EPSC Abstracts,
Vol. 4, EPSC2009-140,2009
European Planetary Science Congress,

Basaltic Materials in the Circum-Hellas Volcanic Province: New Insights

D.A. Williams (1), R. Greeley (1), R.L. Fergason (2), J.-P. Combe (3), F. Poulet (4), P. Pinet (5), T.B. McCord (3), G. Neukum (6) and the HRSC Co-Investigator Team.

(1) Arizona State University, Tempe, Arizona, USA, (2) U.S. Geological Survey, Flagstaff, Arizona, USA, (3) The Bear Fight Center, Winthrop, Washington, USA, (4) Université Paris-Sud, Orsay, France, (5) Université Paul-Sabatier, Toulouse, France, (6) Freie Universität, Berlin, Germany, (David.Williams@asu.edu / Fax: +480-965-8102)

Overview

We have used a variety of data sets (HRSC, OMEGA, THEMIS, HiRISE, CTX, MOLA, MOC, TES, MARSIS) from the latest generation of Mars orbiters to study the volcanoes and wrinkle-ridged plains surrounding the Hellas impact basin on Mars, a region we call the *Circum-Hellas Volcanic Province* (CHVP) [1-3]. Covering >4.9 x 10^6 km^2, comparable in size to the Elysium Volcanic Province, it contains the six oldest central vent volcanoes on Mars, ranging from 3.5-3.9 Ga, based on crater counts on HRSC and THEMIS images [2, 4-5]. The wrinkle-ridged plains surrounding these volcanoes, also inferred to be of volcanic origin, formed from 3.4-3.8 Ga [2]. Since the cessation of volcanism in the Hesperian Period, this region has been heavily modified by aeolian, fluvial, and periglacial-permafrost processes, eliminating visible evidence of most lava flow boundaries and other volcanic features at most locations [1-5].

Multispectral analyses of OMEGA and HRSC data, using a variety of techniques [1], indicates that dark materials exposed in the CHVP are basaltic in composition, consistent with earlier studies [6, 7]. Most dark materials are located in topographic lows, such as impact crater or caldera floors, on the flanks of the volcanoes, or in dune fields or other deposits concentrated or exposed by local winds. A key question from our earlier work is whether these dark materials were transported from elsewhere on Mars by regional winds, are local deposits exposed by aeolian winnowing or deflation, or are exposed by another mechanism. New studies are providing additional insight on the nature of these dark materials.

Insights from Spectral Analyses

The dark materials in the Malea Planum portion of the CHVP show slight variations in modal mineralogy with location. In particular, there are obvious trends in these data from west to east: olivine and low-calcium pyroxene (LCP) content increases, high-calcium pyroxene (HCP) content decreases, and the ratio of LCP to total pyroxene increases. There is an apparent correlation between composition and age, in which the dark deposits associated with the 3.6 Ga volcanic features Amphitrites Patera and the 3.6 Ga flows within crater Mitchell have higher olivine and LCP percentages and higher LCP/(LCP+HCP) ratios than those deposits associated with the 3.8 Ga volcanic features Malea and Pityusa Paterae. This result assumes that the 'edifice' cratering model age for each volcanic feature [1] correlates to its associated dark deposit. Furthermore, the age variations are within the uncertainty limits of the technique, and thus may not reflect real differences in age. However, if these trends and correlations are valid, it indicates a potential compositional change in the CHVP magmas with time and space.

The variation in composition with location suggests that the dark material in Malea Planum is not derived from elsewhere on Mars and transported and deposited in topographic depressions by regional winds; such aeolian activity should homogenize the compositions such that these deposits should be the same throughout the region. Rather, the differences in modal mineralogy are more consistent with variations in compositions of the volcanic deposits at each location, perhaps due to equilibrium or fractional crystallization in flows or magma chambers when the deposits were emplaced, or variations in

EPSC Abstracts,
Vol. 4, EPSC2009-140, 2009
European Planetary Science Congress,

assimilation of crustal material as the magmas rose through the crust.

Insights from New Images

Fig. 1 shows an HRSC image of one of these dark deposits, exposed on the inside rim of Malea Patera, originally interpreted as buried vents exposed with dark materials being redistributed by local winds [1]. Our previous imaging of these deposits all occurred southern summer. However, a new HRSC image and the HiRISE image at right (**Fig. 2**), obtained in early southern spring, suggest that seasonal CO_2 ice accumulation buries these deposits, and that they are re-exposed annually via sublimation of this ice, perhaps via the mechanism reported by Kieffer et al. [7] for similar dark spots located at the south pole of Mars.

