CORRELATION OF MAJOR PLIOCENE AND MIOCENE ASH-FLOW SHEETS, EASTERN SNAKE RIVER PLAIN, IDAHO

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ABSTRACT

Recent mapping and laboratory studies indicate at least seven major ash-flow sheets on the northern and southeastern margins of the eastern Snake River Plain. Four of these sheets are located on the northern margin of the Plain between Howe Peak in the southern Lost River Range and Yellowstone National Park; three sheets are on the southeastern margin between Idaho Falls and Yellowstone National Park. Preliminary correlations indicate that some of these sheets have similar caldera sources.

The lowest major ash-flow sheets on the northern margin of the eastern Snake River are the tuff of Howe Peak exposed in the southern Lost River and Lemhi Ranges and the tuff of Edie Ranch exposed in the southern Beaverhead and Centennial Mountains. These units are similar stratigraphically and petrographically as well as having similar magnetic polarities, but the distribution patterns of the tuffs indicate that they are distinct and have unique sources. The source for the tuff of Howe Peak is believed to be buried on the plain east of the Lost River Range whereas the tuff of Spring Creek, the lowest major ash-flow sheet on the southeastern margin of the plain, erupted from the Rexburg caldera complex approximately 6.3 m.y. ago. Preliminary mapping and laboratory studies indicate that the tuff of Edie Ranch may be equivalent to the tuff of Spring Creek and may represent a distal facies of an extensive ash-flow sheet. The tuff of Howe Peak is unique and does not correlate with the tuffs of Spring Creek or Edie Ranch.

The middle major stratigraphic unit on the northern margin of the eastern Snake River Plain is the tuff of Blue Creek which is interpreted to be equivalent to the tuff of Elkhorn Spring on the southeastern margin. Petrographic characteristics and magnetic polarity of these ash-flow sheets are similar. Volcanic facies relationships indicate that the tuff of Blue Creek represents the near-source facies of a regionally extensive, large-volume ash-flow sheet; the tuff of Elkhorn Spring is part of this sheet but is a distal facies which was ponded within the Rexburg caldera complex. Facies relations suggest a buried caldera south and east of the Lemhi Range and south of the Beaverhead Mountains as source for these units.

The youngest major ash-flow sheets on the eastern Snake River Plain are the tuff of Kilgore exposed on the northern margin of the plain, and the tuff of Heise, exposed on the southeastern margin. The tuff of Kilgore and the tuff of Heise are interpreted as equivalent units on the basis of similar petrographic characteristics, magnetic polarities, and facies relations. Preliminary mapping indicates that the source for these units is a buried caldera located near Kilgore, Idaho.

INTRODUCTION

The eastern Snake River Plain is a late Cenozoic volcanic province which extends from the Twin Falls area northeastward to Yellowstone National Park (fig. 1). This paper describes and suggests possible correlations between seven major, large-volume, rhyolitic ash-flow sheets which are exposed in the mountains bounding the northern and southeastern margins of the plain (fig. 2). Distribution patterns and similarities in the petrographic characteristics and magnetic polarities of the ash-flow sheets suggest that some have a common source and thus may be correlated across the plain and over large areas. We describe the stratigraphic units exposed on both margins of the plain and present evidence for correlation or noncorrelation between the ash-flow sheets. The reader is referred to figure 3, a stratigraphic correlation chart of the tuffs exposed on the northern and southern margins of the eastern Snake River Plain.

The eastern Snake River Plain is a bimodal volcanic province which has developed since mid-Miocene time, about 15 million years ago (Armstrong and others, 1980; Armstrong and others, 1975). Until recently the plain has been regarded as a predominantly basaltic province (Hamilton, 1960) but

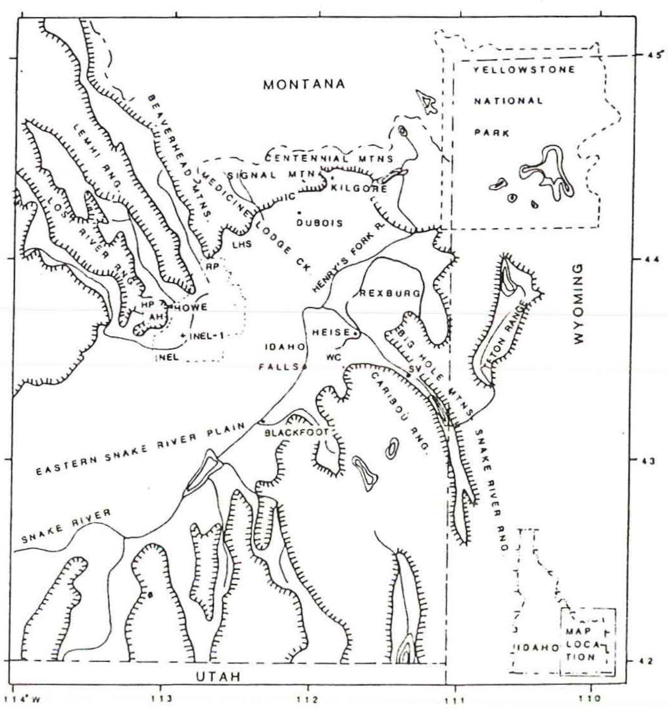

Figure 1. Index map of eastern Snake River Plain, southeast Idaho.

