Bulletin No. 50

FIELD GUIDEBOOK

COLLEGE TEACHERS CONFERENCE IN GEOLOGY

Sponsored by National Science Foundation

OREGON STATE COLLEGE
CORVALLIS, OREGON

June 15–27, 1959

Prepared under Direction
of
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1959

Price $1.50

FOREWORD

This Centennial year, marking Oregon's first 100 years of statehood, may well be considered to mark the first 100 years since Oregon's pioneer geologist and missionary minister, Thomas Condon, began to explore the geology in the State. It seems fitting, therefore, to dedicate to the memory of Thomas Condon, this "Field Guidebook to Geologic Trips along Oregon Highways," which was prepared for immediate use by the 1959 College Teachers Conference in Geology and for future use by the interested public.

In the autumn of 1852, the young Reverend Condon and his wife, representing the Home Missionary Board of the Congregational Church, sailed from New York around the Horn to San Francisco, and from there continued their trip to Oregon. Mr. Condon was forced to leave behind him his geology books and his collections of rocks and fossils, which were his hobby. But once settled at his first church in St. Helens, Oregon, he soon began to observe the geologic formations about him, and noted in his first report to the Home Missionary Board that the village was "built on a bluff of porous volcanic rock." Although his early years of pioneer life in western Oregon left him little time for scientific research, he took time to collect a few rocks and fossils.

In 1862, the Condons moved to The Dalles, at that time the head of navigation on the Columbia River and gateway for gold miners and military personnel. It was here that Mr. Condon's interest in geology, particularly paleontology, began to be greatly aroused as he roamed the hills near his home. His first find consisted of excellent fossil leaves in a sandstone quarry near The Dalles, and later he found vertebrate bones twenty miles southeast of the settlement. These discoveries and his great enthusiasm for them awakened the interest of everyone around him, especially the military personnel.

In 1864, Captain John Drake and his soldiers, while on a military expedition against marauding Indians in central Oregon, camped at Beaver Creek. At this place, now known as the Bernard Ranch locality near Suplee, they collected fossils for Mr. Condon. These fossils later proved to be of Cretaceous age.

For the next ten years Condon collected widely in central Oregon and made frequent trips into Turtle Cove north of Picture Gorge and to other vertebrate localities. He sent much of his material east to experts for identification and corresponded with Blake, Newberry, Meek, Marsh, Cope, Leidy, and other noted geologists and paleontologists of the time. Several, including Marsh and Le Conte, visited him.

Later, Condon's studies took him all over Oregon. His remarkable fossil collections and his observations on geology came to be a great stimulus to others and thus began the formal study of geology and paleontology in Oregon. He was made the first State Geologist in 1872 and in 1876 became Professor of Geology and Natural History at the University of Oregon. His volume "The Two Islands" published in 1902 was the first book on the geology of Oregon.

Most of the places described in the "Field Guidebook to Geologic Trips along Oregon Highways" and today easily reached by automobile and paved roads, were probably visited long ago by Thomas Condon who got there by much less luxurious methods. It is hoped that those using the Guidebook will derive as much enjoyment from the geology of Oregon as Thomas Condon did.

Hollis M. Dole
Director

May 25, 1959

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ACKNOWLEDGMENTS

HOW TO USE THE GUIDEBOOK

This Guidebook has been prepared with a dual purpose in mind. First, to serve as a guide and reference book for college teachers of geology participating in the National Science Foundation sponsored conference. Second, to serve as a guide to the professional geologist and the layman who has an interest in geology and is desirous of visiting parts of Oregon that have particular geologic significance.

The Guidebook contains the road logs of seven trips, representing a total of 1,100 miles of geology along Oregon highways. The seven trips are as follows:

(1)   Corvallis to Newport via Depoe Bay.
(2)   Eugene to Coos Bay via Reedsport.
(3)   Corvallis to Prineville via Bend and Newberry Crater.
(4)   Prineville to John Day via Mitchell.
(5)   John Day to upper Bear Valley.
(6)   Logdell to Pine Creek (Jurassic).
(7)   Picture Gorge to Portland via Arlington.

In following the road logs, the hour hand position of the clock designates directions. For example, beginning at Corvallis, 12 o'clock represents the direction ahead on the road, so 9 o'clock would be to the left and 3 o'clock to the right. If traveling toward Corvallis, the reverse would be true. Accumulative mileage is stated in the first column of the log and is referred to the starting point of the trip. Interval mileage is listed in the second column, which enables the user to start or finish the trip at any point.

Geologic strip maps, as well as cross sections and other illustrations, accompany the trip logs to help clarify the geology. The position of each map in relation to the trip route is indicated on index maps and also in the logs. Absence of geologic maps for any trip or part of a trip generally indicates the absence of geologic mapping in that area.

The correlation charts in the Guidebook include many formations occurring in Oregon. All formations are briefly identified in the alphabetical list with the charts. Those formations encountered on the trips, however, are described in more detail. These descriptions appear under the heading "Stratigraphic Sequence," with the formations arranged from youngest to oldest and grouped according to the region in which they occur. They will be found accompanying the appropriate trips.

AN OUTLINE OF GEOLOGY AND MINERAL RESOURCES
By the Staff
State of Oregon Department of Geology and Mineral Industries

GEOLOGY

Paleozoic Rocks

Oregon's earth surface has a history dating back more than 400 million years. Ancient schists in southern Jackson County and limestone in Grant and Crook counties, although not dated with certainty, are probably the oldest rocks in the State and may be as old as the Devonian period of the Paleozoic.

In late Paleozoic time (Carboniferous and Permian periods), Oregon was invaded by shallow seas. Products of erosion and volcanism were deposited on the sea floors along with shells, corals, and other limestone-forming materials. Subsequently these deposits were subjected to rock-forming processes. Today, limestone, marble, shale, slate, sandstone, and volcanic rocks of Paleozoic age are exposed in the Wallowa and Blue mountains of northeastern Oregon and in the Suplee region of central Oregon where they have been uplifted, folded, and faulted by mountain-building processes. The thick sections of these ancient rocks are mute evidence of the almost inconceivable time required to form and emplace them. Typical fossils in Oregon's Paleozoic rocks are brachiopods, corals, and fusulinids, as well as a few remains of extinct trees such as fern and calamites.

Mesozoic Rocks

Rocks of the Mesozoic era formed between 200 and 100 million years ago. Such rocks are sub-divided into Triassic, Jurassic, and Cretaceous systems. They cover large areas of northeastern, central, and southwestern parts of Oregon. These rocks include marine sediments, volcanics, and igneous intrusions. The sedimentary rocks were deposited in shallow seas and basins that covered much of the State. In south-western Oregon, late Jurassic to early Cretaceous shales, siltstones, and conglomerates have wide distribution and serve as important stratigraphic units for the field geologist. Large areas in southern Grant County and also in Baker and Wallowa counties are occupied by Triassic and Jurassic limestones and shales. Cretaceous sandstones occur in patches in southwestern Oregon, and in central Oregon. Fossil animals of the Mesozoic in Oregon include a few remains of marine reptiles and a great abundance of mollusks of which ammonites, aucellas, and trigonia are typical. Fossil plants are chiefly cycads and ginkgos.

Widespread ultrabasic igneous rocks of peridotite and serpentine are exposed in the Greenhorns and the Strawberry Range in Grant and Baker counties, and in the Klamath Mountains of Douglas, Jackson, Josephine, and Curry counties. The ultrabasic rocks are important economically because of their associa-tion with chromite and nickel deposits. In late Mesozoic times granitelike igneous rocks were intruded into older rocks both in the northeastern and southwestern parts of the State. These rocks are associated with some of Oregon's metallic mineralization.

Cenozoic Rocks

The youngest geologic era is the Cenozoic. This era is so well represented in Oregon and therefore of special interest to students of the earth sciences that some descriptive detail is warranted. The Cenozoic has two main divisions called the Tertiary and Quaternary periods. The Tertiary time interval is much the greater, probably ranging from 60 million down to 1 million years ago. The Quaternary, the age of man, began at the close of the Tertiary and includes time down to and including the present. The Oregon Tertiary period is subdivided into epochs known from oldest to youngest as Eocene, Oligocene, Miocene, and Pliocene. Tertiary rocks are represented by thick sections in the State, except in the interior of Curry and Josephine counties where they have only limited extent. The Quaternary period is subdivided into the Pleistocene epoch, or Ice Age, and the Recent epoch with the Pleistocene occupying much the larger proportion of time.

Eocene: During the Eocene epoch, 60 to 40 million years ago, western Oregon was covered by a shallow sea where thousands of feet of volcanic rocks and sediments accumulated. These rocks now make up most of the Coast Range and crop out along the western part of the Willamette Valley. Some of the Eocene marine beds contain fossil shells. Late Eocene brackish-water deposits in the Coos Bay area contain

coal beds. On the land east of the sea (central and eastern Oregon) rocks ejected from numerous active volcanoes produced the Clarno formation. This formation is composed of a thick series of lava flows, agglomerates, and volcanic ash, together with lenses of sediments deposited in lake basins. These sediments contain abundant fossil remains of semitropical plants such as palms, figs, and pecans, indicating a warm humid climate throughout the State and the absence of a climatic barrier such as the Cascade Range of today. Recent discoveries have been made in the Clarno formation of fossil remains of rhinos, 4-toed horses, tapirs, crocodiles, and other animals.

Oligocene: In Oligocene time, 40 to 30 million years ago, the sea spread into Oregon as far east as the present Cascade Range and a little south of Eugene. Since the Cascade Range was not yet in existence, the ancestral John Day, Crooked, and Deschutes rivers flowed westward across the State directly into the sea. Thick deposits of tuffaceous shales and sandstones were laid down on the sea floor together with a wide variety of marine shells. These fossiliferous rocks are now exposed in northwest Oregon and throughout the Willamette Valley. On land, volcanoes erupted lavas and explosive materials, particularly in the region now occupied by the Cascade Range. Volcanic ash was carried many miles by the wind and deposited in lakes and basins, and was the cause of the preservation of a large amount of plant and animal remains. Of special interest are the formations in the John Day River valley where down-cutting by the river has exposed high jagged cliffs of green, red, and buff volcanic tuffs. Fossil remains, first collected from these tuffs by Dr. Thomas Condon, who later established the department of geology at the University of Oregon, have become world famous, and a State park bearing his name has been established on the John Day River. A large variety of plants and animals, many of which have long been extinct, have been excavated in these John Day beds. The vertebrate fossils are especially outstanding and may be seen in museums throughout America and Europe.

Miocene: The Miocene epoch, ranging from 30 to 15 million years ago, marked the withdrawal of the sea from western Oregon except for embayments along the coast and at the mouth of the Columbia River where fossiliferous marine shales and sandstones were deposited. Such deposits in Lincoln County contain bones of whales and sea lions as well as an abundance of fossil shells. During this epoch, volcanism continued to pile up lavas, tuffs, and other volcanic rocks in the Cascade region. Volcanic eruptions showered the John Day country with ash which aided in preservation of still more fossil plants and animals. The dawn redwood was the dominant tree of the epoch, and animals included giant pigs, oreodonts, 3-toed horses, giraffe-camels, antelopes, rodents, and carnivores.

Probably the most outstanding event in Miocene time occurred during the middle of the epoch when the basaltic lavas poured out flow upon flow over extensive areas, particularly in northeastern Oregon and southeastern Washington, to form the famous Columbia River basalt formation which is exposed so strikingly in the Columbia River Gorge and in the canyon of the Snake River. Deep chemical weathering of the top flows of this basalt in northwestern Oregon resulted in the formation of large deposits of high-iron bauxite, an ore of aluminum. Limonite bog iron deposits in Columbia County are also associated with these lavas.

Pliocene: The Cascade Range was born in late Miocene to early Pliocene time. It grew in height along a north-south belt due to the accumulation of lava from large shield volcanoes together with regional uplift. The high snow-clad peaks we see today, however, were formed by still later eruptions mainly in the Pleistocene epoch. Building of the Cascades caused a climatic revolution in Pliocene time. The mountains became an obstacle to the course of moisture-laden air from the ocean forcing it to lose its moisture on the western side of the range. Thus the formation of the Cascade Range represented not only a physiographic boundary but also a separation of the State into two distinct climatic provinces. Western Oregon continued to be a region of mild humid climate, thick vegetation, and large rivers. Eastern Oregon, on the other hand, developed a semi-arid to arid climate with meager vegetation. Forests gave way to wide grasslands populated with horses, camels, and antelopes. Rivers which once flowed westward across the Cascade region were now deflected in other directions, and some became ephemeral. Where lakes existed in central Oregon, minute aquatic plants with siliceous skeletons formed beds of white diatomite.

In Pliocene time nearly the whole of south-central and southeastern Oregon was buried under sheets of lava on as grand a scale as the Columbia River lavas of the preceding epoch. Later these lavas were broken up into a mosaic of block-fault mountains such as the Steens Mountain and Abert Rim. In western Oregon, uplift of the Coast Range caused the ocean to recede leaving only small embayments where marine sediments and shells were deposited, as at Cape Blanco and Coos Bay.

Pleistocene: Late in Pliocene time the climate of Oregon became much cooler. At high altitudes permanent snow fields grew thicker and larger until they became glaciers. This marked the beginning of the Pleistocene epoch or Ice Age, which began about 1 million years ago.

One of the outstanding events of the Pleistocene epoch in Oregon was the eruption of a row of large volcanic cones, extending from Mount Rainier in Washington to Mount Shasta in California. Volcanoes, such as Mount Hood, Mount Jefferson, and Mount Mazama, were superimposed on top of the older Cascade Range. From their bases, streams of lava poured down valleys on both sides of the Cascades. Glaciers near their peaks sent tongues of ice for many miles down the flanks of the cones, gouging out the rock and giving the volcanoes their present jagged outlines.

In southwestern and northeastern Oregon, rivers eroded rocks containing mineral veins, redepositing the heavier minerals such as gold and platinum in gravels along their courses. Along the Oregon coast, the ocean receded and left notable terraces containing black sand, particularly in Coos and Curry counties. The Willamette Valley had become a structural trough between the rising Coast and Cascade ranges, and for a short time during the Ice Age it was filled with flood waters from melting continental glaciers far to the north. Normally this trough was occupied by the meandering Willamette River, and the region was inhabited by elephants, mastodons, and ground sloths whose fossil teeth and bones are found in silt and peat deposits. In southeastern Oregon large lakes occupied down-faulted valleys. Their former extent is seen in ancient shore lines more than 200 feet above present-day remnants such as Summer, Goose, Abert, and Warner lakes. In this region fossil bones of Pleistocene mammals, birds, and fresh-water shells are found in old lake beds. Deposits of alkali salts are associated with the drying up of these lakes.

Recent: During the last 25,000 years, representing the Recent epoch, there have been a number of notable geologic events in Oregon. The majestic Mount Mazama, a huge volcanic cone towering to a height of 12,000 feet, was probably a familiar landmark of the early Indians in central Oregon. This volcano erupted with great violence about 7,000 years ago with such rapid removal of magma beneath it that the top collapsed forming the present Crater Lake caldera. Explosion was accompanied by avalanches and showers of pumice and ash which spread over a vast area in central Oregon. Newberry Crater was formed in a similar way by the explosion of Newberry Volcano, driving Indians from their caves in Fort Rock. Final eruptions of these two volcanoes occurred between 1,000 and 2,000 years ago. Final eruptions of South Sister are believed to have taken place less than 1,000 years ago. Elsewhere along the crest of the Cascades as well as in the Bend region there have been numerous small lava flows and cinder cones, some of which may have formed only a few centuries ago. One of the most spectacular flows is the desolate region of tortuous black lava at McKenzie Pass. In far eastern Oregon, the Diamond and Jordon craters are surrounded by wastes of black basaltic lava that is centuries old but looks as though it had just congealed.

Within historic times, small volcanic eruptions have occurred on Mount Shasta and Mount Lassen in California and on Mount St. Helens in Washington. None are definitely known for Oregon, but this is no proof that our volcanoes are extinct. Volcanism appears to be dying out, however, in this part of the world.

Other significant events have taken place in recent times: Glaciers have shrunk to small remnants at high elevations. Streams have eroded canyons in mountainous regions and have filled valleys and basins with sediment. Landslides have occurred in areas of steep slope and incompetent rock. The ocean has worn away projecting points of land leaving many isolated off-shore rocks. And the wind has built sand dunes along the coast. Even man has succeeded in changing the shape of part of the topography and some of his activity has been very helpful to the geologist. Wherever man makes a deep cut through rock strata for a highway or excavates a quarry, he reveals in cross section a segment of the geologic history of Oregon.

MINERAL RESOURCES

Metals
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Mineral deposits are directly related to the geology and rock types of the State. The gold and silver mines of northeastern and southwestern Oregon are associated with pre-Tertiary rocks. Copper, lead, and zinc deposits, with accessory gold and silver, occur both in Tertiary rocks of the Cascades and the pre-Tertiary rocks of southwestern Oregon. Some copper deposits, all of the chromite, and the nickel deposits are associated with the ultrabasic rocks of central and southwestern Oregon.

Mercury deposits occur widely distributed throughout the State and have been found in many different kinds of rocks. However, commercial deposits are confined to Tertiary rocks. There are three general mercury areas in the State - namely, the western foothills of the Cascades; central Oregon, especially the Ochoco Mountains area; and the extreme southeastern part of Harney and Malheur counties. Oregon is one of the five states in the Nation which produce mercury. Volume of production varies greatly from year to year due to price fluctuation.

Limonite iron ore deposits occur within basalt formations in Columbia and Clackamas counties. Limonite ear Scappoose in Columbia County is mined for paint pigment. For 27 years before 1900, limonite near)swego in Clackamas County was used as a source of iron.

Ferruginous bauxite is found at the top of Columbia River basalt in several northwestern counties. The bauxite deposits have been explored extensively in Washington, Columbia, and Marion counties.

The only nickel mine in the United States is located near Riddle in Douglas County. The nickel silicate ore is mined in a large open pit and trammed down to a smelter which produces ferronickel alloy. Approximately 1 million tons of ore containing 1.5 percent nickel are mined annually.

Gold was discovered in Oregon in 1852 and for many years it contributed the bulk of the State's mineral wealth. Gold mines were shut down during World War II by a government order since declared illegal by the courts, and only a few have reopened. The "freezing" of the price of gold at 1934 levels and increased mining costs are other factors in the decline in gold production.

Uranium ore was discovered near Lakeview in 1955. Subsequent exploration and development of the deposit revealed ore of commercial grade and tonnage. The U.S. Atomic Energy Commission approved the construction of a concentration plant late in 1957. Other occurrences of uranium are known in Crook and Harney counties.

Nonmetallics
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Limestone of high purity is found in large deposits of pre-Tertiary age in the northeastern and southwestern parts of the State and is used primarily in making portland cement. Impure limestone of Tertiary age is found in the northern Willamette Valley. A lime-burning plant was constructed near Baker in 1957. High-grade limestone from a quarry 10 miles distant is trucked to the plant.

Coal of subbituminous rank associated with Tertiary sediments is widely distributed mostly in western Oregon. The largest field and the only one with an important production record is at Coos Bay. Fairly extensive but undeveloped coal seams crop out on Eden Ridge in southern Coos County.

Diatomite occurs in large deposits in several places in central, eastern, and south-central parts of the State. It has been produced and processed consistently for many years at a quarry on the Deschutes River near Terrebonne in Deschutes County.

Pumice, abundantly distributed over central Oregon, has been produced commercially from pits near Bend in Deschutes County and near Chemult in Klamath County. By far the largest production since World War II has been for lightweight aggregate.

Expanded shale which has found increasing utilization as lightweight aggregate since World War II is produced in two large plants in Washington County.

Silica as crushed quartz is produced at a plant at the town of Rogue River in Jackson County.

Excellent refractory clays occur at Hobart Butte in Lane County and near the town of Molalla in Clackamas County, but at present are not in commercial production. Common clays used in making brick and tile occur in several parts of the State. The greatest number of plants are in the northern Willamette Valley.

Oregon is one of the principal semiprecious gem-producing states in the Union. It is famous for its agates, petrified wood, opal, jasper, and particularly the "thunder eggs" found in central Oregon. Each year thousands of rockhounds search for these gems, from the beaches to the easternmost parts of the State. The value of semiprecious gems produced annually is estimated to be $1,000,000.

Metallurgical Plants

Electro-process metallurgical plants have increased steadily in number and value of production since World War II. Included in the list of metallurgical products are: aluminum, elemental silicon, ferronickel, ferrosilicon, calcium carbide, titanium, zirconium, hafnium, and steel. Many of the raw materials used in the State's metallurgical plants originate outside the State and are shipped here for processing largely because of the low-cost electric power.

Mineral Production

Gold accounted for the bulk of the State's mineral wealth for almost 90 years, but began a rapid decline in the period 1942 to 1945. Today the value of gold produced annually is less than $100,000. The annual value of nickel production is greater than gold ever was. A booming construction period since 1945 saw sand and gravel production rapidly expand to the point where its value is greater than any other mineral commodity. If the value of all of the metals treated in metallurgical plants in the State is considered, the total far exceeds that of sand and gravel, and Oregon's metallurgical industries are still growing in size and number.

MAP OF OREGON
SHOWING
GEOMORPHIC DIVISIONS

SCALE OF MILES
0   10   20   30   40   50

PACIFIC OCEAN

ASTORIA

COASTAL PLAIN

TILLAMOOK

PORTLAND

THE DALLES

PENDLETON

PLATEAU

JOSEPH UPLAND

CANYON

UMATILLA

DESCHUTES

ENTERPRISE

COAST RANGE

SALEM

WILLAMETTE VALLEY

RANGE

Cascades

Western

High

Cascades

MOUNTAINS

Wallowa Mts.

Elkhorn

BAKER

Greenhorn

Mts.

SNAKE RIVER

BLUE

Ochoco Mts.

JOHN DAY

Strawberry Mts.

EUGENE

BEND

HIGH

VALE

LAVA

PLAINS

OWYHEE

ROSEBURG

CASCADE

UPLAND

Steens Mts.

ROME

BASIN   —   RANGE

Pueblo

FIELDS

KLAMATH   GRANTS PASS

MOUNTAINS   MEDFORD

Siskiyou Mts.

KLAMATH FALLS

LAKEVIEW

STATE OF OREGON
Department of
GEOLOGY
and
MINERAL INDUSTRIES

Index Map of Oregon Showing General Location of Cenozoic Stratigraphic Columns.

	PACIFIC COAST STANDARD SECTION after Weaver, et al., 1944; Moore, et al., 1956		NORTHWESTERN OREGON after Warren, Norbisrath, and Grivetti, 1945; Lowry and Baldwin, 1952	PORTLAND, OREGON AREA after Treasher, 1942; Watkins, Griffin, and Swenson, 1956; Trimble, 1957; Baldwin, 1957	YAQUINA BAY AREA after Schenck, 1928; Vokes, Norbisrath, and Snavely, 1949	COOS BAY AREA after Turner, 1938; Allen and Baldwin, 1944; James, 1950	EUGENE - CORVALLIS AREA after Vokes, Snavely, and Myers, 1951; Vokes, Myers, and Hoover, 1954
RECENT and UPPER PLEISTOCENE	Terrace materials and Bay Point Formation		Alluvium and dunes / Elk River beds and lower terraces / Portland sands and gravels	Alluvium / Clackamas terraces / Portland sands	Alluvium and dunes / Elk River beds / Coquille Formation	Alluvium and dunes / Elk River beds / Coquille Formation	Alluvium
PLIO-PLEISTOCENE	Tulare Formation / San Joaquin Clay		Terraces	Glacial outwash / Boring lavas	Terraces	Terraces / Port Orford Formation	Weathered gravels
PLIOCENE	Etchegoin Formation		Portland Hills Silt / Troutdale Formation	Troutdale Formation / Rhododendron Formation	hiatus	Empire Formation	hiatus
MIOCENE	Jacalitos Formation / Neroly Formation / Cierbo Formation		"Upper Miocene" beds / Columbia River Basalts	Columbia River Basalts	Post-Astoria volcanic rocks	Miocene beds.	Columbia River Basalts
MIOCENE	Diatom Mont. / Monterey shale	Briones Fm. / Temblor Fm.	Astoria Formation		Astoria Formation		
OLIGO-MIOCENE		Vaqueros Fm.		hiatus	Nye mudstone		gabbro and diorite intrusives
OLIGO-MIOCENE	Kreyenhagen shale	Blakely Fm.	Scappoose Formation		Nepheline syenite intrusives		Goshen plant-bearing tuffs
OLIGOCENE		Lincoln Fm.	Pittsburg Bluff Formation		Yaquina Formation	Tunnel Point Formation	Eugene Formation / tuffs
OLIGOCENE		Keasey Fm.	Keasey Formation		Toledo Formation	Bastendorff Formation	
UPPER EOCENE	Conoos Fm.	Tejon Fm.	Cowlitz Formation	Goble volcanic series	Moody shale member	Coaledo Formation	Fisher Formation / Spencer Formation
MIDDLE EOCENE	Domengine Formation		Yamhill Formation		Tyee (Burpee) Formation	beds of Sacchi Beach / Tyee Formation	Lorane shale member / Tyee Formation
LOWER EOCENE	Capay Formation		Tillamook volcanic series (base not exposed)	not exposed	Siletz River volcanic series (base not exposed)	Umpqua Formation / volc. rocks	Kings Valley siltstone memb. / Siletz River volcanic series (base not exposed)
UPPER PALEOCENE	Meganos Formation				not exposed	not exposed	not exposed
LOWER PALEOCENE	Martinez Formation						

SUGGESTED CORRELATION CHART FOR THE COAST RANGE CENOZOIC OF OREGON By D. O. Cochran

	COLUMBIA RIVER GORGE after Williams, 1916; Allen, 1932; Hodge, 1938	NORTH SANTIAM RIVER after Thayer, 1939; Lowry and Baldwin, 1952	McKENZIE RIVER after Callaghan and Buddington, 1938; Williams, 1953	SOUTHERN CASCADES after Williams, 1953 and 1957; Wells, 1955 and 1956
RECENT and UPPER PLEISTOCENE	Alluvium Portland sands and gravels	Alluvium terraces	Alluvium terraces	Alluvium terraces
PLIO-PLEISTOCENE	Mt. Hood and related flows, agglomerates, and tuffs. Cascade andesite (Cascan)	Mt. Jefferson and related flows, agglomerates, and tuffs. Cascade andesite (Cascan)	Three Sisters and related flows, agglomerates, and tuffs. Cascade andesite (Cascan)	Mt. Mazama and related flows, agglomerates, and tuffs. olivine basalts
PLIOCENE	Troutdale formation Rhododendron formation	Fern Ridge tuff Rhododendron formation	tuffs and agglomerates Rhododendron formation	hiatus
MIOCENE	Columbia River basalt Eagle Creek formation	Columbia River (Stayton) basalt Molalla formation	hiatus	Heppsie andesite
OLIGO-MIOCENE		Mehama formation	Nimrod granite	dioritic intrusives
OLIGOCENE	hiatus	Illahe (Eugene) formation Sardine lavas	Eugene formation — tuffs and aggls.	undifferentiated flows, tuffs and agglomerates; Little Butte volc. series; Wasson and Roxy fms. Upper Calapooya formation
EOCENE	Goble volcanic series	Breitenbush tuffs	Fisher formation	Lower Calapooya (Colestin) fm.

SUGGESTED CORRELATION CHART FOR THE CASCADE RANGE CENOZOIC OF OREGON By D. O. Cochran

SUGGESTED CORRELATION CHART FOR EASTERN OREGON CENOZOIC By D. O. Cochran

	MAMMALIAN CENOZOIC STAGES	JOHN DAY VALLEY after Stock, 1946; Thayer, 1956	HARNEY BASIN after Piper, et al., 1939	STEENS-PUEBLO MOUNTAINS after Merriam, 1910 Fuller, 1931; Cochran, unpubl.	OWYHEE RIVER after Bryan, 1929; Kirkham, 1931; Baldwin and Corcoran, unpubl.	DESCHUTES-UMATILLA PLATEAU after Hodge, 1931 and 1942; Williams, 1957
RECENT and UPPER PLEISTOCENE	Rancho la Brea	Alluvium	Alluvium / Diamond Craters volcs.	Alluvium / Mesa basalts	Alluvium / Cow Lake volc. rks.	Alluvium / glacial gravels
PLIO-PLEISTOCENE	Irvingtonian	hiatus	Terrace deposits		Inner Canyon flows	Madras fm. — Not in contact
	Blancan		Harney fm.	Thousand Creek fm.	Grassy Mtn. basalt / "Up. Idaho" fm. – Rome bed.	Shutler fm.
PLIOCENE	Hemphillian	fanglomerates	fanglomerates		hiatus	Dalles fm.
	Clarendonian	Rattlesnake fm.	Danforth fm.	Danforth (?) fm.		
		Mascall fm.		Virgin Valley fm.	"Lower Idaho" fm. (Pinnacle Pt.)	
	Barstovian	Columbia River basalt	Steens basalt / older rhyolites	Canyon Rhyolite fm. / Steens basalt / Steens Mts. Volc. Srs. / Pike Cr. fm. / Alvord Creek fm.	Owyhee basalt / Payette fm.	Columbia River basalt
MIOCENE	Hemingfordian		base not exposed	base not exposed	base not exposed	
	Arikareean	Upper John Day fm.				Upper John Day fm.
OLIGO-MIOCENE		Middle John Day fm.				Middle John Day fm.
	Whitneyan	Lower John Day fm.				Lower John Day fm.
OLIGOCENE	Orellan					
	Chadronian					
	Duchesnean	Clarno fm.				Clarno fm.
EOCENE	Uintan					
	Bridgerian					
	Wasatchian					

Alvord Creek formation (Fuller, 1931) 800 to 1000 feet thick. Well-stratified acidic tuffs, predominantly white; with a 100± foot basic andesite flow near the top. Consists of descending: 1. white tuff, 2. flow of basic andesite, 3. white tuffaceous sediments with flora, 4. buff,stratified tuff, 5. brownish tuffs. Flora correlates with Mascall (Chaney).

Astoria formation (Cope, 1880) 1400± feet thick. Dominantly a gray- to bluish-gray, soft, medium- to fine-grained feldspathic or tuffaceous sandstone. Micaceous sandy shales are commonly interbedded with the sandstone, and dark greenish-gray conglomerate is locally present. A few beds of light-gray to white fine-grained tuff are also present. Calcareous, sandy concretions are common in the lower part of the formation. Fauna:
- Acilia (Truncacila) conradi (Meek)
- Nucula washingtonensis (Weaver)
- Nuculana chehalisensis (Weaver)
- Nuculana ochsneri elmana (Etherington)
- Natica (Tectonatica) oregonensis (Conrad)
- Natica (Tectonatica) saxea (Conrad)
- Polinices (Neverita) inezana (Conrad)
- Crepidula praerupta (Conrad)

Bastendorff shale (Schenck, 1927) 2300 feet thick. Thinly laminated, blue to steel-gray shale streaked by lighter thin tuffaceous beds with some thin strata of carbonaceous sandy shale and feldspathic sandstone. Fauna:
- Uvigerina sp.
- Bulimina sculptilis (Cushman)
- Bulimina jacksonensis
- Coscinodiscus sp.

Boring lava (Treasher, 1942) A product of local volcanic action, characteristically a light-gray, open-textured, (diktytaxitic) olivine basalt. Light-brown altered olivine (iddingsite) phenocrysts are characteristic. Flow structure is common. Incorporated pebbles derived from the Troutdale formation are not uncommon. Vugs in the lava contain optically positive hornblende, pargasite, which includes both edenite and hastingsite, hedenbergite, tridymite, olivine, and hematite.

Breitenbush tuffs (Thayer, 1939) 7500 feet thick. Water-worked land-laid tuffs, breccia, conglomerate, and interlayered lava flows. "Leaves" of evergreen and deciduous trees are present.

Calapooya formation (Wells and Waters, 1934) 5000+ feet thick. Conglomerates, tuff, breccia, and lava flows in Black Butte- Elkhead area. Consists in some places mainly of true volcanic breccias; in other places it is largely fine tuff, while elsewhere flows ranging from basalt to dacite occur. Upper part contains the majority of lavas.
    Lower part (Calestin formation) contains thick masses of conglomerate derived from volcanic rocks, waterworn tuffs, and a few interbedded flows.

Canyon "Rhyolite" formation (Merriam, 1910) 400+ feet thick - Cañon Rhyolite of Merriam. A highly silicic dense "rhyolite" with characteristics suggesting welding in some areas and with flow structures present elsewhere. Type area is Virgin Valley, Nevada.

Cascade andesite (Ira Williams, 1916; Hodge, 1931) 500 + feet thick. Andesite lavas and some agglomerates, tuffs, and ash.

Clarno formation (Merriam, 1901) 400+ feet thick. Shales, tuffs (waterlaid), with andesitic and rhyolitic lavas, volcanic agglomerates, sands and clays. Fauna: Uintatheres, Amynodon.

Coaledo formation (Diller, 1899) 6000 to 8000 feet thick. Upper: gray, medium- to fine-grained tuffaceous sandstone which contains less indurated carbonaceous sandstone members, sandy shale, carbonaceous shale, and coal. Concretions, as well as coarse sandstone, grit, and coarse grit lenses, occur in places.

1350-2770 feet thick. Middle: medium-gray tuffaceous shale with some sandy lenses; several beds of well indurated light-colored tuff present. 3000 feet thick. Lower: blue-gray medium- to coarse-grained nodular sandstone predominates, with some grit and intercalated fine-grained sandy shale beds which are darker in color than the sands. The sandstone, which weathers to a buff color, is tuffaceous, and many of the pebbles in the few conglomerate lenses are of fine-grained basaltic material. Mud cracks, coal beds, and coarse cross-bedded sand lenses indicate shallow water to nonmarine conditions of deposition. 1775-1900 feet thick. Fauna:

Echinodermata	Foraminifera - Upper Coaledo
Eoscutella coosensis (Kew)	Ammobaculites cf. hockleyensis (Cushman and Applin)
Pelecypoda	Quinqueloculina cf. minuta (Beck)
Tracia dilleri (Dall)	Robulus inornatus (d'Orbigny)
Venericardia hornii (Gabb)	Foraminifera - Lower Coaledo
(subsp. clarki (Weaver and Palmer)	Cyclammina pacifica (Beck)
Lucina (Here) aragoensis (Turner)	Quinqueloculina imperialis (Hanna)
	Marginulina cf. subbullata (Hantken)

Columbia River basalt (Russell, 1893) 300 to 4000+ feet thick. (Stayton volcanics) Dark gray to black, finely crystalline basalt. Columnar basalt flows in places interbedded with pyroclastic material and sediments. (On the map legends of the Guidebook, "Coriba" has been used for Columbia River basalt merely as a matter of convenience and to save space.)

Coquille formation (Baldwin, 1945) 95 feet thick. Basal thin-bedded sandy clay, wood-bearing and peaty cross-bedded sands, and overlying conglomerate.

Cow Lake volcanic rocks (Baldwin and Corcoran, unpublished).

Cowlitz formation (Weaver, 1912) 1000 feet thick. Upper: Dark gray, fossiliferous shales and fine-grained micaceous, shaly sandstone with much interbedded, tuffaceous sandstone and greenish-gray, waterlaid tuff. The tuffs are commonly cemented with calcite which causes them to weather out as resistant bonds. Gastropods are common in these tuffaceous zones although mollusks are scattered throughout the upper zone. The shales contain Forminifera. Middle: Gray, massive and stratified, fine- to medium-grained, micaceous sandstone containing much fragmental plant material. In places the sandstone member is massive but generally is fairly well stratified. May have calcareous concretions up to 3 feet long. Fossils seldom found except at base. Lower: Dark-gray, well-stratified, brown-weathering, fossiliferous claystone and siltstone containing a mixture of much white volcanic ash. Foraminifera and Mollusca are common. The shale generally weathers to a brown, soft, greasy, crumbly, decomposed shale, which may show slight stratification. Base: Well-indurated, rust-stained, pebble, cobble, and boulder conglomerate, locally fossiliferous. The conglomerate was derived almost entirely from volcanic material.

Fauna:	Pelecypods	Foraminifera
	Acila decisa (Conrad)	Bulimina ovata cowlitzensis (Beck)
	Glycymeris eocenica (Weaver)	Cibicides natlandi (Beck)
	Gastropods	Cyclammina pacifica (Beck)
	Exilia dickersoni (Weaver)	
	Ficopsis cowlitzensis (Weaver)	

Dalles formation (Cope, 1880; Condon, 1902) 1000 to 1500 feet thick. Gravels, sands, and silts resting unconformably on Columbia River basalt. Sands are white to gray in color.

Danforth formation (Piper and others, 1939) 20 to 800 feet thick. In the southern part of the Harney Basin the unit displays four local facies: 1. a distinctive tuff breccia member, purplish-gray and massive with a vitreous brownish-gray matrix enclosing abundant unoriented fragments of white pumice, black obsidian, and massive inflated rhyolite; 2. a member of basaltic breccia and associated siltstone, sandstone, conglomerate, and two intercalated sheets of basalt; 3. stratified siltstone, sandstone, and ash; and 4. spherulitic rhyolite. Fresh water fauna are Pisidium sp., Flumincola fusca (Haldeman), and Gyraulus parvus (Say).

Diamond Crater volcanic rocks (Piper and others, 1939) 750 feet± feet thick. Basalt flows and scoria; type locality, Diamond Craters, Harney County.

Eagle Creek formation (Ira Williams, 1916) 500 to 2700 feet thick. Volcanic materials: tuffs, breccias, agglomerates, and lava flows. Vitrophyric, fine-grained or porphyritic. In order of importance, lava types are: pyroxene andesite, hornblende andesite, trachy-andesite, pyroxene trachyte, pyroxene basalt, hornblende basalt, and olivine basalt.

Elk River beds (Diller, 1902) 20-90 feet thick. Basal gray sand with overlying rusty grovels.

Empire formation (Diller, 1896) 3000 feet thick. Massive poorly bedded sandstone with minor interbeds of siltstone and a prominent fossiliferous conglomerate lens (Coos conglomerate). Fauna (representative):

Echinodermata	Pelecypoda
Echinanchnius blancoensis (Kew)	Nuculana impressa (Conrad)
Anorthoscutum oregonense (W.B.Clark)	Nuculana acuta (Conrad)
Anorthoscutum oregonense (W.B.Clark)	Nuculana whitmani (Dall)
vor. semigibbosus (Howe)	Scaphopoda
Molluscoidea	Dentalium petricola
Acila (Truncacila) conradi (Meek)	Gastropoda
Acila (Truncacila) empirensis (Howe)	Calliostomo cammani (Dall)
Acila (Truncacila) blancoensis (Howe)	Turcica gabbi (Dall)

Eugene formation (Smith, 1924) 8000 to 15,000 feet thick. A marine arkosic to micaceous sandstone consisting primarily of unaltered andesine, euhedral pyroxene crystals and dark mica. Quartz is a minor constituent. The fresh dark olive to bluish-gray rock weathers to an orange-brown color. Fauna:

Nucula sp.	Acrilla (Ferminoscala) dickersoni (Durham)
Acila shumardi (Dall)	Epitonium (Boreoscala) condoni (Dall)
Nuculana washingtonensis (Weaver)	Epitonium (Bareoscala) condoni oregonense (Dall)
Yoldia (Kalayoldia) tenuissima (Clark)	

Fem Ridge tuffs (Thayer, 1933) 1500 feet thick. Conglomerate, tuff, and breccias. Lower beds mainly tuffs, sandstone, and fine pebble beds; upper portion comprises coarse andesitic conglomerate in a tuffaceous matrix.

Fisher formation (Schenck, 1927) 7000 feet thick. Continental deposits. Consisting of clastic, andesitic lapilli tuff, and breccias with basaltic and rhyolitic debris. Coarse waterlaid conglomerates as much as 50 feet thick are found in the lower part of the formation. There is wide variation in color of the tuffs from locality to locality. Colors range from medium-gray, grayish-blue, grayish-green, and grayish-red to grayish-olive and yellowish-brown.

Goble volcanic series (Warren and others, 1945) 5000 feet thick. A section of widespread basic flows and pyroclastic rocks. The basal part of the series appears to be interbedded with tuffaceous sediments which contain a Cowlitz (upper Eocene) fauna.

Grassy Mountain basalt (Bryan, 1929) 400+ feet thick. Black to greenish-black olivine basalt, commonly vesicular.

Harney formation (Piper and others, 1939) 750 feet thick. Massive basaltic tuff and breccia, sandstone, and siltstone; scoriaceous and massive basalt intercalated at a few horizons.

Heppsie andesite (Wells, 1956) Thickness unknown. Light-gray andesitic flows; porphyritic rock with a microcrystalline groundmass, and phenocrysts of feldspar and hornblende or pyroxene.

Illahe formation (Eugene equivalent) (Thayer, 1933, 1939) 360+ feet thick. Well-bedded tuffaceous massive sandstones ranging from pebble conglomerates to massive white ash and fine silts; fine-grained silty sandstones are most common. Weathers to light-brown sandy soil. Fauna:

Macrocallista pittsburgensis (Dall)	Nucula (Acilia rdi (Dall)

Inner Canyon flows (Baldwin and Corcoran, unpublished)

John Day formation (Marsh, 1875) 1000 to 1500 feet thick. Upper: andesitic tuffs, sand and gravels. Ignimbrite of rhyolitic composition. Fauna: Mesohippus, Elotherium, Nothoeyon. Middle: drab to red trachyte tuffs, basalt flows at base (Picture Gorge). Lower: red, white, and green tuffaceous shales. Archaeotherium, Elotherium.

Keasey formation (Schenck, 1927) 1800 to 2200 feet thick. Upper: Faintly stratified, sparingly fossiliferous, fine-grained tuffaceous sandstone and tuffaceous shale with bands of pebbles and fine tuff. Middle: Light-gray, unstratified, harsh, tuffaceous siltstone containing scattered well-preserved fossils, predominantly mollusca and foraminifera. Lower: Dark-gray, well-stratified, fossiliferous claystones and siltstones, with glauconitic layers. Fauna:

Pelecypods	Gastropods
Acila neholemensis (Hanna)	Exilia lincolnensis (Weaver)
Nemocardium weaveri (Anderson and Martin)	Epitonium keaseyense (Durham)
Scaphopods	Foraminifera
Dentalina	Eponides kleinpelli (Cushman and
Crinoids	Frizzell)
Isocrinus oregonensis (Moore and Vokes)	Planulina haydoni (Cushman and
Isocrinus neholemensis (Moore and Vokes)	Schenck)

Kings Valley siltstone member (Siletz River volcanic series) Vokes and others, 1954) 3000 feet thick. A tuffaceous siltstone in the uppermost part of the Siletz River volcanic series. It consists of dark greenish-gray tuffaceous siltstone and sandstone with minor amounts of shale. When fresh the pyroclastic material is visible and the rock is usually not fissile. Upon weathering it breaks down into shaly-appearing claystone or weathers to spheroidal masses. Megafossils from Kings Valley:

Pelecypoda	Gastropoda
Glycimeris sagittata (Gabb)	Homalopoma umpquaensis (Merriam and Turner)
Glycimeris cf. G. perrini (Dickerson)	Euspirocrommium n. sp.
Barbatia (Acar) n. sp.	Turritella cf. T. andersoni (Dickerson)
Barbatia (Obliquorca) morsei	Turritella bramkampi (Merriam and Turner)

Foraminifera: Discocyclina (Asterocyclina) aster (Woodring)
           Pseudophragmina (Proporocyclina) psila (Woodring)

Lorane shale member (Tyee formation) (Vokes and others, 1951) 600 feet thick. Previously considered a member of Spencer formation. Consists primarily of foraminiferal, silty to sandy shales and mudstones with a relatively thin fine- to medium-grained arkosic and micaceous sand at the base. Intercalated sandstone and siltstone strata become more common toward the top.

"Lower Idaho" formation (Pinnacle Point beds) (Cope, 1884; Kirkham, 1931) Thickness not published. Quartzose sandstones interbedded with friable sandstone and siltstones, well cemented and resistant basal orthoquartzite.

Madras formation (Hodge, 1927) 600 feet thick. Unconsolidated and commonly cross-bedded fluviatile silts, sands, and gravels consisting of andesite and basaltic debris of Pliocene-Pleistocene age located in central Oregon (Deschutes Valley). Local coarse layers laid down by torrential mud flows and pumiceous tuff which is, in part, water lain interbedded or capped by several olivine basalt flows. Most widespread unit is a welded dacite tuff.

Mascall formation (Merriam, 1901) 800 to 1000± feet thick. Tuffs, ash, silts, gravels, and sands. Contains diatomitic shales, lignitic coal seams and partings of pumice. Fauna: Merychippus, Alticamelus, Dromomeryx.

Mehama volcanics (Thayer, 1933, 1939) 600 feet thick. Terrestrial tuffs, lavas, and breccias which for the most part were water laid. Contain fossil wood. Tuff is white to green in color.

Mesa basalt (Merriam, 1910) 25 to 50 feet thick. Olivine basalt, widely spread over region of Virgin Valley and Thousand Creek. West of Denio, Nevada.

DEFINITIONS FOR CENOZOIC FORMATIONS OF OREGON (Continued)

"Miocene" beds (James, 1950) No surface expression; concretionary sandstone cemented by calcium carbonate bearing Miocene fauna dredged out of Coos Bay.

Molalla formation (Baldwin, 1950, Lowry and Baldwin, 1952) Thickness not published. Consists of sandstone, conglomerate, and silt of fluviatile origin which are highly tuffaceous and light colored. The sandstone and conglomerate occur in the lower part of the section and contain poorly preserved fossil leaves.

Nye mudstone (Smith, 1926) 2500 feet thick. A monotonous series of dark-gray to black, smooth-fracturing mudstones with occasional siltstone layers and thin lenses of hard calcareous material. Selenite and jarosite formed by secondary mineralization are common along joints. The mudstone weathers easily, and commonly the bedrock is covered with small chips of mudstone and grayish-brown clay. Fauna:

Nucula n. sp.
Acila (Truncacila) pockardi (Clark)
Nuculana cf. N. chenalisensis (Weaver)
Palinices (Euspira) n. sp.
Cancellaria n. sp.
Priscofusus n. sp. aff. P. hannibali (Clark and Arnold)

Owyhee basalt (Bryon, 1929) 1200 to 1500 feet thick. Black to red, dense to scoriaceous and cindery augite-hypersthene basalt; few interbeds of water-lain tuff; local basal gray-white tuff.

Payette formation (Lindgren, 1898) 1000 to 1400+ feet thick. Lake beds and terrestrial series of well consolidated ash, carbonaceous shale and cooly shale, and sandstone; interbedded with local basalt flows (Columbia River basalts ?)

Skull Springs fauna
Tomarcutus cf. brevirostris
Hypohippus sp.
Parahippus near coloradensis (Gidley)
Merychippus isonesus (Cope)
Rhinocerotid
Chaliocothere

Sucker Creek fauna
Hypohippus near asborni (Gidley)
Parahippus avus (Marsh)
Merychippus isonesus (Cope)
Merychippus brevidontus
Drommomeryx near borealis (Cope)
Rhinocerotid
Moropus

Pike Creek formation (Fuller, 1931) 1500+ feet thick. Series of alternating acid flows and stratified tuffs in descending order:
1. Biotite dacite 500+ feet thick.
2. Upper tuffs 40± feet.
3. Little Alvord Creek rhyolite.
4. Upper laminated rhyolite flow 250 to 500 feet.
5. Middle tuffs 200 to 300 feet.
6. Lower laminated rhyolite 200+ feet.
7. Lower tuffs, 200+ feet.

Pittsburg Bluff formation (Hertlein and Crickmay, 1925) 700 to 850 feet thick. Upper: Firm, sparingly fossiliferous, tuffaceous sandstone and shale with beds of fine-grained, white tuff. Lower: Stratified, cross-bedded sandstone with pebble bands, and carbonaceous material. Massive, loosely consolidated, brown-weathering, medium-grained, micaceous, concretionary sandstone. Gray, fine-grained, fossiliferous sandstone with calcareous beds. Fauna:

Pelecypods
Acila shumardi (Dall)
Nuculana washingtonensis (Weaver)
Solen townsendensis (Clark)
Gastropods
Bruclarkia columbiana (Anderson and Martin)
Polinices washingtonensis (Weaver)
Foraminifera
Few arenaceous forms

Port Orford formation (Baldwin, 1945) 200 feet thick. Basal buff sand overlain by conglomerate followed by a rusty sand which grades upward into a blue-gray argillaceous sand which bears fossiliferous concretions.

Portland hills silt (Lowry and Baldwin, 1952) 25-100 feet thick. A thick, structureless, light-brown silt that covers much of the Portland hills and which overlies both the Coriba and the Troutdale formations. It is considered to be a late and quiet water phase of the Troutdale formation. Fauna: a rhinoceros tooth that tentatively dates silt as Hemphillian (middle Pliocene).

Portland sand and gravels (Buwalda and Moore, 1930) 500 to 600 feet thick. Relatively thick deposit of sand and fine gravel. Lowry and Baldwin (1952) suggest that the sand was deposited by the Columbia and Willamette rivers during the rise in sea level following the Illinoian glaciation, while Trimble (1957) attributes them to deltaic deposits laid down in the ponded basin during a late Pleistocene flood or floods.

Rattlesnake formation (Merriam, 1901) 185 to 300 feet thick. Marked by a prominent cliff-forming volcanic tuff member interbedded with gravels and silts. The tuff is 50 to 75 feet thick, and shows features typical of an ignimbrite. This member is ashy near the bottom, semivitreous to vitreous in the central and upper parts, and composed throughout of shards, clear glass, and pumice fragments. It is overlain by boulder conglomerates. Ungulates: Pliohippus, Neohipparion.

Rhododendron formation (Hodge, 1933) 100 to 500 feet thick. Basaltic breccia, tuffs, and flows. Hypersthene andesite tuff breccias are dominant. Trimble (1955) states as follows: "Wide lateral extent of the pyroclastic part of the formation, an abundance of noncarbonized wood in the tuff breccia, and the absence of sorting and stratification point toward a volcanic mudflow origin of the tuff breccia.

Roxy formation (Wells, 1956) 1900 feet thick. Dominantly flows, commonly vesicular and scoriaceous, ranging in texture from felsitic to glassy and in color from black through purplish to pink to white. Local layers of flow breccias and agglomerates.