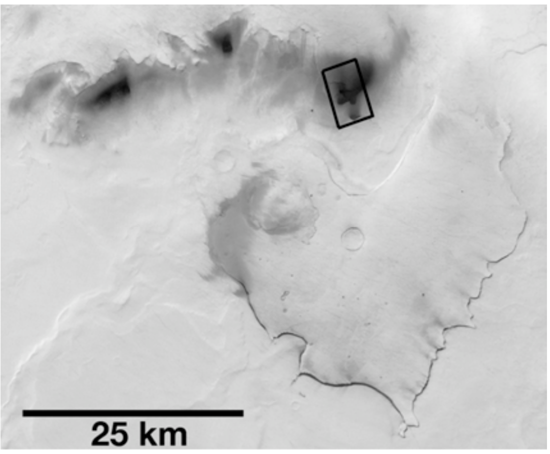

Figure 1: Portion of HRSC nadir image from orbit 2133 (25 m/pixel), obtained on 11 Sept 2005 (L_s = 285.5˚, southern summer). This image shows dark deposits exposed on the inside rim of Malea Patera (63˚S, 52.7˚E), just north of an unusual heart-shaped mesa. Local winds are redistributing the dark materials, but clearly they represent local exposures, originally suggested to be partially-exposed vents [1]. Black box refers to Fig. 2.

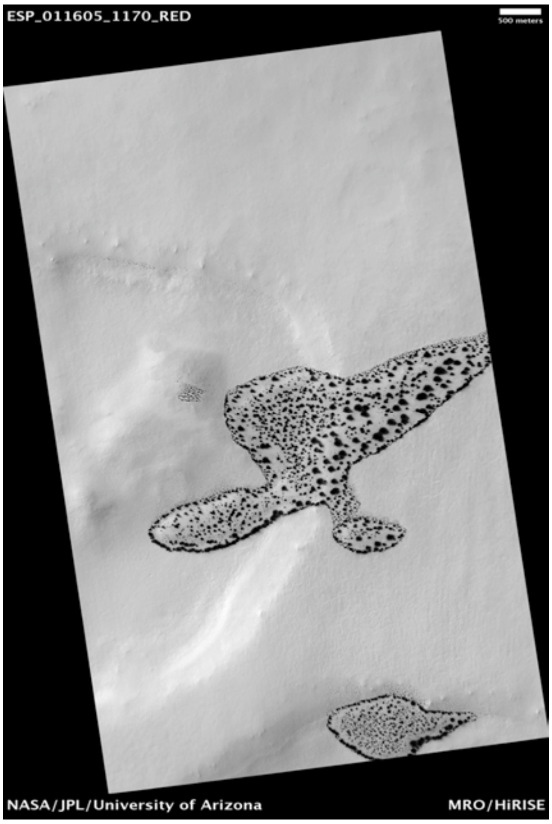

Figure 2: HiRISE image ESP_011605_1170 (25 cm/pixel), showing a close-up view of the dark deposit in Fig. 1, but obtained on 16 Jan 2009 (L_s = 192.6˚, early southern spring). We interpret this image as indicative of defrosting around buried dark material. The morphology and appearance of these dark spots are similar to those reported near the south pole by Kieffer et al. [7] that are thought to be exposed by CO_2 jets formed by sublimation beneath translucent slab ice from Mars' seasonal south polar cap.

Bibliography

[1] Williams, D.A. et al. (2009a) *Planet. Space Sci.,* in press.

[2] Williams, D.A. et al. (2009b) *EPSL,* in review.

[3] Williams, D.A. et al. (2009c) *EPSL,* in review.

[4] Williams, D.A. et al. (2007) *JGR,* 112, E10004, doi:10.1029/2007JE002924.

[5] Williams, D.A. et al. (2008) *JGR,* 113, E11005, doi:10.1029/2008JE003104.

[6] McCord, T.B., et al. (1982) *JGR*, 87, 10,129-10,148; McCord, T.B., et al. (2007) *JGR*, 112, E06004, doi:10.1029/2006JE002769.

[7] Kieffer, H.H., et al. (2006) *Nature*, 442, 793-796.