Extrusive! Extrusives! Extrusives!
A Study of Quaternary and Late Tertiary Volcanics in the High Cascades of Southern Oregon

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Introduction

The Cascade Range stretches from Northern California to British Columbia and is considered to be the result of subduction zone volcanism. It is largely a chain of calc-alkaline andesitic volcanics; however, basalts are also present and may be associated with the extensional tectonics of the Basin and Range and/or the processes of active back-arc spreading regions. This years Cascade Keck Project continued the west to east traverse across the Cascades in southern Oregon which was begun by the 1991 Keck group. The traverse was continued into the vicinity of Lake of the Woods. The region of study to be addressed here is an area of seven square miles that lies just east of the Rye Spur area. Two weeks were spent in the field mapping, determining stratigraphic relations, and collecting samples to be used for thin section and chemical analyses. X-Ray Fluorescence (XRF) was used to determine major and trace elements concentration. Inductively Coupled Plasma techniques were also used to add addition trace element data. K-Ar dates are available for a limited number of samples and in conjunction with field relations are the basis for determining the stratigraphic sequence. The K-Ar dates have been supplied by Mertzman and are yet to be published.

Unit Descriptions

"Anarchy is the law of nature, and order the dream of man."

-Henry Adams

Volcanics associated with Rye Spur dominate the western and north western portions of the field area and are expressed as the Rye Spur Olivine-Plagioclase Basalt and the Rye Spur Basaltic Andesite. The Rye Spur Olivine-Plagioclase Basalt at 2.78+/-.09 Ma is the oldest unit in the area. This unit is chemically characterized by having the highest MgO and CaO concentrations at >10% and >9% respectively. It displays olivine phenocrysts of 2-3mm along with smaller and less abundant plagioclase laths. The olivine tends to form euhedral to subhedral crystals and in some cases have formed an ophitic texture with plagioclase and orthopyroxene. Glomeroporphrytic clumps are also present and contain olivine+pyroxene+/-plagioclase. When these clumps contain plagioclase they can be as large as 3mm. Some small vesicules(>1mm) are present and the plagioclase dominated ground mass can display a trachytic texture. The RyeSpur Basaltic Andesite is the second oldest unit -1.58+/-.03.Ma. This unit is distinguished by a dark ground mass associated with glomeroporhrytic clumps of plagioclase+olivine+pyroxene that may occur up to 5mm in diameter. (Gilmore,1992).

The north central region of the field area contains another unit associated with Rye Spur volcanics in the pseudo Rye Spur Basaltic Andesite. While very similiar in hand specimen and thin section to the Rye Spur Basaltic Andesite, the pseudo Rye Spur unit is enriched in MgO and depleted in SiO2 compared to the Rye Spur Basaltic Andesite. The pseudo Rye Spur unit outcrops as two kiapukas with in the Chaffe Point unit making it the older of the two units. The Chaffe Point unit has been dated at 1.22+/-.04 Ma. The feature characterizing this unit is the abundance (10-15%) and size (2-3mm) of the olivine phenocrysts.

The Cat-in-the-Bag High Alumina Olivine Tholeiite (CITB HAOT) has been dated as 1.02+/-.05 Ma. Occuring in the south central region of the field area this unit is characterized by vesicules filled by dictytaxitic plagioclase laths, a light to medium grey groundmass, some small glomeroporphrytic aggregates containing olivine and plagioclase. In a few aggregates orthopyroxene is also present. Contemporaneous with the CITB HAOT is the Long Creek Basalt (1.02+/-.09 Ma) located in the north east corner of the field area. A sugary texture and a near olivinepheric behavior, 7-10% olivine phenocrysts <1mm serve to distinguish this unit.

Next youngest units are the Rye Spur Andesite and the Whistler's Andesite. These are both two pyroxene andesites; however, the Rye Spur andesite exhibits glomeroporphrytic clumps of plagioclase and either orthopyroxene or clinopyroxene. The Whistler's unit is also less silica rich (56-57% SiO2) than Rye Spur unit (59-60% SiO2). Both of these units have sources which lie south of the field area; due to field relations the Rye Spur Andesite is considered the older of the two units.

The Fourmile Creek Two Pyroxene Olivine bearing Andesite (0.21+/-.18 Ma) is a highly vesicular unit with well formed olivine phenocrysts and a groundmass dominated by plagioclase laths with minor amounts of olivine. The source of this unit is found north of the field area where it has produced a large flow often outcropping as large boulders.

Discussion

Plots of FeO/MgO vs. SiO2 show all samples falling within the calcalkaline field except for samples JS-305, 412 and, 414 in the tholeiitic field. Samples JS-413 and 906 plot near the boundary between these two fields (Fig-1). These samples all represent what has been classified on the map, by hand sample, and by thin section as the Cat-in-the Bag HAOT. Hart et al. (1984) has classified similiar basalts into HAOT - K2O<0.39, TiO2<1.35; and three types of "transitional tholeiites" characterized by low-K (<0.5), low- Ti (<2.0); low-K, hi-Ti (>2.0); and hi-K (>0.5), hi-Ti (>2.0). According to Hart only JS-305 and 414 can be classified as HAOT. Sample JS-906 is low-K, low-Ti tholeiite(LKLT). According to this classification JS-412 and 413 are hi-K, low-Ti tholeiites (HKHTs). This HKHT tholeiite was unrecognized by Hart, but in this study it was found in close association with the HAOT and LKLT tholeiites in the field. The CITB HAOT will now be refered to as as the CITB basalts.

