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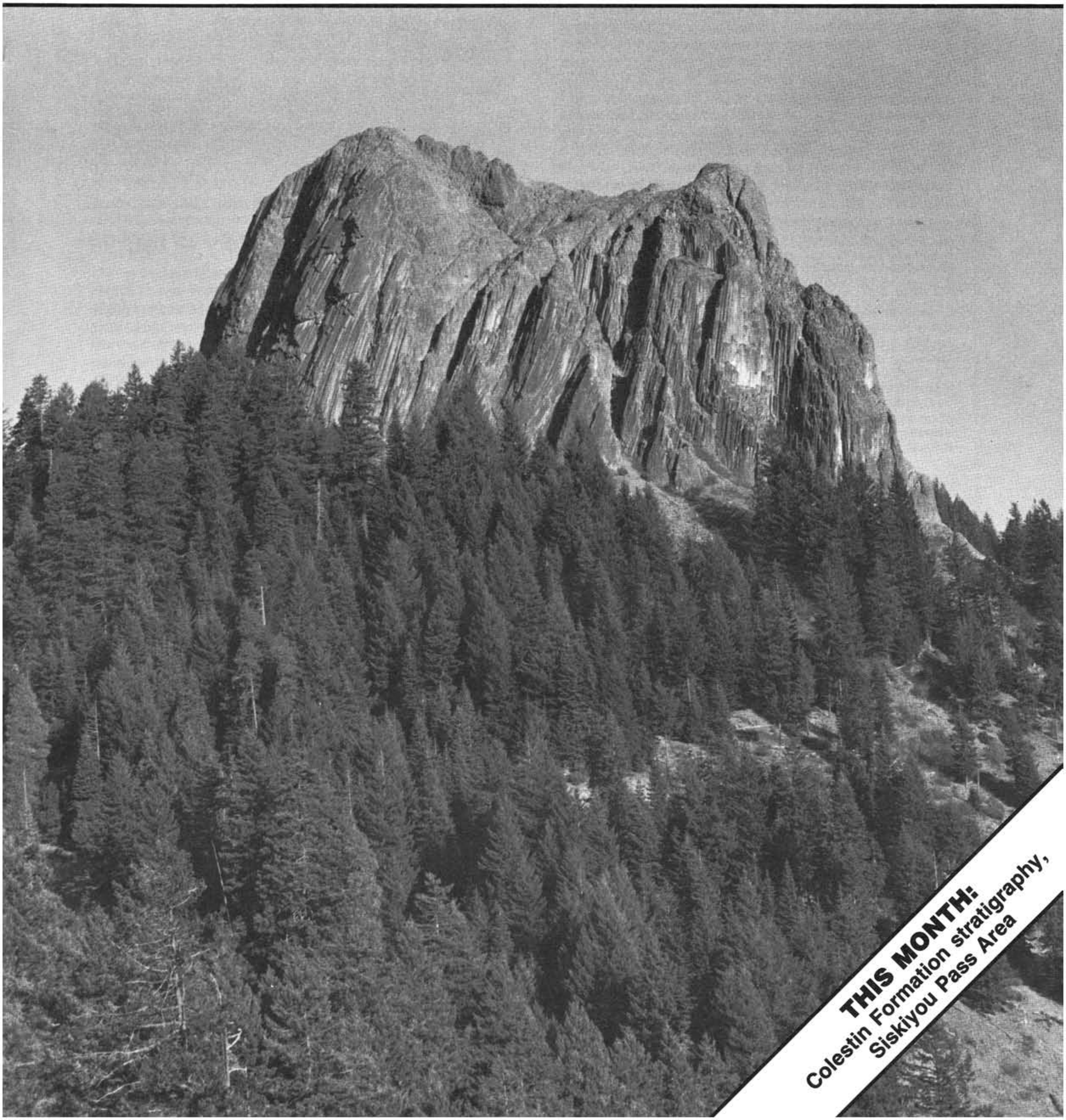

THIS MONTH:
Colestin Formation stratigraphy,
Siskiyou Pass Area

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The style to be followed is generally that of U.S. Geological Survey publications (see the USGS manual *Suggestions to Authors*, 6th ed., 1978). The bibliography should be limited to "References Cited." Authors are responsible for the accuracy of the bibligraphic references. Names of reviewers should be included in the "Acknowledgments."

Authors will receive 20 complimentary copies of the issue containing their contribution. Manuscripts, news, notices, and meeting announcements should be sent to Beverly F. Vogt, Publications Manager, at the Portland office of DOGAMI.

COVER PHOTO

Pilot Rock, seen here from the south, is a Tertiary hornblende andesite plug located in the Siskiyou Pass area. See related article beginning on next page.

OIL AND GAS NEWS

Drilling planned for July

Further exploration in the Mist Gas Field is likely to begin this month. ARCO Oil and Gas Co. has 18 permits in effect in the field and plans to start drilling activities in midsummer. The permits are in T. 5 N., R. 4 W.; T. 6 N., R. 4 W.; and T. 6 N., R. 5 W., and range in proposed total depth from 2,000 to 4,850 ft.

In addition, Leadco, Inc., formerly Leavitt's Exploration and Drilling Co., plans to drill its locations in sec. 17, T. 5 N., R. 4 W., this summer. The proposed depth for both of these locations is 2,500 ft.

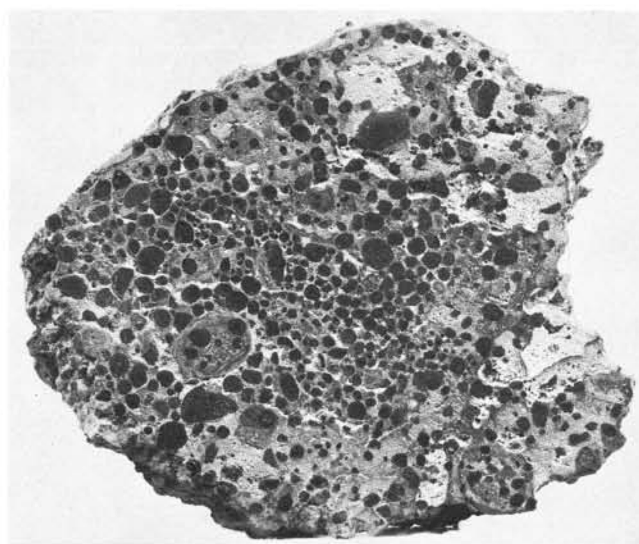
Mountain States Petroleum to file for permits

Mountain States Petroleum of Roswell, N. Mex., plans to submit applications to drill for locations in Douglas County and possibly in Coos County. As part of the drilling program, the company may reenter the Hutchins & Marrs well Great Discovery 2 in sec. 20, T. 30 S., R. 9 W. The work is planned for this drilling season. □

Glimpses of DOGAMI history — bauxite discoveries made

Sizeable deposits of ferruginous (iron-bearing) bauxite (aluminum ore) were discovered in 1944 in Washington County, north and west of Portland, by geologists of the Oregon Department of Geology and Mineral Industries (DOGAMI). Following this initial discovery, other large deposits of aluminum ore were found in Columbia and Washington Counties.