Sacchi Beach beds (Allen and Baldwin, 1944) Thickness not published. Siltstone containing abundant mica and thin beds of gray sandstone.

Sardine series (Thayer, 1936, 1939) 6000 feet thick. Chiefly andesitic – individual flows range from rhyolite to basalt – some tuff and breccia.

Scappoose formation (Warren and Norbisrath, 1946) 1500 feet thick. Gray, yellowish-weathering, firm, fossiliferous, sandy, tuffaceous shale and shaly sandstone, commonly spotted with pumiceous material. Loosely consolidated, medium-grained sandstone. In some places strata show pebble bands, cross bedding, and interbedded carbonaceous material. Bottom is generally believed to be a conglomerate composed of cobbles and boulders of basic lavas. Fauna:

Pelecypods
Acila muta (Clark)
Macrocallista weaveri (Clark)
Gastropods
Bruclarkia acuminata (Anderson and Martin)

Shutler formation (Hodge, 1932) Thickness not published. Gravels, sands, and silts of Pliocene-Pleistocene age resting unconformably on Columbia River basalt east of the Deschutes River in north-central Oregon.

Siletz River volcanics (Snavely and Baldwin, 1948) 10,000+ feet thick. Consist principally of pillow basalts, breccia, and pyroclastic rocks. Basalt breccia is dark grayish-green on the fresh surface and contains veinlets of calcite and zeolites which are commonly concentrated between the pillows. The basalt is aphanitic to porphyritic and is commonly vesicular or amygdaloidal. The weathered rock is yellowish-gray.

Spencer formation (Turner, 1938) 4500 feet thick. Consists of a lower massive basaltic and arkosic sandstone; a middle micaceous sandstone unit whose composition suggests that it was derived from the Tyee formation and uppermost beds which are fine-grained siltstones and massive sandstones. Fauna:

Nucula sp.
Acila (Truncacila) decisa (Conrad)
Acila (Truncacila), n. sp.
Nuculana cowlitzensis (Weaver and Palmer)
Yoldia (Portlandella) cf. Y. duprei (Weaver and Palmer)

Steens Mountain andesitic (volcanic) series (Fuller, 1931) 1300± feet thick. Andesite breccias, flows and thin-bedded andesitic tuffs in descending order: 1. upper andesitic series with breccias, 2. great andesite flow, 3. thin beds of coarse andesitic tuff, and 4. basic andesitic flow.

Steens basalt (Fuller, 1931) 3000+ feet thick. Extensive series of thin flows of light-gray holocrystalline olivine basalt.

DEFINITIONS FOR CENOZOIC FORMATIONS OF OREGON (Continued)

Thousand Creek formation (Merriam, 1910) 400+ feet thick. Light-colored stratified tuffs, containing rhyolite fragments and pumice. Ungulates: <u>Pliohippus</u> (?), sp., <u>Equus</u> (?) sp.

Tillamook volcanics (Warren, Norbisrath, and Grivetti, 1945)10,000± feet thick. A series of submarine lava flows and interbedded tuff and breccia. The basic lavas are of a greenish-gray color, altered and fractured.

Toledo formation (Harrison and Eaton, 1920; Schenck, 1927) 2500-3000 feet thick. Upper sandy member is 1000-1200 feet thick. The lower part of this member is fine-grained, argillaceous and micaceous sandstones, siltstones, and shales. The upper part is poorly stratified, firm, micaceous and tuffaceous siltstones with limy concretions. The lower member of this formation, the Moody shale, is 1500 to 1800 feet thick. It is a dark-gray to block, hard, tuffaceous mudstone with some limy bands a few inches thick. Glauconite is abundant in some horizons. Carbonaceous material and plants are abundant near the base. This member is easily weathered to light gray or rust-colored slopes. Fauna:

Upper sandy member	Moody shale member
Acila (Truncacila) shumardi (Doll)	Acila (Truncacila) decisa (Conrad)
Nuculana washingtonensis (Weaver)	Nuculana cowlitzensis (Weaver and Palmer)
Yoldia chehalisensis (Arnold)	Nuculana voderensis (Dickerson)
Crenella porterensis (Weaver)	Yoldia (Portlandia) duprei (Weaver and Palmer)
Natica weaveri (Tegland)	Natica sp.
Polinices washingtonensis (Weaver)	Conus vaderensis (Weaver and Palmer)
Calyptraea washingtonensis (Weaver)	Gemmula fosteni (Weaver and Palmer)
Crepidula ungana (Doll)	Scaphander costata (Gabb)

Troutdale formation (Hodge, 1933) 1500+ feet thick. Mud flows of agglomerates that contain enormous, irregular, highly vesicular, slaggy and glassy andesitic boulders. Columbia River basalt pebbles abundant, small lenses of faceted quartz pebbles. Crystal tuffs and glassy pellets 1/10 inch in diameter form brown sandstone or grit beds.

Tunnel Point sandstone (Doll, 1898) 800+ feet thick. Fine-grained tuffaceous sandstone of angular to subangular fragments containing abundant glass; at base is a massive concretionary bed composed chiefly of quartz and feldspar with an admixture of tuffaceous material and glauconite; near top is interbedded sandstone interbedded with brittle shale and a thin bed of tuff in which glass shards are conspicuous. Fauna:

Pelecypoda – Macoma molinana (Doll)   Gastropoda – Galeoda oregonense (Doll)
Spisula veneriformis (Clark)

Tyee formation (Diller, 1898) 5000 + feet thick. Consists of sandstone beds 6 inches to 12 feet thick; generally they are 3 feet to 8 feet thick. The basal part of each bed is a medium- to coarse-grained, micaceous, arkosic sandstone. These grade upward into siltstones and mud stones at the top of each bed. The fresh rock is firmly compacted, gray- to blue-gray and commonly has calcareous cement. Angular quartz feldspars, tuffaceous materials and deformed muscovite and biotite are the most abundant constituents. Fauna:
Amphimorphina californica (Cushman and McMasters)

Clavulinoides sp.	Plectofrondicularia cf. D. packardi
Cibicides cf. C. warreni (Cushman and	(Cushman and Schenck)
R. E. and K. C. Stewart)	Marginulina subbullata (Hantken)
Pseudoparrella sp.	Bulimina cf. B. bradyi (Weinzierl and Applin)

Umpqua formation (Diller, 1898) 12,000 + feet thick. Thin-bedded dark tuffaceous sandy shale with intercalated flaggy sandstone beds. To east, on Middle Fork of Coquille River, massive tuffaceous sandstone members are present. Intercalated volcanic series: basalt, medium- to fine-grained tuffs, flow breccias, mud flows, and coarse agglomerates. Fauna:
Pelecypoda – Nuculana parkei (Anderson and Hana) subsp. coosensis Turner
Glycymeris fresnoensis Dickerson

Upper Idaho formation (Rome beds) (Cope 1884; Kirkham, 1931) 4000± feet thick. Predominantly light-colored, poorly indurated tuffaceous shales; some interbeds of volcanic ash and diatomite, upper portion sandy. Fauna: Dipoides stirtoni. (Locality: 5 miles southwest of Rome, Oregon.)

Virgin Valley formation (Merriam, 1907, 1910) 1000 to 2000 feet thick. Upper zone: White to buff beds. Ash and diatomaceous beds. Middle zone: Gray to yellow and brown shales and clays. Carbonaceous shales, lignites, diatomaceous beds. Lower zone: White to green, purple, and red clays and ash. Ungulates: Hypohippus, Parahippus, Merychippus, Dromomeryx.

Wasson formation (Wells, 1956) 1100 feet thick. Pyroclastic rocks of dacitic or rhyolitic composition. Most conspicuous is a chalky white tuff bed 250 feet thick.

Yaquina formation (Harrison and Eaton, 1920) 4000 feet thick. At the type area the formation is a coarse-grained, massive micaceous sandstone with abundant tuffaceous material. Cross-bedding and conglomerate lenses are common. Carbonaceous material is abundant and locally noncommercial coal lenses are found. The upper two-thirds of the formation is a fine- to medium-grained, gray to brown, massive, micaceous and tuffaceous sandstone. North of the Yaquina River the beds are less massive; cross bedding is more common and organic material is much more abundant. South of the type area, near Alsea Bay, it is typically massive. Contains much less carbonaceous material and has much glauconite. The basal zone is a thick bed of almost pure glauconite. The uppermost beds in this area are generally thinner and more silty than at the type locality. Almost pure tuffs and tuffaceous shales are common.

	SOUTHWEST OREGON After Wells (1953, 1955)	CENTRAL OREGON After Merriam and Berthiaume (1943) Lupher (1941), Thayer (1956)	SUMPTER-BAKER AREA After Gilluly (1937) Taubeneck (1955) Pardee and Hewett (1941)	WALLOWA MOUNTAINS After Ross (1938) Smith and Allen (1941)
CRETACEOUS	Hornbrook formation Horsetown formation Paskenta formation (Myrtle fm. of Diller) Granitoid intrusive rocks	"Chico" formation Beds at Mitchell dikes (dioritic porphyry, etc.)	Granitoid intrusive rocks	Granitoid intrusive rocks
JURASSIC	Knoxville formation 　　　　　　Peridotite Galice formation Rogue formation Dothan formation	Lonesome formation Trowbridge shale Izee group Colpitts group Mowich group Donovan formation		

TRIASSIC	Applegate group	Graywacke and shale
		
		Diorite, granite, and gabbro
		Ultrabasic intrusive rocks
		  (peridotite, serpentine
		  and dunite)
				Hurwal formation
				
				Martin Bridge formation
				
				Lower sedimentary series

PERMIAN		Metavolcanic and sedimentary
		  rocks (in Canyon Mountain)
		
		Coyote Butte formation
			Clover Creek greenstone
			Elkhorn Ridge argillite
			Burnt River Schist
			  (these three formations may
			  interfinger – base not exposed)
				Clover Creek greenstone
				
				Black slate
				
				(base not exposed)

PENNSYLVANIAN		Spotted Ridge formation		
MISSISSIPPIAN		Coffee Creek formation (base not exposed)		
DEVONIAN				
SILURIAN	Old Schists (along California border south of Medford) (base not exposed			
ORDOVICIAN				
CAMBRIAN				

(vertical text between Central Oregon and Sumpter-Baker columns, spanning Pennsylvanian row: Schist and phyllite in the Pueblo Mountains)

Correlation Chart of the Pre-Tertiary Formations of Oregon, by E. M. Baldwin.

DEFINITIONS FOR PRE-TERTIARY FORMATIONS OF OREGON

Applegate group – Altered lava flows, flow breccias, and pyroclastic rocks, mostly of basic composition with some intrusive rocks. Includes lenses or argillite, chert, quartzite, conglomerate, and marble. Exposed over hundreds of square miles in southwestern Oregon and northwestern California.

Burnt River schist – Greenstone schist, quartz schist, conglomeratic schist, and some interbedded limestone, slate, and quartzite.

"Chico" formation – Sandstones, shales, and conglomerates containing an upper Cretaceous fauna.

Clover Creek greenstone – Altered volcanic flows and pyroclastic rocks with subordinate limestone and chert.

Coffee Creek formation – Well-bedded, fairly pure limestone, carbonaceous limestone, argillaceous to sandy limestone, and calcareous sandstone. Contains Striatifera and Gigantella brachiopods.

Colpitts group – The Colpitts group is separated from the Mowich group by an erosional unconformity and a faunal hiatus. The group is divided into the lower Weberg formation of limestone and calcareous sandstone and the upper Warm Springs formation of fine-grained sandstone, shale, and mudstone. The age of the group is early middle Jurassic (Lupher, 1941).

Coyote Butte formation – Light olive-gray limestone interbedded with large amounts of sandstone. Limestone contains abundant fusulinids.

Donovan formation – The Donovan formation is the oldest of the Jurassic rocks observed by Lupher (1941). The formation crops out in on area of less than 320 acres along the Silvies River 19 miles north of Burns at the Donovan Ranch. The sediments consist of hard, green and gray noncalcareous sandstone. Sandy shale, red sandstone, and yellowish calcareous sandstone are well represented. Limestone and conglomerate are also present in lesser amounts. The red sandstone contains abundant fossil mollusca. It has been considered similar to the red Hardgrave sandstone of the Taylorville region of California. Red sandstones appear at several places and in each have yielded abundant fossils.

Dothan formation – Chiefly sandstone with much interbedded dark shale.

Elkhorn Ridge argillite – Argillite, tuff, and chert with subordinate limestone and greenstone masses. Interbedded limestone contains fusulinids.

Galice formation (upper Jurassic) – Composed mainly of dark to block slates, some sandstone and conglomerates (Diller, 1907).

Hornbrook formation – Indurated uniform fine-grained, greenish-gray arkosic sandstone with local lenses of coarse conglomerate and sandy shale. Fossiliferous and calcareous in places.

Horsetown formation – Lower Cretaceous (Shasta series). Consists of shales, sandstones, and conglomerates. (Note: Upper Jurassic and lower Cretaceous of southwestern Oregon are being redefined by R. W. Imlay.)

Hurwal formation – Argillaceous sediments comprising slaty and shaly beds, some sandstone and quartzite, and a conspicuous hard black hornfels.

Hyde formation – See Izee group.

Izee group – The Izee group consists of two thick early middle Jurassic formations (Lupher, 1941). The Hyde formation (Toarcian, according to Imlay) is a massive blue-gray sandstone in the lower part of the Izee. The Snowshoe formation includes about 2,800 feet of shales and laminated sandstone in the upper part of the Izee group (Bajocian, according to Imlay). The Izee group bevels the Colpitts and Mowich

groups and lies discordantly upon the Triassic strata. There are also marked lithologic differences as well as faunal differences between the Colpitts and Izee groups.

Knoxville formation (Jurassic) – Chiefly sandstones and shales with calcareous and conglomeratic layers. Characterized by Aucella piochii. (Note: Upper Jurassic – lower Cretaceous of southwestern Oregon is being redefined by R. W. Imlay.)

Lonesome formation – Included with upper Jurassic rocks by Lupher (1941) and placed in early Callovian by Imlay. No fossils have been reported, and until better evidence is found, the age will remain uncertain. Thick, resistant beds of sandstone and conglomerate at the base of the formation differentiate it lithologically from the underlying Trowbridge shales. Above the conglomerate beds, shale increases until it is the predominant lithology. The shales contain interbeds of gray, bluish-gray, and greenish sandstone ranging in thickness from a few inches to 75 feet.

Martin Bridge formation – Calcareous shale, limestone, agglomerate, basalt, andesite, and tuff.

Mitchell beds – Mainly shale, sandstone, and conglomerate.

Mowich group – The Mowich group is exposed along the opposite flanks of a truncated anticlinal structure It includes the Robertson, Suplee, and Nicely formations. The Robertson formation is the lower member of this group. It consists of a basal conglomerate and coarse greenish gray sandstone overlain by a reef limestone composed largely of the pelecypods, Plicatostylus gregarius Lupher and Packard. The Suplee formation overlies the Robertson formation. It is composed of calcareous gray medium- to fine-grained sandstone and gray granular limestone. Fossils, mostly pelecypods, are abundant. The youngest member of the group is the Nicely formation, a dark gray to black sandy shale containing black calcareous concretions which in many places contain well preserved fossils. The age of the Mowich group according to Lupher (1941) ranges from middle Lias to upper Lias. Imlay has placed the group in the Pliensbachian and Toarcian ages.

Nicely formation – See Mowich group.

Paskenta formation – Knoxville (Paskenta) horizon, the true Knoxville. The 4,000 feet of dark or yellowish Cretaceous clay shales forming the upper part of the Knoxville of previous reports. Contains typical subtropical fauna with abundant Aucella, which are apparently confined to this interval.

Robertson formation – See Mowich group.

Rogue formation – Volcanic rocks. Mainly massive light to dark gray altered lava flows, tuffs, agglomerates, and flow breccias of dacitic and andesitic composition.

Snowshoe formation – See Izee group.

Spotted Ridge formation – Ranging from compact mudstones and cross-bedded sandstones to very coarse boulder conglomerates with local bedded chert. Age determined on flora.

Suplee formation – See Mowich group.

Trowbridge formation – Trowbridge shale formation overlies the Snowshoe formation of the Izee group. It crops out along Antelope Creek and the upper valley of Lewis Creek. The formation is composed of a thick section of dark gray and black shale with only minor amounts of arenaceous material. Flinty calcareous concretions occurring along the bedding planes characterize the formation. The concretions have yielded such fossils as have been found in these rocks. The age is given as early upper Jurassic by Lupher (1941), and early Callovian by Imlay.

FIELD TRIP NO. 1

CORVALLIS TO DEPOE BAY VIA NEWPORT

By
David A. Bostwick

This trip begins at Corvallis, Oregon, and follows U.S. Highway 20 to Newport on the coast, thence north on U.S. Highway 101 (Coast Highway) to Depoe Bay. Total distance is logged at 69.1 miles. Formations encountered on the trip are described below under Stratigraphic Sequence for the Coast Range. This is followed by the trip log and geologic strip maps.
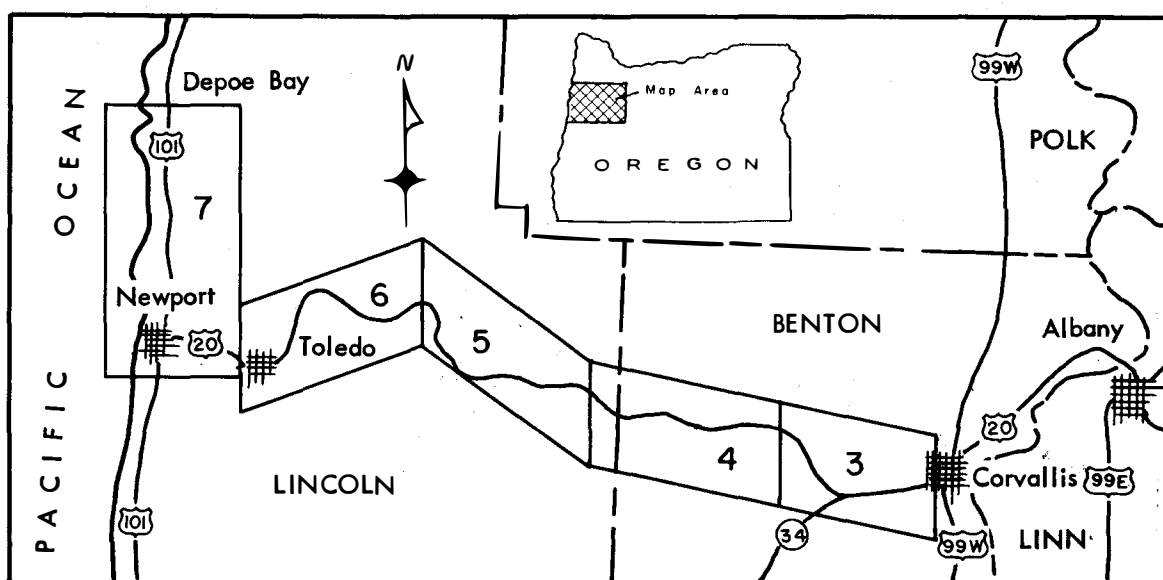
Index map of the Corvallis-Depoe Bay area showing route of field trip and position of geologic strip maps accompanying road log.

STRATIGRAPHIC SEQUENCE FOR THE COAST RANGE

QUATERNARY

Dune sands and terrace deposits: Pleistocene terrace gravels and Recent dune sands occur in relatively thick deposits along the coastal area, extending inland as much as 2 miles from the shore. Beds of sand and clay containing wood are exposed at Newport beneath the wave-cut platform of the Elk River terrace (Diller, 1903). These beds are similar to and are correlated with beds of the Coquille formation, named by Baldwin (1945) for local estuarine deposits at the mouth of the Coquille River south of Coos Bay.

Terrace sands and gravels that rest upon the wave-cut platform are correlated with the Elk River beds of Diller as restricted by Baldwin. Dune sands, some of them partly indurated, now largely cover the terraces and lower hills to the east. These dunes in part represent reworked material derived from the Coquille and Elk River beds.

GENERAL LEGEND

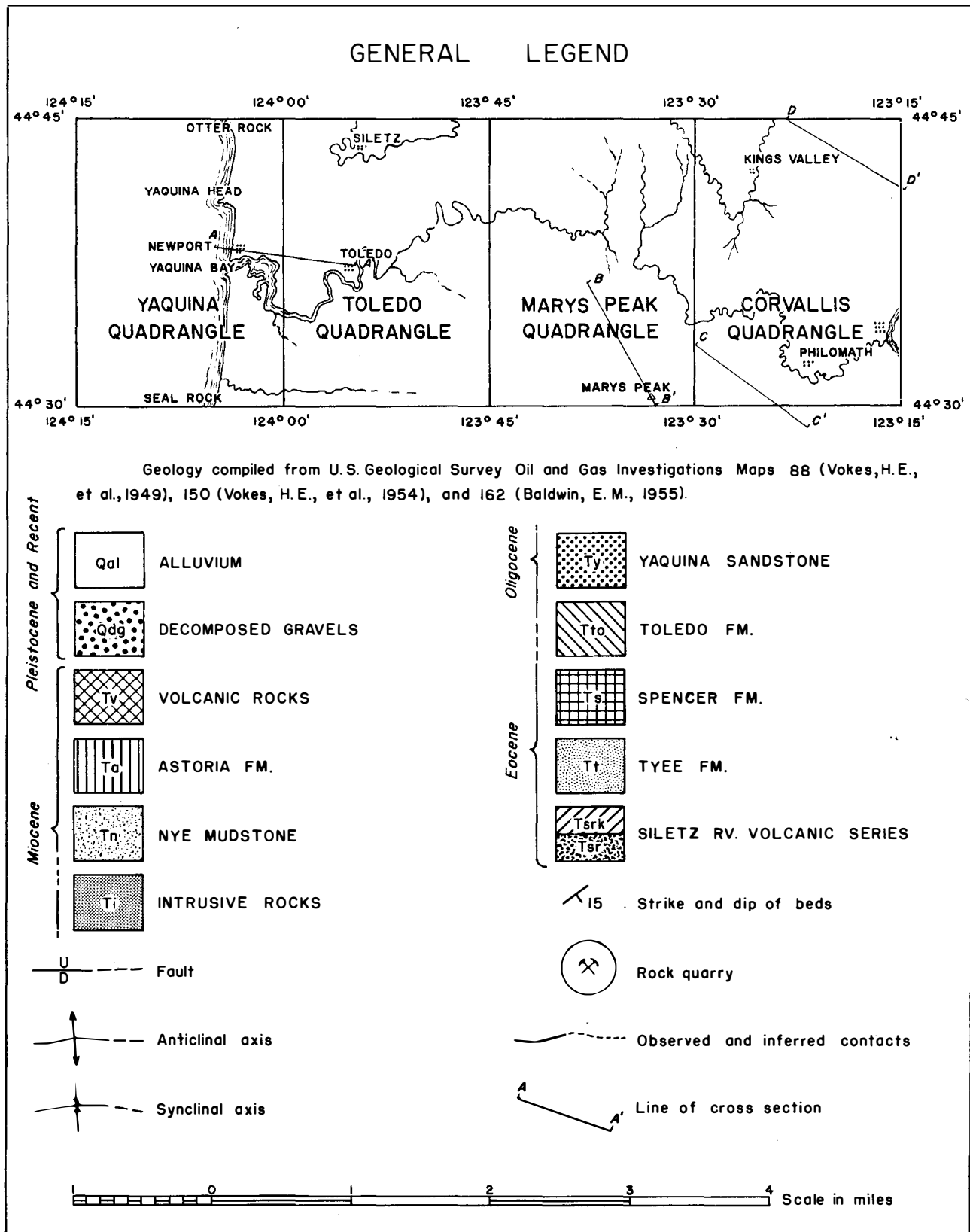124° 15' 124° 00' 123° 45' 123° 30' 123° 15'
44° 45' 44° 45'

OTTER ROCK
SILETZ
KINGS VALLEY
YAQUINA HEAD
NEWPORT
YAQUINA BAY
TOLEDO
B
YAQUINA
QUADRANGLE
TOLEDO
QUADRANGLE
MARYS PEAK
QUADRANGLE
C
CORVALLIS
QUADRANGLE
PHILOMATH
MARYS PEAK
B'
SEAL ROCK

44° 30' 44° 30'
124° 15' 124° 00' 123° 45' 123° 30' 123° 15'

Geology compiled from U.S. Geological Survey Oil and Gas Investigations Maps 88 (Vokes,H.E., et al.,1949), 150 (Vokes, H.E., et al., 1954), and 162 (Baldwin, E.M., 1955).

Pleistocene and Recent

Qal — ALLUVIUM

Qdg — DECOMPOSED GRAVELS

Miocene

Tv — VOLCANIC ROCKS

Ta — ASTORIA FM.

Tn — NYE MUDSTONE

Ti — INTRUSIVE ROCKS

Oligocene

Ty — YAQUINA SANDSTONE

Tto — TOLEDO FM.

Eocene

Ts — SPENCER FM.

Tt — TYEE FM.

Tsrk / Tsr — SILETZ RV. VOLCANIC SERIES

⌐15 . Strike and dip of beds

(⚒) Rock quarry

Observed and inferred contacts

Line of cross section

——— Fault (U / D)

——— Anticlinal axis

——— Synclinal axis

0 1 2 3 4 Scale in miles

Figure 1

Representative cross sections of the Coast Range, Oregon. Refer to general legend. Qal, unconsolidated silt, sand, and gravel; Qls, landslide debris; Qdg, decomposed gravels; td, terrace gravels and dune sands; Ta, Astoria fm.; Tn, Nye mudstone; Ti, intrusive rocks; Ty, Yaquina sandstone; Tto, Toledo fm.; Ts, Spencer fm.; Tt, Tyee fm.; Tsrk, Kings Valley siltstone; Tsr, Siletz Rv. volcs.

Figure 2

MIOCENE

Basaltic rocks: Yaquina Head, 4 miles north of Yaquina Bay, is formed of coarse basaltic agglomerates and flows intruded by dikes of basalt. These unconformably overlie a baked contact zone of the Astoria formation. A hard, light-colored, fine-grained tuff of unknown origin occurs in a fault zone on the south side of Otter Rock. Basaltic intrusives, many of them very small, cut the sedimentary rocks north of Newport. Contacts with the sedimentary rocks show li ttle alteration. Dikes are common and cut flows and pyroclastics. Columnar jointing is conspicuous in many of the intrusives and is especially well developed in the Iron Mountain intrusive and in the road cut along the highway just south of Otter Crest parking area.

Ages of the volcanic and intrusive rocks are not certainly known but may be as old as late Miocene.

Astoria formation: A sequence of about 500 feet of fossiliferous sandstones and sandy shales unconformably overlies the Nye mudstone along the coast, outcropping in the sea cliffs between Yaquina Bay and Otter Rock and again at Depoe Bay. The sequence is considered to be, at least in part, correlative with the Astoria formation of middle Miocene age at Astoria, Oregon.

The beds north of Newport, although predominantly sandy, exhibit a variable lithology. Most of the rock consists of gray to blue-gray, soft, fine- to medium-grained sandstone, which commonly contains feldspathic material and in places is tuffaceous. Dark, micaceous, sandy shales are common interbeds in the sandstone. A few beds of hard, fine-textured tuff and dark conglomeratic lenses are locally present. Large, hard, calcareous sandstone concretions are common in the lower part of the formation. The concretions are generally fossiliferous, containing invertebrate and vertebrate material.

Pleistocene terrace deposits and Recent dune sands generally cover the contact of the Astoria and Nye formations and obscure other exposures of the Astoria away from the sea cliffs.

Nye mudstone: About 2,500 feet of black massive mudstones disconformably overlie the Yaquina sandstone in the Newport area. These mudstones constitute the Nye formation, named by Schenck (1927). The mudstone sequence contains a few siltstone beds and lenses of resistant calcareous material. Networks of selenite crystals and jarosite are common along joints. Weathering characteristically has covered bedrock with a deep layer of small, iron-stained chips and grayish-brown clay. Fish scales and spines are common in the Nye, as are poorly preserved Foraminifera. The megafauna is sparse and poorly preserved, and so far has not yielded material definitely indicative of age. The foraminiferal fauna is considered to indicate a probable early Miocene age.

OLIGOCENE

Yaquina sandstone: The Yaquina formation was named by Harrison and Eaton (1920) for sandstones exposed at the town of Yaquina on Yaquina Bay, 3 miles southwest of Newport. The formation includes about 2,700 feet of shallow-water deposits, consisting mostly of light-gray to brown, tuffaceous, carbonaceous sandstones and interbedded sandy tuffs. The lower part of the formation is coarser-grained and contains more tuffaceous material than the upper part. Fossils are common in the upper part. Carbonaceous material is present throughout the formation, some of it coaly.

Brackish and shallow-water characteristics become more pronounced northward from Yaquina Bay, showing more cross-bedding, more carbonaceous material, and less massive bedding. The beds weather to iron-stained sands. Conglomerate lenses containing basalt pebbles are increasingly common northward. At Otter Rock and Seal Rock, beds assigned to the Yaquina consist mostly of cross-bedded, coarse-grained, yellowish sandstone containing pebbles and fossil wood. Iron sulfide concretions are common. The lithology of the rocks at these two localities is not typical of the Yaquina elsewhere and seems to represel · local facies of the formation.

The fauna of the Yaquina indicates an upper Oligocene age for the formation and a correlation with the Blakeley of Washington.

Toledo formation - Upper Member: The Toledo formation, described by Harrison and Eaton (1920) from exposures along the banks of the Yaquina River, is separable into two members.

The upper, unnamed, member of the Toledo formation consists of more than 1,000 feet of sandstones, tuffaceous siltstones, and glauconitic beds. This upper sandy member includes poorly stratified, micaceous, and tuffaceous siltstones that contain limy concretions. The member weathers to a tan, silty to sandy clay that closely resembles the Lower, Moody shale member.

The molluscan fauna indicates a middle Oligocene age for the upper Toledo, and the member has been correlated with the Keasey formation, Columbia County, Oregon, and the Lincoln formation of Washington.

EOCENE

Toledo formation - Moody shale member: The lower member of the Toledo formation is composed of dark-gray mudstones interbedded silty sandstones and glauconitic sandstones. It was named the Moody shale by Schenck (1927). This member is from 1,500 to 1,800 feet thick. When freshly exposed the beds are dark-gray to black, hard, tuffaceous mudstones that include irregular limy beds a few inches thick. The mudstones are much fractured. Interbedded sandstones contain coarse pumiceous material. Abundant glauconite occurs at many levels. The rock weathers to form rounded slopes of soft, light-gray to rust-colored fragments. Pelecypods and fish scales are common, along with generally poorly preserved Foraminifera. The fauna of the Moody shale member indicates an upper Eocene age, and the member is correlated with the Cowlitz formation of Washington.

Spencer formation: In a few outcrops in the vicinity of Corvallis the Tyee is unconformably overlain by basaltic, arkosic, and micaceous sandstone beds. These beds are referred to the Spencer formation (Turner, 1938). Probably much of the sandstone of the Spencer consists of reworked Tyee sandstone. The Spencer is mostly covered by alluvium of the Willamette Valley. The thickness near Corvallis may be more than 4,500 feet. The Spencer crops out in the Country Club hill southwest of Corvallis and has small exposures west and northwest of Corvallis. However, it has not been found west of Philomath.

A large upper Eocene fauna from the Spencer indicates a correlation with the Cowlitz formation of Washington and the Tejon of California. It would also be correlative with the Moody shale member of the Toledo formation exposed north and south of Toledo, Oregon.

Tyee formation: A thick sequence of rhythmically bedded sandstones and siltstones overlies and probably overlaps the Siletz River volcanic series in the region west of Corvallis. This sequence is correlated with the Tyee formation described by Diller (1898) in the Roseburg, Oregon, area.

The Tyee generally consists of beds of arkosic sandstone interbedded with dark gray siltstone. The sandstone beds range in thickness from 6 inches to 12 feet and average about 5 feet. The beds consist of medium- to coarse-grained micaceous arkosic sandstone that grades rapidly upward into dark gray siltstone. The contact of the top of the sandstone beds with the overlying siltstones is relatively sharp and commonly marked by ripple marks and small scour channels. The rhythmic character of the bedding is uniform and distinctive. The complete Tyee section is not known, but the formation is reported to be 6,000 to 7,000 feet thick in parts of the Toledo and Tidewater quadrangles.

The sandstone of the Tyee is calcareous, firmly compacted, and gray to blue-gray in color on freshly exposed outcrops. It contains angular grains of quartz, plagioclase (predominately soda-rich), wrinkled flakes of biotite and muscovite, and fragments of tuff. A few miles north of Corvallis the sandstone contains small sub-angular basalt pebbles cemented by altered tuff. West of Philomath the basal Tyee does not contain material reworked from Siletz River lavas, and basal conglomerates have not been found.

The uppermost exposed part of the Tyee consists of thin-bedded siltstone and mudstone that weather to light-grayish orange or light-gray chips. The upper beds are soft and poorly exposed.

Megafossils have not been found in the Tyee in the area west of Corvallis, but fragments of plants,

mostly reeds, are common, especially in the siltstones of the rhythmic units. To the south, near Cottage Grove and Roseburg, Oregon, molluscan faunas indicate a middle Eocene age for the Tyee and a corre- lation with the Domengine of California. At least part of the Tyee seems to have been deposited under offshore conditions. In the area west of Corvallis a rapid deposition in brackish water seems indicated. Certain features of the Tyee suggest deposition by turbidity currents.

Siletz River volcanic series: The oldest rocks exposed within the west-central border area of the Willamette Valley are a thick sequence of basalt flows, flow breccias, and minor amounts of interbedded tuffaceous siltstone and tuff. The upper part of the series consists of thin-bedded tuffaceous siltstone and water-laid tuff that interfinger with flows. The whole sequence of flows and siltstones has been named the Siletz River volcanic series by Snavely and Baldwin (1948) and is considered to be early Eocene in age.

The upper part of the Siletz River volcanic series consists of tuffaceous beds and interfingering ba- saltic flows, and it has been named the Kings Valley member of the volcanic series for the exposures of the beds along both sides of Kings Valley. In the vicinity of Kings Valley the member is about 3,000 feet thick. The beds are soft and poorly exposed, and the complete sequence is not known. Dark-gray, shaly tuffaceous siltstone and interbedded basalt flows, tuffs, and minor amounts of flow breccia are in- cluded in the lower part of the member. The upper part of the member is also poorly exposed and includes thin-bedded tuffaceous siltstone and some thin beds of relatively pure tuff.

The Kings Valley member is interpreted to represent a late pyroclastic phase of vulcanism that pro- duced the thick sequence of basaltic flows in the lower part of the series. Fossils in the Kings Valley member are generally poorly preserved. Near Marys Peak a fairly large molluscan assemblage has been collected that indicates a correlation with the lower Umpqua west of Roseburg, Oregon (Turner, 1938). It would, therefore, be correlative with the Capay formation of California.

The lower part of the sequence is predominately zeolitic pillow basalt. The pillows average less than 2 feet in diameter. Amygdaloidal structure is common in the flows; flow breccia and coarse pyro- clastic material is rare. Secondary minerals, particularly chloritic minerals and zeolites, have resulted from hydrothermal alterations that accompanied the submarine flows, and calcite and zeolites are commc fillings in the vesicles in the basalt and between pillows. The tuffaceous sediments interbedded in the flows are thin-bedded, well-stratified, and contain much clay. At Coffin Butte, about 6 miles north of Corvallis, sedimentary beds between pillow lavas contain a foraminiferal fauna considered by W. W. Ra (in Vokes, Myers, and Hoover, 1954) to indicate a warm, shallow-water environment and to correlate with the Crescent formation in Washington and possibly with part of the Umpqua formation of southwest Oregon. Faunas from both these last two formations are considered to be of early middle Eocene age.

ROAD LOG: CORVALLIS TO DEPOE BAY VIA NEWPORT

Mileage

0.0   Corvallis, Oregon, post office. Follow U.S. Highway 20 north two blocks to A Street.
       (1.5)   Turn right on A Street. From Corvallis to Philomath the highway for the most part is on
                   Willamette Valley alluvium.

(Begin Fig. 3)

1.5   Oregon Forest Research Center
       (0.5)

2.0   Marys Peak at 12 o'clock, highest mountain in the Coast Range (4097 feet). Its upper
                   part is made up of a thick sill of diorite and gabbro intruded into Tyee sediments of middle
                   Eocene age. The highest part of the mountain is the upthrown side of a normal fault that
       (0.3)   cuts across the mountain in a northeast direction. At the base of Marys Peak a thick
                   section of the Siletz River volcanic series (early Eocene) is exposed.

2.3   Country Club hill at 9 o'clock. This is an outcrop of the Spencer formation of late
       (1.7)   Eocene age.

4.0   Highway crosses the Tyee formation of middle Eocene age in the north-trending ridge.
       (0.2)

4.2   Highway crosses the northeast-trending Corvallis fault.
       (0.8)

5.0   Philomath city limits.
       (1.5)

6.5   Road junction. Continue straight ahead on U.S. Highway 20.
       (0.1)

6.6   Poorly exposed Siletz River volcanic flows.
       (1.3)

7.9   Small sawmill on the left. Logged-over hillside illustrates in a small way the problem of
       (0.2)   erosion on denuded slopes in the Coast Range.

8.1   Slump topography conspicuously developed on south side of highway.
       (0.2)

8.3   Basalt outcrop.
       (1.5)

9.8   View of Coast Range at 12 o'clock.
       (0.7)

10.5   Wren sawmill at 3 o'clock.
       (0.3)

10.8   Road junction with Oregon Highway 223. Continue straight ahead.
       (0.6)

11.4   Bridge over Marys River.
       (1.6)

13.0   Highway here is on the Kings Valley member of the Siletz River volcanic series. The
       (0.1)   Kings Valley fault trends northeast across this area.

(Begin Fig. 4)

13.1   Road cut exposes Kings Valley siltstone and interbedded basalt.
       (0.3)

13.4   Quarry in basalt. Note the weathered soil profile and spheroidal weathering developed
                   in the basalt blocks under the soil layer. A siltstone-basalt contact is exposed in the road
                   cut just east of the quarry. The basalt is probably a flow but its massive character suggests
       (0.2)   the possibility of a sill. The siltstone beds have the westerly dip that is characteristic of
                   the strata from here to the coast.
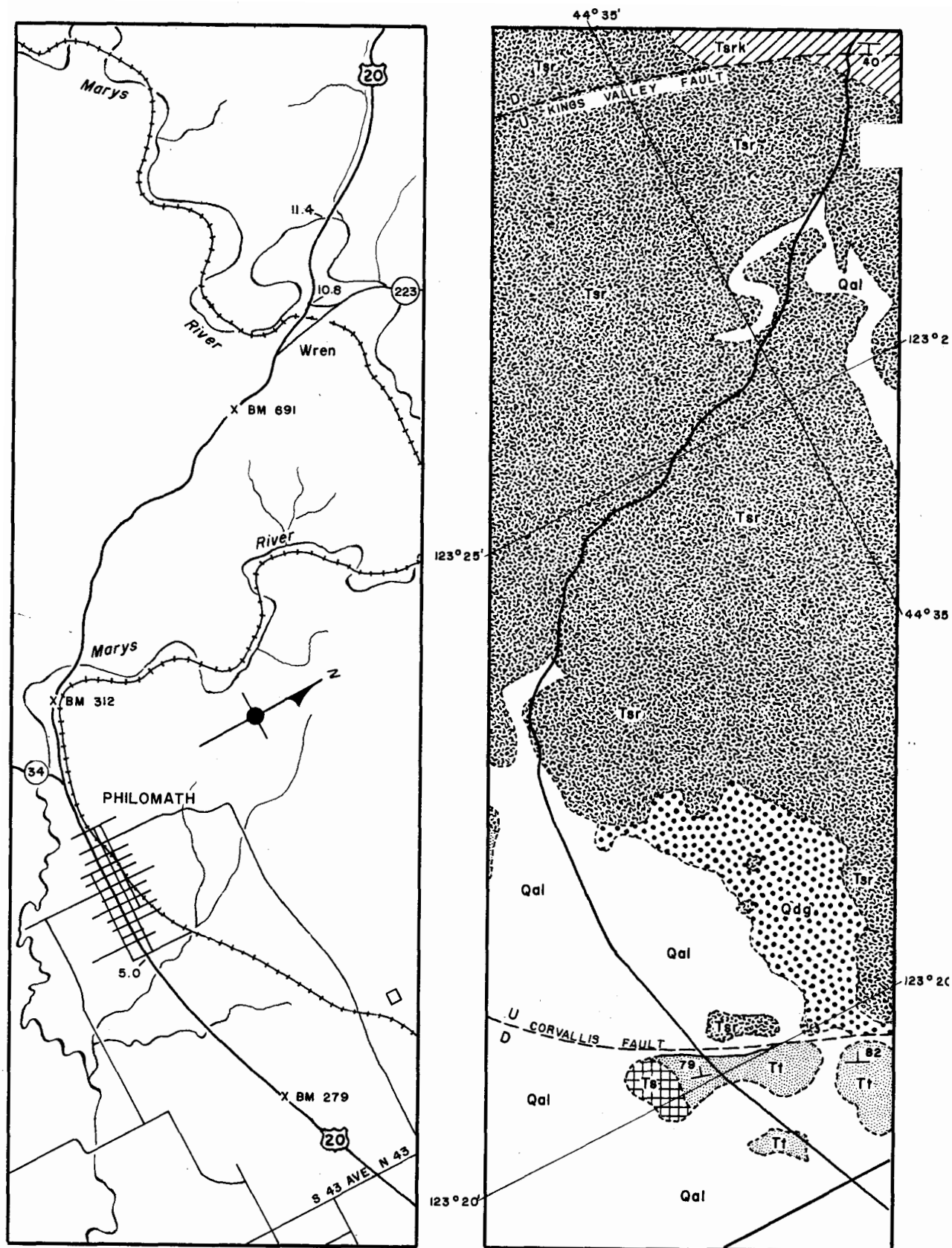
Figure 3
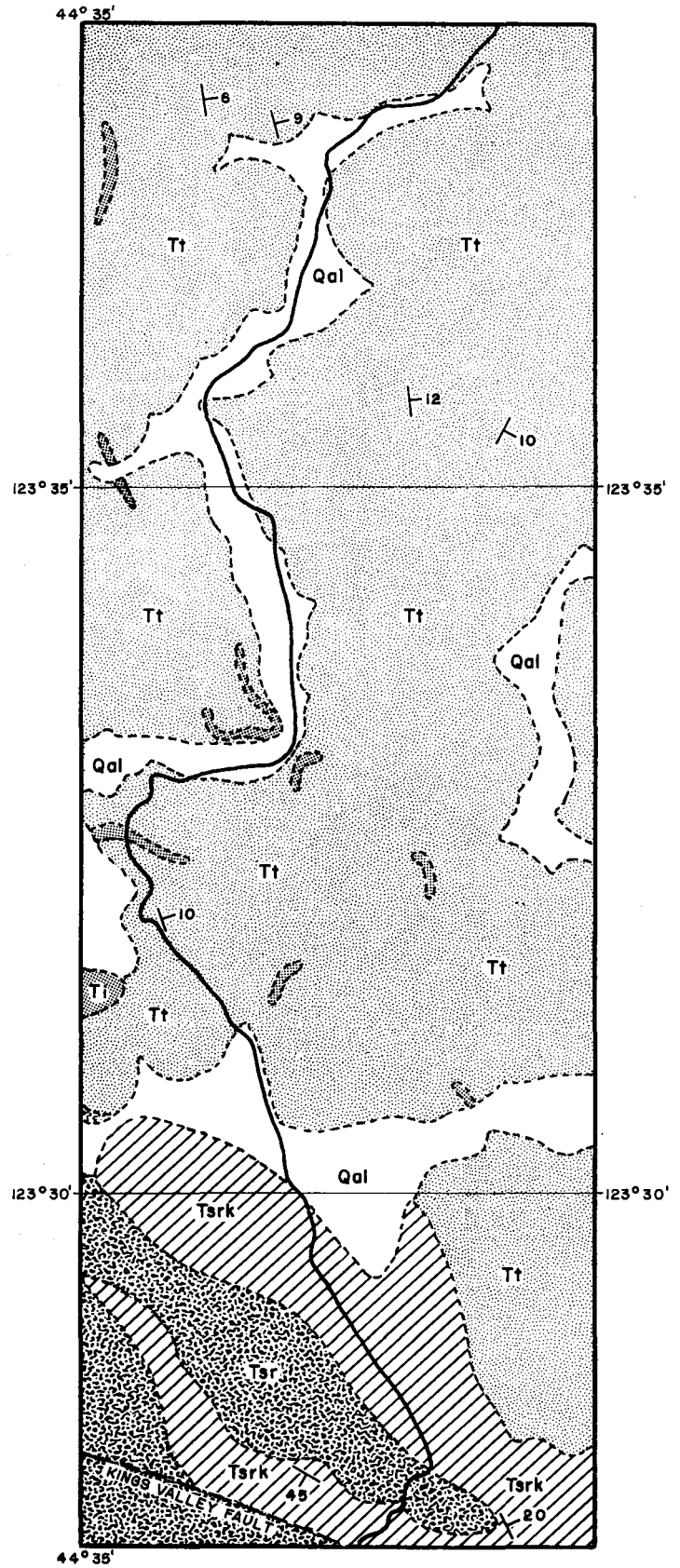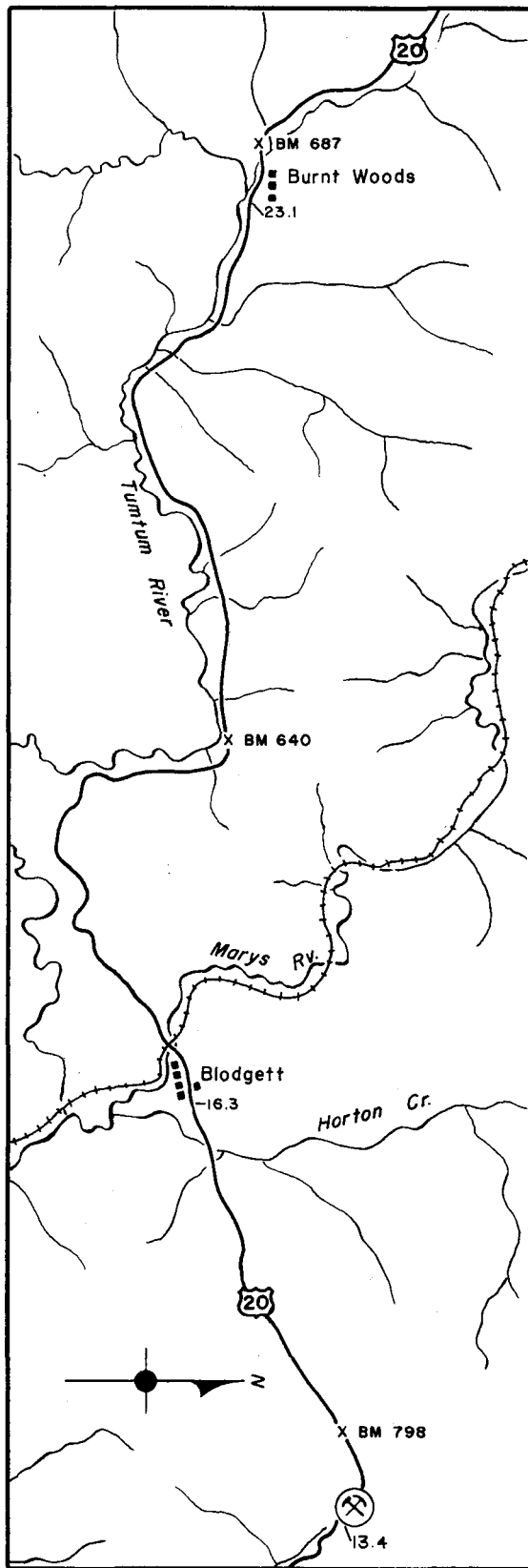
Figure 4

Mileage

13.6   Back into the Kings Valley siltstone.
      (2.3)

15.9   Marys Peak at 10 o'clock. Approximate contact of Tyee formation and Kings Valley
      (0.4) siltstone at this point.

16.3   Blodgett. Road junction. Continue straight ahead on U.S. Highway 20.
      (0.3)

16.6   Tyee tuffaceous shales and sandstones exposed in road cut. Fragments of fossil plants,
             mostly reeds, occur in the shales. Slide on the south side of the road shows the common
             effect of excavations into deeply weathered material. A basalt intrusive is exposed at
      (6.5) the west end of the road cut on the south side of the road.

23.1   Burnt Woods.
      (8.1)

(Begin Fig. 5)

29.2   Terrace or bench cut into the valley sides at 11 o'clock indicates rejuvenation of the area.
      (0.4)

29.6   Massive sandstone of the Tyee formation, dipping westward.
      (0.2)

29.8   In view ahead, on south side of the highway, bent trunks of trees reflect active creep of
             the steep slopes of deeply weathered Tyee beds. Creep and slumping in the valley slopes
      (2.7) are evident for several miles.

32.5   Slump feature at 9 o'clock.
      (0.3)

32.8   Eddyville.
      (0.2)

33.0   Railroad crossing and bridge.
      (0.1)

33.1   Road junction. Continue straight ahead on U.S. Highway 20.
      (0.2)

33.3   The Tyee formation is well-represented by the rhythmically bedded sandstones and siltstones
             exposed in the road cut. The sandstone is arkosic and micaceous. Characteristically each
             sandstone bed makes a sharp contact with the underlying siltstone and grades rapidly upward
             into the siltstone bed above. Fossil plant fragments are common in the siltstones. Spheroidal
             weathering of the massive sandstone beds near the top of the profile produces a distinctive
      (2.0) structure.

35.3   The railroad tracks on the left of the road connect Corvallis and Toledo and are owned by
             the Southern Pacific. At one time the line offered passenger service from Corvallis to
      (2.9) San Francisco via steamship out of Yaquina Bay.
(Begin Fig. 6)

38.2   Chitwood. The rhythmically bedded Tyee beds here are very similar to those at Eddyville
             but are considerably higher in the stratigraphic section. The strongly entrenched meanders
             of the Yaquina River seen from Eddyville to Yaquina Bay indicate rejuvenation of a coastal
             plain now evident only as hill tops ranging in elevation from 750 to 1,000 feet near Chitwood
             but decreasing in elevation toward the coast. Uplift in the Coast Range, as in the Klamath
             Mountains, has been episodic, producing several upland erosion surfaces, beginning probably
      (4.1) in late Miocene or early Pliocene and continuing into Recent time.

