EXPLORING THE LINK BETWEEN GEOCHEMISTRY AND VOLCANO MORPHOLOGY ON THE EASTERN SNAKE RIVER PLAIN, A PLANETARY ANALOG TO MARS VOLCANISM

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Introduction: The eastern Snake River Plain (ESRP) is known as a region of 'plains-style' volcanism [1]. Consisting of extensive rift systems, overlapping shield volcanoes, evidence of hydromagmatic activity, and intrusive rhyolitic domes; the ESRP is considered a bimodal volcanic provenance (Figure 1). Imagery from MOC, MOLA, and THEMIS reveal that the Tempe Terra and Syria regions of Mars exhibit many of the same volcanic features found on the ESRP [2, 3, 4]. Therefore studies of the morphology of the ESRP shields are insightful based on the topographic manifestations of volcanic processes [3, 4, 5]. Volcano morphology is typically a function of eruptive rate/magma supply, gas content, and composition. This study aims to explore the possible connection between the composition, i.e. the geochemistry and texture, of ESRP basalts and the resultant shield morphology. On-going research continues to quantify links between volcanic processes and topography on Mars [2, 3, 6]. This study will aid in the interpretation of remote sensing data collected on Martian shield volcanoes and also help determine possible future sampling locations on both the ESRP and Mars.

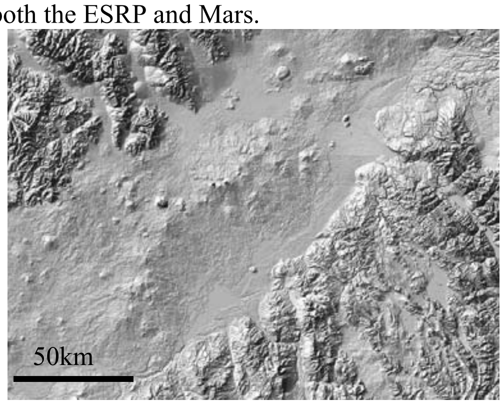

Figure 1: Digital topography image of the ESRP showing volcanic topographic highs.

Morphology of ESRP shield volcanoes

Based on their topographic profiles, ESRP basaltic shields have been grouped into three general categories: low profile, dome-shaped, and shields with caps [2]. This study examines three shields with caps: Table Legs Butte, Quaking Aspen Butte, and Circular Butte, and two low-profile shields: Wapi and Hells Half Acre. Transects of these capped shields and low-profile shields are created using GPS receivers (Figure 2). Both shield types consist of tholeiitic basalt with plagioclase and olivine phenocrysts. For the capped shields, there is no overall variation in crystal content or mineral phases from the cap to the distal flanks of the volcano. However, both Table Legs Butte and Circular Butte contain higher crystal contents overall (average of 25% to Quaking Aspen Butte's 4%) and display a very strong diktytaxitic texture. These two shields also display the most prominent summit caps. Table 1 lists each shield with its corresponding maximum slope angle. Quaking Aspen Butte basalts are fine-grained and weakly diktytaxitic, which is similar to the texture of the low profile shields basalts of Wapi and Hells Half Acre. Therefore there is a positive correlation between a strong diktytaxitic texture, higher crystal content, and summit steepness.

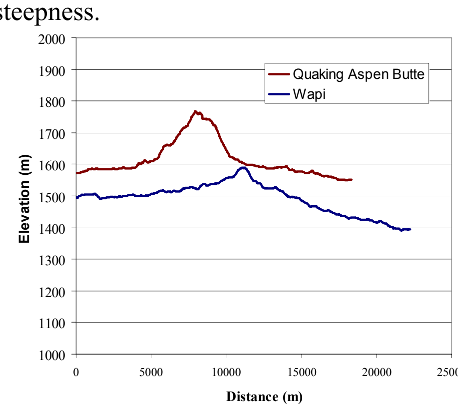

Figure 2: Profiles of capped shield Quaking Aspen Butte and low-profile shield Wapi.

