Pre-Cougar Point Tuff Volcanic Rocks Near the Idaho-Nevada Border, Owyhee County, Idaho

by

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ABSTRACT

Along the Nevada border in south-central Owyhee County, Idaho, Eocene- and Miocene-age volcanic units in the upper Sheep Creek drainage are exposed beneath the areally extensive Cougar Point Tuff. The Eocene-age rocks, referred to as the Bieroth volcanics, consist of three units—the Alder Creek tuff, the Cedar Canyon tuff, and the volcanic neck of Browns Basin. The Bieroth volcanics are ferrolatitic to rhyodacitic in composition and contain abundant phenocrysts, including hornblende and biotite. The Bieroth volcanics are part of the Eocene province of calc-alkaline volcanism that extends southward, and generally becomes younger, from the Challis volcanic field in central Idaho into Nevada.

Six volcanic units of probable Miocene age have been identified as follows: the Rough Mountain rhyolite, the lapilli tuff of Sheep Creek, the Johnstons Camp rhyolite, the Browns Basin tuff, the Whiskey Draw rhyolite, and the Rattlesnake Draw tuff. All are rhyolitic in composition and all have chemical compositions and phenocryst assemblages indicating that the units belong to the Snake River Plain volcanic province. They contain fewer phenocrysts than the Eocene units and no hydrous phenocrysts, except for minor biotite in one unit.

Field evidence suggests that at least three of the Miocene units erupted from a local volcanic source, perhaps forming a small caldera, now buried, in the process. This postulated volcanic center is considered to be part of the southwest to northeast trend of major eruptive centers constituting the Snake River Plain volcanic province, and it predates the much larger Bruneau-Jarbidge eruptive center to the northeast, from which the overlying Cougar Point Tuff was erupted.

INTRODUCTION

Several previously unreported Tertiary volcanic units are exposed along the Idaho-Nevada border in the Black Leg Creek and Indian Hay Meadows 7½-minute quadrangles in south-central Owyhee County, Idaho. These units, along with the overlying Cougar Point Tuff, were recently mapped by Bernt (1982) in the upper part of the Sheep Creek drainage. It is our purpose here to describe the stratigraphic relations, petrography, and chemical composition of these pre-Cougar Point Tuff volcanic units.

Two main groups of pre-Cougar Point Tuff volcanic rocks occur in the upper Sheep Creek drainage area (Figure 1). The older group, the Bieroth volcanics, consists of three units: the Alder Creek tuff, the Cedar Canyon tuff, and the volcanic neck of Browns Basin. These units are thought to be of Eocene age and are the approximate time equivalent of the undivided volcanic unit in northern Nevada which Bushnell (1967) called the “Bieroth Andesite.” The younger group, thought to be Miocene in age, includes six units: the Rough Mountain rhyolite, the lapilli tuff of Sheep Creek, the Johnstons Camp rhyolite, the Browns Basin tuff, the Whiskey Draw rhyolite, and the Rattlesnake Draw tuff. The first three of these units apparently were erupted during the Miocene from a local center of volcanic activity. The Browns Basin and Whiskey Draw units, which at least partly overlie the first three units, may have been erupted locally or may have come from eruptions in another area. We lack good stratigraphic control for the Rattlesnake Draw tuff; thus, its assignment to the pre-Cougar Point Tuff Miocene-age group of volcanic units is only tentative.

In Idaho, the pre-Cougar Point Tuff volcanic units lie unconformably on Cretaceous-age biotite granodiorite of the Cottonwood Creek pluton (Coats and McKee, 1972; Bernt, 1982). The Cougar Point Tuff, which overlies the Bieroth volcanics and the earlier Miocene-age volcanic units, is welded ash-flow tuff units believed to have erupted from the Bruneau-Jarbidge eruptive center (Bonnichsen, 1982a this

