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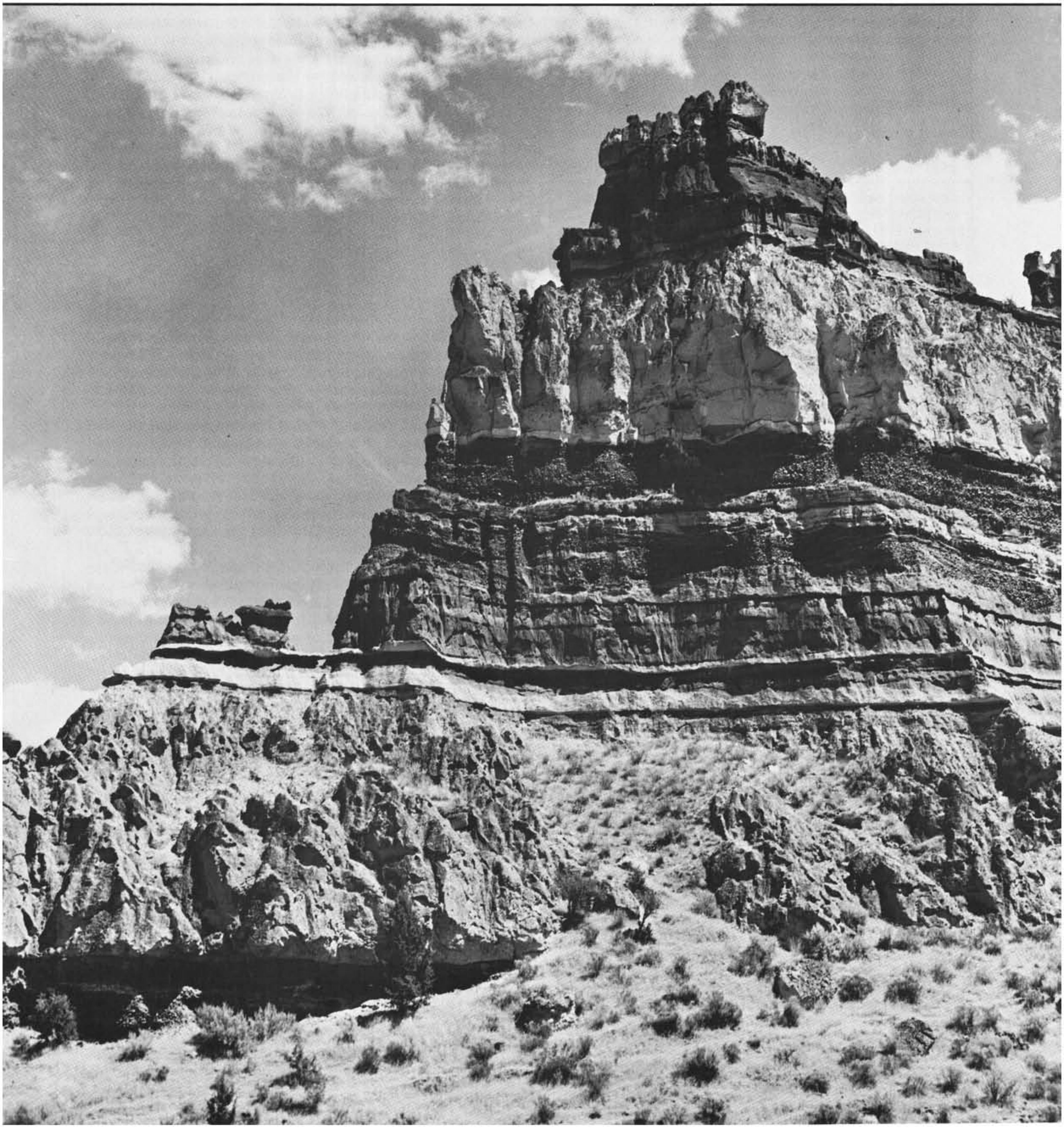

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COVER PHOTO

Part of the Deschutes Formation of the newly-defined Dalles Group exposed at the Island, Cove Palisades State Park, west of Madras, Oregon. Light-colored rocks are ash-flow tuffs, medium-gray unit at the base is a lahar, capping rock is a basalt, and dark units containing numerous small rounded rocks are gravel deposits. The Dalles Group and its five formations are discussed in the article beginning on the next page. Photo courtesy Oregon State Highway Division.

DOGAMI releases mid-Willamette Valley geologic maps

New five-color geologic maps for the mid-Willamette Valley between West Salem and Buena Vista have been released by the Oregon Department of Geology and Mineral Industries (DOGAMI).

The Department announces the publication of map set GMS-18 in its Geological Map Series, entitled *Geology of the Rickreall, Salem West, Monmouth, and Sidney 7½-minute Quadrangles, Marion, Polk, and Linn Counties, Oregon*, by DOGAMI Geologist James L. Bela.

The study area includes the area covered by the Salem 15-minute quadrangle and for these maps is divided into two sections; the northern portion is covered by the Rickreall and Salem West 7½-minute quadrangle maps, and the southern part by the Sidney and Monmouth 7½-minute quadrangle maps. The maps show thirteen surficial and bedrock geologic units, major lineaments, locations of abandoned oil and gas wells, and landslides.

Geologic map set GMS-18 is now available at the DOGAMI Office, 1005 State Office Building, Portland, OR 97201. The purchase price is $5.00. Payment must accompany orders of less than $20.00. □

Dallas Peck new Director of USGS

On September 18, 1981, the United States Senate confirmed the appointment of Dallas L. Peck as the new Director of the U.S. Geological Survey (USGS). With this action, Peck became the 11th Director of the 101-year-old USGS, succeeding H. William Menard, who resigned in January 1981.

Peck, 52, is a native of Cheney, Washington, and attended the public schools of Spokane, Washington. He received formal training in geology at California Institute of Technology (B.S. with honors, 1951, and M.S., 1953) and Harvard (Ph.D., 1960). He joined the USGS in 1951, and much of his career has been involved in geological and geothermal energy studies in the West, including field research at the USGS Hawaiian Volcano Observatory.

In 1977, Peck was named Chief Geologist and head of the USGS Geologic Division. Special assignments have included serving as U.S. member of special scientific delegations to the Soviet Union, Great Britain, Italy, Iceland, New Zealand, and Japan. Peck is the author of more than 50 scientific reports and publications; in recognition of his research efforts, he was awarded the Department of Interior's Meritorious Service Award in 1970. His leadership as Chief Geologist earned him the Department's highest award, the Distinguished Service Award, in 1979, and the Presidential Meritorious Executive Award in 1980. □

CONTENTS

Dalles Group: Neogene formations overlying the Columbia River Basalt Group in north-central Oregon

by Saleem M. Farooqui,[1] *John D. Beaulieu,*[2] *Russell C. Bunker,*[1] *Donald E. Stensland,*[3] *and Richard E. Thoms*[4]

Neogene sedimentary rocks lying above the Columbia River Basalt Group in north-central Oregon have been the subject of geologic study for over 100 years, including a full range of regional treatments, quadrangle maps, and detailed siting studies. The accumulated knowledge of this past work and the accelerated pace of geologic study in the area point to the need for a more coherent geologic synthesis of the Neogene deposits in order to improve communication, to enhance present understanding of the area, and to provide for more effective stratigraphic problem solving in the future.

Recently completed reconnaissance mapping (Farooqui and others, 1981) performed for Rockwell-Hanford Operations under contract to the U.S. Department of Energy provided a unique opportunity for the Oregon Department of Geology and Mineral Industries (DOGAMI) to develop the needed synthesis. The consistent stratigraphic framework arising from this effort is the basis for the formal establishment here of five formations and the elevation of the former Dalles Formation to group status.

—John D. Beaulieu, Deputy State Gologist, Oregon Department of Geology and Mineral Industries

ABSTRACT

Five discrete, mappable Miocene-Pliocene (Neogene) deposits occur north of the Blue Mountains in Oregon. Because these deposits have been variously mapped and referred to in the literature, conflicting and confusing nomenclature has developed. Using the lithologies, mappability, age and contact relationships, historic priorities and usage, and geographic separation of these deposits, we are formally defining five discrete formations: the Chenoweth, Tygh Valley, Deschutes, Alkali Canyon, and McKay Formations. Many of these formations have been mapped historically as the Dalles Formation, which we propose to raise to group rank. The Chenoweth, Tygh Valley, and Deschutes Formations contain chiefly volcaniclastic and volcanic rocks and are confined to The Dalles, Tygh, and Madras basins, respectively. The Alkali Canyon and McKay Formations contain chiefly epiclastic rocks and are confined to the Arlington and Agency basins, respectively.

The Dalles Group is middle Miocene to early Pliocene in age and overlies the Columbia River Basalt Group. The elevation of the Dalles Formation to a group status does not prejudge the situation outside the area of northeastern Oregon.

INTRODUCTION

In the literature the name Dalles Formation has been applied to indurated Neogene[5] epiclastic, pyroclastic, and volcaniclastic deposits and minor basalt flows overlying the Columbia River Basalt Group of Swanson and others (1979) in north-central Oregon on the north side of the Blue Mountains between the Cascade Range on the west and longitude 118° W. on the east. The deposits occur in geographically isolated basins (Figure 1), namely The Dalles, Tygh, Madras, Arlington, and Agency basins (Farooqui and others, 1981), that have developed chiefly in the Columbia River Basalt Group. The basins are defined by broad, flat-bottomed, singly or doubly plunging synclines that acted as depositional basins for the Neogene deposits. The Dalles, Tygh, and Madras basins are filled primarily with volcaniclastic sediment derived from the ancestral Cascade Range volcanoes. The Arlington and Agency basins are filled chiefly with epiclastic sediment derived from the northern flank of the Blue Mountains.

