Folding of rhyolite flows in a series of Exogenous Domes, Porphyry Peak, San Juan Mountains, Colorado

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INTRODUCTION

The Porphyry Peak Rhyolite is named for its exposures on the slopes of Porphyry Peak, one of the topographic highs rimming the Bonanza Caldera in the San Juan Volcanic Field of southern Colorado. Through mapping flow foliations, Varga and Smith (1983) identified three separate extrusive centers in the Porphyry Peak area: Porphyry Peak East, Porphyry Peak West and a flat-topped dome located southwest of Porphyry Peak (Figure 1). The Porphyry Peak rhyolite is exposed on all three of these extrusive domes.

The rhyolite consists of greyish-white to pink rhyolite flows, tuffs, and intrusive rhyolites (Varga and Smith, 1984; Burbank, 1932). There is extensive foliation in the rhyolite, with the exposures on East Porphyry Peak splitting into thin slabs similar to a shale. It is also distinguished by the intricate and complex folding of these foliations (Figure 2). The rhyolite is especially distinguished by its pronounced flow lineation which manifests itself as small-scale folds.

The relationship between the foliations and the lineations, and consequently the type of deformation which occurred to produce these lineations, is poorly understood. In July and August 1999, I conducted a detailed structural survey of the Porphyry Peak area. I measured the lineations and foliations which occur in the Porphyry Peak Rhyolite. These measurements, when analyzed with stereographic projection, indicated that the lineations show a range of rakes from high to low. Similar types of lineations have been noted in pahoehoe basalt flows in Hawaii (Fink, 1978) and in rhyolitic lava flows (Gregg, Fink, and Griffiths, 1998; Fink, 1980).

RESEARCH METHODS

I used a stereonet analysis to determine the preferred orientation of the foliations and lineations within the rhyolite. Porphyry Peak East and West domes show the expected radial distribution of foliation orientations, while in the southwest dome, foliations strike between 0 and 45 degrees and dip to the southeast. However, this result is probably an artifact of the data collection, as no data were collected for the southwestern half of the dome, due to a lack of exposure in the area.

Figure 3 shows the relationship between pairs of lineations and foliations which were taken at the same locality. Rakes range from high to low, with the highest distribution being at the extremes of the range.

DISCUSSION AND CONCLUSIONS

Varga and Smith (1983) report seven lineation and foliation pairs from the Porphyry Peak rhyolite that show a range of foliation to lineation relationships from low rake, nearly horizontal, to high rake, steeply plunging lineations. They suggest that the lineations might plunge in the direction of the vent. This study suggests that while some high angle, steeply plunging lineations occur, a number of lineations plunge gently to the ENE on the East Porphyry Peak dome and southeast on the Southwest dome.

Fink (1980), (Gregg, Fink, and Griffiths, 1998) have both noted the presence of small scale folds in lava flows. These researchers determined that the folds are the result of compression and viscosity differences between the upper and lower portions of the lava flow. The bottom portion of the lava flow cools less quickly then the top portion which is exposed to the air. This temperature difference results in a viscosity gradient, with the lava on the bottom of the flow being less viscous than the lava on the top portion of the flow. As the lava flow is compressed in the direction of extrusion, the more viscous top portion of the flow wrinkles, forming folds with long axes oriented perpendicular to the flow direction (Figure 4). It is possible that some of the folds in the Porphyry Peak rhyolite were formed in this way.

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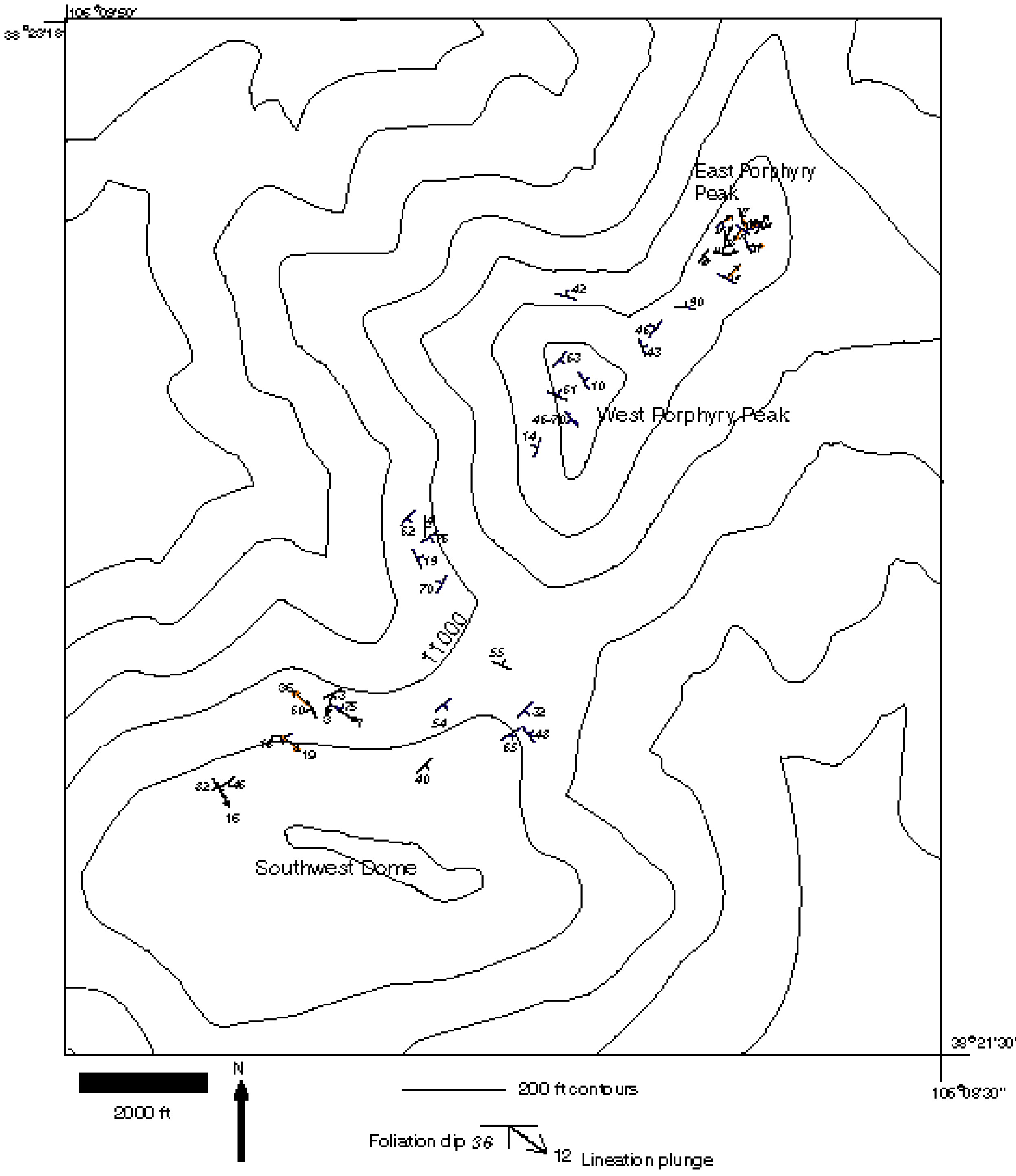