Volcanic units of Miocene age

- Trd - Rattlesnake Draw tuff
- Tw - Whiskey Draw rhyolite
- Tbb - Browns Basin tuff
- Tj - Johnstons Camp rhyolite
- Tlt - lapilli tuff of Sheep Creek
- Trm - Rough Mountain rhyolite

Bieroth volcanics of Eocene age

- Tv - volcanic neck of Browns Basin
- Tc - Cedar Canyon tuff
- Ta - Alder Creek tuff
- Kg - granodiorite of Cottonwood Creek pluton

Figure 1. Geologic map of the pre-Cougar Point Tuff volcanic units in the upper Sheep Creek drainage area, south-central Owyhee County, Idaho. Inset shows location of this area just north of the Idaho-Nevada border.

The units that constitute the Bieroth volcanics in the upper Sheep Creek drainage area have chemical compositions indicating they are better classified as rhyodacite or quartz latite, rather than andesite (Table 1). Consequently, we have dropped Bushnell’s (1967) original name for the group. We agree with Bushnell, though, in assigning this group of rocks to the Eocene, based on their similarity in petrologic characteristics and stratigraphic position with nearby radiometrically dated units in the Jarhidge Mountains (Dead Horse Tuff of Coats, 1964; 40.9 million years, recalculated for new decay constants using the tables of Dalrymple, 1979), and in the Poison Creek area of
Table 1. Chemical analyses of samples of the Bieroth volcanics (1-5) and of the Miocene age volcanic rocks in the upper Sheep Creek drainage area (6-10).

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<th>Unit</th>
<th>Alder Creek tuff</th>
<th>Cedar Canyon tuff</th>
<th>Cedar Canyon tuff</th>
<th>Volcanic neck of Browns Basin</th>
<th>Rough Mountain rhyolite</th>
<th>Lapilli tuff of Sheep Creek</th>
<th>Johnstons Camp rhyolite</th>
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Notes:
The samples were analyzed for major oxides by a combination of X-ray fluorescence and atomic absorption at Washington State University (XRF) and at the Idaho Bureau of Mines and Geology (AA), and for minor elements by X-ray fluorescence at Washington State University.

Total iron is reported as Fe₂O₃.

1. Sample 372, devitrified rock from the Alder Creek tuff; NE¼NW¼ sec. 36, T. 16 S., R. 5 E., Owyhee County, Idaho.
2. Sample 361, glassy welded tuff from the Cedar Canyon tuff; NE¼SW¼ sec. 29, T. 16 S., R. 5 E., Owyhee County, Idaho.
3. Sample 371, glassy welded tuff from the Cedar Canyon tuff; SW¼SE¼ sec. 25, T. 16 S., R. 5 E., Owyhee County, Idaho.
4. Sample 395C, glassy welded tuff from the Cedar Canyon tuff; NE¼SE¼ sec. 17, T. 47 N., R. 56 E., Elko County, Nevada.
5. Sample 358A, volcanic breccia from the volcanic neck of Browns Basin; SW¼SE¼ sec. 29, T. 16 S., R. 5 E., Owyhee County, Idaho.
6. Sample 345A, vitrophyre from the Rough Mountain rhyolite; SE¼NW¼ sec. 30, T. 16 S., R. 5 E., Owyhee County, Idaho.
7. Sample 337, devitrified and altered rock from the lapilli tuff of Sheep Creek; NE¼NW¼ sec. 18, T. 16 S., R. 5 E., Owyhee County, Idaho.
8. Sample 264A, vitrophyre from the Johnstons Camp rhyolite; NW¼SE¼ sec. 14, T. 16 S., R. 5 E., Owyhee County, Idaho.
9. Sample 351, devitrified rock from the Johnstons Camp rhyolite; SE¼NW¼ sec. 20, T. 16 S., R. 5 E., Owyhee County, Idaho.
10. Sample 364A, basal vitrophyre of the Browns Basin tuff; NW¼NW¼ sec. 33, T. 16 S., R. 5 E., Owyhee County, Idaho.
northern Owyhee County (unnamed biotite rhyolite unit of the Chalins Volcanics cited in Armstrong and others, 1980, p. 8, 44.7 million years).