Although the deposits in these basins have been given many names, the Dalles Formation has been the name most commonly applied. Because the many names make present nomenclature confusing and stratigraphic interpretation unnecessarily difficult, we believe that a systematic rock-stratigraphic nomenclature is desirable. A recent assessment of the Neogene stratigraphy of north-central Oregon (Farooqui and others, 1981), coupled with previously published data, has allowed us to raise the Dalles Formation to group status and to formally assign five discrete formations to the group. This paper reviews the history of the Dalles Formation nomenclature, explains the basis for the revision in stratigraphic rank, and describes its constituent formations.

REVIEW OF STRATIGRAPHIC NOMENCLATURE

Condon's "Dalles Group" (Condon, 1874; Cope, 1880; and McCornack, 1928) was briefly studied by Knowlton (1902), Williams (1916), Collier (1916), Bretz (1917, 1921), and Buwalda and Moore (1929, 1930). Piper (1932) mapped the "Group" as the Dalles formation, suggesting it was approximately correlative with the Ellensburg formation of Smith (1903) and Mascall formation of Merriam (1901).

Newcomb (1966, 1969) formalized the Dalles Formation and extended it eastward from The Dalles to the Arlington area. He discarded the name "Shutler formation," which had been applied earlier to the supra-basalt deposits in the Arlington area (Hodge, 1941), because of its stratigraphic and lithologic ambiguity. Newcomb (1971) and Shannon and Wilson (1971, 1972, 1975a,b, 1981) demonstrated that the Dalles Formation overlies both the Columbia River Basalt Group and also the Rattlesnake and Selah members of the Ellensburg Formation of Schmincke (1964) where they project beyond the edges of overlying basalt flows of the Columbia River Basalt Group (Swanson and others, 1979). Because of lithologic similarities, Shannon and Wilson (1972) extended the Dalles

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[2] Oregon Department of Geology and Mineral Industries, Portland, Oregon.
[3] Southwestern Community College, Coos Bay, Oregon.
[4] Portland State University, Portland, Oregon.
[5] The Neogene includes the Miocene and Pliocene Epochs. Age assignment of the epoch boundaries is based on Berggren and van Couvering (1974), who revised the time boundaries between the Miocene-Pliocene and Pliocene-Pleistocene to 5.0 and 1.8 m.y., respectively. This revision, adopted by the U.S. Geological Survey (Sohl and Wright, 1978), is followed in this paper.

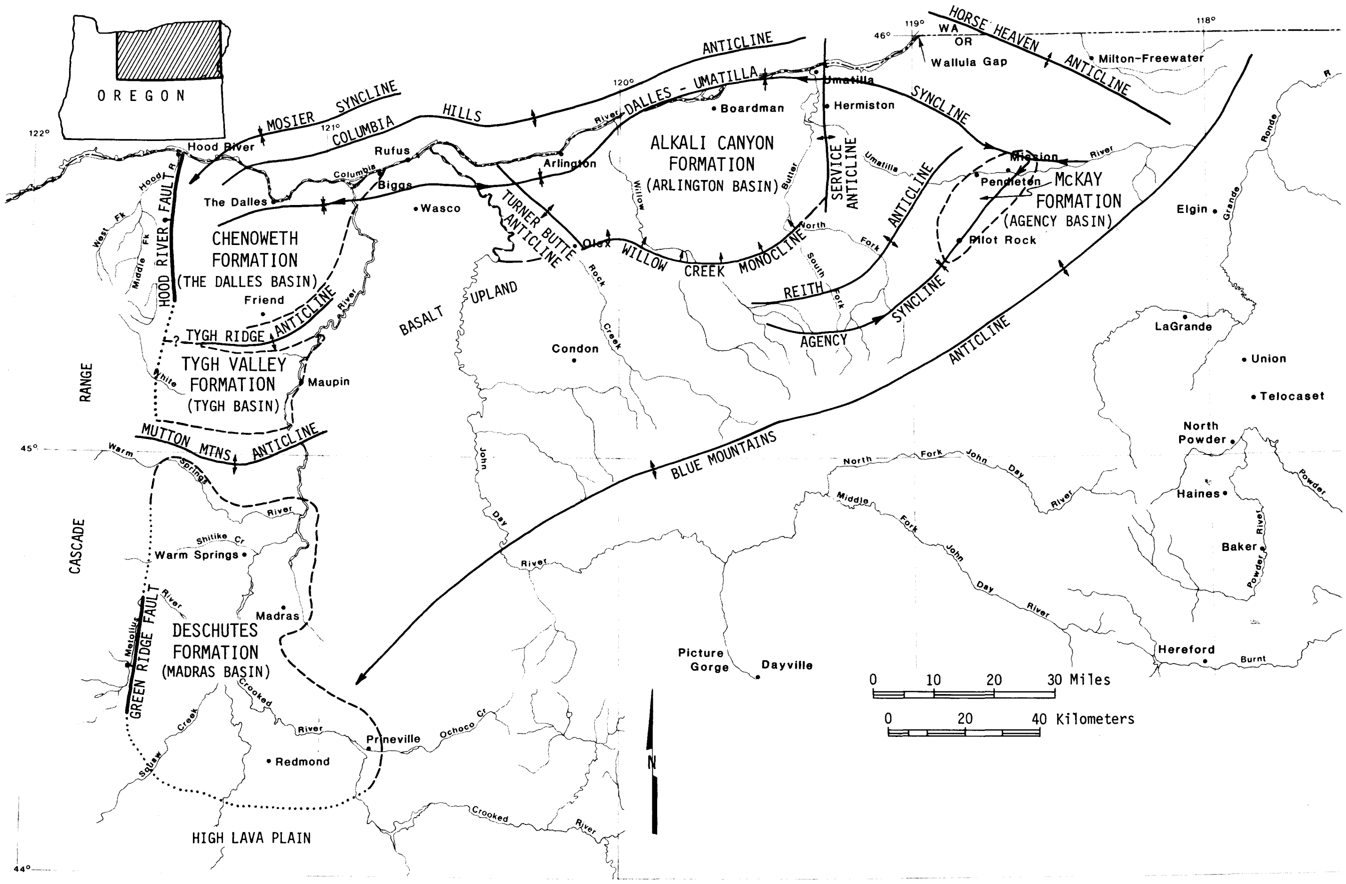

Figure 1. Generalized locations of the formations of the Dalles Group and their depositional basins.

Formation eastward from Arlington to the Boardman and Pendleton-Pilot Rock areas so as to include the fanglomerate of Hogenson (1964) and "McKay beds" of Shotwell (1956).

Hodge (1941) extended his Dalles formation south of The Dalles to latitude 44° N. He also mapped a fault sliver along the south flank of Tygh Ridge as John Day Formation. This sliver was mapped as part of the Mascall Formation by Wells and Peck (1961) and as Ellensburg Formation by Waters (1968b). Waters (1968a,b) also mapped the Dalles Formation in Tygh Valley and near Madras.

Use of the name Dalles in stratigraphic nomenclature for the Madras area has a history independent of that for the Dalles Formation at The Dalles and to the east. Russell (1905) called the heterogeneous assemblage of sediments, ash-flow tuffs, and lava flows exposed in the Deschutes and Crooked River Canyons the "Deschutes sands." Stearns (1930) termed these rocks the Deschutes formation. Hodge (1928, 1940) named similar rocks near Madras the Madras formation, but later (Hodge, 1942) called them Dalles formation. Williams (1957), Robinson and Price (1963), and Robinson and Stensland (1979) also used the name Madras Formation for these deposits, but Waters (1968a), Robinson (1975), and Robison and Laenen (1976) used the name Dalles Formation. Stensland (1970), Peterson and others (1976), and Taylor (1980) also used the name Deschutes Formation, citing its priority.

BASIS FOR REVISION OF STRATIGRAPHIC NOMENCLATURE

The Dalles Group is formally proposed for stratigraphic units in Oregon historically referred to as the Dalles Formation that either overlie the Columbia River Basalt Group or can be demonstrated laterally to overlie it. This name conforms to the provisions of the Code of Stratigraphic Nomenclature (American Commission on Stratigraphic Nomenclature, 1970), does not prejudge the situation outside the area, and follows many decades of work in Oregon.

Data now are sufficient to elevate the Dalles Formation formally to group status and to identify its constituent units (formerly, in part, collectively termed the Dalles Formation) as related but distinctly mappable formations. Each formation is sufficiently unique to permit its mapping as a geographically discrete unit. The Dalles Group is confined to The Dalles, Arlington, Boardman, Pendleton, Pilot Rock, Tygh Valley, Madras, and Redmond areas, where the name Dalles was used previously.

The Dalles Group is characterized as follows:

1. The Dalles Group is composed of five discrete, mappable formations. Some of the formations may originally have graded locally into one another; these contacts, if they are preserved, are chiefly buried beneath younger volcanic rocks.
2. The formations of the Dalles Group are mappable units and have been treated extensively as such in the literature.
3. The formations overlie the Columbia River Basalt Group by definition. Contacts with the basalt are sharp and well defined. Where flows in the Columbia River Basalt Group overlie interbeds of the Ellensburg Formation, those interbeds and their mappable extensions beyond the basalt pile are *not* considered part of the Dalles Group.

