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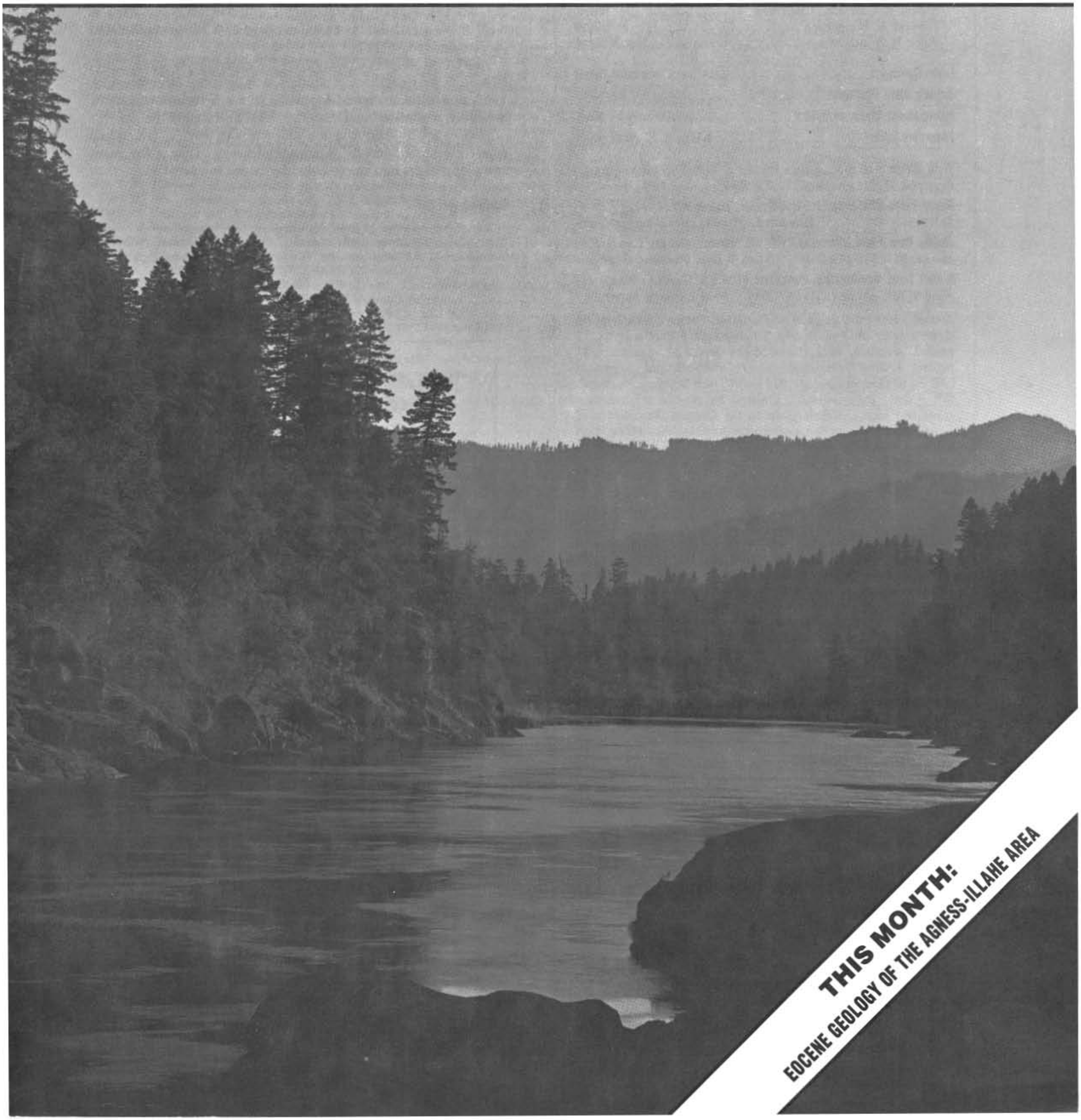

THIS MONTH:
EOCENE GEOLOGY OF THE AGNESS-ILLAHE AREA

OREGON GEOLOGY

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Oregon Geology is designed to reach a wide spectrum of readers interested in the geology and mineral industry of Oregon. Manuscript contributions are invited on both technical and general-interest subjects relating to Oregon geology. Two copies of the manuscript should be submitted, typed double-spaced throughout (including references) and on one side of the paper only. Graphic illustrations should be camera-ready; photographs should be black-and-white glossies. All figures should be clearly marked, and all figure captions should be typed together on a separate sheet of paper.

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 bibliographic 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

Typical topography along the Rogue River near Illahe. Article beginning on next page describes the Eocene geology of this area. Photo courtesy Michael S. Miller, U.S. Bureau of Mines, Spokane, Washington.

OIL AND GAS NEWS

Columbia County — Mist Gas Field

ARCO Crown Zellerbach 23-15, located in SW¼ sec. 15, T. 5 N., R. 4 W., was drilled to a total depth of 2,770 ft and completed to production on December 10, 1985. This is an offset to the ARCO Crown Zellerbach 31-16, originally drilled and completed by Reichhold Energy. Neither well is on line yet.

ARCO Longview Fibre 23-25, located in SW¼ sec. 25, T. 6 N., R. 5 W., was drilled to a total depth of 1,979 ft and completed on December 15, 1985.

ARCO Columbia County 23-22, located in SW¼ sec. 22, T. 6 N., R. 5 W., near three producers, was spudded December 10, 1985, and drilled to a total depth of 2,028 ft. This well was also a producer, completed on December 20. This brought the number of ARCO successes during the year to eight, seven of which had been originally filed by Reichhold Energy. This is the most completions yet in a single calendar year.

Recent permits

Permit no.	Operator, well API number	Location	Status, proposed total depth (ft)
344	ARCO Columbia County 41-2-1 009-00185	NE¼ sec. 2 T. 5 N., R. 5 W. Columbia County	Application; 2,000.

AIME member receives national award

Harry Czyzewski, P.E., President of Oregon Technical Services Center, Inc., Portland, and a life member of the American Institute of Mining Engineers (AIME), has been named to receive the Roger W. Truesdail Award for Outstanding Service to Independent Laboratories from the American Council of Independent Laboratories (ACIL).