Publication of these studies by DOGAMI in the late 1940's and early 1950's resulted in large-scale exploration and evaluation projects by Alcoa, Aluminum Company of Canada, and Reynolds Metals Company.



The specimen shown above is typical of the pisolitic (made up of pealike grains) variety of bauxite that is commonly found in the deposits in Washington and Columbia Counties. The dark-brown pisoliths usually contain more than 40 percent iron and are imbedded in a lighter colored matrix that consists largely of limonite (goethite) and gibbsite. □

Volcanic stratigraphy of the Oligocene Colestin Formation in the Siskiyou Pass area of southern Oregon

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ABSTRACT

The Oligocene Colestin Formation, situated at the base of the Tertiary volcanic sequence in the Western Cascades in southern Oregon, consists of nonmarine volcaniclastic and pyroclastic deposits and lava flows. In its type area near the Oregon-California border, the formation is broken down into nine informal members that have a combined maximum thickness of approximately 1,600 m. Each member is characterized by one of the following lithologic types: (1) coarse volcaniclastic deposits of andesitic and basaltic composition, (2) rhyolitic pyroclastic and reworked pyroclastic deposits, and (3) basaltic and andesitic lava flows.

The upper boundary of the Colestin Formation is mapped at a stratigraphically higher position than that mapped by Wells (1956). The lithostratigraphic units added to the Colestin Formation are consistent with Wells' (1956) definition that the formation is dominantly volcaniclastic.

In the lower part of the formation, the members are contained within an east-west-trending graben. The graben is bounded to the north by the Siskiyou Summit fault and to the south by less well-defined east-west faults located in the Oregon-California border area. During deposition of the Colestin's upper members, the graben continued to subside on the north, but at the graben's southern boundary, subsidence slowed, and volcanic material overflowed and obscured the graben faults. Prior to graben faulting and deposition of Colestin detritus, the area south of the Siskiyou Summit fault was uplifted. This uplift produced the northward-dipping paleoslope and southward thinning of the underlying upper Eocene Payne Cliffs formation. Later graben subsidence along the Siskiyou Summit fault juxtaposed the Payne Cliffs formation and the Colestin Formation.

Deposition of the volcaniclastic and pyroclastic debris within the graben occurred in an alluvial apron-type setting. The aprons developed adjacent to volcanic centers situated to the east along the Oligocene Cascade arc. Periodically, lava flows inundated the alluvial surface, but more commonly, volcanic material was deposited by laharic debris flows, stream floods, and pyroclastic flows.

A distinctive type of coarse-grained volcaniclastic deposit, termed "hyperconcentrated flood flow deposits" (Smith, 1986), is common in the Colestin Formation. These deposits consist of discontinuous, horizontally bedded, very poorly sorted, pebbly conglomerates and granular sandstones that are clast supported. In the Colestin Formation, these deposits commonly grade upward from matrix-supported debris-flow deposits (lahars).

INTRODUCTION

The Western Cascade Range of southern Oregon and northern California consists of deeply eroded andesitic and basaltic stratovolcanoes and shield volcanoes, rhyolitic pyroclastic deposits, related intrusive rocks, and epiclastically reworked material derived from these primary volcanic products. The volcanic strata of the Tertiary volcanic sequence of the Western Cascades range in age from latest Eocene/early Oligocene to late Miocene. The initiation of Cascade volcanism has been dated at 35-40 million years (Ma) from rocks of the Western Cascades (Smith and others, 1980; Fiebelkorn and others, 1983) and from rocks at the base of the John Day Formation in central Oregon (Swanson and Robinson, 1968; Robinson and others, 1984).

This paper describes the stratigraphy and depositional history of volcanic epiclastic, pyroclastic, and lava-flow lithostratigraphic units situated at the base of the Western Cascade Tertiary volcanic sequence in southern Oregon (Figure 1). Nine informal members belonging to the Oligocene Colestin Formation in its type area (Wells, 1956) have been mapped over an area of about 100 km². These members have a combined maximum thickness of approximately 1,600 m. The area of detailed study stretches along the Western Cascade Range for 15 km from the Oregon-California border to 4 km north of Siskiyou Pass (Figure 2). This paper deals almost exclusively with the Colestin Formation in its type area.

The base of the Tertiary volcanic sequence of the Western Cascades is well exposed in the Siskiyou Pass area, owing to 1,000 m of relief in the Tertiary units and relatively sparse vegetation. The lower members of the Colestin Formation are exposed along streams draining the Siskiyou Mountains, and the upper members are well exposed in natural outcrops and in roadcuts along Interstate 5 and Highway 99, which transect the upper part of the formation in the Siskiyou Pass area.

The Tertiary and Cretaceous rocks in this area form a northeastward-dipping homocline with dips ranging from 35° in the Cretaceous Hornbrook Formation to 8° in the Oligocene Roxy For-

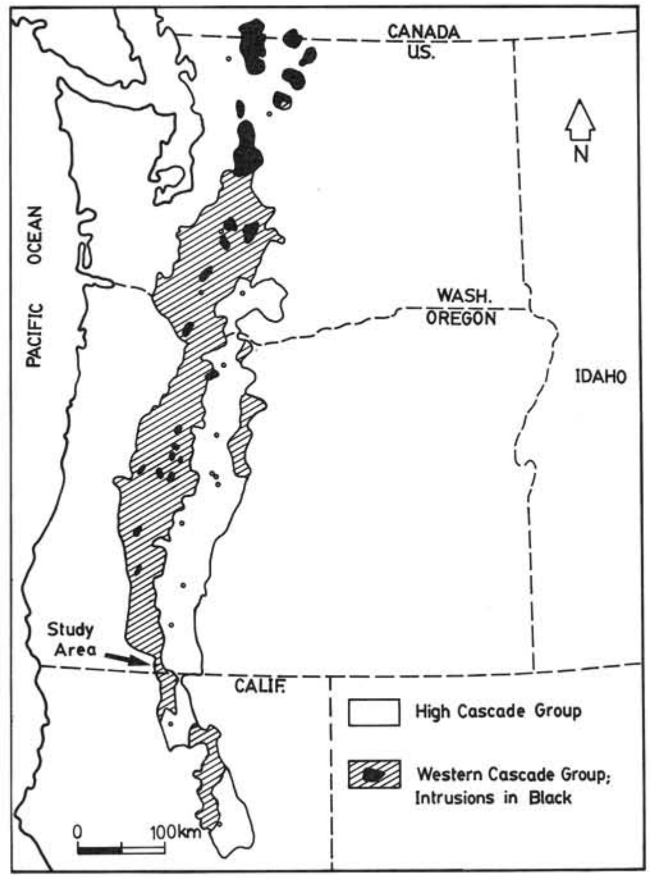

Figure 1. Geologic map of the Cascade Range showing the study-area location and the distribution of Western and High Cascade rocks (modified from Hammond, 1979). Open circles are major andesite-dacite volcanic centers.