42.3   Highway now on the Toledo formation. The Toledo contact with the Tyee is obscure and not
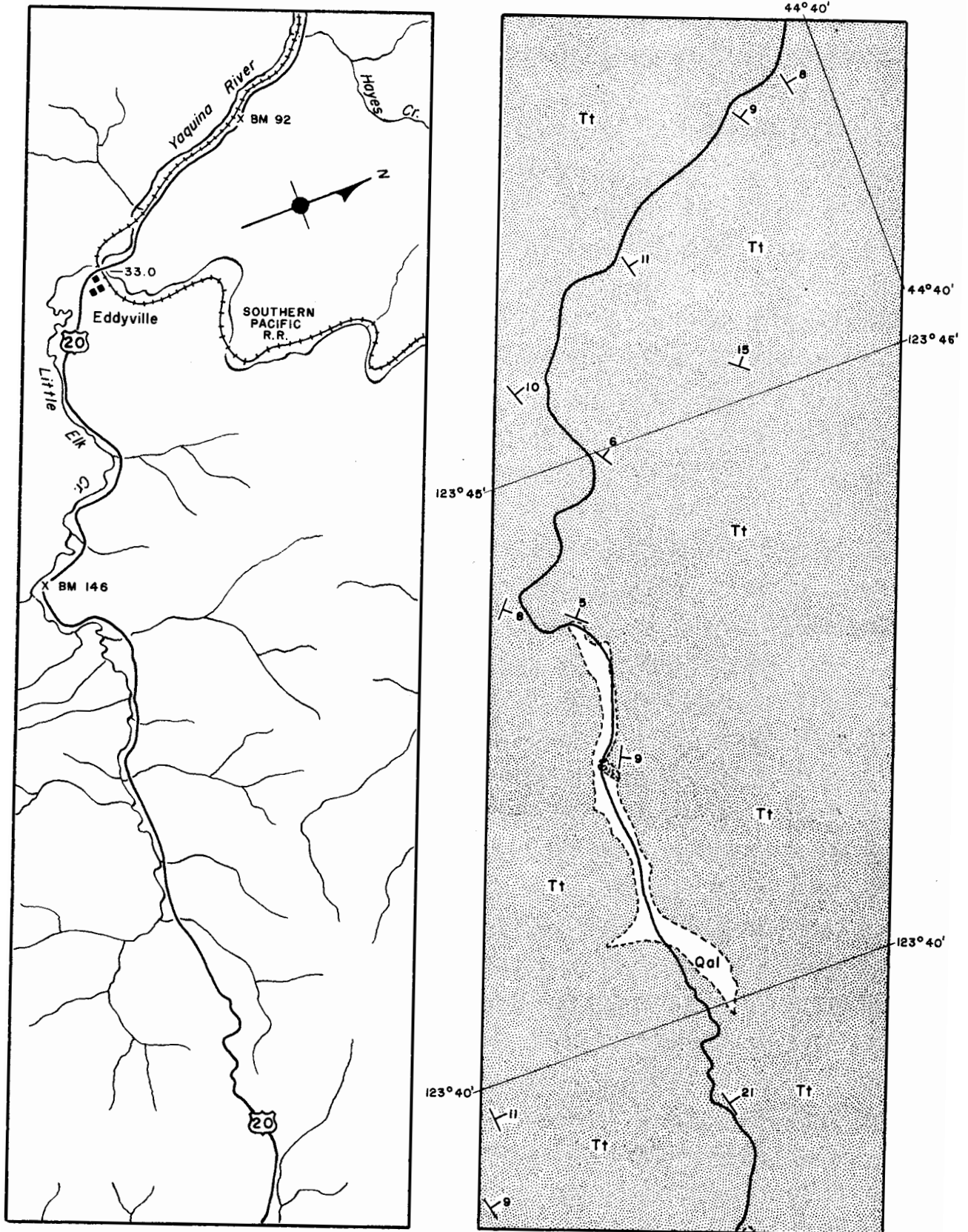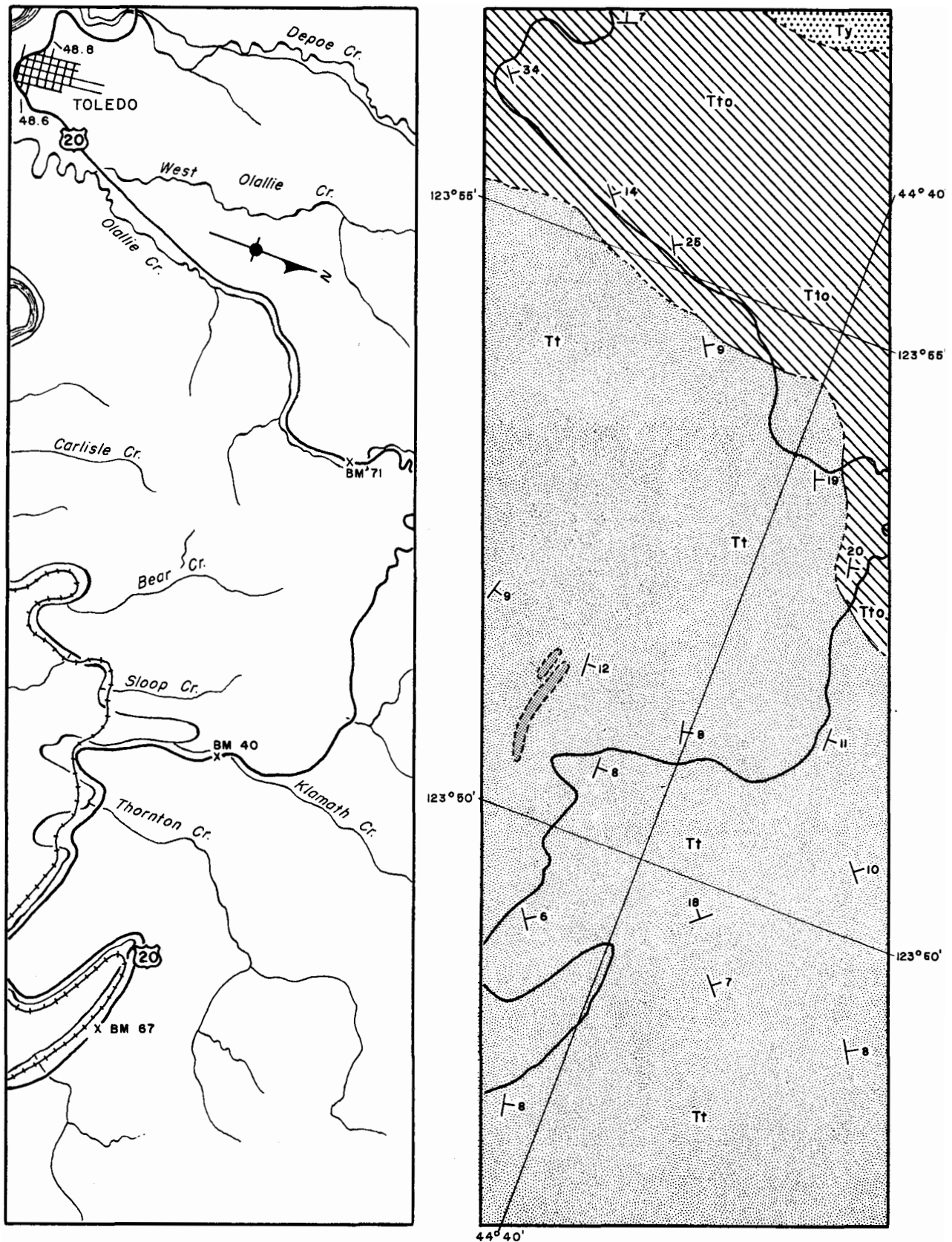   (1.5) definitely located.

Figure 5

Figure 6

Mileage

43.8	Pioneer Mountain summit, 422 feet.
(1.6)	
45.4	Exposure of the basal beds of the Toledo overlying the Tyee with angular unconformity in
(3.2)	the new road cut on the south side of the road.
48.6	Toledo city limits.
(0.4)	
49.0	Moody shale member of the Toledo formation is exposed in the road cut on the north side
(0.8)	of the road.
49.8	Moody shale member of the Toledo exposed on the right side of the highway. Mollusca
(0.3)	and Foraminifera have been identified from this locality.

(Begin Figs. 7a and 7b)

|	
50.1	Georgia Pacific paper mill on the left.
(0.6)	
50.7	Railroad crossing.
(0.1)	
50.8	Road junction with Oregon Highway 223 to Siletz. Continue on U.S. Highway 20.
(1.5)	
52.3	Yaquina sandstone on right side of road.
(1.6)	
53.9	Contact of Nye shale with underlying Yaquina sandstone is exposed on the right side of
(0.1)	the road.
54.0	Yaquina Bay at 9 o'clock. This is a drowned valley.
(1.5)	
55.5	Pacific Ocean ahead at 12 o'clock.
(0.3)	
55.8	Newport city limits.
(0.6)	
56.4	End of U.S. Highway 20. Junction with U.S. Highway 101. Turn right onto U.S. High-
(0.9)	way 101 (Coast Highway).
57.3	Sub-Recent "fossil" sand dunes are exposed along the highway for the next several miles. Newport is built on the dune sands and on Elk River terrace sands and gravels that rest
(1.0)	upon an elevated wave-cut platform.
58.3	Yaquina Head at 11 o'clock. This promontory is made up of basaltic flows and agglomerate.
(0.6)	
58.9	Agate Beach turnoff. After storms, collectors find quantities of yellow and orange chal- cedony on the beach, some of it suitable for cutting. Source of the chalcedony seems to
(0.2)	have been the terrace gravels on the elevated wave-cut bench overlooking the sea cliff.
59.1	Road to Yaquina Head and lighthouse on the left. This basaltic headland affords a good view of the coast. Sea lions frequently and whales occasionally are sighted from here. The lighthouse is situated on a small grassy slope that represents a remnant of a once much larger elevated wave-cut terrace. Below the parking area a steep trail descends to a basalt pebble beach. The wave-cut cliff exhibits the rough texture of volcanic agglomerate. The beach pebbles and cobbles represent the more resistant basalt fragments after the waves
(0.7)	have worked over the cliff-derived debris.
59.8	Iron Mountain at 2 o'clock. This is a basaltic intrusive.
(1.0)	
60.8	Sea stacks at 11 o'clock.
(0.8)	
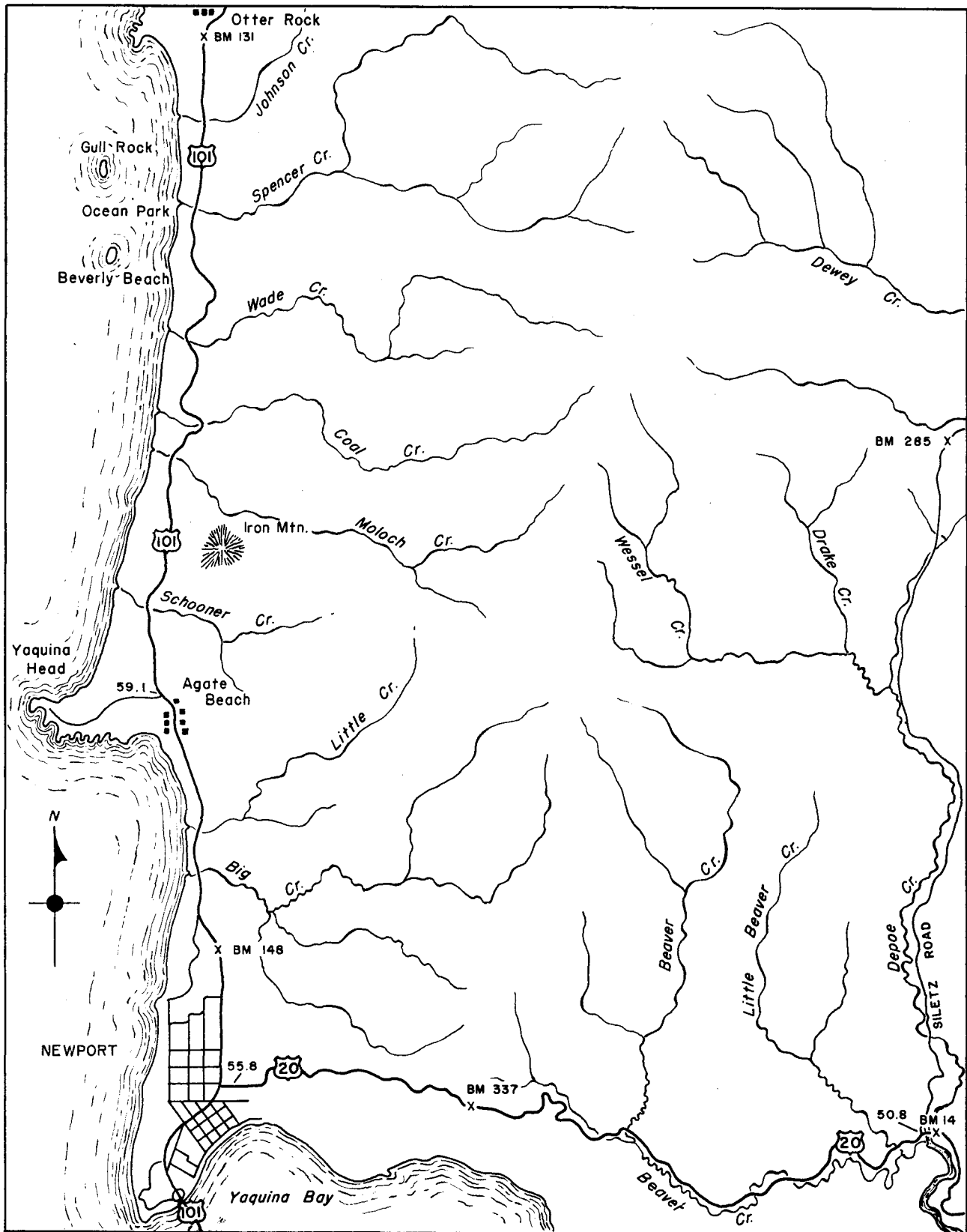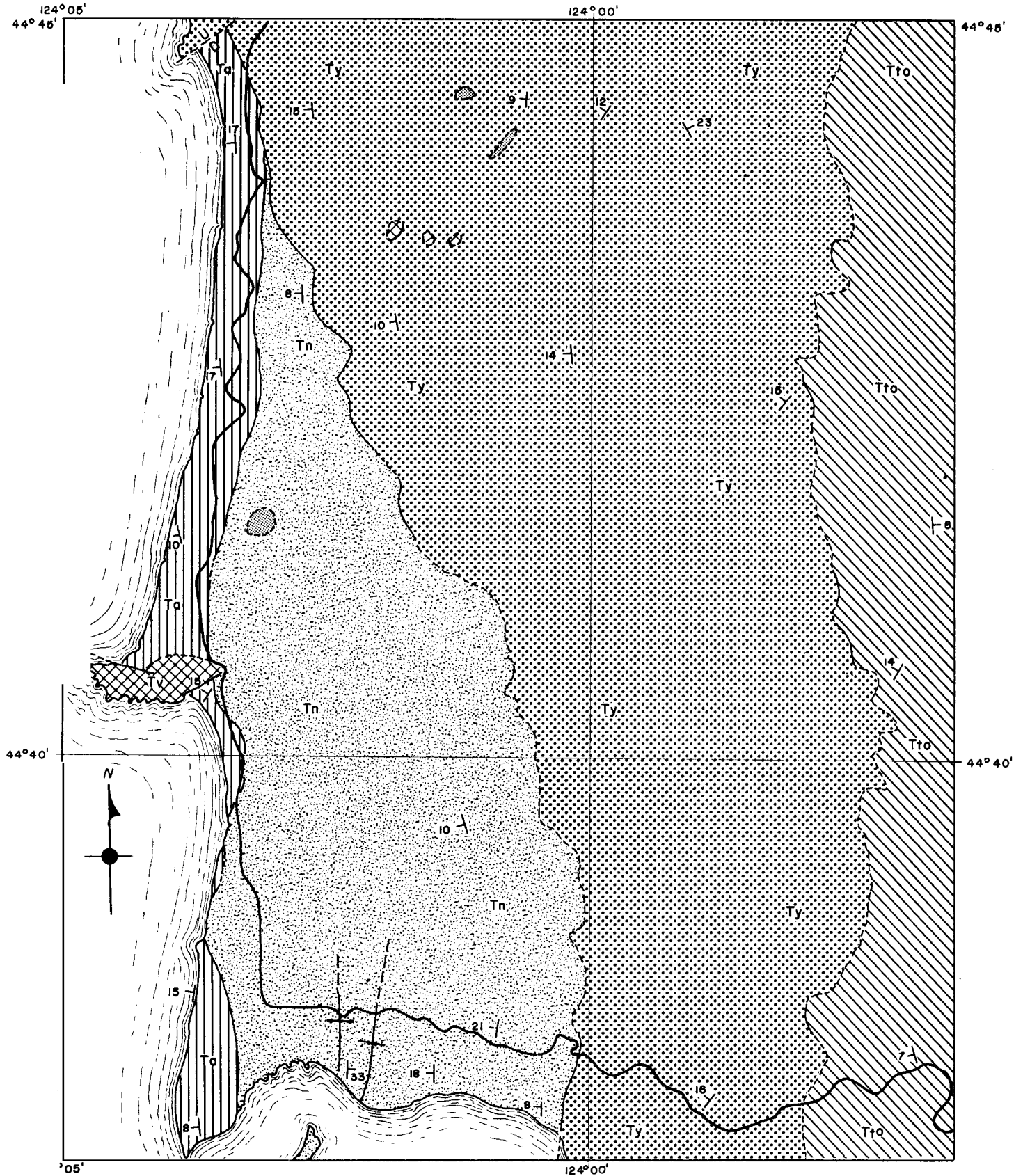
Figure 7a

Figure 7b

Mileage

61.6   Sub-Recent sand dunes on both sides of the highway.
     (0.9)

62.5   Beverly Beach turnout on right. Wave-cut cliff on the left below the highway is formed
              in the Astoria formation. Miocene fossils can be collected from limy beds in the Astoria
     (1.1)   along the cliffs here. "Cannonball" concretions in the sandstone are conspicuous in one
              bed.

63.6   Otter Rock junction.   Turn left to Otter Rock and Devils Punch Bowl State Park.
     (0.4)

64.0   Road to Devils Punch Bowl State Park to the left. The park is on an elevated wave-cut
              terrace cut into Yaquina sandstone. The Punch Bowl at the end of the head is a collapsed
              sea cave. A path leads down to the beach on the south side of the head. Just above the
              beach the path crosses a massive bed of well-indurated tuff. From the beach, looking
              back toward the descending path, there can be seen a fault zone separating the upthrown
              Yaquina sandstone beds that comprise the head and the less resistant Astoria siltstones in
              the sea cliff on the right. The Yaquina is relatively thin bedded at this locality and has
              conspicuous cross bedding. Iron sulfide concretions are abundant. The Astoria formation
     (0.2)   is dark blue gray here and underlies relatively thick dune sands.

64.2   Turn right off old road onto U.S. Highway 101 and continue north.
     (0.4)

64.6   Basalt intrusive on right side of the highway.
     (0.5)

65.1   Columnar jointing is well developed in the basalt intrusive exposed on the right side of
     (0.3)   the highway.

65.4   Otter Crest turnout. From this observation point can be seen the terraces just traversed.
     (0.8)   The parking area on old Highway 101, below, is on another elevated terrace remnant.

67.2   Rocky Creek State Park.
     (0.2)

67.4   Whale Cove.
     (1.4)

68.8   Depoe Bay city limits.
     (0.3)

69.1   Depoe Bay and boat basin. Basalts and pyroclastic rocks are exposed in this area. Hy-
              draulic action has enlarged the jointing in the volcanic breccia at various places. Along
              one of these joints the roof has caved forming an opening to the surface about 6 feet long
              and 3 feet wide. When winds and tide are favorable, waves rush into the narrow passage-
              way periodically developing sufficient head to cause the sea water to spout, sometimes as
              high as 30 feet into the air. The Astoria formation is exposed at the northeast corner of
   the inner bay and also along the south side of the outer bay.

FIELD TRIP NO. 2

EUGENE TO COOS BAY VIA REEDSPORT
By
Ewart M. Baldwin

This trip starts at the University of Oregon Campus at Eugene, Oregon, and follows U.S. Highway 99 south to junction with Oregon Highway 38; thence west on Oregon Highway 38 to Reedsport; and south on U.S. Highway 101 (Coast Highway) to North Bend and Cape Arago in the Coos Bay area. Total distance is logged at 131.6 miles.

For information about the formations encountered, see correlation chart for the Coast Range Cenozoic of Oregon and the accompanying definitions of the formations.
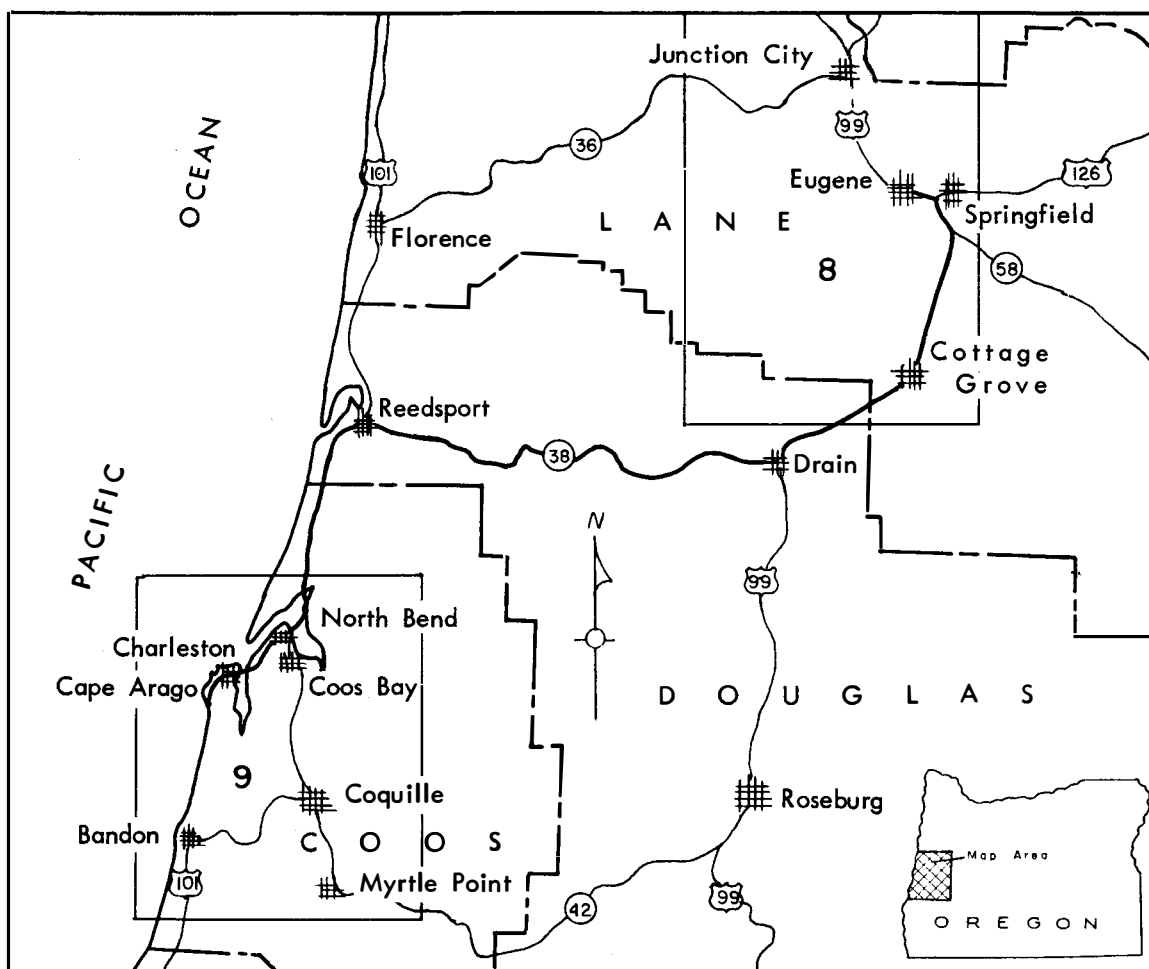
Index map of the Eugene-Coos Bay area showing route of field trip and position
of geologic maps accompanying road log.

ROAD LOG: EUGENE TO COOS BAY VIA REEDSPORT

Mileage

0   Eugene, Oregon. Condon Hall, University of Oregon campus at 13th and Kincaid,
   (0.3)   Geology Departmental Office.
(Begin Fig. 8)

0.3   Erb Memorial Student Union Building. Eugene is situated upon the Eugene formation of
                 middle Oligocene age, and on river alluvium. Many of the earlier good fossil collec-
                 tions were from tunnels excavated on the campus when installing the heating system.
   (1.7)   Go east on U.S. Highway 99.

2.0   Judkins Point – a basaltic intrusive probably in the form of an east-dipping sill.
   (3.7)   Continue on U.S. Highway 99.

              Between Judkins Point and the point overlooking the junction of the Coast and Middle
                 Forks of the Willamette River the Eugene formation is cut by basaltic dikes. The basalt
                 may be middle Miocene equivalent to the Columbia River basalt. Some of the larger
                 bodies resemble the lithology of the Judkins Point intrusive.

5.7   Tuffaceous sediments that have been sliding toward the highway. Many yards of this
                 weathered material have been removed. Cracks and tilted trees may be seen for many
   (.4)   yards up the hill.

6.1   An upper Oligocene flora has been collected from the small butte immediately south of
                 the overpass. The bedded tuffaceous sediments are probably younger than most of the
                 Eugene formation. The flora is listed by Roland W. Brown in the "Geology of the southern
                 and southwestern border areas of the Willamette Valley, Oregon" by Vokes, Snavely,
   (.4)   and Myers (1951).

6.5   Road Junction of Oregon Highway 38 to Oakridge and Klamath Falls and U.S. Highway 99.
   (2.0)   Continue right and south on Highway 99.

8.5   Goshen flora of Chaney and Sanborn (1933) from highway cut on old highway where road
   (1.5)   went around small hill. About 100 yards north of overpass across main highway.

              Large depression is called Camas Swale. Gravels on floor of swale may point to occupancy
                 by Willamette River during one of its stages of meandering. Pointed peak to the north is
                 Spencer Butte, an intrusive body of diorite in the form of an east-dipping sill.

10.0   Terrace capped by thoroughly decomposed gravels.
   (2.1)

12.1   Junction with road to Creswell. Creswell Butte is located just south of town. Outcrops
                 of a quartz-bearing diorite are exposed along the old highway 0.8 mile from the main
   (8.3)   intersection in Creswell. The diorite is in an east-dipping sill.
                 Continue south on U.S. Highway 99.

20.4   Junction of highway and road from Cottage Grove. Rock surrounding this junction is
                 purplish tuff and tuffaceous sandstone of the Fisher formation. Massive Fisher tuffs crop
   (6.9)   out along Pass Creek.
                 Continue south on U.S. Highway 99.

27.3   Massive outcrops of cemented Fisher tuffs.
   (1.1)

28.4   Flora of Sanborn (1937) from railroad cut paralleling main highway. Leaves obtained near
   (1.6)   base of Fisher formation and near top of Spencer formation are probably upper Eocene.
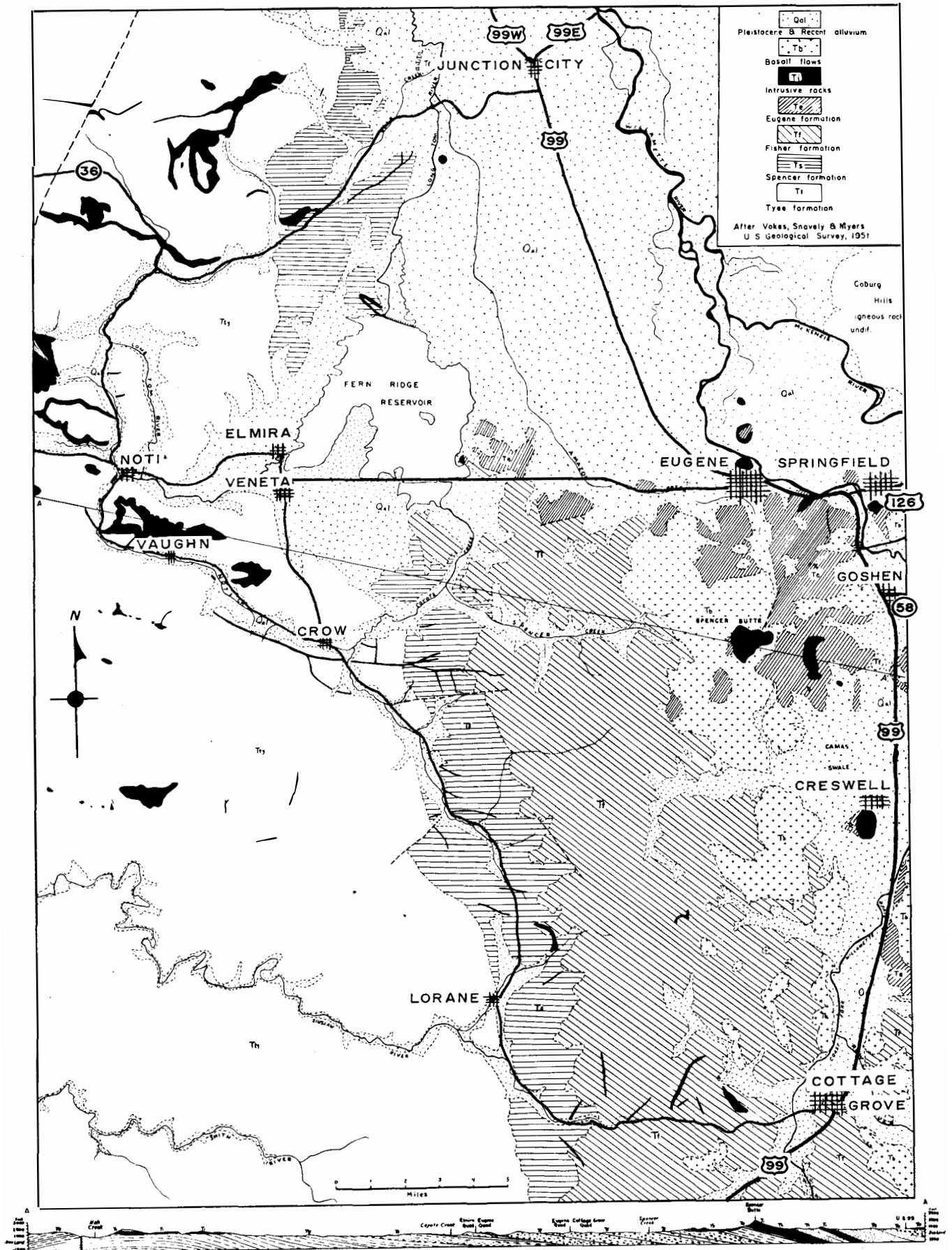
Fig. 8 – Geologic Map of the Eugene Area.

Mileage

30.0   Coal bed exposed in the road cut on point. This is near the top of the Comstock forma-
              tion of Turner (1938) and included within the Spencer formation by Vokes, Snavely, and
    (.2)   Myers (1951)

30.2   Base of the Spencer formation. Pebbly tuffaceous sandstone disconformably resting upon
              siltstone and thin-bedded sandstone of the Tyee formation. There is a larger percentage
              of siltstone in the Tyee formation at this point similar to that in the Lorane shale member
    (.9)   near Lorane, Oregon, and the upper part of the Tyee formation south and west of Elkton.

31.1   Dike by old overpass over railroad just west of Comstock. Comstock fauna of Turner and
              others along north edge of dike in highway cut.   Contains <u>Venericardia</u> and <u>Turritella</u>.
    (.3)   (Little left of Comstock.)

31.4   Massively bedded sandstone of the Tyee formation which is more typical of this formation
    (1.7)   than the siltstone at the top.

33.1   Junction of Oregon Highway 38 to Coast and U.S. Highway 99 southward to Roseburg.
              Turn right on Highway 38 to Coast, via Drain.

    (7.1)   Tyee formation along highway to Drain. (see Turner, 1938, Drain to Comstock section, p.21)

40.2   <u>Drain:</u>   Junction of highway south and Oregon Highway 38 west. A large basalt quarry in
              the south edge of Drain reveals flows of vesicular and zeolitized basalt which dip north-
              ward approximately 35 degrees. This basalt is considered a part of the Umpqua formation
              and underlies the Tyee sandstone exposed along the highway. Continue westward on
    (4.5)   Oregon Highway 38 toward Coast.

44.7   Jack Creek. Tuffaceous sediments of the Umpqua formation are present north of the high-
              way. The hill northwest of this crossing is underlain by basalt of the Umpqua formation.
    (1.6)   (Geology of Drain and Anlauf quadrangles, L. Hoover, in preparation.)

46.3   Red vesicular and zeolitized basalt in small quarry above highway.
    (1.0)

47.3   Siltstone overlying basalt and underlying massive sandstone which is the base of the Tyee.
              This location, mentioned by Turner (1938), contains orbitoids, other Foraminifera, and
    (3.6)   some mollusks. The fossils are in the Umpqua formation.

              West of this point to Elkton, the Tyee formation has a homoclinal dip westward of approx-
              imately 15 degrees.

50.9   Tunnel through meander neck of Elk Creek. Massive Tyee sandstone.
    (1.2)
52.1   Bridge over Elk Creek to south side of creek.
    (.9)
53.0   To the south in broad meadow is old cutoff meander of Elk Creek.
    (1.5)
54.5   Bridge over Elk Creek near its junction with Umpqua River. Side road to left follows River
              upstream or crosses bridge to south side. One and a half miles west of bridge along Henderer
              Road is large fresh road cut along the south bank of the River. The strata contain a large
              percentage of siltstone. Both mega and micro fossils are relatively abundant. The massive
              Tyee sandstone is generally unfossiliferous, but the upper silty beds of the Tyee formation
    (.2)   contain assemblages in places.

54.7   <u>Elkton</u> on Oregon Highway 38. The strata at Elkton dip approximately 10 degrees south-
    (3.8)   westward but gradually swing to a southward dip a few miles west of Elkton.

Mileage

58.5   Siltstone, similar to that across river from Elkton.
    (2.0)

60.5   Apex of sharp turn on highway. Dip is gently southeastward. Center of south plunging
          syncline is occupied by silty fossiliferous phase of the Tyee formation.
    (2.5) More massively bedded Tyee is exposed west of this point.

63.0   Mouth of Paradise Creek.
    (1.6)

64.6   Sawyer Rapids. Massive Tyee sandstone.
    (4.0)

68.6   Center of syncline.
    (3.8)

72.4   Green Acres. Large landslide from northwest slope at one time partially blocked river.
    (2.3) Note large blocks of Tyee by houses just west of Wells Creek.

74.7   Scottsburg, on Oregon Highway 38.

    (.5)

75.2   Center of highway bridge over Umpqua River. This is the head of tide water.
    (3.3)
          Massively bedded Tyee strata dip eastward between the bridge and the mouth of Mill Creek.

78.5   Mill Creek. Seven miles up the creek a major landslide composed of large blocks of Tyee
          sandstone has dammed the creek approximately 300 feet high and created Loon Lake and
    (.8) the alluvial flats of Ash Valley beyond the lake.

79.3   Small·ravine from the south. Fault breccia is exposed in this small creek indicating align-
          ment along a fault. East side is down thrown. Sudden change in attitude and general dip
    (1.8) west of fault is very gently southward, in many places appearing to be almost horizontal.

81.1   Mouth of Charlotte Creek. New highway construction obtains fill rock from quarry in
    (3.9) massive Tyee sandstone.

85.0   Large jetty rock quarry on opposite bank of Umpqua River. Large blocks of Tyee barged to
    (4.9) jetty at mouth of the Umpqua River near Winchester Bay.

89.9   Schofield Creek Road. Very narrow pass between river and Schofield Creek has been sub-
          merged during certain alluvial stages of the Pleistocene. Highway between here and
    (2.3) Reedsport frequently blocked by slides.

92.2   Reedsport. Junction of Oregon Highway 38 and U.S. Highway 101. Turn left (south) on
    (.6) U.S. Highway 101 (Coast Highway).

92.8   Bridge over Schofield Creek.
    (.5)
93.3   Alluvial flat of a former channel of Schofield Creek that flowed farther westward before
          turning northward. Smith River joins Umpqua River from the northeast. ·All the streams
          along this part of the coast have been drowned, perhaps more than 200 feet during late
    (.9) stages of the Pleistocene accompanying post Wisconsin deglaciation.

94.2   Deep cut in southwestward dipping massively bedded Tyee sandstone.
    (2.3)

96.5   Winchester Bay, near the mouth of the Umpqua River.
    (1.5)

98.0   Lookout at top of hill south of Winchester Bay. Jetties of the river mouth visible. A small
    (1.5) lake, Lake Marie, is situated at base of hill in Umpqua Lighthouse State Park.

Mileage

99.5   Clear Lake. Most of the larger lakes are the result of downcutting of streams beneath
              present sea level during eustatic changes of sea level. Subsequent drowning and blocking
    (1.0)   of channel mouths by sand dunes forms lakes.

100.5   Base of Coaledo formation resting upon Tyee sandstone. Pebbly, fossil-bearing sandstone
    (.7)   is largely obscured by grass.

101.2   Weathered siltstone of the Coaledo formation. Large slides have disrupted the highway
    (.8)   at this point.

102.0   Eel Lake. This lake is a drowned stream system.
    (1.7)
103.7   Junction with road to Tenmile Lake and the town of Lakeside. Continue south on U. S.
    (.5)   Highway 101.

104.2   Bridge over Tenmile Creek.
              Tree-covered dunes with live dunes to the west obscure older formations for many miles
    (3.9)   south of Tenmile Creek.

108.1   Side road to south Tenmile Lake. Crosses sand dune area, Coaledo formation up hill to
    (2.5)   radar station and Tyee sandstone beyond in arms of lake.

(Begin Fig. 9)

110.6   Bridge over North Inlet. Sand dune area to west spreads southward into the North Spit
    (2.9)   that encloses Coos Bay.

113.5   Coaledo sandstone at north end of bridge across the bay.
    (1.3)
114.8   North end of large McCulloch Bridge across Coos Bay. Road to south goes to Glasgow
              and to upper Coos River. Landsliding is common in the area between the two bridges.
    (2.0)   Coaledo formation crops out at this point.

116.8   North Bend. Intersection at Coos Bay Hotel. Turn right (west) for road to Empire.
    (.8)
117.6   Intersection in Bangor. Turn left and continue on road to Empire.
    (1.9)
119.5   Empire lakes may be seen to the right of the road in depressions in the old dunes. Dunes
    (.5)   between Bangor and Empire are forested. They are probably Pleistocene.

120.0   Road to Coos Bay to left. Continue straight ahead into Empire.
    (3.7)   In Empire turn south toward Charleston.

123.7   Pidgeon Point is a small point of Empire sandstone. The Empire formation is lower to
              middle Pliocene and at this point dips gently westward toward the synclinal axis paral-
              leling South Slough. One can park here and follow the beach southwestward approxi-
    (.4)   mately one half mile to Fossil Point.

124.1   Fossil Point is located along the bay opposite the road intersection just west of the Barview
              grocery. One must go through private property to get there by the short way but at low
              tide it may be reached by way of Pidgeon Point. This is a very unusual accumulation of
              fossils and conglomerate within the Empire formation. This has been discussed by Dall
    (1.3)   and the fossils figured in U.S. Geol. Survey Prof. Paper 59, 1909, and by Weaver, 1942.
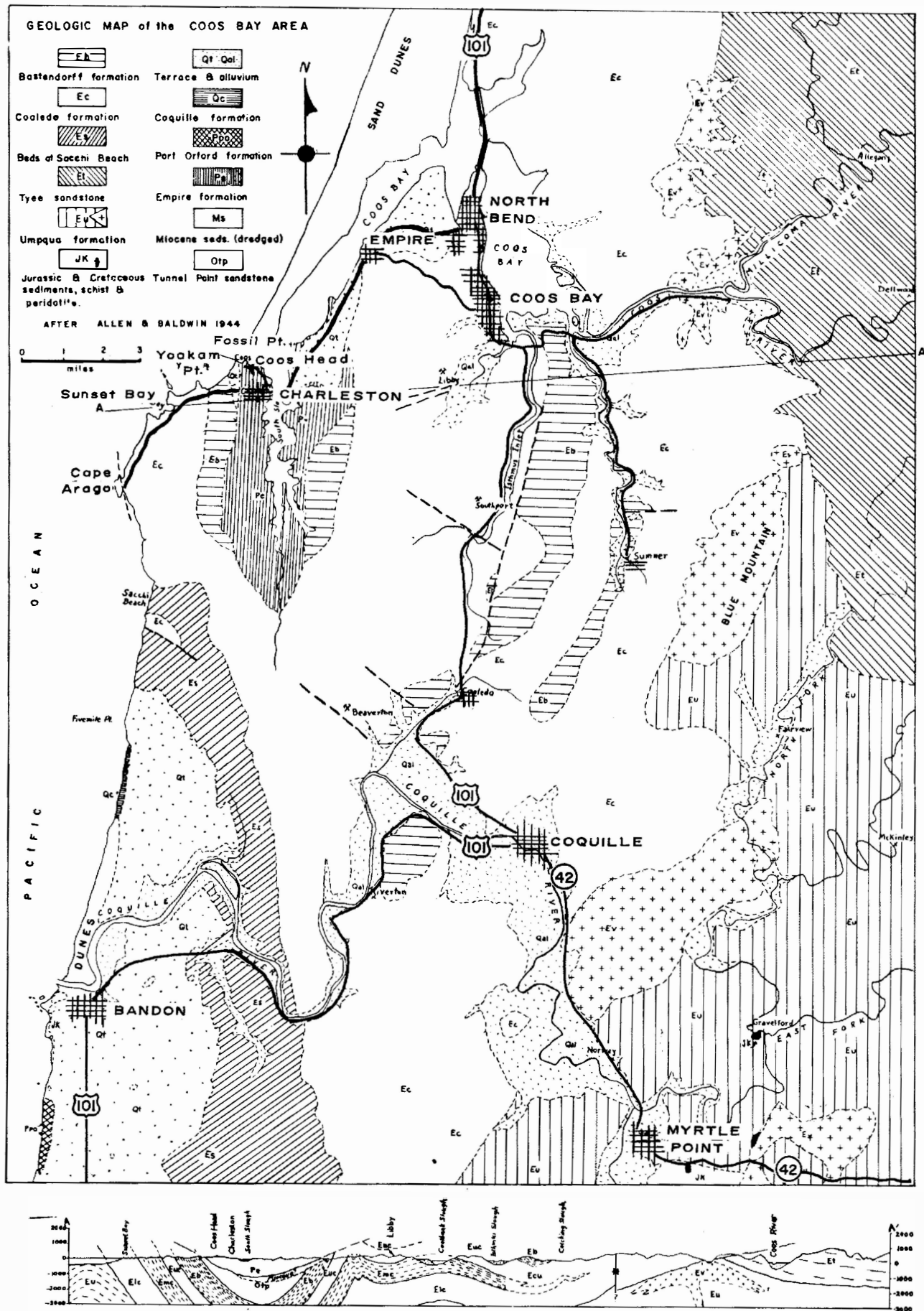
Fig. 9 – Geologic Map of the Coos Bay Area.

Mileage

125.4   Center of the bridge across South Slough near Charleston. The Slough follows the axis of
    (.2)   the synclinal structure. See cross section (after Allen and Baldwin, 1944).

125.6   Charleston. Coos Head and the Marine Biological Station to the right along the bay.
    (.3)

125.9   Seven Devils Road that leads to Sacchi, Merchant, and Agate beaches and to Bandon.
    (.5)   Continue on main road toward Cape Arago.

126.4   Side road to Coos Head and to the beach at the Jetty at the entrance to Coos Bay. Empire
            formation makes up the headland at Coos Head and at the end of the Jetty. This is a mas-
            sive sandstone at this point dipping eastward toward the center of the syncline. A Naval
    (1.0)   Research Laboratory is situated on Coos Head.

127.4   Bastendorff Beach. The Beach is situated between two sandstone headlands. Mussel Reef
            (Yoakam Point) composed of Coaledo sandstone is situated to the west and Tunnel Point com-
            posed of the mid-Oligocene Tunnel Point formation is situated to the east. The strike of
            the Bastendorff formation is northward with a steep dip to the east. The lithology is that of
            shale, easily eroded, thus accounting for the wide beach. The upper Bastendorff contains
            a Refugian microfauna. The formation is considered to be both upper Eocene and lower
    (.2)   Oligocene. (Cushman and Schenck, 1928, and Stewart, R. E., 1956)

127.6   Side road to the right leads to Mussel Reef (Yoakam Point). On the point steeply dipping
            beds of upper Coaledo jut out into the ocean. Coal bed approximately 5 feet thick is
            situated in the cove along the west side of the point. A good view of the beaches both
            east and west may be obtained from this point. Late Pleistocene faulting has dislocated
    (.6)   the wave-cut terrace with the east side uplifted.

128.2   Side road to Cape Arago Lighthouse. Lighthouse is on Cape Gregory whereas Cape Arago
            is situated approximately 3 miles southwest. Steeply dipping beds of lower Coaledo sand-
            stone dip eastward. The lighthouse is upon an island whose tip points seaward. The middle
    (.5)   Coaledo siltstone and shale is exposed along the beach to the east.

128.7   Sunset Bay. The bay is carved in the top of the lower Coaledo and the base of the middle
            Coaledo. The broader backside of the bay being in the middle Coaledo siltstones. Several
            faults with relatively small displacement have localized erosion at this point to form the
            bay. Foraminifera of the Coaledo formation are described by Detling, 1946, and Cushman,
            Stewart, and Stewart, 1947. Stumps exposed at low tide along the margin of the bay and
    (.2)   in Big Creek grew during an earlier stand of the sea.

128.9   Bridge across Big Creek. This creek heads in the Bastendorff shale, and cuts through the
    (.9)   upper and middle Coaledo formations.

129.8   Shoreacres. This State park is the former home of Louis Simpson, a prominent Coos Bay
            lumberman. The vista house is situated near the former residence and the formal garden
            with many exotic plants is situated to the west. Steeply dipping lower Coaledo sandstone
            has been truncated by the sea during the formation of this prominent marine terrace. A
            higher marine terrace is visible to the south. The sandstone displays prominent concretions
    (1.8)   and flutings along the shoreline.

131.6   Cape Arago. The road from the lighthouse to this point has been paralleling the strike.
            A faulted anticline in the lower Coaledo trends northward through the Cape. The beds
            on the east dip eastward, those to the west dip westward. The rocks off shore display a
            reversal in dip with the dip once again eastward. Many interesting structural features are
            displayed in North Cove. The beds have been deformed along the fault. Channeling is

displayed in the Cooledo formation along the shore near a small waterfall. Dott (1955) suggests that bedding features point to deposition by turbidity currents.

Middle Cove just south of the lookout is o favorite spot to collect fossils. Turner (1938) lists many species from this spot. Sand dollars ore relatively abundant in the sandstone.

South Cove and the cliffs to the south show eastward dipping sandstone. Intraformational conglomerate is prominently displayed.

Bridge Creek 4 miles west of Mitchell. Cretaceous shales intruded by andesite sills. The house is on the axis of the Mitchell anticline. (Oregon State Highway Commission photo)

Looking south across the John Day River valley at Strawberry Mountain near John Day, Oregon. (Oregon State Highway Commission photo)

FIELD TRIP NO. 3

CORVALLIS TO PRINEVILLE VIA BEND AND NEWBERRY CRATER
By
W. D. Wilkinson and H. G. Schlicker

This trip starts in Corvallis, Oregon, at Van Buren Street bridge over the Willamette River and goes east on county roads to Lebanon. From Lebanon it follows U.S. Highway 20 up the South Santiam River, crosses the Cascade Range at Santiam Pass, and continues through Sisters to Bend. From Bend it goes south on U.S. Highway 97 to Newberry Crater and returns to Bend. Thence it goes east on U.S. Highway 20 past Pilot Butte, turns north on Powell Butte road, joins U.S. Highway 126, and proceeds east to Prineville. Total distance of the whole trip is logged at 241.1 miles.

Formations encountered between Corvallis and Sisters are described below under Stratigraphic Sequence in the Willamette Valley and Cascade Range. (Formations east of Sisters are described in Field Trip No. 4 under Stratigraphic Sequence for Central Oregon.) Road log and accompanying geologic maps follow formation descriptions.
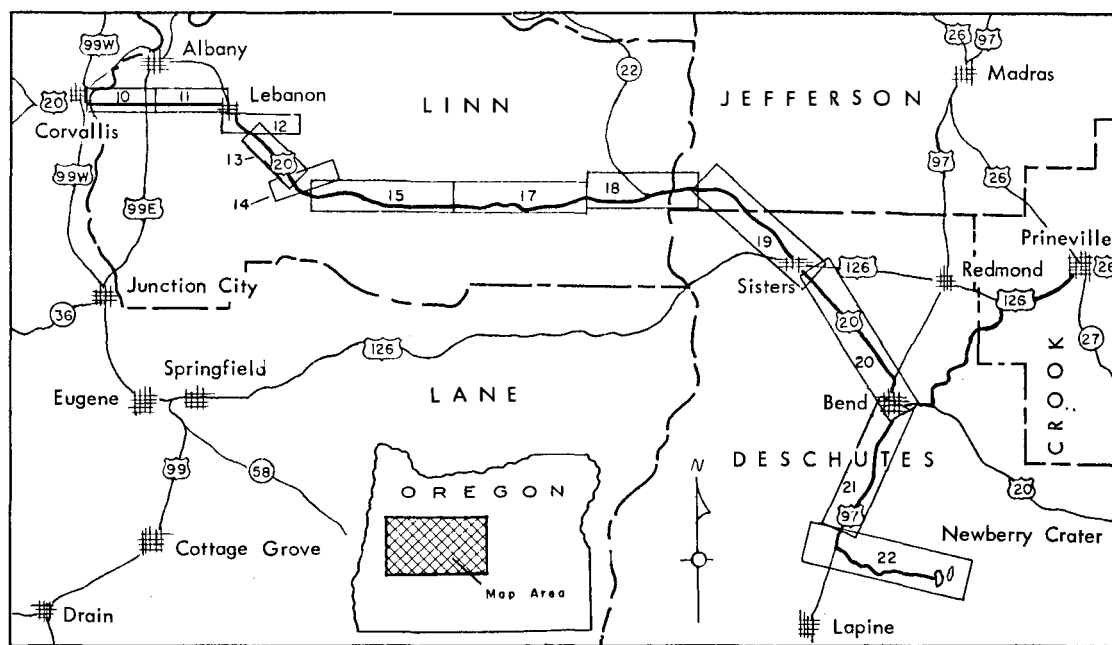
Index map of the Corvallis-Prineville region showing route of trip and position of geologic strip maps accompanying road log.