ALDER CREEK TUFF

A light reddish purple tuff unit is exposed in a small area along Alder Creek near the Idaho-Nevada border (Figure 1). This unit was called the tuff of Alder Creek by Bernt (1982). Although field relations are somewhat obscure, the Alder Creek tuff appears to be overlain by the Cedar Canyon tuff and is therefore the oldest unit of the Bieroth volcanics in Idaho.

The Alder Creek tuff is moderately compacted and welded, and is extensively weathered and devitrified. The presence of flattened glass shards and pumice fragments shows that the unit is a welded ash-flow tuff. Subangular to subrounded lithic fragments, principally of basalt porphyry, are common. The relatively large size and abundance of the lithic and pumice fragments suggests a nearby source for the unit.

The tuff contains approximately 25 percent of phenocrysts of quartz, plagioclase (An$_{43-50}$), and sanidine, and accessory amounts of biotite, black opaques, apatite, and zircon. Tridymite(?) is present as a secondary mineral in pores.

An analysis of one sample of the Alder Creek tuff (Table 1, no. 1) has the composition of a rhyodacite, and is about as silicic as the most silicic of the three analyzed samples of the overlying Cedar Canyon tuff (Figure 2). The Alder Creek tuff analysis differs from the Cedar Canyon tuff, however, by being a little less feric and much richer in K$_2$O.

CEDAR CANYON TUFF

A rhyodacite welded tuff unit occurs widely in

Figure 2. Silica variation diagram comparing the Bieroth volcanics and Miocene rocks in the upper Sheep Creek drainage area with the Cougar Point Tuff and rhyolite lava flows from the Bruneau-Jarbidge eruptive center. The Bieroth volcanics are analyses 1-5 in Table 1; the upper Sheep Creek Miocene volcanic units are analyses 6, 8, 9, and 10 in Table 1; the Cougar Point Tuff rocks are analyses 1-5 in Table 1 of Bonnichsen and Citron (1982 this volume); and the Bruneau-Jarbidge eruptive center rhyolite lava flows are analyses 1, 2, and 5 in Table 1 of Bonnichsen (1982b this volume). Weight percentages of the oxides were normalized to a sum of 100 percent for plotting.
both the eastern and western parts of the area shown in Figure 1. Nearly identical rhyodacite occurs near the confluence of McDonald Creek and the Bruneau River in northern Nevada, about 12 kilometers southeast of the area in Figure 1 (see Figure 2 in Bonnichsen, 1978a this volume, for this location). We have included all of these occurrences in the Cedar Canyon tuff unit, named for the side canyon which joins the Bruneau a short distance downstream from McDonald Creek. We recommend the Bruneau Canyon occurrence as a reference locality because of the good access and exposure there (Figure 3).

The Cedar Canyon tuff unit consists mainly of light to brownish gray, moderately to strongly compacted, vitric-crystal welded tuff. Three flows, each approximately 30 to 50 meters thick, are present along the Bruneau River. More than one flow unit probably occurs in the Sheep Creek area, but this was not confirmed because of poor exposures. The total thickness of the Cedar Canyon tuff is at least 90 meters. Flattened glass shards, angular crystal fragments, and pumice inclusions indicate that the unit consists of welded ash-flow tuff.

The Cedar Canyon tuff contains 30 to 50 percent of phenocrysts of quartz, plagioclase (An$_{50-60}$), and sanidine, and accessory amounts of hornblende, biotite, black opaques, apatite, zircon, hypersthene, and allanite(?). Secondary epidote, kaolinite, chlorite, and tridymite(?) occur locally. The matrix consists of glass and deformed glass shards with varying degrees of devitrification to microlites, but even where glassy the matrix is light colored. Minor amounts of accidental lithic fragments, which are apparently basalt, are present. The unit appears slightly altered along Sheep Creek, but elsewhere is relatively fresh.