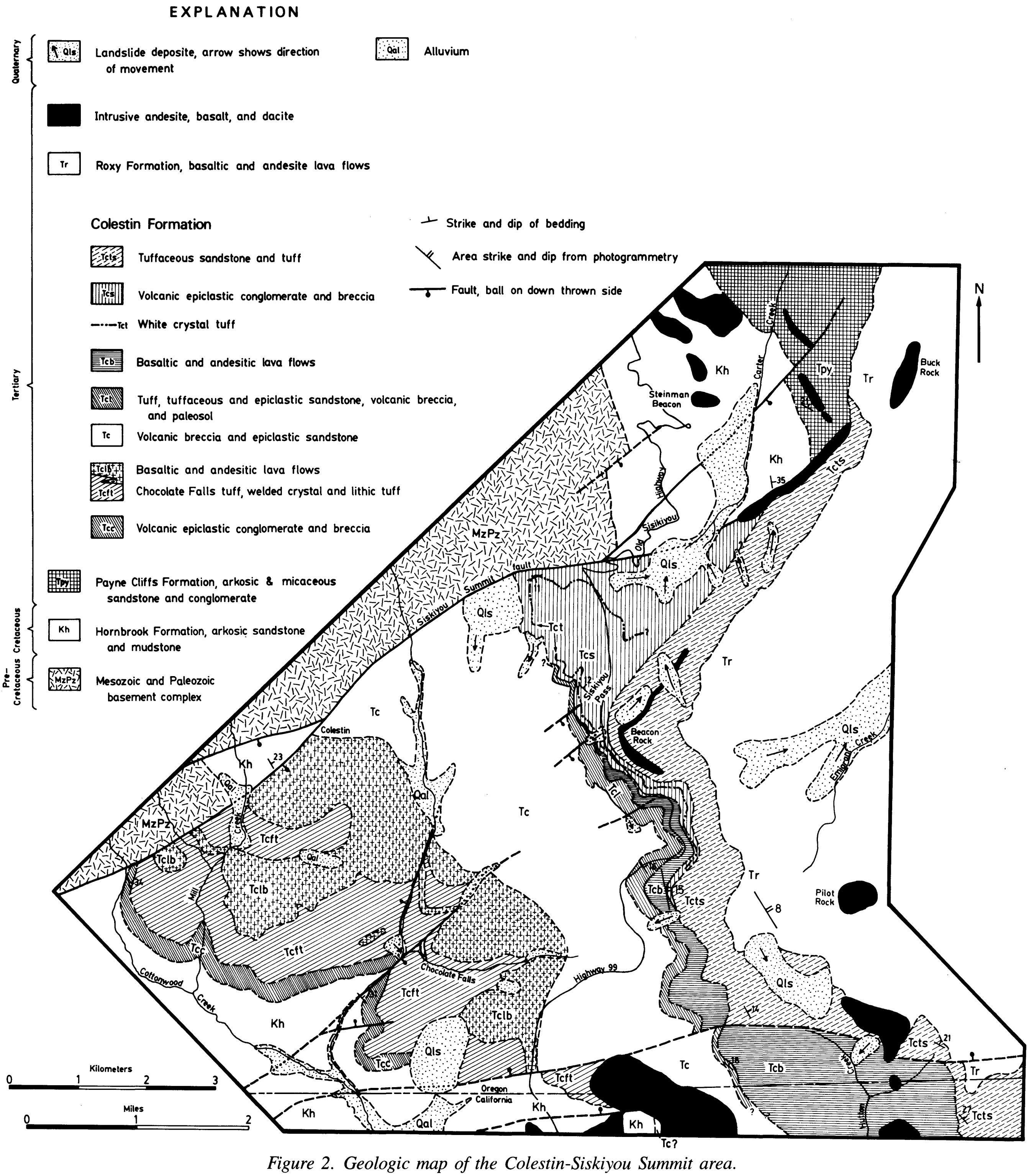

Figure 2. Geologic map of the Colestin-Siskiyou Summit area.

mation. In general, dips decrease to the east, away from the Klamath Mountains Province. Numerous high-angle faults offset the Tertiary and Cretaceous rocks and trend northeast, east-west, and northwest. The Siskiyou Summit fault is a major fault that trends northeast-southwest, offsets the outcrop pattern of Cretaceous and Tertiary rocks by as much as 15 km, and brings the Colestin Formation in contact with basement rocks of the Klamath Mountains Province.

The Colestin Formation was initially mapped and defined by Wells (1956) for sequences of volcaniclastic and pyroclastic rocks that crop out in scattered locations at the base of the Western Cascade Tertiary volcanic sequence in the Medford quadrangle. Wells (1956) designated an area near the town of Colestin along the California-Oregon border as the type area of the Colestin Formation. Lava flows overlying these volcaniclastic rocks were assigned to the Little Butte Volcanic Series, the base of which is represented in the Ashland-Medford area by the Oligocene Roxy Formation (Wells, 1956). The base of the Little Butte Volcanic Series was defined by Wells (1956) as the stratigraphically first 100-ft-thick lava flow in the Tertiary volcanic rocks of the Western Cascades. Peck and others (1964) used Wells' (1956) Colestin and Little Butte divisions of the Tertiary volcanic rocks and mapped them to the north of the Medford quadrangle in the central Oregon Cascades.

Carlton (1972) completed a petrographic and stratigraphic study of the Colestin Formation in the Siskiyou Pass-Colestin area and also studied the formation to the south in northern California. Carlton (1972) followed Wells' (1956) Little Butte/Colestin boundary but apparently did not map any lithologic units in the Colestin Formation.