Conserved element ratios plots of Ti/K vs. P/K (Fig-2) make the differences between the CITB basalts more obvious (Russel, Stanley; 1990). These samples fell into three distinct groups: JS-305, 414 ; JS-412, 906 ; and JS-413 in order of highest to lowest ratios. This would support a hypothesis that while lithologically similar these rocks were formed from three distinct magmas. This can be further supported by noting where these units occur within the mapped flow of the CITB basalts. Samples JS-305 and 414 can be truly classified using K and Ti values as HAOT and are found at the front of the flow. Samples JS-906 (LKLT) and JS-412 (HKHT) are found on the eastern most lobe of the flow, while sample JS-412 (HKHT) is found on a middle lobe of the flow. This correlation between magma type and location on the flow suggests that the HAOT lava is the oldest followed by the remaining CITB basalts. Assemblage test diagrams support the same hypothesis of liquid-crystal fractionation for each group - olivine, plagioclase and augite were each extracted in some proportion from these magmas.

It can also be hypothesised from conserved element ratios that the Rye Spur Olivine-Plagioclase Basalt came from the same magma as the eastern lobe of the CITB basalts, and was therefore a result of olivine, plagioclase, and augite extraction. The Chaffe Pt and Long Creek Basalts are of the same magma source as the central lobe of the CITB basalts and can also be hypothesised to be a result of olivine, plagioclase, and augite.

Conserved element ratios suggest that The Rye Spur Basaltic Andesite, Pseudo Rye Spur Basaltic Andesite, Whistler's Basaltic Andesite, and the Fourmile Creek Andesite are all from the same magma source. The hypothesis that all of these lavas my be related by olivine and plagioclase extraction cannot be disproven by Pearce Element Ratio assemblage test diagrams, nor can the hypothesis that Whistler's Basaltic Andesites are related by olivine, plagioclase, and augite extraction be disproven.

There is no direct correlation between magma type and age, yet for this limited number of samples there appears a pattern to the type of magma over time. The magma types seen to oscillate over time between magmas of high Ti/K vs. P/K ratios and magmas of lower ratios. The magmas of higher ratios tend to be more primitive with MgO/FeO + Fe2O3ratios of 1.16 to 0.70 in the more primative magmas to 0.55 and 0.71 in magmas with lower ratios.

REFERENCES CITED

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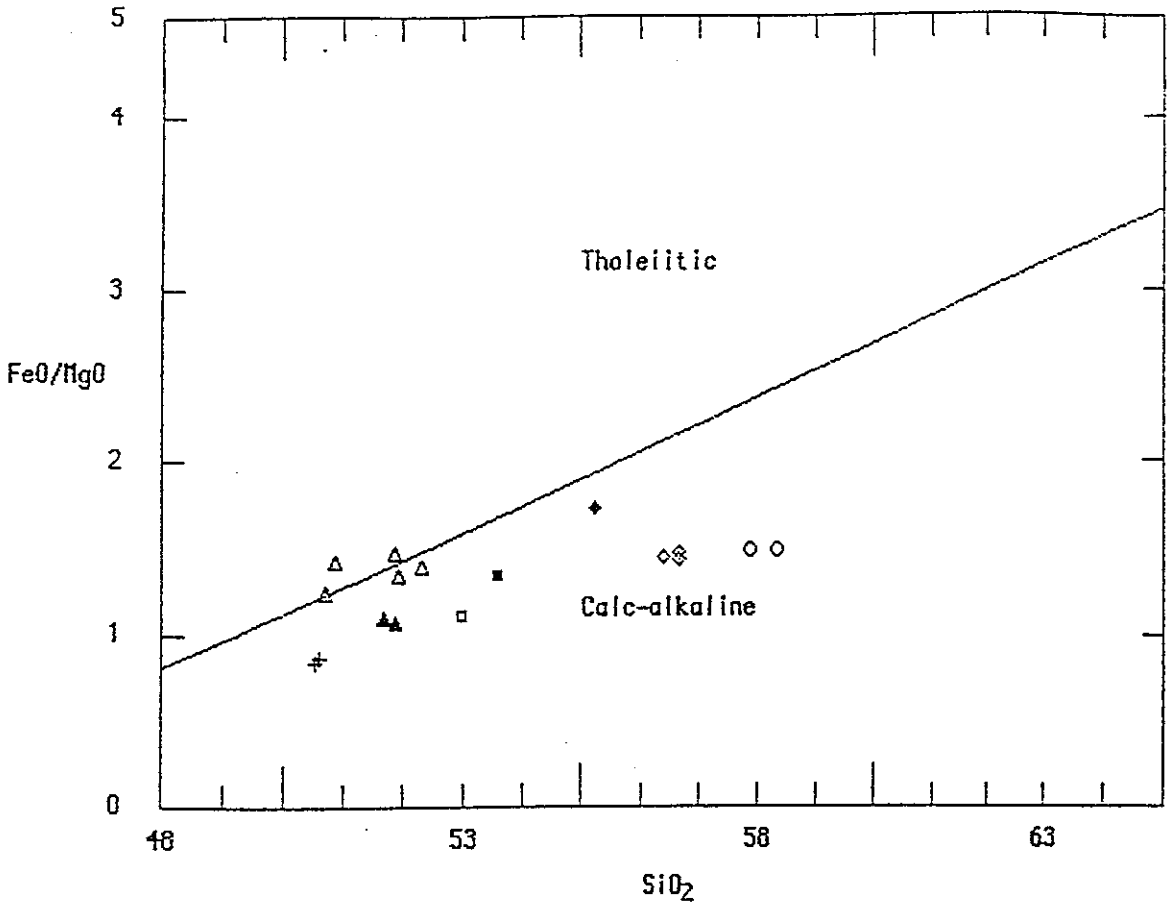