Three analyses from the Cedar Canyon tuff are presented in Table 1 (no. 2, 3, and 4) and are plotted in Figure 2. The one from the Bruneau Canyon reference locality is intermediate in composition between the other two. Its petrography and chemistry reveal that the unit can be classified as a hornblende-biotite rhyodacite or biotite rhyodacite.

VOLCANIC NECK OF BROWNS BASIN

A volcanic neck is exposed in the central part of Browns Basin near the Idaho-Nevada border (Figure 1). The neck is roughly oval in outline with a maximum width of approximately 275 meters. It rises about 10 meters above the surrounding Cedar Canyon tuff which it intrudes (Figure 4). The rock of the neck consists of dusky red, scoriaceous to massive, brecciated ferrolatite which is moderately to strongly stained by iron oxides. No internal structures were found in the neck.

The rock contains scattered phenocrysts of plagioclase (An$_{60-45}$) and altered pyroxene. Secondary minerals include chlorite as an alteration of pyroxene and stilbite as druses in pores. The matrix is pervasively stained by limonite, but is predominantly glass with minor microlites.

An analysis of a sample (Table 1, no. 5) has a composition that could be classified as ferrolatite, or perhaps as iron-rich dacite. The composition of this sample is similar to the other Bieroth volcanic samples, except that it is significantly enriched in iron, titanium, and phosphorus and contains less silica and alumina (Figure 2). In this respect the volcanic neck is similar to some lavas in the nearby Snake River Plain volcanic province that Leeman (1982 this volume) suggests were produced by a combination of fractional crystallization and contamination of basaltic magmas. However, based on the spatial association of the volcanic neck with the Cedar Canyon tuff and its general chemical similarity to the other units of the Bieroth volcanics, we have included the volcanic neck as part of the Bieroth volcanics, and consider it to be Eocene in age. This must be considered as a tentative assignment, as field relations only indicate the volcanic neck to be younger than the Cedar Canyon tuff.
Figure 5. Photomicrograph of the basal vitrophyre of the Rough Mountain rhyolite. The thin irregular bands are clear glass that may be deformed shards, and the enclosed, relatively thick angular particles are fragments of dark-colored glass containing abundant microlites. View is approximately 1 millimeter wide.

Figure 4. The volcanic neck of Browns Basin. The neck rises about 10 meters above the surrounding Cedar Canyon tuff of the Bieroth volcanics.

VOLCANIC UNITS OF MIocene AGE

ROUGH MOUNTAIN RHYOLITE

A thick rhyolitic welded-tuff unit, the Rough Mountain rhyolite, is exposed in the deep narrow canyon of Sheep Creek, 1.2-4.5 kilometers north of the Idaho-Nevada border (Figure 1). Previously (Bernt, 1982), this unit was called the rhyolite of Sheep Creek, but because that name would have been confused with that of the earlier-named Sheep Creek rhyolite, a large rhyolite lava flow in the Bruneau-Jarbidge eruptive center (Bonnichsen, 1981, 1982b this volume), the welded-tuff unit has been renamed for a prominent hill just west of Sheep Creek canyon. The Rough Mountain rhyolite is more than 170 meters thick and appears to be a single flow unit. The unit overlies the Bieroth volcanics and is overlain by the Whiskey Draw rhyolite, the lapilli tuff of Sheep Creek, the Johnstons Camp rhyolite, the Cougar Point Tuff, and the Banbury Basalt.

The Rough Mountain rhyolite is typically a reddish brown, massive, lithoidal welded tuff with abundant phenocrysts. No flow layering was observed in outcrop. A black vitrophyre is present along the southeastern margin of the unit; along this margin the contact with the underlying Bieroth volcanics is nearly vertical, suggesting that the unit filled a paleo-depression in the older rocks. The vitrophyre contains features which resemble flattened pumice, and lithophysae with devitrification coronas occur near the base of the vitrophyre. Float at the base of the unit suggests that a pyroclastic base surge deposit occurs there.