LITHOSTRATIGRAPHIC UNITS OF THE COLESTIN FORMATION

In its type area, the Colestin Formation can be divided into nine informal members that consist predominantly of one of the following lithologic types: (1) volcaniclastic conglomerates and sandstones with clasts of andesitic and basaltic composition, (2) rhyolitic tuffaceous sandstones and tuffs, and (3) basaltic and andesitic lava flow sequences. These members pinch out and interfinger with each other and are largely contained in a northeast-southwest-trending graben (Figure 3). The graben is bounded to the north by the Siskiyou Summit fault and is more diffusely bounded to the south by a series of east-west faults in the Oregon-California border area. Syndepositional graben faulting may have been widespread during deposition of the Colestin Formation and could explain the general thickening of most members toward the Siskiyou Summit fault.

Member Tcc

A basal fluvial conglomerate tens of meters in thickness rests with angular discordance on the Hornbrook Formation in most of the study area. The unit is poorly consolidated and poorly sorted and contains cobbles and boulders of andesitic and basaltic lava flow fragments (volcanic epiclasts of Fisher, 1966) and minor amounts of quartzite and argillite cobbles. Overlying the basal conglomerate is a ledge-forming, matrix-supported volcanic breccia unit (lahar) that is up to 20 m thick. The laharic unit contains altered and unaltered cobbles and boulders of basalt and andesite in a matrix of coarse sand. To the south, this member pinches out, and the overlying member Tcft rests on the Cretaceous Hornbrook Formation.

Member Tcft

A pyroclastic flow sequence up to 250 m thick is here informally referred to as the tuff of Chocolate Falls for exposures along Chocolate Falls Creek. The base of the tuff of Chocolate Falls consists of a lithic-rich pumice lapilli tuff. The bulk of the tuff of Chocolate Falls consists of tan crystal and pumice tuff with abundant white medium-grained plagioclase crystals and yellow pumice lapilli that are slightly elongated parallel to bedding. Most of the tuff is welded to varying degrees, and some parts display vapor phase alteration and devitrification textures. A dark-gray vitrophyre is locally present in the stratigraphic middle of the tuff sequence. This vitrophyre has an obsidianlike appearance where it is well developed.

Member Tclb

The lower basaltic member consists of basaltic and andesitic lava flows and can be divided into two parts (Figure 3). The lower sequence is interbedded with the upper part of the tuff of Chocolate Falls, and the upper sequence overlies the tuff. These lava flow units cap most of the ridges and form dip slopes in the upper Cottonwood Valley area. The lavas consist predominantly of plagioclase and pyroxene-phyric basaltic andesites.

Member Tc

Member Tc is an undifferentiated sequence of poorly consolidated volcanic debris flows, andesitic flow breccia, weathered volcanic siltstone, and volcaniclastic sandstone. The unit crops out very poorly and in some roadcuts resembles Quaternary colluvium or landslide debris.

Member Tcl

Member Tcl is a heterogeneous collection of lithologic units that are well exposed in Interstate 5 and Highway 99 roadcuts along the south side of Siskiyou Pass. The base of the member is defined by a white pumice lapilli tuff that forms white, ashy-looking outcrops where it is poorly welded and tan flaggy outcrops where it is welded (Figure 4). The tuff contains fine-grained brown biotite and a small amount of carbonized plant debris and has a slightly eutaxitic foliation.

Above the pumice lapilli tuff is a 10-m-thick sequence of tuffaceous sandstones and siltstones (Figure 5). Upward in this sequence of sandstones, the amount of tuffaceous material gradually decreases in favor of lava flow fragments. The tuffaceous sandstones grade upward into a 40-m-thick sequence of massive to crudely bedded brown sandstones composed of volcanic epiclastic debris (lava flow

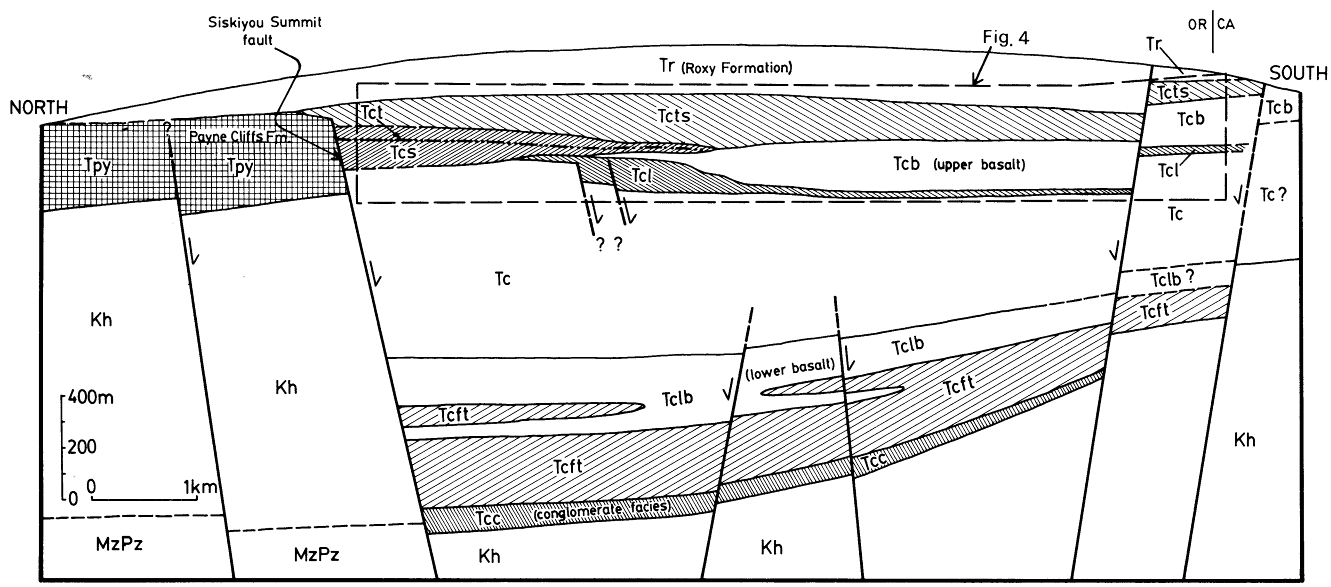

Figure 3. Composite cross section along strike of the Colestin Formation and Payne Cliffs formation. The area of Figure 4 is outlined with dashed lines.

