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REMOTE SENSING AND FIELD STUDY OF THE GREAT RIFT, EASTERN SNAKE RIVER PLAIN, IDAHO: IMPLICATIONS FOR EXTRATERRESTRIAL RIFT SYSTEMS. A. A. J.

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Introduction: The Great Rift is one of several northwest trending volcanic rift zones in the eastern Snake River Plain (ESRP), Idaho. The rift zones are defined by aligned volcanic vents, bracketed in places by linear, subparallel sets of tension cracks. The injection of dikes into these rift systems is a popular model accounting for a portion of the aseismic extension across the ESRP [1]. The pattern of surface deformation along the Great Rift suggests that dikes, if present, have stalled at uniform depths beneath the surface [2]. The Great Rift is analogous in many ways to rift systems found in Iceland, Hawaii, and elsewhere in the solar system. Detailed field study of the Great Rift is therefore relevant to extraterrestrial rift studies.

This study tests the hypothesis that a relationship exists between the presence of central fissure eruption and the depth to the tip of an arrested dike. Similarly, a relationship between the presence of central fissure eruption and inferred dike width is also tested. Flow velocities in dikes are proportional to dike width [3]. Enhanced erosion due to high flow velocity should increase the likelihood of eruption. Shallower depths of intrusion invite the exsolution of volatiles, further increasing likelihood of eruption. Confirming these relationships will support inferences made about inaccessible rift systems for which only SAR or panchromatic imagery is available.

This study also tests the use of Airborne Synthetic Aperture Radar (AirSAR) as a tool for identifying the fissures that define the Great Rift. Since the last extensional events (3.5ka to 2ka), some of the tension cracks in the preexisting basalt have been partly or wholly buried by loess. Theoretically, the AirSAR penetrates the loess and reveals the buried fissures (Figure 1).

Methods: The hypothesis of this study involves three variables: the presence of central eruptive fissures, the width of the inferred dikes, and the depth to their arrested tips. Eruptive fissures were clearly identified in the field and on digital orthoquarterquads (DOQQs). The width of an inferred dike is proportional to sum of the surface strain [4]. This surface strain was measured by summing measurements of fissure widths along twenty-two transects aligned perpendicular to the rift (Figure 2). Fracture

widths were measured using a tape measure between pin lines in the preexisting basalt. The orientation of each fracture was measured with a Brunton compass and compared to the orientation of the tape measure to check for significant shear offset. The depths of the dike tips were taken to be half the distance between the surface deformation maxima [2] (Figure 2).

AirSAR responses to various fracturing conditions were qualitatively determined via ground truthing. A map of fractures visible in AirSAR images was created and compared to one made from DOQQs at the same scale.

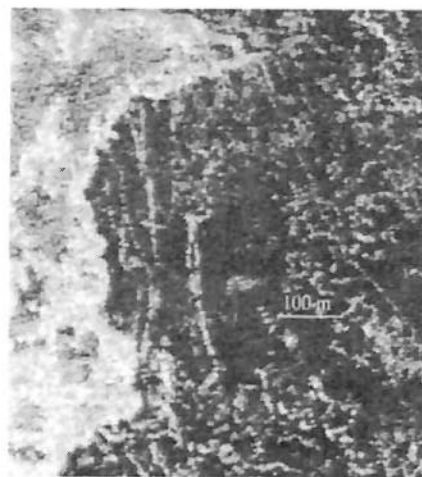


Figure 1: AirSAR image (contrast stretched, RGB = P-HV;L-HV;P-HH) showing tension cracks on the east side of the Great Rift, adjacent to a coeval lava flow near King's Bowl.

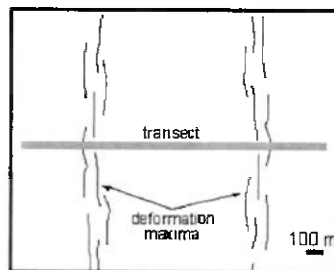


Figure 2: Example sketch of transect perpendicular to the rift.

Data: The two largest and most prominent crack sets found along the Great Rift are the New Butte and King's Bowl crack sets. Figures 3 and

4 show summed fracture width measurements for each transect taken across these segments. Each transect is plotted against horizontal distance with north at the left-hand side of the graph.

