**Miocene to Holocene Volcanism of Robinson Butte and Vicinity, Southern Oregon Cascades**

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Orogenic Cascade Range volcanism from the late Mesozoic through the Holocene is well preserved in the rock record. Chains of smaller volcanic structures extend between larger composite volcanoes such as Mt. Shasta in northern California and Mt. McLoughlin in south-central Oregon. My field area encompasses one such smaller structure, Robinson Butte, and additionally includes several peripheral units ranging in age from 19 My to approximately 20-30 Ky (Mertzman 1991 and 1988) [Figure 1]. It comprised the southwestern 8 square miles of our group's general west-east transect through the southern Cascades in the vicinity of Fish Lake, OR. Rock types are primarily calc-alkaline basalts and basaltic andesites, as are the majority of the regional neighboring volcanic units.

Two weeks in the field were spent mapping, establishing stratigraphic relationships, collecting samples, and preparing specimens for analysis. Laboratory work consisted of major element analysis by x-ray fluorescence and trace element analysis by inductively coupled plasma techniques. Thirty-three thin sections were examined in the petrographic microscope and selected samples were dated using K-Ar techniques.

Eleven units were initially defined in the field and later modified slightly following geochemical data analysis. Distinguishing lithologic features include phenocryst size and abundance, comparative modal plagioclase percentages, and the relative abundances of olivine, orthopyroxene, and clinopyroxene.

Unit Lithologies, Petrography, and Geochemistry:

Chimney basaltic andesite is by far the oldest unit in the region--19.6 ± 0.3 My (Mertzman, 1991). Forming two kipukas west of Robinson Butte, it crops out as platy, chimney-like stacks which contain angular inclusions of dark, aphanitic rock. Its most prominent features are phenocrysts of deceptively hornblende-like orthopyroxene (to 4 mm in length) and chalky plagioclase. The latter is blocky and shows oscillatory zoning in thin section. Notably, Chimney basaltic andesite has the highest $Al_2O_3$ (19.44 wt.%) and Cr (9 ppm) values.

Grizzly Creek basaltic andesite underlies Robinson Butte basalt flows and resembles a heavily weathered version of Robinson Butte basalt. Heavily iddingsitized olivine phenocrysts are larger (0.5-3 mm), however, and modal plagioclase is more prominent in both hand sample and thin section (62%). Cr, Ni, and Sr levels are high, but otherwise samples 53 and 54, both from this unit, are unlike each other [Figures 2 and 3]. While 53 capped a small rise in the field and consists of relatively equal amounts of olivine and pyroxenes, sample 54 outcropped as platy shelves and contains relatively low olivine, no clinopyroxene, and high orthopyroxene (30%). Accurate observations are difficult to make, however, due to lack of fresh samples within the unit.

Butte Creek basalt forms coherent fine-grained, olivine-bearing cliffs through which both the highway and Little Butte Creek have cut. Though presently considered as one unit, chemical and petrographic data have wide ranges in the several samples collected. The unit is potentially divisable into higher (samples 29 and 50) and lower (samples 21 and 46) potassic units which border on the divisions into trachy-basalt and basaltic andesite [Figure 2]. With one exception, all samples contain 45-55% plagioclase and 15-30% olivine. Clinopyroxene is rare and orthopyroxene, when present, varies from 2-35%. Based on field and hand specimen observations, sample 41 was also included as part of this unit. Chemically, however, it plots near Robinson Butte basalt but lacks all characteristic lithologic and petrographic features and is relatively depleted in $Al_2O_3$. Additionally, it is enriched in MgO, Cr, and Ni--perhaps suggesting a genetic relationship with Robinson Butte basalt by olivine fractionation (Wilson, 1989) [Figure 3].

Rye Spring basaltic andesite is a regionally widespread unit. Dated to 6.06 ± 0.10 My (Mertzman, 1991), it crops out as fine-grained, medium grey, weathered boulders and sugary-textured float. In thin section, ground mass makes up only 3% of this plagioclase-dominated (65-70%), orthopyroxene and opaque-bearing unit. Slightly less siliceous and sodic in this area than the 'typical' Rye Spring unit type, it appears to be chemically similar to both the younger North Fork basaltic andesite and the stratigraphically older Butte Creek basalt.

