K-Ar age of silicic volcanic rocks within the lower Columbia River basalt group at Timber Butte, Boise and Gem counties, west-central Idaho

D.M. Clemens and S.H. Wood

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K-Ar AGE OF SILICIC VOLCANIC ROCKS WITHIN THE LOWER COLUMBIA RIVER BASALT GROUP AT TIMBER BUTTE, BOISE AND GEM COUNTIES, WEST-CENTRAL IDAHO

DREW M. CLEMENS
SPENCER H. WOOD
Department of Geology and Geophysics, Boise State University, Boise, ID 83725

The Timber Butte study area is located approximately 65 km north of Boise, Idaho (fig. l). The rhyolites discussed in this preliminary study are here named for Timber Butte, where the type section for the Timber Butte Rhyolite (TBR) is exposed (Clemens, 1990). This locality also represents the eastern margin of the Miocene Columbia River Basalt Group (CRBG) in the Weiser Embayment (Hooper, 1988, Fitzgerald, 1982). Poor exposures allow for several possible TBR-CRBG stratigraphic interpretations. One sample of sanidine-phenocryst separates was dated using the K-Ar method to ascertain whether these silicic volcanics were correlative with the Eocene Challis Volcanics (Moye and others, 1988) of east-central Idaho, or the lower CRBG basalts of the Weiser Embayment (Fitzgerald, 1982).

GEOLOGIC SETTING

The boundary or contact separating the Cretaceous Idaho batholith and the Miocene CRBG (fig. 2) bisects the Timber Butte study area, and is about 50 km east of the Cornucopia dike swarm. This dike swarm represents the feeder system for the earliest flows of the CRBG, the Imnaha Basalt (Hooper, 1988). Previous work (Kirkham, 1931) correlated the TBR with the extensive Miocene rhyolite flows of the Idavada Group (Armstrong and others, 1975) in the Owyhee Mountains of southwestern Idaho and southeastern Oregon. These silicic rocks were later subdivided into a group of 15-16.4 Ma precious-metal mineralized, hydrous-mineral bearing rhyolites (2-3% biotite, ± hornblende, ± pyroxene) which include the Silver City, Wall Creek, Jarbidge rhyolites, and the 9-14 Ma nonmineralized, relatively anhydrous Idavada rhyolites (Armstrong and others, 1975, Ekren and others, 1984). However, the hydrous mineral assemblage (20% biotite ± hornblende, ± pyroxene) of the upper flow at Timber Butte indicates that this rhyolite was formed under different pressure and temperature constraints than those which produced the contemporaneous, relatively anhydrous Idavada rhyolites.

A dissected surface on granodiorite of the Cretaceous Idaho batholith forms the basement in the study area. Unconformably overlying the granodiorite are weathered R_0 flows of the Imnaha Basalt (Fitzgerald, 1982), using the CRBG magnetic stratigraphy defined by Hooper and Swanson (fig. 3). Imnaha R_0 flows either lap onto or underlie aphyric glassy and perlitic rhyolite flows. The lower TBR has a reversed polarity. A poorly sorted accretionary lapilli tuff separates the glassy flows from overlying, reversed polarity, aphyric, stony flows which comprise the middle TBR. The upper TBR consists of a phyric unit with an N polarity, which was sampled for dating by the K-Ar method. The glassy nature of the lower TBR, the presence of the overlying accretionary lapilli tuff unit suggest the presence of a nearby vent, according to criteria published by Bonnichsen and Kauffman (1987), and Cas and Wright (1987). The low temperature of the upper TBR flows, as inferred from their hydrous mineral assemblage, would have imparted a high viscosity to these flows, causing them to have a small areal extent, and placing the vent's location at or near Timber Butte.

R_0 and N_0 Imnaha Basalt flows lap onto and surround the TBR. These in turn are overlain by early, phyric R_1 Grande Ronde Basalt flows (Hooper and Swanson, 1990, Hooper, 1988, Hooper and others, 1984). The lower CRBG Imnaha and Grande Ronde basalts and the TBR are capped by the hackly jointed, aphyric dacite of Soldier Creek, informally named here for the nearby Soldier Creek drainage (fig. l). Stratigraphic relationships cannot be fully resolved by field mapping without an accompanying detailed geochemical survey to distinguish the lower CRBG from the local Weiser Basalt Group (Swanson and Hooper, in press). Possible interpretations are shown in figure 4.

