08-14

LAY REPORT: ERUPTION HISTORY OF THE FISSURE ERUPTION THAT PRODUCED SUNSET CRATER VOLCANO

Sarah L. Hanson
Adrian College, Earth Science Dept., 110. S. Madison St., Adrian, MI 49221
slhanson@adrian.edu

A report submitted to Western National Parks Association in fulfillment of WUPA Research Grant Number #08-14

INTRODUCTION

Over 600 volcanic vents are exposed in the San Francisco Volcanic Field (SFVF), an ~5000 km^2 volcanic field that extends eastward from near Williams, AZ to several kilometers east of Flagstaff, AZ. Volcanism began approximately 6 million years ago in the western part of the field and since that time the locus of activity has migrated eastward culminating with the eruption of Sunset Crater Volcano ~ 900 years ago. This youngest event began as lava fountained along a southwest trending, 10 km long, fissure that produced a series of vents including Sunset Crater, Rows of Cones, Gyp Crater, and Vent 512, collectively referred to as the Sunset Crater Volcanic Chain (SCVC). Eruptive activity along the fissure ceased as the eruption became focused on the northern end producing Sunset Crater Volcano, a 300 m tall cinder cone and two lava flows, the Kana'a and the Bonito flows. Recent studies suggest that the eruption of Sunset Crater Volcano was a short lived event that began between AD 1040 and 1100. The purpose of this project is to use whole rock and mineral geochemical relationships in an effort to ascertain whether the SCVC as a whole was also produced by a single short-lived eruption or is the result of a longer-lived more complex magmatic system.

RESULTS

Recent geochemical studies by Hanson (2006) have shown that basalt lavas in the SFVF were derived from melting of mantle material. Volcanic episodes within the SFVF all resulted from distinct melting events, each produced by variable amounts of melting (referred to as partial melts). Each of these melts were chemically modified by melting and assimilation of variable amounts of material from the lower crust during ascent (crustal contamination) and by fractional crystallization, a process whereby minerals such as olivine and pyroxene are removed from the melt.

Geochemical analyses of basalt from Gyp Crater, Vent 512, and the Sunset Crater lava flows suggest that Sunset Crater lavas *may* be genetically related to the fissure lavas, thus the result of a single melting event. Removal of olivine ± pyroxene via fractional crystallization of a single melt source could account for some of the geochemical variation. However, fractional crystallization alone cannot explain the enrichments and depletions observed in some element concentrations. For example, lower Th/Ta ratios for the fissure eruptive products are consistent with a lesser degree of crustal contamination for these magmas. Additionally, higher TiO_2 and Zr concentrations, which are typically not affected by crustal contamination, are higher in fissure basalt suggesting that melt was derived from a smaller amount partial melt than the Sunset Crater Volcano lavas. Thus, the SCVC likely represents a complex system that was derived from a single melt source. The earlier fissure eruption (Vent 512, Gyp Crater, and Rows of Cones) was produced by a smaller degree of partial melt that was modified by lower crustal contamination. Shortly thereafter, as time proceeded and/or as deeper levels of the magma chamber were tapped, Sunset Crater Volcano and the associated lava flows were produced from a melt generated by a larger amount of partial melting that underwent a slightly greater degree of lower crustal contamination. These melts both were compositionally modified by subsequent fractional crystallization of olivine ± clinopyroxene. These melts ascended quickly to the surface and produced a short duration eruption, perhaps as little as a few months to as long as 40 years as suggested by Ort et al. (2002).

REFERENCES

Hanson, S.L. (2006) Characterization and Correlation of Lava Flows in Wupatki National Monument, Northern Arizona, Western National Parks Association Research Report no. 06-11, 12 p.

Ort, M.H., M.D. Elson, and D.E. Champion (`2002) A paleomagnetic dating study of Sunset Crater Volcano. Technical Report No. 2002-16, Desert Archaeology, Inc. 16p