A thin section of the vitrophyre contains phenocrysts of quartz (3 percent), sanidine (17 percent), plagioclase (An30-40) (5 percent), and accessory amounts of hypersthene (3 percent), black opaques, and zircon (percentages are visual estimates). Sparse cumulophyric aggregates of feldspar and hypersthene are present. The matrix consists of dark glass with discontinuous, very elongate pieces of clear glass molded around the fragments of dark glass (Figure 5) and the phenocrysts. The clear glass may have been shards, which now are highly deformed.

A chemical analysis of a Rough Mountain rhyolite sample (Table I, no. 6) reveals that the rock is a rhyolite very similar to several of the Cougar Point Tuff units, especially the more silicic ones (Figure 2; and compare with the analyses in Table I in Bonnichsen and Citron, 1982 this volume).

We interpret the Rough Mountain rhyolite unit to have been deposited as a single thick ash flow, because it lacks internal flowage structures and it contains deformed glass fragments and shards(?), flattened pumice fragments, and possible base surge deposits. The tuff has been greatly compacted, welded, and extensively devitrified; locally the sanidine has been pervasively altered to clay minerals. The relatively great thickness of this unit, its apparent confinement to a paleo-depression, and perhaps its somewhat altered condition suggest that it is an intracaldera facies of a more extensive ash-flow sheet.

LAPILLI TUFF OF SHEEP CREEK

A consolidated, but unwelded, tuff unit up to about 40 meters thick is exposed in Sheep Creek canyon north of the area underlain by the Rough Mountain rhyolite.
Mountain rhyolite (Figure 1). This unit is referred to as the lapilli tuff of Sheep Creek; it lies on the Rough Mountain rhyolite and is overlain by the Cougar Point Tuff. Its age relative to the Browns Basin tuff and to the Johnstons Camp rhyolite is not known, but it is thought to have formed at about the same time as those units, and during the same episode of volcanism.

The lapilli tuff of Sheep Creek is well bedded and moderately sorted, with some layers exhibiting bimodal grain sizes. The tuff is yellowish green and moderately dense with approximately 20 percent of irregular pore spaces. The unit is interpreted to be an air-fall pyroclastic deposit, and it is classified as a lapilli tuff on the basis of its particle size.

A thin section of the tuff contains approximately 15 percent of phenocrysts of sanidine and plagioclase (An₄₅-₅₀), and accessory amounts of black opaques, and zircon. Tridymite is present as a secondary mineral in cavities. The matrix consists of undeformed glass shards, which are almost totally devitrified, and pervasive secondary silica. Pumice fragments and reddish lithic fragments up to a centimeter long are common. A green mineral, perhaps celadonite, coats the surfaces of some outcrops.

A chemical analysis of the lapilli tuff (Table 1, no. 7) shows that it has been strongly altered, with the partial loss of alkalis and alumina and a concomitant increase in silica (SiO₂ accounts for 83.5 weight percent of the cation oxides when the sum in Table I is normalized to 100 percent).

The considerable thickness and coarse particle size of the lapilli tuff of Sheep Creek suggests that it is a near-vent air-fall deposit. This unit's existence shows that volcanic activity occurred in the upper Sheep Creek drainage area before the Cougar Point Tuff was erupted.

JOHNSTONS CAMP RHYOLITE

A rhyolite lava flow with local domal forms is exposed at several places in the upper Sheep Creek drainage (Figure 1). Its name comes from exposures at Johnstons Camp in the Indian Hay Meadows quadrangle (Bernt, 1982). The Johnstons Camp rhyolite is overlain by the Whiskey Draw tuff and the Cougar Point Tuff, and is apparently above the Rough Mountain rhyolite, although this could not be proven in the field. The unit is locally at least 60 meters thick. It is poorly exposed and may consist of several individual volcanic domes, but we consider it more likely that it is a continuous lava flow with a limited areal extent and a local source.

