

CONTROLS OF PHYSICAL PROPERTIES OF SNAKE RIVER PLAIN LAVAS ON SURFACE MORPHOLOGIES

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Volcanic rocks of the eastern Snake River Plain are dominated by basalts which show a high degree of topographic uniformity. The surface of the eastern plain is made up primarily of coalesced and overlapping lava shields. Individual vents were short-lived and apparently active for short periods of time, commonly for only a single eruption. On the whole, the distribution of vents appears random, although short fracture-controlled vent chains (less than 6 km in length) are common. The vents in any one chain are commonly few in number and evidence of fissure eruption from the chains is not apparent. The basalts of the eastern Snake River Plain are olivine tholeiites which show a narrow composition variation resulting from olivine and plagioclase fractionation, which are the only phenocrysts found in the basalts. This results in a degree of petrologic uniformity which is reinforced by the fact that most basalts are either micro-porphyritic or contain less than 10% phenocrysts.

Early reference to the geology of the eastern Snake River Plain emphasized the low relief and flat topography of the terrain. The low profiles and long slopes of the shields are apparently the result of a combination of low hydrostatic head feeding the eruption coupled with low viscosities of the erupted lava. In the Snake River Plain Province, the top of the asthenosphere probably extends to the base of the crust and is no doubt the site of fractionation as indicated by the composition of cumulate xenoliths. Typical Snake River basalt is phenocryst-poor and most likely erupted at temperatures very near the liquidus. Calculation of magma density at appropriate liquidus temperatures for the range of basalt compositions found on the eastern Snake River Plain yield a range of from 2.68 to 2.82 g/cc. Seismic studies of the Western Snake River Plain and the Basin and Range Province suggest that such values are similar to the average density for the crust of the Snake River Plain. It seems unlikely that the hydrostatic pressure within the magma reservoirs would exceed lithostatic pressure of the overburden, and as the Snake River Plain is in approximate isostatic equilibrium, it follows that because magma and crust densities are very nearly the same, that there is insufficient hydrostatic head to result in typically tall vents. Possibly the abandonment of a single vent in favor of eruption at closely spaced points in a vent chain substitutes for vent elevation.

The typical basalt flow of the eastern Snake River Plain is a "flood" of pahoehoe lava less than 25 m thick. Slopes of the distal flow surfaces range from 0.75 - 2.0 grade per cent and may in some instances increase near the vent to 5 - 6 grade per cent although they often do not. The vents may be marked by central craters, lava lakes or other evidence of late stage activity but many are featureless. The youngest flows cover areas on the order of 10^4 km².

Viscosities for the lavas may be calculated from the oxide components of composition at chosen temperatures. For the range of observed composition and liquidus temperatures, the range in viscosities is approximately 300-700 poises with most of the range being due to temperature variation. This low range of fluid values no doubt contributes to most of the uniformity in style of the flows.

Atypical vents showing high relief are present on the eastern Snake River Plain however. One such type of high-relief vent is the result of a pyroclastic phase of activity in the eruption. Pyroclastic activity is identifiable at approximately 25% of the vents in the Hell's Half Acre region

of the Snake River Plain although it is a dominant process in less than 5% of the vents. Pyroclastic vents are striking; they are tall, steep-sided and are often marked by deep, large diameter central craters. Atypical steep-sided flow vents can often be shown to be associated with a dominant period of pyroclastic activity from which they inherited their steep slopes.

Another divergent group of shields with tall vents are characterized by highly porphyritic basalt and the topographic distinction between these vents and those of normal flows are probably the result of viscosity differences due to the contained phenocrysts. Phenocrysts within a melt increase the viscosity. Typical Snake River basalts contain less than 10% phenocrysts whereas the coarsely porphyritic basalts found in association with the tall vents commonly contain more than 25% phenocrysts. This high percentage of phenocrysts increases viscosity by at least a factor of two orders of magnitude.

On a more detailed scale, there is a large degree of variation between flows and within local portions of a single flow. Preliminary results suggest that flows with a higher percentage of phenocrysts tend to be thicker, have rougher surface textures and somewhat different channel morphologies compared with more typical Snake River flows. Within a single flow, the surface can be broken into two portions. The portion near the flow front tends to be very rough and characterized by rapid changes in micro-topography, collapse pits, typical pahoehoe structures, etc. The portions of the flow away from the front are comparatively smooth and may lack all the typical pahoehoe features. Rough calculations of yield stresses and surface tensions based on flow morphologies have been found to be within observed or experimental ranges for lavas. This suggests that the smaller scale features of the flow can be interpreted as dependent on these physical properties. It is postulated that the behavior of Snake River lavas can be treated as that of Bingham materials. Quantitative and semi-quantitative descriptions of Snake River lava flow behavior are in the process of being calculated.