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evidence from boreholes and geophysical studies indicate that rhyolites are the more voluminous component. Recent mapping of extensive ash-flow sheets on the periphery of the eastern Snake River Plain by H.J. Prostka and the authors of this paper suggests that the rhyolites have source calderas that are now largely buried beneath the basalt lava flows (unpublished field data, H.J. Prostka, D.J. Doherty, G.F. Embree, L.A. McBroome, 1972-1980). The basaltic lava flows form a relatively thin veneer (typically less than 1 km) over rhyolitic ash-flow tuffs and lava flows (Doherty, 1979; Doherty and others, 1979; Embree and others, 1978). More than 2400 m of rhyolite was encountered in a 3160 m exploratory geothermal test well (INEL-1) drilled in the northwestern part of the eastern Snake River Plain (McBroome and Doherty, unpublished data).

The idea that rhyolites and even major calderas are concealed beneath the basalts of the Snake River Plain is not new. Mansfield and Ross (1935) commented on the overall similarity in the appearance of the welded tuffs on both northern and southern margins of the eastern Snake River Plain. They suggested that rhyolites were also buried beneath the basalts and sediments of the plain itself and suggested that the source calderas for the rhyolites are in the Yellowstone Park area (Mansfield and Ross, 1935). Stearns and others (1939) interpreted the differences in character of the rhyolites in various parts of the plain as evidence that the rhyolites had different sources. They suggested that a chain of rhyolite volcanoes extended from Boise to Yellowstone Park along the axis of the Snake River Plain. Kirkham (1931) proposed that volcanism on the plain became progessively younger to the northeast toward the Yellowstone Plateau. These concepts are similar to current models for the evolution of the eastern Snake River Plain-Yellowstone Plateau volcanic province (for example Smith and Christiansen, 1980).

During 1972 to 1978, H.J. Prostka established the preliminary stratigraphic framework for the rhyolites of the eastern Snake River Plain and proposed a conceptual model for the locations of some of the source calderas. Prostka's initial understanding of the volcanic stratigraphy and the application of his models to our field and laboratory studies have made it possible for us to advance in the development and understanding of the Pliocene and Miocene volcanic strati-

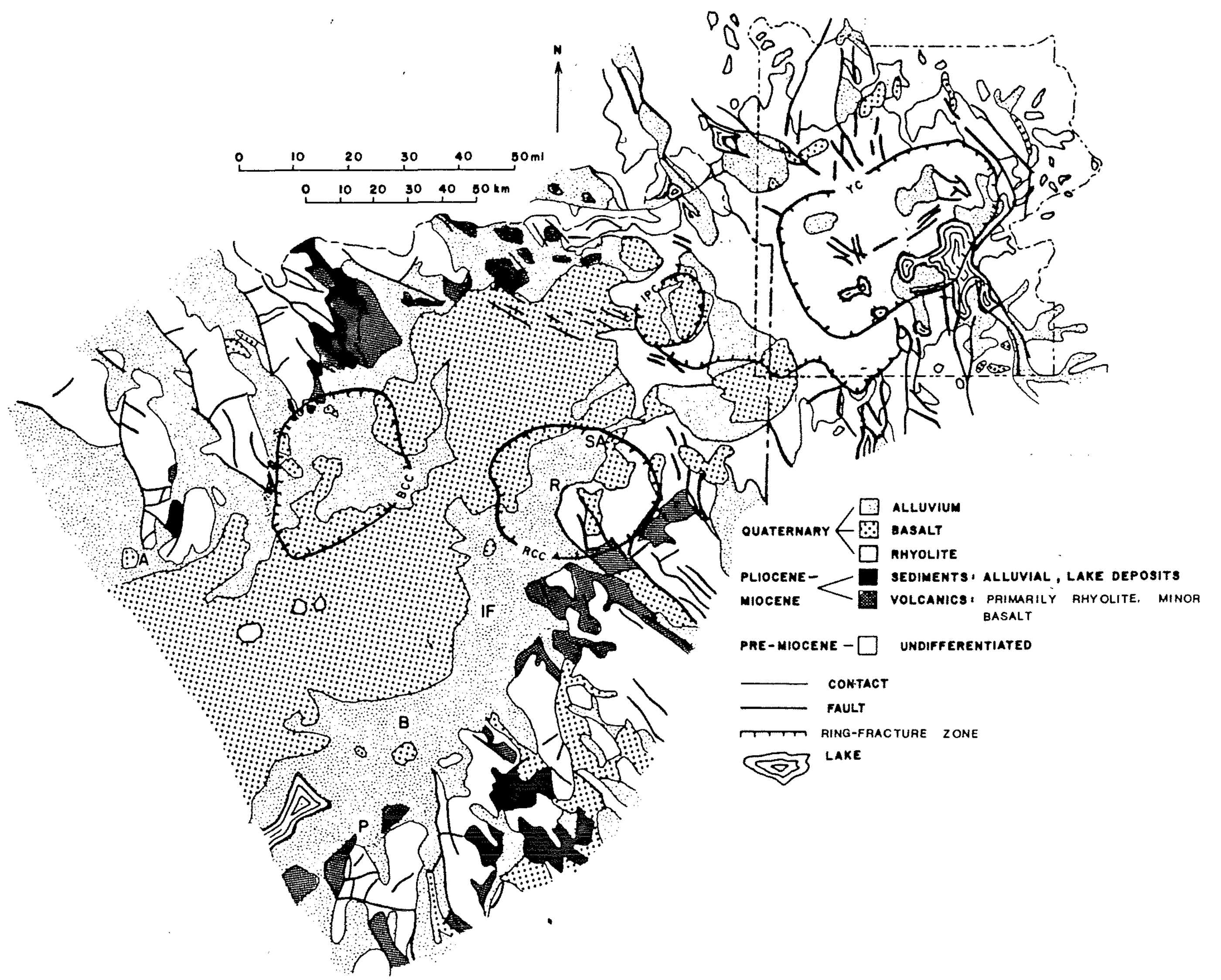

Figure 2. Generalized geologic map of the eastern Snake River Plain and Yellowstone National Park area modified from J.G. Bond (1978) and Smith and Christiansen (1980).

graphy of the eastern Snake River Plain.