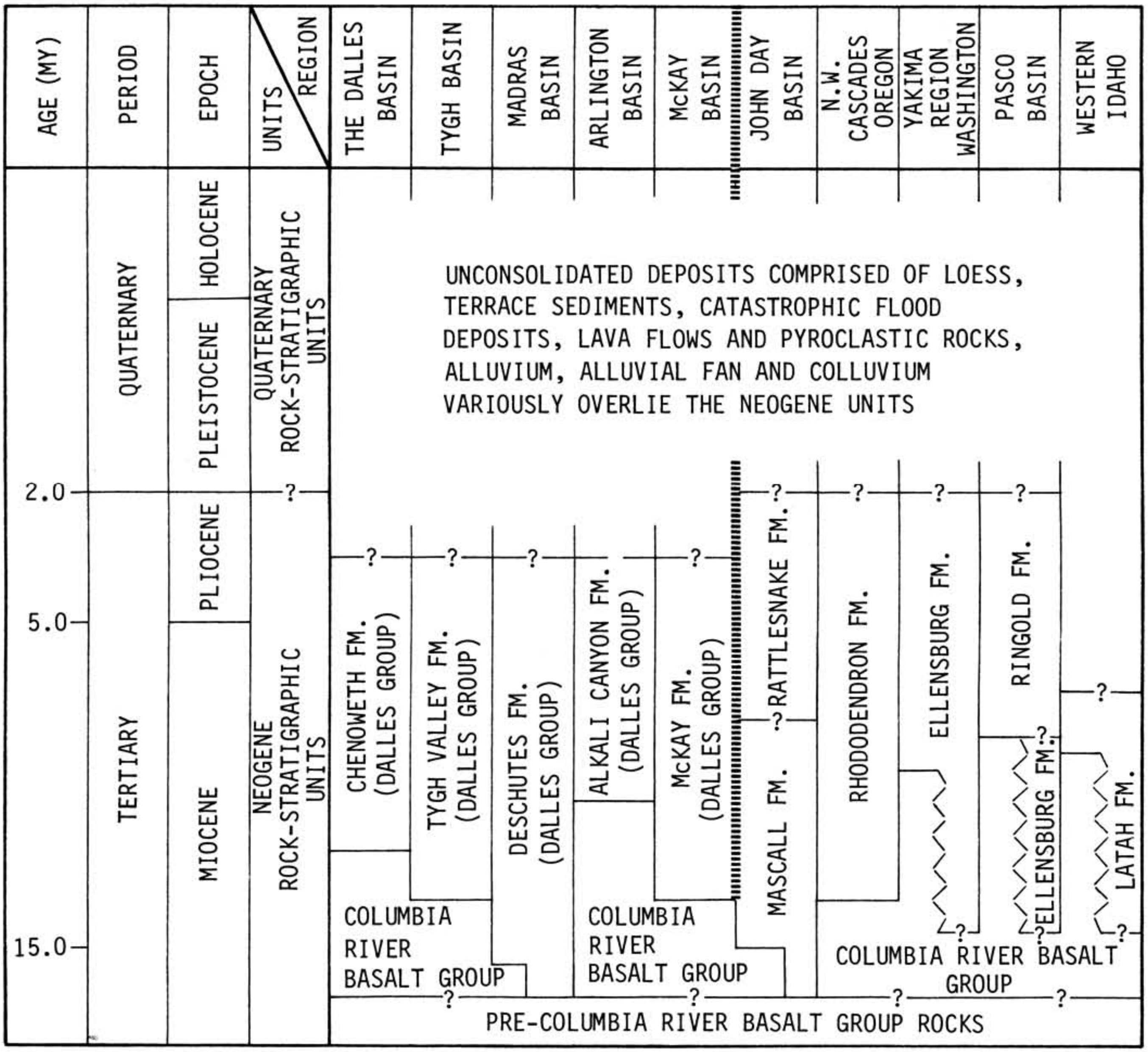

Figure 2. Regional correlation chart of the Dalles Group.

4. The group is overlain by a variety of Quaternary deposits. Because contacts with these deposits may be either sharp or gradational, they are defined for each formation. The gradational contacts are based on lithologic criteria that provide the greatest utility in mapping. The Quaternary units are excluded from the underlying formations.
5. All five formations are of middle(?) Miocene to Pliocene age.

In using the name Dalles, historic priorities and popular usage of older nomenclature are maintained. Further, the name Dalles Group is applied only to those units for which the name Dalles Formation has been used previously. It is not the intent to extend the name Dalles Group into other areas containing analogous rocks for which other terminology may be in common usage.

The five formations of the Dalles Group are the Chenoweth, Tygh Valley, Deschutes, Alkali Canyon, and McKay Formations. The locations of these formations are shown in Figure 1; their regional stratigraphic correlations are presented in Figure 2. The formations are described in the following sections.

CHENOWETH FORMATION

Indurated volcaniclastic deposits overlying the Columbia River Basalt Group in The Dalles area are herein formally named the Chenoweth Formation of the Dalles Group. The name Chenoweth comes from Chenoweth Creek (T. 2 N., R. 13 E.), which is just west of The Dalles, Wasco County, Oregon. The formation was previously mapped as the Dalles Formation (Condon, 1874; Cope, 1880; Piper, 1932; Newcomb, 1966, 1969).

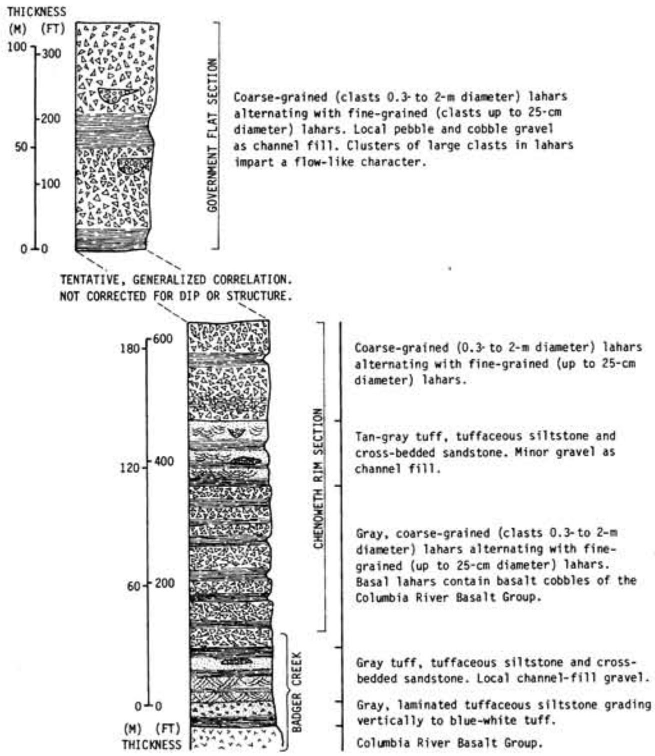

Figure 3. Reference sections of the Chenoweth Formation. Locations: Badger Creek and Chenoweth Rim sections in NE¼ sec. 30, T. 2 N., R. 13 E.; Government Flat section in NE¼ sec. 10, T. 1 N., R. 12 E.

The Chenoweth Formation is confined to The Dalles basin, which consists of two broad, flat-bottomed synclines, The Dalles-Umatilla and the Mosier synclines. The Ortley anticline separates the Mosier and The Dalles-Umatilla synclines, but it plunges southwestward, thereby allowing the connection of the Chenoweth Formation between the two synclines. The basin is bordered by the Columbia Hills anticline to the north in Washington, by the Cascade Range to the west, by the Tygh Ridge anticline to the south, and by the basalt upland to the east of the Deschutes River (Figure 1).

The formation is an eastward-spreading volcaniclastic debris fan consisting of interbedded agglomerate; tuff breccia; pumiceous lapilli tuff; lithic lapilli tuff; andesitic and basaltic conglomerate and sandstone; tuffaceous sandstone, siltstone, and clay shale; and minor basalt flows. The tuff breccia commonly consists of angular andesite clasts, 2 to 10 cm in diameter, isolated in a tuff matrix. The agglomerate consists of large, angular, boulder- and cobble-sized andesite clasts in a sandy tuffaceous matrix. The tuff breccia and agglomerate are interpreted to be lahar deposits owing in part to their common occurrence in lenticular channels and in sheets. The other rock types commonly are thick or lenticularly bedded. Beds are commonly less than 1 m thick and laterally discontinuous, exhibiting abrupt lithofacies changes. The formation also contains a 15-m-thick interbedded basalt flow along Fulton Ridge (Tps. 1 and 2 N., Rs. 14 and 15 E.; Newcomb, 1969). Figure 3 shows the reference sections of the Chenoweth Formation. Because abrupt lithofacies changes are common, no single section is entirely representative of the formation. Therefore, reference sections, rather than a type section, are designated.

Lahars and interbedded conglomerate and sandstone rich in andesite clasts dominate the western part of the formation near the foothills of the Cascade Range. Farther northward and eastward, the proportion of lahars decreases, while "normal" fluvial deposits of conglomerate, sandstone, and siltstone become more common. Newcomb (1969) interpreted the formation as consisting of a proximal "volcanic-sedimentary" debris fan deposit that changes distally to a "sedimentary" deposit. The source area for the volcanic sediment lies toward the Cascade Range, but its precise location is uncertain. Because the Chenoweth Formation is overlain by andesite flows toward the Cascade Range, it cannot be easily traced to its source.