Czyzewski has had a long and distinguished career within ACIL and in the broader consulting engineering/testing community. He is a past president of ACIL, served on its board for six years, and headed its Tax-Favored Competition

*(Continued on page 22, **Czyzewski**)*

Eocene geology of the Agness-Illahe area, southwest Oregon

by Raisuddin Ahmad, Department of Geology, University of Oregon, Eugene, Oregon 97403*

INTRODUCTION

The Agness-Illahe area (Figure 1) straddles the Mesozoic-Cenozoic boundary in southwestern Oregon. Published regional geologic maps that include the Agness-Illahe area are those of Wells and Peck (1961), Dott (1971), and Baldwin (1974). Baldwin (1974) describes and differentiates the early Tertiary formations of southwestern Oregon; however, the Agness-Illahe area has not been mapped in local detail. The Rogue River cuts through the Tertiary and pre-Tertiary rocks in the area (Figure 2), creating excellent outcrops that make up a continuous section thousands of meters thick. These outcrops have received very limited attention by the previous workers, except for some paleontological investigations by Thoms (1975) and Miles (1977).

The present study was initiated to prepare a geologic map of the area and to study the stratigraphy, structure, lithology, and petrography of exposed rock units. The purpose of the study was to reconstruct the Eocene geologic history of the area.

Field work for this study was conducted during the summers of 1978 and 1979. Much of the measurement of the stratigraphic section was done along the Rogue River canyon, but part of the section was also measured along roadcuts and in outcrops on top of the mountains. In areas lacking continuous outcrops, thickness of stratigraphic section was approximated.

REGIONAL GEOLOGICAL SETTING

The area under investigation is located within the Agness quadrangle, southwest Oregon (Figure 1). It covers about 91 km^2 (35 mi^2). Within the area, Tertiary rocks of the Coast Range are tectonically juxtaposed with pre-Tertiary rocks of the Klamath Mountains to the south, southeast, and southwest. Farther to the east lie the Cenozoic, chiefly andesitic volcanic rocks of the Cascade volcanic arc. The Klamath Mountains consist of tectonically stacked sedimentary and metasedimentary rocks that were intruded by dioritic and ultramafic igneous bodies (Dott, 1965). The Oregon Coast Range consists of Cenozoic sedimentary rocks with thick submarine pillow basalts and other basic intrusive bodies (Snavely and Wagner, 1963; Snavely and others, 1969; Baldwin, 1974, 1975).

The region has been affected by intense tectonic activity. Pre-Tertiary rocks of the Klamath Mountains are very intensely folded and faulted. Thrust faulting is a common structural phenomenon in both the pre-Tertiary and lower Tertiary rocks in the region (Baldwin, 1974, 1975). The intensity of folding in the Klamath Mountains is greater than in the Oregon Coast Range. Folds in the Klamath Mountains trend mainly northwest-southeast, whereas those in the Coast Range have dominantly north-south and northeast-southwest trends.

STRATIGRAPHY

The major part of the Agness-Illahe area is underlain by Tertiary rocks, and the present study deals with the Eocene formations of the area. Pre-Tertiary rocks include sedimentary rocks of the Myrtle Group (Baldwin, 1974) in the western part of the area and small intrusive bodies of serpentinite; however, these rocks are not discussed in this report. Baldwin (1974) elevated the Eocene Umpqua Formation of Diller (1898) to group status and subdivided it into the Roseburg, Lookingglass, and Flournoy Formations (Figure 3). Baldwin (1974) further subdivided the Lookingglass Formation into the Bushnell Rock, Tenmile, and Olalla Creek Members and the Flournoy Formation into the White Tail Ridge and Camas Valley Members. Contacts between the members are gradational in places.

Roseburg Formation

The Roseburg Formation is partially exposed along the Rogue River canyon near the Rogue River bridge between Waters Creek and Slide Creek, where it is in fault-bounded contact with the pre-Tertiary Myrtle Group sediments to the south-southwest (Figure 3). The zone of contact between the Roseburg Formation and the overlying Bushnell Rock Member of the Lookingglass Formation (Figure 4) is poorly exposed; however, the massive-bedded conglomerates of the lower Bushnell Rock Member distinguish it from the upper part of the Roseburg Formation. The zone of contact was mapped near Twomile Creek (Figure 3).

The thickness of Roseburg Formation strata exposed in the Agness-Illahe area is about 130 m (426 ft). These strata are made up of sandstones and siltstones and appear to represent the upper(?) part of the formation. Baldwin (1975) indicated that the Roseburg Formation is about 3,000-4,000 m (9,800-13,000 ft) thick at its type section at Glide. Faulting of this formation against the pre-Tertiary units in the Agness-Illahe area probably cut out its lower part.

Within the study area, the Roseburg Formation consists of a turbidite sequence of three distinct types of rocks: pebbly sandstone, sandstone, and siltstone. The sandstones are hard, compact subfeldspathic lithic wackes containing angular to subrounded quartz; plagioclase; potassium feldspars; heavy minerals; and igneous, metamorphic, and sedimentary rock fragments. Calcite, chert, and hematite are the principal types of cements. Detailed petrographic description is given in Ahmad (1981).

Miles (1977) studied planktonic Foraminifera and calcareous nannofossil assemblages of the formation in the Agness-Illahe area and assigned them to zone P7/8 of the standard tropical zonations. Miles indicated that the Foraminifera may in part be stratigraphically as low as zone P6b, which is late Paleocene in age. Thoms (1975) examined the benthic Foraminifera of the lower Umpqua Formation (Roseburg Formation of Baldwin, 1974) and assigned them to the Penutian Stage. On the basis of the age determination of Miles (1977) and the stratigraphic position below the pre-Lookingglass unconformity, Roseburg Formation rocks of the area can be tentatively correlated with the upper part of the formation in the type area near Glide (Baldwin, 1975) as well as in other northern sections (Ahmad, 1981, 1982).

No significant paleocurrent information was found during the present investigation. Snavely and Wagner (1963) determined that during early Eocene time, the paleocurrent direction in the area was northward. Ahmad (1981) suggested that sediments of the Roseburg Formation in the Agness-Illahe area were derived mostly from a terrain much like the present Klamath Mountains to the south (Figure 5A) and were probably transported by high-gradient streams in a subtropical climate (Miles, 1977).