North Fork porphyritic basaltic andesite appears in various locations beneath Robinson Butte basalt. Its most prominent characteristic is large (to 1 cm+ in diameter), bimodal in size plagioclase phenocrysts. These vary greatly in size and concentration to give the unit a wide range of appearances. The North Fork basaltic andesite commonly also contains visible clinopyroxene, olivine, and orthopyroxene. K-Ar isotope dating places this unit at 3.97 ± 0.08 My (Mertzman, 1991). A similar unit appearing in the far southeast is younger, 3.42 ± 0.06 My (Mertzman, 1992), with generally smaller phenocrysts, distinct orthopyroxene and hornblende, and higher $SiO_2$ and total alkali weight percentages [Figure 2].

Robinson Prairie II and I trachy-basalts are two similarly anomalous units. Robinson Prairie II aphyric olivine trachy-basalt crops out as scattered coherent boulders southwest of Robinson Butte. It is made up of 35% unaltered olivine (phenocrysts and ground mass), >15% opaques, lath-like orthopyroxene (10%) and 11% clinopyroxene. Chemically, Robinson Prairie II consistently plots entirely in its own domain. Of all my units, it has the highest $TiO_2$, $P_2O_5$, P, Ce and lowest $SiO_2$ and $Al_2O_3$ values. It also has an exceedingly high Sr level of 1416 ppm, as well as 786 ppm Ba, both of which are second only to Robinson Prairie I--also an alkalic trachy-basalt. Sr and Ba values for this neighboring unit are 1604 ppm and 1323 ppm, respectively. However, it contains 25% clinopyroxene and very little olivine or opaques. Plagioclase and pyroxene zoning is obvious in thin section, as is a generally broken-up, much older overall appearance than the Robinson Prairie II trachy-basalt.

Robinson Butte is the central feature of my field area, rising to 5864 ft. Isotope dating pinpoints Robinson Butte basalt as the second youngest unit in the region, at 0.40 ± 0.30 My (Mertzman, 1991). A glomeroporphyritic, two pyroxene olivine basalt, it is also characterized by plagioclase microphenocrysts which give the unit a white speckled appearance. Partially iddingsitized olivine (20-35%) and chrome spinel are abundant in thin section, along with clinopyroxene (8-14%) and orthopyroxene (25-30%). Total alkali levels are low, from 3.1 to 3.3 wt% [Figure 2]. Based on vegetative cover, the most recent blocky flow extended as a high arm off to the northeast. Random fluctuations in glome size and density are the only minor variations within the unit, with the exception of oxidation from a medium grey color to red as one ascends to the peak (threshold ≈ 5400 ft..). Pyroclastics, however, are most abundant on what is probably a parasitic 'arm' extending off to the south and at a cinder pit to the southeast. The latter is apparently older than Robinson Butte proper, based on a flow which skirts the cinder cone and on the relatively high, undepleted quantities of Cr (448 ppm) and Ni (177 ppm) [Figure 3]. It is otherwise characteristic of Robinson Butte basalt as defined above.

The youngest unit is Brown Mt. andesite which formed in two stages of blocky flows (as indicated by vegetative development) and created numerous tumuli structures. This fine-grained lava consists almost entirely of plagioclase laths and has the highest $SiO_2$ weight percentage. Opaques (5%), olivine (3%), and orthopyroxene (2%) are also visible in thin section. The farthest westward extent of Brown Mt. andesite ends northeast of Robinson Butte after it apparently flowed down part of the Little Butte Creek valley.

