DIVERSE ERUPTIONS AT ~2,200 YEARS B.P. ON THE GREAT RIFT, IDAHO: INFERENCES FOR MAGMA DYNAMICS ALONG VOLCANIC RIFT ZONES.

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Introduction: Compositionally and morphologically diverse lava flows erupted on the Great Rift of Idaho ~2.2ka [1-3] during a volcanic "flare-up" of activity following ~2 ky hiatus in eruptions. Volcanism at Craters of the Moon (COTM), Wapi and Kings Bowl lava fields around this time included primitive and evolved compositions, separated over 75 km along the ~85 km-long rift (Fig. 1), with striking variability in lava flow emplacement mechanisms and surface morphologies. Although the temporal associations may be coincidental, the system provides a planetary analog to better understand magma dynamics along rift systems, including that associated with lunar floor-fractured craters [4-6]. This study aims to help bridge the knowledge gap between ancient rift volcanism evident on the Moon and other terrestrial planets, and active rift volcanism, e.g., at Hawai'i and Iceland.

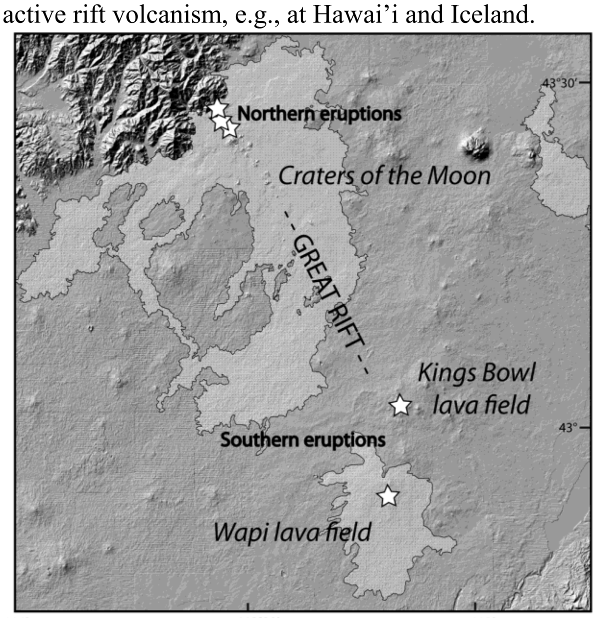

Fig. 1 Regional map of the Great Rift, Idaho, USA within the eastern Snake River Plain. Shaded areas outline the overall extent of lava fields erupted since ~15 ka, with stars placed at eruptive vents active ~2.1 – 2.3 ka.

Diversity of Eruptions: Eruptions at COTM typically produce evolved compositions with various surface types including lava ponds, hummocky, rubbly or slabby pāhoehoe and block lavas. Surrounding areas of the eastern Snake River Plain, including Wapi and Kings Bowl, are typified by olivine tholeiites that build coalescent low-shield volcanoes [2,9,10]. The essentially contemporaneous eruptions from both the northern (10 eruptions) and southern (2 eruptions) ends of the Great Rift encompass the full range of morphological and compositional types. Here we assess the differences based on field investigation of flow morphologies and chemical analyses of a representative suite.

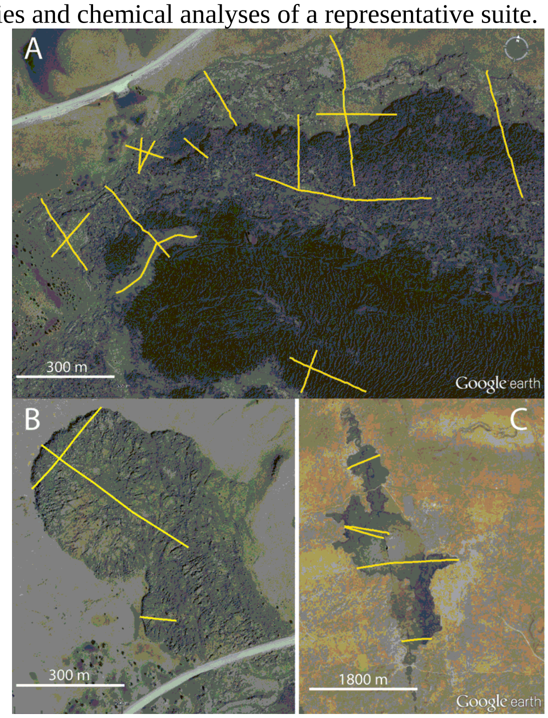

Fig. 2. Landsat images (from Google earth) depicting lines of DGPS profiles measured on various lava surfaces: A – North Crater and Big Craters flows (COTM), B – Highway flow (COTM), C – Kings Bowl lava field.

Lava Flow Morphology. Great Rift field work in 2014 and 2015 included surficial studies of Kings Bowl lava field (south) and North Crater, Big Craters, and Highway flows (north) (Fig. 2). High-resolution (cm-scale) differential GPS (DGPS) topographic profiles were measured on all surfaces over linear distances ranging <100 to ~1800m. Topographic relief varies considerably, with some surfaces relatively low (~1-2 m relief) and others much higher (>5 m).