During the early Tertiary period, a forearc basin was in existence in western Oregon on the trench slope along the active subduction zone where the Farallon Plate was being subducted beneath the North American Plate (Dickinson, 1976). This forearc basin is the north-trending eugeosynclinal basin of

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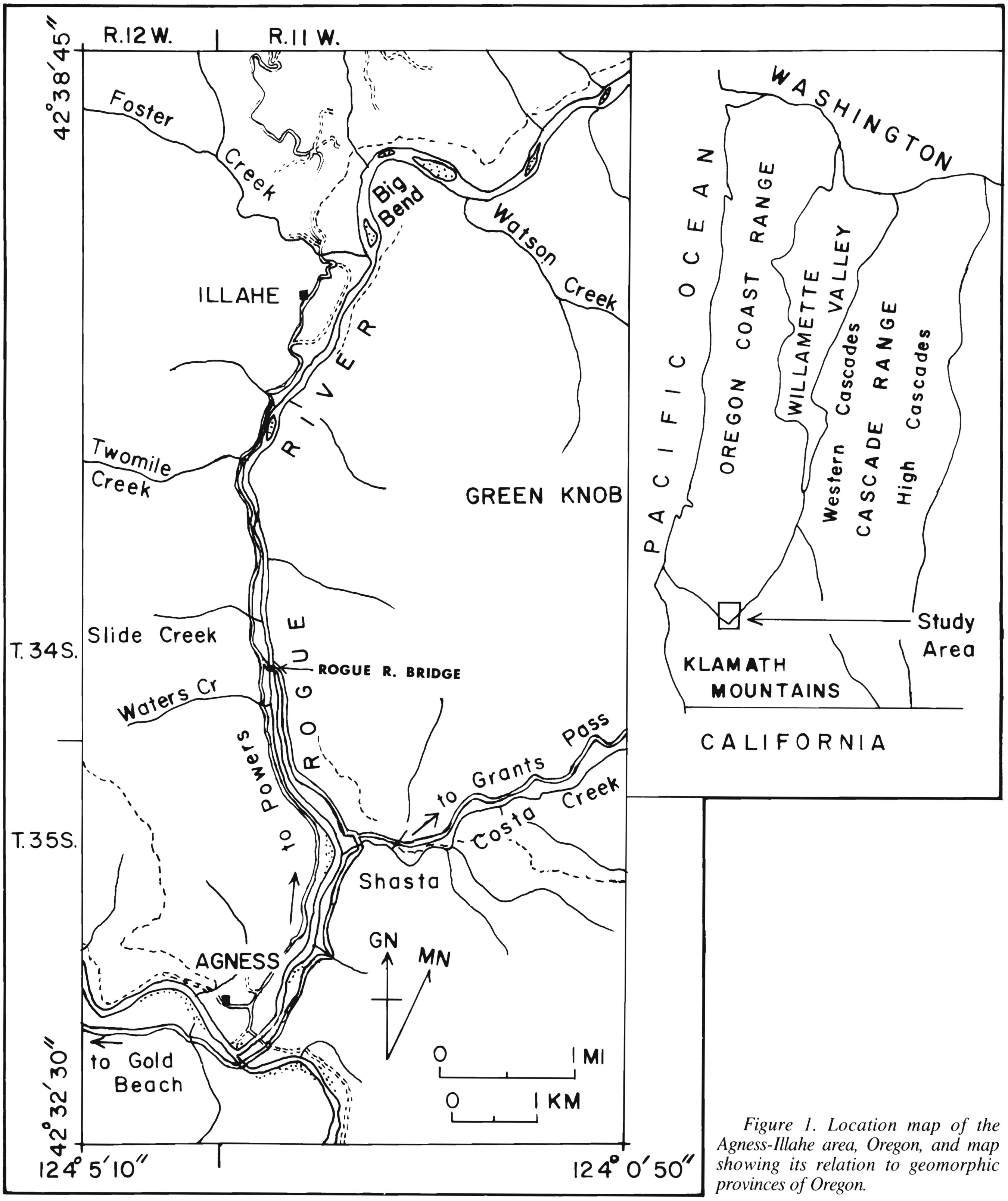

Figure 1. Location map of the Agness-Illahe area, Oregon, and map showing its relation to geomorphic provinces of Oregon.

Snavely and Wagner (1963). Turbidite sandstones of the Roseburg Formation are believed to have been deposited in this forearc basin (Figure 5A). A detailed discussion on the depositional environment of this formation is available in Ahmad (1981).

Lookingglass Formation

The Lookingglass Formation in the Agness-Illahe area is in unconformable contact with the underlying Roseburg Formation. This unconformity is a striking break in the Coast Range Tertiary record (Baldwin, 1974, 1975). In the Agness-Illahe area, the Lookingglass Formation is represented by the Bushnell Rock

Member and the Tenmile Member. The Olalla Creek Member is missing (Figure 4), because either it was not deposited in this area or it was eroded away before deposition of the Flournoy sediments (Ahmad, 1982).

Bushnell Rock Member: This member attains a thickness of about 735 m (2,411 ft) in the Agness-Illahe area. It has a basal sequence of petromict conglomerates followed stratigraphically by approximately 665 m (2,182 ft) of turbidite sandstones and siltstones (Figure 4). The conglomerate sequence is about 70 m (230 ft) thick and is composed of two distinct units: a basal unit of massive-bedded, moderately to poorly sorted conglomerate and an upper unit containing relatively thinner bedded, normally graded, well-sorted conglomerates (Ahmad, 1981).

Fossils are rare in Bushnell Rock conglomerate within the study area. A few boulders of conglomerate, contain fossils of the pelecypod *Buchia* (Cretaceous) that were probably derived from the pre-Tertiary formations. The molluscs *Venericardia aragonia, Tellina, Turritella, Amaurellina,* and oyster fragments are the most frequently found fossils (Haq, 1975).

Based on clast composition, fossil content of some conglomeratic boulders, and structural and textural criteria, this author (Ahmad, 1981) suggested that conglomerates of the Bushnell Rock Member were derived from the Klamath Mountains to the south and were deposited in a fluvio-neritic environment (Figure 5B). The relatively thinner bedded, normally graded, well-sorted, clast-supported conglomerates of the upper unit are believed to be resedimented conglomerates formed by turbidity currents.