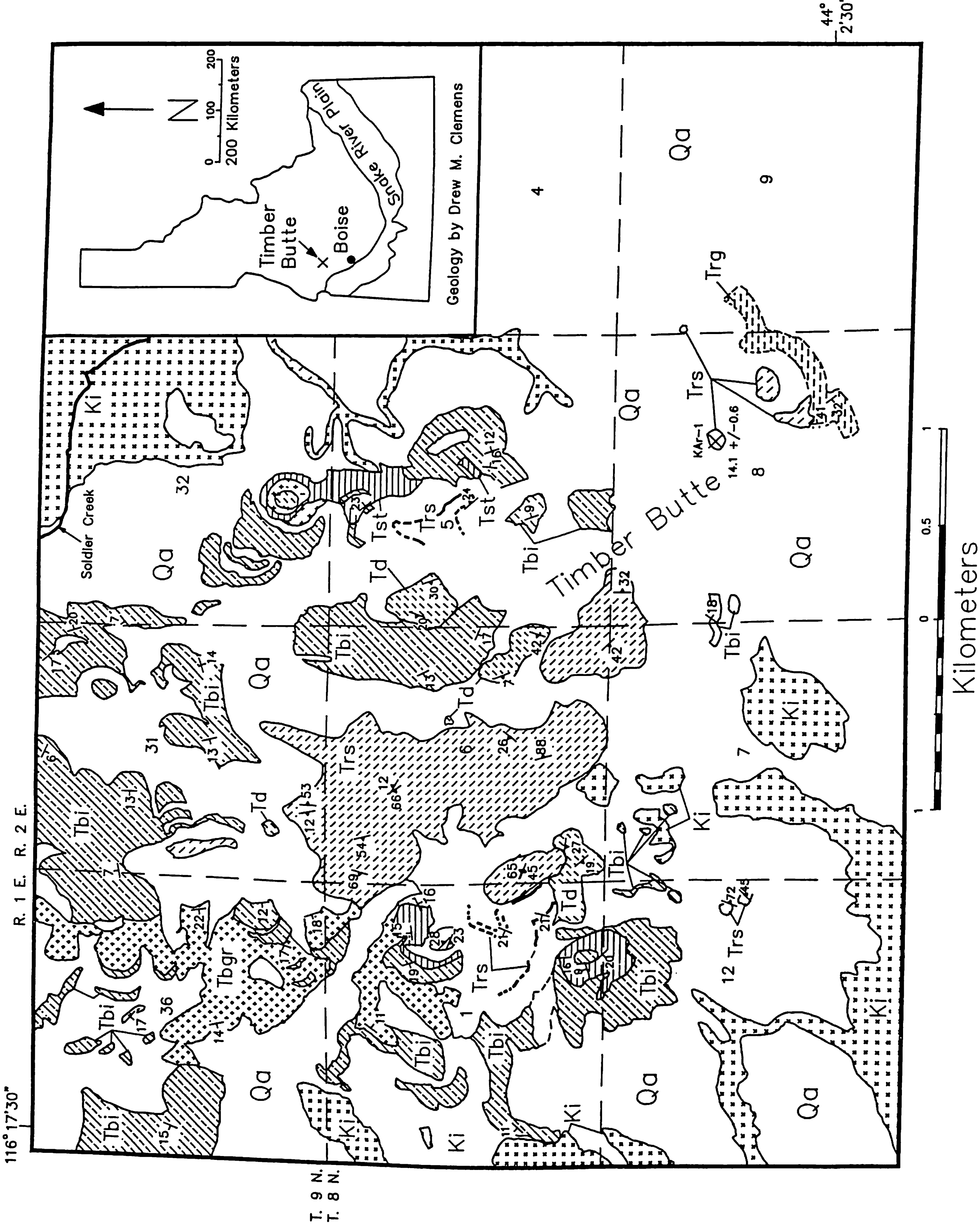
ANALYTICAL PROCEDURES

Large rhyolite slabs containing sanidine were reduced using a hydraulic rock splitter to remove all weathered material. The resulting fresh rhyolite was crushed in a porcelain jaw crusher and sieved at Boise State University, retaining the 80-200 mesh material. The sanidines were removed from the sieved fraction by using heavy liquid separation techniques, and treated with dilute HF and HNO_3 at the Geochron Laboratories Division of Krueger Enterprises, Inc. The constants and formulas used for the age determination were those of Steiger and Jaeger (1977).