Discussion:

A few general characteristics apply to all the above rock units. All rocks are holocrystalline and some degree of trachyitic development is evident in most, especially those composed of finer grains. Plagioclase is the dominant mineral, manifested in the overall high $Al_2O_3$ levels (Gill, 1981). CaO, however, correlates negatively with $SiO_2$, affected by clinopyroxene fractionation and suggesting basaltic evolution from calcic to sodic as is also evidenced by NaO trends (Gill, 1981). Olivine, rarely included in the groundmass, usually contains chrome spinel inclusions and iddingsite. Both olivine and opaque concentrations--most likely magnetite or titanomagnetite (Wilson, 1989)--are the highest in Robinson Butte basalt. MgO, $P_2O_5$, Ni, and Cr also correlate negatively with $SiO_2$. The MgO, Ni, and Cr trends suggest olivine fractionation, closely associated with chrome spinel in most of the units. Based upon these observations, Robinson Prairie I and II trachy-basalts and perhaps Butte Creek basalt' may be the predecessors of Robinson Butte basalt and/or Butte Creek basalt. All of the above show some chemical similarities to Rye Spring, while Brown Mt. andesite and Chimney basaltic andesite appear dissimilar to other units. Overall chemical data is scattered, forms few absolute trends, and provides little definitive evidence for genetic relationships between the varied and complex rock units from the Robinson Butte vicinity.

References:

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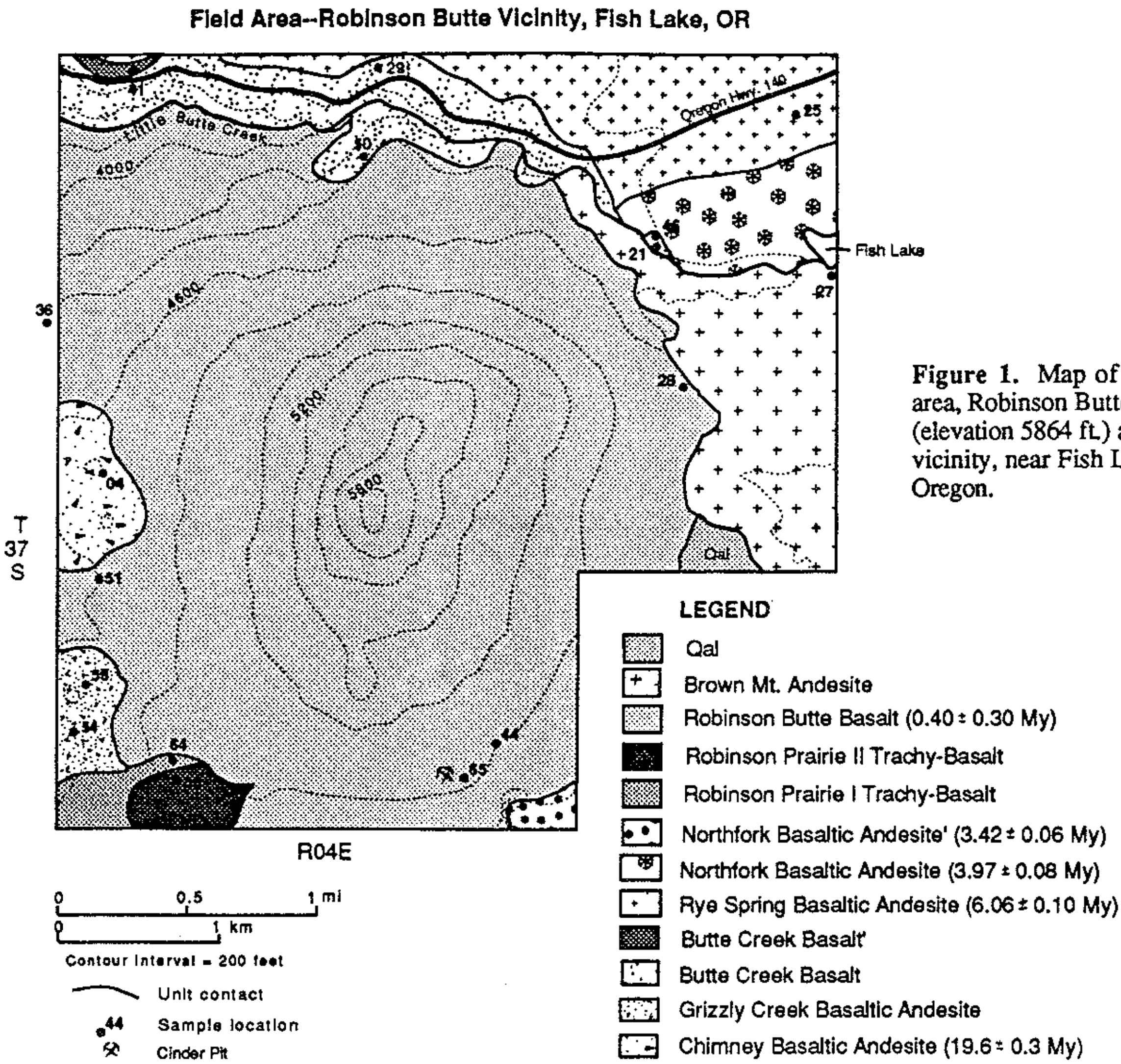


