THE GEOLOGY OF THE MT. McLOUGHLIN-BROWN MOUNTAIN REGION, SOUTHERN OREGON

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INTRODUCTION

The first Keck Geology Consortium research project in the southern Oregonian Cascades was conducted on the flanks of Mt. McLoughlin volcano during July and August of 1991. The research group consisted of ten rising senior geology majors representing seven of the Keck consortium colleges and three faculty supervisors. During the time of the project, the group received several faculty visitors including Cathryn Manduca (Carleton), Jeffrey Noblett (Colorado College), John Winter (Whitman College), and Bud Wobus (Williams). Each of these visitors was of much assistance in helping the students formulate their research plans and to get them off on the right heading.

GEOLOGIC SETTING

The Cascade volcanic province is often divided into two parts on the basis of age and style of volcanism. Calc-alkaline volcanic rocks of the Western Cascades erupted from Late Eocene to Miocene time in a broad band across much of western Oregon and Washington. The arc narrowed markedly during Pliocene and Pleistocene time to form the majestic High Cascade volcanoes of today. The Cascade arc of today is approximately on average 80 km wide and stretches from Lassen Peak in northern California to Mt. Garibaldi in British Columbia.

The Cascade subduction zone is somewhat peculiar compared to other convergent plate margins. No deep focus earthquakes (>100 km) have been detected with the present Juan de Fuca subduction even though seismic tomography has detected and imaged a subducting slab at depths greater than 100 km (Rasmussen and Humphreys, 1988).

With the Juan de Fuca divergent boundary being quite close to the subduction zone, the plate being subducted is relatively warm and thin. This situation may be a root cause for the lack of intermediate and deep seismicity. It may also effect the angle at which the Juan de Fuca plate is being subducted as well as the rate at which it is occurring. Presently subduction is on the order of 4 cm/year at an angle of approximately N50^{o} E to the Pacific Northwest continental margin. This oblique subduction results in a regional stress field in which the greatest principal stress (horizontal compression) is oriented nearly north-south while the least principal stress (horizontal extension) is aligned nearby east-west (Smith, 1982). The Upper Klamath graben situated immediately to the east of the field area may be a direct result of this stress field orientation.

OVERVIEW OF RESULTS

Ten students mapped and sampled nearly 70 mi^2 in the Oregonian Cascades on the southern flanks of Mt. McLoughlin. With the exception of several isolated kipuka of older mid-Miocene western Cascade two-pyroxene andesite (K-Ar age, 19.6 m.y.) the oldest volcanic rocks in the region are associated with the Rye Spring shield volcano which was active 6.6 to 6.0 m.y. ago. These mafic rocks are characterized by relatively low MgO (3 to 5%) and high P2O5 (0.5 to 0.6%) (See Figure 1).