DISCUSSION AND CONCLUSIONS

Field relationships, magnetic stratigraphy, and poor exposures allow an interpretation that the TBR was emplaced during or after the extrusion of the Imnaha and early Grande Ronde Basalts (fig. 4). On the basis of field relations and magnetic stratigraphy alone, figure 4a)-c) are possible, with the extrusion of the TBR occurring before or during the Imnaha Basalt episode being favored. Published K-Ar ages and magnetic character of the CRBG (Hooper and Swanson, 1990, Hooper, 1988, 1984, Fitzgerald, 1982) in conjunction with the upper TBR sanidine date (14.1 Ma) favor figure 4c) or d). If we accept the best fit interpretation of TBR-CRBG field relations depicted in figure 4b) and presented in this paper, then the published ages for the extrusion of the Imnaha Basalt (17.5-16.5 Ma), the Grande Ronde Basalt (16.5-14.5 Ma), and their changes in magnetic polarity are 1-3 m.y. too old. Further detailed geochemical studies to differentiate local volcanic units belonging to the post CRBG Weiser Basalt (Fitzgerald, 1982) from the CRBG and dating of the TBR are necessary to resolve this conflict with the CRB chronology.

The hydrous mafic mineral assemblage of the TBR indicate that these rhyolites formed under lower pressure and temperature regimes than those which produced the high temperature, high pressure Idavada rhyolites (Ekren and others, 1984). This difference is also reflected in their respective geochemistries (fig. 5), which suggest that the parental magma of the TBR formed at shallower depth in the upper crust relative to the parental magma which produced the Idavada rhyolites (Norman and Leeman, 1989). The geographic nearness of the Cornucopia Dike Swarm to Timber Butte, the upper crust affinity and age of the TBR


Timber Butte
Boise
Snake River Plain
0 100 200
200 Kilometers
N
Geology by Drew M. Clemens
Soldier Creek
Timber Butte
KAr-1
14.1 +/-0.6
Qa
Ki
Tbi
Trs
Td
Tst
Tbgr
Trg
R. 1 E.
R. 2 E.
T. 9 N.
T. 8 N.
116°17'30"
44° 2'30"
1 0.5 0 1
Kilometers