Conglomerates of the Bushnell Rock Member are overlain by turbidite units consisting of sandstone, siltstone, and pelagic shale. These rocks are very well exposed along the Agness-Illahe Road as well as in the Rogue River canyon near the mouth of Twomile Creek. The sandstones are gray, hard, moderately compact, coarse- to medium-grained, and moderately to poorly sorted feldspathic to subfeldspathic lithic wackes. They contain quartz, chert, plagioclase feldspars (Ab_{60}-Ab_{85}), potassium feldspars, rock fragments excluding chert, serpentine and nonmatrix chlorite, heavy minerals, and clay matrix (Ahmad, 1981).

A few organic constituents such as echinoderm fragments, fragments of Foraminifera, and indurated fragments of spumellarian Radiolaria were found in these sandstones. These microfossils were identified by William N. Orr (personal communication, 1981). A middle Eocene crab (Kooser and Orr, 1973), echinoderms, gastropods, and pelecypods are also present in these sandstones. All of these megafossils are of early to middle Eocene age. The outcrop from which these fossils were collected lies about 1 km (0.6 mi) southeast of the mouth of Shasta Costa Creek and is accessible by a trail (Figure 3).

After comparing the petrographic characteristics of these sandstones with selected sandstone suites of known provenances, this author (Ahmad, 1981) suggested that Lookingglass sandstones in the study area were derived mostly from the Klamath Mountain terrane to the south (Figure 5B). Lithology, sedimentary structure, and the presence of shallow-marine faunas suggest that sandstones of the Bushnell Rock Member in the Agness-Illahe area were deposited in a shallow forearc basin (Ahmad, 1981, Figures 36-37). Reconstruction of the paleogeography at the time of formation of the Bushnell Rock Member is shown in Figure 5B.

Tenmile Member: The Tenmile Member is made up of about 240 m (787 ft) of turbidite sandstone and siltstone (Figure 4). These rocks are very well exposed along the Rogue River canyon near Illahe and Foster Bar. Each turbidite unit generally contains beds of gray, moderately compact, medium- to fine-grained, normally graded lithic sandstone and siltstone. Calcite and chert

Figure 2. Rogue River canyon carved into the Eocene strata offers excellent outcrops that are continuous for several kilometers in the Agness-Illahe area.

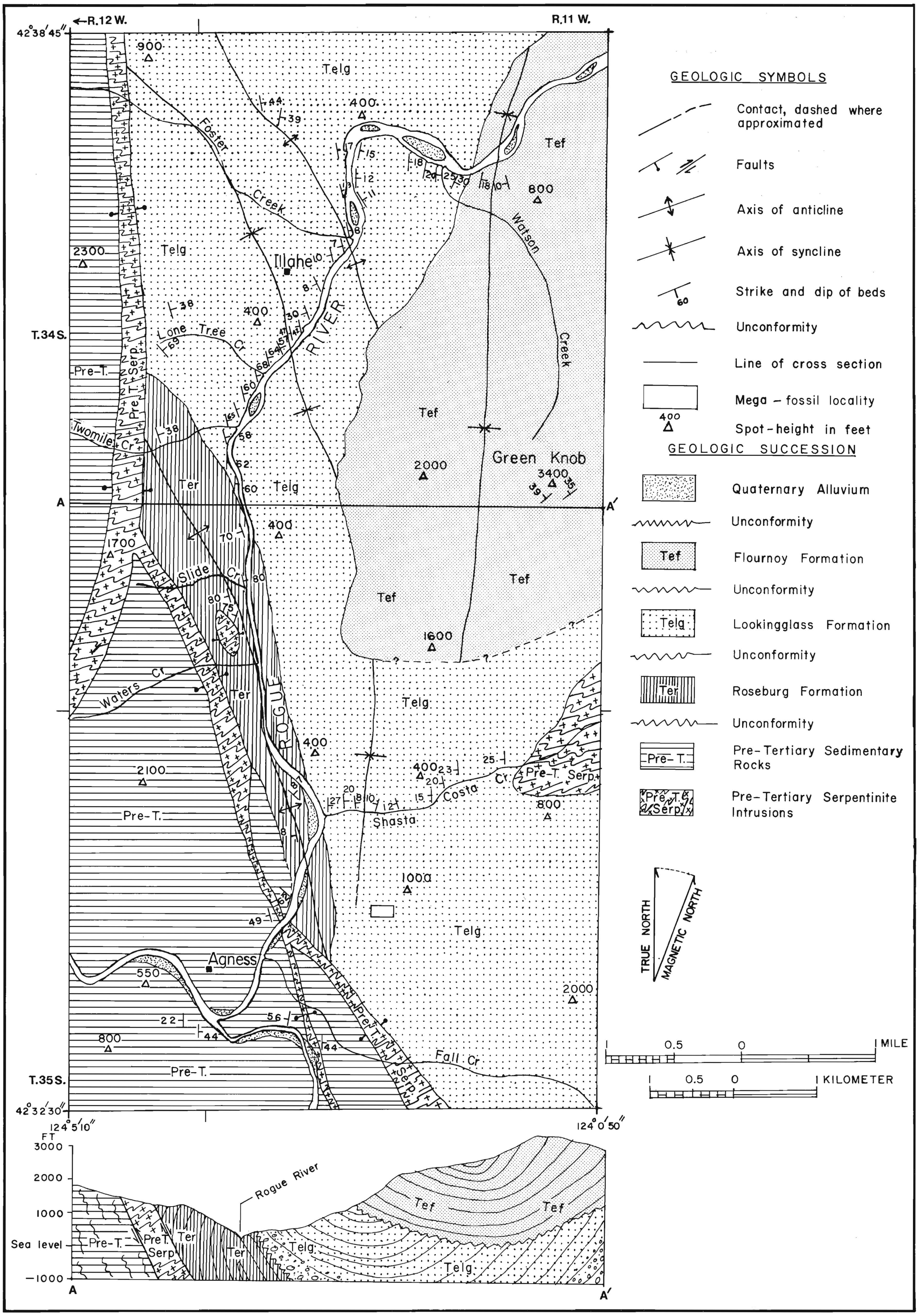

Figure 3. Geologic map of the Agness-Illahe area.