STRATIGRAPHIC SEQUENCE FOR WILLAMETTE VALLEY AND CASCADE RANGE

PLEISTOCENE

The older sediments of the Willamette Valley area are represented by a series of three gravel terrace deposits and a later deposit called the Willamette silt. The gravels correspond to alternating alluviation and erosion related to the glacial and interglacial stages of the Cascade Range.

Willamette silts: The Willamette silts, mapped and named by Allison (1953), are parallel-bedded silts and associated materials which cover the majority of the Willamette Valley lowland. At Albany the silts are about 15 feet thick, but they thin out at higher elevations. The silts do not occur above 400 feet elevation.

The Willamette silts are composed of angular grains and cleavage fragments of a variety of common minerals, mainly quartz and feldspars. Interbedded with the silt and lying on the surface are numerous rocks varying in size from small chips to boulders weighing several tons. The coarse fragments and boulders are composed of granite, schist, gneiss, quartzite, slate, and a variety of other rocks foreign to northwest Oregon. Several boulders have been reported to have glacial striae. A study by Allison (1935) describes these rocks as glacial erratics deposited by melting icebergs which originated in northeastern Washington and floated down the Columbia River. Ice jamming in the Columbia River caused the Willamette Valley area to become flooded to a depth of 200 feet. As the ice melted and the flood waters receded these erratics were left stranded throughout the Willamette Valley area.

The Willamette silts are the last materials of glacial origin to be deposited on the valley plain. They are believed to be of late Pleistocene age corresponding to the latest glacial stage, the Wisconsin or Tioga in eastern Washington (Allison, 1953).

Linn gravels: The Linn gravels are widespread in the area between Albany and Lebanon. South of Albany, however, they are covered by a thin veneer of Willamette silt and are exposed only where streams have cut through the silt.

The Linn gravels in the Albany quadrangle are mainly pebble gravels, sand, and clay. Pebbles 1 to 3 inches in diameter show considerable rounding. In general, the material is in the form of fans deposited by the South Santiam, Willamette, and Calapooya rivers. The gravels are only a few tens of feet thick. They extend from about 10 to 30 feet above the stream beds to a few feet below the level of the present streams. These gravels appear to be considerably younger than the underlying Leffler gravels and older than the silt. They are considered to be of early Wisconsin age.

Leffler gravels: The Leffler gravels occur in terraces between the elevations 300 and 500 feet above sea level. According to Allison and Felts (1956), these gravels once covered most of the valley area, and the present occurrences are merely remnants exposed along the terrace slopes. Much of the top surface of the gravels is covered by Willamette silt. The Leffler gravels were derived partly from local sources and partly from the Cascade Mountains to the east, and were deposited by the North and South Santiam rivers. Their texture differs from area to area but is predominantly pebble size. The gravel is weathered deeply and an oxidized reddish-brown soil has been developed.

Deposits of Leffler gravels along the North Santiam River appear to be a valley train from the Mill City glacier. Allison (1936, 1953) and Thayer (1939) consider them to be the Kansan stage of middle Pleistocene age.

Lacomb gravels: The Lacomb gravels occupy the terraces above 400 feet elevation in the Cascade foothills. The occurrences are in the canyons of Crabtree and Beaver creeks in the Lebanon and Snow Peak quadrangles, in the hill at Jefferson Cemetery, and between Hardscrabble Hill and Knox Butte in the Albany quadrangle. The gravels are composed mainly of cobbles and pebbles of basalt and andesite but

contain considerable petrified wood and chert. They are deeply weathered and are believed to be early Pleistocene in age.

PLIOCENE TO RECENT

High Cascade and related volcanics: The Pliocene, Pleistocene, and Recent history of the Cascade Mountains and adjacent areas is largely one of vulcanism. Throughout this time, eruptions from fissures and central vents occurred at frequent intervals. Lavas, pyroclastic rock, and associated volcanic debris piled up to form the High Cascades, thus building the major physiographic feature separating western and eastern Oregon.

Because of the varied character, place, and time of extrusion, these volcanics are grouped together in this brief account. For more detailed description, reference may be made to Hodge (1940-b), Williams (1953, 1957), and others listed in the accompanying bibliography.

The older rocks of the High Cascades are composed mainly of olivine basalt and basaltic andesite including, according to Hodge (1940-a & b), some agglomerate and other volcanic debris. Later effusions are andesitic and dacitic; these lavas are glaciated. Late in the Pleistocene, after appreciable erosion, basaltic lava poured down the canyons to form the intracanyon flows. The most recent effusions have produced pumice and cinder cones, dacitic glowing avalanche deposits, and some flows of pyroclastic andesite.

MIOCENE TO PLIOCENE

Rhododendron formation (?): The younger rocks of the Western Cascades are composed of lavas and tuffs of upper Miocene and possibly lower Pliocene age. These volcanic rocks are equivalent in part to the Rhododendron formation and for the sake of convenience are referred to in the strip maps and correlation charts as Rhododendron formation (?). At the base of the formation there are dense black basalt flows which may be equivalent to the Columbia River basalt or Stayton lavas. Above the basalts the lithology varies from andesites and basalts to tuffs and breccias. Some of the breccias are similar to the older Mehama volcanics. They are usually less indurated, however, and are separated stratigraphically from the Mehama volcanics by a series of lavas.

The upper Miocene volcanics unconformably overlie the Mehama formation and dip generally to the west. Near their sources, these volcanics have high but variable dips which are probably initial dips rather than structural.

Fossil leaves found in scattered occurrences within these volcanics are dated upper Miocene. Volcanics overlying the leaf-bearing beds are younger, possibly lower Pliocene.

MIOCENE

Stayton lavas: The Stayton lavas, named by Thayer (1939), are a series of basaltic flows, generally less that 500 feet thick, exposed in the Willamette Valley and Cascade foothill areas. They cap the Eola Hills northwest of Salem, the Salem Hills south of Salem, and have been traced by Thayer to the crest of the Mehama anticline in the Western Cascades. Southward, Allison and Felts have mapped Stayton lavas in a number of small discontinuous areas extending to the southern boundary of the Lebanon quadrangle. Lavas of similar lithology and stratigraphic position are exposed at Sweet Home and in the South Santiam River gorge a few miles east of Foster.

The Stayton lavas are dark gray to black, dense or vesicular, hypocrystalline, slightly porphyritic basic rocks composed of basic plagioclase, clino-pyroxene, magnetite, and volcanic glass. Olivine is minor and occurs as small phenocrysts. Typical exposures of Stayton lavas show well developed columnar structure, and the flows are usually flat or slightly dipping. The lavas have been gently folded into broad anticlines and synclines.

The Stayton lavas unconformably overlie the Eugene and Mehama formations and are overlain by Fern

Ridge tuffs and other volcanic rocks which have yielded fossil leaves of upper Miocene age. The Stayton lavas are therefore regarded as middle Miocene and are correlated with the Columbia River basalt on the basis of lithology and stratigraphic position.

OLIGOCENE TO MIOCENE

Mehama volcanics: The Mehama volcanics were named for tuffs, breccias, lavas, and interbedded water-laid sediments exposed northeast of Mehama, Oregon. Similar rocks occur throughout the Western Cascades of Oregon.

Although tuff and breccias predominate, there is considerable variation in the lithology of the Mehama volcanics from place to place. In some areas coarse mudflow breccias are dominant, while in other places thick sequences of lavas, probably of intracanyon origin, predominate. East of Cottage Grove, dacite and welded tuffs are commonly interbedded with basalt flows and tuff breccias. Carbonized wood fragments and logs as well as fossil leaves are abundant in some of the tuffs.

In the Lebanon quadrangle, the Mehama volcanics are typically waterlaid, thin bedded, locally cross bedded, tuffaceous sandstones and siltstones with occasional lenses of pebble conglomerate. The sandstones and siltstones vary in composition from place to place and range from nearly pure volcanic glass to nearly pure quartz. The conglomerates are composed of rounded pebbles, mostly porphyritic andesite and basalt.

The thickness of the Mehama volcanics is estimated to be greater than 2,500 feet.

In the Mehama area the volcanics are believed to interfinger with the Eugene formation to the west, while in the Lebanon area Allison and Felts note that the upper Mehama overlies the Eugene formation. The Mehama volcanics are overlain stratigraphically by the Columbia River basalt formation. The base of the Mehama volcanics is not exposed.

Fossil leaves in the volcanics range in age from lower Oligocene to lower Miocene. Allison and Felts (1956) suggest that the Mehama may range downward into the Eocene. The bulk of the Mehama is thought to be middle Oligocene to Oligo-Miocene in age.

Eugene formation: The Eugene formation was named for marine sandstone, sandy shale, conglomerate, and tuff exposed in quarries and road cuts within the city limits of Eugene, Oregon. Similar rocks are exposed along the eastern edge of the Willamette Valley a few miles north of Silverton. They also crop out along the western edge of the Salem and Eola hills in the Salem and McMinnville quadrangles where they were called the Illahe formation by Thayer (1939). Similar material exposed on the eastern flank of the Coast Range and called the Pittsburg Bluff formation is equivalent to the Eugene formation.

These sediments are predominantly tuffaceous sandstones with minor fine conglomerate lenses. The composition of the sandstones according to Allison and Felts (1956) is devitrified volcanic glass, quartz, feldspar, and pieces of basaltic rock, cemented with secondary silica and limonite. Small pieces of chert, mica flakes, crystals of diopside, hypersthene, pargasite, and magnetite make up about 5 percent of the rock. Some grains show considerable rounding.

Although continuous sections of the Eugene formation are lacking, 600 to 1,000 feet crop out on the slopes of Peterson Butte in the Lebanon quadrangle. The formation has been estimated to be 2,500 feet thick in the Salem quadrangle, and as much as 8,000 feet thick in the Eugene area (Vokes, et al, 1951). The formation dips about 8° eastward.

The Eugene formation is unconformably overlain by the Columbia River basalt and equivalent Stayton lavas of middle Miocene age. Dikes of basalt thought to be feeders of the Columbia River basalt intrude the Eugene formation at many localities.

On the basis of fossils, the Eugene formation is nearly everywhere middle Oligocene. West of Eugene, however, some strata may be as old as lower Oligocene; and in the Molalla quadrangle the Butte Creek beds, which appear to correlate with the Eugene formation on the basis of stratigraphic and lithologic similarity, are thought by Durham, Harper, and Wilder (1942) to contain an early Miocene fauna.

ROAD LOG: CORVALLIS TO PRINEVILLE VIA BEND AND NEWBERRY CRATER

Mileage

0.0   Corvallis, Oregon.   At Van Buren Street bridge – Willamette River crossing. Beginning
     (0.5)   of field trip. Set odometer if driving own car.

(Begin Fig. 10)

0.5   Gravel pit at 3 o'clock. Sand, silt, and gravel. Typical valley fill. Materials are
             basaltic, andesitic, and some chalcedonic pebbles, all representative of the drainage
     (0.4)   of the Willamette River, including reworked terrace gravels.

0.9   Flood or scour channels have been found in Recent alluvial terraces. These channels are
             common over the valley surface. Until flood control dams were constructed higher in the
             drainage, the channels flooded each spring and the area from the bridge to this point
     (0.8)   suffered periodic inundation. Severe floods are now rare.

1.7   At 3 o'clock there is a higher terrace in the Recent alluvium.
     (0.8)

2.5   Owl Creek drains into Colorado Lake. The lake is probably an oxbow lake comparable
     (0.5)   to many such lakes near the Willamette River in this region.

3.0   Road junction – take right-hand road to Lebanon. In the foreground the rise is to a
     (0.5)   terrace covered by Willamette silt.

3.5   The Willamette silt surface extends across the remainder of the Albany quadrangle except
             in stream trenches excavated below the silt-covered valley plain. Included in the silts
             or lying on the surface are larger particles ranging from chips a fraction of an inch across
             to boulders several feet in diameter. These coarse fragments are composed of granite,
             gneiss, quartzite, slate, schist, and various other rocks foreign to the Willamette Valley.
             These erratics and silts are considered to have been rafted in by ice during the Pleistocene
             when the valley was filled by fresh waters from the Columbia. The influx was presumably
             caused by ice-jamming of the Columbia River below the present mouth of the Willamette
     (1.4)   River. Considered by Allison to be "Wisconsin (Tioga?) age."

4.9   Railroad crossing – check point.
     (0.4)

5.3   Albany-Peoria road junction. Continue east to Lebanon.
     (0.3)

5.6   Note small streams meandering across the gently westward-dipping Willamette silt surface.
     (1.9)

7.5   Crossing U.S. Highway 99E. At 1 o'clock the major prominence in the distance is Peterson
             Butte. This is a complex plug and associated radiating dikes. The dikes form the ridges
             radiating from the center of the peak. Flanking the central core and cropping out well up
             on the slope is the Eugene formation, a marine sediment of Oligocene age. The Eugene
             sediments are mainly tuffaceous sandstones and subordinate conglomerate. The finer com-
     (0.2)   ponents are fossiliferous.

7.7   Railroad crossing.
     (1.2)

8.9   At 5 o'clock. The small butte standing above the valley floor in the distance is a Tertiary
     (1.4)   intrusion of diabasic or basaltic rock.

44° 35'

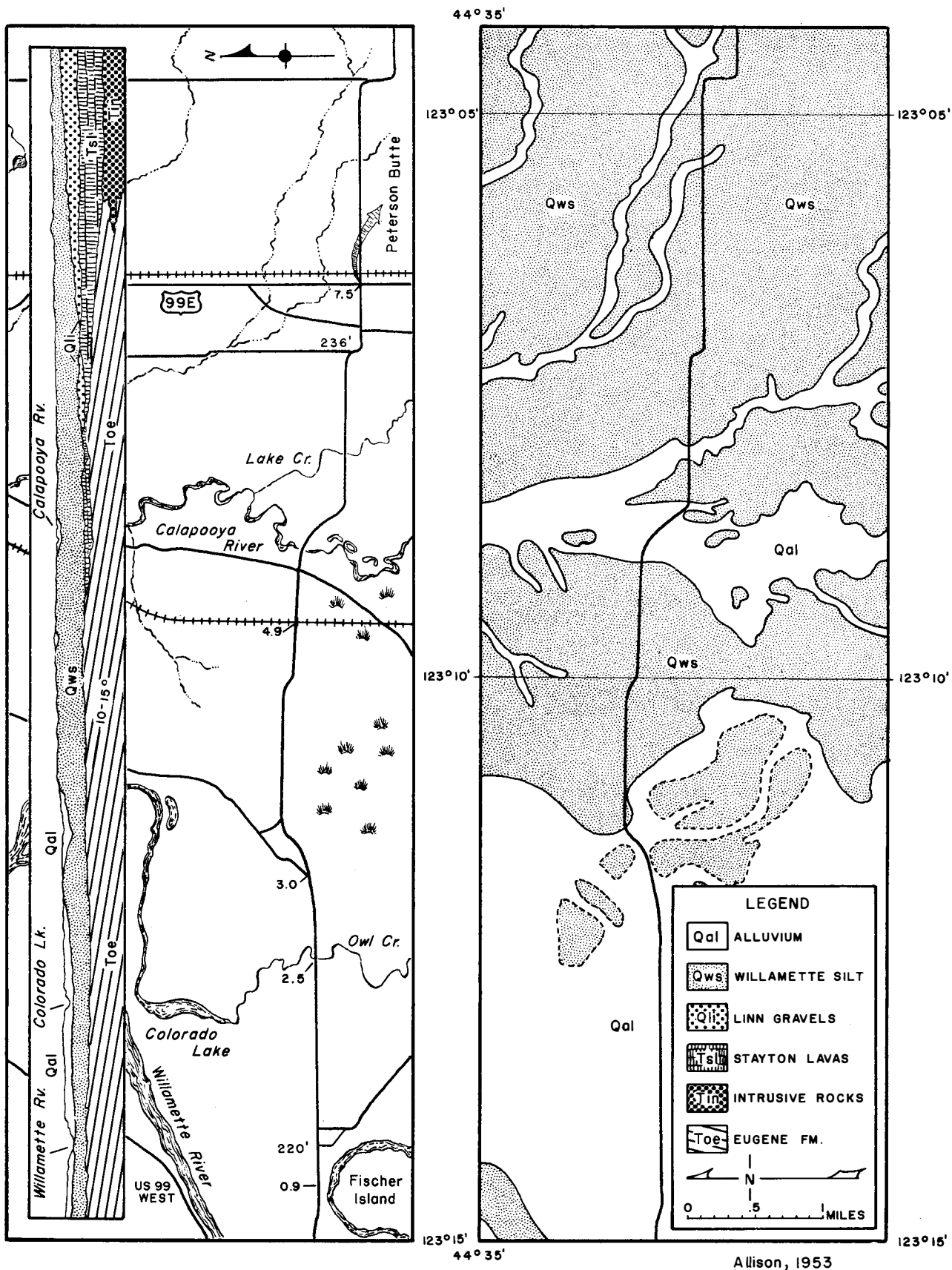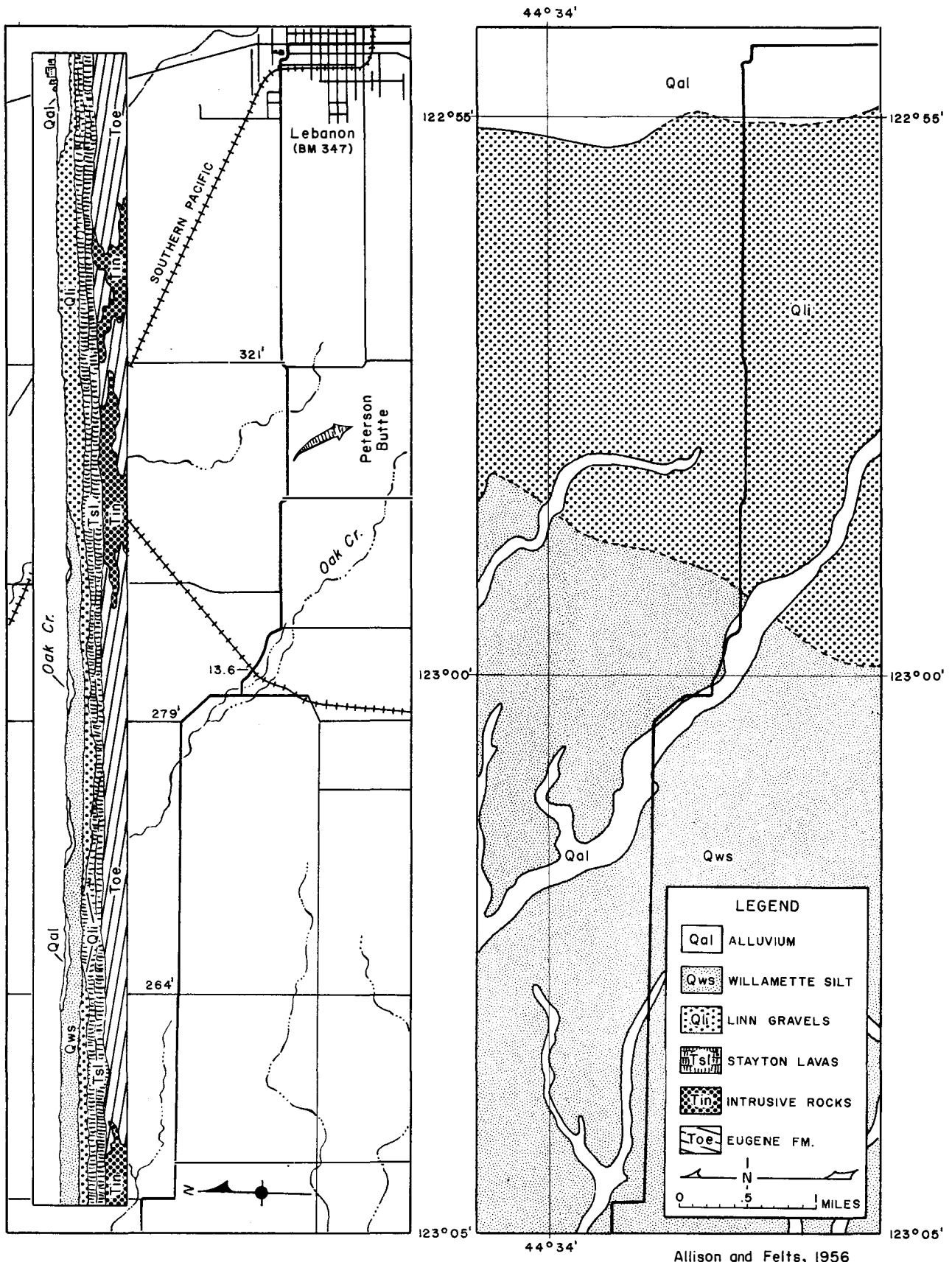123° 05'   123° 05'

Qws   Qws

Peterson Butte

99E   7.5'

236'

Lake Cr.

Qal

Calapooya
River

Calapooya Rv.

Tsll

Qll

Toe

4.9'

123° 10'   Qws   123° 10'

Qws

10-15°

3.0

Owl Cr.

Colorado Lk.

2.5

LEGEND

Qal   Qal   ALLUVIUM

Colorado
Lake

Qws   WILLAMETTE SILT

Qll   LINN GRAVELS

Willamette Rv.

Qal   Qal   Tsll   STAYTON LAVAS

Willamette River

Tin   INTRUSIVE ROCKS

Toe

220'   Toe   EUGENE FM.

US 99
WEST   0.9   Fischer
Island

N

0   .5   MILES

123° 15'   123° 15'
44° 35'   Allison, 1953

Figure 10

Mileage

(Begin Fig. 11)

10.3   New overpass on U.S. Highway 99 E. The gravel fill material is obtained locally from the Willamette silt and underlying Linn gravels. Only a few feet of top soil need be
   (0.3) removed to reach the gravels.

10.6   Road crossing. Continue east toward Lebanon.

       To the east the foothills of the Cascades are visible rising from the valley floor. Peterson Butte and other intrusives still are prominent features but they will soon become insignifi-
   (3.0) cant in the welter of mountains and valleys of the Cascades.

13.6   Railroad crossing. Check point.
   (0.7)

14.3   From this point to the city limits of Lebanon is 3.5 miles. Linn gravels in the older terrace dip gently to the west and northwest under the Willamette silts. Typically these form broad valley-plain terraces 25 to 30 feet above major streams. They are assumed to be approximately 30 feet thick. The Linn gravels are mainly pebble and granule gravels moderately well sorted and rounded, and include Cascade Mountain rock types such as andesites, basalts, and dacites. Weathering has been sufficient to soften pebbles and form clay at the surface. Unlike earlier gravels, a large part of the original deposit is present to the extent that the fan shape is preserved west of Lebanon. These gravels show fluviatile depositional characteristics. They are considered to be equivalent to early Wisconsin or Iowan stage in the chronology of the North Central States or Tahoe of the Sierra Nevada of California. North and east of Lebanon, Leffler gravels crop out in higher terraces. These gravels are much more
   (3.4) deeply weathered and are considered to be Kansan or Sherwin stage.

17.7   <u>Lebanon</u> city limits. Turn right one block, then left two blocks to Main Street (U. S. High-
   (0.2) way 20)

17.9   Turn right on U.S. Highway 20 and go south through Lebanon. The town of Lebanon is set on Quaternary alluvium of the South Santiam River valley. On the west, paralleling the
   (1.3) road, the Linn gravels form the surface.

(Begin Fig. 12)

19.2   Small bridge across stream.
   (0.1)

19.3   Intersection, keep left on U.S. Highway 20 to Sweet Home. Linn gravels.
   (0.7)

20.0   Cascade Plywood Company - produces one of the principal lumber products of the region. The plant is located on the Linn gravel surface. At 9 o'clock, Ridgeway Butte. Miocene Stayton lavas overlie the Oligocene Eugene and Mehama formations. These lavas are dark gray to black flow rocks. They are dense or vesicular hypocrystalline, slightly porphyritic basic rocks. The mineral composition is mainly basic plagioclase, clinopyroxene, magnetite, very small amounts of olivine, and green or brown glass. They are younger than the Eugene formation and the Mehama volcanics and are thought to be equivalent to the Columbia
   (2.6) River basalt of middle Miocene age.

22.6   (Boundary of quadrangle). At 3 o'clock, upper Miocene basalts form a ridge against which
   (1.0) Quaternary gravels and silts have been deposited by the South Santiam River.

44°34'

122°55'   122°55'

Qal

SOUTHERN PACIFIC

Lebanon
(BM 347)

321'

Peterson
Butte

Oak Cr.

Qli

13.6

123°00'   123°00'

279'

264'

Qal   Qws

LEGEND

Qal	ALLUVIUM
Qws	WILLAMETTE SILT
Qli	LINN GRAVELS
Tsl	STAYTON LAVAS
Tin	INTRUSIVE ROCKS
Toe	EUGENE FM.

N

0   .5   1 MILES

123°05'   123°05'

44°34'

Allison and Felts, 1956

Figure 11

LEGEND

Qal	ALLUVIUM
Qli	LINN GRAVELS
Qle	LEFFLER GRAVELS
Tsl	STAYTON LAVAS
Tin	INTRUSIVE ROCKS
Toe	EUGENE FM.
Tom	MEHAMA VOLCANICS

Strike and dip notation with value 3

N

0   0.5   MILES

Allison and Felts, 1956

Figure 12

LEGEND

Qal	ALLUVIUM
Qli	LINN GRAVELS
Tin	INTRUSIVE ROCKS
Tro?	RHODODENDRON FM.
Tsl?	STAYTON LAVAS
Tom	MEHAMA VOLCANICS
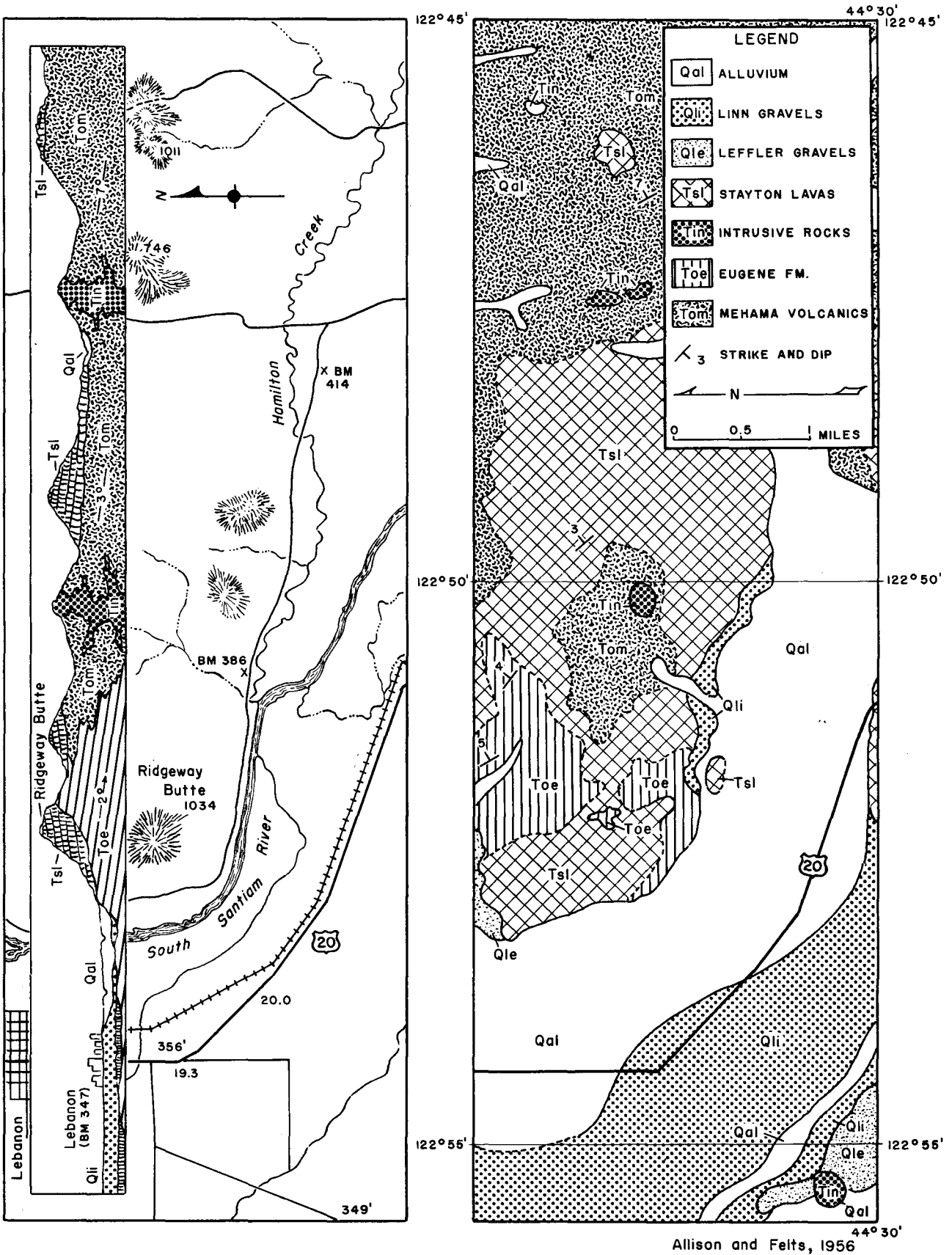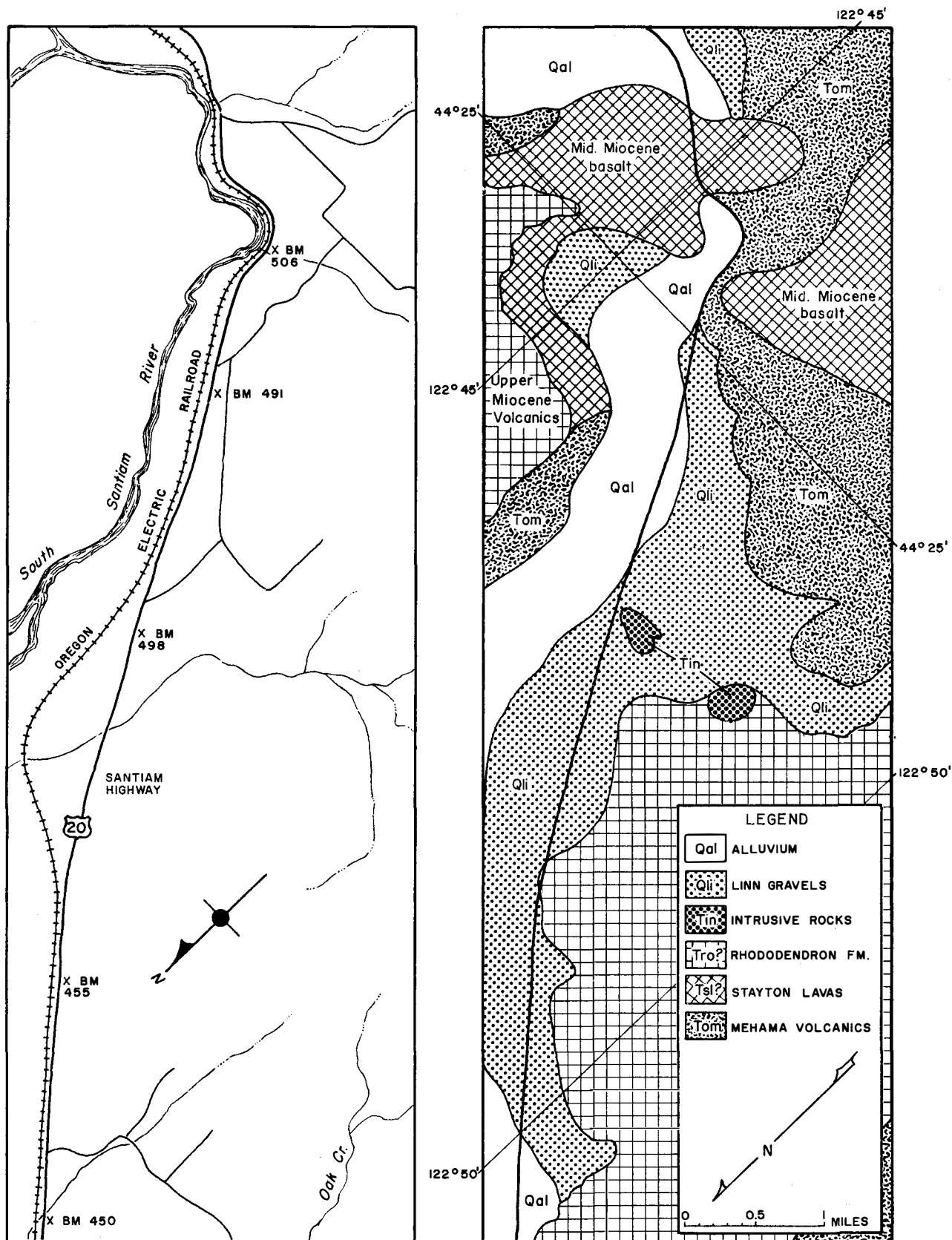
Oregon Dept. Geol. and Min. Industries, 1959

Figure 13

(Begin Fig. 13)
Mileage

23.6
(1.1)
Paralleling the road is a higher, somewhat older Quaternary terrace composed of pebbles and cobbles of basalt, andesite, and dacite typical of the rocks of the Cascades.

24.7
(0.4)
At this point the road rises and traverses the surface of the older terrace. The ridge to to the south at 5 o'clock is composed of upper Miocene basalts against which the gravels abut.

25.1
(2.5)
At 9 o'clock. A ridge of upper Miocene basalt (Rhododendron formation ?) may be seen overlying a limited exposure of Mehama volcanics.

27.6
(1.5)
Liberty road intersection check point. The contact between Miocene basalt above the Mehama volcanics is exposed in the small butte protruding through the terrace gravels. The lavas have been weathered to a typical brown soil.

29.1
(0.7)
At 3 o'clock. In the road cut the character of the terrace materials may be seen.

(Begin Fig. 14)

29.8
Terrace abuts against Mehama formation which is in turn overlain by middle Miocene basalt.

(1.6)   Sweet Home city limits.

31.4
(0.2)
In the road cut on the right and at river level on the left are excellent exposures of middle Miocene basalt. The columnar jointing as well as the black dense character of the rock is well displayed.

31.6
(1.5)
Contact of basalt overlying the Mehama formation. Fossilized wood is unusually abundant in the Mehama formation in this area.

33.1
(2.0)
Terrace gravels containing increasing numbers of cobbles and boulders abut against the ridges of basalt paralleling the river valley.

35.1
(0.2)
Foster, Oregon. Gerlinger mill produces kiln dried lumber. The drying sheds are to the right. Remnants of the terrace abut against Mehama volcanics.

(Begin Fig. 15)

35.3
(0.8)
Railroad overpass. Gravels exposed in road cut. Well-rounded cobbles and pebbles in a silt matrix.

36.1
(0.3)
Highway drops over edge of a terrace, which is here underlain by the Mehama formation cropping out in the road cut at 3 o'clock.

36.4
(0.4)
Quaternary terrace at road level. The ridge at 3 o'clock is Miocene basalt comparable to that observed at Sweet Home. The ridges at 9 o'clock are upper Miocene volcanics over-lying the Mehama formation.

36.8
(2.0)
A higher terrace at 3 o'clock composed of well-rounded cobbles is plastered against the basalts of the valley wall. Only a small remnant of the original terrace remains. Basalts of middle Miocene age form the ridges parallel to the road. In the cuts, columnar jointing of the basalts is well displayed. The bench underlying the road is a basalt flow; in this respect it differs from the terrace surfaces upon which the road was built lower in the valley.

Figure 14

Figure 15

Mileage
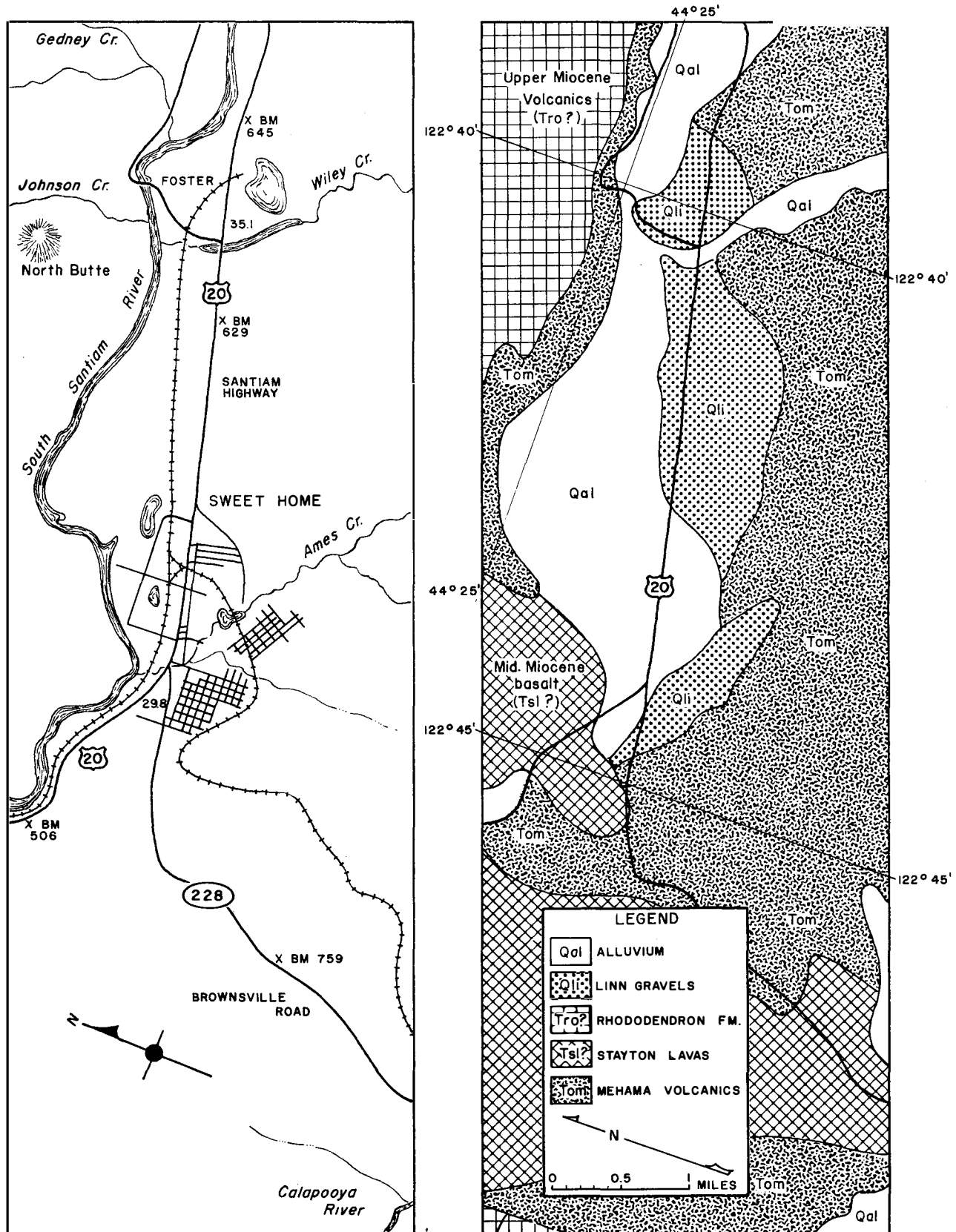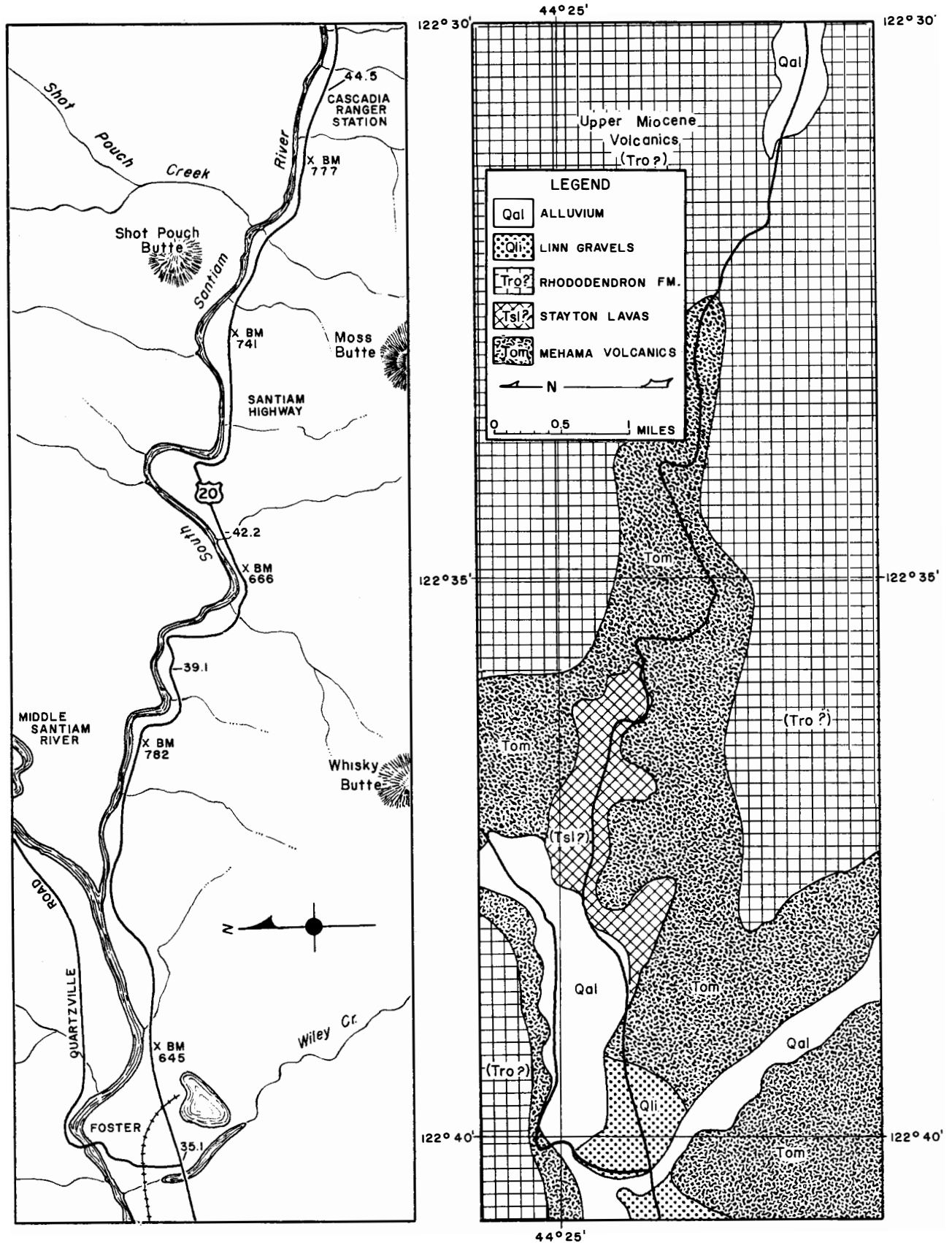
38.8   Contact of Miocene basalt and the underlying Mehama formation may be observed in the
              road cuts. The character of the exposures indicates the nature of the undulating surface
     (0.3)   of the Mehama at the time of extrusion of the overlying basic lavas.

39.1   Road crosses the contact between the Mehama formation and the basalts.
     (2.3)
41.4   At 9 o'clock the Mehama formation is well exposed along the stream bank, and at 3 o'clock
     (0.8)   it is exposed at the side of the road.

42.2   Small basalt dike cutting the Mehama formation.
     (1.1)
43.3   A quarry has been developed in the dense dark gray to black columnar basalt of probable
     (1.2)   upper Miocene age.

44.5   Cascadia Ranger Station. Check point.
     (1.5)
(Begin Fig. 16 (Legend) and Fig. 17 (Map)

46.0   Cascadia State Park. The mineral springs located near the bank of the stream were well
              known to the early settlers. Soda water from these springs and others in the vicinity was
              bottled and used as medicinal water as well as in mixed drinks. This is the first State park
              encountered on this trip and is one of 161 such parks in Oregon. Oregon leads the nation
              in this respect. When the 50 parks of Washington and 11 each in Montana and Idaho are
              added the total is 233 for the Northwest. Every year about 15 million people visit and
              enjoy this group of parks.

              The stream channel is cut in Mehama formation volcanics. However, this formation can
              best be seen at Wolf Creek where Wolf Creek, Canyon Creek, and the South Santiam have
              cut deep precipitous-walled canyons through the breccia volcanics of the Mehama formation.
              Mehama volcanics are shown on accompanying strip map as part of "Twc": Tertiary basalt
     (1.2)   and andesite flows of the Western Cascades.

47.2   Wolf Creek crossing.
     (0.6)
47.8   Mehama formation crops out in the road cut at 3 o'clock. The type locality of the Mehama
              described by Thayer is in the vicinity of Mehama, Oregon, in the North Santiam River
              valley. At the type locality the Mehama not only includes breccias but also tuffs and lavas.
              It is considered to be oligocene in age. The rock exposed in this road cut is typical breccia
              of the Mehama formation. Much of this formation previously observed has been near the
              contact of the overlying basalts. The upper surface of the formation has been characterized
     (0.2)   by deep weathering and alteration to clay even though the fragments retain their shape.

48.0   Canyon Creek. The brecciated character of the Mehama volcanics is well displayed in the
              shear walls of the creek canyon. The bank of the river and ridge at 9 o'clock are composed
     (3.0)   of this material.

51.0   Bridge over South Santiam River check point. From the river crossing to and beyond the
     (0.9)   quarry, basalts overlying the Mehama formation are exposed in the road cuts.

51.9   Quarry at 9 o'clock.
     (1.6)
53.5   Continuous cliffs at 9 o'clock. These fine-grained gray platy andesitic or dacitic lavas are
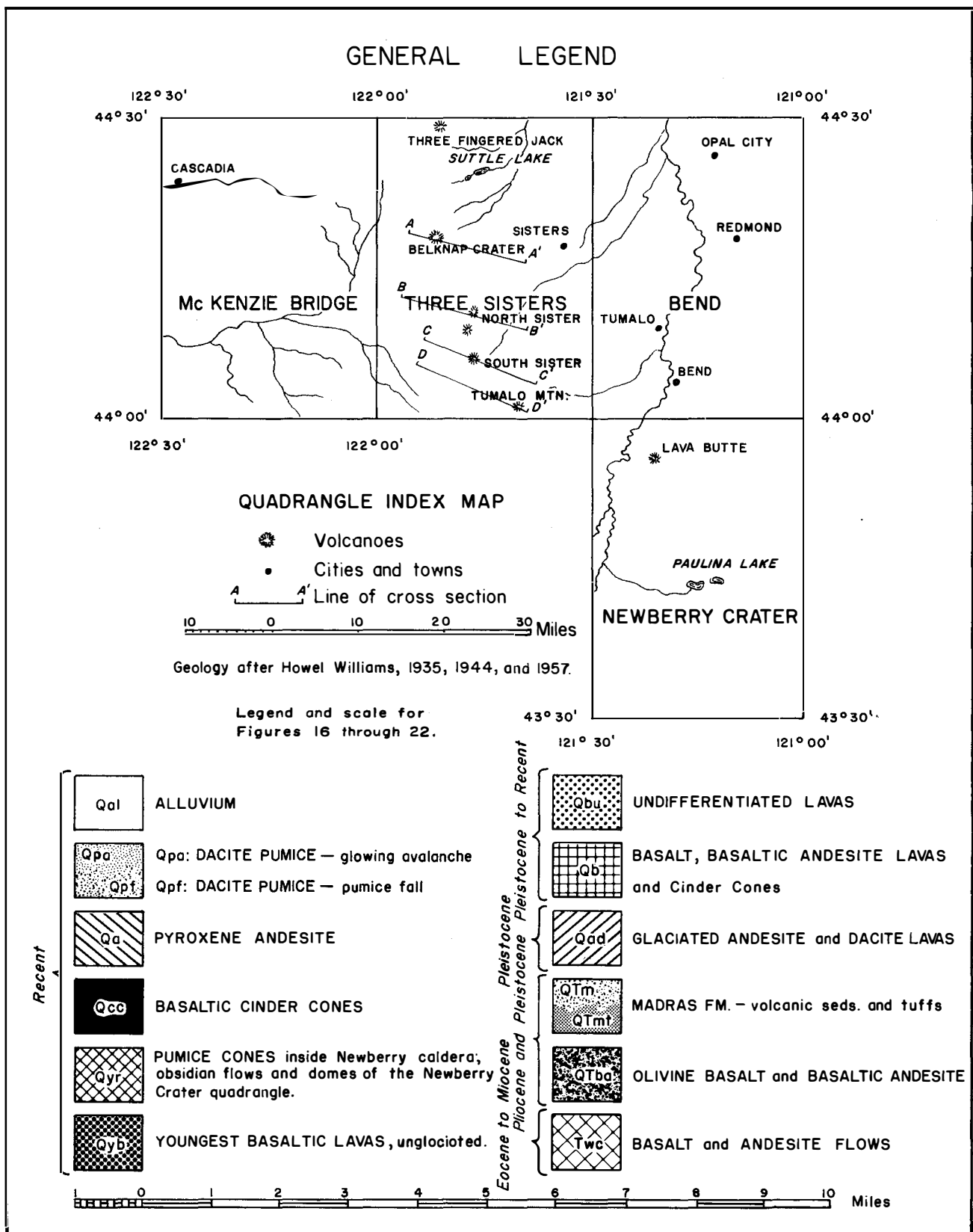   (0.2)   typical of the middle part of the Western Cascades.