- Rye Spur Olivine-Plagioclase Basalt
- Rye Spur Basaltic Andesite
- Pseudo Rye Spur Basaltic Andesite
- Chaffe Point Olivnepheric Basalt
- Cat-in-the Bag HAOT
- Long Creek Basalt
- Whistler's Basaltic Andesite
- Fourmile Creek 2px Olivne Bearing Andesite

Figure 1: MgO/FeO vs. SiO2. Field divide into Tholeiites and Calcalkalines

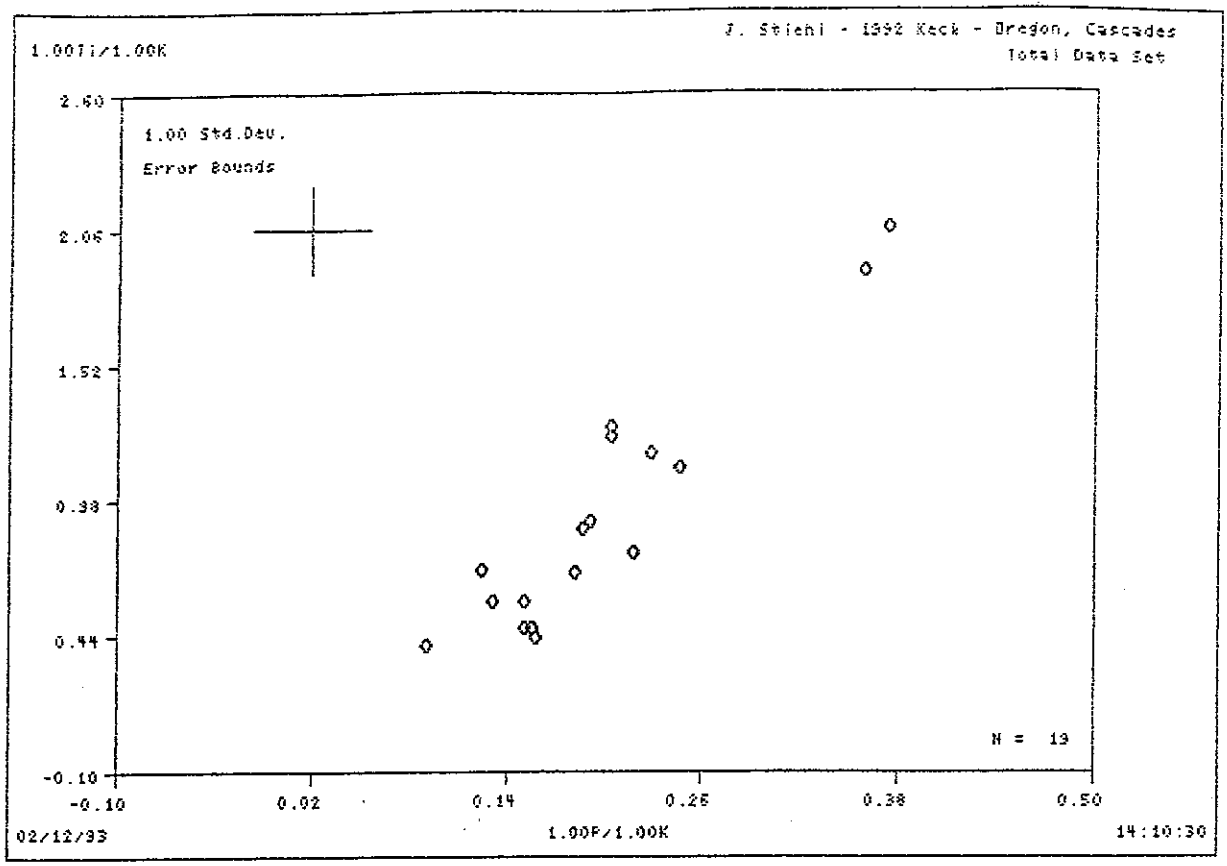

Figure 2: Conserved elemenets Ti/K vs. P/K. Groupings represent 4 distinct source magmas.