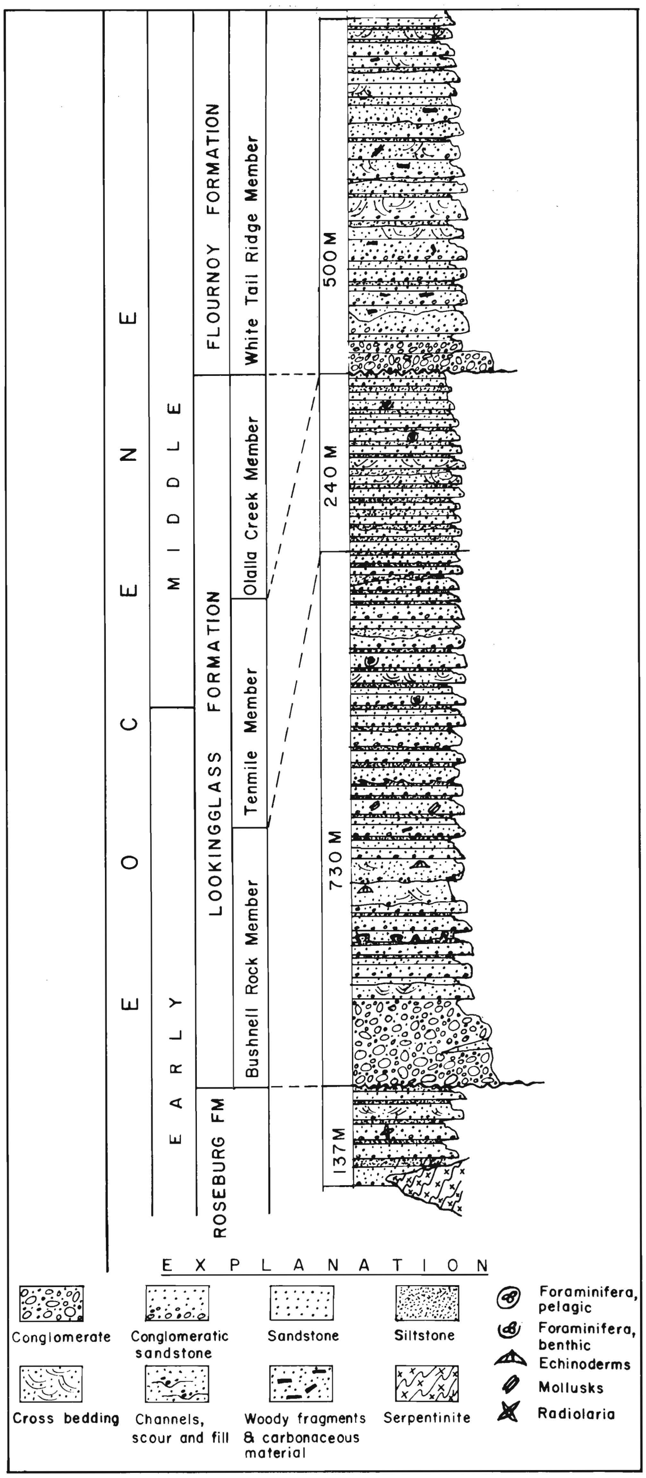

Figure 4. Measured stratigraphic column of the rocks of early to middle Eocene age in the Agness-Illahe area, Oregon.

are the main cementing agents. Micro cross-laminations are present in the upper part of some fine sandstone beds. Small-scale scour-and-fill structures are present in some of the beds of siltstones.

Some microfaunas found in the Tenmile Member are similar to those of the Bushnell Rock Member sandstones. Based on the textural and mineralogical criteria, the Tenmile Member sandstones appear to have been derived mainly from the Klamath Mountains to the south. Bed geometry, sedimentary structures, and presence of shallow-water megafossils and microfossils suggest that the sandstones were deposited by turbidity currents in a forearc basin. Figure 5C shows a paleogeographic reconstruction of the area during deposition of the Tenmile Member sediments.

Flournoy Formation

The Flournoy Formation crops out in a considerable part of the study area (Figure 3) and attains a thickness of about 500 m (1,640 ft) (Figure 4). The southern extent of the formation is not well exposed. The base of the formation is marked by a 50-m (164-ft)-thick sequence of brown, graded sandstone. These conglomerates and sandstones are well exposed near the mouth of Watson Creek. Because of structural and lithologic similarities, the Flournoy Formation rocks of the study area are believed to represent the White Tail Ridge Member exposed in its type area in the Flournoy Valley and described by Baldwin (1974, 1975).

White Tail Ridge Member: The conglomerates at the basal part of this member are massive bedded and clast supported with a matrix consisting of sand- and silt-size materials. The clast size ranges from about 15 cm (6 in.) to 2 cm (0.8 in.), with an average size of about 5 cm (2 in.). The average clast size gradually decreases stratigraphically upward. The clasts are rounded to subangular and are made up of fragments of basalt, diorite, andesite, dacite, rhyolite, sandstone, conglomerate, limestone, chert, greenstone, schist, and metasedimentary rocks including quartzite.

These conglomerates closely resemble those of the lower unit of the Bushnell Rock Member except for smaller clast size of the latter. Conglomerates of the White Tail Ridge Member were probably deposited in a shallow-marine environment (Baldwin, 1974), but the basal part exposed near Watson Creek is probably fluvial, as suggested by the absence of faunas.

In the study area, sandstones of the White Tail Ridge Member attain a thickness of about 450 m (1,480 ft). These sandstones are light-brown to light-gray, moderately hard, coarse- to medium-grained, normally graded, and moderately to poorly sorted subfeldspathic lithic wackes. They contain mainly quartz, feldspar, lithic fragments, and variable amounts of matrix materials. Mica flakes and small fragments of plant debris are present along the bedding planes and dispersed within sandstone beds. Calcite, clay minerals, chert, and ferruginous materials are the main cementing materials. Extensive replacement of matrix materials by calcite is conspicuous. Some of the sandstone beds have cross-laminations and scour-and-fill structures.