Two calderas that will be discussed in the text are the Rexburg caldera complex (Prostka and Embree, 1978; Prostka, 1979; Prostka and others, 1979) and the Blue Creek caldera (fig. 2) (unpublished data, McBroome, 1981). These calderas differ from each other in the signature of their gravity anomalies (fig. 4). This is attributed to their location and surrounding rock types.

The full extent of the Rexburg caldera complex (Prostka and Embree, 1978; Prostka 1979; Prostka and others, 1979) and the location of its western margin have been determined, in part, from gravity data which disclose a large negative anomaly superimposed on the regional gravity high of the eastern Snake River Plain (figs. 2 and 4) (Mabey and others, 1974). The circular shape of the anomaly, in contrast to the elongate anomalies related to the Basin and Range structures north and south of the plain, suggests that the gravity low is related to a buried caldera. Mabey (1978) suggested that 1.0-2.5 km of low-density caldera fill would account for an anomaly of this magnitude.

Detailed geologic mapping, petrographic studies, and the application of regional gravity data indicate that a buried caldera is located south and east of the Lemhi Range and south of the Beaverhead Mountains (fig. 4). The caldera is the source for the tuff of Blue Creek (McBroome, 1981), unpublished thesis, Univ. of Colorado). The source caldera for the tuff of Blue Creek differs from the Rexburg caldera complex in that it is centered on a positive gravity anomaly. The positive gravity may be due to dense latitic intrusive rocks that were encountered at depth in the exploratory geothermal test well, INEL-1 (McBroome and Doherty, unpublished data, 1981), and may be related to resurgence of the caldera. The intrusive is surrounded by less dense, rhyolitic, pyroclastic deposits on the west and less dense, tuffaceous lacustrine sediments (Doherty, 1979; Doherty and others, 1979) on the east in the caldera moat-zone (McBroome, 1981, unpublished thesis, Univ. of Colorado).

STRATIGRAPHY

Tuff of Howe Peak

The tuff of Howe Peak is an extensive rhyolitic ash-flow sheet exposed along the northern margin of the eastern Snake River Plain in the southern Lemhi and Lost River Ranges (fig. 1). The type section has been described at Howe Peak (Howe Peak 7½′ quadrangle, sec. 31, T. 5 N., R. 29 E.), southeastern Lost River Range, where the thickness of the unit averages 30 m (unpublished data, McBroome, 1981.).

At the type section, the tuff of Howe Peak is an out-flow facies of a compound cooling unit (Smith, 1960a). The base generally consists of inversely graded air-fall ash which is overlain by a well-sorted ground surge deposit, a near-source deposit (Sparks and Walker, 1973). The overlying pyroclastic flow is dark brown, crystal-rich, locally pumice-rich, and moderately to densely welded at the base. The pyroclastic flow grades upward into a basal vitrophyre which is typically bluish-black, crystal-rich, slightly hydrated, and spherulitic. Above the basal vitrophyre, the tuff of Howe Peak is slightly less crystal-rich, has a well-developed lithophysal zone, and