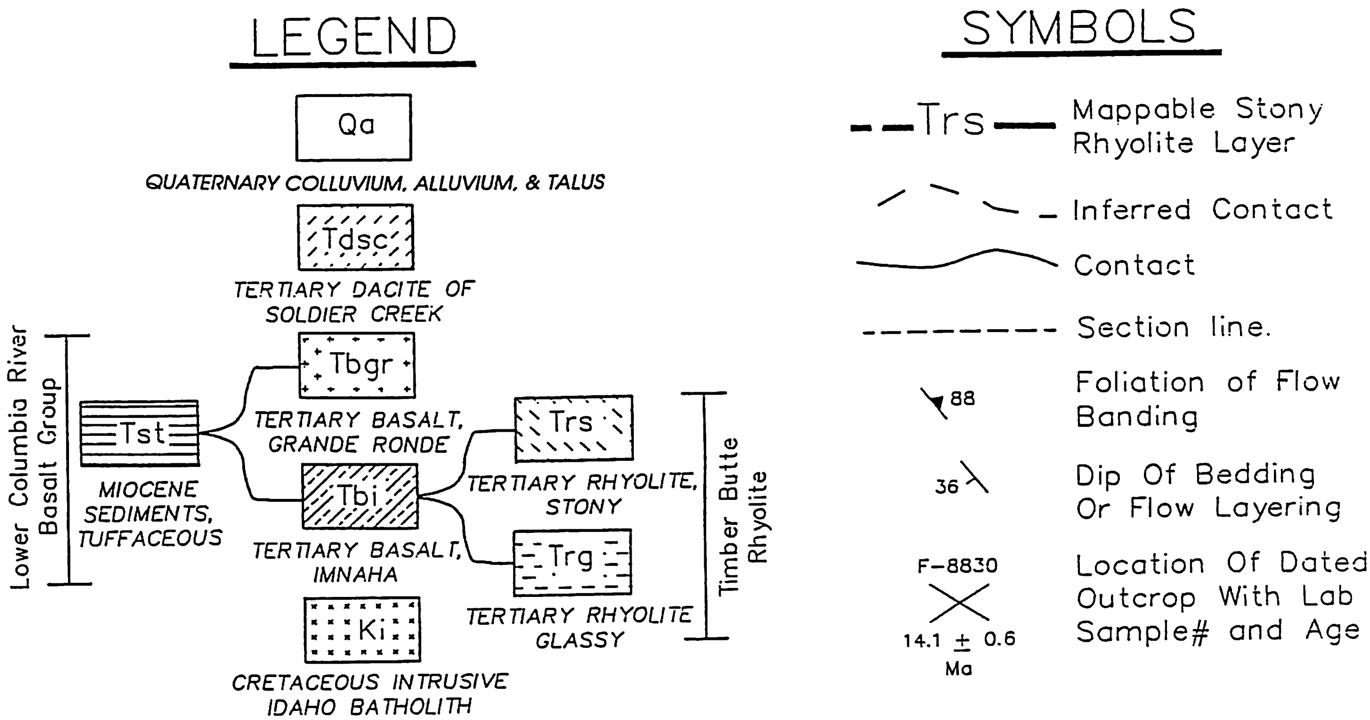


FIGURE 1. a) Outcrop geologic map of the Timber Butte Area, and b) Correlation of units.

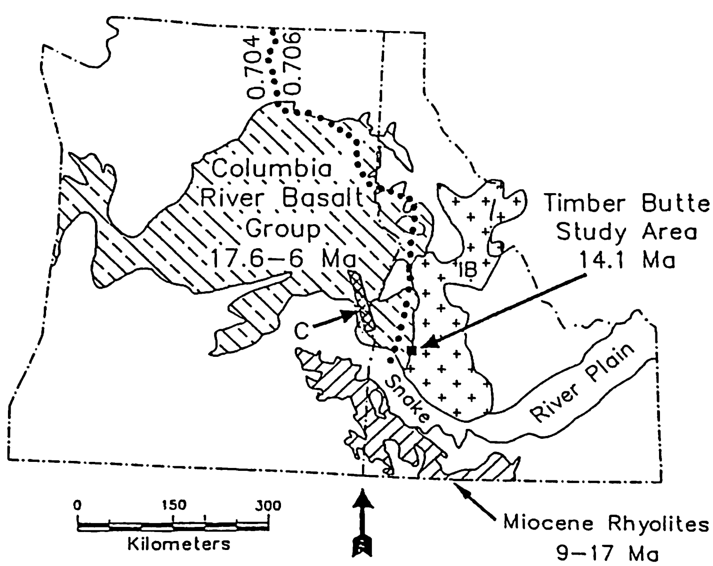


FIGURE 2. Regional geologic map showing the Columbia river Basalt Group, the Idaho batholith (IB), Cornucopia Dike Swarm (after Hooper, 1988), Miocene rhyolites in southwestern Idaho and southeastern Oregon (Stewart and Carlson, 1978), the $^{86}Sr/^{87}Sr$ isopleth (Moye and others, 1988), and the Timber Butte Study Area.