Newcomb (1969) reported a total thickness of approximately 550 m for the "volcanic-sedimentary" facies, noting that thicknesses decrease distally to approximately 137 m near the Deschutes River and to 30 m north of the Columbia River. Piper (1932) reported thicknesses of 275 m (sec. 28, T. 1 N., R. 12 E.) and 198 m (sec. 29, T. 2 N., R. 13 E.).

The Chenoweth Formation lies upon the Priest Rapids and Frenchman Springs Members of the Columbia River Basalt Group (Swanson and others, 1981). Generally south of latitude 44°33′ N., it overlies the Frenchman Springs Member. The Chenoweth Formation is locally overlain by Quaternary loess near the Columbia River. The loess is distinguishable from tuffaceous siltstone of the Chenoweth Formation by its relatively nonindurated state and lack of stones. Southwest of The Dalles, Quaternary(?) intracanyon basalt lies in the valleys of Fivemile Creek and the South Fork of Mill Creek, both of which are cut into the Chenoweth Formation. To the west, andesite lavas of the Cascade Range overlie the formation.

The Chenoweth Formation is of late Miocene to early Pliocene(?) age, as indicated by K/Ar and paleontologic age determinations. Buwalda and Moore (1930) dated vertebrates in the formation as early Pliocene. These paleontologic ages are uncorrected with respect to Berggren and van Couvering's (1974) epoch boundaries but are now considered to be most likely Miocene age. K/Ar dates reported by Farooqui and others (1981) are 5.1 ± 0.5, 5.7 ± 0.6, and 7.5 ± 0.7 m.y.

TYGH VALLEY FORMATION

Indurated epiclastic and volcaniclastic deposits and basalt flows overlying the Columbia River Basalt Group in the Tygh Valley-Juniper Flat area are herein formally named the Tygh Valley Formation of the Dalles Group. The name Tygh Valley comes from the town of Tygh Valley (sec. 3, T. 4 S., R. 13 E.) in Wasco County, Oregon. The formation was earlier mapped as the Dalles and John Day formations (Hodge, 1941), the Dalles and the Mascall formations (Wells and Peck, 1961), and the Dalles and the Ellensburg Formations (Waters, 1968b). We include also the olivine basalt of Waters (1968b) in the Tygh Valley Formation.

The Tygh Valley Formation is confined to the Tygh basin, which consists of a broad, flat-bottomed, west-plunging syncline. The basin is bordered by the Tygh Ridge anticline to the north, the Cascade Range to the west, the Mutton Mountains to the south, and the basalt upland to the east of the Deschutes River (Figure 1).

The epiclastic and volcaniclastic rocks of the formation consist of weakly cemented basaltic, andesitic, and pumiceous sandstone and conglomerate; tuffaceous siltstone and sandstone; tuff; pumice lapilli tuff; tuff breccia; and agglomerate. The tuff breccia and agglomerate, which are similar to those in the Chenoweth Formation, are also interpreted as lahar deposits. Beds are lenticular and 1 to 20 m thick.

Because abrupt horizontal and vertical lithofacies changes are common, no single section is entirely representative of the formation, and no type section is designated. One reference section near Tygh Valley, however, is reasonably represen-

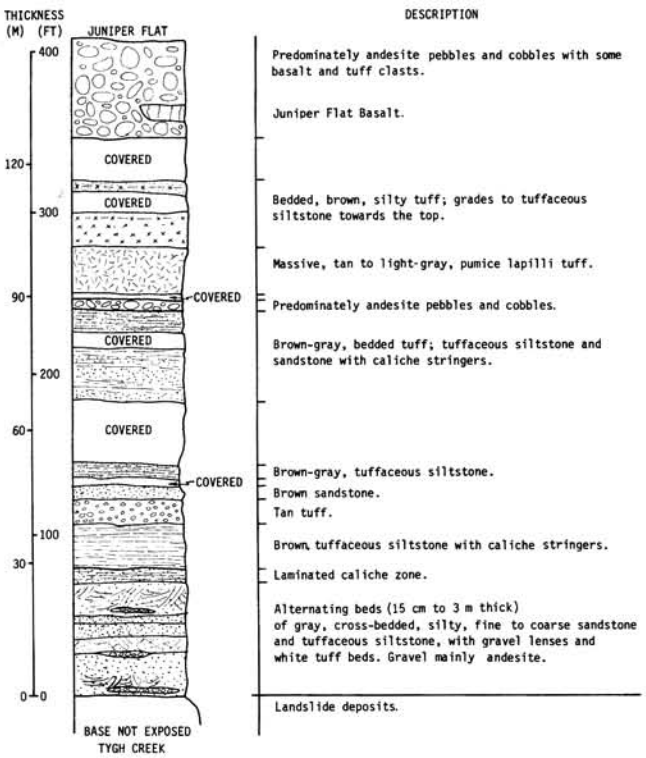

Figure 4. Reference section of the Tygh Valley Formation. Location: North-facing roadcut along Tygh Valley-Wamic road, sec. 4, T. 4 S., R. 13 E.

tative of the heterogeneity of the Tygh Valley Formation (Figure 4). Here it consists of interbedded siltstone, sandstone, conglomerate, tuff, and a basalt flow. The basalt, the "Juniper Flat basalt" (olivine basalt of Waters, 1968b), is discontinuous at this section and appears to be interbedded with gravel. Westward up Badger Creek and northwestward up Tygh and Jordan Creeks, the "Juniper Flat basalt" is overlain by andesite-rich lahars that pass upward into andesite lavas. These andesite lavas were separated by Farooqui and others (1981) from the Tygh Valley Formation, but the contact between them and the formation is approximate. The contact may be gradational; westward thickening of the lavas and concomitant thinning of sediment suggests interbedding of lavas with sediment. Trimble (1963) and Taylor (1980) reported similar relations for the Rhododendron and Deschutes Formations, respectively.

The exact contact between the Tygh Valley Formation and the Chenoweth Formation is difficult to locate precisely. The Tygh Valley Formation is generally distinguished from the Chenoweth Formation by its separate location and paucity of lahars. On the western end of Tygh Ridge, south of the former hamlet of Friend, andesite-rich lahars typical of the Chenoweth Formation overlie basalt inferred to be the "Juniper Flat basalt." This may suggest that the upper part of the Chenoweth Formation or its equivalent may overlie the Tygh Valley Formation (Farooqui and others, 1981). Final resolution awaits more detailed mapping.

The Tygh Valley Formation lies disconformably on the Frenchman Springs Member along the northern edge of the Tygh basin and on the Grande Ronde Basalt of the Columbia River Basalt Group along the southern edge of the basin (Swanson and others, 1981). It is overlain by Miocene-Pliocene andesite flows of the Cascade Range.

The Tygh Valley Formation is of middle Miocene to Pliocene age because it overlies the approximately 14-m.y.-old Frenchman Springs Member (McKee and others, 1977) and includes basalt and tuff dated at 7.5 ± 0.8 and 4.9 ± 0.5 m.y., respectively (Farooqui and others, 1981).

DESCHUTES FORMATION

Russell (1905) called the heterogeneous assemblage of interbedded volcanic, volcaniclastic, pyroclastic, and epiclastic rocks exposed in the Deschutes and Crooked River Canyons in the Prineville-Redmond-Madras-Warm Springs area the "Deschutes sand." Since then, these deposits were variously mapped as the Deschutes Formation (Stearns, 1930; Hodge, 1942; Peterson and others, 1976; Stensland, 1970; Taylor, 1980), the Madras formation (Hodge, 1928, 1940; Williams, 1957; Robinson and Price, 1963; Robinson and Stensland, 1979), and Dalles Formation (Hodge, 1942; Waters, 1968a; Robinson, 1975; Robison and Laenen, 1976). To remove the confusion in the nomenclature, we herein formally restore the name Deschutes Formation because of its historic priority and because of excellent exposures of the unit along the Deschutes River. We assign the formation to the Dalles Group.

The Deschutes Formation occurs in the geographically isolated Madras basin, which consists of several broad synclines developed on the southwest-plunging Blue Mountains anticline. The boundaries of the basin are defined by the Mutton Mountains to the north, the Cascade Range to the west, the High Lava Plains to the south, and Blue and Ochoco Mountains to the east (Figure 1).