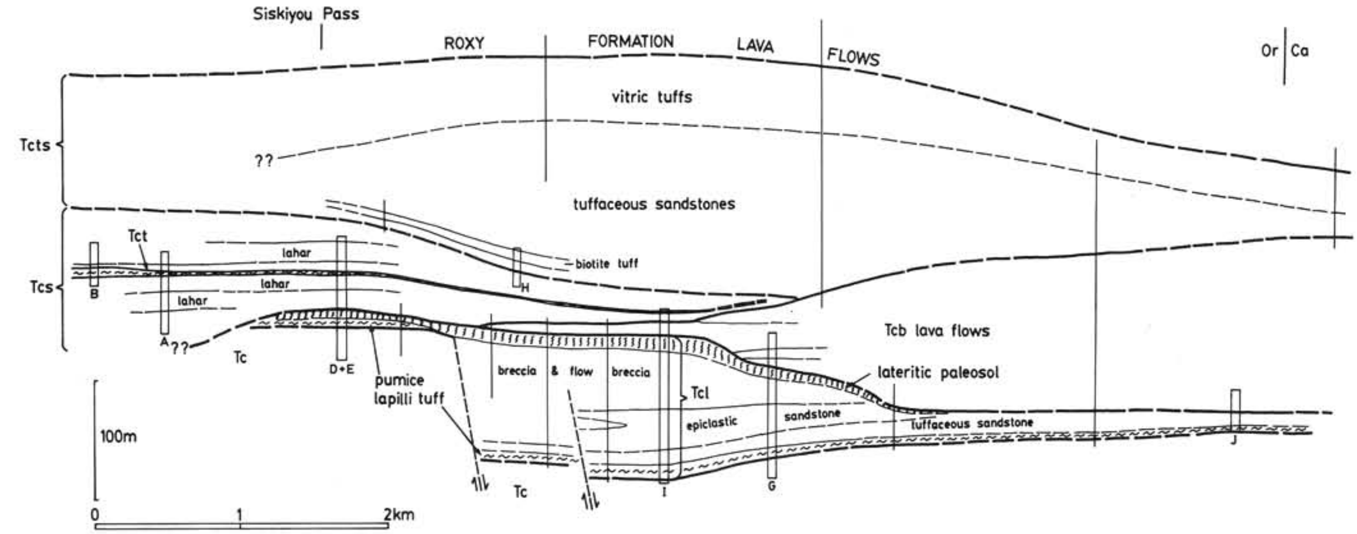

Figure 4. Stratigraphy of informal members Tcl, Tcb, Tcs, and Tcts in the upper part of the Colestin Formation between Siskiyou Pass and the Oregon-California border. Lettered rectangles are detailed measured sections, and vertical lines are well-exposed sections that were measured approximately (from Bestland, 1985b).

fragments). In the Interstate 5 roadcuts, this unit contains numerous dark-colored strips and spots, with the strips being on the order of 1-3 m long and 10-30 cm wide. Many of the strips and spots form halos around carbonized branches. Petrographic examination reveals that the dark coloration is due to pervasive chlorite cement.

Overlying the massive sandstones is a unit of unconsolidated andesitic boulder breccia that is up to 50 m thick. Scattered throughout this unit is andesitic flow breccia. Capping the boulder breccia is a weathered horizon that is locally up to 10 m thick. The weathered origin for this clayey siltstone is indicated by a gradation in clast alteration from largely unaltered clasts in the underlying breccia to a saprolite and up into a red clayey siltstone with well-developed ped structures and root traces. A chemical analysis (atomic absorption) of a red bricklike horizon in the paleosol (Figure 6) gave a composition of 26 percent Fe_2O_3, 47 percent SiO_2, and 9.5 percent Al_2O_3.

Member Tcb

Basaltic and andesitic lava flows of member Tcb rest on the paleosol of member Tcl and pinch out to the north between members Tcl and Tcs (Figure 4). A 30-Ma age of a lava flow in this member was determined by Sutter (1978). The unit forms dip slopes and scattered cliffy outcrops. Member Tcb thickens abruptly to the south, whereas member Tcl thins abruptly to the south. Paleosols, consisting of red and white silty claystone with well-developed ped structures, overlie the altered tops of lava flows in member Tcb along Highway 99, 2 km south of Siskiyou Pass. Near the California-Oregon border, member Tcb is approximately 200 m thick.

Member Tcs

Member Tcs, which consists of volcanic epiclastic sandstones, conglomerates, and lahars of andesitic and basaltic composition, is well exposed in roadcuts on Interstate 5 and Highway 99 along Siskiyou Pass. Channelized conglomerates and sandstones are common in this unit. Channel orientations and rare cobble imbrication in these deposits indicate a paleocurrent direction to the southwest. To the south of Siskiyou Pass and paralleling Highway 99, member Tcs pinches out between members Tcb and Tcts.

Many of the matrix-supported boulder and cobble lahar units grade upward into clast-supported, discontinuously bedded, pebbly conglomerates and granular sandstones (Figures 7, 8, and 9). The bedding in these conglomerates is produced by size variation and grading of the sand and gravel. These types of bedded, clast-supported conglomerates are termed "hyperconcentrated flood flow deposits" by Smith (1986) and are thought to represent a type of flow that is intermediate between the en-masse flow of laharic debris flows and normal fluvial flow.

Member Tct

A distinctive white crystal tuff is sandwiched between the darker colored volcaniclastic sandstones and conglomerates of member Tcs. This unit was mapped separately as member Tct (Figure 10). The tuff has a maximum thickness of 10 m in the northern part of its outcrop area and thins abruptly to the south. Lapilli-sized carbonized plant fragments are abundant and are generally aligned subparallel to bedding, as are the numerous plagioclase and quartz crystals. Petrographic examination of the vitric matrix of the tuff indicates that the glass shards are weakly welded and almost completely altered to zeolites (heulandite and clinoptilolite). Scanning electron microscope examination of the carbonized plant material reveals it to be composed of charcoalized wood fragments. Charcoal is in-

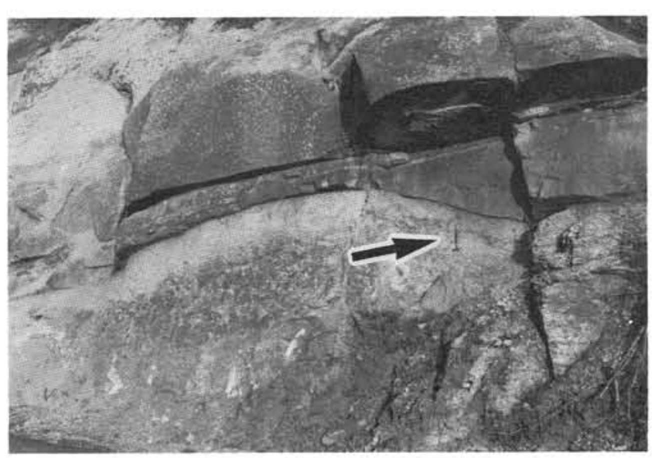

Figure 5. Roadcut along Highway 99, 2½ mi south of Siskiyou Pass, exposing the pumice lapilli tuff that marks the base of informal member Tcl. The pumice tuff is cut by a channel containing coarse, well-cemented tuffaceous sandstone. Hammer (see arrow) is just under the channel-pumice tuff contact.