Thoms (1975) assigned the microfossils of the Flournoy Formation to the Ulatisian Stage. Based on the study of planktonic foraminiferal assemblages, Miles (1977) indicated that sediments of the Flournoy Formation were deposited during middle Eocene time and assigned them to zone P7/8.

Bed thickness (about 1 m [3.3 ft]), presence of shallow-water planktonic and benthic Foraminifera (Miles, 1977), presence of small fragments of wood, and normal grading of the sandstones suggest that the sandstones at the basal part of the White Tail Ridge Member were deposited in a shallow-marine shelf environment or in the upper trench slope by turbidity currents. With continued transgression of the sea, the upper, thinner bedded sandstones were probably deposited in a deeper water environment on the upper trench slope or on the lower trench slope. A paleogeographic reconstruction of the area at the time of deposition of the White Tail Ridge Member sediments is shown in Figure 5D.

STRUCTURAL GEOLOGY

The geological structure of the Agness-Illahe area is complicated. Two anticlines, two synclines, and three major faults have

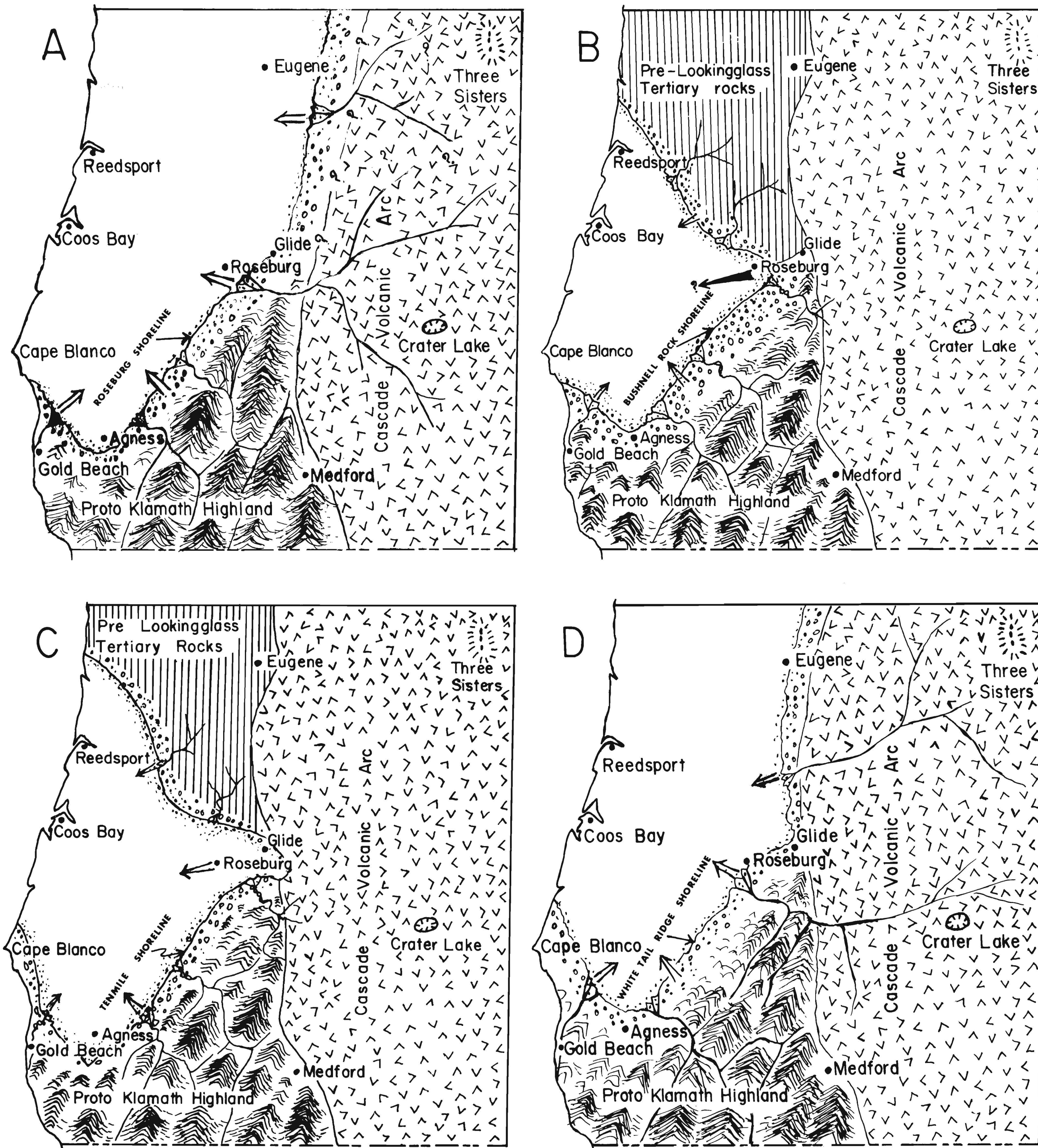

Figure 5. Paleogeographic maps of southwest Oregon at different times during the early to middle Eocene: A = during deposition of the upper Roseburg strata; B = during deposition of the Bushnell Rock Member of the Lookingglass Formation; C = during deposition of the Tenmile Member of the Lookingglass Formation; D = during deposition of the White Tail Ridge Member of the Flournoy Formation.

been mapped (Figure 3). Four major episodes of deformation can be recognized: (1) deformation of the pre-Tertiary Myrtle Group sedimentary strata prior to the deposition of sediments of the Roseburg and younger formations, (2) deformation and uplift of the Roseburg Formation prior to deposition of sediments of the Lookingglass Formation, (3) deformation and uplift of the Lookingglass Formation and the previously deformed Roseburg and pre-Tertiary strata, and (4) post-Flournoy deformation affecting the Flournoy and other older rocks of the area.

Strata of the Roseburg, Lookingglass, and Flournoy Formations are folded into several anticlines and synclines (Figure 3). These folds are asymmetric and generally trend north-northwest; however, the axial trends appear to be more northerly in the younger formations. Strata on the southwestern flanks of these folds are more steeply dipping relative to those on the northeastern flanks. Some of the folds are localized only within the strata of a single formation. Plots of the poles of bedding planes on a Schmidt equal-area net tend to cluster around different points for different formations, suggesting separate episodes of tectonic activity responsible for their deformation (Ahmad, 1981). The general trend of the anticlinal fold axis in the Roseburg Formation within the map area is approximately N. 10° W., which is a deviation from the regional northeast-southwest trend of the folds of the same formation in the Oregon Coast Range (Baldwin, 1974).