The Johnstons Camp rhyolite consists of black vitrophyre and grayish red lithoidal rhyolite. The vitrophyre occurs at the top and along the margins of the flow, and the lithoidal rhyolite occurs in the flow interior. The base of the unit is not exposed and no internal flow layering was noted. The domal forms are thought to be preserved from the time of viscous flowage; similar bulbous forms are common in the marginal zones of most rhyolite lava flows in the Bruneau-Jarbidge eruptive center (Bonnichsen, 1982b this volume). Complex joint patterns characterize some parts of the unit (Figure 6); these joints probably were formed after bulk flowage in the unit had ceased, during the time of shrinkage and compaction that accompanied and followed devitrification and cooling.

Thin sections reveal that the rhyolite contains about 17 percent of phenocrysts of plagioclase (An₄₀-₅₀), minor amounts of sodic sanidine, and accessory amounts of pigeonite, augite, black opaques, and zircon. The groundmass consists of microlites, and tridymite occurs as a secondary mineral in lithoidal rhyolite. No glass shards, pumice fragments, lithic fragments, or flowage structures were found. The rock is very dense and strongly compacted.

Two samples of the Johnstons Camp rhyolite were analyzed (Table 1, nos. 8 and 9; Figure 2); they are similar to one another and to the samples from the Rough Mountain rhyolite and the Browns Basin tuff. Figure 2 also shows that the Johnstons Camp rhyolite has a composition like that of the volcanic units associated with the Bruneau-Jarbidge eruptive center.

Our interpretation is that the Johnstons Camp...
rhyolite is a lava flow of limited areal extent. By analogy with the situation in the Bruneau-Jarbidge eruptive center, we suggest that the Johnstons Camp unit is contained within a zone of subsidence which developed during the time or after the Rough Mountain rhyolite and perhaps other units had erupted.

**BROWNS BASIN TUFF**

A welded ash-flow tuff unit, varying up to about 60 meters thick, is exposed around the margins of Browns Basin, a small valley for which the unit was named (Bernt, 1982), located east of Sheep Creek canyon (Figure 1). The Browns Basin tuff unit lies above a thin layer of air-fall tuff, which, in turn, overlies the Cedar Canyon tuff unit of the Bieroth volcanics. Farther to the east (Figure 1), the Browns Basin tuff lies on the west flank of the Cottonwood Creek pluton. The Browns Basin tuff is overlain by the Whiskey Draw rhyolite and by the Cougar Point Tuff at various localities, but no field relationship has been observed to indicate its age relative to either the Johnstons Camp rhyolite or the lapilli tuff of Sheep Creek. The Browns Basin tuff extends southward into Nevada, where it is well exposed.

The Browns Basin tuff at most localities consists of a 2- to 3-meter-thick basal vitrophyre layer overlain by a pale red to grayish red lithoidal rhyolite layer. This layer commonly contains near its base a 3- to 6-meter-thick lithophysal zone with rounded to slightly elongate, 3- to 20-centimeter-long gas cavities. The unit is thoroughly compacted and densely welded throughout, and flattened pumice fragments occur locally.

A thin section from the basal vitrophyre contains approximately 35 percent of phenocrysts of sanidine (20 percent), plagioclase (An0-40) (8 percent), quartz (3 percent), and accessory amounts of pigeonite (2 percent), augite (1 percent), black opaques, zircon, apatite, and monazite (percentages are visual estimates). The matrix consists of deformed glass shards and fine-grained, subangular to subrounded lithic fragments and fragments of glass. The rock can be classified as a vitric-crystal rhyolite tuff.

An analysis of a Browns Basin tuff sample (Table 1, no. 10) suggests that the unit is a little more feric than the Rough Mountain rhyolite, being more like the Johnstons Camp rhyolite in composition. Its composition is very similar to the more feric units of the Cougar Point Tuff (Figure 2; and compare with the analyses in Table 1, Bonnichsen and Citron, 1982 this volume).