GENERAL LEGEND

122° 30' 122° 00' 121° 30' 121° 00'
44° 30'

THREE FINGERED JACK
SUTTLE LAKE

CASCADIA

OPAL CITY

REDMOND

A
BELKNAP CRATER SISTERS A'

McKENZIE BRIDGE
THREE SISTERS BEND
NORTH SISTER TUMALO
C
B'
D SOUTH SISTER
C'
TUMALO MTN.
44° 00' D'

122° 30' 122° 00'

LAVA BUTTE

QUADRANGLE INDEX MAP

✳ Volcanoes
• Cities and towns
A ——— A' Line of cross section

10   0   10   20   30 Miles

Geology after Howel Williams, 1935, 1944, and 1957.

PAULINA LAKE

NEWBERRY CRATER

43° 30'

Legend and scale for
Figures 16 through 22.

121° 30' 121° 00'

Qal	ALLUVIUM	
Qpa / Qpf	Qpa: DACITE PUMICE — glowing avalanche / Qpf: DACITE PUMICE — pumice fall	
Qa	PYROXENE ANDESITE	
Qcc	BASALTIC CINDER CONES	
Qyr	PUMICE CONES inside Newberry caldera; obsidian flows and domes of the Newberry Crater quadrangle.	
Qyb	YOUNGEST BASALTIC LAVAS, unglaciated.	

Recent

Qbu UNDIFFERENTIATED LAVAS

Qb BASALT, BASALTIC ANDESITE LAVAS and Cinder Cones

Qad GLACIATED ANDESITE and DACITE LAVAS

QTm / QTmt MADRAS FM. — volcanic seds. and tuffs

QTba OLIVINE BASALT and BASALTIC ANDESITE

Twc BASALT and ANDESITE FLOWS

Eocene to Miocene Pliocene and Pleistocene Pleistocene Pleistocene to Recent

1 0 1 2 3 4 5 6 7 8 9 10 Miles

Figure 16

Figure 17

Mileage

53.7   Trout Creek Forest Camp.

(0.7)

54.4   Landslide area. A relatively recent slide crossed the river and caused a temporary dam.
              The slide material is unsorted debris of glacial origin which was deposited high on the side
(0.7)   of the valley.

55.1   Moraine capping andesitic flow.

(0.9)

56.0   Tuffaceous interbeds at 9 o'clock.

(1.3)

57.3   Soda Fork Creek check point.

(0.5)

57.8   Tuffaceous breccias associated with andesitic flows. From this point for the next 10.5
(1.4)   miles pyroclastics are the predominant rocks exposed.

59.2   House Rock Forest Camp.

(0.3)

59.5   At 9 o'clock porphyritic andesite is in contact with tuffaceous shales and thin-bedded
(0.1)   gritty sandstones.

59.6   Tuffaceous siltstones, sandstones, and volcanic breccias are exposed in the road cuts
              at 9 o'clock. Thin layers of carbonaceous material including a carbonized log may be
(0.4)   observed.

60.0   Storm Creek. Continuous outcrop of tuffs, andesitic flows, and pyroclastics.

(0.7)

60.7   Crazy Creek.

(0.7)

61.4   Sheep Creek. This is an active landslide area. The area is composed of tuffs, cinders,
              and volcanic breccias in clay matrix overlying an andesite flow exposed in the channel
              of Sheep Creek. This slide has proved to be particularly annoying to the State Highway
(1.2)   Department.

62.6   Past the slide area tuffaceous beds and volcanic breccia with interflows of andesites crop
(0.2)   out in road cuts.

62.8   At 3 o'clock the valley of the South Santiam extends westward to the Willamette Valley.
              At 9 o'clock the interbedded character of the tuffs, volcanic breccias, and flows may be
(0.4)   noted in the road cut.

63.2   The road at this point has been moved in order to overcome landsliding. The tuffs and
(1.3)   pyroclastics are unstable when saturated.

64.5   The prominent cliff at 2 o'clock is known as Jump-off-Joe. The lookout station is manned
              during the fire season. These are andesitic lavas of the Western Cascades, probably late
              Miocene or early Pliocene age. For the next 2.5 miles colorful pink, green, and cream
(0.8)   tuffs and tuffaceous pyroclastics crop out in the cuts alongside the road.

65.3   Excellent outcrops of the tuffaceous breccia.

(0.4)

65.7   Green massive tuffs and tuffaceous breccia.

(1.0)

66.7   A remnant of a moraine lies on andesitic lava flows. The mountain to the left is Iron Mountain
(1.6)   a somewhat eroded cinder cone with several plugs standing up in bold relief.

Round Lk.
Cache Mtn.

Long
Lk.

Square
Lk.

SANTIAM
HIGHWAY

20

BM X
4772

Hayrick
Butte

Big
Lake

Hoodo
Butte

Lost Lk. Cr.

Lost
Lake

Sand Mtn.

79.6

X BM
4437

NORTH
SANTIAM
HIGHWAY

Nash Crater

22

20

Clear
Lake

X BM
3422

Fish
Lake

Lava
Lake

US
20

N

Hackleman Creek

Toad Cr.

Echo Cr.

Echo Mtn.

Slide Cr.

X BM
4131

44° 25'

QTba

121° 50'

Qad

Sand

Qyb

122° 00'

QTba

5

Twc

T
5

44° 25'

121° 50'

122° 00'
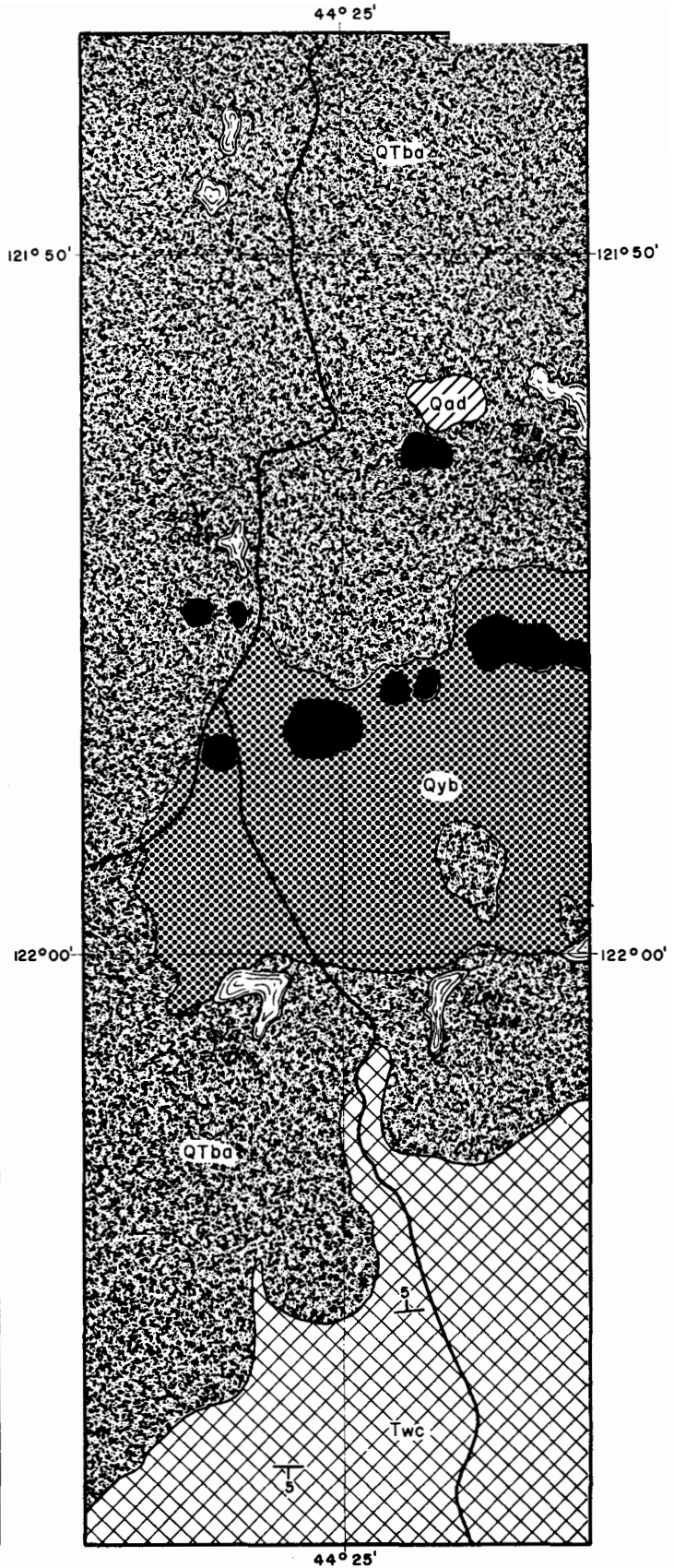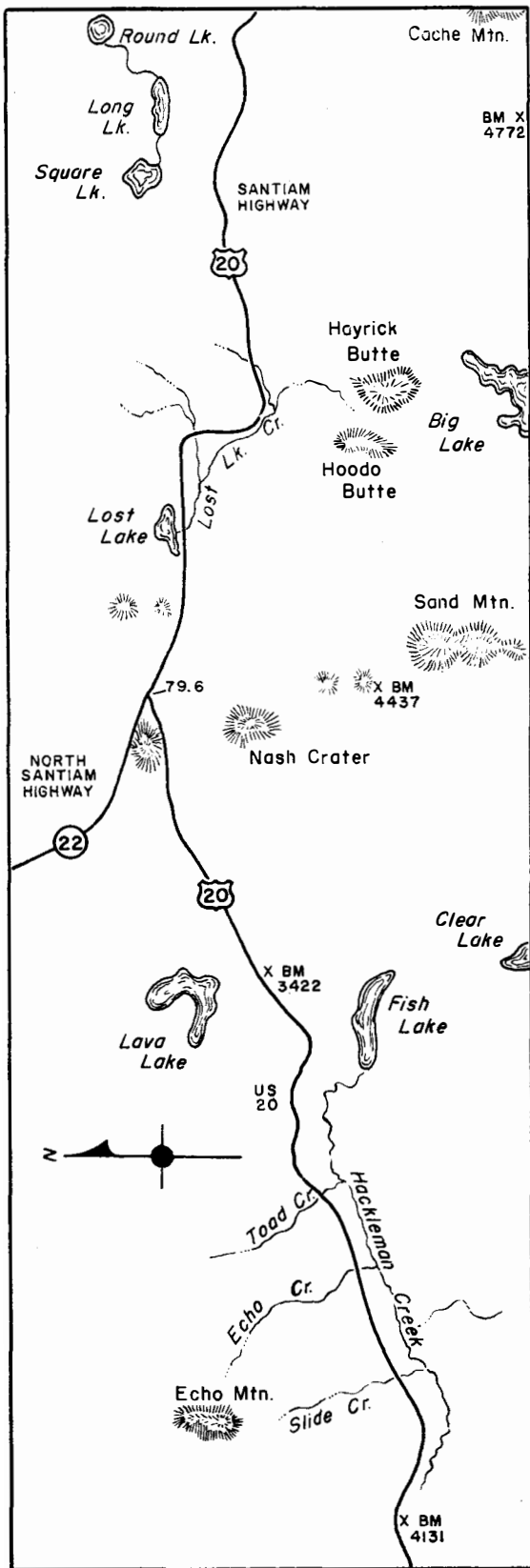
Figure 18

(Begin Fig. 18)

Mileage

68.3   Platy andesites. Summit of Santiam Pass.

(0.6)

68.9   Tombstone Prairie.

(2.4)

71.3   At 12 o'clock is Three Fingered Jack, one of a number of eroded Pliocene central vents
(0.8)   of the High Cascades.

72.1   Lost Prairie check point.

(4.1)

76.2   Road junction to Clear Lake. Recent unglaciated basaltic lavas. Probable source was
              Nash Crater, Sand Craters, and other cinder cones located along a fissure trending north-
              northwest. Flows from these volcanoes dammed the headwaters of the McKenzie River
              drainage to form Clear Lake and Fish Lake. Beneath the surface of Clear Lake tall trees
              are still standing, indicating the relatively recent age of the flows. Probable age not
              more than 1000 years. These vesicular olivine basalts are exposed on both sides of the
(2.3)   road from this point to the North Santiam road junction.

78.5   At 9 o'clock. This is Little Nash Crater, one of many basaltic cinder cones common to
(1.1)   the Bend-Newberry Crater region.

79.6   Junction North and South Santiam highways. Continue eastward on U.S. Highway 20
(1.2)   toward Bend.

80.8   Cinders from the many cinder cones of the area are exposed in the road cuts.

(0.6)

81.4   Contact of glaciated lava and unglaciated basaltic cinders of the High Cascades.

(0.9)

82.3   Columnar jointing in Cascade andesite.

(0.5)

82.8   Moraine debris from Pleistocene glaciers.

(0.8)

83.6   12 o'clock a cinder cone. As noted at the road junction, cinder cones will become common
(0.5)   features of the topography in this part of central Oregon.

84.1   Excellent outcrop at 9 o'clock of gray platy andesite. The jointing is typical of andesite
(0.6)   of the area. These rocks are olivine basalt and basaltic andesites.

84.7   Santiam Lodge ski area (Hoodoo Bowl). The bowl and head wall are located about one mile
(1.1)   south of the highway. Skiing is good from mid-November to late March.

85.8   Santiam Pass. Elevation 4817.

(0.6)

86.4   Continuation of gray andesitic basalt.

(1.3)

87.7   At 3 o'clock is Mount Washington, elevation 7802, a High Cascades central vent. All
              that now remains of the volcano is the lava plug which solidified in the original conduit.
              This mountain is often climbed, but offers something of a challenge to the climber because
(1.6)   of the rock work at the top.

(Begin Fig. 19)

89.3   At 1 o'clock is Black Butte, probably the largest cinder cone in the Cascades. This is com-
              posed of pyroxene andesite. The road surface throughout much of this region is made of

Left map

126

20

X BM
3205

105.9

Squaw Cr.

SISTERS
BM 3184 ─ 105.1

X BM
3198

MC KENZIE
HIGHWAY

Indian Ford Creek

SANTIAM
HIGHWAY

126

20

X BM
99.9 ─ 3240

N

Fourmile
Butte
Grahdm
Butte

Black
Butte
6415

Black Butte
Swamp

Fivemile Butte

Sixmile
Butte

95.0 X BM
3326

Dry Cr.

Cache Cr.

92.6

Suttle
Lake

Cache Mtn.

Blue Lk.

Right map

121° 30'

QTmt

QTm

Qb

44° 20'
121° 30'

QTmt

Qb

121° 40'

Qb

Qa

44° 20'

121° 40'

Qb

QTba
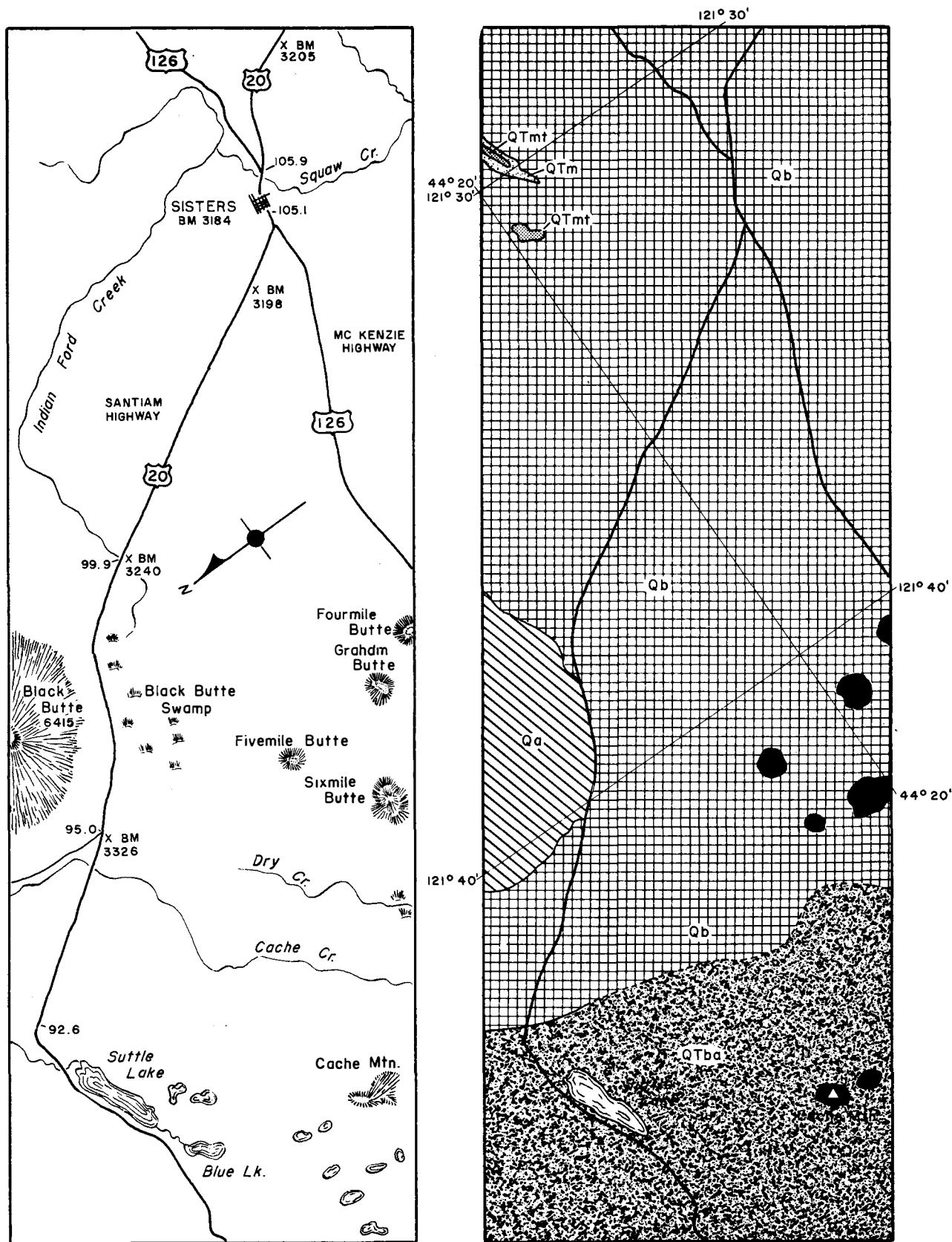
Figure 19

Mileage

cinders quarried from nearby cones. This has proved to be the best material for roads
(0.6)   in this area.

89.9   At 3 o'clock is Blue Lake, a lava-dammed lake. Across the valley may be seen the
            scraggy, poorly timbered surface of a relatively recent lava flow that dams the lake.
(0.5)   At 9 o'clock andesitic basalt flows with distinct top and bottom flow breccia crop out.

90.4   Suttle Lake at 3 o'clock. These two lakes are considered excellent for fly and troll
            fishing at certain times of the year. During the summer they are the center of a recrea-
(1.5)   tion area which includes boating and water skiing.

91.9   Suttle Lake is dammed by moraines. The moraine is exposed in road cut at 9 o'clock. At
            3 o'clock the poorly sorted moraine forms a hummocky surface through which the outlet
(0.3)   creek of Suttle Lake flows to the northeast.

92.2   Green Ridge at 12 o'clock. Fault escarpment extending generally due north for several
(0.4)   miles, the fault ending in Black Butte.

92.6   At this point the contact is crossed between glaciated lavas and the younger basaltic
            andesites and cinder cones of the Deschutes group. This group includes all those lavas,
            torrential wash materials, intracanyon flows, late lavas and cinder cones, generally
            believed to be late Pliocene, Pleistocene, and Recent, and occurring on the eastern
            flanks and east of the Cascade Mountains. For the next 12.5 miles the road traverses
            the upper surface of this group which has been covered to varying depths by pumice and
            ash. The soil produced by slight weathering of this volcanic debris supports a fine stand
            of ponderosa pine. This timber in the past and at present is one of the important resources
(3.4)   of the region.

96.0   Metolius junction. Head waters of the Metolius River 4 miles north are of interest because
            the river is fully born from large springs at the base of Black Butte which is now at 10 o'clock.
            Because of the constant flow from this source and other similar sources, the Deschutes River
            is unique in maintaining a flow which varies only a few feet throughout the year. The
            springs are supported by glacial-melt waters from the High Cascades flowing through the
            porous lavas and at times actual subterranean streams flowing through lava tubes. Continue
(0.7)   east on U.S. Highway 99.

96.7   Highway swings around base of Black Butte. At 3 o'clock is first glimpse of the Three Sisters.
            It should be noted that the flora has changed to the pine forest, manzanita, and yellow pines
(3.2)   of eastern Oregon.

99.9   Indian ford - historical marker. "Here was a ford on the Indian mountain trail mentioned
            by Lieut. John C. Fremont. The only recorded use by the early whites was by Lieut. Henry
(5.2)   L. Abbot and Pacific Railroad Survey party in September, 1855."

105.1   Sisters, entrance to town.   At 4 o'clock is excellent view of the Three Sisters.   These are
            Quaternary volcanoes of different ages. The north is oldest, the middle is intermediate,
            and the south is youngest. All are central vents. The associated lavas are andesite and
            dacite. This is the junction of the Santiam Highway 20 and the McKenzie Highway 126.
            The trip west on U.S. Highway 126 passes through the Belknap Crater flows which are com-
            parable to those observed at the North and South Santiam junction; but, probably somewhat
(0.8)   older. See Figure 23 for cross sections of the geology of this area.

105.9   Highway junction. Turn right (U.S. Highway 20) to Bend. Leaving Sisters, Oregon.
(0.5)

Mileage

106.4   From 9 o'clock low Madras formation shield cone. The surface here is composed of
                          vesicular olivine basalt containing hyaline opal or chalcedony in vesicles. This lava
                          flow is about 30 to 40 feet thick and in most places lies upon torrential wash sediments
                          which are also a part of the Madras formation. The flow is overlain in places by later
                          torrential wash sediments as well as pumice and ash from Newberry Crater. The over-
                          lying materials, particularly the Newberry Crater pumice, thicken to the south and east.
                          There is a change in the vegetation from the pine forest of the upland to the typical
                          juniper and sage brush of the plateau. Pine timber will be again encountered on the
                          slopes of the Ochoco Mountains. The average elevation of the high plateau of central
                          Oregon is 4000 feet. Potatoes, clover, and cattle are the principal source of revenue
          (13.0)   for the immediate area.

(Begin Fig. 20)

119.4   Quarry. Excellent section of torrential wash volcanic debris. Volcanic conglomerate
                          overlain by a coarse pumiceous tuff. This rests on the lava flow and may be considered
                          as part of the Madras of the Deschutes group. The highway drops into the valley of the
          (1.6)   Deschutes.

121.0   Pumice Quarry ½ mile to right. Fine examples of "nue ardente" pumice and welded tuff.
                          The 15- to 20-foot exposures show no bedding features but a high degree of uniformity
                          throughout the deposit. This pumice is mined here and at other pits in central Oregon
                          for use in the building trades. It is used as the aggregate for cement blocks. The fines
                          are preferred by plasterers as a plaster aggregate. The physical properties of the products
                          make them highly desirable for many structures. There is a red cinder quarry on the south
                          slope of Laidlaw Butte north of Pumice Quarry. The cinders are also used in the manufac-
          (1.7)   ture of cement blocks.

122.7   Deschutes River.
          (0.3)
123.0   Torrential wash on top of basalt.
          (0.9)
123.9   Pressure ridge. These are usually characterized by a fracture through the ridge. ··They are
          (2.4)   common to this surface from here east to Powell Buttes.

126.3   At 11 o'clock is Pilot Butte, a cinder cone and landmark in the Bend area.
          (1.1)
127.4   Bend, Oregon. It is of interest that the city waste disposal is through wells drilled into
          (0.8)   the basalts and because of the porosity and lava tubes the waste is dispersed.

128.2   Follow sign U.S. Highway 97 (The Dalles-California Highway) through Bend. The under-
          (2.4)   pass drains into a lava cavern about 90 feet below the surface.

(Begin Fig. 21)

130.6   Bend city limits. Continue south on U.S. Highway 97.
          (0.6)
131.2   Lava Butte at 12 o'clock. From 10 to 11 o'clock Newberry caldera and associated cinder
          (3.8)   cones.
135.0   About 1 mile west at 3 o'clock lava flow from Lava Butte. This flow will be seen from
          (3.5)   the top of the butte.

138.5   Cinders from Lava Butte.
          (0.5)
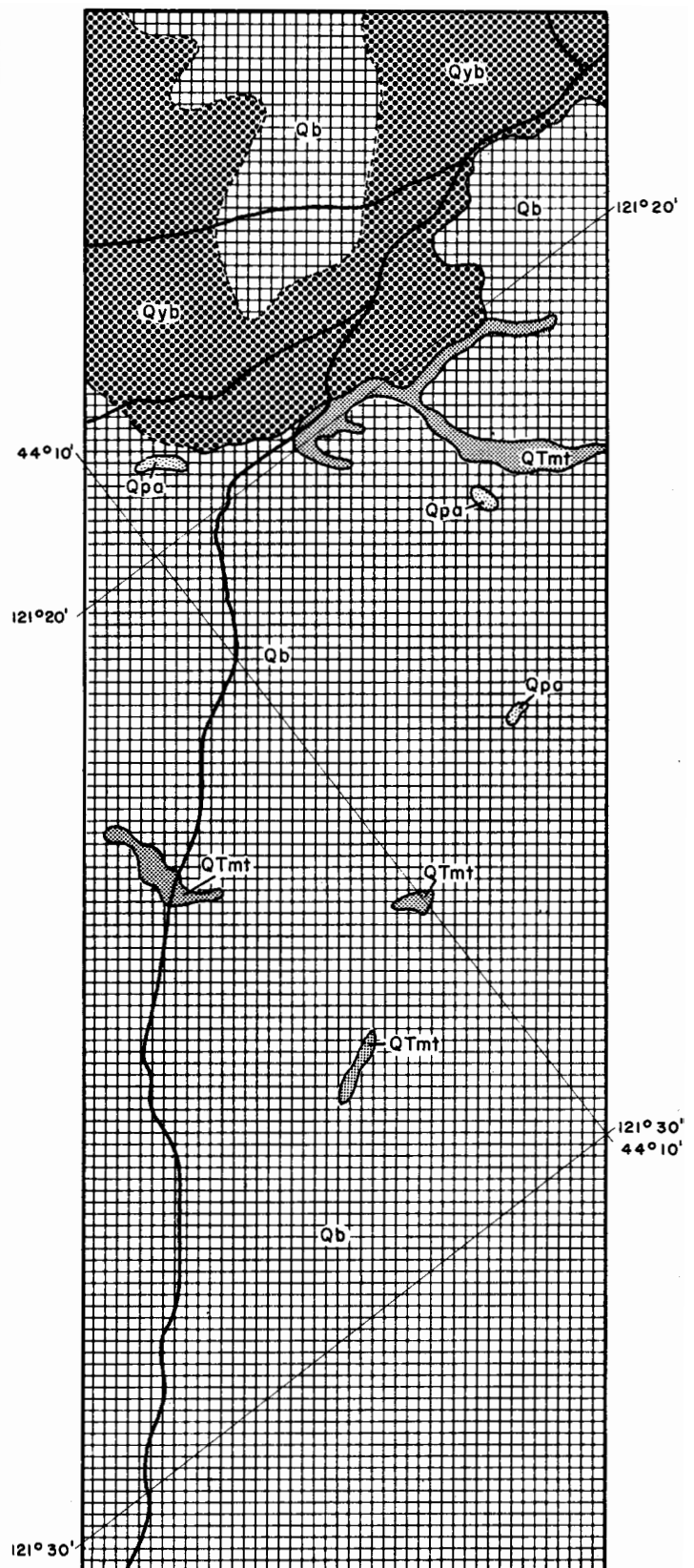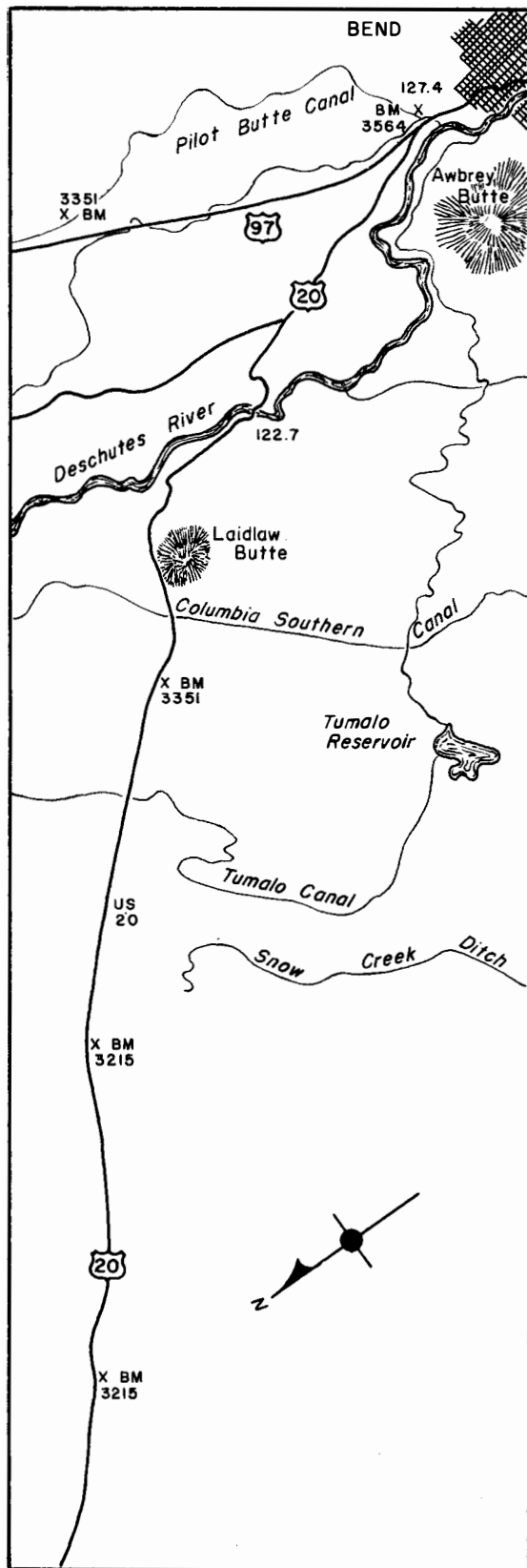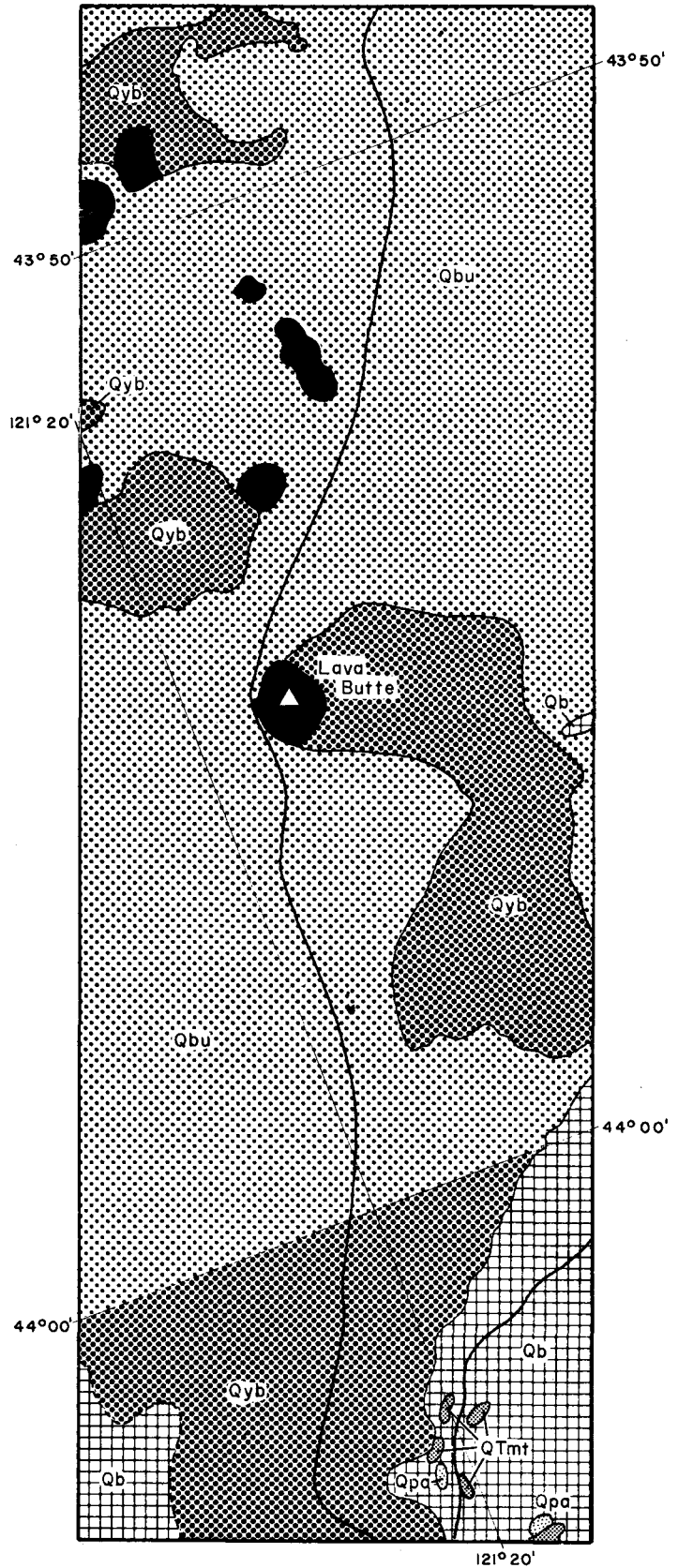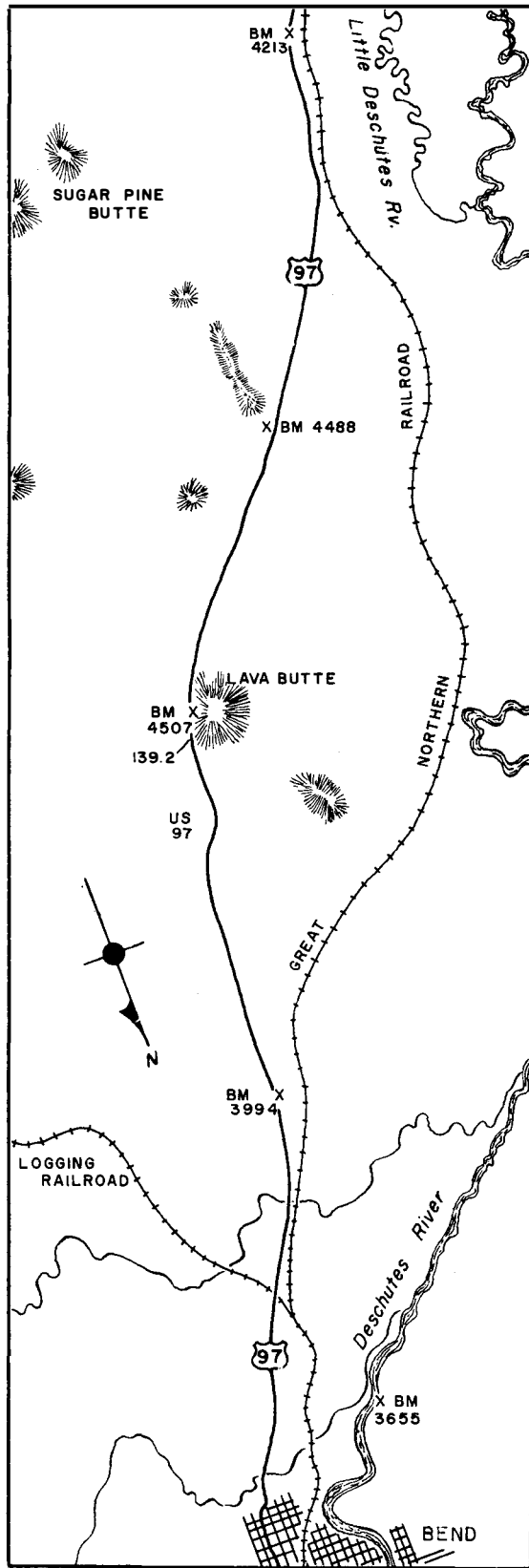
Figure 20

Figure 21

Mileage

139.0	Edge of flow.
(0.2)	
139.2	Road junction to Lava Butte. Lava Butte is a relatively recent cinder cone. It has a crater in the top approximately 150 feet deep. On the south side it is breached by a lava flow which poured out around the base and flowed to the west and north, extending to the valley of the Deschutes at Benham Falls. A noteworthy feature is the relation of the flow to the older terrain; it is reasonable to believe that most flows of the region
(0.1)	bear this relation to previous flows and surfaces.
139.3	Note fault escarpment, with south side down about 30 feet. The trend is southeast and
(1.3)	said to be traced to Newberry Crater.
140.6	Lava Cave ¼ mile to left. Lava tube or lava cave. The withdrawal of lava from beneath the crust is indicated by the flow lines and grooves found along the sides and top of the cave. Also at some places stalactites of lava form small pendants. The floor is silt-covered and at the western extremity the tube is plugged with silt. The entrance is through
(2.4)	a collapsed hole in the roof.
143.0	Lava Cast Forest junction. About 11 miles east there are casts of trees that were engulfed
(0.9)	in a relatively recent lava flow.
143.9	Cross section of cinder cone. This cinder cone has been mined for road metal. The section of red and black cinders shows distinctly the angle of repose assumed by the pyro-
(0.6)	clastics as they fell after explosive eruption.
144.5	Side trip. Turn right on old road and go for 0.9 mile, then left to mined-out cinder cone. The core of the cinder cone is of andesite and andesite breccia. Prior to mining, the cone was approximately 200 feet high. Flanking pumice and cinders can be seen in the exposed cuts. Unlike Lava Butte, where the lava flow breached the side of the cone, here the lava was confined to the center conduit, solidifying but never reaching the surface. An interesting feature of some of the cinders is the blue iridescent surface. Return 1.5 miles to
(1.5)	U. S. Highway 97.
146.0	Turn left on U.S. Highway 97 and continue south.
(2.4)	
	South end of Century Drive. This side trip loops miles into the eastern slopes of the Cascades. It gives access to the Bachelor Butte ski area and other lake and stream recreational
(3.7)	areas.

(Begin Fig. 22)

152.1	Road junction to Newberry caldera. The area south and west of the junction is probably a Pleistocene lake bed. For the next 16 miles the road rises up the gentle west slopes of
(16.0)	Newberry volcano and enters the caldera where Paulina Creek flows out of Paulina Lake.
168.1	The crater and vicinity have been described by Howel Williams (1935). The following remarks have been taken largely from his report. Newberry volcano is in the form of a circular shield having a diameter of approximately 20 miles at the base. It rises about 4000 feet above the floor of Columbia River basalt. On the outer slopes there are more than 150 basaltic cinder cones. The slope of the shield varies between 3 and 4 degrees, somewhat steeper toward the summit. The inside is a great amphitheater surrounded by walls averaging 1000 feet in height along the north and east sides but dwindling westward to disappear at the outlet of Paulina Lake.

The amphitheater is occupied by Paulina Lake and East Lake. Paulina Lake is about

Red Hill
X BM 6089
Weasel Butte
Sand Butte
The Dome
X BM 6377
East Lake
Lost Lake
NEWBERRY CRATER
North Paulina Pk. BM 7680
Paulina Lake
Paulina Pk. BM 7985
X BM 6331
Kawak Butte
Paulina Creek
Mc Kay Butte
BM X 4677
Z
152.1
4203 BM X
US 97
97
Little Deschutes Rv.

43° 40'
121° 10'
Qbu
Qbu
121° 10'
43° 40'
East Lake
Qyr
Qyr
Paulina Lake
Qyr
121° 20'
Qbu
Qyr
121° 20'
Qbu
Qpf

Figure 22

A — RECENT BASALTIC FLOWS AND SCORIA — BELKNAP — LITTLE BELKNAP — McKENZIE PASS — BLACK CRATER — YOUNGER SHIELD VOLCANOES — TROUT CR. BUTTE — A'

B — SCOTT MTN. CONE — DACITE — SIMS BUTTE — LITTLE BROTHER — NORTH SISTER — SUMMIT CONES — Squaw Creek — B'

C — HUSBAND — ANDESIT AND DACITE — SOUTH SISTER — BROKEN TOP — C'

D — SPHINX — WIFE — LECONTE CRATER — DACITE — DEVIL'S HILL — DACITE — CAYUSE FLOW — TODD MTN. — ANDESITE AND DACITE — TUMALO MTN. — D'

Outer or Dip Slope of Main Cone

Obsidian Flow

Basalt Flow

East Lake

Paulina Lake

Obsidian Domes

Obsidian Flow

PANORAMIC SKETCH OF NEWBERRY CALDERA, FROM PAULINA PEAK ON SOUTH RIM. (after Williams, 1935)

Figure 23

<u>Mileage</u>

two miles long and 1½ miles wide. The depth varies from 200 to 230 feet and the slopes rise sharply close to the shore. It is fed from East Lake and from springs, among which are some that have a temperature of 110° F. East Lake is 40 feet higher and much shallower. The deepest sounding was in an east-west trench, probably a fissure where the depth is 165 feet. There are warm alkaline springs on the southeast side.

The main episodes are (1) upbuilding of the main shield, chiefly by rhyolitic and basaltic eruptions from the central caldera, (2) enlargement of the caldera principally by down faulting, (3) parasitic eruptions of rhyolite and basalt, both on the flanks of the shield and floor of the caldera.

The main mass of Newberry volcano was built up by outpourings from a single summit caldera enclosed by many minor vents and in late stages by fissure eruptions. Explosive eruptions added little until the shield had reached nearly its present proportions. Early eruptions were rhyolitic followed by basalt flows, scoria, tuff, and more basalt flows. Finally came the eruption of Paulina Peak rhyolites, which are exposed on the south wall. Recent eruptions began with a rhyolite extrusion high on the southeast rim. The lava flowed down onto the caldera floor. There were also flows and explosions of basalt and rhyolite, chiefly from a north-south line of vents that bisects the caldera. On the outer flanks there were parasite eruptions of basaltic cinders and viscous domes of rhyolite.

Of particular interest is the largest and youngest of the obsidian flows. It covers almost a square mile and is composed, for the most part, of shiny black obsidian blocks stacked one upon another to a height 100 feet above the road level. The flow originated from a vent close to the south wall of the caldera. Lava poured out and flowed northward for about a mile. The surface of the flow is deeply furrowed and grooved and concave toward the vent.

Between the two lakes, a north-south line of white rhyolitic pumice cones rise, almost bisecting the caldera. The oldest and most heavily timbered cone rises to about 300 feet and has a crater 100 feet deep at the top. Except for some rhyolite and basalt fragments, the cone is made up of white pumice fragments as much as a foot in diameter.

The largest of the cinder cones occupies the neck between the two lakes near the center of the caldera. It rises to 700 feet and has a steep-walled crater about 250 feet deep. Gray and buff pumice lapilli form the bulk of the cone. There are fragments of basalt and obsidian found with the pumice indicating that both explosion and quiet eruption alternated. The conclusion of activity of the vent was characterized by the rise of a small blocky dome of obsidian in the middle of the crater floor. (See Fig. 23.)

These notes point out some of the obvious things relative to this caldera but the interested person is referred to the paper by Howel Williams mentioned at the beginning of these remarks.

(43.0)   The return trip to Bend is 43 miles to the road junction of U.S. Highway 97 and U.S. Highway 20 going east out of Bend. The accumulated mileage at the junction is 211.1.

211.1   <u>Bend</u>, at junction of U.S. Highway 97 and U.S. Highway 20. Turn right on U.S. 20 and go east toward Burns.

              Pilot Butte at 12 o'clock. This cinder cone is similar to those already observed, but as
(0.8)   noted it is a landmark in this area.

211.9   Pilot Butte junction and U.S. Highway 20. Pilot Butte may be ascended via the paved road spiraling to the top. An excellent view is presented from the top of the Butte. The young flow now being crossed has been mapped by Williams as one originating in Newberry
(3.4)   Crater.

215.3   <u>Road junction</u>. Powell Buttes at 11 o'clock. These are rhyolite domes of Clarno or John
(0.9)   Day age which stood high enough to miss being engulfed by the younger lavas and pyroclastics.

Mileage

Turn left (north) on secondary paved road toward Prineville.

216.2   Fork in road. Keep left to Prineville.
    (1.6)

217.8   Note rock fence similar to those observed in New England. The boulders come from the
               fields, and as can be seen there is no shortage of material. However, these fields once
    (0.4)   cleared and irrigated are very fertile, raising excellent crops of clover or potatoes.

218.2   Crossroad. Continue straight ahead to Prineville.
    (2.8)

221.0   Powell Buttes at 2 o'clock. These Buttes have recently been mapped by Williams as John
               Day formation (1957), but they have also been considered to be of Clarno age. They are
               rhyolite domes much older than the surrounding rocks. At the type locality of the John
               Day formation the section is composed entirely of tuffs. Even so, it is possible that the
    (3.6)   Buttes are John Day age and a potential source of tuffs.

224.6   Pressure ridge on the surface of the Madras formation. It has a crack or split lengthwise
    (0.7)   of the ridge. This split is a typical feature of such pressure ridges.

225.3   Gray Butte at 10 o'clock. Similar to Powell Buttes.
    (2.0)

227.3   Highway rises onto terrace gravels, which are extensive in this area. Note the young
    (3.1)   lavas on the left and the old Powell Buttes to the east bordering the basin of accumulation.

230.4   Gravels in road cut are cobbles and boulders of rhyolite from Powell Buttes and silts from
               the drainage of Dry River to the east. The dry channel can be traced parallel to U. S.
               Highway 20 for many miles to the east. The channel swings north after passing Powell
               Buttes and finally is deflected east by the young lava flow to the west. The gravels are
    (2.9)   terrace gravels deposited by this old stream.

233.3   Powell Butte Post Office at junction of U.S. Highway 126. Turn right onto U.S. Highway
               126 and go east toward Prineville. The flow is now definitely trending east, closing the
    (0.6)   basin. The basin was alluviated, then spilled over to the north.

233.9   Lower part of basin of alluviation. The drainage is to the east into the Crooked River.
    (4.9)

238.8   Edge of Madras rim above the valley of Crooked River.
    (0.3)

239.1   35 feet of vesicular Madras lava overlying thick section of tuffs and volcanic conglom-
    (0.4)   erates which are considered to be part of the Madras formation.

239.5   Viewpoint at Prineville.

               At 12 o'clock is Gray Butte in the distance. This is a Clarno butte protruding through the
               younger lavas. At 1 o'clock in the foreground are gravel terraces filling basin. These
               gravels were deposited subsequent to damming of the Crooked River by intracanyon flows
               farther west. In the background the Ochoco Mountains form the horizon. At 3 o'clock in
               the foreground are probable Clarno volcanics overlain in the background by John Day forma-
               tion tuffs and rhyolites. The John Day tuff can be recognized by the white slopes. At
               4 o'clock is the continuation of the rim incised by the valley of Ochoco Creek. At 6 o'clock
               the Crooked River debouches into the valley. The river flows generally westward from its
               headwaters following a meandering course, as one might assume from its name.

    Stop   Upstream the meandering course has been superimposed on the folded Columbia River basalt
               surface. The probable history of the immediate region: The original folded, faulted, and

eroded Columbia River basalt surface was filled by the Deschutes group and modified to a relatively flat surface by the late lava flows. Streams developed on the late surface as indicated by the olluviation already noted. The valley in the foreground, once much deeper than now, has been alluviated by the Crooked River because of damming by intra-canyon flows. Its gradient has thus been increased and a new cycle of erosion will soon

(0.8)   ensue.

240.3   Highway junction and viewpoint road return.

(0.3)

240.6   Plastered gravels, similar to terrace gravels of the valley floor, are unsorted and com-

(0.3)   posed mainly of basalts from higher in the Crooked River drainage.

240.9   Contact of young, cross-bedded gravels and gravelly tuffs of the Madras formation.

(0.2)

241.1   Entering Prineville.

The Rattlesnake formation welded tuff has been used as a decorative stone in the archway of the Ochoco Inn.

Palisades near Camp Hancock, Clarno, Oregon. Hoodoos in volcanic breccia of the Clamo formation. (Oregon State Highway Commission photo)

FIELD TRIP NO. 4

PRINEVILLE TO JOHN DAY VIA MITCHELL
By
W. D. Wilkinson

This trip starts at Prineville; goes northeast on U.S. Highway 26 to the Mitchell Cretaceous area; makes a short side trip north on the Service Creek Road (Oregon Highway 207). From Mitchell it continues east on U.S. Highway 26, through Picture Gorge to John Day. Total distance is logged at 108.8 miles.

Formations encountered on this trip are described, beginning on next page, under Stratigraphic Sequence for Central Oregon. This is followed by the road log and geologic strip maps.
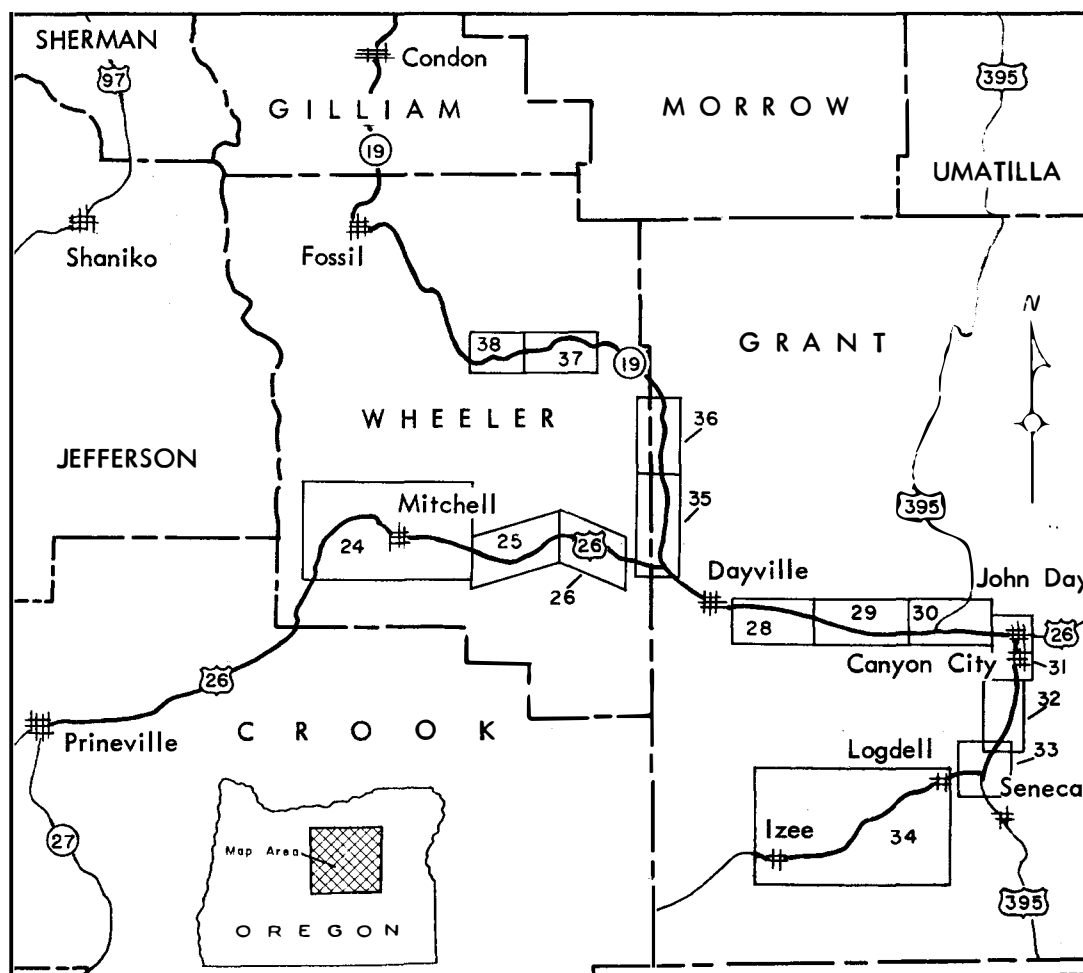
Index map of Central Oregon showing routes of field trips and position of geologic maps accompanying road logs.