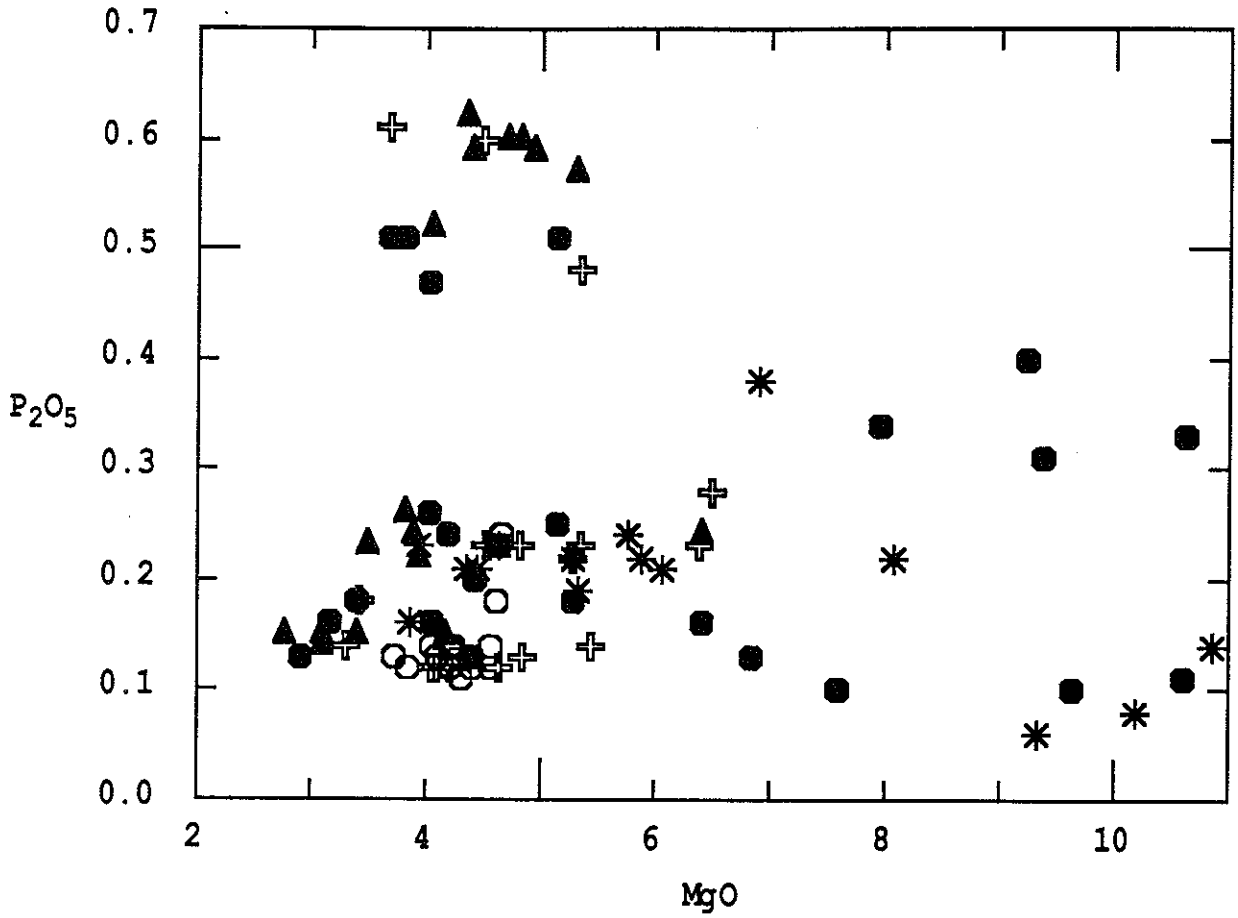

Figure 1. P2O5-MgO variation diagram for many of the lavas in the Mt. McLoughlin region. The highest P2O5 values are from the field units of Rye Spring and Rye Prime (ignore the different symbols)

Subsequent volcanism 5.6 m.y. ago produced mineralogically unique amphibole-olivine low Si andesite flows. Textural equilibrium between the amphibole and the olivine suggests elevated PH2O and higher pressure crystallization (10 to 15 kb) of the phenocryst phases (Yoder and Tilley, 1962; Eggler, 1972). All other extrusives in the map area contain only anhydrous silicate minerals. Sporadic basaltic and andesitic volcanism continued through the Late Pleistocene; no activity is younger than the late Wisconsin glacial activity.

Data from samples representing each stratigraphic unit depict two nearly parallel linear trends on a K2O-SiO2 diagram (See Figure 2). The lower K2O-SiO2 trend has a K2O value of 0.3% @ 50% SiO2 while the higher K2O-SiO2 trend has a K2O value of 0.7%. In general the older (4-7 m.y. old) Cascade lavas belong to the higher trend while the younger lavas (<2 m.y.) tend to below to the lower one including all the Mt. McLoughlin-Brown Mt. lavas. This geochemical pattern may be tied to both changes in the rate and angle of subduction.