Several prominent faults were mapped (Figure 3). All of the major faults appear to be normal/reverse faults along which the rocks of Roseburg and Lookingglass Formations were down-dropped against the pre-Tertiary rocks of the Myrtle Group. Displacements along the faults could not be determined. Large masses of serpentinite occur along the fault zone. In addition to the faults mapped, several minor east-west-trending transverse faults that extend for distances of only a few tens of meters occur in the map area.

Joints are very common in rocks of the Roseburg and Lookingglass Formations. Most of the joints are rectilinear, but a few of them have corners that are somewhat rounded and have nearly polygonal shapes that resemble mud cracks. The oblique joints are most common in the upper part of the Tenmile Member. At some places the joints are limited to individual strata, but in most localities they extend across several strata. Length of individual less joints varies from than a meter to several meters.

CONCLUSIONS

(1) The Roseburg and Lookingglass Formations within the Agness-Illahe area have fault-bounded contacts with the pre-Tertiary rocks of the Klamath Mountains. (2) Strata of the Roseburg Formation exposed in this area consist essentially of turbidite sandstones deposited in a gradually subsiding forearc basin during late Paleocene to early Eocene time. (3) The Bushnell Rock Member unconformably overlies the Roseburg Formation. Its basal massive-bedded conglomerates are believed to have been deposited in fluvio-neritic environments; the upper, normally graded, and relatively thinner bedded conglomerates and turbidite sandstones were deposited in continental-shelf to -slope environments along the forearc basin. Subsidence of the basin continued while the turbidite sandstones of the Tenmile Member were deposited in the forearc basin. The Olalla Creek Member is missing in the study area, perhaps because of non-deposition or erosion of the member due to tectonic uplift above base level prior to deposition of the Flournoy Formation. Deposition of the Lookingglass sediments took place during early Eocene to early middle Miocene time. (4) Conglomerates of the White Tail Ridge Member unconformably overlie the Olalla Creek Member of the Lookingglass Formation in the study area and, except for the probably nonmarine rocks near the mouth of Watson Creek, are tentatively interpreted to have been deposited in a shallow-marine environment. However, further study is needed for a better environmental interpretation of these conglomerates. The overlying turbidite sandstones of the member are believed to have been deposited in a forearc basin during middle Eocene time. (5) The intensity of folding of the Roseburg, Lookingglass, and Flournoy Formation strata decreases gradually upward in the stratigraphic section, reflecting a gradual decrease in the intensity of tectonic activity in the area since early Eocene time. (6) The Roseburg and Lookingglass strata were intruded by large masses of serpentinite.

ACKNOWLEDGEMENTS

Most of the contents of this paper are from the author's master's thesis (Ahmad, 1981) that was completed at the Geology Department, University of Oregon. I express my special thanks to E. M. Baldwin, who introduced me to the Agness-Illahe area, helped during the field work, critically reviewed the manuscript, and made valuable comments and suggestions. I thank Sam Boggs, Jr., who generously supervised the project, critically reviewed the manuscript, and made valuable comments and suggestions. Some financial support for the field work and preparation of maps and thin sections was provided from the Student Research Fund of the Geology Department, University of Oregon.

REFERENCES CITED

Ahmad, R., 1981, Stratigraphy, structure, and petrology of the Lookingglass and Roseburg Formations, Agness-Illahe area, southwestern Oregon: Eugene, Oreg., University of Oregon master's thesis, 150 p.

- - -1982, Eocene stratigraphy of the Agness-Illahe area, southwest Oregon [abs.]: Proceedings of the Oregon Academy of Science, v. XVIII, p. 96.

Baldwin, E.M., 1974, Eocene stratigraphy of southwestern Oregon: Oregon Department of Geology and Mineral Industries Bulletin 83, 40 p.

- - -1975, Revision of the Eocene stratigraphy of southwestern Oregon, *in* Weaver, D.W., Hornady, G.R., and Tipton, A., eds., Paleogene Symposium and selected technical papers: 50th Annual Meeting, Pacific Sections, AAPG, SEPM, SEG, Long Beach, Calif., April 1975, p. 49-64.

Dickinson, W.R., 1976, Sedimentary basins developed during the evolution of Mesozoic-Cenozoic arc-trench system in western North America: Canadian Journal of Earth Sciences, v. 13, no. 9, p. 1268-1287.

Diller, J.S., 1898, Roseburg folio, Oregon, folio 49 *of* Geologic Atlas of the United States: U.S. Geological Survey.

Dott, R.H., Jr., 1965, Mesozoic-Cenozoic tectonic history of the southwestern Oregon coast in relation to Cordilleran orogenesis: Journal of Geophysical Research, v. 70, no. 18, p. 4687-4707.

- - -1971, Geology of the southwestern Oregon coast west of the 124th meridian: Oregon Department of Geology and Mineral Industries Bulletin 69, 63 p.

Haq, Z.N., 1975, The geology of the northwest quarter of the Roseburg quadrangle, Douglas County, Oregon: Eugene, Oreg., University of Oregon master's thesis, 75 p.

Kooser, M.A., and Orr, W.N., 1973, Two new decapod species from Oregon: Journal of Paleontology, v. 47, no. 6, p. 1004-1046.

Miles, G.A., 1977, Planktonic Foraminifera of the lower Tertiary Roseburg, Lookingglass, and Flournoy Formations, southwest Oregon: Eugene, Oreg., University of Oregon doctoral dissertation, 354 p.

Snavely, P.D., Jr., and Wagner, H.C., 1963, Tertiary geologic history of western Oregon and Washington: Washington Division of Mines and Geology Report of Investigations 22, 25 p.

Snavely, P.D., Jr., Wagner, H.C., and MacLeod, N.S., 1969, Geology of western Oregon north of the Klamath Mountains, *in* U.S. Geological Survey, in collaboration with the Oregon Department of Geology and Mineral Industries, Mineral and water resources of Oregon: Oregon Department of Geology and Mineral Industries Bulletin 64, p. 32-46.