**Figure 1.** Map of field area, Robinson Butte (elevation 5864 ft.) and vicinity, near Fish Lake, Oregon.

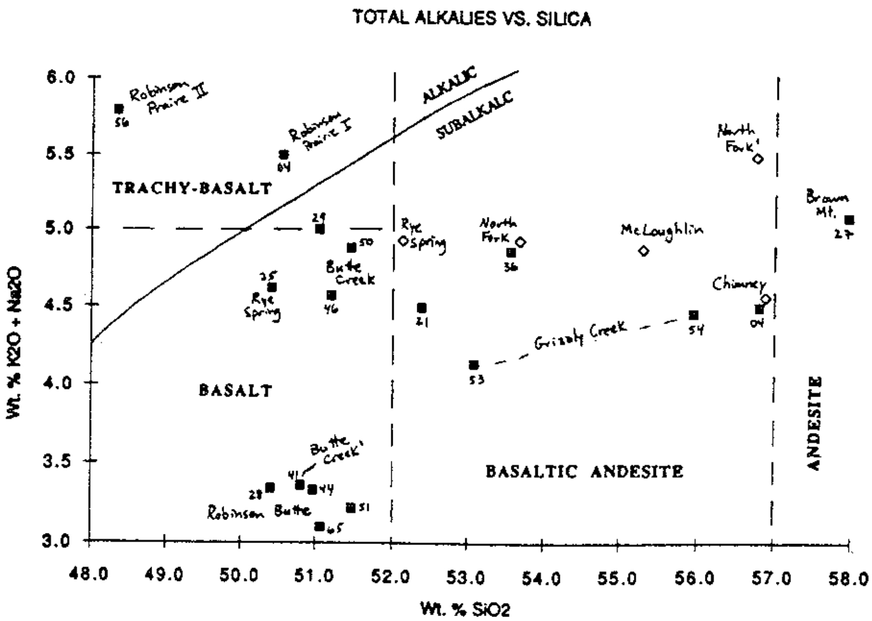


**Figure 2.** Total alkalies, wt. % K2O + Na2O, versus wt. % SiO2. Classification divisions after LeBas et al, 1986. Dark squares are from my field area [see Fig. 1]. Numbers correspond to rock sample locations and names to their respective units. Open diamonds are data points from selected regional units (Mertzman, 1988, 1991, and 1992), included for comparative purposes.