Shield Name	Shield Type	Max. Slope Angle (°)
Circular Butte	Capped	37
Table Legs	Capped	35
Quaking Aspen	Capped	30
Wapi	Low profile	20
Hells Half Acre	Low profile	19

Table 1: Average slopes of all three types of ESRP shield volcanoes

Geochemistry of ESRP volcanoes: Both Quaking Aspen Butte and Table Legs Butte were sampled for bulk rock major and trace element analyses for this study. Geochemical data from Wapi, Hells Half Acre, and Circular Butte is from published sources [7, 8]. There appears to be no large distinction between both types of shields in major element data (Figure 3). The capped shields show major element chemistries that encompassing both ends of the fractionation trend. This data shows there is no correlation between greater average slope angle and a more evolved basaltic compositions since Quaking Aspen Butte is a capped shield and yet has the most primitive geochemical signature.

Trace element plots for also reflect no trend between the two shield types and enrichment in incompatible elements (Figure 4). Within the capped shields category itself, Circular Butte and Table Legs Butte display enrichment in trace elements compared to Quaking Aspen Butte. Both these shields have higher average crystal content of plagioclase, which is reflected in their higher Eu and Ba values (Figure 5). Therefore this data reaffirms the connection between higher crystal content and steep shield morphology.

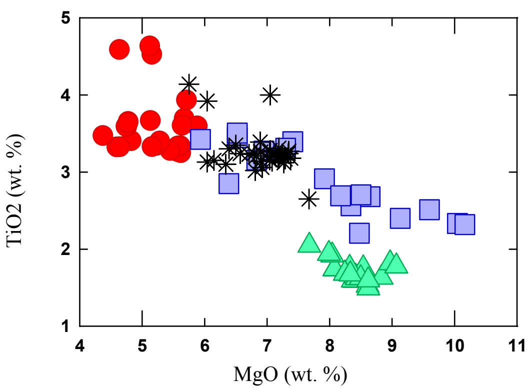

Figure 3: Variation diagram for low profile shields Wapi and Hells Half Acre (squares) vs. capped shields Table Legs (circles), Circular Butte (stars), and Quaking Aspen (triangles).

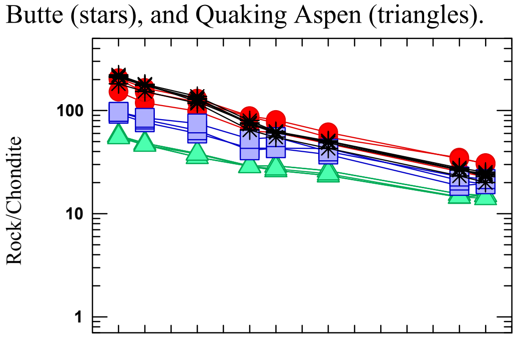

Figure 4: REE plot for low profile shields and capped shields.

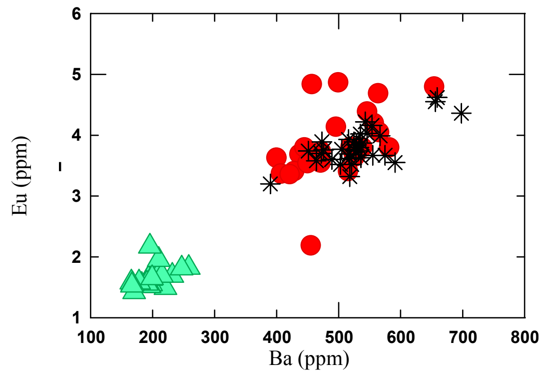

Figure 5: Ba vs. Eu plot for capped shields, reflecting higher crystal content in Table Legs Butte and Circular Butte samples.

Conclusions: There is a positive correlation between a strong diktytaxitic texture, higher crystal content, and increased summit steepness among the ESRP shields. The geochemistry shows that steeper capped shield volcanoes are not necessarily more evolved then low profile shield volcanoes. Since the diktytaxitic texture is well-developed in the most prominently capped shields, this suggests that volatile content of the magma may be a controlling factor in shield morphology. Therefore other parameters, such as higher initial water or carbon dioxide concentrations, will be explored. This study will continue by examining microprobe data from Quaking Aspen Butte and Table Legs Butte to get estimates on intrinsic magma properties, such as temperature, pressure, and oxygen fugacity. Thermodynamic modeling with the MELTS program for Table Legs Butte and Quaking Aspen Butte will help evaluate these parameters as well and will aid in the assessment of the petrologic evolution of each shield.

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