Stensland (1970) provided detailed information on the Deschutes Formation. It consists of epiclastic and pyroclastic sedimentary rocks; welded and nonwelded ash-flow tuff; interbedded, intracanyon, and plateau-forming basalt flows; basaltic intrusions and cinder cones; diatomite; and mudflow deposits. The rock types are complexly interbedded, resulting in abrupt lithofacies changes. Individual units are commonly

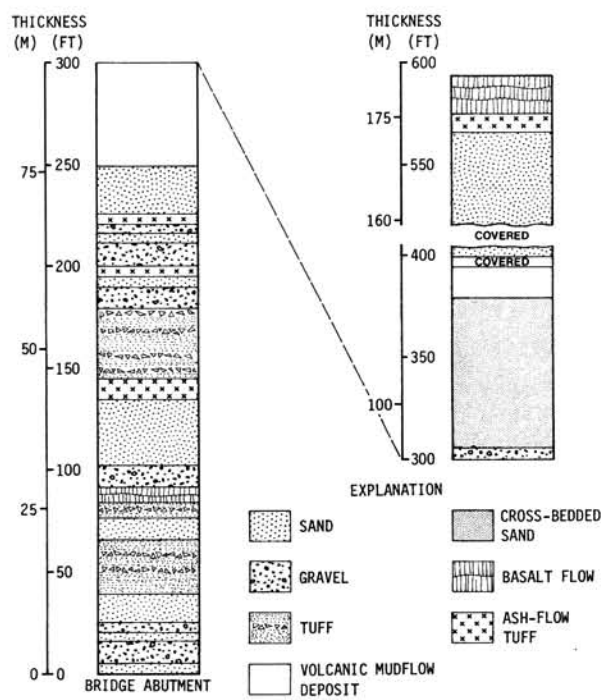

Figure 5. Reference section of the Deschutes Formation. Location:Roadcut on west side of Lake Billy Chinook, secs. 16 and 21, T. 12 S., R. 12 E.

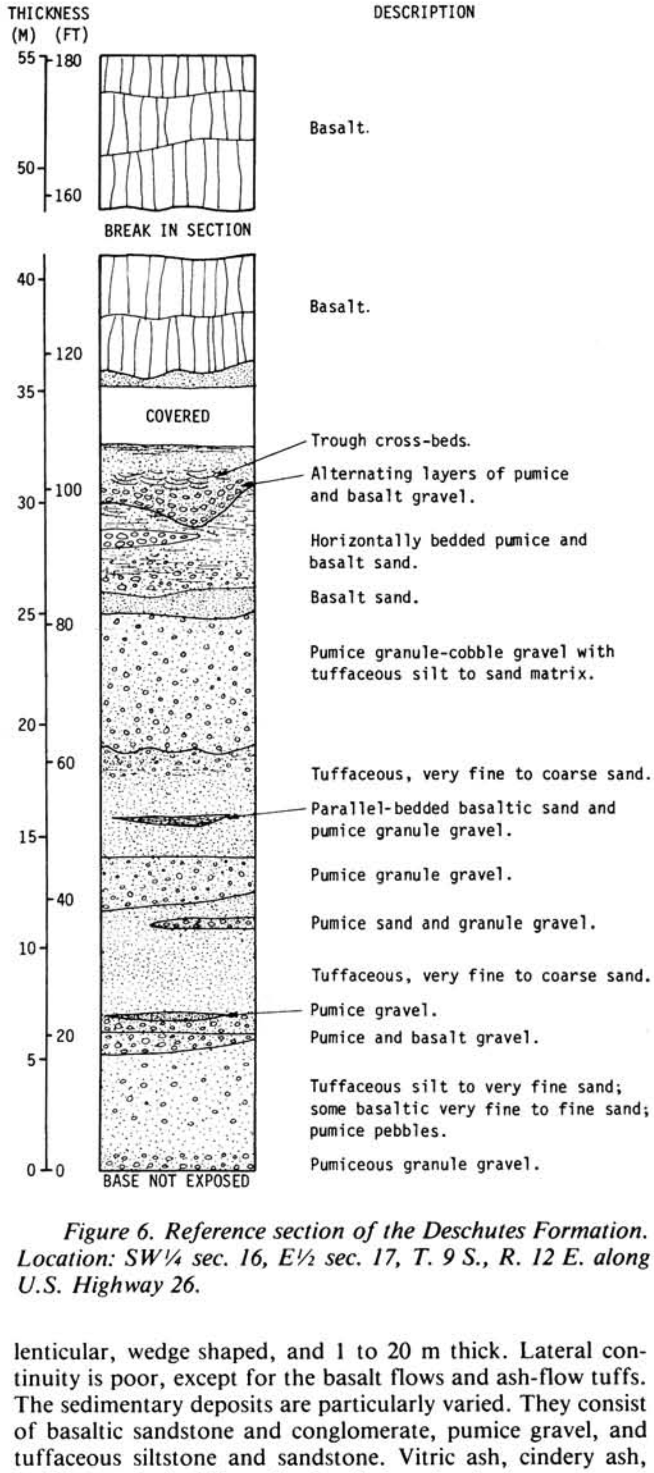

Figure 6. Reference section of the Deschutes Formation. Location: SW¼ sec. 16, E½ sec. 17, T. 9 S., R. 12 E. along U.S. Highway 26.

lenticular, wedge shaped, and 1 to 20 m thick. Lateral continuity is poor, except for the basalt flows and ash-flow tuffs. The sedimentary deposits are particularly varied. They consist of basaltic sandstone and conglomerate, pumice gravel, and tuffaceous siltstone and sandstone. Vitric ash, cindery ash, lapilli, pumice lapilli, and volcanic breccia also are common. Because abrupt lithofacies changes are common, no single section is entirely representative of the formation. Therefore, two reference sections, rather than a type section, of the Deschutes Formation are presented in Figures 5 and 6.

Thickness of the Deschutes Formation varies. Stensland (1970) reported thicknesses of less than 30 m to as much as 240 m, noting that the formation wedges out against hills eroded in older rocks. Hodge (1940) reported a thickness of 300 m near Warm Springs. The reference sections at Lake Billy Chinook (Figure 5) and northwest of Warm Springs (Figure 6) are 190 m and 55 m thick, respectively.

The Deschutes Formation is unconformable on the John Day and Clarno Formations and on the Grande Ronde(?) Basalt of the Columbia River Basalt Group, but it does not interfinger with the Columbia River Basalt Group. The Deschutes Formation is locally overlain by Quaternary deposits and lava flows. Near the Cascade Range, the formation is overlain by andesite flows and by andesite and basalt gravel.

The Deschutes Formation is of middle Miocene to early Pliocene age. Chaney (1938, 1944, 1959) described its flora as early to middle Pliocene. Evernden and James (1964) reported K/Ar dates of 4.3 and 5.3 m.y., and Armstrong and others (1975) reported K/Ar dates of 4.9 ± 0.5, 5.8 ± 1.0, and 15.9 ± 3.0 m.y. Dates for plateau-forming basalts in the Deschutes Formation are 8.9 ± 1.0 and 10.7 ± 1.2 m.y.; one interbedded basalt flow is 13.2 ± 1.5 m.y. (Farooqui and others, 1981). Except for the 15.9-m.y. date, these dates place the Deschutes Formation in the middle Miocene to early Pliocene.

ALKALI CANYON FORMATION

Indurated epiclastic deposits overlying the Columbia River Basalt Group in the Arlington-Boardman area are herein formally named the Alkali Canyon Formation of the Dalles Group. The name comes from Alkali Canyon (T. 2 N., Rs. 20 and 21 E.), 16 km southwest of Arlington, Gilliam County, Oregon. The formation was previously named the "Alkali lake beds" (Hodge, 1932); the "Shutler formation" (Hodge, 1941, 1942); fanglomerate (Hogenson, 1964); Dalles Formation (Newcomb, 1969, 1971a; Shannon and Wilson, 1971, 1972, 1973, 1975a,b, 1981; Farooqui, 1980); and Tertiary sedimentary rocks (Walker, 1973).

The Alkali Canyon Formation occurs only in the Arlington basin, which consists of the broad, flat-bottomed, doubly plunging Dalles-Umatilla syncline. The basin is bordered by the Columbia Hills anticline on the north, the Service anticline to the east, the Blue Mountains to the south, and basalt upland to the west (Figure 1).

The Alkali Canyon Formation is composed of basalt gravel and tuffaceous sediment. Because rapid lithofacies changes are common, no single section is entirely representative of the formation, and a reference section, rather than a type section, is designated. The reference section is in Alkali Canyon (Figure 7), where the basal Alkali Canyon Formation is a 5-m-thick, light-gray vitric tuff overlying the Selah member of the Ellensburg Formation (Newcomb, 1971). This vitric tuff is here assigned to the Alkali Canyon Formation. Newcomb (1971) tentatively assigned it to his Dalles Formation, noting its presence above the Pomona Member (Columbia River Basalt Group). This relation is confirmed by subsurface data (Shannon and Wilson, 1981). North of Alkali Canyon, the vitric tuff underlies much of the Chem-Security Systems waste disposal site but extends westward only as far as the W¼ sec. 25, T. 3 N., R. 20 E. (Shannon and Wilson, 1971, 1981).