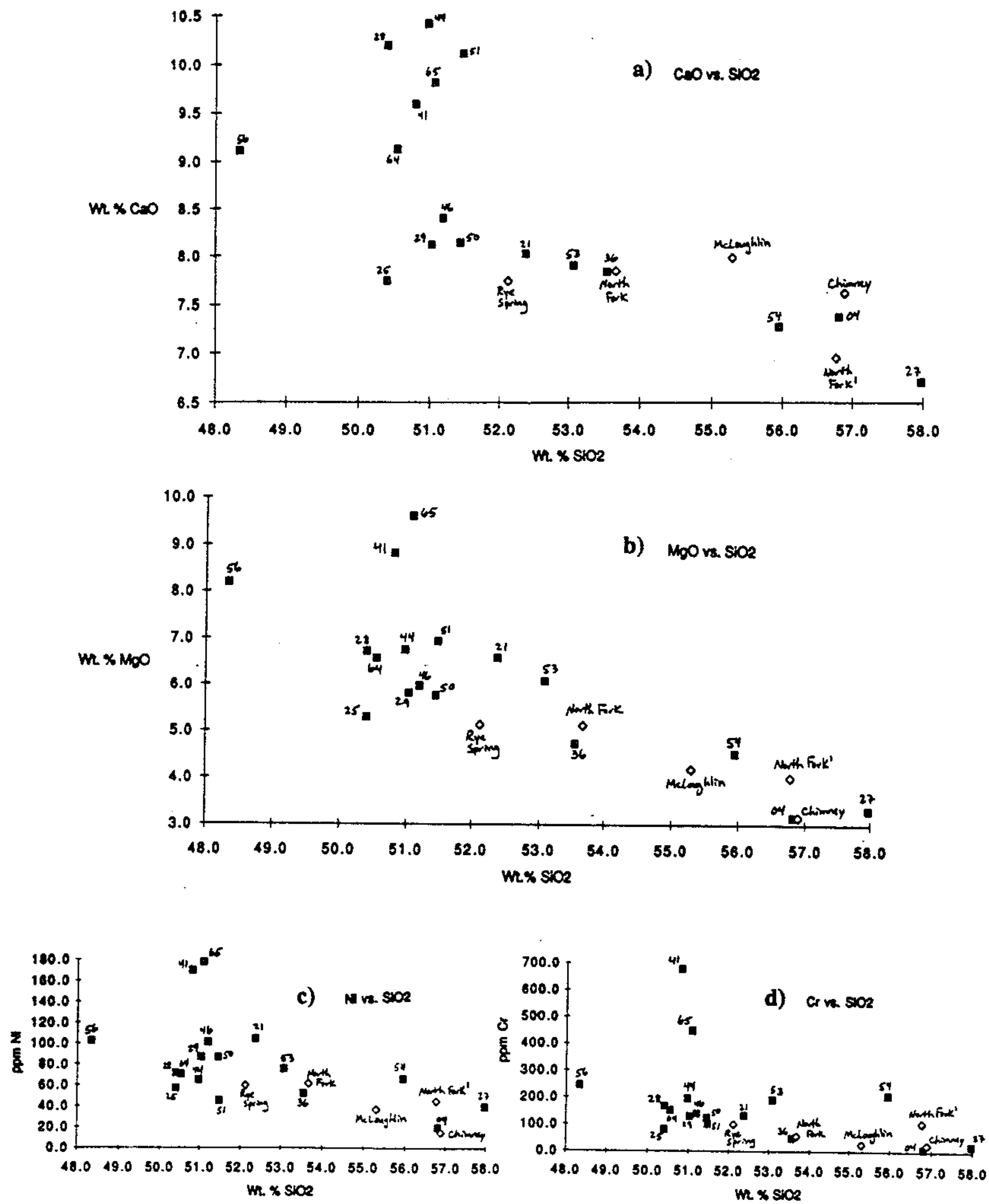


Figure 3. Dark squares are units from my field area, open diamonds are data points from selected regional units (Mertzman, 1988, 1991, 1992). Numbers correspond to rock sample locations [see Figure 1]. **a)** Wt. % CaO vs. SiO2, showing three major groupings of relative CaO-enriched, intermediate, and depleted samples, possibly due to clinopyroxene fractionation. **b,c,d)** Wt. % MgO versus SiO2 and ppm Ni and Cr versus wt. % SiO2, respectively. Note enrichment in samples 41, 56, and 65, suggestive of less evolved magma source(s). Negative correlations with SiO2 probably correspond to olivine fractionation.