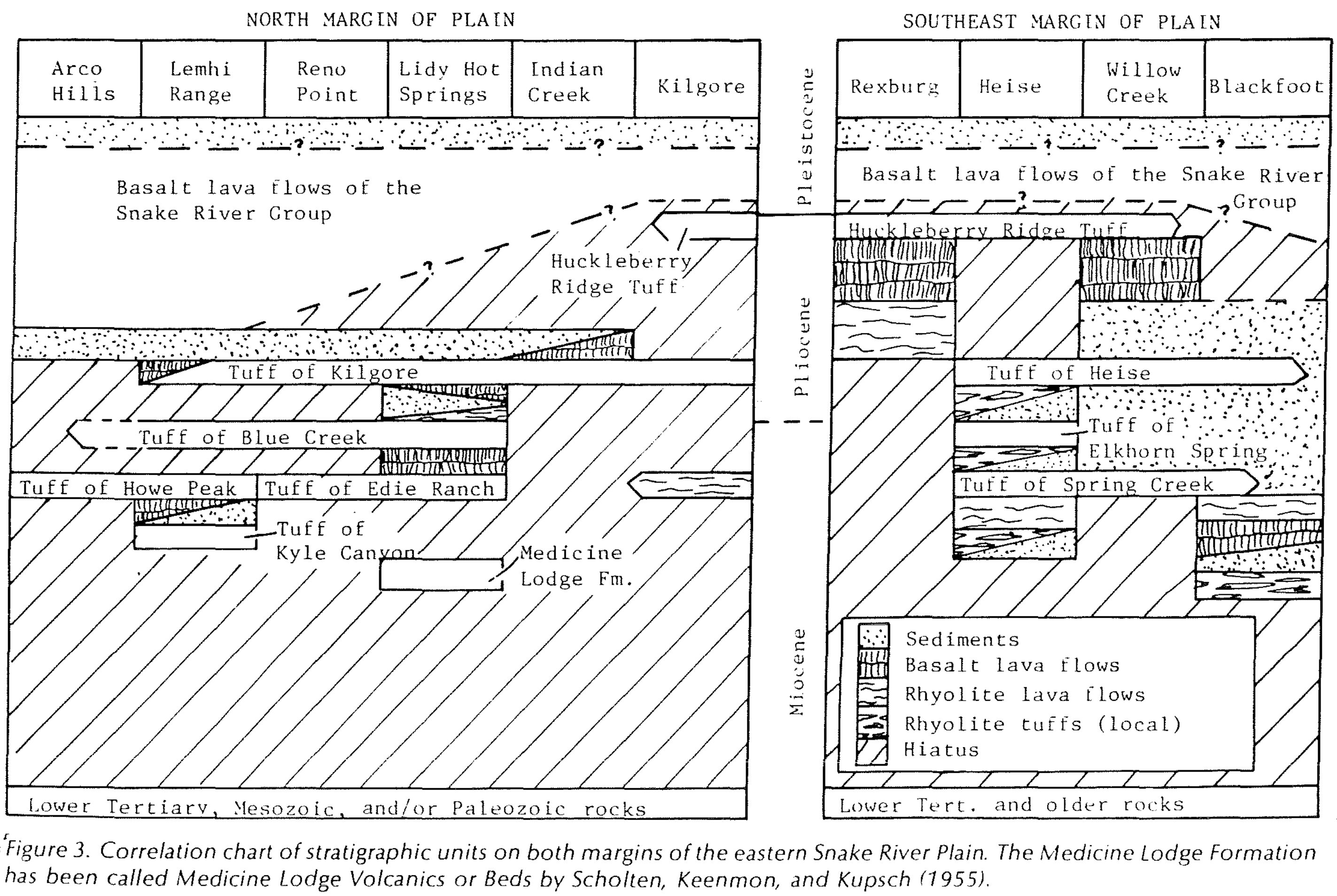

Figure 3. Correlation chart of stratigraphic units on both margins of the eastern Snake River Plain. The Medicine Lodge Formation has been called Medicine Lodge Volcanics or Beds by Scholten, Keenmon, and Kupsch (1955).

grades upward into a densely welded, crystal-rich, devitrified tuff. In places, the pyroclastic flow has a vitric layer at the top of the unit. The tuff of Howe Peak shows some vertical zonation in terms of phenocryst content and composition; the phenocryst content ranges from approximately 20 percent crystals at the base to about 10-15 percent in the upper parts. Phenocrysts consist of sodic plagioclase, sanidine, quartz, augite, hypersthene, magnetite, and zircon. Average composition of the plagioclase ranges from An_{30} at the base to An_{43} at the top. The relative abundance of augite also decreases upward through the tuff. The tuff of Howe Peak has normal magnetic polarity.

At various locatioins, the tuff of Howe Peak overlies the tuff of Kyle Canyon (a local tuff of limited extent) (fig. 3), alluvial fan gravels, and basaltic lavas. It is commonly in contact with the overlying tuff of Blue Creek where both tuffs form gentle, eastward-facing dip slopes and rest unconformably on top of Paleozoic sedimentary strata.

Tuff of Edie Ranch

The tuff of Edie Ranch is an extensive ash-flow sheet exposed in the southern Beaverhead and Centennial Mountains (fig. 1). The average thickness is 30 m but ranges from 2-3 m near Kilgore, Idaho to 100 m where it fills paleovalleys in the Beaverhead Mountains. The type section is 33 km west of Dubois, Idaho in the Edie Ranch 15′ quadrangle (Skipp, Prostka, and Schleicher, 1979).

The unit is a light-gray, purple, and brown, crystal-rich, densely welded ash-flow tuff that has compound cooling features which include a well-developed lithophysal zone beneath a densely welded, devitrified zone (Smith, 1960b). The phenocryst content ranges from 15-20 percent at the base of the unit to approximately 5 percent at the top of the unit. Phenocrysts include sodic plagioclase, sanidine, quartz, augite, and zircon; the relative amount of augite increases upward in the sheet. Flexgate magnetometer measurements indicate that the tuff of Edie Ranch has normal polarity.