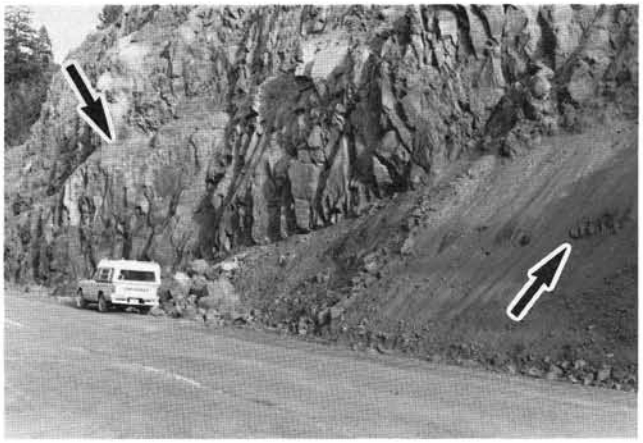

Figure 6. Roadcut along Highway 99, 2 mi south of Siskiyou Pass, exposing contact between the paleosol at the top of informal member Tcl and lava flows of informal member Tcb. Arrow on right side points to bricklike ferruginous horizon in paleosol; arrow on left side points to red paleosol interbed between lava flows.

dicated by fused and distorted cell walls and results from incomplete burning at a minimum temperature of around 290 °C (Cope and Chaloner, 1980).

Member Tcts

This member consists of approximately 250 m of tuffaceous sandstones, siltstones, and intercalated vitric and pumiceous tuffs. The unit as a whole is light colored and, compared to other Colestin units, is finer grained and less well exposed. The white vitric tuff and the underlying tuffaceous sandstones of member Tcts are tentatively correlated with Vance's (1984) Soda Springs member (J. Vance, personal communication, 1984), which Vance (1984) dated at 27 Ma.

A stratigraphic sequence consisting of lacustrine tuffaceous claystones, organic-rich layers with tuffaceous claystones, and welded pumice lapilli ignimbrite is exposed along Beacon Rock. The light-pink pumice lapilli tuff has a well-defined eutaxitic foliation and abundant biotite, feldspar, and quartz crystals in a welded vitric groundmass.

Capping the sequence of tuffaceous sandstones is a distinctive

Figure 7. Roadcut along Highway 99, half a mile north of Siskiyou Pass, exposing an indistinctly planar bedded granular sandstone-pebbly conglomerate sequence (informal member Tcs) that grades down into the matrix-supported volcanic breccia shown in Figure 9. Arrow points to the coarse-grained basal layer of the light-colored unit that is the white crystal tuff (informal member Tct). Outcrop is approximately 10 m thick.

Figure 8. Closeup of poorly sorted, granular sandstones (informal member Tcs) of Figure 7 that are interpreted as hyperconcentrated flood flow deposits.

white vitric tuff. The most widespread tuff has a brilliant white color and contains sparse plagioclase crystals and pumice lapilli in an unwelded vitric groundmass. Associated with this tuff is a light-gray welded and locally lithophysal tuff containing sparse, altered feldspar crystals. The gray tuff represents a welded part of the capping white tuff.

The capping white vitric tuff can be traced throughout the map area. It overlies the Siskiyou Summit fault on the west side of Buck Rock with no apparent offset. This relationship demonstrates that movement of the Siskiyou Summit fault, at least in this area, ended before deposition of this tuff.

PAYNE CLIFFS FORMATION

A discussion of the Colestin Formation is not complete without mention of the closely related Payne Cliffs formation (informally named by McKnight, 1971, 1984). North of the Siskiyou Summit fault in the Ashland-Medford area, the upper Eocene Payne Cliffs formation of McKnight (1971, 1984) lies at the base of the Teritary sequence; south of the fault, however, the Colestin Formation lies at the base of the Tertiary section. The outcrop extent of the Payne Cliffs formation thins to the south and ends at the Siskiyou Summit fault (Figure 2). The stratigraphic relations between the Payne Cliffs formation and the Colestin Formation are not well understood. The upper volcaniclastic part of the Payne Cliffs formation may be coeval with some part of the Colestin Formation; however, the exact correlation is not known.

Figure 9. Closeup of matrix-supported volcanic breccia (lahar; informal member Tcs) that grades up into the granular sandstones of Figure 8.

The formation consists predominantly of arkosic and micaceous sandstones and conglomerates with quartzite, argillite, metamorphic, and granitic clasts. The upper part of the formation is dominated by volcaniclastic material. McKnight (1971, 1984) has identified a gradation from arkosic and micaceous sandstones and conglomerates in the lower part of the Payne Cliffs formation to volcaniclastic and tuffaceous sandstones, conglomerates, and siltstones in the upper part of the formation. The volcaniclastic deposits at the very top of the formation examined in this study can be grouped into those with and those without muscovite. The Colestin Formation does not contain muscovite in any quantity. Abundant muscovite in Payne Cliffs volcaniclastic material indicates that north of the Siskiyou Summit fault, Cascade material was mixed with Klamath Mountain detritus. The volcaniclastic deposits without muscovite are very similar in composition, color, grain size, and sorting to many of the sandstones in the Colestin Formation. However, none of the members recognized in the Colestin Formation were identified in the upper volcaniclastic part of the Payne Cliffs formation.

The arkosic sandstones and conglomerates were deposited by a northward-flowing braided river system (McKnight, 1971, 1984). During deposition of the Payne Cliffs formation, an uplifted source area was present to the south in the Klamath Mountains (McKnight, 1971, 1984). A southern source area is indicated from the northward-dipping paleoslope and northward thickening of the formation (McKnight, 1971, 1984). The problem is: What happened to the formation in the Siskiyou Summit area? One interpretation is that the Payne Cliffs formation was deposited in the Siskiyou Summit area, which was subsequently uplifted, causing the formation to be eroded. This interpretation fits with the thinning of the Payne Cliffs formation to the south, which could have resulted from beveling of the formation during uplift. During deposition of the Colestin Formation, however, the area south of the Siskiyou Summit fault was downfaulted, thereby containing Colestin detritus. Therefore, a reversal of movement is indicated for the Siskiyou Pass area, with uplift occurring during the deposition of the Payne Cliffs formation and downfaulting occurring during Colestin deposition.

