RELATIONSHIP OF VOLCANISM AND FRACTURE PATTERNS IN A VOLCANO-TECTONIC STRUCTURE WEST OF ALPHA REGIO Eric B. Grosfils and James W. Head, Dept. of Geological Sciences, Brown University, Providence, R.I. 02912.

Introduction: Volcanism is widespread on the surface of Venus[1], and Magellan data confirm that extrusive volcanism is linked to a range of tectonic and volcanic environments[2]. One subject requiring further investigation is the relationship of extrusive deposits to intrusive processes, and their importance to the formation and evolution of the crust[3,4]. Terrestrial lineaments associated with central volcano-tectonic structures may be the manifestation of the emplacement of subsurface dikes[5] and their orientation is often linked to regional stress fields[6]. Similar lineament geometries appear in Magellan data, suggesting that analogous emplacement processes occur. To pursue this possibility further, we are mapping and analyzing an elliptical structure near Alpha Regio. Here we present the basic characteristics of the structure, the major geologic units of the region, and preliminary interpretations of regional stratigraphic relationships and the systems of structural elements.

Description: A generally circular feature (45-60 km in diameter) lies within an ellipse (16S, 352E) forming an eye-like structure located 1500 km northwest of Alpha Regio (Fig. 1). The major axis of the ellipse runs NE-SW, aligned along a regional, 500 m topographic high coincident with the northern "arm" of Alpha and extending to the southwest tip of the ellipse; the minor axis aligns with the center of a gentle depression, 60 km wide and 300 m deep, which cuts the regional high. The circular feature in the center of the ellipse is the focal point of a complex system of regional lineaments, including two dominant sets (NW-SE, parallel to the minor axis in the vicinity of the ellipse and N-S at greater distances from the ellipse).

Several features and units are observed (Fig. 1a): The Interior Ring is a radar bright region 5-10 km wide defined by both small concentric lineaments and graben, and termination of radial lineament sets. It encircles a region of plains and small shields. The Exterior Ring is a highly elliptical (major axis, NE-SW, of 210 km; minor axis of 105 km) radar bright region, 10-20 km wide, defined by concentric lineaments as well as, locally, an increase in the brightness and/or density of crosscutting lineaments. The Alpha Disrupted Zone extends west from the "arm" of Alpha and has a westward-tapering wedge shape with edges defined by enhanced radar brightness as well as increased lineament curvature and termination. Radar Dark Plains are distributed throughout the region but occur preferentially away from the elliptical structure. Radar Bright Plains are distributed throughout the region but occur preferentially adjacent to and within the elliptical structure. Shield Plains are characterized by multiple small domes 1-4 km in diameter that occur preferentially in zones along the trend of the major axis of the Exterior Ring.

Structures (Fig 1b) include: Fractures (lineaments with no topographic expression; range from a few hundred meters to tens of km in length; commonly occur as either linear, parallel members of a densely packed group or as isolated features). Fissures (narrow, negative topographic features which range up to 1 km wide with no detectable flat bottom). Graben (negative topography with a flat floor; typically linear, up to 2 km across and a few tens of km in length; often occur in *en echelon* pairs. In general, structures have four patterns of occurrence: 1) straight, 2) curved, 3) *en echelon*, and 4) sinuous (which appear to be interconnected *en echelon* patterns).

Stratigraphy: Radar Dark Plains often appear to embay Radar Bright Plains (NW of the Alpha Disruption Zone and immediately NE of the Interior Ring), and are thus locally younger. Shield Plains are almost completely devoid of lineaments, suggesting that they are young relative to the other plains units in the region. Structural elements display cross-cutting relationships with units and each other. South of the elliptical structure, one set of troughs terminates at a 150 km E-W plains unit boundary, while another continues across.

Preliminary Interpretation: The Interior Ring and the plains and shields within it are interpreted to be the surface manifestation of a subsurface magma reservoir, with the shields and plains representing surface eruptions. The radial structural elements that begin at the rim of the interior ring and extend outward for hundreds of km are interpreted to be the surface manifestations of dikes propagating radially away from the magma reservoir. The scale of this feature and its associated structure is comparable to dike swarms observed in the Canadian Shield[7] and other terrestrial cratons. The abundance of the structural elements and their great lengths, combined with the lack of topography commonly associated with volcanic edifices, suggest that the majority of the magma is intruded laterally through dikes, rather than building an edifice through extrusion. The Interior Ring concentric graben appear to reflect subsidence, perhaps following magma reservoir depletion related to dike emplacement. For example, a single dike 300 km long, 6 km high, and 3 m wide would represent a volume of 5.4 km^3. Fracture density and orientations are generally related to distance from the Interior Ring; within 1-2 ring radii of the rim, the elements are most dense and predominantly radial; within 2-3 radii they are less dense and predominantly oriented NW-SE; outward of 3 radii, they are less dense and oriented generally N-S. A distinctive S-shaped perturbation is noted in the vicinity of the Alpha Disrupted Zone. We interpret these relationships to mean that dike emplacement is responding to reservoir geometry and local stresses in the vicinity of the reservoir, and to regional tectonic stresses away from the reservoir. The S-shaped perturbation is interpreted to represent a response to local structural discontinuities similar to that observed when dikes encounter fracture zones in terrestrial oceanic lithosphere[8]. Straight structural elements are interpreted to represent dikes where the least compressive stress is oriented perpendicular to the dike plane; curved elements are interpreted to represent rotation of the least compressive stress about an axis parallel to the plane of the dike; *en echelon* elements to represent rotation about an axis parallel to the direction of dike propagation[9]. We interpret the majority of the long dikes to have been emplaced in a regional stress field with the maximum compressive stress oriented along a general N-S trend. We are presently analyzing the detailed orientations and relationships of the structural elements, their sequence, and the relationship of these features to extrusive volcanic units, in order to further develop and test these preliminary interpretations.

1) V. Barsukov *et al.* (1986) JGR **91**, D378; 2) J. Head *et al.* (1991) submitted to Science; 3) J. Head (1990) EMP **50/51**, 5; 4) L. Wilson and J. Head (1991) this volume; 5) K. Nakamura (1977) JVGR **2**, 1; 6) H. Ode (1957) GSAB **68**, 567; 7) W. Fahrig and T. West (1986) Geol. Surv. Can. Map 1627A; 8) J. Karson (1987) Geol. Assoc. Can. Sp Pap. **34**, 229; 9) D. Pollard (1987) Geol. Assoc. Can. Sp Pap. **34**, 5.

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Fig. 1. Geologic sketch map (a) and map of structural elements (b).