STRATIGRAPHIC SEQUENCE FOR CENTRAL OREGON

QUATERNARY

Alluvium: Pleistocene to Recent alluvial deposits occur in flood plains and terraces along most of the streams of central Oregon. The material represents the debris from the adjacent highlands. The composition is silt, sand, and gravel normally found along stream valleys and typical of the immediate area. One distinctive feature is the frequent presence of a white ash layer. This layer varies in thickness from a few inches to several feet, and has generally been attributed to the explosive eruption of Newberry Crater. The ash fall, which probably extended over a wide area of central Oregon, was reworked by wind and water, and finally deposited along streams.

PLIOCENE TO PLEISTOCENE

Madras formation: The Madras formation was originally named and described by Hodge (1927). It is a thick piedmont deposit lying east of the High Cascades and is composed of olivine basalt and andesitic lavas interbedded with partially consolidated, torrential and lacustrine sand, silt, gravel, agglomerate, and basaltic volcanic debris. The youngest basalt flow caps the formation and forms the rimrock, which is so noticeable in the region of Sisters, Redmond, and Prineville. The rimrock is a gray, vesicular, olivine-bearing lava. Many of the vesicles are filled by opal or chalcedony.

Williams (1957) found of particular interest a welded dacite tuff which extends over an area of at least 200 square miles northwest of Redmond. The top and bottom of the flow are only moderately welded but the central portion is firmly welded. The color near the top is pinkish, becoming gray toward the center. Streaky banding is caused by elongate, flattened lapilli, black obsidian bombs, and whitish pumice.

Fossil leaves have been found in the Madras formation near Warm Springs and were determined by Chaney (1938) to be early or middle Pliocene. The leaf beds are evidently in the lower Madras. Most of the formation, however, is assigned to late Pliocene and early Pleistocene.

PLIOCENE

Rattlesnake formation: This, like many of the other formations of the John Day valley, was named by Merriam (1901). The type locality is along Cottonwood Creek 4.5 miles west of Dayville, Oregon. The formation may be seen on both sides of the John Day River along the highway between the towns of Dayville and John Day.

The Rattlesnake formation is one of the more striking features of the area because of its colorful layer of welded tuff. This layer separates two alluvial members and is 30 to 40 feet thick. Along the north side of the river, the brown to brick-red tuff stands in bold cliffs capped by low rounded hills of gravel, silts, and soil. Deep valleys separate the monolithic masses in such a manner that the outcrops appear as massive monuments or ancient buildings, depending upon one's imagination. Along the south side of the river, the welded tuff layer is not prominent. Here the gravels have accumulated in coalescing fans and the deposits could reasonably be called fanglomerates.

The welded tuff layer is composed of glass shards and prismatic fragments of plagioclase as well as scattered angular fragments of basalt. Some fragmented crystals of potash feldspar, ferromagnesian minerals, and flakes of biotite may be seen.

That part of the Rattlesnake formation beneath and overlying the welded tuff is composed of loosely-consolidated boulders, cobbles, gravel, sand, silt, and clay which washed from the highland south of the basin of accumulation. Bedding is not noticeable in the gravels but it is displayed in the lenses of sand, silt, and clay and in some places there is distinct cross-bedding.

At the type locality 90 percent of the alluvial components, ranging from sand to boulders, is Columbia River basalt. West of the section there is an increasing amount of well-rounded polished pebbles which were originally components of the Cretaceous conglomerates. Eastward there is a similar increase in pebbles and cobbles which were originally part of the older rocks of that area.

The lower gravels of the formation are Pliocene in age as indicated by vertebrate fossils studied by Stock (1948). Chaney also supports this age in his report on a flora from the Rattlesnake. The upper gravels, however, are probably Pleistocene in age. Maximum thickness of the Rattlesnake formation is 800 feet and the average is 200 feet. It overlies the Mascall formation with distinct angular unconformity.

Rocks of a similar lithology and age are widely distributed throughout east-central Oregon south of the Ochoco Mountains. They have been correlated with the type Rattlesnake formation lithologically and on some fossil evidence by Wilkinson (1939) and more recently by Campbell (1958).

MIOCENE

Mascall formation: The Mascall formation was named by Merriam (1901) after the excellent exposures observed near the Mascall Ranch 4 miles west of Dayville on the old post road to Antone. These outcrops are easily seen from the present highway just south of Picture Gorge.

The formation is composed of both water- and wind-laid tuffs accompanied by some conglomerate beds. The sediments at the type locality on the Mascall Ranch are mainly fine-grained tuffs, clayey tuffaceous shales, sandy shale, and lenses of conglomerate. The color varies from gray to buff to cream, with deeper yellow shades occurring near the base of the section.

Some of the beds in the Mascall formation are well cemented and stand out; others are friable and less prominent. Bedding can frequently be distinguished by the variations in color. The glass shards and ash that originally composed much of the formation have been altered to clay, particularly in the lowermost part of the section at the Mascall Ranch.

Farther east in the John Day valley, the formation, as described by Thayer (1956) is largely "water-laid volcanic ash, aeolian tuffs, and rhyolitic welded tuffs interbedded with well-rounded polished pebble gravels". Although the tuffaceous character of the formation is maintained, it differs from the type locality by the presence of welded tuffs.

An upper Miocene age for the Mascall formation was determined by Merriam (1901), Knowlton (1902), and other early workers on the basis of the abundant vertebrate fauna and flora. Most of Merriam's vertebrate collection came from the low rolling hills at the Mascall Ranch. The fossil plants identified by Knowlton came chiefly from the white tuffaceous shales on the Van Horn Ranch about 15 miles east of Dayville. Other areas of Mascall formation in central Oregon have been correlated with the John Day valley deposits by Chaney (1925) and Downs (1956).

In the John Day valley the formation rests conformably or nearly so upon the Columbia River basalt. South of the Ochoco Mountains, however, the formation was deposited unconformably upon the warped and eroded Columbia River basalt surface. The thickness of the Mascall formation is variable but may be as much as 2,000 feet.

Columbia River basalt: The huge volume of basic lavas that covers most of eastern Oregon and parts of southern Washington were referred to as Columbia River basalts by I. C. Russell (1905).

These basalts consist of a series of individual lava flows that are superimposed one upon another. The individual flows vary in thickness from 30 to 100 feet or more. Frequently the top of a flow may be identified by a baked red soil layer, at other times by a brecciated zone.

The rock is generally fine-grained black to gray in color. Prismatic basic plagioclase may be recognized with the hand lens. Often olivine occurs in granular masses and is usually clear yellowish green.

The thickness varies greatly and sometimes within very short distances. In central Oregon along the John Day valley, thicknesses of 2,000 to 3,000 feet are not uncommon.

OLIGOCENE TO MIOCENE

John Day formation: The varicolored tuff beds which are well exposed along the John Day River north of Picture Gorge were first noted by Thomas Condon in the 1860's. Later, in 1872, O. C. Marsh visited the region and in 1875 referred to the basin as "John Day". In 1901 Merriam used the name "John Day formation". The formation is well known for its abundant fossil plants and vertebrates.

In the John Day valley this formation is characterized by colorful tuffs. The lower member is brick red; the middle pale green; and the upper buff to cream. Between the middle and upper members there is generally a welded tuff layer of variable thickness seldom exceeding 75 feet.

The vitroclastic character of these tuffs is recognizable only by microscopic examination. Glass shards and pumice fragments of the original deposition have been altered to clay minerals including appreciable amounts of bentonitic clays. Crystalline material is common and includes sanidine, oligoclase, magnetite, biotite, quartz, zircon, limonite, and hematite. Brookite has been reported by Coleman (1949) from the Turtle Cove and Sheep Rock localities. These minerals are minute and seldom recognizable in the hand specimen. The composition of the tuffs is reasonably uniform even though the color varies throughout the section. The colors are probably caused by ferric and ferric-ferrous compounds. This lithology is typical of most of the John Day formation in central Oregon.

Although some of the beds exposed in the John Day valley are ash falls which have been reworked and deposited under fluviatile and lacustrine conditions, the bulk of the material in this area was probably of aeolian origin. The probable source of the ash was volcanoes 50 to 100 miles west of the central Oregon basins of accumulation. Total thickness of the formation at Sheep Rock in the John Day valley is about 800 feet.

In the Bend area, just east of the Cascade Mountains, the John Day formation, as described by Williams (1957) is "principally flows and domes of rhyolite, welded rhyolite tuff laid down by glowing avalanches, bedded rhyolite tuffs formed by airborne showers of ash, and varicolored, fluviatile and lacustrine tuffaceous sediments". This description adds the rhyolite flows and domes which are not typical of the formation in the John Day valley and elsewhere in central Oregon.

Recent work on the vertebrate material in the tuff beds by Schultz and Faulkenberg (1949) places the Upper John Day in the Miocene. The lower red beds are considered to be upper Oligocene.

EOCENE TO OLIGOCENE

Clarno formation: The Clarno formation originally described and named by Merriam (1901) from outcrops at Mitchell and Clarno Ferry, Oregon, has since been found to be very widely distributed throughout central Oregon.

The formation is composed of several distinctive rock types. Of particular importance are the tuff beds. These range from fine-grained tuffaceous shales to coarse gritty tuffaceous sandstones. The finer water-laid fissile shales have been and still are a prolific source of fossil leaves, stems, nuts, and wood, all typical of a tropical flora. Recently Oligo-Eocene mammalian remains were discovered by Lon Hancock in upper Clarno tuffs near the type locality at Clarno bridge.

Volcanic conglomerates and breccias are widespread in the Clarno formation. They are composed of unsorted angular blocks, subrounded cobbles, and boulders, held in a tuffaceous matrix. Hornblende andesite is the most prominent constituent although basalts are not uncommon. These rocks are distinctive because of their buff to gray color, rough jagged surface and tendency to form pock-marked, nearly vertical cliffs.

When first observed, an impression of widespread continuity of a distinctive lithic unit strikes the observer. Most of this material is of mud flow origin and even though the lithology is similar over a wide area, the emplacement both in time and space varies from one locality to another, so that the impression of continuity is erroneous.

Volcanic breccias and conglomerates are interfingered with hornblende andesite and basalt flows. In the hand specimen the andesite is characterized by acicular crystals of hornblende and prismatic plagioclase frequently stained red. The rock as a whole is gray to dark gray usually having greenish tinge.

Plugs, dikes and sills of andesite, basalt, rhyolite and dacite are common features associated with the volcanics of the Clarno formation. These intrusives are expressed topographically in the form of buttes and irregular ridges.

The Clarno formation rests unconformably on the Cretaceous at Mitchell and is unconformably overlain by the John Day formation at other localities. This, in addition to studies of fossil leaves and more recently mammalian fossils, places the Clarno as Eocene to lower Oligocene in age.

CRETACEOUS

Cretaceous rocks have been known in central Oregon since the days of Dr. Condon. Various people have examined these rocks but no one has proposed acceptable formational names. The largest areal exposure covers approximately 150 square miles in the vicinity of Mitchell, Oregon. Here an excellent section across an anticlinal structure is exposed in road cuts extending from the town of Mitchell westward for a distance of 5 miles.

The Cretaceous of the area consists of a series of shales, siltstones, conglomerates, and graywackes having a maximum thickness of 5800+ feet.

The shales are bluish gray on the fresh surface and gray where weathered. Except where freshly exposed, outcrops are covered by fine, blade-shaped chips seldom over an inch in length. Bedding in the shales is indistinct because of fracturing, jointing, and spheroidal weathering. Intercalated well-indurated beds of siltstone and sandstone, usually 2 to 6 inches thick, delineate the bedding and structure of the shales. Concretions of various shapes, but most commonly spheroid, are numerous in the shales, and many contain marine fossils, particularly ammonites.

The conglomerates are composed of rounded or subrounded cobbles and pebbles in a matrix of angular particles of graywacke. Lenses of graywacke are prominent. A wide variety of rock types occurs in the conglomerates. The most prevalent, based on pebble counts, are chert, quartzite, granitics, and basalt. Minor amounts of vein quartz, sandstone, shale, limestone, phyllite, andesite, dacite, and gabbroic rock are encountered. The associated graywackes are fine to coarse grained, poorly sorted, but well indurated. They are composed of fragments of shale, basalt, quartzite, and chert as well as the minerals biotite, magnetite, feldspar, and chlorite. The color varies from shades of gray to yellowish brown.

In regard to the age of the fossils, Packard (1946) states that "the 20 or more new species, together with the previously described species of the fauna indicate that the lower shale fauna is most closely allied to middle and upper Horsetown of California." Recently Jones, in a personal communication, states that this lowermost shale member is Albian, which is in accord with the observation of Packard.

TRIASSIC

Lithic units of the Triassic of central Oregon have not been assigned formational names, but Thayer (1956) has mapped various rock units of this age in the Aldrich Mountain, Mount Vernon, and John Day quadrangles. Brief descriptions of these rocks are presented in the explanation of the map. The following remarks have been compiled from this source.

Lower Triassic of the area is characterized by a series of ultrabasic rocks. These include dunite, peridotite, pyroxenite, pyroxene-rich peridotite, gabbro, and serpentine derived from peridotite. Quartz diorite and albite granite form irregular masses in the late-middle Triassic. The dunite and serpentine are of particular interest because of their relation to chromite deposits of the region. The dunite is an olivine rock containing accessory chromite and associated with all chromite deposits. The serpentine is mostly derived from peridotite and is so altered and sheared that the original rock type is not readily determinable. It is a host rock for chromite deposits.

The upper Triassic is characterized by graywacke and shale. These rocks are well-bedded pencil shales, siltstones, and graywackes grading into grits. Thayer further describes the graywacke shale member as follows:

"Well-bedded dark siltstones and shales, massive beds of graywacke and grit, and volcanic tuffs, totaling about 12,000 feet thick. Lowermost 2500 feet consists mostly of fine-grained siliceous mudstones in which lenses of brecciated older rocks of all types are intercalated. Some of the breccias undoubtedly water laid, but most do not seem water worked. Wherever seen, lower contacts of lenses faulted, upper contacts depositional. Lower beds nonvolcanic, but along upper parts of ridge east of Fields Creek medium-grained volcanic tuffs are dominant. Abundant water-worked serpentine debris near base of formation shows that serpentine and related rocks are older."
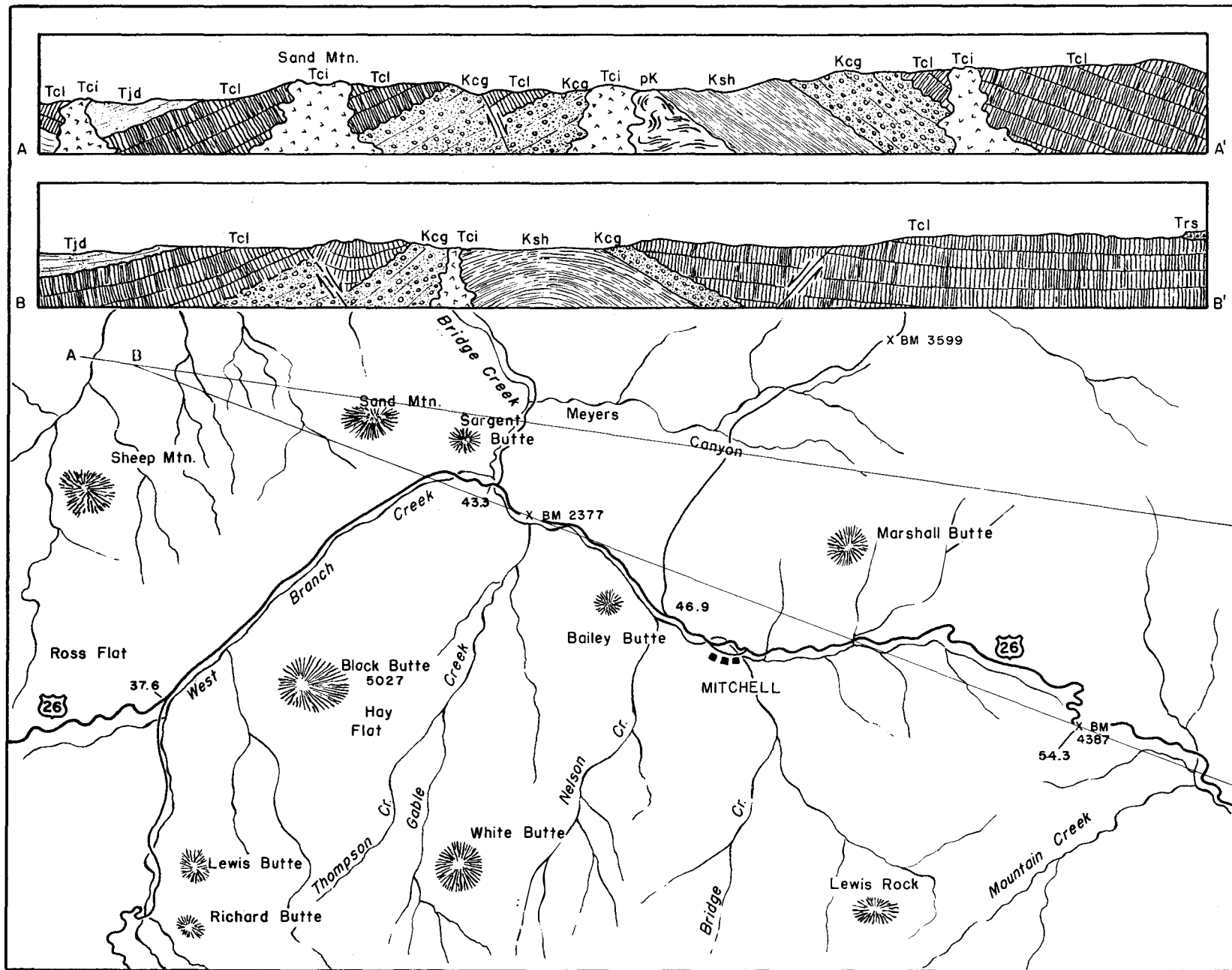
ROAD LOG: PRINEVILLE TO JOHN DAY VIA MITCHELL

Mileage

| 0.00 | Prineville, Oregon. From Ochoco Inn, go east on U.S. Highway 26 toward Mitchell. |

(0.4)

0.4   At 9 o'clock. Poorly sorted gravels of the valley fill are exposed in the embankments north of the Highway. This is the face of the terrace observed from the viewpoint west of Prineville.

(0.9)

1.3   At 11 o'clock. Outcrop of massive rhyolite underlain by John Day tuff beds. Terrace gravels abut against this rhyolite block.

(0.6)

1.9   At 3 o'clock. Basaltic rim rock at the top of the Madras formation rises gently to the east

(1.5)

3.4   At 11 o'clock. A second large slab of massive rhyolite overlying John Day tuffs crops out. These rhyolite blocks are part of the John Day formation in this locality. Presumably they are large landslide blocks and this one has possibly moved a distance of 4 miles from higher in the Ochoco Mountains to the north.

(1.6)

5.0   At 3 o'clock local landsliding. Landslide features will be common throughout the remainder of the trip. Such slide areas occur where lavas overlying tuff beds have been undercut. This is frequently seen where John Day tuff beds are overlain by Columbia River basalts. The large slide areas are distinguished by hummocky ground and displaced rock.

(1.6)

6.6   Ochoco Reservoir, a rock-filled dam. It is one of the first irrigation projects in Oregon. The water stored during the spring is used to irrigate the recent terrace surface from the dam site to a distance of several miles west of Prineville.

(1.8)

8.4   Mill Creek Valley. Continuous exposures of Clarno basalts. Some landslide blocks.

(1.2)

9.6   Terrace gravels plastered against Clarno basalt.

(0.5)

10.1   Basalt Quarry. This basalt is probably Clarno but difficult to distinguish from Columbia River basalt because of the glassy character.

(1.1)

11.2   Veazie Creek road junction. The area to the north and east has been prospected for cinnabar for a number of years. Many prospects have been found which show colors, but only one proved to be economic. This was the Horse Heaven mine which up until recently was a large producer. The mine is located about 35 miles north and slightly west of this point.

(1.1)

12.3   Clarno tuff beds.

(1.2)

13.5   Forest boundary.

(1.2)

14.7   Small dike Clarno basalt.

(0.1)

14.8   Junction of old Ochoco highway. Keep left on U.S. Highway 26. The smaller cinnabar prospects are along the ridges flanking Ochoco Creek to the east.

In the road cuts and the valley walls of Marks Creek a variety of basalts, hornblende andesite, and volcanic breccias crop out for the next 16 miles. These lithic units are a part of the Clarno formation. The basic lavas are characterized by a thin platy

jointing, frequently displaying curved surfaces. The rock on the fresh surface is black to dark gray. Prismatic feldspars can be identified in the hand specimens of both the basalts and andesites. Distinct elongated prismatic feldspar and well-formed crystals of hornblende characterize the andesites. The Clarno flows and sediments are dipping between 20° and 40° to the southeast in the ridge east of the Highway.

(15.9)

30.7   Ochoco summit 4720 elevation. For the next several miles beyond the summit, large
(0.7)   road cuts offer an opportunity to observe various aspects of the Clarno formation.

31.4   On both sides of the Highway buff-colored deeply weathered tuff breccia is exposed.
(0.3)

31.7   At south end of cut, the basaltic volcanic conglomerate is cut by a coarse-grained basic intrusive. All cobbles forming the conglomerate are basalt. As progress is made through the cut, volcanic breccias and more volcanic conglomerates are intruded by basalts. Most of the frequently observed narrow white stringers and veins are composed of zeolite. In many of the Clarno intrusions, as well as flows, excellent zeolite and calcite crystals
(0.3)   may be found.

32.0   Excellent example of spheroidal weathering. The joint pattern can still be easily discerned.
(0.7)

32.7   Bedded carbonaceous tuff beds. Beginning at this point and continuing for the next 2.2 miles are a series of interbedded carbonaceous tuffs, tuffaceous siltstones, gritty tuffaceous sandstones, and volcanic conglomerate. The lithology displayed in the several road cuts
(0.3)   is unique within the Clarno formation.

33.0   At the beginning of this cut the volcanic conglomerate is overlain by gritty tuffaceous
(0.2)   sandstones.

33.2   Basic intrusive. Spheroidal weathering has developed along the jointing system. This intrusive is a small sill. Beneath the sill is a thick section of gritty tuffaceous sediments.
(0.2)   These sediments are dipping 20° SW and strike N. 46° W.

33.4   Beginning of cut. Alternating beds of carbonaceous shales, tuffaceous siltstones, and gritty sandstones containing leaf imprints and frequently fish scales. The sediments are cut by a basic intrusion; again this is a sill. The irregular bottom surface of the sediments is caused by the intrusive. The white veins are calcite and zeolite. At the north end
(0.6)   of the cut there is a fault gouge zone 20 feet wide.

34.0   The Clarno formation as displayed in the series of deep road cuts is composed essentially of interbedded tuffaceous carbonaceous shales, siltstones, sandstones, and some cobble conglomerate. This material is associated in the vicinity with volcanic breccia and andesitic mud flows. These rock types have been traced westward to Bear Creek and east to the head of the west Branch Creek drainage. The shales and sandstone contain glass, carbonaceous material, fragments of basic igneous rocks, and small amounts of magnetite and pyrite. The conglomerates are composed predominantly of basalt cobbles, but chert, quartzite, metavolcanics, metasediments, and granitic pebbles, have been found in varying amounts. The volcanic breccia is composed mainly of blocks of hornblende andesite embedded in a tuffaceous matrix of the same composition. The conglomerate and particularly the breccia are distinctive in outcrops. They develop cliffs having an irregular surface caused by weathering out of angular blocks. Because of the softer matrix in the breccia, hoodoo and spire forms are common. The color in outcrop varies from greenish dark gray to buff. The sediments continue to crop out in the road cuts and frequent basic
(0.1)   intrusions can be observed. The traverse is down the section of Clarno.

Figure 24a

LEGEND

Qal	ALLUVIUM	Tci	CLARNO INTRUSIVES	
Tol	OCHOCO LAVAS	Tcl	CLARNO LAVAS	
Trs	RATTLESNAKE	Kcg.	CRETACEOUS CGL.	
Tcr	CORIBA	Ksh	CRETACEOUS SHALE	
Tjd	JOHN DAY	pK	PRE-CRETACEOUS	

—N—

1 0 1 2 3 4 MILES

PRINEVILLE TO JOHN DAY VIA MITCHELL
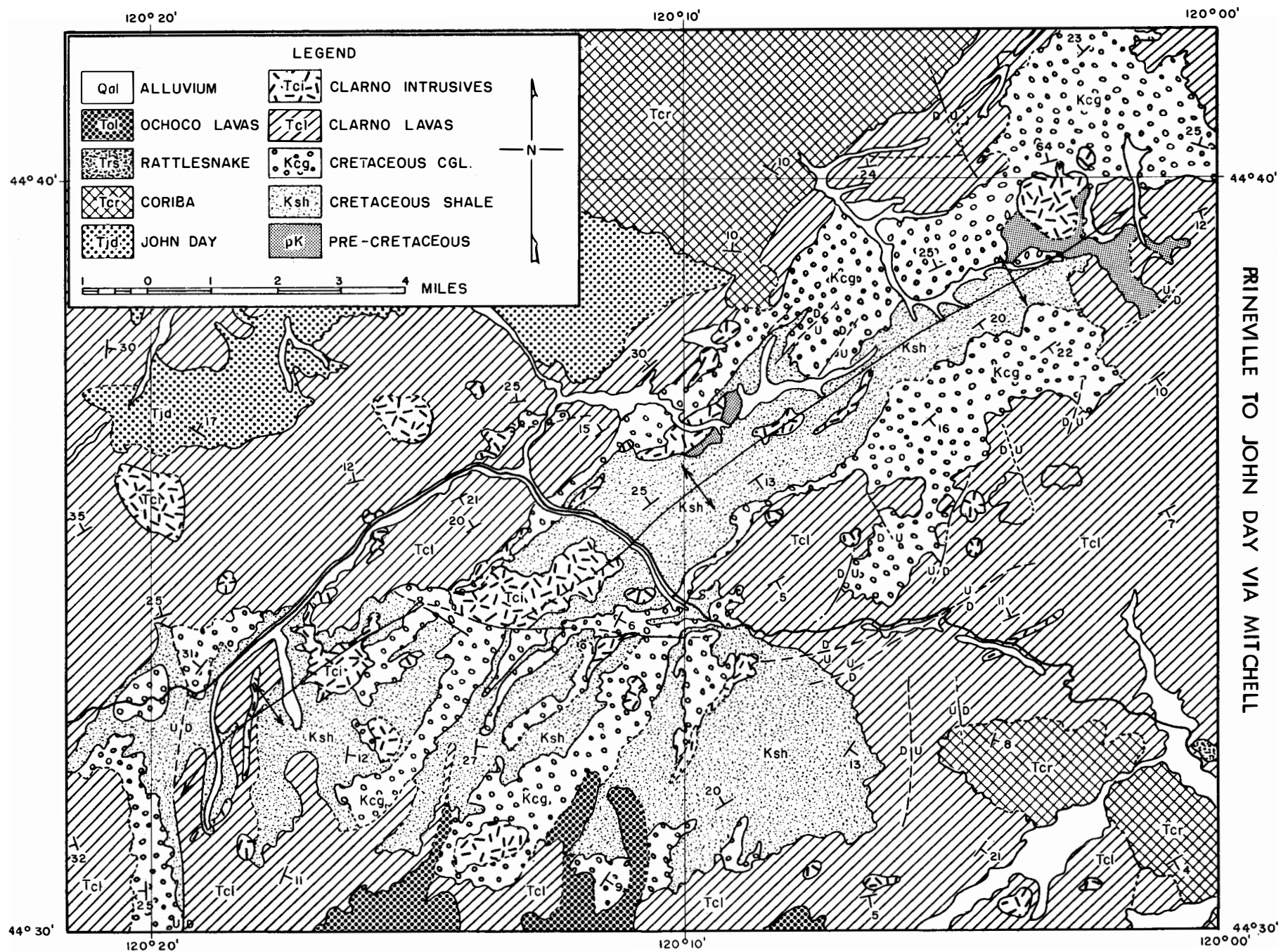
GEOLOGY at MITCHELL, OREGON (Wilkinson, et al., 1959)

Figure 24 b

Mileage

34.1   At 2 o'clock Black Butte, an andesite intrusion, rises to an elevation of 5027. It cuts
through Cretaceous rocks disturbing the structure in the sediments flanking it. Radiating
from the plug are a number of andesite dikes of similar composition. At 3 o'clock the tip
of White Butte barely rises above the horizon at an elevation of 5627. This intrusion has
greatly disturbed the Cretaceous sediments around its flank, in fact, it has changed the
eastward dip of the conglomerate to a steep westward dip. The top of White Butte is
almost a continuous outcrop of light-gray platy hornblende andesite, in contrast to the
(0.1)   darker gray hornblende andesite of Black Butte.

34.2   In this road cut, near the base of the Clarno formation, some minor faulting is displayed.
The deeply weathered breccia contains large blocks of altered pumice and in this respect
differs from the younger andesitic breccias of the formation. Above the pumice tuff breccia
(0.3)   are carbonaceous tuffaceous shales in turn overlain by a massive tuffaceous siltstone.

(Begin Figs. 24a and 24b)

34.5   Series of basalt intrusions.
(0.4)

34.9   In the road cut a fault contact can be seen between Clarno volcanic breccias and Creta-
ceous shales. The shales have been severely fractured. The fault strikes north-south and
(0.5)   dips 80° west. The pitch of the grooves is 25° north. The gouge zone is about 15 feet wide.

35.4   Small exposures and irregular patches of Clarno tuff beds overlie Cretaceous conglomerate.
(0.6)   The attitude of the Clarno tuffs has been greatly disturbed.

36.0   This road cut is of particular interest since it is the only place where thrust faulting is
clearly indicated. Massive Cretaceous conglomerate at the top of the cut overrides the
thin-bedded Cretaceous siltstones and shales. Boulders and cobbles of siltstone along the
fault plane were rounded during the thrusting. The gouge zone thickens to the south. The
shales and siltstones have been finely fractured throughout the zone. Along the fault plane
there is always a small amount of water oozing to the surface. In the cuts for the next sev-
eral miles the attitudes of the shale siltstone series are much steeper than the regional atti-
tudes on the west limb of the major structure. The disturbed attitude can be attributed in
part to the thrusting and in part to the many dikes extending westward from Black Butte.
Looking toward Black Butte the ridges in front of the butte are dikes flanked by
Cretaceous shale;   however, the ridge on the skyline south and east of Black Butte is a
(0.7)   thick conglomerate graywacke dipping to the east.
The low valley in the foreground is Cretaceous shale. Shale valleys can be mapped
readily because they represent the tillable land. Graywacke, conglomerate, and Clarno
rocks are covered by sagebrush, juniper, and grass and for the most part constitute the
grazing land.

36.7   Cretaceous shales and thin beds of siltstone are here overlain by massive pebble conglom-
erate. The conglomerate caps the ridges away from the road. Near the road junction
(0.9)   ahead, shale has been partially incorporated in the gray andesite intrusive.

37.6   Road junction of old highway across the Ochoco Mountains. Continue northeast toward
(0.3)   Mitchell on U.S. Highway 26.

37.9   At 12 o'clock is Sutton Mountain. Series of Columbia River basalt flows overlying John
Day and Clarno. The flows are dipping 11° to the northwest. As viewed from this point
(0.2)   they are the east limb of a major syncline, the axis of which trends northeast.

38.1   At left side of road, well-bedded buff to cream Clarno tuffs contain excellent fossil leaves.
(1.8)   Overlying the tuff beds there is a thick basic lava flow.

Mileage

39.9   This flow farther west is in turn overlain by bedded tuffs and volcanic breccia. The dip
        is 27° W. and the strike is north-south. This is part of the nose of the Sutton Mountain
(0.7)   syncline.

40.6   At 3 o'clock, in the small valley draining westward into West Branch Creek, is one of
        the historic leaf localities of the Clarno formation. Collections have been made by Chaney,
        Sanborn, and Brown. Brown confirmed the Eocene age of these tuffs. The tuffaceous out-
        crops in this valley are dark thin-bedded, carbonaceous shale. Excellent leaf impressions
        may be obtained; however, it requires work. The skeleton of a small fresh-water fish was
(1.2)   found as well as the wings of beetles.

41.8   At 11:30 o'clock is a rhyolite plug. The white dome hill with radio station on top is
        Sargent Butte, a dacite intrusion probably of late Eocene age. It has warped the sur-
(0.6)   rounding basic flows as well as altering the tuffs adjacent to it.

42.4   West Branch Creek crossing.
(0.9)

43.3   Bridge Creek and road junction to Painted Hills State Park, 6 miles northwest. Continue
        eastward on U.S. Highway 26 toward Mitchell. Northwest-dipping Clarno basalts are
        continuous for 2.5 miles down Bridge Creek where they are overlain by John Day red beds.
(0.2)   The erosional and angular unconformity is well shown.

43.5   Contact between the Clarno basalts and the Cretaceous upper conglomerate and graywacke
        beds on the west limb of the Mitchell structure. The conglomerate overlies a thin section
(0.1)   of bluish-gray thin-bedded Cretaceous shales which so far have proved nonfossiliferous.

43.6   The middle shale member is in turn resting upon a lower conglomerate graywacke series.
(0.2)   These beds dip 28° to the northwest and strike northeast.

43.8   Turn right onto old highway leading to Mitchell. At 12 o'clock the high ridge is an ande-
        site intrusion. The conglomerate just observed overlies the lower shale member which crops
        out along the old road for about 2.3 miles. The shales have sagged but in general the dips
(0.8)   are westward in accord with the structure.

44.6   The multiple basalt dike has the form of the letter J; the stem parallels the road and actually
(0.6)   holds up the flat surface north of the shale ridge.

45.2   Probable axis of the structure. Strike is generally NE-SW.
(0.7)

45.9   This cut exposes the shale as well as the siltstone and fine-grained sandstone. The silt-
        stone, and to some degree the shale, weathers into spherical forms resembling concretions.
        The real concretions, however, are well cemented, usually quite round rather than oblate,
(0.3)   and some contain a rewarding ammonite.

46.2   Contact between shale and andesite. Here the intrusive cuts across the shale bedding. It
        is interesting to note the minor alteration of the rocks at the contact. At 3 o'clock across
        Bridge Creek the intrusive parallels the bedding of the shale. Along the creek bank beneath
        the sill contact, ammonites identified as Desmoceras have been collected. The shale is the
        lower member of the Cretaceous in this immediate area. Probably Albian age as indicated
(0.2)   by Packard.

46.4   Conglomerate on east flank of the Mitchell anticline overlies the lower shale. At the bottom
        of the section there is a rather thick layer of pebble conglomerate associated with interbeds
        and lenses of graywacke. The conglomerate in some places becomes a cobble conglomerate
        with cobbles and pebbles set in a matrix of angular particles. Outcrops are generally yellow-
        ish brown but the fresh surface is dark greenish brown.

Ecola State Park near Cannon Beach. Sea stacks and headlands formed by erosion of basaltic rocks typical of Oregon coast scenery.

Cove Palisades State Park near Madras. Canyon cut in Madras formation by the Crooked River. Mount Jefferson in background.

Looking east up the Columbia River from Chanticleer Point. Vista House to the right; Beacon Rock on Washington side in background.

Castle Rock on the John Day River near Kimberly. John Day tuff beds capped by a layer of welded tuff.

Oregon State Highway Commission photos

Mileage

The rock types represented in the conglomerate include chert, quartzite, granite, meta-igneous rocks, and basalt. Minor amounts of various other igneous and metamorphic rock are encountered.

The graywacke is fine to coarse grained, poorly sorted, and well indurated. The cementing material is generally siliceous and chloritic. Quartz and quartzite grains predominate but appreciable amounts of feldspar are also present. Lesser amounts of olivine, biotite, chlorite, and basalt grains occur.

Shale overlies the conglomerate. Good outcrops occur along the Service Creek road and the adjacent hills. These shales are overlain by a massive conglomerate exposed

(0.3)   in road cuts at Mitchell, Oregon.

46.7   ` This shale and siltstone member has no lithologic characteristic that distinguishes it from the lower shale member. However, it does lie on the lower conglomerate and so is strati-
(0.1)   graphically higher in the section.

Begin side trip north

46.8 = (0.0)   Bridge Creek – Junction of Service Creek road (Oregon Highway 207).

Begin side trip 4.8 miles north on Highway 207 to see section through Cretaceous shales
(0.4)   overlying the conglomerates previously observed.

Basalt dike. In the road cut to the right and in the slopes below the road is the eastern extremity of the "lazy" J-shaped dike that was first observed on the western limb of the
(0.3)   anticline.

0.7   At 10 o'clock an extension of the Bailey Butte intrusion. The peculiar layering is a
(0.1)   jointing phenomenon caused by cooling.

0.8   Contact of upper conglomerate and shale. Small patches of conglomerate typical of the
(0.1)   top of the Cretaceous east of Mitchell crop out in the road cuts.

0.9   Dike at 9 o'clock. This extends westward for 4 miles and is the outcrop of the J-shaped
(0.2)   basalt dike previously observed.

1.1   12 o'clock Sutton Mountain. A number of the many flows constituting the Columbia River basalts are well exposed in this mountain. The top of the mountain dips gently to the
(1.5)   northwest. It is one limb of a major northeast-trending syncline.

2.6   Hudspeth logging road junction. Private road.
(0.7)

3.3   Ridge at 9 o'clock. A very limited outcrop of pre-Cretaceous rocks occupying an area of less than 10 acres. The rocks are phyllites, limestones, cherts, and cherty limestone. The
(0.5)   small grayish mass at the crest of the ridge is limestone.

3.8   Alluviated and eroded basin of Meyers Creek. The white layer in the alluvial fill is reworked ash from the Newberry Crater eruption. Many of the deep valleys of this region have been filled to appreciable depths by Recent alluvium. Because this region is subject to severe thunder showers and cloud bursts, sudden floods occur in the narrow canyons. In 1957, gravel, silt, and sand from adjacent slopes and valleys were deposited
(0.9)   in the upper end of this valley to a depth of 4 to 6 feet in a matter of 45 minutes.

4.7   At the point where Bridge Creek and Myers Canyon join, the 1957 flood crests were simultaneous, and an estimated 54,000 cubic feet of water passed in a very short period of time. When the large volume of water from the eastern slope debouched from the

Mileage

narrow valleys onto the gently sloping surface at the upper part of Meyers Canyon, debris accumulated quickly to the depths already mentioned. The water flowed in a sheet over the lip of alluvium into the narrow canyon and became recharged with debris and again deposited its load near the mouth of the canyon. This process was repeated at least once in lower Bridge Creek drainage. Several hundreds of acres of cultivated land were destroyed during the 45 minutes to an hour of the flood's duration.

Turn around

Looking south from Hudspeth Logging road on return to Ochoco Highway. From this point the view at 12 to 9 o'clock is south to the scarp on the horizon. The highest point is Mount Pisgah. This is the north-facing scarp of a south-dipping basalt surface. The conical-shaped butte in front of the scarp is White Butte. On the northwest side just above the visible base a rather large dark-colored outcrop is evident. This outcrop is the continuation of the north-trending and east-dipping ridge. The dip of the conglomerate ridge is 21° to the east. However, the conglomerate on the flank of White Butte dips 31° west. It is quite evident that the intrusion has pushed its way through the Cretaceous shales and conglomerates. At contact, the conglomerates are slightly more indurated and deeper in color.

At 2 o'clock Black Butte stands high on the horizon. The cultivated area at the base is a shale valley called Hay Flat. Fossils have been collected from these shales which can be correlated with fossils found at Bailey Butte.

Beginning with the conglomerate ridge east of Hay Flat, a number of similar conglomerate ridges separated by shale valleys can be observed. It is of interest to note that a corresponding number of such ridges and valleys does not occur on the north side of Bridge Creek. This suggest an east-west fault parallel to Bridge Creek on the south side of the valley south of Bailey Butte, with displacement along the fault of between 10 and 12 thousand feet, and movement of the south side toward the west relative to the north side. If this is true, all of that section from the first conglomerate ridge east of Black Butte is higher in the Cretaceous progressively eastward. A further search for better and more paleontologic evidence is in progress. Various hypotheses have been suggested such as (1) normal faulting, (2) low angle thrusting associated with the Ochoco fault zone, (3) a series of different conglomerate horizons, (4) progressive landslides. The best answer to date seems to be thrusting from the southeast.

46.8	Junction of U.S. Highway 26 and Service Creek Road. Round trip to pre-Cretaceous locality was 9.6 miles. At 12 o'clock, on south side of Bridge Creek, the conglomerates overlying the upper shale member crop out. The dip is 28° southeast and the strike is
(0.6)	northeast.
47.4	Bridge Creek crossing east end of main street, Mitchell.
	The relation of the Clarno formation to the underlying conglomerates of the Cretaceous is well shown directly above the Motor Court in the valley wall. The Clarno formation appears to be conformable but at the crest of the ridge it is clearly evident that the Clarno was deposited on an erosional surface. The Clarno formation in this section is composed of
(0.2)	volcanic breccia and conglomerate overlain by a massive platy hornblende andesite flow.
47.6	U.S. Highway 26 junction at Mitchell. Proceed eastward toward John Day.
(1.0)	
48.6	Small fault with distinct slickensides on the fault plane. Clarno volcanic boulder conglomerate crops out at 9 o'clock. Large blocks of Cretaceous conglomerate have been incorporated in this boulder conglomerate. The blocks are sometimes so large that they
(0.8)	may be mistaken for Cretaceous outcrops.

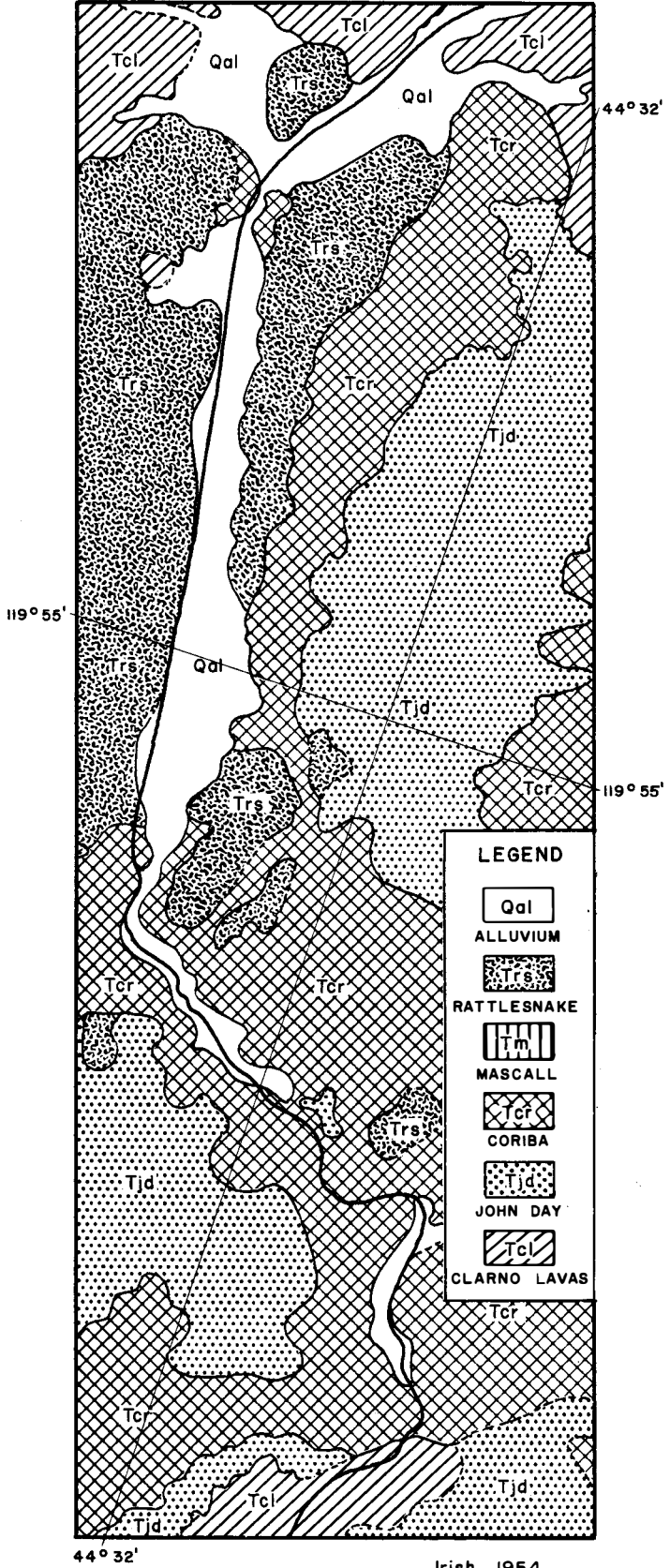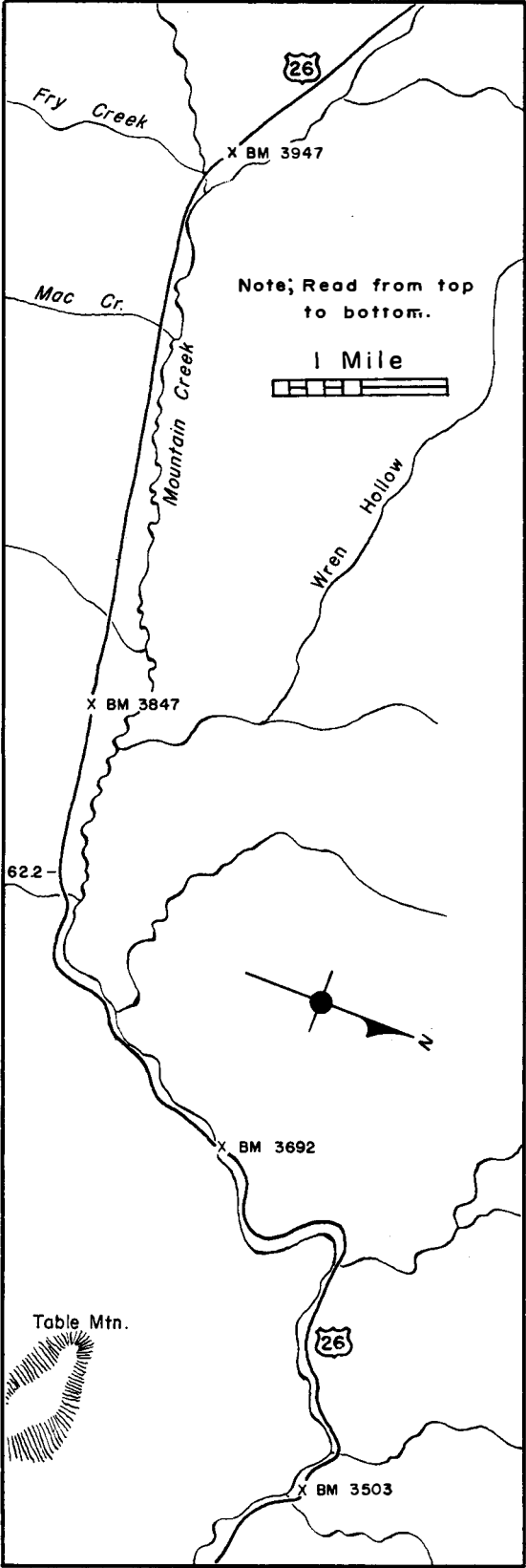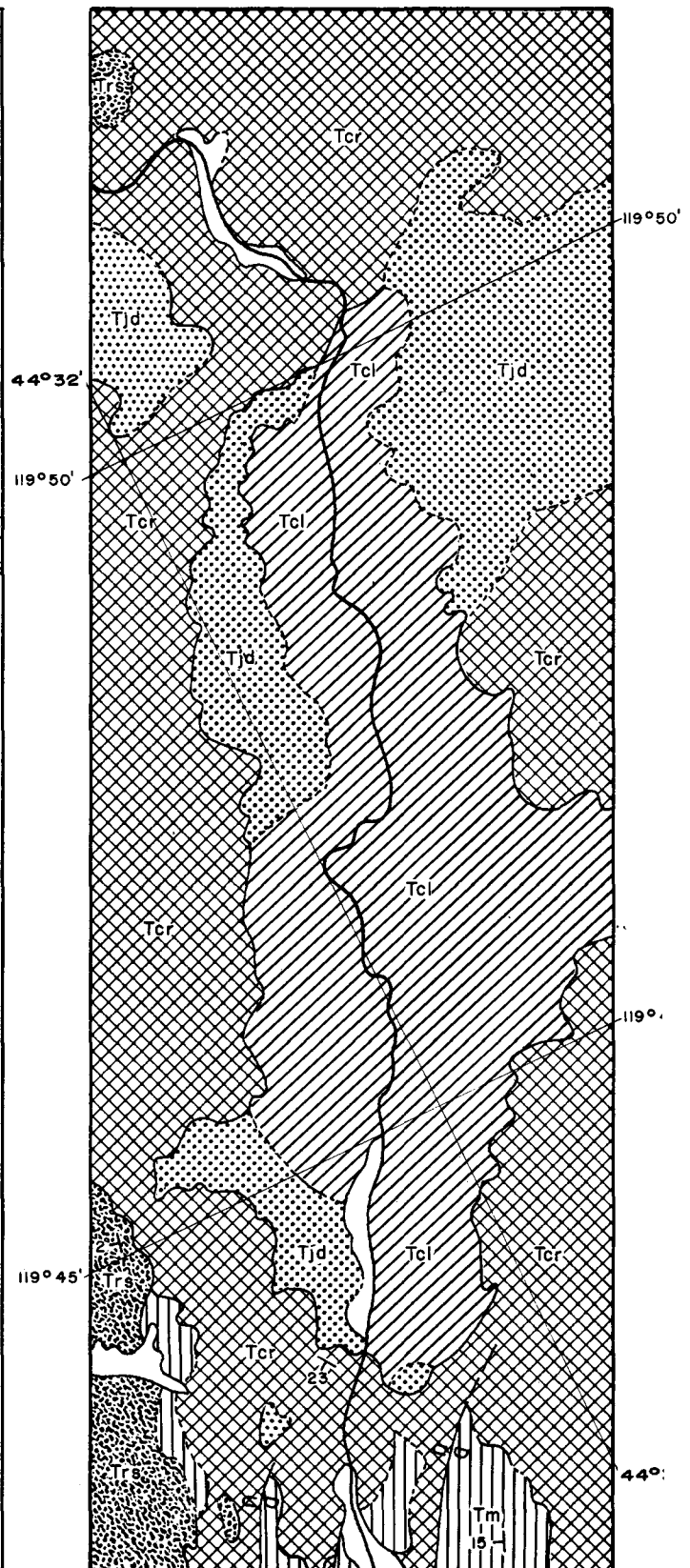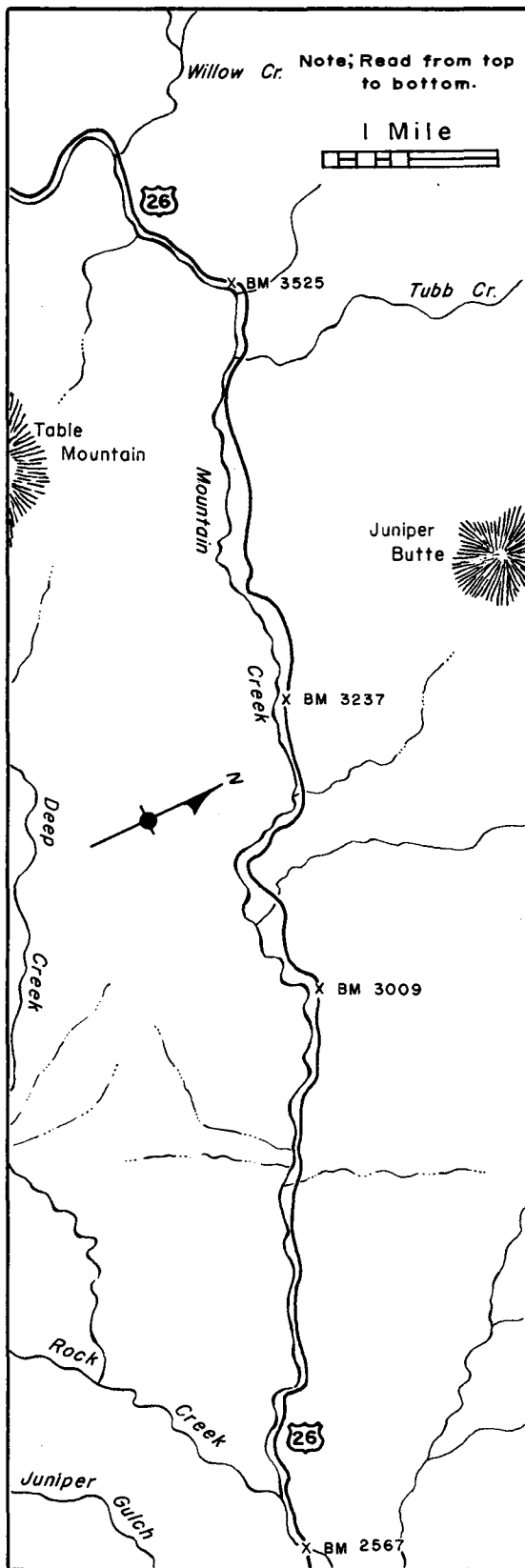Figure 25

Mileage

49.4   Platy Clarno basalt. The jointing is typical, particularly the curvature of the joint planes.
  (1.1   Volcanic breccia interfingers with the basalt flows.