The vitric tuff is overlain at this section by 2 to 3 m of tan, iron-stained, carbonate-veined, tuffaceous silty clay. The upper surface of the silty clay is scoured into channels up to 2 m wide and deep that are filled with basalt gravel and that comprise the 3-m-thick middle part of the section. East of this section, along the northern wall of Alkali Canyon, the middle part is 6 to 15 m thick (Newcomb, 1971). In the reference section, the gravel is partly carbonate-cemented, ranging from granules to small boulders, with cobbles most common. Locally a sand matrix partly fills interstices among the clasts; elsewhere the gravel is openwork. Tuffaceous, micaceous,

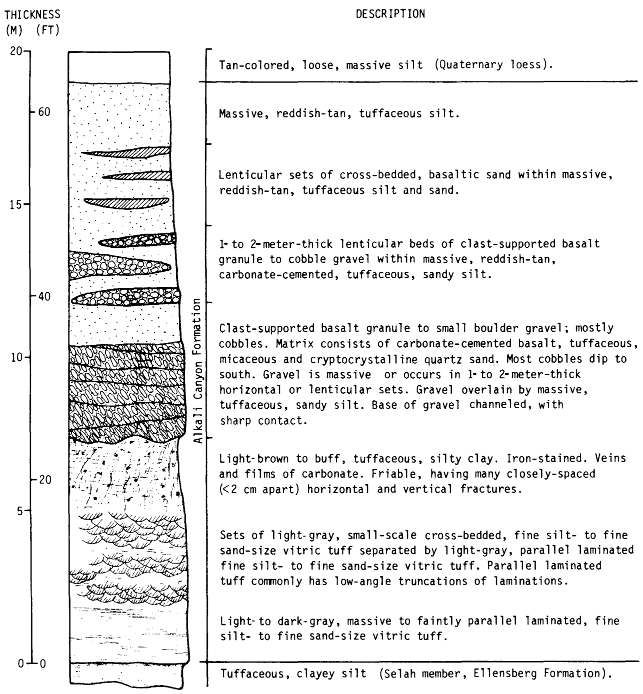

Figure 7. Reference section of the Alkali Canyon Formation. Location: Chem-Security Systems site access road, SE¼ sec. 25, T. 2 N., R. 20 E.

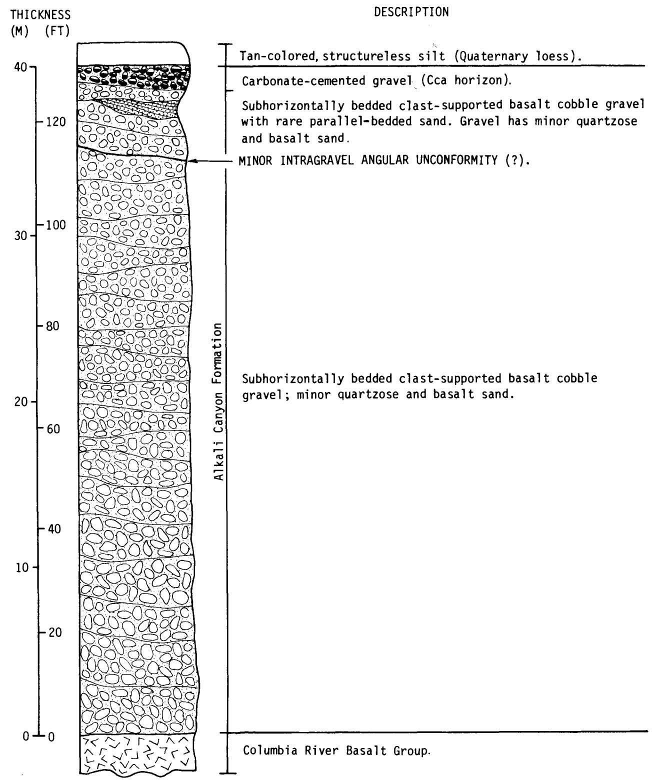

Figure 8. Reference section of the Alkali Canyon Formation. Location: NW¼ NW¼ sec. 21, T. 1 S., R. 21 E. Below the unconformity (?), beds trend N. 10° W. to N. 50° E.; apparent dips are 40° to 60° W. Above the unconformity (?), beds trend N. 10° E.; apparent dip is 10° W.

cryptocrystalline-quartz sands comprise the matrix. The gravel is commonly massive, but 1-m-thick horizontal and lenticular beds also occur. The cobbles commonly dip southward, indicating a general northward transport direction.

The upper 10 m of this section is comprised of red-tan, carbonate-cemented, tuffaceous sandy silt. The lower 3 m consists of sandy silt interbedded with 1- to 2-m-thick, lenticular, cross-stratified gravel beds. Lenticular sets of cross-bedded basaltic sand isolated in sandy silt generally comprise the middle part of this 10-m-thick upper section. The uppermost 2 to 3 m of section consists of loose to compact, massive tuffaceous silt.

The four-fold division of the Alkali Canyon Formation occurs only locally. Another section near Olex (Figure 8) consists entirely of basalt-cobble gravel in a quartzose and basaltic sand matrix. There the Alkali Canyon Formation rests directly on the Frenchman Springs Member of the Columbia River Basalt Group.

Other exposures and subsurface data reveal more diversity within the Alkali Canyon Formation (Shannon and Wilson, 1975a,b). Gravel pit exposures commonly display horizontal, 1- to 2-m-thick beds of massive and cross-stratified cobble gravel. The cobbles show southward-dipping imbrication, indicating general northward transport. Tuffaceous sand and silt lenses are interbedded with and truncated by the gravel beds. Temporary exposures in trench walls at the Chem-Security Systems site (sec. 25, T. 3 N., R. 20 E.) revealed a lenticular, 1-m-thick clay bed overlying the gravel near the top of the formation. The clay is thinly laminated and interbedded with a thin, vitric tuff bed. Gravel overlies the clay and tuff.

The depositional environment of the Alkali Canyon Formation is poorly understood. Hogenson (1964) interpreted it as fanglomerate. The assemblage of bedding types, sedimentary structures, and coarse grain sizes, together with general northward transport direction and the proximity of the Blue Mountains, suggests that the deposits represent the "proximal braided stream" type of deposit described by Rust (1978). However, local alluvial fans also constitute part of the depositional system of the Alkali Canyon Formation (Farooqui and others, 1981).

Regionally, the Alkali Canyon Formation lies both disconformably and unconformably on the Elephant Mountain, Pomona, Priest Rapids, and Frenchman Springs Members of the Columbia River Basalt Group. It also locally overlies the Rattlesnake and Selah members of the Ellensburg Formation. A slight angular unconformity is present where the Alkali Canyon Formation overlies the edges of the basalt members (Newcomb, 1971; Shannon and Wilson, 1971, 1973, 1975a,b, 1981).

Our investigations support previous work by Newcomb (1971), Shannon and Wilson (1972, 1975a,b), and Kent (1978) indicating that the Alkali Canyon Formation is a post-Columbia River basalt unit but that it does not interfinger with it, as do interbeds of the Ellensburg Formation.

The Alkali Canyon Formation is of late Miocene to early Pliocene(?) age, based on vertebrate fossils assigned to the Hemphillian by Shotwell (1956). According to Berggren and van Couvering (1974), the Hemphillian is late Miocene to early Pliocene in age. The Alkali Canyon Formation is not older than late Miocene, however, because it overlies the 10.5-m.y.-old (McKee and others, 1977) Elephant Mountain Member of the Columbia River Basalt Group (Shannon and Wilson, 1975b).

McKAY FORMATION

Indurated sedimentary deposits overlying the Columbia River Basalt Group in the Pendleton-Pilot Rock area are herein formally named the McKay Formation of the Dalles Group. The name McKay comes from McKay Reservoir (T. 1 N., R. 32 E.) in Umatilla County, Oregon. The formation was earlier named "McKay beds" (Shotwell, 1956), fanglomerate (Hogenson, 1964), Dalles Formation (Shannon and Wilson, 1972; Gonthier and Harris, 1977; Farooqui, 1980), and Tertiary sedimentary rocks (Walker, 1973).

The McKay Formation occurs only in the Agency basin. The basin is defined by the doubly-plunging, flat-bottomed Agency syncline, which is geographically separated from other nearby basins by the Blue Mountains, Reith, and Horse Heaven anticlines (Figure 1).

The McKay Formation is composed of partially cemented basalt gravel and interbedded tuffaceous sand and silt. Because abrupt lithofacies changes are common, no single section is entirely representative of the formation, and reference sections, rather than a type section, are designated. Reference sections of the formation are near McKay Reservoir (Figure 9) and Mission (Figure 10). The McKay Reservoir section (Figure 9) consists of dense, aphyric basalt gravel and less common cobbles and small boulders of red vesicular basalt. The gravel contains an estimated 10 percent sand-silt matrix, ranging from very coarse sand to silt. The matrix is commonly carbonate cemented, with the very coarse to fine sand fraction composed of subrounded to angular basalt grains and the finer matrix of carbonate "nodules" and quartzose fine sand to silt. Rare sand-silt lenses fill depressions atop gravel beds in the lower half of the section. The silt is quartzose; the sand is mostly basaltic. Gravel beds overlie these sand-silt lenses along irregularly scoured contacts. In the interval from between approximately 40 to 43 m above its base, the section consists of lenticular, 0.5-m-thick sand beds. The sand beds are weakly carbonate cemented and iron stained. They interfinger with .5- to 10-cm-thick lenticular pebble layers. The sand beds are overlain by approximately 2 m of tuff. The upper surface of the tuff is channeled and is overlain by cobble gravel that contains several boulders of calichified silt.