Error bars are based on measurement errors determined from repeated transects. Error was found to be $\pm 5\%$ of the total strain measured in each of three repeated transects. These measurements of surface strain most likely represent minimum thicknesses of the inferred dikes beneath the surface [4].

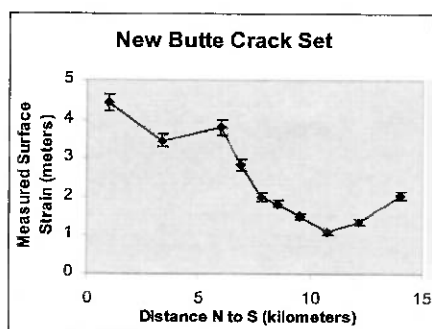


Figure 3: The northern fractures of the New Butte set are covered by lava flows, leading up to an eruptive center questionably associated with the fracturing. The width between deformation maxima is generally 1.75km.

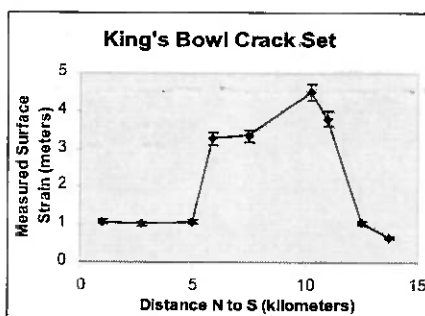


Figure 4: Coeval central eruptive fissures are found in locations with measured strain above 1.00m. The width between deformation maxima is generally 1.1 to 1.25km.

Preliminary Interpretations: Surface strain along the New Butte crack set generally increases to the north, toward a potentially coeval eruptive center in line with the rift. Along the King's Bowl crack set, strain measurements are generally highest where the most intense eruption has occurred. These observations suggest that there is a correlation between arrested dike thickness and the presence of central eruptive fissures. Uneven distribution of

the strain between the deformation maxima was found in several locations along the rift and may suggest localized inclination of the inferred dikes.

Based on the width between the deformation maxima, the tip of the dike inferred beneath the King's Bowl crack set is at approximately 600m depth. Likewise, the New Butte crack set is underlain by an inferred dike arrested at 880m depth. The extensive eruption along the shallower King's Bowl system, contrasted with the lack of eruption over the exposed segment of the New Butte system, is consistent with the concept that central eruptive fissures are more likely where dike tips are shallower. Eruption of the shallower dikes may be driven by the exsolution of volatiles above a critical depth.

Multiple mechanisms can account for the arrest of a dike beneath the surface [5, 6]. One such mechanism is the encounter of an advancing dike tip with strata having contrasting mechanical properties [5]. Differences in Young's modulus from one stratigraphic layer to the next may inhibit the advancing crack enough to arrest the dike [6].

Dike tip depths are uniform within each crack system, but differ from one system to the next. This suggests either an abrupt change in the thickness of the basalt veneer over the ESRP or that the dike arrest is not stratigraphically controlled. Neutral buoyancy is an alternative mechanism of dike arrest which may apply to the ESRP. To further investigate the latter model, differences in dike height along the rift will be modeled using buoyancy constraints and the new data set.

AirSAR imagery was effective in identifying areas of fracturing in loess covered regions, but provided little advantage in detailed fracture mapping. On other planets, multiple dike systems found to have a uniform distance between deformation maxima could indicate a stratigraphic control on dike arrest, revealing the structure of the subsurface. Central eruptive fissures along such systems likely indicate locations of maximum dike width.

References: [1] Kuntz, M. A. et al. (1986) *GSA Bulletin*, 97, 579-594. [2] Pollard, D. D. et al. (1983) *Tectonophysics*, 94, 541-584. [3] Philpotts, A. R. (1990) *Prentice Hall*, 498p. [4] Mastin, L. G. and Pollard, D. D. (1988) *JGR*, 93, 13,221-13,236. [5] Ryan, M. P. (1987) *Geochemical Society, Special Publication 1*, 259-287. [6] Gudmundsson, A. (2003) *Bull. of Volc.*, 65, 606-619.