Its more widespread distribution but thinner configuration in comparison with the Rough Mountain rhyolite suggest that the Browns Basin tuff may be an outflow-facies type of unit which flowed away from the area where it was erupted. A comparison of the assemblages and mutual abundances of phenocrysts in the Browns Basin tuff and the Rough Mountain rhyolite shows that the two are very similar. This suggests that they may be genetically related; perhaps both were erupted from different portions of the same magma chamber, with the Browns Basin tuff flowing away from the eruption site, whereas the Rough Mountain rhyolite filled a depression formed by surface collapse over the partially evacuated magma chamber. This suggestion must remain as speculation, however, until more is known about the distribution of the Browns Basin tuff in northern Nevada; the unit could also have flowed into Idaho from that region.

**WHISKEY DRAW RHYOLITE**

A rhyolite unit, named the Whiskey Draw rhyolite (Bernt, 1982) for its exposures in a small tributary to Black Leg Creek, occurs at several localities (Figure 1). The unit lies above the Rough Mountain rhyolite and the Browns Basin tuff, probably above the Johnstons Camp rhyolite, and below the Cougar Point Tuff. The unit has a maximum thickness of 90 meters.

The rhyolite is gray and typically hard, dense, and completely devitrified. Rounded to elliptical vesicles up to 3 centimeters across are abundant, and larger irregular gas cavities containing yellow to orange jasper locally occur near the top of the flow.

A thin section of the rhyolite contains about 7 percent of phenocrysts of sanidine, plagioclase (An35-40), and quartz, and accessory amounts of black opaques and zircon. Tridymite(?) occurs in some of the vesicles, and secondary silica resulting from deuteric alteration is present. Poorly preserved shards were tentatively identified, suggesting the unit originated as an ash flow.

A chemical analysis of a Whiskey Draw rhyolite sample (Bernt, 1982) reveals the unit to be similar to the rhyolites in the Bruneau-Jarbidge eruptive center and elsewhere in the Snake River Plain volcanic province; thus, we consider it to be Miocene in age. Like the Rattlesnake Draw tuff, the Whiskey Draw rhyolite is chemically very similar to the lowest Cougar Point Tuff unit (Bonnichsen and Citron, 1982 this volume). Its stratigraphic position suggests that the Whiskey Draw rhyolite might be the upper part of the Browns Basin tuff, but the differences in chemistry and phenocryst assemblages between the two units suggest that they probably are from separate eruptions and perhaps are from different areas. Currently we do not know if the Whiskey Draw rhyolite is from a local volcanic center, or if it might be an early unit from the Bruneau-Jarbidge eruptive center and should
be assigned to the Cougar Point Tuff.

RATTLESNAKE DRAW TUFF

A dense, generally altered welded tuff unit, the Rattlesnake Draw tuff, is exposed in the Cottonwood Creek and Rattlesnake Draw drainages in the southern part of the area in Figure 1. The unit overlies the Cedar Canyon tuff of the Bieroth volcanics and lies beneath the Cougar Point Tuff and perhaps beneath the Whiskey Draw rhyolite.

The tuff is very hard because of silicification and has undergone minor brecciation which has obscured its original character. The unit's occurrence northwest of the Cottonwood Creek pluton (Figure 1) is not as silicified as the localities to the east. All exposures of the unit are devitrified and vary from brown to grayish red in color. Phenocrysts of biotite, black opaques, and zircon are present, but those of feldspar and quartz were lacking or have been destroyed. Relict shards and flattened pumice (?) fragments occur locally, and small partially filled lithophysae are common. Veinlets and vug fillings of secondary silica are common throughout the unit.

The presence of biotite and the unit's field distribution suggest that the Rattlesnake Draw tuff could be part of the Eocene-age Bieroth volcanics. However, an analysis of a sample reported by Bernt (1982) reveals the rock to be chemically very similar to the Miocene-age rhyolite units in the Snake River Plain volcanic province. Its chemical composition is particularly similar to that of the lowest unit in the Cougar Point Tuff (Bonnichsen and Citron, 1982 this volume). At present insufficient data are available to determine if the Rattlesnake Draw tuff was erupted from a local volcanic center or if it is an early unit from the Bruneau-Jarbidge eruptive center and should be assigned to the Cougar Point Tuff.