Thoms, R.E., 1975, Biostratigraphy of the Umpqua Group, southwest Oregon, *in* Weaver, D.W., Hornaday, G.R., and Tipton, A., eds., Paleogene Symposium and selected technical papers: 50th Annual Meeting, Pacific Sections, AAPG, SEPM, SEG, Long Beach, Calif., April 1975, p. 513-562.

Wells, F.G., and Peck, D.L., 1961, Geologic map of Oregon west of the 121st meridian: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-325. □

BLM shares income, forecasts mineral-resource activity

Oregon gains cash from BLM

Oregon and its counties received $511,188.28 from the U.S. Bureau of Land Management (BLM) as their share of 1985 income from public lands. The total includes $186,784.61 from grazing income and $324,403.67 from sale of minerals, timber, and land. Nationwide, BLM distributed a total of $3,306,989.62 from these sources to counties and states.

Not included in the above is income from BLM's management of the so-called O&C lands. These are lands that were once given to the Oregon and California Railroad Company to subsidize railroad construction but were taken back by the Federal government when the company failed to live up to the agreement. From this source, Oregon counties in which O&C timberlands are located received a total of $61,123,527.98 for fiscal year 1985.

States and counties receive half of the income from mineral leases and patents, a share varying from 12.5 to 50 percent of grazing fees and leases, and 4 percent of the income from land and materials sales. Counties in which O&C timberlands are located receive 75 percent of the income but voluntarily return 25 percent to the Federal treasury for investments in O&C land management.

Mineral-resource plans revealed

A five-year forecast of mineral-resource development is now available for the first time concerning BLM activities in Oregon and Washington. The 56-page report describes important Pacific Northwest minerals, their present status, and BLM forecasts for the agency's five-year plans. BLM manages mineral and energy resources on approximately 53 million acres of public lands and is minerals trustee for more than 3 million acres of Native American lands in Oregon and Washington.

Patrick Geehan, BLM deputy state director for mineral resources, expects an increase, by 1990, of approximately 15 percent in agency work devoted to mineral resources, mostly in oil-and-gas, geothermal, and hard-rock-mining programs. The anticipation of more activity in these fields is reflected in specific forecasts in the report:

There will be at least one new oil or natural gas commercial discovery in BLM's Spokane or Salem districts by 1990.

There will be no unusual new demand for geothermal leasing, but emphasis will shift from leasing to exploration, probably on the flanks of the Cascades.

Coal exploration will continue west of the Cascades.

Gold prices will rise and thus lead to consequent rising activity in mining claims.

Demand for sand and gravel and for non-energy leasable minerals such as potassium, sodium, and phosphates will remain about the same, while the market for uranium is depressed now and will likely remain so for some time.

Geehan said that the agency welcomes comments from the public both on description of mineral terrains and interpretation of future BLM needs.

— Compiled from BLM news releases

Fireballs sighted

The following fireballs were seen in the skies over Oregon and reported to Dick Pugh in the recent months:

November 4, 1985, observation by Erica Nissel at 7:55 p.m. PST in the Portland area, Multnomah County, where there were many city lights. The fireball was first seen 5° east of north at an altitude of 45° and last seen 5° west of north at an altitude of 35°. The duration of the event was 3 seconds. The extremely bright, silver-white, oval fireball was half the size of the full moon and had a silver-white tail that covered the full length of the path. The observer heard a whistling sound during the last third of the event.

November 13, 1985, observation by Gordon Bolton at 10:14 p.m. PST, 2 km north of Forest Grove, Washington County. The fireball was first seen 30° east of south at an altitude of 40° and last seen 60° east of south at an altitude of 10°. The duration of the flight was 3 seconds. The yellow-white fireball, which was four times the diameter of Venus, had a short yellow tail. No sound was heard, no breakup was observed, and the fireball did not cast a shadow.

These sightings have been reported to the Scientific Event Alert Network, Smithsonian Institution. Anyone with any additional information about these or other fireball sightings should contact Dick Pugh, Cleveland High School, 3400 SE 26th Avenue, Portland, OR 97202, phone (503) 233-6441. □

North Santiam mining area — additional information

We are supplying here some information that should have been part of the article and field trip guide on the North Santiam mining area published in the December 1985 and January 1986 issues of Oregon Geology:

ACKNOWLEDGMENTS

The authors gratefully acknowledge the cooperation and support of Shiny Rock Mining Company and its president, George Atiyeh, who made this project possible. The discussion and road log were abstracted from a paper prepared for the Penrose Conference titled "Geochemistry of the Environment Near a High-Level Nuclear-Waste Repository" that was held at Rippling River Resort near Mount Hood, September 9-14, 1984. George Priest reviewed an early draft of this manuscript.

REFERENCES CITED

Hammond, P.E., 1979, A tectonic model for evolution of the Cascade Range, *in* Armentrout, J.M., Cole, M.R., and TerBest, H., Jr., eds., Cenozoic paleogeography of the western United States: Pacific Coast Paleogeography Symposium 3, Anaheim, Calif., Society of Economic Paleontologists and Mineralogists, Pacific Section, p. 219-237.

Hammond, P.E., Anderson, J.L., and Manning, K.J., 1980, Guide to the geology of the upper Clackamas and North Santiam Rivers area, northern Oregon Cascade Range, *in* Oles, K.F., Johnson, J.G., Niem, A.R., and Niem, W.A., eds., Geologic field trips in western Oregon and southwestern Washington: Oregon Department of Geology and Mineral Industries Bulletin 101, p. 133-167.

Wells, F.G., and Peck, D.L., 1961, Geologic map of Oregon west of the 121st meridian: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-325. □

***(Czyzewski,** continued from page 14)*

Committee. He has received "Distinguished Service" awards from the Oregon and national divisions of the American Consulting Engineers Council and the National Council of State Boards of Engineering Examiners. He was given several national Engineering Excellence awards and, in 1972, was named "Professional Engineer of the Year" by the Oregon Chapter of the National Society of Professional Engineers.

He is author of more than 50 published papers and technical discussions on metallurgy, mechanics, and research and development administration and has been a member of many national and state boards and advisory committees.

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