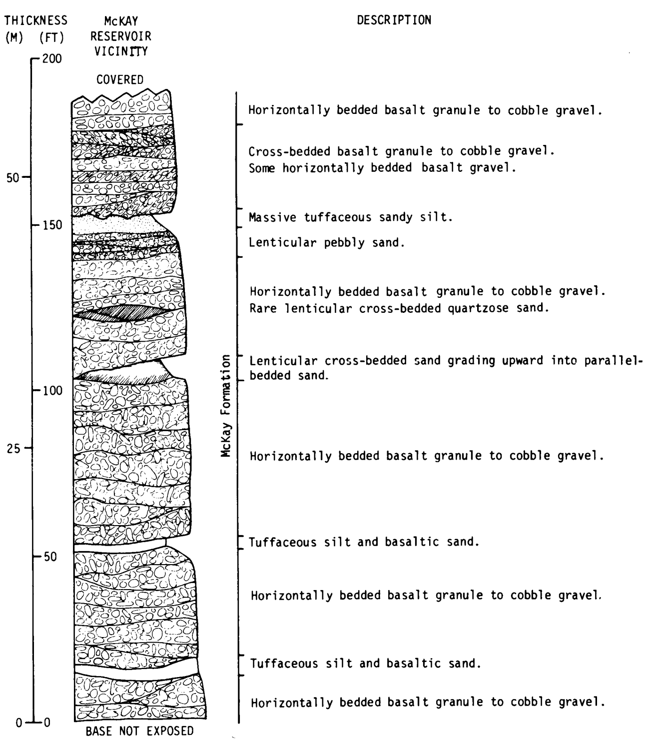

Figure 9. Reference section of the McKay Formation. Location: E¼ sec. 33, T. 2 N., R. 32 E.

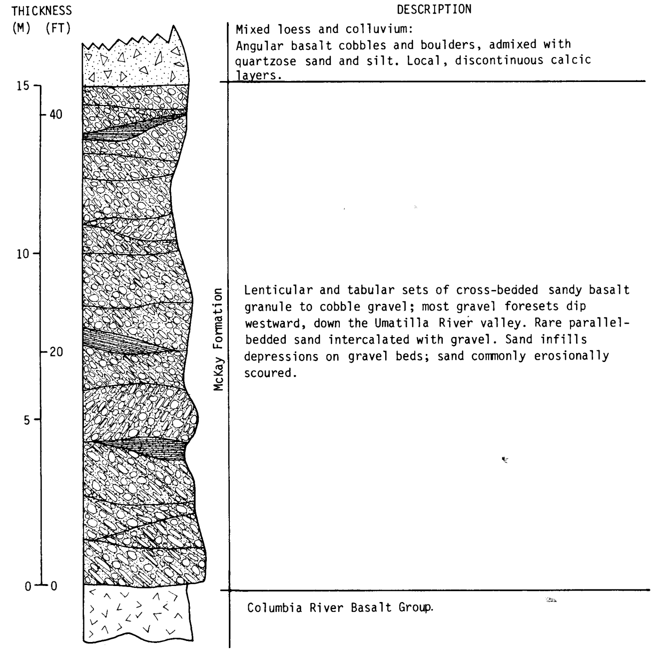

Figure 10. Reference section of the McKay Formation. Location: North-facing roadcut, NW¼ NE¼ NE¼ sec. 12, T. 2 N., R. 32 E.

The Mission section (Figure 10) consists of 0.5- to 1-m-thick lenticular cosets of cross-stratified sandy basalt granule to cobble gravel. A minor sand matrix coats the gravel; however, most gravel is openwork. The cross-bedding dips westward.

The McKay Formation was earlier mapped by Hogenson (1964) as fanglomerate; however, it may, in part, be a valley-fill deposit. The thickest observed sections are in or near the Birch-McKay Creek and Umatilla River valleys. Away from these valleys, the McKay Formation thins rapidly, suggesting it was deposited within the ancestral valleys of these streams.

Thickness of the McKay Formation varies. The McKay Reservoir section, whose base is not exposed, is 55 m thick. The Mission section is estimated to be 15 m thick. The McKay Formation disappears or thins to 2 to 5 m within 5 km west of Birch Creek. Well logs (Gonthier and Harris, 1977) show it is 4 to 77 m thick between McKay Creek and the Blue Mountains.

The McKay Formation is conformable atop the Frenchman Springs Member and Grande Ronde Basalt of the Columbia River Basalt Group (Swanson and others, 1981) within the Agency syncline. An angular unconformity between it and the basalt, however, can be inferred where horizontal beds of the McKay Formation are adjacent to the flanks of the bordering Blue Mountain, Reith, and Horse Heaven anticlines. At its upper contact, the McKay Formation is overlain by Quaternary loess; however, this contact is commonly difficult to locate precisely because gravel-free tuffaceous silt in the upper McKay Formation is similar to, and underlies, the loess. Because 0.5 to 1 m of loess commonly overlies basalt outcrops near the McKay Formation, this loess thickness was used locally to approximately locate the contact between loess and silt of the underlying McKay Formation.

The McKay Formation is of late Miocene to early Pliocene age. Shotwell (1956) described its fauna as Hemphillian. Based on Berggren and van Couvering's (1974) chronology, the Hemphillian was approximately from 10 to 4.5 m.y. or late

Miocene to early Pliocene. The formation is not older than middle Miocene, however, because it overlies the approximately 14-m.y.-old Frenchman Springs Member of the Columbia River Basalt Group.

ACKNOWLEDGMENTS

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Plate-tectonic maps of Circum-Pacific region available from AAPG

Three new plate-tectonic maps of the Circum-Pacific region have just been published by the American Association of Petroleum Geologists (AAPG). The full-color maps of the Northwest, Northeast, and Southeast Quadrants depict active plate boundaries, plate-motion vectors, major intraplate faults, seismic epicenters, Holocene volcanic activity, and magnetic lineations. Accretionary terrane along the Pacific rim, including the coast of western United States, Canada, and Mexico, is shown on the Northeast map sheet. The final two maps in this 1:10,000,000 series, the Southwest and Antarctica sheets, are scheduled for publication this year.

The basic Circum-Pacific Map Series consists of five 1:10,000,000 scale maps and a basin-wide map at a scale of 1:20,000,000. Additional thematic maps now under preparation include the Geologic, Tectonic, Energy Resources, Mineral Resources, and Geodynamics Series.

The plate-tectonic maps are available from the AAPG Bookstore, P.O. Box 979, Tulsa, OK 74101, at $8.00 each. Also available are full-color geographic maps at $12.00 each or $30.00 for a set of six maps and base maps, for plotting purposes, at $6.00 each or $20.00 for a set of six maps. The maps are rolled and shipped postpaid in a tube. □

New Western Regional Geologist for USGS appointed

G. Brent Dalrymple, 44, of Palo Alto, Calif., a research geologist recognized for his work in the field of geochronology, has been appointed Western Regional Geologist for the U.S. Geological Survey (USGS), Department of the Interior, with headquarters in Menlo Park, Calif. He succeeds Joseph I. Ziony, who has returned to special studies on fault hazards of southern California with the Western Center's Office of Earthquake Studies.

Dalrymple, a native Californian and long-term resident of the San Francisco Peninsula, has been working as a geologist at the Western Region headquarters since 1963, when he started his USGS career as a geologist with the Branch of Theoretical Geophysics. He gained early recognition for his published works on the geomagnetic-reversal time scale, one of the key geologic findings that led to the earth science theory of plate tectonics.

Dalrymple has published widely in scientific journals and other publications and has co-authored a textbook on potassium-argon dating. In addition to his early studies on geomagnetic reversals, he has published a series of papers on the hot-spot hypothesis for the origin of the Hawaiian Islands and on such other subjects as the history and timing of volcanoes, the thermoluminescence of lunar samples, and the development of radiometric-dating techniques.

Until his current assignment, Dalrymple had been serving with the Branch of Isotope Geology for some ten years. He first was project chief, then branch representative for the Western Region headquarters. In his post as Western Regional Geologist, he will coordinate all USGS Geologic Division programs and manage division facilities in Alaska, Arizona, California, Hawaii, Idaho, Nevada, Oregon and Washington, as well as the Pacific Trust Territories. □

ABSTRACTS

The Department maintains a collection of theses and dissertations on Oregon geology. From time to time we will print abstracts of new acquisitions that we feel are of general interest to our readers.

STRATIGRAPHY AND SEDIMENTATION OF THE SPENCER FORMATION IN YAMHILL AND WASHINGTON COUNTIES, OREGON, by Fathi Ayoub Al-Azzaby (M.S., Portland State University, 1980)

The Spencer Formation in Yamhill and Washington, Counties, Oregon, is exposed in a narrow belt 27 km long, from ¼ to 3 km wide, and with a maximum thickness of about 400 m. The formation is composed entirely of sandstone with interbedded thin layers of mudstone in the uppermost member. The sedimentary structure and paleoecology indicate a shallow marine depositional environment. The upper member of the Spencer Formation contains more quartz, plagioclase, and hornblende than does the lower member, but K-feldspar is less abundant than in the lower member. Shallower water conditions for the deposition of the upper member are indicated by sedimentary structures and the abundance of pebbly lenses and coaly material. Eighteen species of megafossils collected from the formation indicate that the Spencer Formation is of the Tejon stage (late Eocene of the West Coast).

The Spencer Formation in the study area is unconformably underlain by fine sediments of the Yamhill Formation of late Eocene (Narizian) age, which are in turn underlain by the upper middle Eocene Tillamook Volcanics. The Spencer Formation is overlain by a unit previously mapped as undifferentiated Oligocene marine sediments (Schlicker and Deacon, 1967). For this thesis, these sediments were separated into three units, partially mapped in the northern part of the study area: (1) A separate mudstone, siltstone, and sandstone unit called in this thesis the Stimson Mill bed, which intertongues with and overlies the Spencer Formation. The stratigraphic position of this unit is uppermost Eocene, not Oligocene as previously interpreted. (2) A thick sequence of interbedded basaltic and carbonaceous fine sandstone, pebbly sandstone, and thin-bedded shale of the Gries Ranch Formation which overlies the Stimson Mill bed of early Oligocene age. (3) A sandstone and mudstone unit, probably the middle Oligocene Pittsburg Bluff Formation, which overlies the Gries Ranch Formation. To the east of the study area, these units are unconformably overlain by the late Oligocene Scappoose Formation, which is, in turn, uncomformably overlain by the Columbia River Basalt Group of Miocene age.

