 m/pixel), and wide coverage (swath width ∼30 km). Representative surface areas for age determination were mapped on image maps, and several low shields in each shield cluster were dated by crater counts. The goal was to derive absolute ages for a given shield, but also to determine whether the shields within one shield cluster formed at roughly the same time or over a prolonged period. The second question was whether or not the clusters have comparable ages. The results are essential to determine the history of late-stage volcanism in Tharsis and, therefore, help to put constraints on models of the endogenic evolution of Mars. We determined the ages of 60 shield volcanoes and lava flows in Tharsis. The ages within a given shield cluster are similar among themselves, with a smaller spread in the age distribution in the younger clusters. Most clusters have ages <100 Ma. Shields in Tempe Terra are older, with ages of a few hundred million years. The oldest cluster is located in Syria Planum (ca. 1.3 Ga - 2.9 Ga). Our results indicate that Late Amazonian volcanism is more widespread in Tharsis than previously recognized. Based on our results it appears possible that Mars is volcanologically not dead yet. Ongoing work investigates the volumes of erupted products and implications for the outgassing history and atmospheric evolution of Mars.

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