COLESTIN-ROXY FORMATION BOUNDARY

The Roxy Formation in the study area consists predominantly of dark-colored, dense plagioclase-phyric pyroxene basalts and andesites and only minor amounts of volcaniclastic and pyroclastic deposits. These lava flows cap ridges and form prominent dip slopes around Pilot Rock. Many landslides originate at the contact between the tuffs of member Tcts and the overlying basalts. Area strike and dip measurements using photogrammetric techniques (Ray, 1960) indicate that a slight angular discordance exists, at least locally, between these lava flows and the underlying Colestin Formation units (Figure 2).

Figure 10. Roadcut along the east side of Siskiyou Summit on Interstate 5, exposing a channel cut into volcanic conglomerates and breccia of informal member Tcs that is filled by the white crystal tuff (informal member Tct). Arrow points to carbonized plant debris in informal member Tct.

The boundary between the Colestin and Roxy Formations by the author (Bestland, 1985a,b) and in this report differs from the boundary mapped by Wells (1956), Carlton (1972), and Smith and Page (1977). The boundary between the Little Butte Volcanic Series and the Colestin Formation was defined by Wells (1956) as being the stratigraphically first 100-ft-thick lava flow. In the Siskiyou Pass area, the boundary between the Colestin Formation and the Little Butte Volcanic Series is recognized in this study to be at the contact of the white tuffs of member Tcts and the prominent cliff-forming basaltic lava flows designated as Roxy Formation. Volcanic strata previously assigned to the basal Roxy Formation by Wells (1956) consist chiefly of volcaniclastic and pyroclastic rocks. The lithology of these rocks is consistent with Wells' (1956) original designation that the Colestin Formation consists predominantly of volcaniclastic and pyroclastic deposits.

Wells' (1956) Colestin-Little Butte Volcanic Series boundary was mapped by previous workers at the base of member Tcb. The stratigraphic findings of this study demonstrate that the lava flows of member Tcb pinch out to the north between volcaniclastic deposits of Colestin members Tcl and Tcs (Figure 4). In the area of this pinch-out, previous workers have mapped a fault between the lava flows of member Tcb and the volcaniclastic rocks of members Tcl and Tcs (Elliott, 1971; Carlton 1972; Smith and Page, 1977; Smith and others, 1982). A thick paleosol horizon can be traced across the pinch-out of member Tcb. Syndepositional faults are located in the vicinity of the pinch-out of member Tcb. These faults cut member Tcl but do not noticeably offset the overlying members Tcs and Tct (Figure 4).

Future work on the lower parts of the Tertiary volcanic sequence in northern California may reveal that members Tcb, Tcs, and Tcts are of formational extent. Additional mapping to the south of the California border is needed to substantiate this suggestion and would hinge on whether the pronounced disconformity, represented by the strongly ferruginized paleosol, can be traced to the south.

DISCUSSION

Volcanic apron facies

The depositional environment of the Colestin Formation was interpreted on the basis of detailed stratigraphic and sedimentological work on the upper part of the formation (Bestland and Boggs, 1985). This work has resolved many of the lateral stratigraphic problems in a north-south direction (Figure 4). Unfortunately, proximal-distal facies relationships are not obvious because the source area for the Colestin deposits was located to the east of the formation's north-south outcrop pattern. Volcaniclastic deposits and facies models studied by other workers can be compared to the sedimentary structures and textures and the stratigraphic relationships of the Colestin deposits.

Volcaniclastic facies models that relate the relative distance from a volcanic center(s) have been made by Swanson (1966), Parsons (1969), Smedes and Prostka (1972), and Vessell and Davies (1981). The term "volcaniclastic apron facies" was developed from these studies and refers to volcaniclastic deposits that encircle, or partially encircle, volcanic centers of the stratovolcano type. The apron facies is analogous to an alluvial fan facies in coarseness of deposits and proximity to source area.

The lithology and sedimentary characteristics of the members in the upper part of the Colestin Formation compare well to the medial volcaniclastic facies of Vessell and Davies (1981) and to the coarse alluvial facies of Smedes and Prostka (1972). Distinctive characteristics recognized in the upper Colestin deposits that are indicative of apron facies aside from the coarseness, poor sorting, and high angularity of the clasts include well-developed channels, scarcity of fine-grained deposits, and lateral facies variations that delineate distinctive sequences composing the apron. Numerous large channels are present and are commonly filled with poorly sorted to unsorted conglomerate and sandstone. The channels lack lateral channel migration structures, and some appear to have been cut and filled during the same flood event.

Depositional reconstruction of the upper Colestin Formation

Members Tcl, Tcs, and Tcts represent three volcanic sequences of the apron that were developed adjacent to volcanic centers situated to the east along the Oligocene Cascade arc (Figure 11). Member Tcl accumulated in a small graben that was orientated roughly east-west. Syndepositional graben faulting complicated the stratigraphy and produced a local, but thick, accumulation of volcanic sandstones and breccia. After the small graben was filled, a prolonged period of nondeposition (volcanic quiescence) and weathering followed, producing the paleosol that caps member Tcl.

Effusive basaltic and andesitic volcanism followed the volcanic hiatus. These lava flows of member Tcb lap onto member Tcl to the north and thicken considerably to the southeast. Member Tcb lavas can be interpreted as valley fill or as the flank of a shield volcano. Because member Tcb thickens dramatically to the south and is onlapped to the north by member Tcs, member Tcb is interpreted as the flank of a shield volcano.

Weathering and soil formation on the upper surface of member Tcb was followed by andesitic volcanism of member Tcs. This volcanism produced the andesitic debris contained in the lahars and pebbly sandstones of member Tcs. The volcanic center that produced member Tcs was located to the northeast of the map area (Figure 11). This interpretation is indicated by the thickening of member Tcs to the north, the lapping of member Tcs onto member Tcb, and the southwest-northeast channel orientations in this unit.

Member Tcts represents a large alluvial apron that consists almost totally of rhyolitic pyroclastic debris of both ignimbrite and waterlain origin. The unit consists of sand-sized material and is distinctly finer grained than other Colestin deposits. The grain size could represent a more distal source compared to other Colestin units, but the sediment size probably reflects the grain size of the original pyroclastic material. The pyroclastic volcanism of member Tcts ended abruptly and was followed by effusive basaltic volcanism of the Roxy Formation lava flows.