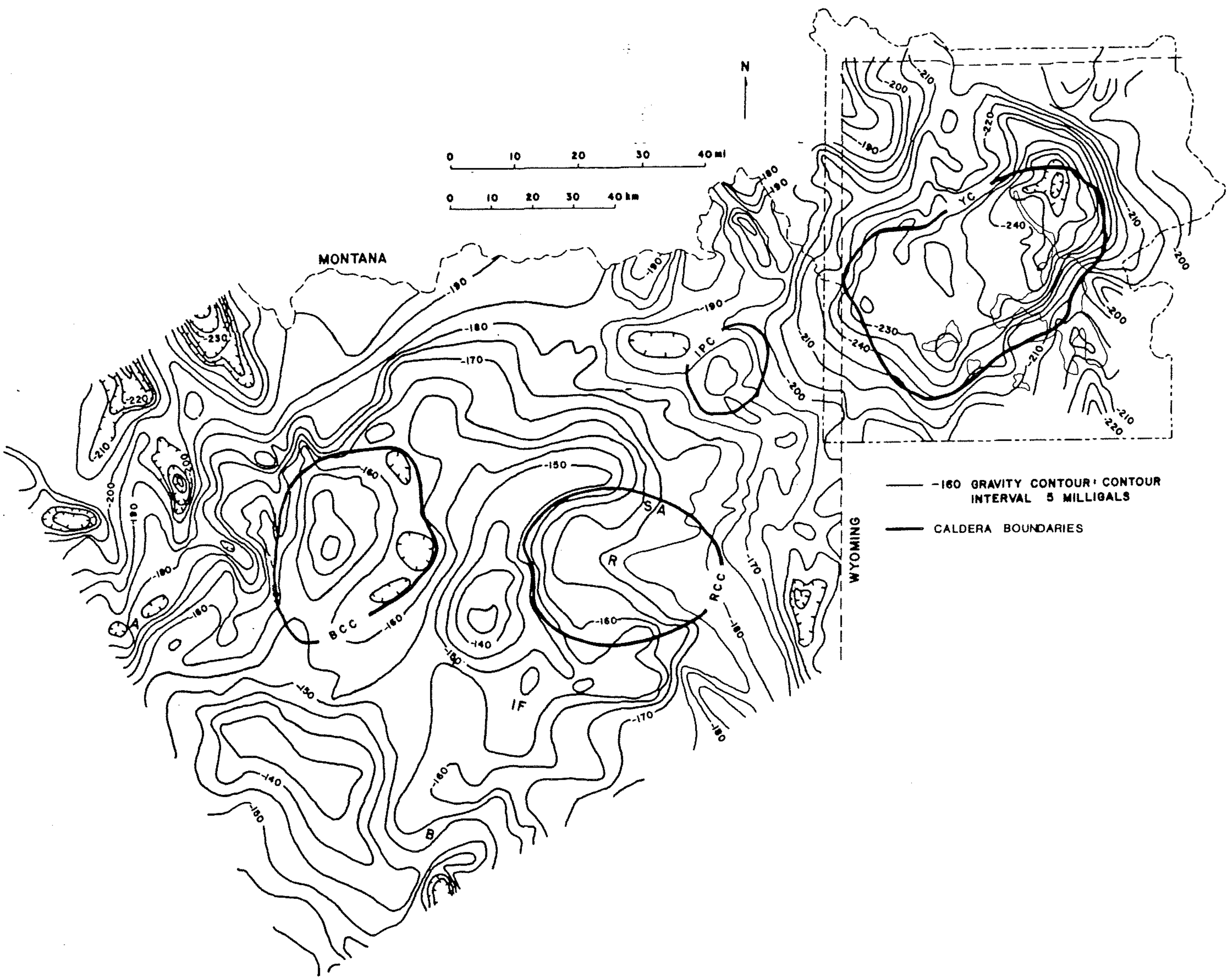

Figure 4. Gravity map of the eastern Snake River Plain and Yellowstone National Park area from Mabey and others (1974) and Smith and Christiansen (1980). The map shows the location of the Island Park, Yellowstone, Rexburg, and Blue Creek calderas.

Tuff of Spring Creek

The type section for the tuff of Spring Creek has been described at Stinking Spring Creek by Prostka and Embree (1978) and is located in the Heise SE 7½' quadrangle, section 10, T. 3 N., R. 41 E. The tuff of Spring Creek originally was designated as the tuff of Heise A by Albee and others (1975).

The tuff of Spring Creek forms one of the most extensive Miocene ash-flow sheets along the southeastern margin of the eastern Snake River Plain. It was the first, major, large-volume rhyolitic ash-flow sheet associated with the development of the Rexburg caldera complex (fig. 4) and was erupted 6.0-6.3 m.y. ago (Protska and others, 1979). The tuff of Spring Creek has been identified at least 50 km south of the Rexburg caldera complex in the vicinity of Blackfoot, Idaho. Its exposed thickness ranges from one or two meters to at least 215 meters. The tuff of Spring Creek is well exposed within and surrounding the southern and eastern segments of the Rexburg caldera complex (Prostka and Embree, 1978). Outside the caldera, the tuff is well exposed in the western foothills of the Caribou Range where it occurs as an eroded, gently folded, discontinuous sheet that rests on Mesozoic sedimentary rocks (fig. 1).

The tuff of Spring Creek is typically densely welded, glassy to devitrified, eutaxitic, and locally lithophysal. It is a gray to brown, crystal-rich tuff containing phenocrysts which include plagioclase, sanidine, quartz, augite, hypersthene, rare biotite, magnetite, and zircon. The tuff of Spring Creek exhibits vertical zonation with regard to the abundance and composition of phenocrysts. Phenocrysts typically range between 15-20 percent near the base and gradually decrease to 3-5 percent near the top of the ash-flow sheet. The plagioclase phenocrysts exhibit a general increase in calcium content upward through the sheet from An_{27-37} at the base to An_{42-45} at the top. The lower parts of the tuff of Spring Creek usually contain up to 2 percent of green pyroxene phenocrysts. Like the tuff of Howe Peak, the tuff of Spring Creek has normal magnetic polarity.

Tuff of Blue Creek

The tuff of Blue Creek is petrographically and magnetically distinct from other ash-flow tuff sheets on the northern margin of the plain. The tuff of Blue Creek is a crystal-poor, densely welded, glassy to devitrified, spherulitic to lithophysal, ash-flow tuff. Phenocryst content throughout the unit averages 1 percent plagioclase; small amounts of pyroxene, magnetite, and zircon are present locally. Field measurements using a flexgate magnetometer indicate this unit has reversed magnetic polarity. Out-flow facies of the tuff of Blue Creek occur in the southern Lemhi Range and in the southern Beaverhead Mountains (fig. 1). The thickness ranges from 0 to 180 m, averaging 100 m.