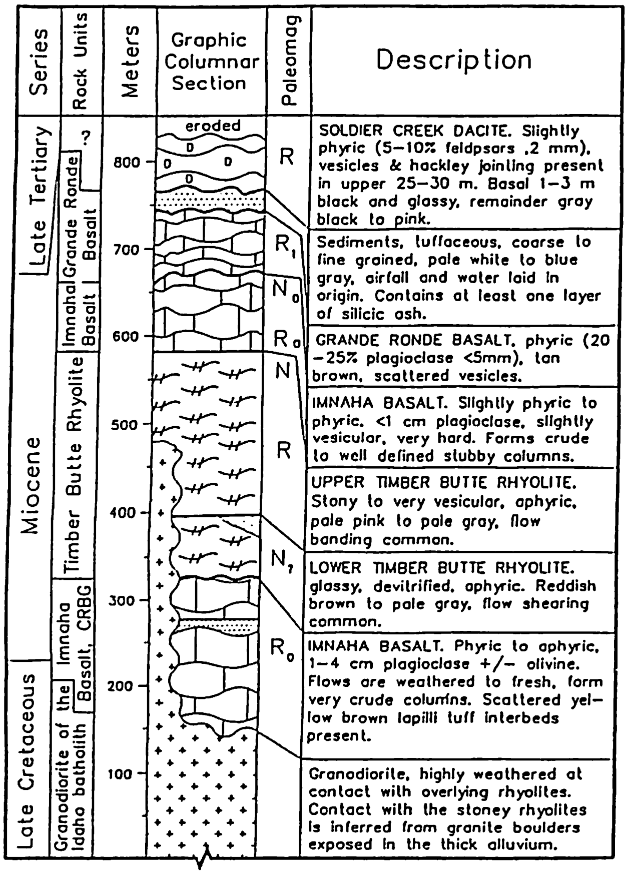


FIGURE 3. Preferred interpretation expressed as a composite stratigraphic column showing the rock units present in the study area and their magnetic polarity. Actual stratigraphic relationship of rhyolite and basalt is uncertain as shown in figure 4.

suggest that the parental magma of the lower CRBG may have partially melted the shallow upper crust. The resulting hydrous, relatively cool and viscous silicic magma was then erupted at or near Timber Butte.

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SAMPLE DESCRIPTION

1. *F-8830* K-Ar
   Rhyolite flow (44°02′30″ N, 116°14′00″ W; SW/4, NE/4, S8,T8N,R2E; Dry Buck Valley 7.5′ quad.; porphyritic rhyolite flow outcrops in a saddle at 4,680 ft near Hill 4851). *Analytical data:* K_2O = 8.25 wt.%; $^{40*}Ar$/total ^{40}Ar = 0.728%. *Collected by:* Drew Clemens.

   (sanidine) 14.1 ± 0.6 m.y.

REFERENCES

Armstrong, R. L., Leeman, W. P., Malde, H. E. (1975) K/Ar dating of Quaternary and Neogene volcanic rocks of the Snake River Plain, Idaho: American Journal of Science, v. 275, p. 225–251.

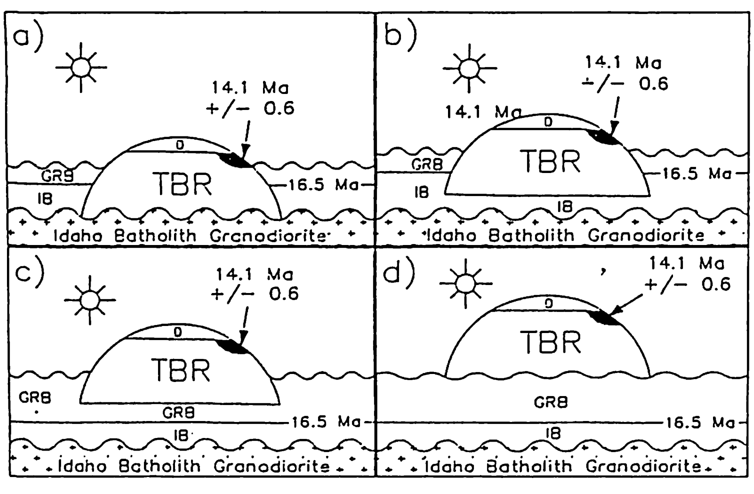

FIGURE 4. Relationships of the Imnaha Basalt may be such that it does not underly the TBR (b), but laps onto the TBR (a), or the Imnaha Basalt and/or the Grande Ronde Basalt may underly the TBR entirely (c and d)! D = Dacite of Soldier Creek, TBR = Timber Butte Rhyolite, GRB = Grande Ronde Basalt, IB = Imnaha Basalt. Dates on Imnaha and Grande Ronde Basalts are from Hooper (1988).