SUMMARY AND CONCLUSIONS

Each lithostratigraphic unit of the Colestin Formation records a distinct episode of volcanism both in the composition of the volcanic products and in the mode of volcaniclastic deposition. Andesitic and basaltic volcanism generated largely effusive volcanic products, which, in turn, were the source material for boulder and cobble debris flows and pebbly hyperconcentrated flood flows. Rhyolitic pyroclastic volcanism produced easily erodible material that was deposited on the alluvial aprons by sandy stream floods and pyroclastic flows.

The rapid lateral facies changes that are ubiquitous in the Colestin Formation developed from deposition around active volcanoes. The lobelike depositional pattern of the members reflects the episodic nature of volcanic eruptions and the shifting of activity between volcanoes along the arc. Rapid erosion of erupted material from steep flanks of volcanoes produced rapid deposition on the alluvial apron. Between periods of deposition, the alluvial apron was eroded and weathered. Another factor that further complicated the stratigraphic interpretation was the syndepositional faulting that occurred during the aggradation of the apron. All of these factors produced a complex local stratigraphy that was worked out by field tracing of marker units (pyroclastic flows, lava flow sequences, and paleosols) and mapping of lithologic units.

All of the members, except member Tcl, are compositionally uniform. They are either rhyolitic tuffs and tuffaceous sediments or basalt-basaltic andesite lava flows and/or lahars. The observation that the members are either rhyolitic or basaltic and andesitic agrees with Lowenstern's (1986) geochemical data, which give a roughly bimodal chemical distribution for the Colestin lava flows and tuffs.

The syndepositional east-west faulting in the Colestin Formation may be widespread in the Western Cascades of southern Oregon.

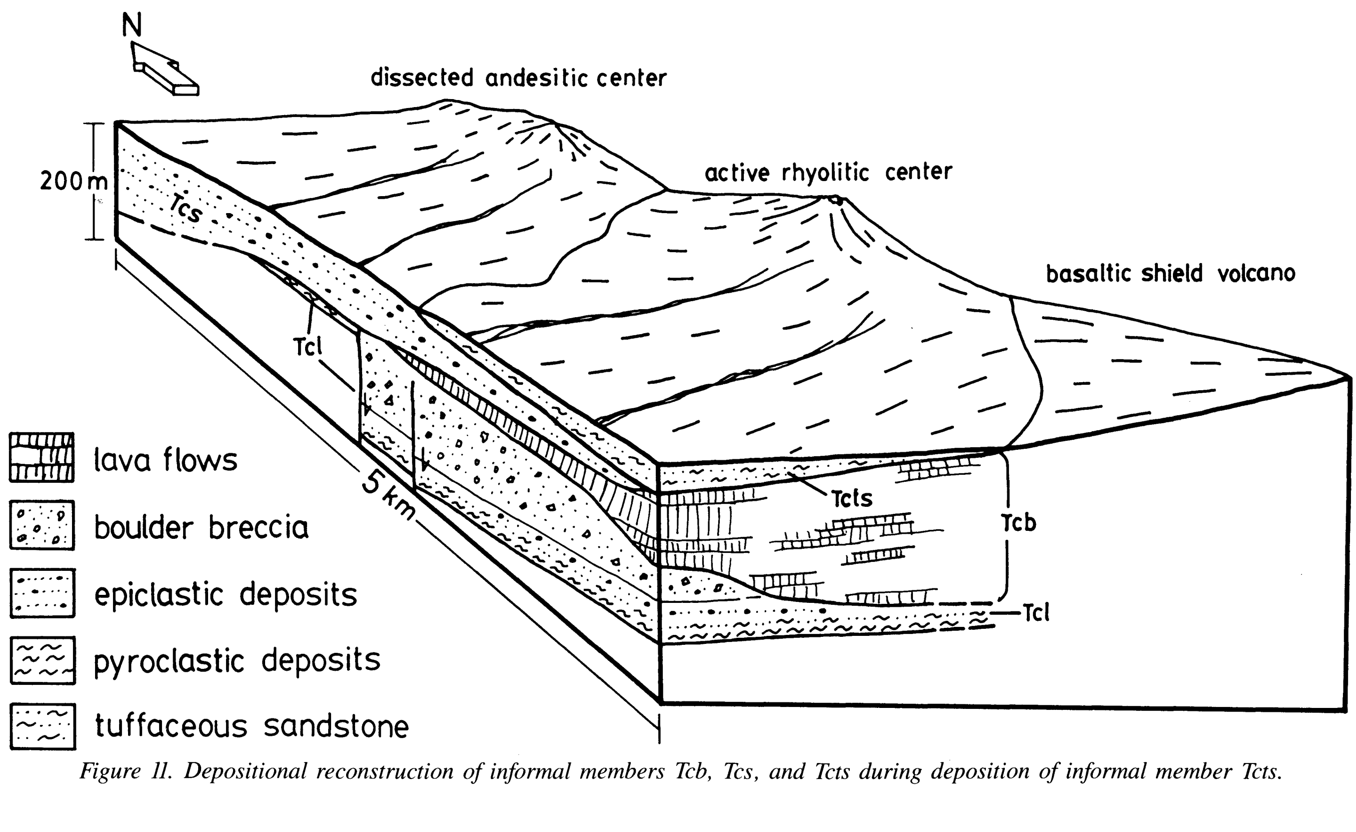

Figure 11. Depositional reconstruction of informal members Tcb, Tcs, and Tcts during deposition of informal member Tcts.

A regional north-south extensional stress, which formed east-west-trending grabens, could explain the pattern of basaltic and rhyolitic rocks at the base of the Western Cascades that is present to the north of the type area of the Colestin Formation. North of the Siskiyou Summit fault, a thick sequence of basaltic lava flows is present at the base of the Western Cascades (Roxy Formation). To the north of these basalts, however, a thick sequence of rhyolitic pyroclastic rocks, principally, the Bond Creek ignimbrite of Smith and others (1980), occurs at the base of the Western Cascades. These relations suggest that a regional east-west tectonic stress influenced the initial character of volcanism in the Western Cascades of southern Oregon. On the other hand, the graben faulting in the Colestin area may be the result of the uplift of the Klamath block and not related to this lithologic pattern at the base of the Western Cascades.

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Produced in cooperation with GeoRef, the computerized information system of the American Geological Institute, the 176-page document continues the periodic additions to the original 1936 work by R.C. Treasher and E.T. Hodge. The bibliography contains an author list with approximately 2,200 titles for the period of 1980 through 1984 and cross-references these entries in subject, county, and rock formation indexes.

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