The name for the tuff of Blue Creek was originally proposed by Harold J. Prostka where the unit was described in the southern Beaverhead Mountains (Skipp, Prostka, and Schleicher, 1979). A good reference section, which is more accessible, is exposed in a roadcut on Highway 33 at the southern tip of the Lemhi Range (Big Lost River 7½' quadrangle, section 35, T. 5 N., R. 31 E.). Here, a complete sequence of the tuff of Blue Creek is seen. The basal units of the tuff of Blue Creek, which overlie the tuff of Howe Peak, consists of orange, air-fall ash and pumice overlain by a 1 meter thick ground surge deposit. Ground surge deposits have been reported to extend no farther than 5-10 km from their source and are interpreted as near-source facies (Sparks and Walker, 1973; Sheridan, 1979). Above the basal section, the pyroclastic-flow of the tuff of Blue Creek characteristically exhibits features indicative of a simple cooling unit (Smith, 1960a). A pumice-rich, eutaxitic, densely welded ash-flow unit is characteristic of the lower proximal part of the tuff of Blue Creek and is easily identifiable by its color and texture: orange, stretched pumice is set in a matrix of black glass shards. This unit forms a sharp contact with the overlying thin vitrophyre which grades upward into a perlitic, spherulitic tuff. A sharp contact separates the spherulitic tuff from a devitrified zone which grades upward into a well-developed lithophysal zone. The section at the southern tip of the Lemhi Range is approximately 75 meters thick.

The location of the source caldera for the tuff of Blue Creek is most likely south and east of the Lemhi Range and south of the Beaverhead Mountains (fig. 4). Evidence for the location of the buried source caldera includes location of near-source, out-flow facies, locations of related rhyolitic lava domes and flows, caldera-related structures exposed in the southern Lemhi Range and Beaverhead Mountains, and lithologic and petrographic data obtained from an exploratory geothermal test well (INEL-1-) (Doherty and others, 1979; unpublished data, McBroome and Doherty, 1981). The interpretation for the location of the buried caldera is supported by geophysical data obtained by Mabey and others (1974), L. Pankratz and H.D. Ackerman (1981), and A.A.R. Zohdy (oral communication, 1980), all at the U.S. Geological Survey.

At the southern tip of the Lemhi Range, a structural block that consists solely of the upper, divitrified platy unit of the tuff of Blue Creek was inhomogeneously deformed and downfaulted approximately 75 m toward the plain. The structures in this block are significantly different from structures observed elsewhere in the same unit; typically the unit dips gently to the east and lacks foliation. Certain structural features such as tightly folded rocks and discordant strikes and dips are unique to this block. A paleomagnetic study of 36 oriented samples from various localities in the tuff of Blue Creek at the southern tip of the Lemhi Range indicates that the secondary flowage features have parallel paleomagnetic directions regardless of the location on the structural block from which the sample was obtained and regardless of the attitude of the flow foliation. The paleomagnetic data suggest evidence for plastic deformation of the unit while it was above its Curie temperature. The deformation probably was associated with the collapse of the Blue Creek caldera shortly after emplacement of the out-flow facies of the tuff of Blue Creek (unpublished data, McBroome, 1981).

Tuff of Elkhorn Spring

The type section for the tuff of Elkhorn Spring has been described from an excellent exposure in the vicinity of Elkhorn Spring in the Heise-7½' quadrangle, section 23, T. 4 N., R. 40 E., (Prostka and Embree, 1978). It was originally described as the tuff of Heise B by Albee and others (1975).

The tuff of Elkhorn Spring is a gray to purplish-gray, devitrified, lithophysal to spherulitic, eutaxitic, densely welded, rhyolitic, ash-flow tuff. Phenocrysts typically comprise less than 1 percent of the rock and are mostly plagioclase. The tuff ranges in thickness from 2 meters to approximately 70 meters. The tuff of Elkhorn Spring occurs above the 5.72 m.y. old (G.B. Dalrymply, personal communication, 1979; Prostka and other, 1979) rhyolite of Kelly Canyon and below the 4.3 m.y.

old tuff of Heise (Armstrong and others, 1980). It has reversed magnetic polarity.

The tuff of Elkhorn Spring is restricted to the southern margin of the plain, mostly along the southeastern edge of the Rexburg caldera complex in the vicinity of Heise, Idaho (fig. 1). A prominent black, densely welded vitrophyre occurs about 3 m above the base. The outcrop pattern of the tuff of Elkhorn Spring is roughly arcuate in form and, in part, outlines the southeastern segment of the moat-zone of the Rexburg caldera complex. The tuff may have been deposited into a local moat-type depression in the vicinity of Heise, along the edge of the caldera. Distribution patterns suggest that the tuff of Elkhorn Spring did not erupt from the Rexburg caldera complex. Instead the tuff postdates the collapse of the Rexburg caldera complex.

Tuff of Heise

The tuff of Heise is an extensive and well-exposed Pliocene rhyolitic ash-flow tuff that is distributed over much of the Rexburg caldera complex and surrounding foothills. The tuff extends from Teton National Park on the northeast to as far southwest as Blackfoot, Idaho (fig. 1). The tuff of Heise is a prominent Pliocene ash-flow sheet on the lower slopes of the Big Hole Mountains and the Snake River and Caribou Ranges. It is at least 40 meters thick in the Snake River graben near Swan Valley, Idaho. The tuff of Heise varies in thickness from about 1 to 150 meters and reflects emplacement onto irregular topography.

The type section has been described by Prostka and Embree (1978) and is exposed at the top of cliffs near Heise which is located in the Heise 7½' quadrangle in section 30, T. 4 N., R. 41 E. Albee and others (1975) originally described this unit as the tuff of Heise C.

The tuff of Heise forms a compound cooling unit. In the area of the Rexburg caldera complex, the tuff of Heise consists of four cooling units. Most of the sheet is comprised of the lower two units with a thin capping veneer of the upper sheets and is well exposed on top of the small horst north of Heise, Idaho.

