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Orthopyroxene Fractionation in the Grande Ronde Basalt Columbia River Basalt Group

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IN THE
GRANDE RONDE BASALT
COLUMBIA RIVER BASALT GROUP

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for
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The Columbia River Basalt was mapped and sampled in the area near the confluence of the Snake and Salmon rivers (Figure 1) by Stephen P. Reidel, and in the northern Blue Mountains-Grande Ronde River area (Figure 1) by Martin E. Ross (1978). Both areas lie 40 kilometers apart along the common boundary of Oregon and Washington and cover over 3,200 square kilometers.

The Grande Ronde Basalt is a quartz tholeiite and is primarily composed of clinopyroxene (augite) and plagioclase (An_{40-60}). The basalt is generally aphyric and fine grained, lacking any significant intratelluric phase. Two flows, however, (the Rogersburg flows) have plagioclase phenocrysts up to 1 centimeter in size. Accessory phases include pigeonite, olivine, and Fe-Ti oxides.

Orthopyroxene, however, was identified in the Grande Ronde Basalt at China Creek (Figure 1) in the lower Salmon River Canyon (Reidel, 1975). More recently, Reidel (1978) has identified orthopyroxene in the Grande Ronde Basalt throughout the lower Salmon and middle Snake rivers area and Ross (1978) has identified orthopyroxene in the Grande Ronde Basalt and Saddle Mountains Basalt in the Blue Mountains-Grande Ronde River area. The pyroxenes occur sporadically throughout the entire Grande Ronde Basalt sequence and within the chilled margins of the Wenaha dike (Saddle Mountains Basalt), but are virtually absent in the interior of the dike and in the Wenaha flow. The Buford flow of Saddle Mountains Basalt also contains scattered crystals of orthopyroxene.

The orthopyroxene (Figure 2) normally occurs as unzoned phenocrysts or microphenocrysts that are partially resorbed. The optic angle ($2V_x$) is 55 degrees to 70 degrees which places them in the bronzite to hypersthene compositional range. Many orthopyroxenes possess a pale pink-green pleochroism. Commonly, plagioclase and orthopyroxene are intergrown (Figures 3 and 4) with the plagioclase showing a weak optical zonation.

Six orthopyroxenes were microprobed using the ETEC Autoprobe at the National Aeronautics and Space Administration by Philip E. Long. Five orthopyroxenes were from the Grande Ronde Basalt (Figures 5, 6, 7, 8, and 9) and one from the Buford flow of the Saddle Mountains Basalt. The orthopyroxenes are primarily bronzite in composition, but some analyses show that hypersthene is present. The reaction rims of all analyzed orthopyroxene crystals are pigeonite, while the groundmass pyroxene is both augite and pigeonite.

FIGURE 1
LOCATION MAP

FIGURE 2

ORTHOPYROXENE FROM THE
GRANDE RONDE BASALT

(OPX is orthopyroxene.)

FIGURE 3

ORTHOPYROXENE PLUS PLAGIOCLASE IN THE
GRANDE RONDE BASALT

FIGURE 4

ORTHOPYROXENE PLUS PLAGIOCLASE IN THE
GRANDE RONDE BASALT

FIGURE 5

COMPOSITION OF PYROXENES FROM SAMPLE CHI 43

FIGURE 6

COMPOSITION OF PYROXENES FROM SAMPLE DOG 28

FIGURE 7

COMPOSITION OF PYROXENES FROM SAMPLE PLR 28

FIGURE 8

COMPOSITION OF PYROXENES FROM SAMPLE GGS 6

FIGURE 9

COMPOSITION OF PYROXENES FROM SAMPLE GR 387

The resorbed orthopyroxene crystals with pigeonite reaction rims indicate that the phase was unstable under surface to near-surface conditions. A low Al_2O_3 content (0.5 to 1.5 weight percent), however, suggests they probably did not crystallize at great depths.

Preliminary results from least squares linear modeling of the Grande Ronde Basalt indicate orthopyroxene is a necessary phase for mass balancing between flow compositions. Three models were tried in order to determine if selected mineral phases could be used to model the chemical compositions of the flows. The first model:

- (1) Flow A = Flow B + clinopyroxene + plagioclase + olivine approximated surface fractionation. The other two models:
- (2) Flow A = Flow B + clinopyroxene + orthopyroxene + plagioclase + olivine;
- (3) Flow B + plagioclase + orthopyroxene + olivine = Flow A + clinopyroxene + garnet.

The first model failed for flows of the Grande Ronde Basalt; the second model had a fair (<30 percent) success rate; while the third model was used successfully to model greater than 70 percent of the Grande Ronde flows. Success was determined by the residual values falling within the limits recommended by Wright (1974). Even though these models assume the flows are genetically related, they do suggest that orthopyroxene and plagioclase are phases common to the Grande Ronde Basalt.

The similarity of orthopyroxene and plagioclase occurrences in these two areas suggests that they are important intratelluric phases of the Grande Ronde Basalt which reacted out when the basaltic liquids were erupted at the surface. Orthopyroxene and plagioclase probably began crystallizing under stable, low-pressure conditions and then began fractionating from the liquid. With the extrusion of the liquid at the surface, orthopyroxene began reacting out and the sporadic, rare occurrences result from special circumstances which prevented complete liquid-crystal reaction.

The presence of orthopyroxene in the Saddle Mountains Basalt also suggests it might be an important phase in the petrogenetic history of the Saddle Mountains Basalt.

BIBLIOGRAPHY

Reidel, S. P., 1975, "Pyroxene Composition and Subdivision of the Lower Yakima Basalt of the Columbia River Basalt Group in the Snake and Salmon River Canyons of Washington, Oregon, and Idaho," Geological Society of America, Abstracts with Programs (Cordilleran Section), 7 (3), 364 p.

Reidel, S. P., 1978, The Stratigraphy and Petrogenesis of the Grande Ronde Basalt in the Lower Salmon and Adjacent Snake River Canyons, Ph. D. Thesis, Washington State University, Pullman, Washington, 415 p.

Ross, M. E., 1978, Stratigraphy, Structures, and Petrology of Columbia River Basalt in a Portion of the Grande Ronde River-Blue Mountains Area of Oregon and Washington, Ph. D. Thesis, University of Idaho, Moscow, Idaho, 407 p.

Wright, T. L., 1974, "Presentation and Interpretation of Chemical Data for Igneous Rocks," Contributions to Mineralogy and Petrology, 48, pp. 223-248.

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