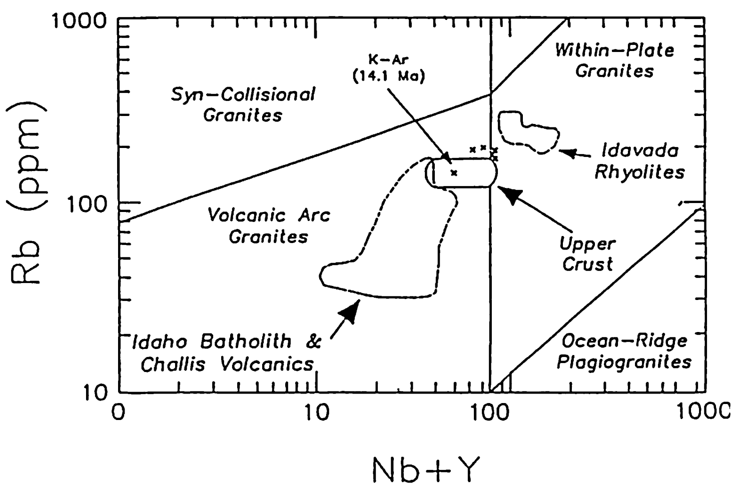

FIGURE 5. Tectonic discrimination diagram for silicic rocks in the study area (X) and the Owyhee rhyolites based on Y + Nb vs. Rb (ppm). WPG = within-plate granites, SYG = syncollisional granites, VAG = volcanic arc field, UC = upper crust, ORG = ocean-ridge plagiogranites (after Norman and Leeman, 1989).

Bonnichsen, B., and Kauffman, D. F. (1987) Physical features of rhyolite lava flows in the Snake River Plain volcanic province, southwestern Idaho: Geological Society of America Special Paper 212, p. 199–145.

Cas, R. A. F., and Wright, J. V. (1987) Volcanic successions, modern and ancient: Allen & Urwin Publishers, London, U. K., 528 p.

Clemens, D. M. (1990) Volcanic stratigraphy and geochemistry of Timber Butte, Valley and Gem Counties, west central Idaho: Boise State University, Honors Senior thesis.

Ekren, E. B., MacIntyre, D. H., and Bennett, E. H. (1984) High temperature, large-volume, lavalike ash-flow tuffs without calderas in southwestern Idaho: U.S. Geological Survey Professional Paper 1272.

Fitzgerald, J. F. (1982) Geology and basalt stratigraphy of the Weiser Embayment, west-central Idaho: Idaho Bureau of Mines and Geology Bulletin 26, p. 103–28.

Hooper, P. R. (1988) The Columbia River Basalt—Continental Flood Basalts: Kluwer Academic Publishers, p. 1–33.

Hooper, P. R., Kleck, W. D., Knowles, C. R., Reidel, S. P., Theissen, R. L. (1984) Imnaha Basalt, Columbia River Basalt Group: Journal of Petrology, v. 25, Part 2, p. 473–500.

Hooper, P. R., and Swanson, D. A. (1990) Columbia River Basalt and associated volcanic rocks in the Blue Mountains Province: U.S. Geological Survey Professional Paper 1437.

Kirkman, V. R. D. (1931) Igneous geology of southwestern Idaho: Journal of Geology, v. 39, p. 564–591.

Moye, F. J., Hackett, W. R., Blakely, J. D., and Snider, L. G., (1988) Regional geologic setting and volcanic stratigraphy of the Challis volcanic field, central Idaho: Idaho Geological Survey Bulletin 27, p. 87–97.

Norman, M. D., and Leeman, W. P. (1989) Geochemical evolution of Cenozoic-Cretaceous magmatism and its relation to tectonic setting, southwestern Idaho: Earth and Planetary Science Letters, v. 96, p. 78–96.

Steiger, R. H., Jaeger, E. (1977) Subcommission on geochronology, convention on the use of decay constants in geo- and cosmochronology: Earth and Planetary Science Letters, v. 36, p. 359–62.

Stewart, J. H., and Carlson, J. E. (1978) Cenozoic tectonics and regional geophysics of the western Cordillera: Geological Society of America Memoir 152, p. 263-5.