A K-Ar age of 4.3 $\pm$0.15 million years was obtained for the tuff of Heise (Armstrong and others, 1980). Magnetic measurements indicate that the tuff of Heise has normal polarity in the lower parts and reversed polarity in the upper two units.

The tuff of Heise represents a compositionally zoned ash-flow sheet. The plagioclase composition becomes slightly more anorthitic (from An_{35} to An_{40}) upward through the sheet.

Tuff of Kilgore

The tuff of Kilgore is exposed along the northern margin of the eastern Snake River Plain from the foothills of the southern Lemhi Range to the southern flank of the Centennial Mountains north of Kilgore (fig. 1). The unit has been described by H.J. Prostka as the tuff of Spencer (Skipp, Prostka, and Schleicher, 1979). Facies relations suggest its source caldera is along the south side of the Centennial Mountains near Kilgore, Idaho where the unit is thickest (100 m). It thins to the west, averaging 30 m in thickness, and forms extensive dipslopes in the vicinity of Medicine Lodge Creek in the southern Beaverhead Mountains. In that area, the tuff of Kilgore laps onto older volcanic units, including the tuffs of Blue Creek, Howe Peak and Edie Ranch. West of Medicine Lodge Creek, the tuff of Kilgore is found in scattered patches in the foothills of the southern Lemhi Range and southern Beaverhead Mountains. In most of these areas, it is generally less than 2 m thick.

The basal vitrophyre of the tuff of Kilgore is fairly thin (1 m) and is densely welded. It consists of a red to black matrix containing abundant black shards; sparse, 1-2 cm-long, black to light gray pumice; and black and red grains of obsidian.

A lithophysal zone, which makes up about one-third of the thickness of the unit, overlies the vitrophyre. Small (0.5-5 cm), white lithophysae make up about 50 percent of the rock, which has a matrix that is medium gray, devitrified, and densely welded. The lithophysal zone stands out as a prominen cliff former and is generally well exposed because it is massive with little or no jointing.

The middle part of the tuff of Kilgore is strongly devitrified, slightly eutaxitic, has pronounced slabby parting, and commonly displays a strong lineation on joint surfaces. Lineations in the platy zone are white and maroon streaks up to 30 cm long, 1-3 cm wide, and only a millimeter or so thick that consist predominantly of vapor phase crystals. Where the rock is non-lineated, it may contain a few lithophysae which are generally larger than those in the lithophysal zone below.

The uppermost zone, where it has not been removed by erosion, is pink to red, vitric, and moderately welded. The vitric tuff contains light-gray, silky pumice and red and black obsidian grains and black shards that are similar to those in the basal vitrophyre.

The tuff is dominantly vitric in the more distal area to the west in the southern Lemhi Range. The lithophysal and platy devitrified zones are missing in many of the areas where the tuff is only a meter or two thick.

The phenocryst content of the tuff of Kilgore ranges from 5-7 percent at the base to approximately 1-2 percent at the top. The predominant phenocryst mineral is plagioclase. Sanidine, quartz, and very sparse tiny, dark green augite crystals occur as rare phenocrysts.

The welded ash-flow tuff, which appears to be the tuff of Kilgore, was encountered in deep boreholes on the Idaho National Engineering Laboratory (INEL) at depths in excess of 777 m (Doherty, 1979, unpublished data; McBroome and Doherty, 1981).

Like the tuff of Heise, the lower units have normal polarity whereas the upper units have reversed polarity.

CORRELATION OF STRATIGRAPHIC UNITS

The following conclusions can be made concerning the correlation of tuffs between the northern and southeastern margins of the eastern Snake River Plain based on the distribution of the major ash-flow tuff sheets in the eastern Snake River Plain and their petrographic and preliminary magnetic polarity characteristics: 1) the tuff of Howe Peak is not equivalent to the tuff of Spring Creek; 2) the tuff of Edie Ranch may be equivalent to the tuff of Spring Creek; 3) the tuff of Blue Creek is equivalent to the tuff of Elkhorn Spring; and 4) the tuff of Kilgore is equivalent to the tuff of Heise. These correlations are considered preliminary until detailed geochemical analyses of trace and rare earth elements that would "fingerprint" the individual ash-flow sheets (Jack and Carmichael, 1968) and fission-track and perhaps other radiometric age determinations are completed.

Tuff of Howe Peak-tuff of Spring Creek (noncorrelation)

The petrography and magnetic polarity are similar for the tuffs of Howe Peak and Spring Creek but the tuffs were not erupted from a common source in the same eruptive period.

Stratigraphic relations on the northern margin of the plain indicate that the source for the tuff of Howe Peak is buried on the plain east of Howe Peak in the southern Lost River Range. The interpretation for the location of the caldera source for the tuff of Howe Peak is based on the near-source stratigraphy present at the type locality, the distribution of this unit, and structural evidence. In addition to a series of en echelon faults mapped at the surface that are downthrown toward the plain (unpublished data, McBroome, 1981), a seismic refraction profile extending from the eastern Arco Hills to east of INEL-1 indicates that a near vertical, 1000 m displacement (downthrown toward the plain) is present approximately 4 km east of the mountain front (Pankratz and Ackerman, 1981). One interpretation for the steep, nearly vertical displacement may be that it is related to a collapsed caldera wall.

Although general petrographic characteristics are similar for both tuffs (both are relatively crystal-rich, have similar mineral contents, and have normal magnetic polarity), the tuff of Spring Creek was erupted from the Rexburg caldera complex (Prostka and Embree, 1978). It is generally confined to the southern margin of the plain although exposures of this unit may be present in the southern Beaverhead and Centennial Mountains on the northern periphery of the eastern Snake River Plain.