Given nearly two dozen samples for which K/Ar ages have been determined, some preliminary statements are in order with regard to compositional variation as a function of geologic time. With decreasing age several features are noticeable:

1) Ba, Be, La, Ce, P2O5, K2O, and La/Yb decrease as a function of decreasing age (See Figure 3 as an example),

2) basalts whose SiO2 contents are $\leq$ 50% make their first appearance approximately 3 Ma years ago, and

3) Fe2O3(Total), MgO, CaO, TiO2, Al2O3, Na2O, Rb, Sr, Y, Zr, Co, and Sc show no particular trend as a function of age. If these trends persist as more absolute ages become available, then it is likely they reflect long term changes in the mineralogy of the source region or perhaps an increasing degree of partial melting. The common thread which links the items listed in (1) is their incompatible behavior in mafic igneous systems. There is much work to be done in southern Oregon wherein petrology, geochemistry, and plate tectonic movement are integrated to provide a comprehensive picture of the generation of the volcanic rocks.

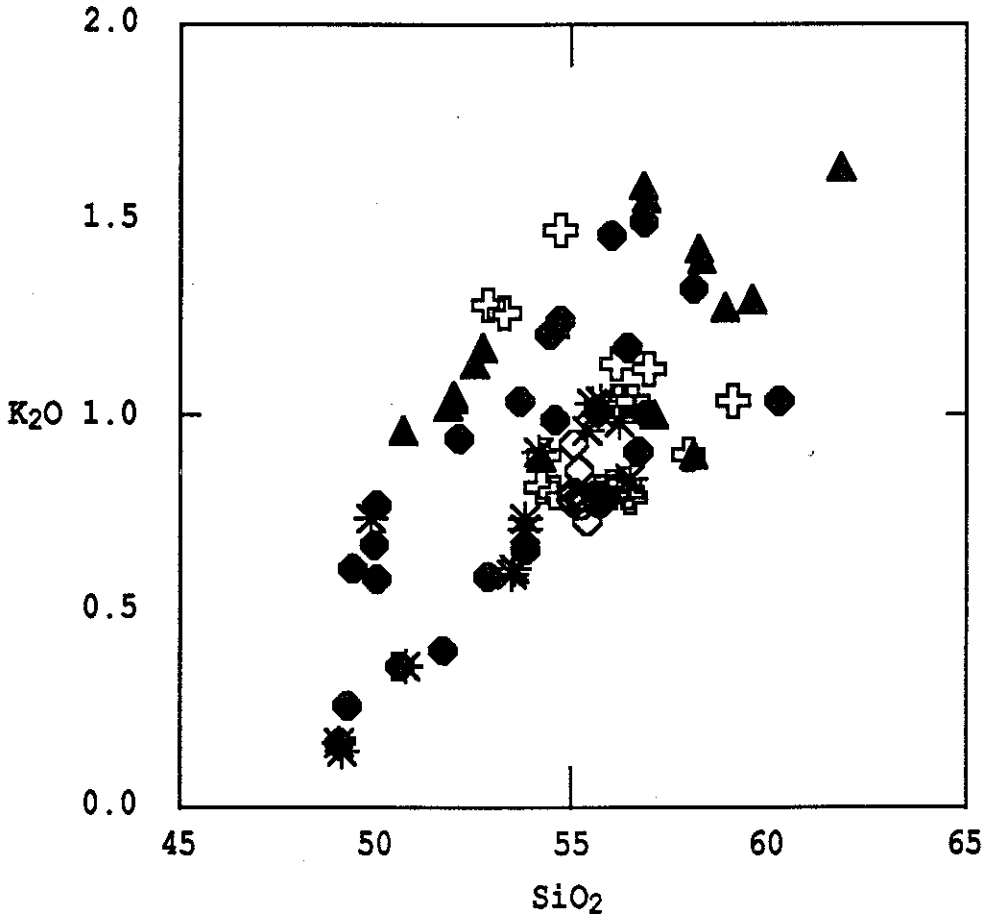

Figure 2. K2O-SiO2 variation diagram. See text for explanation.