Detailed studies of these lava surfaces [7,8] are being used to re-evaluate planetary analog morphological types, including RMS heights and slope, in order to classify and identify textures associated with volcanism and impact melt flows on terrestrial planets. Myriad flow textures attest to significant variation in emplacement modes along a single rift system, most likely due to differences in eruptive rates, pre-existing slopes, and composition. The fact that even relatively viscous lavas (Fig. 2) can produce smooth ponds or lobes of lava suggests that such diversity may not be uncommon in other planetary rift systems.

The comparison of average slope relative to measurement spacing correlates to flow type (Fig. 3). The steepest slopes and greatest variation in slope vs. spacing are *generally* represented by the sequence (highest to lowest): block – "rubbly" – "hummocky" pāhoehoe. Several crossover patterns and the ranges of curves relevant to each indicate that general types, especially pahoehoe, may have multiple morphological varieties.

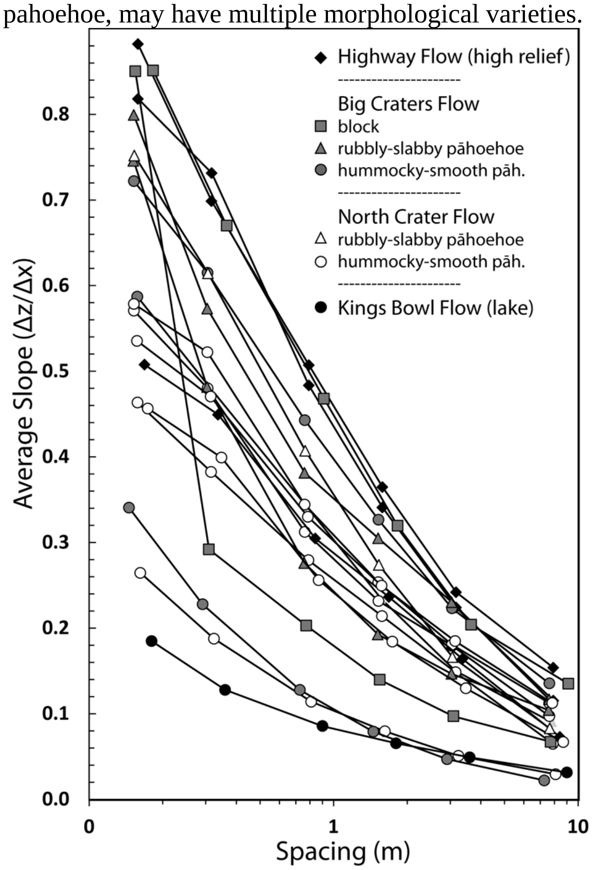

Fig. 3 Average slopes of lava surfaces determined as height differences relative to various spacings between data points.

Compositional Diversity. Geochemical analyses of bulk rock composition [2,9,10, and unpublished data] illustrate the diversity of magma erupted ~2.2 ka along the Great Rift, especially the differences between northern and southern units (Fig. 4). While the high MgO tholeiites (south) are likely derived from primary magmas, the evolved latites (north) likely represent hybrids due to crustal contamination, magma mixing, and long-term residence in subsurface reservoirs.

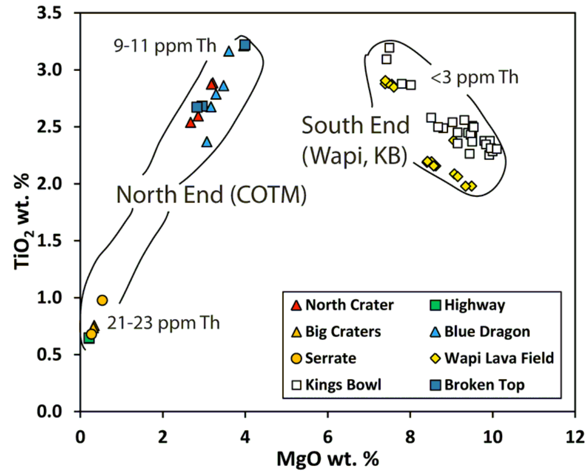

Fig. 4 TiO_2 vs. MgO in bulk compositions from the ~2.2 ka "flare-up" of volcanism along the Great Rift. Major element variations and associated Th concentrations reveal currently active complex magmatic processes along the rift system.

Conclusions: The morphological and chemical diversity within the ~2.2 ka episode may be related to several magma reservoir processes: (1) separate primary and evolved magma batches, (2) lateral magma migration, (3) an extensive magma reservoir spanning the length of the rift, or (4) any combination of these above. At best, the magmatic plumbing system is complicated, and within the current time frame of COTM eruptions (2 – 15 ka), it is apparently still active.

Acknowledgements: This research is supported by the FINESSE project (Field Investigation to Enable Solar System Science and Exploration), PI J.L. Heldmann, a SSERVI research grant to NASA Ames Research Center. Participation by K-12 educators Jeff Karlin, Deirdre Bingaman, Kenneth Hunter, Tiffany Sheely and Shawn Tiegs is greatly appreciated.

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