SUMMARY AND DISCUSSION

We have shown by geologic mapping, chemical analyses, and petrography that two groups of Tertiary-age pre-Cougar Point Tuff volcanic rocks occur in Idaho in the upper Sheep Creek drainage area. The older group, the Bieroth volcanics, are thought to be Eocene in age and are part of a widespread province of calc-alkaline volcanism that extends southwards, and generally becomes younger (McIntyre and others, 1982 this volume; Leonard and Marvin, 1982 this volume; Stewart and Carlson, 1976), from the Challis volcanic field in central Idaho into Nevada.

The younger group, which in many respects is like other rhyolite units within the Snake River Plain volcanic province, is considered to be Miocene in age. Field relations suggest that at least three of the Miocene units—the Rough Mountain rhyolite, the lapilli tuff of Sheep Creek, and the Johnstons Camp rhyolite—were erupted from a local volcanic source prior to the development of the nearby, but much more extensive, Bruneau-Jarbidge eruptive center to the northeast. Not enough is yet known about the Browns Basin and Whiskey Draw units, which at least partially overlie the three locally erupted units, to indicate for sure if they came from the local volcanic center or from somewhere in northern Nevada, or if they might be the first units from the Bruneau-Jarbidge eruptive center, or perhaps have some other source. The remaining unit—the Rattlesnake Draw tuff—is tentatively assigned to the Miocene on the basis of its chemistry, but its field setting actually would not preclude it from belonging to the earlier group of Eocene-age units.

The Bieroth volcanics contain a relatively higher percentage of phenocrysts and typically carry biotite and hornblende, rather than pyroxenes, as their mafic minerals. These older volcanic units, as illustrated in Figure 2, clearly are not as silicic as are the Miocene-age group. The chemical analyses show that the Bieroth volcanics are calc-alkaline and include rocks of intermediate SiO₂ content. The Miocene-age volcanic units, on the other hand, are rhyolites and, as a group, are essentially indistinguishable chemically from other rhyolites associated with the Snake River Plain volcanic province, as is clearly shown in Figure 2.

The probable existence of a local volcanic center in the upper Sheep Creek drainage area is indicated by several lines of evidence. The considerable thickness but restricted areal distribution of the Rough Mountain rhyolite, which suggest it filled a paleo-depression, may signify that the unit has an intracaldera form. The existence of both the lapilli tuff of Sheep Creek and the Johnstons Camp rhyolite are strong evidence that volcanism occurred within the area. The lapilli tuff of Sheep Creek appears to be a near-vent air-fall pyroclastic unit, and the Johnstons Camp rhyolite is interpreted as a rhyolite lava flow covering the vent through which it was extruded. The Browns Basin tuff, which is thinner than but petrographically very similar to the Rough Mountain rhyolite on which it lies and extends away from (Figure 1), could easily be interpreted as an outflow sheet from the same eruption that formed the Rough Mountain rhyolite.

The mutual relationships among the units erupted from the local volcanic center, which we postulate to have existed in the upper Sheep Creek drainage area, imply that the center may have become a small
caldera during its evolution, so as to topographically confine the Rough Mountain rhyolite and the Johnston's Camp rhyolite. The southern margin of such a caldera would have been just north of the northern margin of the Bieroth volcanics and the Cottonwood Creek pluton exposures (Figure 1). The lapilli tuff of Sheep Creek might also be near the margin (northeastern?) of such a structure, but there is too much cover by younger rock units to readily tell. The remainder of such a structure is under the younger rocks, so we really cannot tell if a caldera developed as suggested; however, the idea is in reasonable accord with the rock units as they are exposed. Such a volcanic center would be part of the southwest to northeast trend of major volcanic centers constituting the Snake River Plain volcanic province.

REFERENCES