East Porphyry Peak
West Porphyry Peak
11000
Southwest Dome
38°21'30"
106°08'30"
2000 ft
N
200 ft contours
Foliation dip 36
12 Lineation plunge

Figure 2: Pronounced foliation and folding in the Porphyry Peak rhyolite.

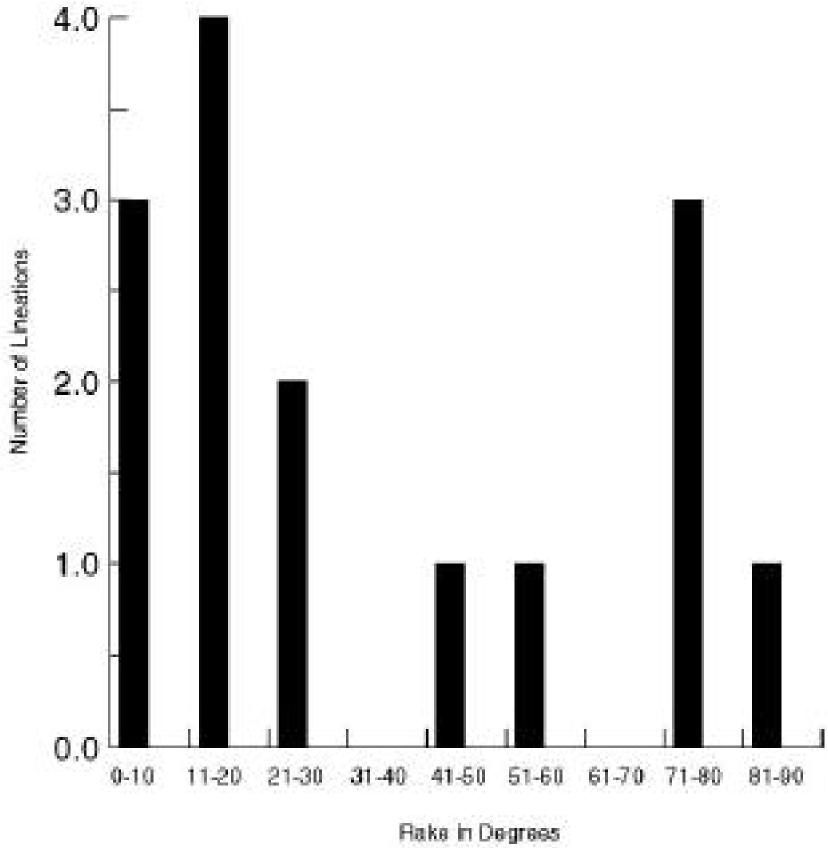

Figure 3: Rake angle vs. number of lineations for pairs of lineations and foliations taken from the same localities in the Porphyry Peak area.

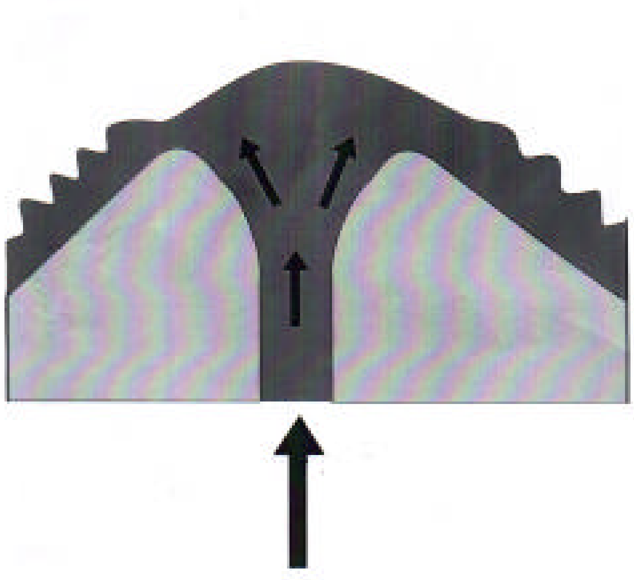

Figure 4: A model of flow folding in lava flows. As flows are compressed in the direction of flow, the less viscous bottom portion of the flow flows more easily than the top portion, causing the upper portion to wrinkle. This process forms folds with long axes oriented perpendicular to the flow direction.