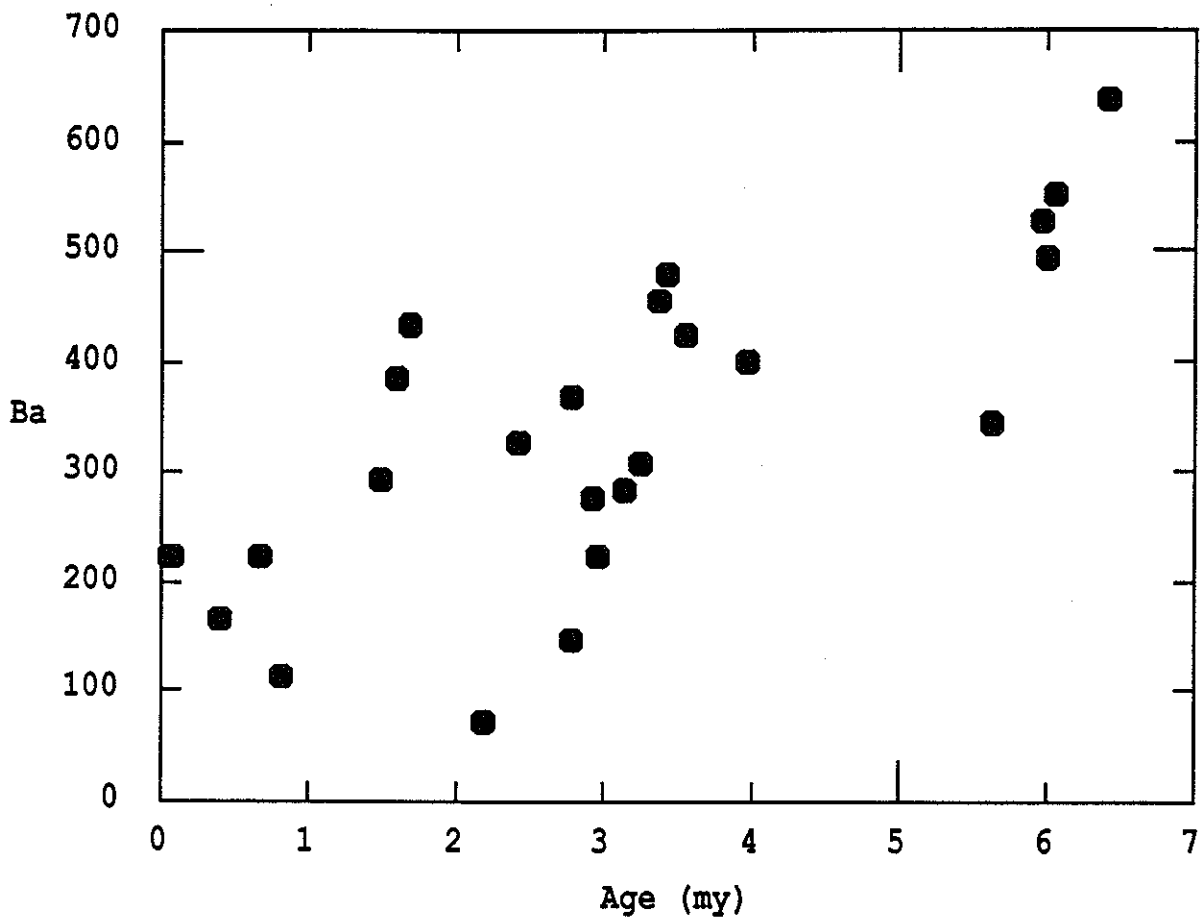

Figure 3. Ba-K/Ar age variation diagram. See text for explanation.

Lastly, of particular interest are two quite different olivine tholeiite basalts. One, a low K high alumina variety ($K_2O<0.3$, $Al_2O_3>17\%$), erupted from a vent south of Fourmile Lake 2.2 m.y. ago and Burton Butte 0.8 m.y. ago. The second type is lower in alumina (15-16%) and richer in K_2O, MgO, Ba, Sr, Ni, Cr, and Zr. Vents for this olivine phyric basalt are located southeast of Fish Lake and south of Fourmile Lake. These vents erupted 2.8--2.9 Ma ago while the Pierce Point scoria cone was active 1.5 m.y. ago. These basalt compositions reflect generation in the upper mantle with little subsequent crystal fractionation. Their origin may possibly be related to Basin and Range extensional tectonism.

References Cited

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