Very well-developed faults with stratigraphic displacement occur throughout the study area, and sills and dikes intrude some of the Eocene and Oligocene rocks.

The considerable thickness of the shallow marine Spencer sandstone unit, along with its good porosity and permeability, well-developed faults, and intertonguing relationship with the overlying unit, suggest that this unit is favorable for the development of good stratigraphic and/or structural oil traps.

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THE PETROGRAPHY, STRUCTURE, AND STRATIGRAPHY OF POWELL BUTTES, CROOK COUNTY, CENTRAL OREGON, by Jan Peter Weidenheim (M.S., Oregon State University, 1980)

Powell Buttes is a major topographic feature located in western Crook County, between Bend and Prineville in central Oregon, and represents a mid-Tertiary silicic volcanic center of probable John Day age. The rocks of Powell Buttes are sparsely porphyritic and include dacite, rhyodacite, basaltic andesite, and flow-banded rhyolite in the form of lava flows and domes.

A warm climate with lush vegetation and frequent ash falls is recorded by carbonized plant remains and ancient soil horizons in tuffaceous sediments. The ash falls were products of Plinean volcanic activity; Pelean-type eruptions produced numerous vitroclastic breccias and lapilli tuffs, some of which contain authigenic clinoptilolite. The deposits and their characteristics suggest that Powell Buttes represents a source area for some John Day air-fall and ash-flow tuffs. The mature topography exhibited by Powell Buttes indicates that erosional processes have been very active there in the past. This implies that Powell Buttes contributed sediment to the nearby Pliocene Deschutes Formation.

Major oxide analyses of Powell Buttes rocks indicate a calc-alkaline suite when plotted on a Peacock diagram and Harker variation diagrams of the major oxides. A plot of Na_2O to K_2O results in an inverse relationship similar to that demonstrated by Walker (1970) for ash-flow tuffs of Oregon, some of which are John Day in age.

A subducting plate has been postulated to have existed approximately 260 km west of the study area during the mid-Tertiary (Atwater, 1970). Calc-alkaline volcanism has been associated with the subduction process and may be related to the silicic lavas exposed at Powell Buttes. Pitts (1979) mapped a major positive gravity anomaly at Powell Buttes and suggested that an olivine-gabbro residuum exists at depth. Other possibilities, however, should be considered because (1) the volume of rhyolite and dacite would require parental mafic and intermediate magmas that should be even more abundant than the silicic lavas, and (2) such residual rocks are not exposed in old, deeply eroded calc-alkaline belts.

A 7.4-km-long east-west normal fault, with the north side downthrown approximately 300 m, is delineated in the central area of Powell Buttes by a subtle, yet abrupt lithologic discontinuity of dacite to rhyolite.

The author has verified the occurrence of geothermal activity in the area adjacent to the northern part of Powell Buttes. Young silicic volcanic centers are usually associated with geothermal activity, but none exist in the region surrounding Powell Buttes.

References

Atwater, T., 1970, Implications of plate tectonics for the Cenozoic tectonic evolution of western North America: Geological Society of America Bulletin, v. 81, no. 12, p. 3513-3536.

Pitts, G. S., 1979, Interpretation of gravity measurements made in the Cascade Mountains and adjoining Basin and Range province in central Oregon: Corvallis, Oreg., Oregon State University master's thesis, 186 p.

Walker, G. W., 1970, Cenozoic ash-flow tuffs of Oregon: Oregon Department of Geology and Mineral Industries, Ore Bin, v. 32, no. 6, p. 97-115. □

OIL AND GAS NEWS

Willamette Valley:

American Quasar Petroleum Company's Kenneth Wetgen 26-32, NE¼ sec. 26, T. 13 S., R. 4 W., Linn County, was drilled to a total depth of 2,620 ft and abandoned as a dry hole on August 24, 1981.

Quintana Petroleum Corporation's Gath 1, SE¼ sec. 16, T. 8 S., R. 2 W., Marion County, was also abandoned as a dry hole. The plugging date was September 7, 1981. Total depth was 6,002 ft.

Future Willamette Valley activity includes a proposed 6,000-ft well to be drilled by Reichhold Energy Corporation in Marion County. The location is near Woodburn in sec. 28, T. 5 S., R. 2 W. In addition, American Quasar Petroleum Company will rework the Hickey 9-12 well in Linn County (sec. 9, T. 12 S., R. 2 W.) to increase its production and may also drill an offset well 1 mi to the north.

Clatsop County:

Oregon Natural Gas Development Company (ONGD), a subsidiary of Northwest Natural Gas Company, is one-third owner of a new drilling rig in Oregon. The company, along with Reidel International and Vorhees Drilling, has dubbed the new drilling company ROVOR and has begun drilling Johnson 33-33 in sec. 33, T. 8 N., R. 8 W., Clatsop County. The well is being drilled directionally to the southwest, to a projected depth of 10,000 ft. The new rig will also be used on one or two subsequent wells in Clatsop County for ONGD.

Mist Gas Field:

Reichhold Energy Corporation, operator of all producing wells in the Mist Gas Field, is currently drilling for a new pool discovery in sec. 33, T. 7 N., R. 5 W., 2 mi from the nearest production. After an unsuccessful straight hole to 2,407 ft, the redrill is being directed to the north. □

BLM publishes self-guided tour of Diamond Craters

Diamond Craters, a volcanic complex located about 55 mi southeast of Burns, Harney County, southeastern Oregon, is the subject of an attractive and informational tour guide recently released by the Bureau of Land Management (BLM).

Diamond Craters, which is described in the guide as a "museum of basaltic volcanism," contains a wide variety of volcanic features, including domes, shield volcanoes, lava pits, lava flows, maars, calderas, volcanic bombs, driblet spires, spines, collapse craters, and spatter cones—all in a relatively small area. The guide is designed to make it possible for someone with very little geologic background to find and understand these features.

Written by Ellen M. Benedict, Pacific University, the guide is based on work by numerous geologists including Bruce Nolf, Central Oregon Community College; Robert Bentley, Central Washington University; Norm Peterson, Oregon Department of Geology and Mineral Industries; Edward Groh; George Walker, U.S. Geological Survey; and Pete Mehringer, Washington State University. It is available free of charge from the Bureau of Land Management and may be obtained over the counter from BLM offices at either 729 NE Oregon St., Portland, OR 97208 [phone (503) 231-6273] or 74 S. Alvord St., Burns, OR 97720 [phone (503) 573-2071]. Requests by mail should be sent to the BLM at either Box 2965, Portland, OR 97208 or 74 S. Alvord St., Burns, OR 97720. □

Northwest Mining Association names convention theme and chairman

Howard J. Adams, Inspiration Development Company, has been named chairman of the Northwest Mining Association's 87th annual convention scheduled for December 3-5, 1981, in Spokane, Washington. More than 2,500 mining and industry members from around the world are expected to meet at the Davenport Hotel and Ridpath Motor Inn to listen to papers structured around the convention theme, "Moving Ahead with America."

Adams and Program Chairman Jackie Stephens, U.S. Borax and Chemical Corporation, have scheduled several first-time sessions and papers for the 1981 convention. The Precious Metals session will feature discussions of newly developed precious metals deposits. Desmond Pretorius of South Afria, one of the most renowned international precious metals experts, is scheduled to deliver a paper. Pretorius is also scheduled to address the convention welcoming luncheon on December 3.

Most of the session topics which have proved popular in the past few years, such as geology, metallurgy, foreign developments, student poster, mining, health and safety, will be repeated this year. A drilling short course will precede the convention short course on November 30 to December 2 at the Davenport Hotel.

Registration information for the convention and/or short course is available from the Northwest Mining Association, 633 Peyton Bldg., Spokane, WA 99201, phone (509) 624-1158. □

Guide to USGS information sources available

A guidebook explaining how to obtain a wide range of products and information from the U.S. Geological Survey (USGS) has been revised and is again available free upon request.

The publication shows addresses and phone numbers of more than 30 USGS public service offices, including libraries, Public Inquiries Offices, National Cartographic Information Centers, publication distribution centers, and the Open-File Services Section, all widely-used facilities designed to make USGS earth-science data more readily available to users.

Single copies of the 42-page publication, "A Guide to Obtaining Information from the USGS, 1981," published as U.S. Geological Survey Circular 777, can be obtained free of charge from the U.S. Geological Survey, Text Products Section, Eastern Distribution Branch, 604 South Pickett St., Alexandria, VA 22304. □

GSOC luncheon meetings announced

The Geological Society of the Oregon Country (GSOC) holds noon meetings in the Standard Plaza Building, 1100 SW Sixth Avenue, Portland, in Room A adjacent to the third floor cafeteria. Topics of upcoming meetings and speakers include:

October 16—*The Story of Petrified Wood*, by Albert J. Keen, Amateur Mineralogist.

November 6—*Death Valley, Land of Many Contrasts*, by Esther Kennedy, Naturalist.

November 20—*Oregon Plant and Animal Fossils*, by William N. Orr, Associate Professor, Department of Geology, University of Oregon.

For additional information, contact Viola L. Oberson, Luncheon Chairwoman, phone (503) 282-3685. □

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