50.5   Historical marker in memory of H. E. Wheeler. "The man for whom Wheeler County was
       named was attacked by Indians at this spot and wounded. He was the mail carrier between
       The Dalles and Canyon City. The mail was looted and the coach destroyed on September 9,
  (0.8) 1866."

51.3   Zeolite veins in volcanic breccia and conglomerate. The flows and breccia came from a
  (3.0) Clarno volcano located north and east.

54.3   Top of pass. East of Mitchell.
  (0.4)

54.7   Red bed exposed in low road cuts. This is probably red tuff at bottom of the John Day
       overlying the Clarno formation. The smooth rolling hills at 11 o'clock are typical of
  (0.5) the upland surface of the Columbia River basalt (Coriba).

55.2   At 12 o'clock the flat-topped mesa is rimmed by a thin layer of Rattlesnake formation
  (0.5) welded tuff. This is the westernmost exposure of this hot cloud avalanche.

55.7   From 12 to 2 o'clock the north-facing crest of the Ochoco Mountains forms the skyline.
       The scarp is an expression of a fault zone which is an extension of the John Day fault,
  (1.4) also the Mitchell fault.

(Begin Fig. 25)

57.1   Rattlesnake mesa at 10 o'clock is capped by welded tuff. At 9 o'clock Columbia River
       basalt dips south toward the highway beneath the Rattlesnake formation. At 3 o'clock
  (1.2) the low ridge is Rattlesnake formation.

58.3   Small outcrop of Columbia River basalt. The low ridges south of road are the beginning
  (1.1) of pediments, a part of the Rattlesnake formation.

59.4   12 o'clock – driving east down a strike valley with Columbia River basalt on the left
       dipping south. The low rim rock and low ridge on right is Rattlesnake welded tuff.
       Rounded hill at 12 o'clock with low dip to the south is 400 feet of Columbia River basalt
  (1.0) capping John Day tuffs.

60.4   Welded tuff of the Rattlesnake in road cut. Skyline at 2 o'clock and rock outcrop at
       3 o'clock one mile south of highway are late Pliocene intrusives along well-defined
  (1.8) post-Rattlesnake fault.

62.2   Antone junction. This road is the old post road to Dayville. At Antone, 5 miles south,
       buff-colored sandstone and pebble conglomerates of upper Cretaceous are exposed.
       Trigonia fauna has been collected and described by E. L. Packard. From this point the
       U.S. Highway 26 crosses the Tertiary section and for the next 4 miles will pass through
  (0.9) Columbia River basalt.

63.1   Mountain Creek bridge.
  (0.5)
63.6   Ash interbed in Columbia River basalt.
  (2.5)
66.1   South side of Mountain Creek. Newberry Crater ash exposed in the valley fill has a
       thickness of about 2 feet. This white ash will be noted frequently throughout the
  (0.4) entire area.

Figure 26

Note; Read from top to bottom.

1 Mile

Willow Cr.

26

X BM 3525

Tubb Cr.

Table Mountain

Juniper Butte

Mountain

Creek

X BM 3237

N

Deep

Creek

X BM 3009

Rock

Creek

26

Juniper

Gulch

X BM 2567

44°32'

119°50'

119°45'

119°50'

119°

44°

Tcr

Tjd

Tcl

Tjd

Tcr

Tcl

Tjd

Tcr

Tcr

Tcl

Tjd

Tcl

Tcr

Trs

Tcr

Trs

Tm

Irish, 1954

Mileage

(Begin Fig. 26)

66.5   The valley of Mountain Creek widens, bringing into view a landslide area over which
    Clarno volcanic breccia, John Day tuffs, and large blocks of Columbia River basalt are
(1.7)   indescriminately dispersed.

68.2   Clarno volcanics and conglomerates crop out for the next 0.1 mile, and in places loose
(1.3)   gravels deposited by Mountain Creek form a mantle on an old terrace.

69.5   Small outcrop of Cretaceous pebble conglomerate and graywacke. This outcrop is lo-
    cated midway between the Antone exposures and those on the John Day River at Humphrey
    Ranch, indicating a north-east trend. Also note the monolith mass of Columbia River
    basalt at 12 o'clock. This is a fault block down-dropped to the north, and is the beginning
    of a series of parallel faults striking N. 50° W. Repetition of Mascall tuffs overlying
(1.9)   Columbia River basalt takes place from north to south across the strike of the normal faults.

71.4   Cream beds of the John Day formation at 9 o'clock. The monolith at 12 o'clock is a fault
(0.5)   block. The road crosses the fault within a short distance.

71.9   Slickensides on left paralleling the fault are smooth and well grooved.
(0.6)

72.5   The ridge at 9 o'clock is Columbia River basalt dipping south. The ridge at 3 o'clock is
    the Mascall formation overlying the basalt. Above the Mascall at 3 o'clock Columbia
(0.7)   River basalt crops out again. This is additional evidence for the faulting already described.

73.2   Birch Creek is here superimposed on Columbia River basalt. The high ridge at 12 o'clock
    is composed of Mascall tuffs overlying Columbia River basalt. This is a second fault
(0.6)   paralleling the one just passed.

73.8   At 12 o'clock rim rock of Rattlesnake welded tuff overlying Rattlesnake gravels and silts
(0.8)   which truncate the south-dipping Mascall tuffs, tuffaceous silts, and gravels.

74.6   Landslide masses of buff-colored lower Mascall tuffs.
(0.6)

75.2   Excellent outcrop of buff-colored Mascall tuff overlain by a thin mantle of gravel. This
(0.2)   outcrop is cut by several small faults.

75.4   Entering gorge which is the result of superimposition of Rock Creek on the south-dipping
    Columbia River basalts after cutting down through the Rattlesnake and Mascall formations.
    The several flows in the Columbia River basalts are well marked by interflow breccias and
(1.4)   red, baked soil layers of varying thickness.

76.8   Picture Gorge. Junction of U.S. Highway 26 and Oregon Highway 19. Keep right on U.S.
    Highway 26 toward John Day. Picture Gorge was named because of ancient Indian writings
    or pictographs on the smooth joint surfaces of the basalt. Refer to Fig. 35 in Trip No. 7 for
(0.5)   geologic map of this area.

77.3   Columbia River basalt-Mascall contact at 3 o'clock. There are 17 Columbia River basalt
    lava flows exposed in the gorge, separated by breccia and soil layers. The Columbia
    River basalts dip to the south. The John Day River flows along or near the axis of a syncline.
(0.2)   This basin was filled by Mascall sediments and later by Rattlesnake materials.

77.5   Mascall Ranch road junction - to viewpoint. Turn right and keep right at fork one mile
    west uphill to old air strip. From this point the relation of Columbia River basalts, Mascall,
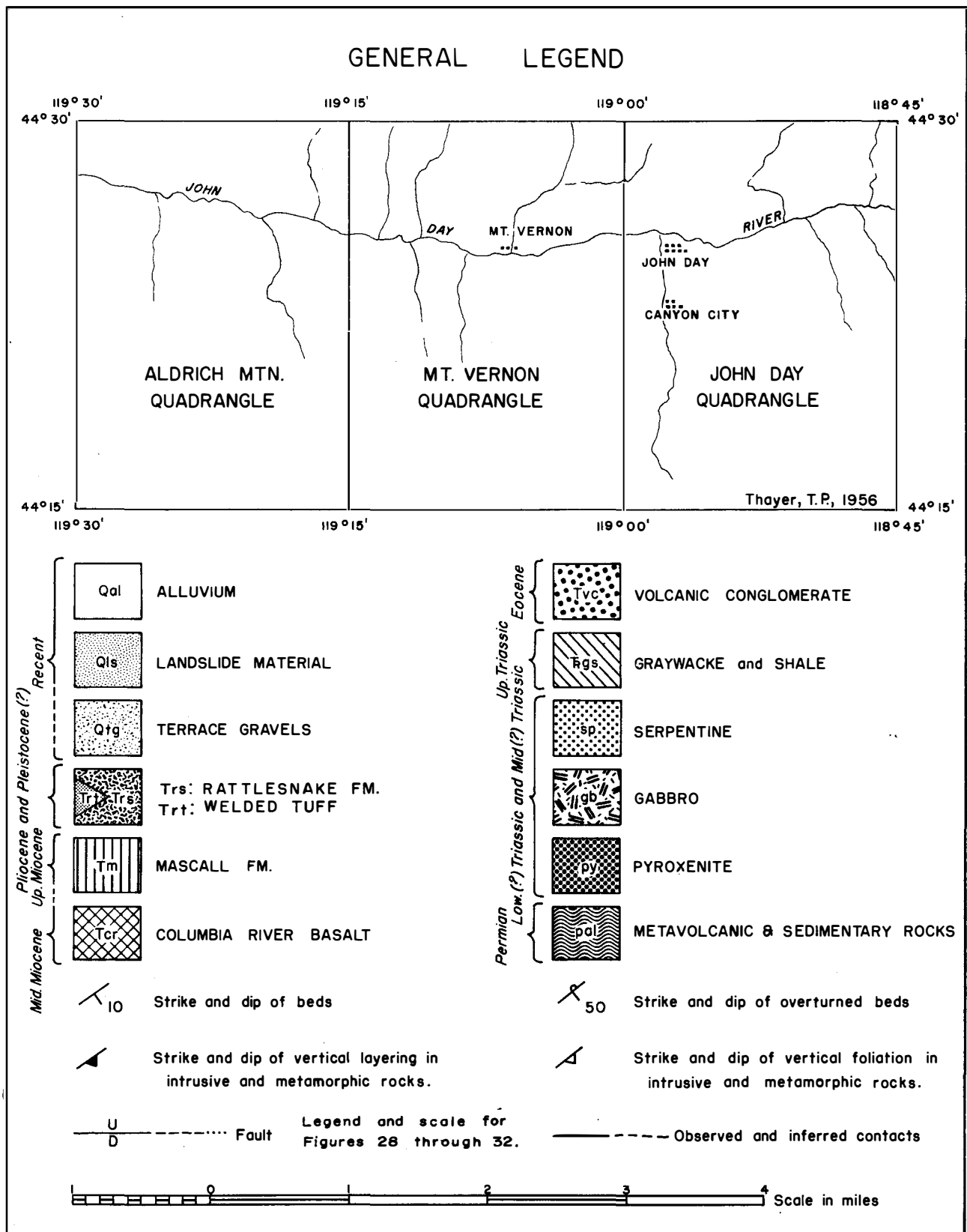   and Rattlesnake formations is well delineated. The south-dipping basalts are overlain con-

GENERAL LEGEND

119° 30'　　　　　119° 15'　　　　　119° 00'　　　　　118° 45'

44° 30'　　　　　　　　　　　　　　　　　　　　　　　44° 30'

JOHN

DAY　MT. VERNON

JOHN DAY

CANYON CITY

RIVER

ALDRICH MTN.
QUADRANGLE

MT. VERNON
QUADRANGLE

JOHN DAY
QUADRANGLE

Thayer, T. P., 1956

44° 15'　　　　　　　　　　　　　　　　　　　　　　　44° 15'

119° 30'　　　　　119° 15'　　　　　119° 00'　　　　　118° 45'

Qal	ALLUVIUM
Qls	LANDSLIDE MATERIAL
Qtg	TERRACE GRAVELS
Trt Trs	Trs: RATTLESNAKE FM. Trt: WELDED TUFF
Tm	MASCALL FM.
Tcr	COLUMBIA RIVER BASALT

Recent

Pliocene and Pleistocene (?)

Up. Miocene

Mid. Miocene

Tvc	VOLCANIC CONGLOMERATE
Rgs	GRAYWACKE and SHALE
sp.	SERPENTINE
gb	GABBRO
py	PYROXENITE
pal	METAVOLCANIC & SEDIMENTARY ROCKS

Eocene

Up. Triassic

Low. (?) Triassic and Mid (?) Triassic

Permian

Strike and dip of beds ⤸10

Strike and dip of vertical layering in intrusive and metamorphic rocks.

U / D — — — Fault

Strike and dip of overturned beds ⤸50

Strike and dip of vertical foliation in intrusive and metamorphic rocks.

Legend and scale for
Figures 28 through 32.

— — — Observed and inferred contacts

Scale in miles

Figure 27

Figure 28

Mileage

formably by Mascall tuffs, silts, and conglomerates. About 150 feet of Rattlesnake silts, poorly bedded gravels, and grits truncate the Mascall sediments. Above the washed sediments of the Rattlesnake the welded tuff member forms the rim rock. This is similar to welded tuff found south of the Ochocos and covering many hundreds of square miles. This tuff is composed of glass shards, pumice fragments, and bits of basalt scattered throughout. It probably represents a short period of time when a hot avalanche˙swept down the old valley of the John Day River. Above the welded tuff layer there is a continuation of the basaltic gravels of the earlier phase of the Rattlesnake.

The John Day River, like Mountain Creek, eroded down through the younger formations and was superimposed on the Columbia River basalt. This superimposition is characteristic of all the creeks west of here such as Rattlesnake Creek, Birch Creek, and Pine

(1.1)   Creek. Return to U.S. Highway 26.

78.6   Note Mascall and Rattlesnake formations paralleling both sides of the highway.

(2.7)

81.3   Enter Dayville.

(0.7)

82.0   Crossing South Fork John Day River.

(0.1)

82.1   At 12 o'clock maximum thickness of Rattlesnake gravels are exposed in the funnel-shaped slide. The light-colored outcrop is composed of glass pellets similar to the welded tuff. This cross-bedded glass sand layer can be traced one half mile south where it joins the welded tuff. Probably represents material that fell in a pond or stream. The total thickness of the section is about 800 feet. Some faulting and slight deformation of the rim can

(1.0)   be observed. Dips as low as $1\frac{1}{2}$ degrees to the south have been measured.

(Begin Figs. 27 and 28)

83.1   The welded tuff bed on the north side of the John Day River at 10 o'clock is about 75 feet thick. Fossil leaves have been collected at the base of the tuff. (Pliocene). The Columbia River dip slope at 11 o'clock is broken by a series of faults trending northwest. It may be accident or fact but for the next eight miles every time the road takes a southeast˙bend it is

(1.1)   parallel to one of the faults.

84.2   John Day River bridge check point.

(1.0)

85.2   At 12 o'clock the series of ribs below the pediment surface on the skyline are Columbia River basalt interflow breccias standing nearly vertical or sometimes slightly overturned. The breccias here proved to be more resistant to erosion than the lavas. The belt of vertical flows is more than a mile wide. On the left or north side of the road the basalts are dipping

(0.9)   to the south 10° or 15°. This is a faulted asymmetrical fold.

86.1   At 1 o'clock three terraces may be seen. Less obvious is the John Day fault which has been

(0.4)   traced with minor interruption as far east as Prairie City.

86.5   Columbia River basalt and thick breccia layers crop out in the gorge. To the south, Mascall

(1.7)   tuffs and Rattlesnake fanglomerates overlie the Columbia River basalts.

88.2   From the last point to this point the south-dipping Mascall crops out at 2 o'clock across the

(0.5)   river. It is cut off to the south by the John Day fault.

88.7   Landslide area from 8 to 10 o'clock extending along the river for about $1\frac{1}{2}$ miles. In the

(0.4)   background the Rattlesnake rim crops out.
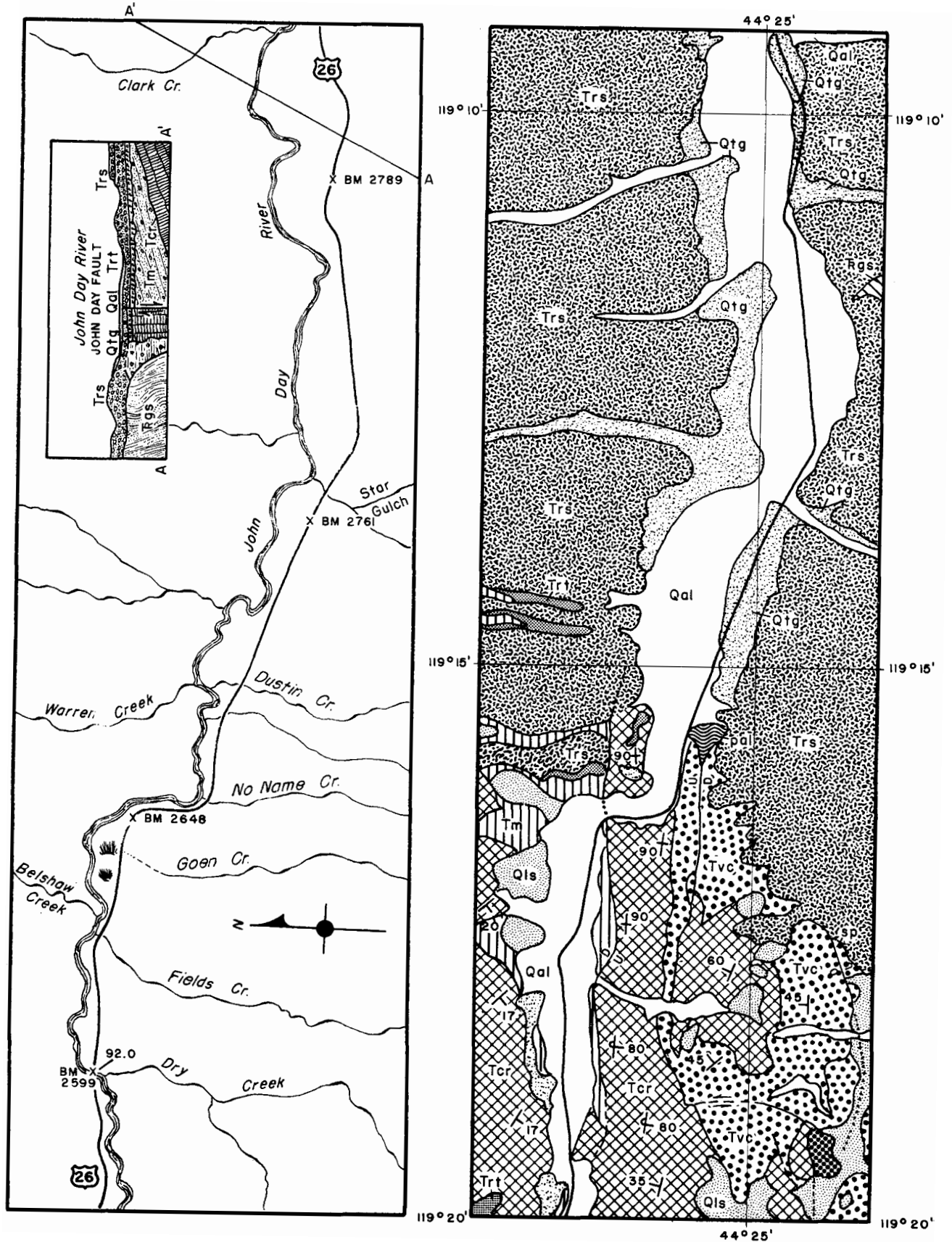
Figure 29

Mileage

89.1   Rattlesnake gravels overlain by welded tuff are exposed in a small landslide block. At
              2 o'clock is Fields Peak.   This is a diorite porphyry intrusion of probable Cretaceous
      (0.7)   age. Elevation of peak is 7360 feet.

89.8   Mascall tuff beds, which are prolific in leaves, crop out for a short distance along the
              roadside. Low-grade coal was found in these beds and was mined and used locally in
      (2.2)   the early days.

(Begin Fig. 29)

92.0   John Day River crossing check point.
      (0.8)
92.8   Fields Creek road junction. This road gives access to the south into the belt of ser-
      (0.5)   pentine, gabbroic rocks, and Triassic sediments. Continue east on U.S. Highway 26.

93.3   Both sides of the valley are bordered by the Rattlesnake formation.
      (0.7)
94.0   Mascall tuff beds and Columbia River basalts bear an overturned relation to each other
      (0.4)   in this outcrop. (See cross sections)

94.4   Breccia rib near road at 3 o'clock. The same vertical attitude as that observed in similar
              breccia ribs just east of Dayville. This relationship indicates the asymmetrical folding
      (1.1)   and faulting along the north face of Aldrich Mountain.

95.5   Strawberry Mountain at 12 o'clock.
      (2.1)
97.6   Terraces in the Rattlesnake fanglomerate both sides of valley. At 12 o'clock is Mt. Vernon,
      (3.3)   a south-dipping Columbia River basalt block.

(Begin Fig. 30)

100.9   John Day River crossing.
      (1.5)
102.4   Entering Mt. Vernon.
      (0.2)
102.6   Junction U.S. Highway 395. Continue east on U.S. Highway 26 toward John Day.
              Welded tuffs of the Rattlesnake at 10 o'clock. (The auriferous Quaternary gravels were
      (1.4)   dredged until recently.)

104.0   Small outcrop of volcanic conglomerates, probably Clarno.
      (0.3)
104.3   John Day bridge crossing check point. Rattlesnake formation on the right.
      (0.2)
104.5   At 9 o'clock first exposure of green serpentine in low rounded hills on north side of valley.
              Also present are metavolcanic sediments of probable Permian age.   These outcrops are
              relatively continuous in the hills on the north side of the valley. On the south side of the
      (3.5)   valley the exposures are Rattlesnake formation.

108.0   Entering John Day.
      (0.8)
108.8   Road junction in town of John Day of U.S. Highway 26 and U.S. Highway 395 south.
              End of traverse.
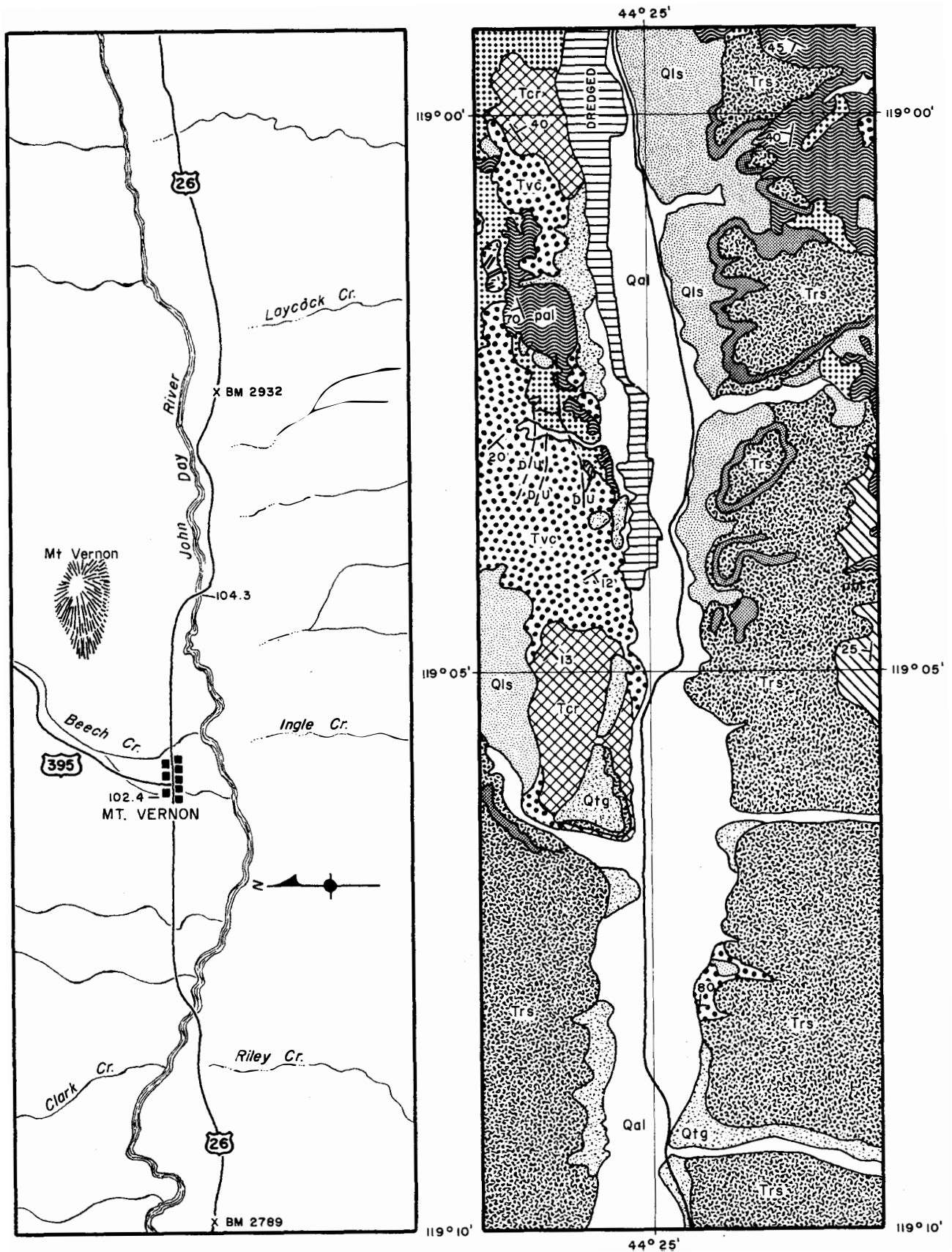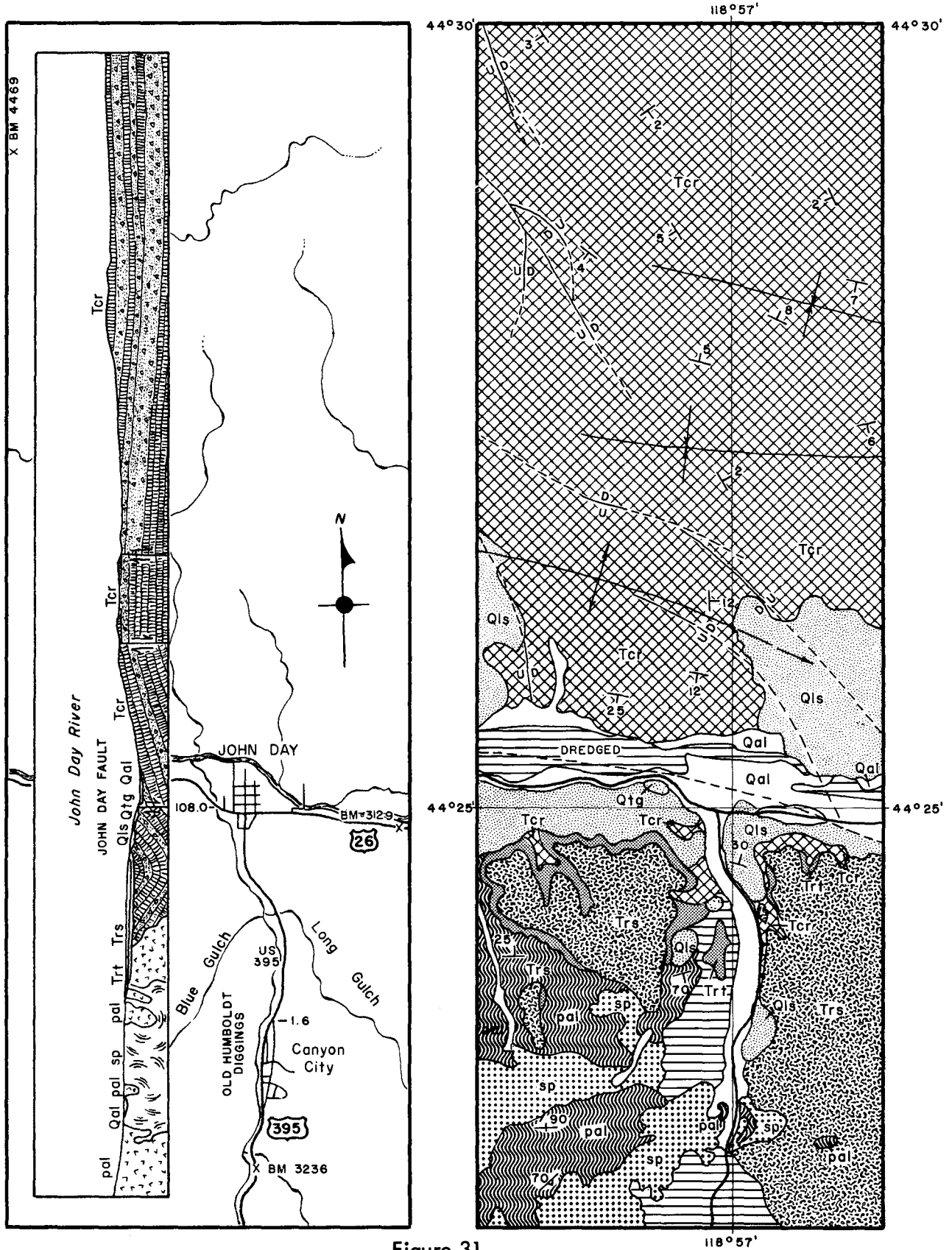
Figure 30

Figure 31

(Refer to Figure 27 for Legend)

FIELD TRIP NO. 5

JOHN DAY TO UPPER BEAR VALLEY
By
W. D. Wilkinson and T. P. Thayer

This trip starts at John Day, Oregon, and follows U. S. Highway 395 south through Paleozoic and Triassic rocks to the junction of the Logdell-Izee road in upper Bear Valley. Total distance is logged at 18.8 miles. For location of trip route, see Index Map of Central Oregon (at beginning of Trip No. 4: Prineville to John Day).

ROAD LOG: JOHN DAY TO UPPER BEAR VALLEY

Mileage

0.00
(Begin Fig. 31)

(0.4)

John Day, Oregon. Turn south on U. S Highway 395 to Canyon City. From John Day to Canyon City note tailings from early-day dredging. Columbia River basalt and Rattlesnake formations parallel the valley on both sides. The Humboldt diggings are on the right side of the road.

0.4

(0.6)

Canyon Mountain at 12 o'clock. Canyon Mountain lies to the southeast of Canyon City. It is composed of a medium- to fine-grained olivine-bearing and noritic gabbro. This mass contains innumerable small veins which formerly were mined for rich gold ore and were probably the source of the placer gold. The first mining was done in the 1850's and has continued in a small way to this day.

1.0

(0.6)

Humboldt placer from 1 to 3 o'clock halfway up the mountain.

1.6

(0.7)

Canyon City. The section from Canyon City to the top of the pass at the Fall Mountain road junction gives the geologist or the person interested in geology an opportunity to examine a typical section of Triassic rocks and some Paleozoic rocks of central Oregon. These rocks have been mapped by T. P. Thayer (1956). From Canyon City to Joaquin Miller Resort, the rocks are Paleozoic and lower Triassic. Hornblende schist, albitized gabbro, serpentine, peridotite, and pyroxenite are visible in the cuts along the Highway. From the resort to the top of the grade, Triassic shales and graywackes stand at high angles or are in overturned folds. Close examination of the outcrops brings to light many features of sedimentation such as graded bedding, ripple marks, and other evidence indicating the manner of deposition.

2.3

(1.4)

Well foliated hornblende schist. Small outcrops on each side of the valley.

3.7

(0.4)
(Begin Fig. 32)

Serpentine on both sides of the valley for the next 1/4 mile. Tailings from dredging operations.

4.1

(1.6)

Albitized gabbro of Canyon Mountain mass. Good outcrop near road, also occurs at Canyon Creek. This rock crops out for the next 2 miles.

5.7

(1.1)

Serpentine in contact with gabbro. Serpentine follows along the righthand side of the creek for the next 2 miles. A pyroxene-rich peridotite is on the left. The creek follows the contact.

6.8

(1.7)

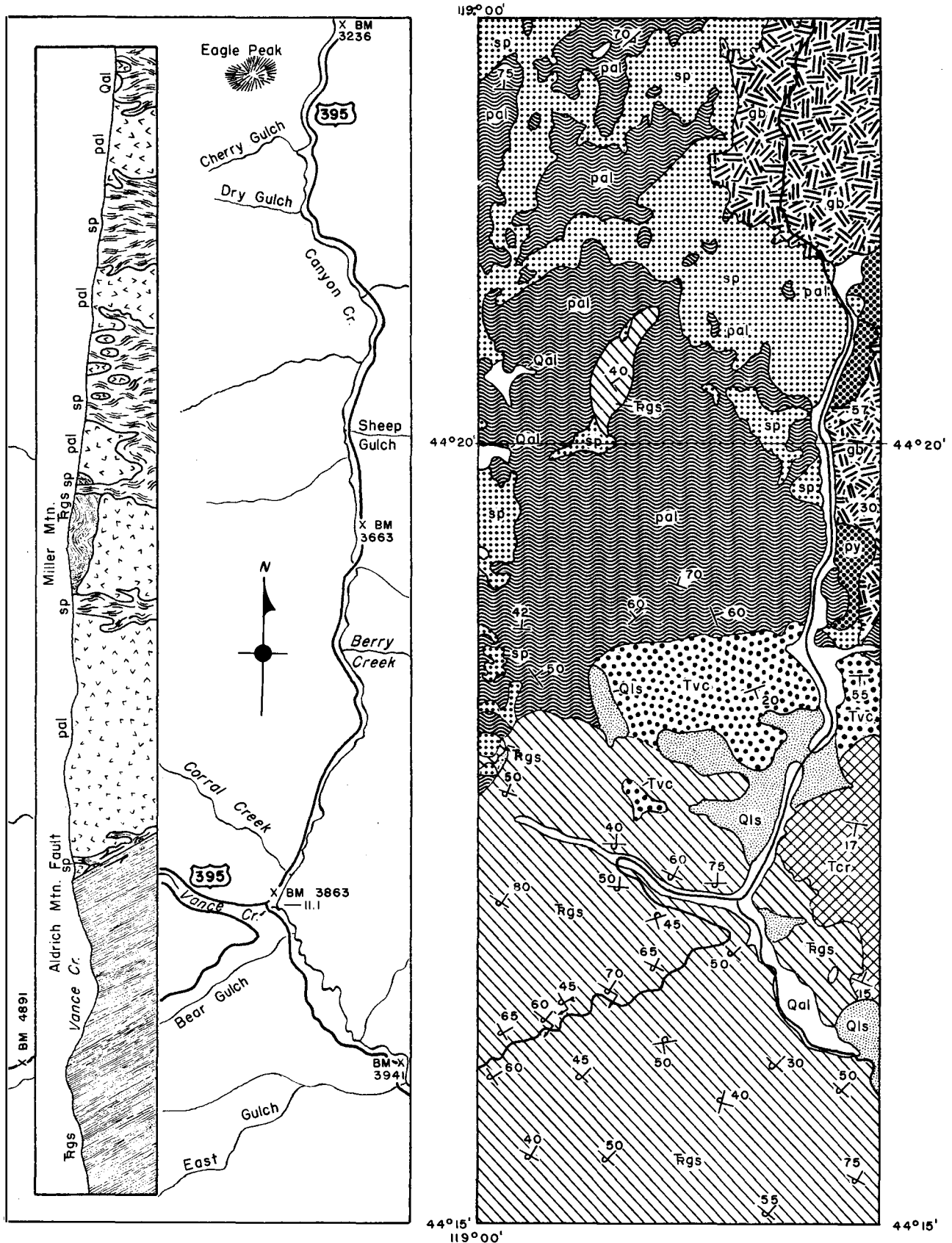Peridotite and pyroxenite. This outcrop is metamorphosed pyroxenite containing pockets of epidotization.

Figure 32

Mileage

8.5
(2.6)
End of Paleozoic and lower Triassic rocks. Eocene Clarno breccias crop out on both sides of the valley for about a mile.

(Begin Fig. 33)

11.1

(3.1)
Joaquin Miller Resort at junction with Canyon Creek Road. From this point, upper Triassic shales crop out for 5.5 miles along U. S. Highway 395. The Highway crosses a northwest-trending asymmetric syncline overturned toward the southwest. The synclinal axis lies practically at Starr Summit. About 10,000 feet of beds are exposed in Highway cuts east of the summit, but are cut by too many faults to make a good stratigraphic section. In general the beds may be divided into three major groups: 1. an upper shale-mudstone sequence in which some more massive beds may be slide materials, 2. a well-bedded sequence of graded graywackes and shales containing some ashy beds, and 3. massive graywackes extensively fractured near major faults. The uppermost beds in the section are limy graywackes with which limestone breccia occurs.

14.2
(0.5)
Triassic shales - overturned beds. Top and bottom may be recognized by observing the graded bedding.

14.7

(0.2)
Curve sign. Excellent examples of graded bedding, ripple marks, and penecontemporaneous folding. Sand rolls and other features of turbidity current deposition may be observed. All the beds are evidently overturned.

14.9
(0.3)
More examples of graded bedding. Isoclinal fold at east end of cut. Midway and near top, sandstone is folded. Beds plunge toward road.

15.2
(0.2)
Folding in Triassic shales.

15.4
(0.1)
Graded bedding shows tops and bottoms of beds. Intricate folding evident. Breccia and gritty sandstone contain fragments of shale.

15.5
(1.0)
Basic dike cutting Triassic shales. Spheroidal weathering well displayed.

16.5

(1.0)
Fall Mountain Lookout road. Elevation 5,152. It is recommended that the geologist interested in the Triassic rock of this region drive to the top of the pass and then walk back down the section a distance of 5.5 miles along the Highway, for it is only in this manner that the interesting and significant features of the section can be fully appreciated.

17.5
(0.3)
Junction Logdell-Izee road west. Continue south on U.S. Highway 395 toward Seneca.

17.8

(0.3)
Limestone breccia associated with limy graywacke exposed west of the Highway about 1/4 mile south of the Izee road. Breccias of this sort are widely distributed in the Triassic rocks at a rather distinct horizon, and are believed to mark a major change in source of materials in the basin. Return to junction of Logdell-Izee road.

18.1
(0.7)
Junction of Logdell-Izee road. Turn left (west) on gravel road.

18.8
Quarry road. Turn right off Logdell-Izee road and drive about 1/2 mile to the State Highway Department quarry. Massive coarse-grained graywacke is admirably exposed.

Geology of Upper Triassic Rocks along US 395
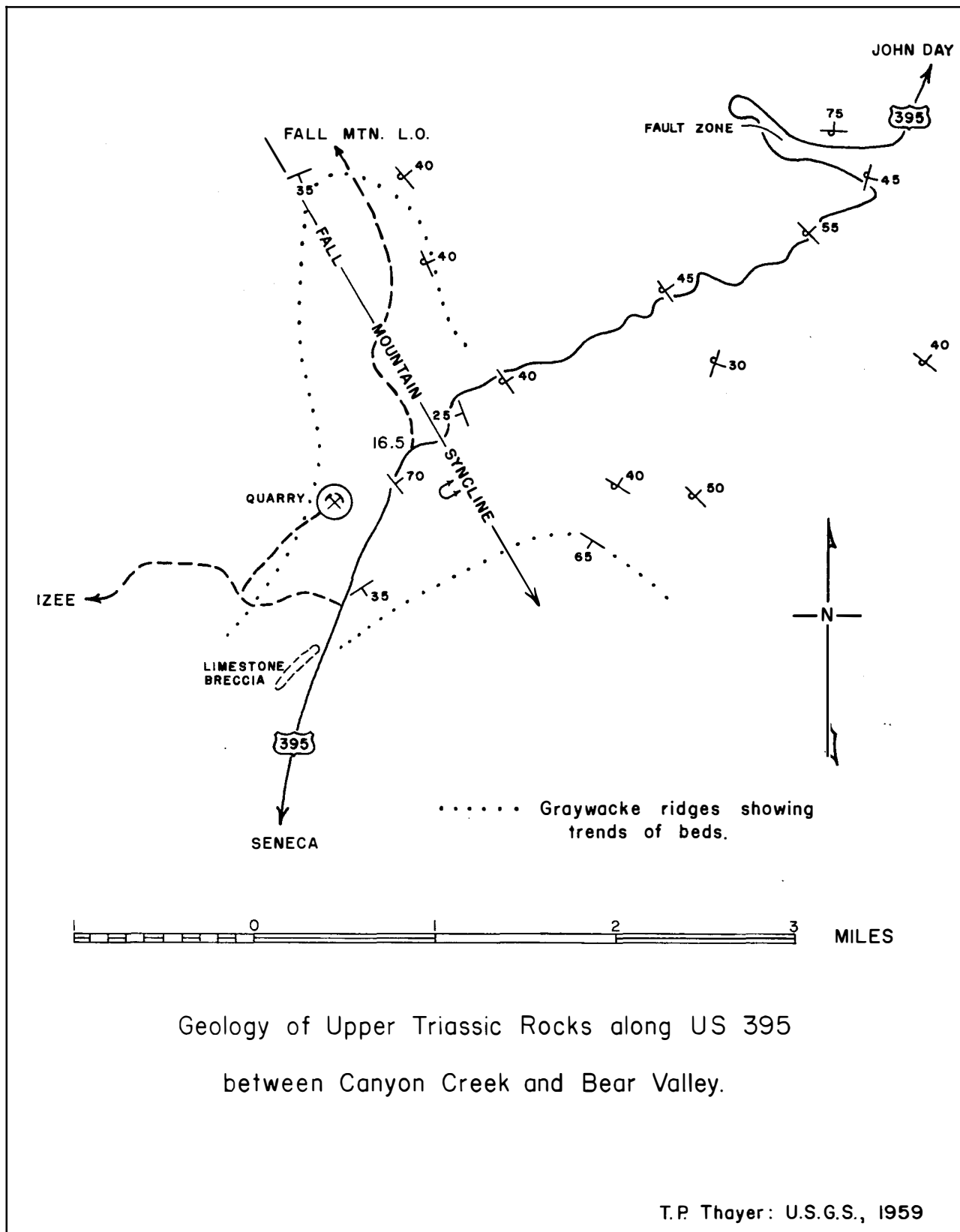between Canyon Creek and Bear Valley.

T. P. Thayer: U.S.G.S., 1959

Figure 33

FIELD TRIP NO. 6

LOGDELL TO PINE CREEK - JURASSIC OF CENTRAL OREGON

This trip starts 17.5 miles south of John Day at the junction of U. S. Highway 395 and the road to Logdell. From here the route follows the Logdell–Izee road (gravel) southwest about 25 miles to the South Fork of the John Day River; turns left and makes a short side trip upriver and back; then proceeds northwest downriver about 9 miles to junction of the Suplee road (graded dirt) at Pine Creek; and goes left on this road up Pine Creek about 2 miles to Cow Creek. Distances given on the road log are scaled from the map and are not actual road miles. Total distance of trip is about 39 miles. For location of trip route, see Index Map of Central Oregon (at beginning of Prineville to John Day trip).

Formations encountered on this trip are described in the alphabetical list accompanying the Correlation Chart of Pre-Tertiary Formations of Oregon (at front of Guidebook).

HISTORY OF JURASSIC SEDIMENTATION IN THE PACIFIC COAST REGION*

By

Ralph W. Imlay**

During early Jurassic time only the northern part of the Pacific Coast region was submerged. The sea apparently covered most of Washington and Oregon and extended across northeastern California and northwestern Nevada. The sediments deposited during the early part of the early Jurassic consist of normal marine sandstone, shale, and limestone that are similar to the underlying sedimentary rocks of late Triassic age and are distinguishable from the Triassic mainly by their fossil content. In contrast the sediments deposited during the later part of the early Jurassic contain much volcanic tuff and lava that are interbedded with sandstone, and shale, and that locally in Nevada are interbedded with conglomerates and fanglomerates. The presence of such rocks, coupled with knowledge concerning Jurassic sedimentation in eastern Nevada, shows that late in the early Jurassic volcanoes arose within or near the sea in the Pacific Coast region and that highlands developed along its eastern and southern margins.

Marine sedimentation continued from early Jurassic into middle Bajocian time in the Pacific Northwest, but the sea was probably less extensive owing to uplift in Nevada in late early Jurassic time. No faunal evidence for a Bajocian sea in Nevada or Washington has yet been found. Its probable existence in those states is inferred from the fact that the early to middle Bajocian was a time of widespread marine invasion in many parts of the world and particularly in North America. The deposits formed at this time in northern California consist of marine sandstone, limestone, and volcanics. Those formed in central Oregon consist mostly of shale, sandstone, volcanic tuff, and lava, but locally the basal beds consist of sandy limestone. Much of the shale and sandstone in central Oregon appears to be tuffaceous.

During late Bajocian and Bathonian time the West Coast region was emergent. Diagnostic Bathonian fossils have not been found, and in those places where detailed studies have been made no stratigraphic unit that might represent Bathonian time is present. The contact between the Bajocian and Callovian rocks indicates, however, that no appreciable uplift, folding, or erosion occurred during Bathonian time.