Tuff of Edie Ranch-tuff of Spring Creek (correlation)

Preliminary mapping and laboratory studies indicate that the tuff of Edie Ranch and the tuff of Spring Creek may be equivalent. Both tuffs are characteristically crystal-rich, have a relative increase in the augite content upward in the sheet, and represent the lowest major ash-flow units in the southern Beaverhead and Centennial Mountains and southeastern margin of the eastern Snake River Plain. Flexgate magnetometer measurements of these ash-flow sheets indicate that the tuffs have normal polarity.

The stratigraphic distribution patterns of both tuffs indicate that they have a similar source caldera. The tuff of Spring Creek erupted from the Rexburg caldera complex 6.0-6.3 m.y. ago (Prostka and others, 1979) and represents the near-source facies of a large-volume, extensive ash-flow sheet; the distal facies of this sheet is represented by the tuff of Edie Ranch. This correlation is considered preliminary and further studies are required to clarify the exact relationship between these two units; thus no change or additional nomenclature is proposed at this time.

Tuff of Blue Creek-tuff of Elkhorn Spring (correlation)

The similarities in the petrographic characteristics and magnetic polarities (both reversed) for the tuffs of Blue Creek and Elkhorn Spring suggest that these units have a common source caldera. Both units are crystal-poor; sodic plagioclase is the only mineral that occurs as a phenocryst. Although study of heavy mineral separates indicates that the crystal morphology and length-to-width ratio of the zircons from these units are the same, the tuff of Blue Creek contains more zircon than does the tuff of Elkhorn Spring. This difference can be attributed to the fact that the tuff of Blue Creek is closer to the source than the tuff of Elkhorn Spring.

Coherent stratigraphic distribution patterns confirm the correlation of the two tuffs. The tuff of Blue Creek is a simple cooling unit which represents the out-flow facies of a regionally extensive ash-flow tuff sheet. Near-source features, such as ground surge deposits, rhyolitic domes, and plastically deformed units, occur in the tuff of Blue Creek in the southern Lemhi Range and the southern Beaverhead Mountains. The tuff of Elkhorn Spring, on the southern margin of the eastern Snake River Plain, forms part of a composite sheet that ponded in the moat-zone of the Rexburg caldera complex. The tuff of Elkhorn Spring is interpreted to be a distal facies of the tuff of Blue Creek.

Because petrographic and field studies indicate the source of the eruptive unit that makes up the tuffs of Blue Creek and Elkhorn Spring is the Blue Creek caldera, the tuff of Blue Creek is proposed as the only name to be used when referring to either tuff. The location of the caldera is suggested by the near-source facies in the tuff of Blue Creek exposed in the southern Lemhi Range and Beaverhead Mountains, by the thick (approximately 2.0 km) intracauldron-fill encountered in the exploratory geothermal test well, INEL-1, and by the regional gravity map of southern Idaho by Mabey and others (1974). These features indicate that the source caldera is located on the northwestern margin of the plain, south and east of the Lemhi Range and south of the Beaverhead Mountains (fig. 2 and 4).

Tuff of Kilgore-tuff of Heise (correlation)

The tuffs of Kilgore and Heise are interpreted to be the same unit based on similarities in petrographic characteristics, distribution of volcanic facies, and magnetic polarities. Flexgate magnetometer measurements indicate the basal units have reversed polarity and the upper units have normal polarity for both tuffs. Morphologic analyses of 1000 zircons from both tuffs indicate that the zircons have a similar source (Troschinetz and Doherty, 1981). As in the tuff of Blue Creek, the amount of zircon present in the distal facies is less than that in the near-source out-flow facies. Preliminary studies by Doherty and Troschinetz indicate that zircon may be useful in correlating large-volume, rhyolitic ash-flow sheets for great distances. Distribution patters indicate that the source caldera of the tuffs of Kilgore and Heise is located near Kilgore, Idaho. The tuff of Heise most likely represents the distal facies of the tuff of Kilgore where the tuff of Heise ponded in part in the Rexburg caldera complex.

CONCLUSIONS

From preliminary evidence concerning seven major Pliocene and Miocene ash-flow tuff sheets exposed on the northwestern and southeastern margins of the eastern Snake River Plain, we conclude that: 1) the tuff of Howe Peak and the tuff of Spring Creek are not equivalent eruptive units and have unique source areas; 2) the tuff of Edie Ranch and the tuff of Spring Creek may be equivalent units whose source is the Rexburg caldera complex; 3) the tuff of Blue Creek and the tuff of Elkhorn Spring are equivalent; the tuff of Blue Creek represents the near-source facies and the tuff of Elkhorn Spring represents the distal facies of an ash-flow sheet erupted from a buried caldera located south and east of the southern Lemhi Range; and 4) the tuffs of Kilgore and Heise are parts of a single, extensive ash-flow tuff sheet erupted from a buried caldera in the vicinity of Kilgore, Idaho. these interpretations are preliminary at present. When completed, analyses of the trace and rare-earth element distribution, and determination of fission track and perhaps other radiometric ages of the individual ash-flow sheets will confirm or alter the interpretations.

We propose the following modification of the nomenclature: the tuff of Blue Creek is the name to be used when referring to either the tuff of Blue Creek or the tuff of Elkhorn Spring; likewise the tuff of Kilgore will refer to the tuff of Kilgore and the tuff of Heise. No change in nomenclature is proposed for the tuffs of Edie Ranch and Spring Creek as the correlation between these units is preliminary.

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