Early in Callovian time a sea in the Pacific Northwest spread eastward across Oregon at least as far as western Idaho and southward in eastern California along the Mother Lode area. There is no faunal evidence that a Callovian sea ever existed in Washington or Nevada, but the distribution of Callovian

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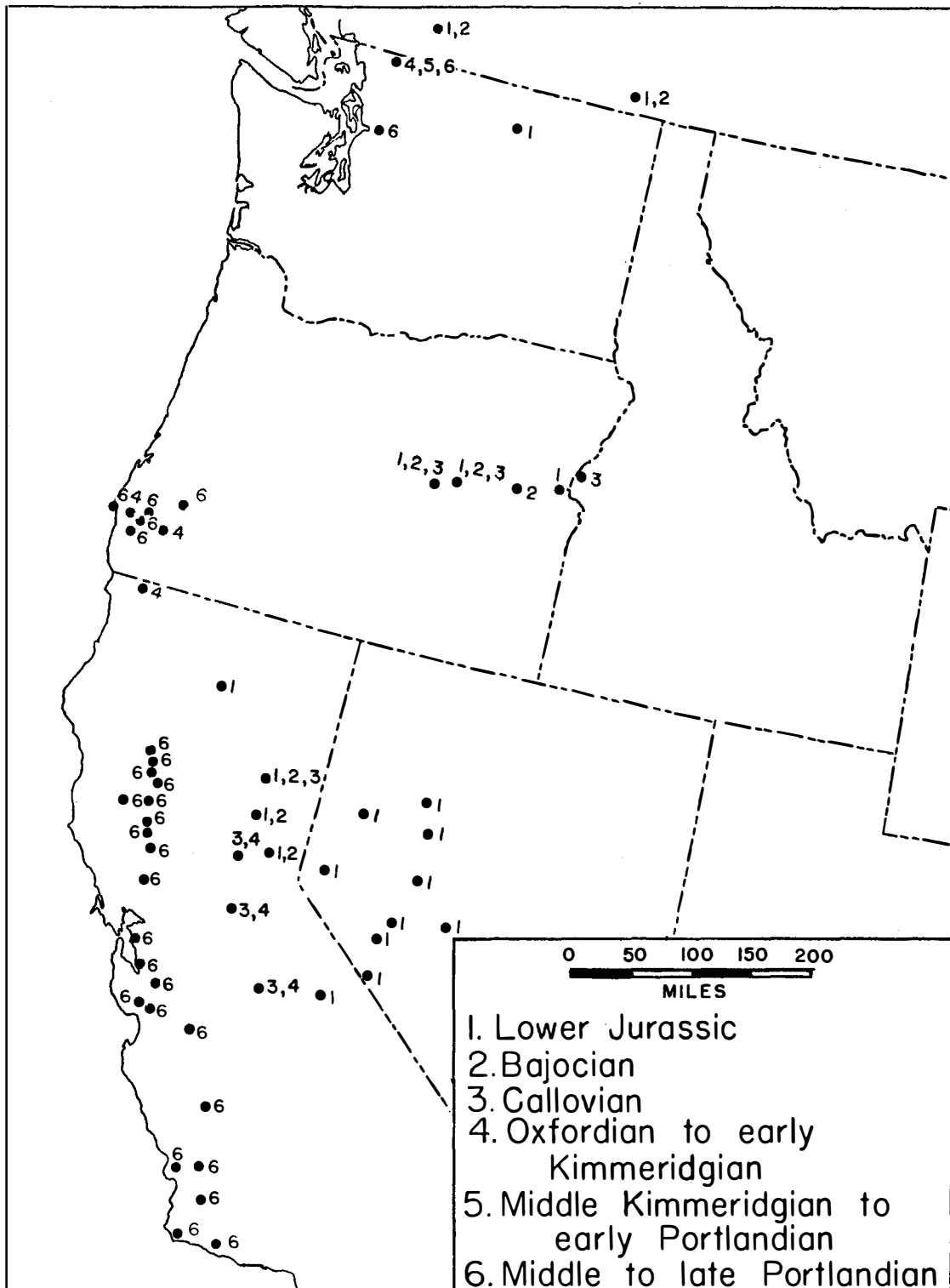
PRINCIPAL JURASSIC FOSSIL LOCALITIES IN CALIFORNIA,
OREGON, WASHINGTON, AND NEVADA.   R. W. Imlay

	EUROPEAN STAGES		CHARACTERISTIC FOSSILS	
UPPER JURASSIC	PURBECKIAN	TITHONIAN	Substeueroceros stontoni	Buchio fischeriona
	PORTLANDIAN		Kossmotia dilleri	Buchia piochii
	KIMMERIDGIAN			Buchia rugosa and Buchia mosquensis (found only in N.W. Washington)
	OXFORDIAN		Amoeboceras (Amoebites) dubium	Buchia concentrica
	CALLOVIAN		Reineckeites Pseudocadoceras, Paracadoceras, Choffatia Lilloettia buckmani, Xenocephalites, Kepplerites	
MIDDLE JURASSIC	BATHONIAN			
	BAJOCIAN		Teloceras, Normonites, Chondroceras Skirroceras, Popilliceras, Sonninia, Witchellia Tmetoceras, Docidoceras, Praestrigites	
LOWER JURASSIC	TOARCIAN		Grammoceras, Catulloceras, Haugia, Harpoceras Hildaites, Fanninoceras, Harpoceras, Dactylioceras Orthohildaites, Hildaites, Peronoceras	
	PLIENSBACHIAN		Gryphaea cf. G. Cymbium, Weyla, Plicatostylus Plicatostylus	
	SINEMURIAN		Eoderoceras, Crucilobiceras, Weyla alata Coroniceras, Arnioceras	
	HETTANGIAN		Psiloceras, Waehneroceras, Euphyllites	

CHARACTERISTIC FOSSILS IN THE JURASSIC ROCKS
OF THE PACIFIC COAST REGION.   R.W. Imlay

rocks in eastern Oregon, California, and British Columbia suggests that a large part of Washington and some of northern Nevada was covered by such a sea.   The duration of the Callovian sea is likewise unknown, but some ammonites from the Mother Lode area indicate that the sea persisted until late Callovian time. The Callovian sedimentary rocks in California consist mostly of sandstone and volcanic tuff that are about 1,500 feet thick in the Taylorsville area.   In central Oregon they consist of sandstone, shale, and volcanic material and attain a thickness of nearly 9,000 feet.

During Oxfordian and early Kimmeridgian time a sea covered southwestern Oregon and parts of northern California at least as far south as the southern end of the Mother Lode area.   There are no records of fossils of that age in Nevada, in the higher part of the Sierra Nevada in California, or in central Oregon, and only meagre records in northwestern Washington.   Most of the sediments were originally clay-stone, but include some sand and tuffaceous material.

At the end of early Kimmeridgian time the sea in Oregon and California was restricted, presumably by rising land masses to the east, and during the remainder of the Kimmeridgian the Pacific Coast region was above sea level except for northwestern Washington.   During this time the older Jurassic beds in southwestern Oregon and in northern California were folded and metamorphosed.   Orogeny may have been accompanied by intrusions of some granitic batholiths.   In contrast, in northwestern Washington sedimentation continued throughout the Kimmeridgian into the Portlandian without any structural disturbance as far as known.

In middle to late Portlandian time a new marine trough appeared along the western margin of the Pacific Coast region as shown by fossils of that age in western California, southwestern Oregon, and northwestern Washington.   In this trough were deposited thousands of feet of terrigenous sediments that contrast markedly with the volcanic sediments that contrast markedly with the volcanic sediments that were deposited earlier in the Jurassic.   Deposition appears to have continued until the end of the Jurassic, but the absence of fossils of earliest Cretaceous (Berriasian) age in California and southwestern Oregon indicates that the sea withdrew briefly immediately after the Jurassic.


ROAD LOG: LOGDELL TO PINE CREEK*

Mileage

0.0	Junction of U. S. Highway 395 and road to Logdell.
(Begin Fig. 34)	
6.8	Logdell.
9.4	Siltstone and thin-bedded sandstone in road cuts in the upper part of the Snowshoe formation.
12.7	Wickiup Creek (check point).
13.0	Siltstone in road cuts in the middle part of the Snowshoe formation.
18.6	Tamarack Creek. Take trail up creek for approximately 1/2 mile. Thin-bedded sandstone, siltstone, and conglomerate in lower middle part of the Snowshoe formation. The Snowshoe formation traversed between these outcrops is a couple of thousand feet thick and is entirely of middle Jurassic (Bajocian) age. Return to road.
25.3	Road junction at South Fork of John Day River. Turn left and go up river 2 miles to axis of Lonesome syncline.

- -

* Compiled from report by Ralph W. Imlay.
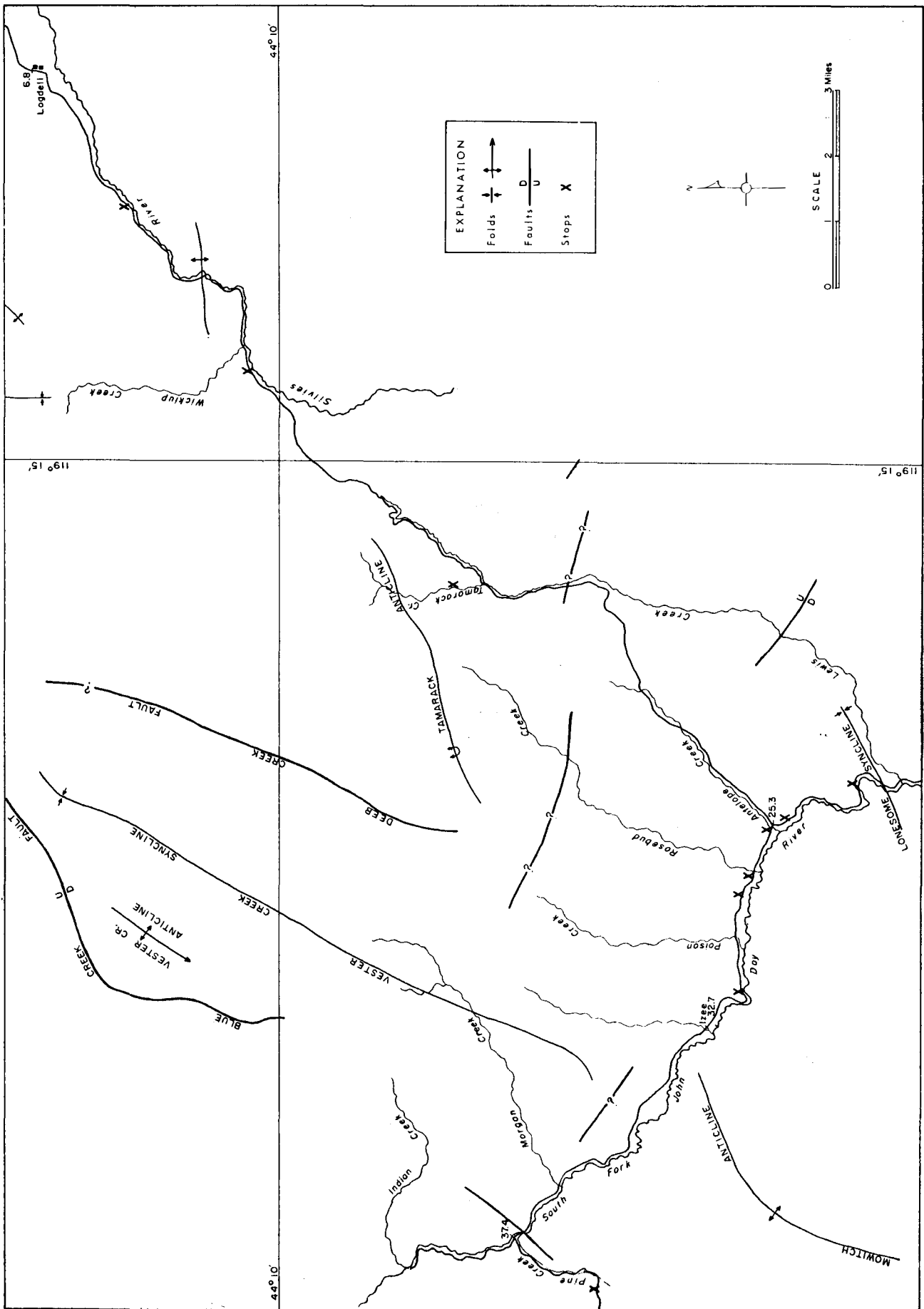
Figure 34

Mileage

25.5   Interbedded units of sandstone and siltstone in the lower part of the Lonesome formation.

27.1   Similar units in the upper part of the Lonesome formation. The formation is about 4,000 feet thick, is entirely of early Callovian age, and has been considered a typical Flysch deposit by a recent visiting geologist from Poland. It contains many markings that are reported to be characteristic of such deposits. These markings are well-exposed on a side road one-quarter of a mile long that enters the South Fork road at Stop 5. Turn around and head downstream.

29.0   Road junction (check point only) (same as mileage 25.3).

29.1   Boundary between the Lonesome and Trowbridge formations. The Trowbridge is much shalier and darker, is about 4,000 feet thick, and is of early Callovian age.

29.9   Trowbridge Ranch (check point only).

30.0   Submarine flow in Trowbridge formation crops out as a ridge former and indicates the complex folding present.

30.3   Note change in color of shale from black to gray at base of the Trowbridge formation.

31.0   Poison Creek (check point).

31.8   The Hyde formation (submarine volcanics) is about 1,500 feet thick and lies within a sequence of Toarcian age (late early Jurassic). Between mileage 30.0 and 31.8 are poor exposures of the Snowshoe formation. These are several thousand feet thick and range in age from late Toarcian to early Callovian.

32.7   Izee.

36.4   Morgan Creek (check point).

37.4   Pine Creek. Turn left.

39.3   At junction of Cow Creek and Pine Creek are excellent exposures of the Robertson formation (Plicatostylus beds), the Suplee formation, and the basal part of the Nicely shale. These are of Pliensbachian and Toarcian ages (early Jurassic).

FIELD TRIP NO. 7

PICTURE GORGE TO PORTLAND VIA ARLINGTON
By
W. D. Wilkinson and John Eliot Allen

        This trip starts in Picture Gorge at the junction of U.S. Highway 26 and Oregon Highway 19. It goes north on Oregon 19 along the John Day River to Condon; continues north on Oregon 19 across the "Shaniko surface" to Arlington; then turns west on U.S. Highway 30 and follows the Columbia River Highway through the Columbia River Gorge to Portland. Total distance of trip is logged at 267.4 miles. For location of trip route, see Index Map of Central Oregon (at beginning of Trip No. 4: Prineville to John Day).
        Formations encountered between Picture Gorge and Condon are described under "Stratigraphic Sequence for Central Oregon" (see Trip No. 4: Prineville to John Day). Formations encountered between Condon and Arlington are discussed in the trip log. Formations along the Columbia River are described under "Stratigraphic Sequence for Columbia River Gorge Area," which will be found accompanying the road log for that part of the trip.

ROAD LOG: PICTURE GORGE TO PORTLAND VIA ARLINGTON

Mileage

0.00   Picture Gorge. Junction U.S. Highway 26 and Oregon Highway 19. Go north toward Fossil on Oregon Highway 19.

(Begin Fig. 35)

        Sheep Rock at 2 o'clock is a landmark in this area exposing brightly colored beds of the
(1.9)   John Day formation. For the next 10 miles, the rocks on both sides of the John Day River back to the cliffs are mainly landslide debris composed of Columbia River basalts and John Day tuffs mingled in utter confusion.

1.9   Historical marker: "This formation takes its name from the river named for John Day of the Astor overland party of 1811.
        "Famous the world over for their wealth of fossil bones, the colorful John Day beds were laid down in late Oligocene and early Miocene times, when volcanic ash choked the streams and filled lake basins.
        "Animals of both forest and plains were entombed. It was a varied fauna including bear, dogs, and giant cats. Rhino lived on river banks. Tiny camels and three-toed horses were abundant. Their bones are buried here and brought to light by erosion, illustrating one chapter of the story of Oregon's ancient past."

        At 12 o'clock Sheep Rock dominates the foreground. The top is capped by four flows of Columbia River basalt. The lower flows are separated by interbeds of tuff showing that the John Day ash fall continued into the period of Columbia River basalt extrusion. The basalts overlie about 1500 feet of varicolored tuff beds. Red beds are considered the lower part of the John Day formation, green beds middle, and cream the upper. A brown welded tuff layer crops out about half way up the side of Sheep Rock. The reference to lower, middle, and upper John Day is more one of convenience, as Coleman (1949), Schultz and Falkenberg (1949), and others have found no stratigraphic or biogenic break throughout this section. The welded tuff layer is offset 50 feet by a north-dipping normal fault. At 3 o'clock looking south, John Day beds dip southward finally disappearing under the Columbia River basalts at the monolithic mass at the mouth of Rock Creek.

119°40'

Johnny Cr.

Dick Cr.

Squaw Cr.

⑲

X BM 2143

Middle Mtn.

Deer Gulch

Windy Pt.

N

John Day River

Sheep Rock

Waterspout Gulch

⑲

X BM 2233

🛡26 🛡26

PICTURE GORGE

Rattlesnake Cr.

BM X 2288

Cottonwood Cr.

Battle Cr.

119°40'

44°35'

44°30'

Qls Tcr Tjd Qal K Tm Trs

44°35'

44°30'

LEGEND

Qal	ALLUVIUM	Tjd	JOHN DAY	
Qls	LANDSLIDE	Tci	CLARNO INTRUSIVES	
Trs	RATTLESNAKE	K	CRETACEOUS	
Tm	MASCALL	pK	PRE-CRETACEOUS	
Tcr	CORIBA	⅄₁₃	STRIKE AND DIP	

0   .5   1   1.5   2 SCALE IN MILES
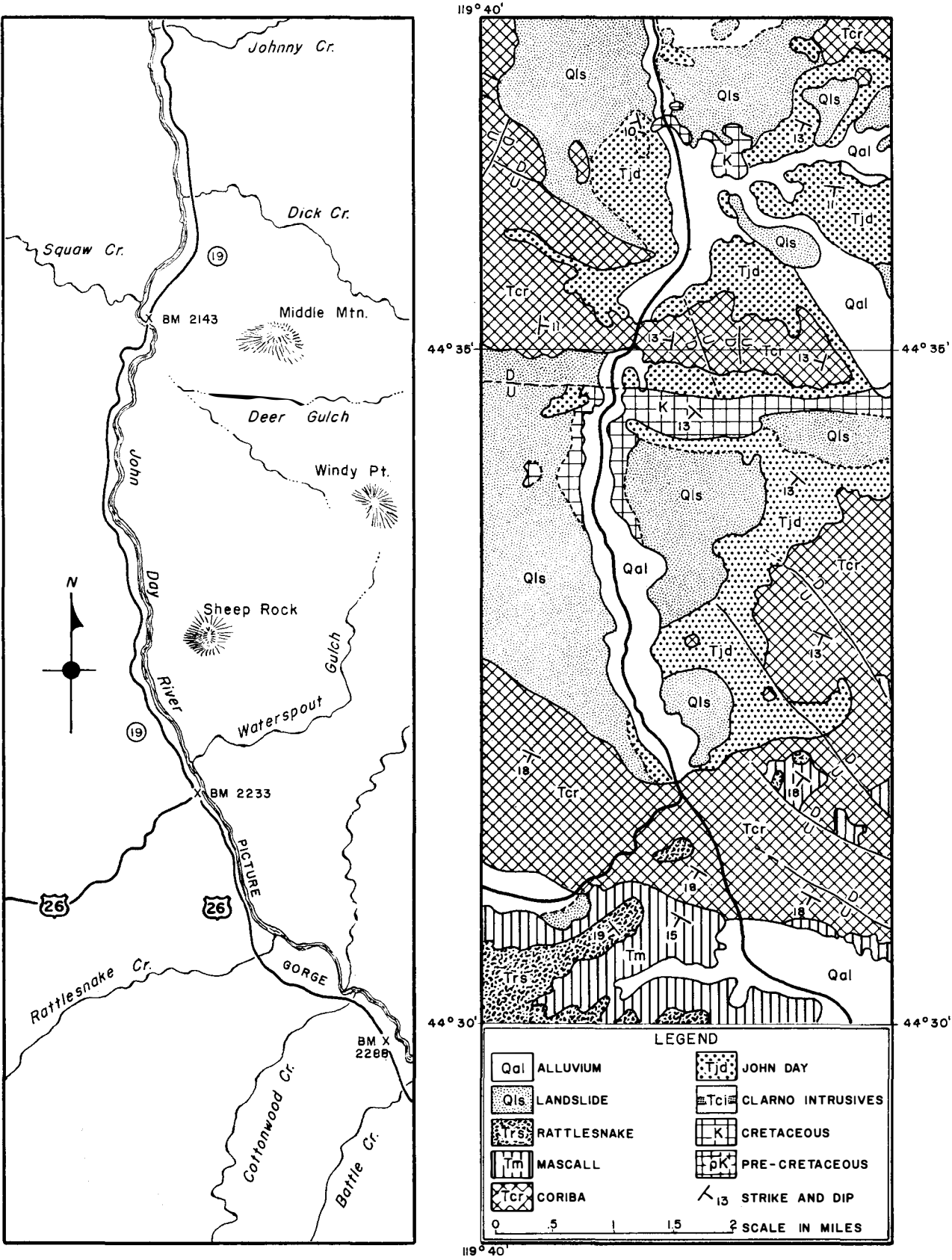
Coleman, 1949

Figure 35

Mileage

Above the monolith, the Rattlesnake formation mesa may be seen. This is the northern extent of the Rattlesnake welded tuff.

Throughout the entire circle the low hills are landslides.

At the viewpoint the monument to the pioneer geologist, Dr. Condon, is mounted on a block of Cretaceous conglomerate from near the Humphrey Ranch located about 3 miles north.

At 9 o'clock the last outcrop of Cretaceous appears low in the river valley. Evidence of faulting may be seen in the change in altitude of the outcrops of Columbia River flows on the ridge in the distance. Also in the background numerous flows of basalt can
(0.6)   be seen in Middle Mountain overlying green John Day tuffs.

2.5   At 9 o'clock Cretaceous sandstone and conglomerates crop out in the road cut. No invertebrate fossils have been found in these beds. But some leaf imprints have been
(1.0)   discovered.

These rocks are exposed in a narrow strip along the valley of Deer Gulch eastward for about 4 miles. They are massive highly indurated conglomerates and sandstones. Quartzite pebbles are most abundant but andesite, granite, diorite, and basic igneous rocks have been observed in lesser amounts.

3.5   Middle Mountain to the north is composed of a series of Columbia River basalt flows. The relationship between the Cretaceous at Deer Gulch and Middle Mountain is that of an
(0.7)   east-west trending fault and places Middle Mountain on the down-dropped side.

4.2   John Day bridge at Humphrey Ranch. Highway crosses to east side of John Day River. John Day welded tuff at 10 o'clock. The relation of the Columbia River basalt to the underlying John Day may be seen. The variation in the thickness of the Columbia River basalt is evident. The basalts poured out over an erosional surface consequently they are thin where they crossed the top of John Day hills and thick where former valleys existed. Where the thin basalt has been cut through there has been a reversal of topography since John Day times. The valley fill reveals a white friable ash from the Newberry
(0.7)   Crater eruption.

4.9   Culvert. This creek drains Turtle Cove. Turtle Cove is of historic interest for it was here in 1869 that Dr. Condon collected vertebrate material, including abundant carapace of turtle for which he named the cove. Oreodont bones and skulls also fascinated Dr. Condon; fragments of such bones may still be collected in the spring of the year after winter rains
(0.9)   have exposed new material.

5.8   At 1 o'clock the brown scraggy outcrop is a pre-Cretaceous schist probably of Paleozoic
(0.3)   age.

6.1   Quartzite breccia which is a part of the older rock series. This is the most northerly
(1.1)   outcrop known of these older rocks in Oregon.

(Begin Fig. 36)

7.2   Castle Rock at 11 o'clock. Buff John Day tuff and welded tuff exposed in colorful cliffs,
(2.3)   commonly photographed from this point and in morning light makes an excellent Kodachrome.

9.5   At 12 o'clock. Pediments in the John Day formation may be seen on the west side of the river. Such pediments will be a feature of the valley for the next several miles. The surfaces of the pediments have a thin layer of gravel lying on the John Day tuff. The
(1.0)   gravels are almost entirely Columbia River basalt.

10.5   Good outcrop of gravel typical of that covering the surface of the pediments.
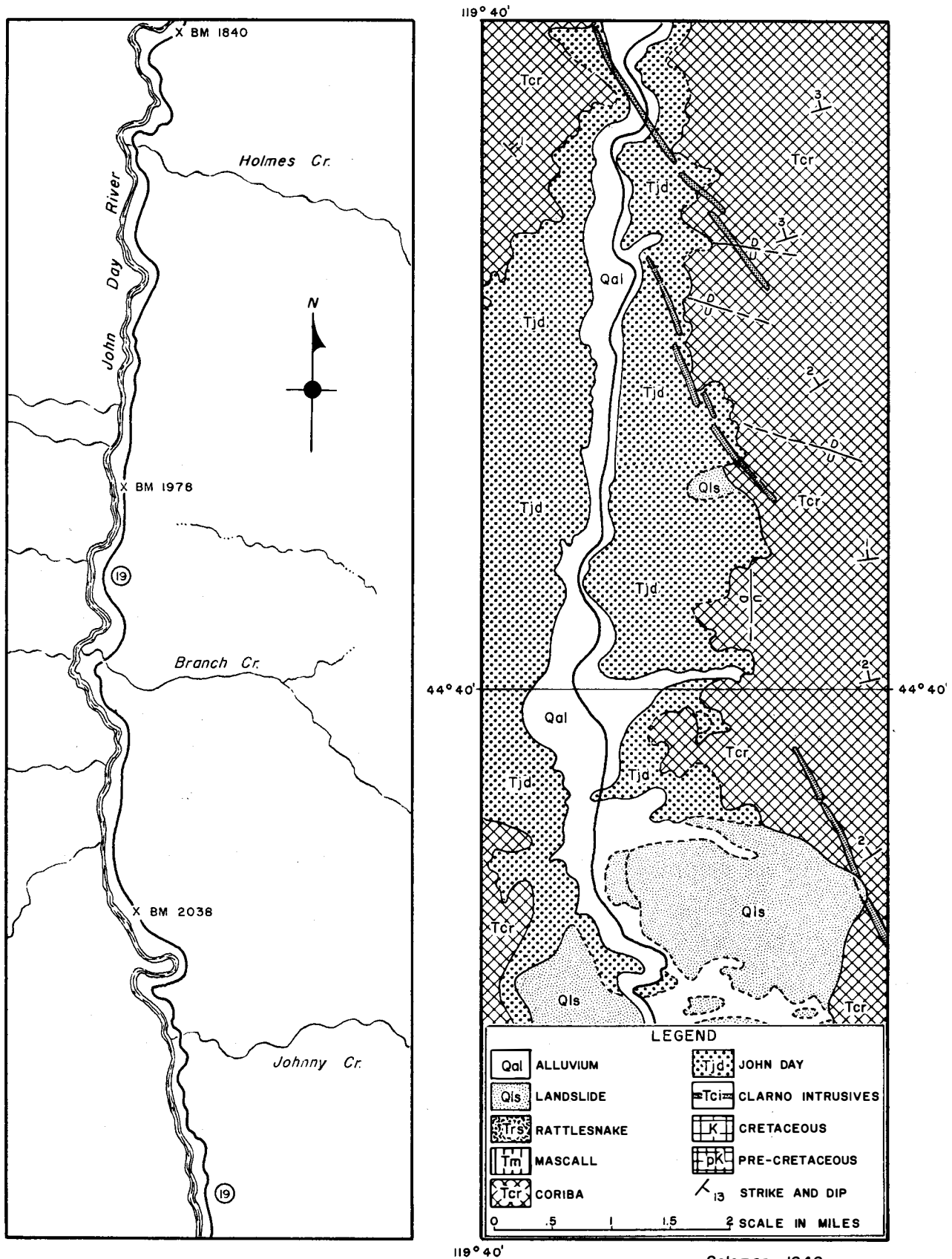(5.9)

Figure 36

Mileage

16.4 The Kimberly dike which here is about 25 feet wide and strikes N. 35° W. for a distance of approximately 4 or 5 miles. It fed one of the numerous flows of Columbia River basalt. Dikes of this sort are considered to have been the principal source of the many flows of Columbia River basalts. They may be observed in many places throughout eastern and central Oregon but are probably best displayed in the Wallowa Mountains of northeastern Oregon where they show beautifully in contrast to the older light-colored granitic rocks

(1.5) of that region.

(Begin Fig. 37)

17.9 North Fork of the John Day River.

(0.3)

18.2 Junction of road east to Monument. The traverse for the next 20 miles is generally west along Oregon Highway 19. Each of the small canyons debouching along the valley is characterized by alluvial fans of recent date. They are formed after flash floods which occur during the spring and summer months. Debris is deposited to depths of as much as

(1.8) 10 feet, covering the road and river terraces.

20.0 Small fan exposing 4 feet of Newberry ash which has already been noted several times. However, this is 110 miles airline from the source.

(0.4) At 12:30 o'clock continuation of the Kimberly dike on skyline.

20.4 Baloney Creek.

(5.1)

25.5 The traverse has passed through a broad syncline and is now entering an anticline structure. The axes of both structures strike northeast. As a result the John Day formation is exposed

(1.3) in the Spray basin. The basalts have retreated from the river.

26.8 John Day outcrop adjacent to the road. An excellent place to examine the tuffs. At 9 o'clock the axis of the Spray anticline may be seen.

(1.0)

27.8 Junction Oregon Highway 207 leading north to Heppner and the John Day Highway (Oregon 19). Continue west on Oregon Highway 19 toward Fossil.

(2.9)

30.7 Spray.

(Begin Fig. 38)

(7.6)

38.3 Note the increase in thickness of the basalts. The structure is synclinal, with the axis lying south of the river and striking approximately east.

(1.9)

40.2 "Hackly" jointing typical of some massive flows of the basalt. Amygdaloidal basalt exposed near road level is unusual in the Columbia River basalt series of flows. Zeolites and quartz fill the vesicles. Such zeolite filling of cavities and joints is usually asso-

(3.1) ciated with Eocene lavas.

43.3 Service Creek. Junction of Oregon Highway 207 to Mitchell. Continue west on Oregon

(0.2) Highway 19 toward Fossil.

43.5 Service Creek post office and store.

(3.0) (End of maps)

46.5 John Day beds are rising into a major anticlinal structure. The anticline axis trends north toward Fossil, but at Fossil it turns to the northeast and continues on this course across the

(2.9) north half of the Spray quadrangle.

Figure 37

44° 49'

Canyon Creek

1746
BM X

Note; Read from top
to bottom.

Long Hollow

N

⑲

Horseshoe Creek

X BM 1710

Juniper Canyon

John Day River

Butler Mountain

Creek

Rollin Creek

Juniper Ridge

X BM 1703

Muleshoe Cr.

Muleshoe Mtn.

⑲

Service Cr.

Pine Canyon

Tcr

3

2

10

5

119°55'

3

Tcr

5

10

Tjd

15

5

10

Tcl

8

10

16

30

30

120°00'

119°55'

120°00'

44° 49'

LEGEND

Qal	ALLUVIUM		Tjd	JOHN DAY
Tcr	CORIBA		Tcl	CLARNO LAVAS
	SYNCLINE		10	STRIKE AND DIP

0   0.5   1   2 MILES
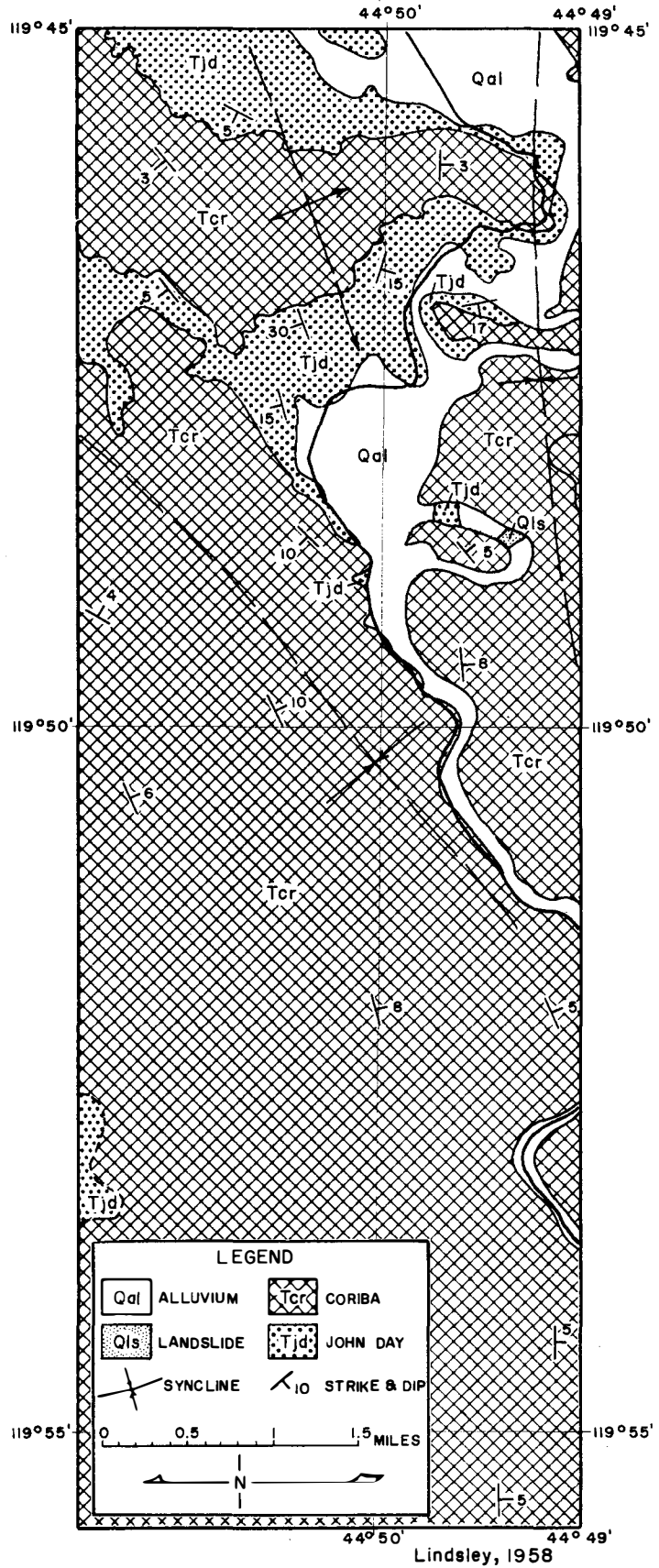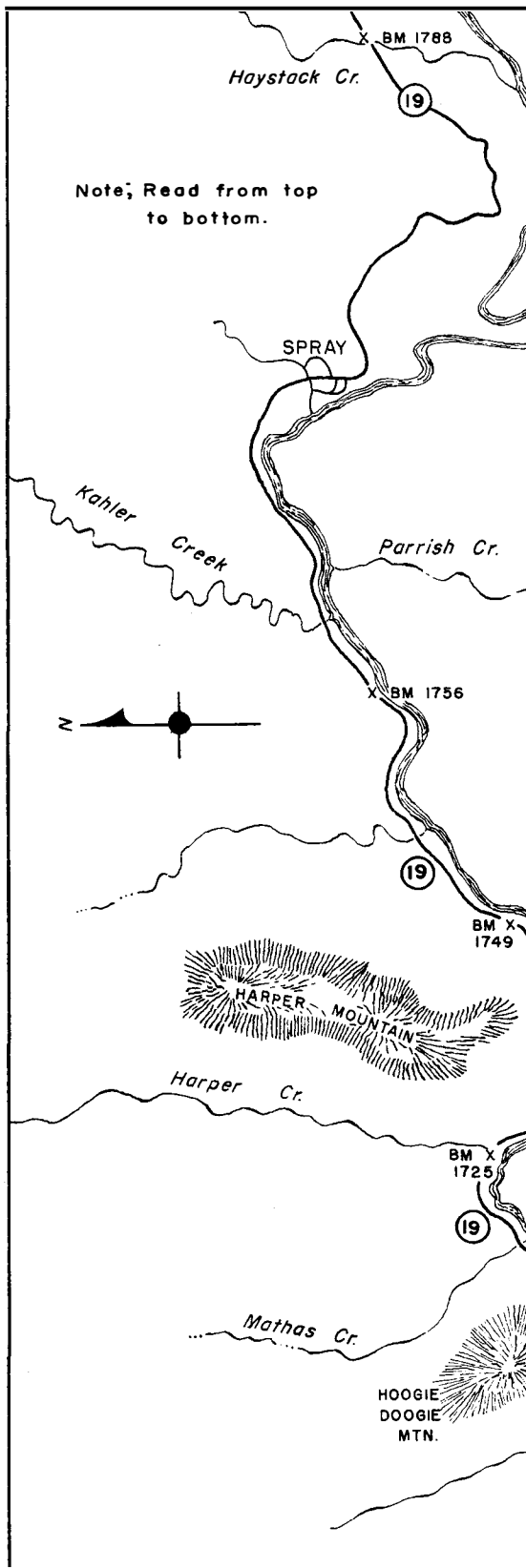
N
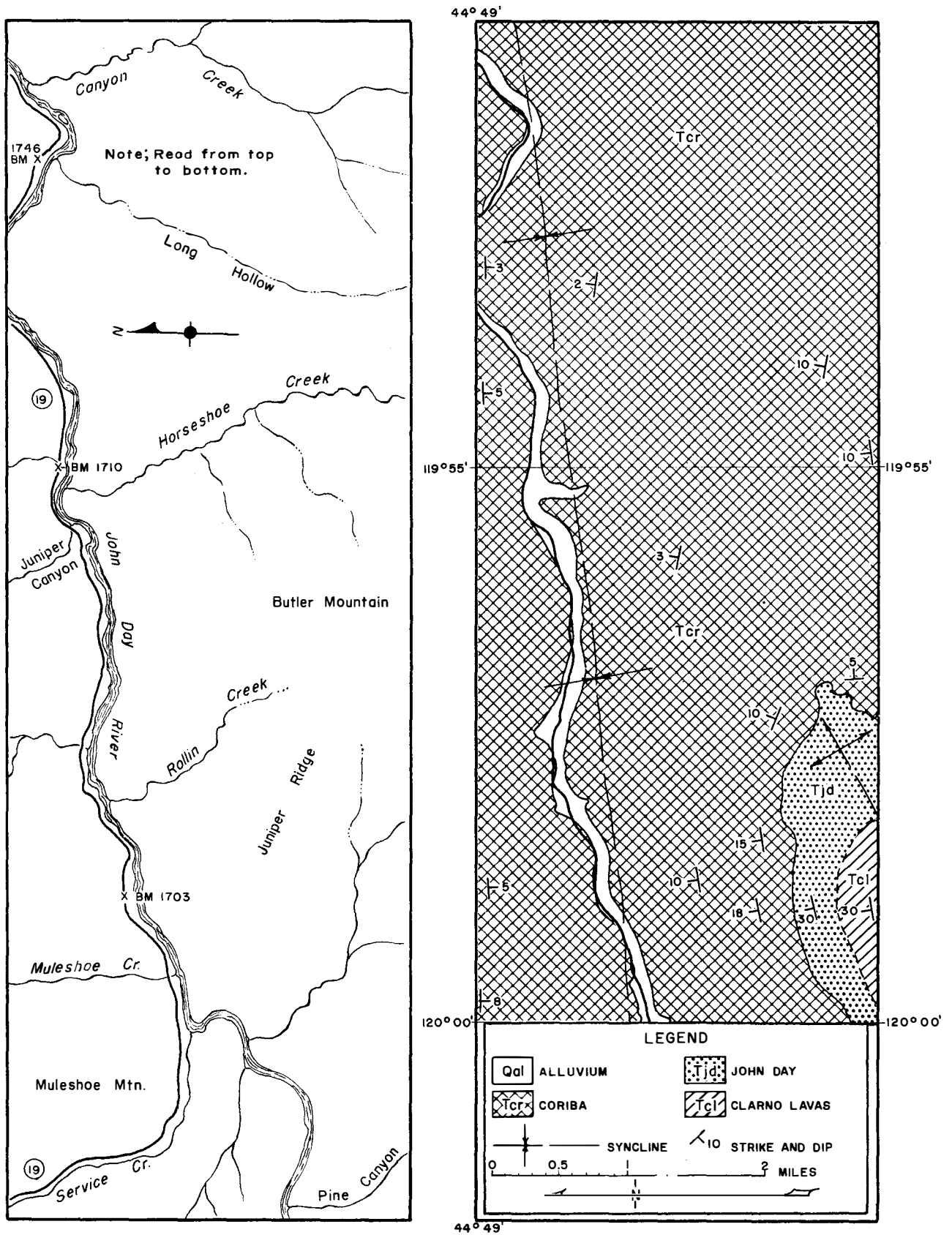
Figure 38

Mileage

49.4   John Day red beds exposed in Creek valley. This is near the base of the John Day forma-
  (0.7) tion. The traverse is down the section through the eastern limb of the Fossil anticline.

50.1   In the road cut at 3 o'clock, a wide dike of Columbia River basalt cuts the John Day tuffs.
  (0.6)

50.7   Clarno basalt and volcanic breccia form the center of the structure.
  (0.6)

51.3   Outcrop of Clarno volcanic breccias and basalts.
  (0.9)

52.2   At 12 o'clock Rancherie Lookout. The conical peak is a Clarno hornblende andesite plug
        which is the remanant of an Eocene volcano out of which the flows and breccia of the
  (1.5) immediate area were extruded.

53.7   Summit. Elevation 3847. Clarno andesites and greenish volcanic breccias.
  (5.6)

59.3   Kinzua junction. Continue on Oregon Highway 19. At 1 o'clock the Columbia River
        basalt overlying John Day and Clarno forms the dip slope of the north limb of the Fossil
  (3.2) anticline.

62.5   Fossil. Entrance to town. Follow Oregon Highway 19 through town.
  (0.5)

63.0   Junction, Oregon Highway 218 west to Clarno. Continue on Highway 19. Highway 218
        leads to the famous leaf, nut, and mammal beds at the type locality of the Clarno formation
  (4.6) about 18 miles southwest.

67.6   Last outcrop of the John Day formation on Oregon Highway 19.
  (0.3)

67.9   Cummings Pass. Elevation 3366. Highway passes over Columbia River basalt north to the
        Columbia River and west to Hood River, except for the limited local basins in which Plio-
  (2.8) cene and Pleistocene gravels have accumulated.

70.7   Mayville check point.
  (7.4)

78.1   Undercut in stream valley. Excellent fine-textured Columbia River lava.
  (4.9)

83.0   Condon. This is the beginning of the eastern Oregon wheat belt. From here north to the
        break of the Columbia River, wheat is grown on the rolling upland surface. This surface
        is not a plain, however, but is deeply incised by youthful box canyons that are not visible
  (2.0) from this vantage point.

85.0   Right turn on Highway 19.
  (0.1)

85.1   Left turn to Arlington on Highway 19.
  (1.1)

86.2   Crest of ridge. Highway passes over the little-eroded original upper Miocene surface
        of the Columbia River basalt, known locally as the "Shaniko surface" named after a small
        town to the west of the John Day River. The Shaniko surface is gently rolling, and is
        incised only by the youthful canyons of the John Day River and its tributaries. It dips
        from here about 4° to the Columbia River to the north, where it is folded and faulted, as
  (7.0) will be seen.

93.2   Gwendolyn. Check point.
        The trip route is now well into the Columbia River basin, which is the largest lava plateau
        in North America. It is entirely underlain by Columbia River basalt. The basalt covers

Mileage

more than 150,000 square miles. Its thickness varies from about 2000 feet up to possibly 10,000 feet in the center of the basin in southeastern Washington, where a recent well is reported to have penetrated 10,000 feet without going through the basalt.

Although structurally and physiographically a basin, it is folded in broad warps, which in south-central Washington trend a little north of west. Folding is best developed around the periphery, as might be expected.

Undoubtedly the basining originated in middle Miocene time as the basalts were being extruded. With a specific gravity over three times that of ice, a 2000-foot section might be expected to produce subsidence as great as that of a mile of ice.

(8.3)

101.5   Road cuts on the east slopes of the upper courses of the canyons expose wind-blown sand
(1.4)   and ash deposited by the prevailing southwesterly winds.

102.9   Mikkalo junction. Entering Juniper Creek Canyon, one of the tributaries of Rock Creek,
             which will be crossed in a few miles.
(2.8)

105.7   Rock Creek bridge.
(1.3)

107.0   Heppner junction.
(0.2)

107.2   Gravels in road cut on right, overlain by caliche at about 1300 feet. This is the southern
             extent of the Shutler formation, formerly called Arlington lake beds. Hodge (1932) con-
             sidered the name "Shutler" to be more appropriate. Formation is composed of water-worn
             gravels in the lower part, overlain by lake beds, overlain in turn by more gravels, and
             lying in a basinal area adjacent to the Columbia River and east of the Deschutes River.
(4.5)   The Shutler formation interfringes westward with the Dalles formation (Hodge, 1942).

             Moraine-like deposits and ice-rafted glacial erratics were emplaced in this area
             during a period of glacial ice jamming which produced ponding. The lake thus formed
             spilled over into Alkali Canyon and thence by way of the John Day River into the Columbia
             River. Bretz (1925) shows an area of ponded water extending east from Arlington to Umatilla,
             and a slight ponding from Arlington west to The Dalles.

111.7   At 9 o'clock, quarry in torrential unbedded and poorly sorted gravels. Note caliche at
(3.2)   contact of gravels and silts.

114.9   Historical marker: "At this point the Oregon Trail crossed from east to west. First trav-
             eled in 1884 by W. W. Weatherford, who settled 5 miles south of here."
(0.8)

115.7   At 8 o'clock Alkali Canyon. It formed a spillway channel for glacial floodwaters from
             the east into Rock Creek 7 miles to the west, thence into the John Day River Canyon.
             The divide area is more than half a mile wide at an elevation of more than 700 feet. In
             the next 10 miles, many spillway channels, some of them with scabland topography, were
(2.8)   carved by the floodwaters from the east, flowing into this canyon, and thence to the south.

118.5   At 3 o'clock scabland basalt crops out.
(0.4)

             Bretz defines channeled scabland as the eroded surface of the Columbia basalt formation.
             It is bare rock or is but thinly covered with basaltic debris. Basins excavated in solid
             basalt are common. Stream gravel, 99 percent basalt, occurs in all scabland tracts.
             Except rarely, it does not occur in terraces, nor does it cover the floors of channels.
             It is deposited in great rounded mounds on the lee side of basalt knobs and elongated
             with the channels. These gravel deposits are interpreted as bars made by glacial rivers.
             Finally, above the level of the scabland and associated deposits is a deep mantle of
             loess on the plateau

Mileage

118.9

    (1.4)

At 3 o'clock thick section of torrential gravel with indistinct foreset beds dipping steeply west. These beds cascaded over the crest from the east to form a thick deposit exposed for the next mile on the right of the Highway.

120.3

    (1.8)

Cut at right exposes lake beds of Shutler formation. Low terraces on right are lake beds about 100 feet above the river.

122.1

    (0.2)

Entering Arlington.

122.3

    (0.5)

Junction with U.S. Highway 30. Turn left and then right through town.

122.8

    (7.9)

Alkali Gulch bridge. Large landslide across the river at 3:00 o'clock. In order to understand the physiography of this area, the structure and history must be summarized. The river flows along the synclinal axis where the gently north-dipping Columbia River basalts are folded (and in places faulted) by the Columbia River monocline. The skyline to the north is higher than the surface to the south. The Spokane floods reached an elevation of at least 1000 feet above the river and the scouring of the basalt with high-level gravel filling in protected reentrants (nearly every tributary canyon) is a prominent feature.

130.7

    (4.5)

Blalock. Note gravel terraces up Blalock Canyon to the south, and at 2 o'clock across the river in reentrant on skyline.

135.2

    (2.1)

Large gravel deposit in mouth of canyon at 3 o'clock.

(Begin side trip)

137.3

    (1.3)

Phillipi Ranch road. Turn left off Highway.

138.6

    (0.1)

Phillipi Ranch junction. Keep right. At elevation 750 feet, this spillway channel from the Columbia River debouched into the John Day River to the west.

138.7

    (1.7)

Characteristic scablands on left.

140.4

Phillipi Ranch viewpoint, elevation 1300 feet. From this viewpoint may be seen much of the evidence for a "Columbia River fault" as described by Hodge (1931). The surface under foot and extending to the southern horizon was designated by Hodge (1931) as the Shaniko surface, a plateau determined by Columbia River basalt and a true expression of the underlying strata. It extends regularly to the foot of the Columbia scarp against which it abuts. While broad gentle warps may be observed, the regional dip is generally northwest and the dip continues in the exposures north of the river. The north dip slope of the Shaniko surface continues to the foot of the Columbia River scarp which rises abruptly along the north edge of the Shaniko surface. The view north from this viewpoint shows three blocks, cut by two "V"-shaped stream valleys, which represent the continuation of the Shaniko surface abutting against the scarp. These blocks are a part of the fault mosaic. Another block much lower at Roosevelt may be seen on the north side of the river opposite Arlington. Due north a block designated as Towal block, is tilted to the east. Evidence of a recent lava flow which presumably crossed the river at Quinton immediately below the viewpoint may be seen west of Towal block. Its brecciated surface is easily recognizable. Creeks crossing the scarp and down-dropped blocks have developed since the faulting.

    Additional evidence for faulting may be seen farther west. This includes more blocks, truncated or faceted spurs, and the abrupt ending of the scarp where it is cut off by the Ortley anticline west of The Dalles.

Mileage

The trip to Phillipi Ranch viewpoint and return is 8.0 miles.

148.4   U.S. Highway 30. Turn left toward The Dalles.
   (2.6)

151.0   Outcrop of volcanic breccia at 9 o'clock, which was eroded to form Quinton surface.
   (1.8)

152.8   Sharp pinnacles across river at about this elevation from 12 to 2 o'clock. It has been
          suggested that these are either intrusions along the Columbia River fault or cemented
   (2.7) fault breccias.

155.5   Note faceted spurs at 3 o'clock.
   (1.6)

157.1   John Day River. Historic Marker: "Named for a member of the Astor party which came
          overland in 1811 and 1812 to build a fur-trading post at Astoria at the mouth of the
          Columbia. After wintering with Indians on the Snake River, John Day and Ramsey
          Crooks were robbed of their clothing and arms by Indians at the mouth of this river
          while attempting to overtake the main party. They wandered naked for weeks before
   (1.5) being rescued."

158.6   At 2 o'clock, break in skyline probably represents course of Columbia River fault of
   (1.0) Hodge (1931).

159.6   Site of John Day Dam, now under construction. Slack water of The Dalles Dam (20 miles
   (2.2) downstream) below this point.

161.8   Entering Rufus.
   (1.8)

163.6   Junction with U.S. Highway 97 to Maryhill, Washington.

          At 3 o'clock concrete replica of Stonehenge built by Sam Hill, railroad mogul. At
          1 o'clock is Maryhill mansion, also built by Hill and dedicated by Queen Marie of
   (2.3) Roumania on her visit to the United States. It is now a State museum.

165.9   Biggs junction, U.S. Highway 97 south to Wasco and Bend.
   (0.4)

166.3   Entering Biggs.
   (0.7)

168.0   Maryhill at 3 o'clock. Note truncated gravels above and to left.
   (1.8)

169.8   Fulton Canyon junction to Wasco.
   (2.0)

171.8   Deschutes River. Historic marker: "The Oregon Trail crossed the hazardous river at this
          point by floating prairie schooners, and swimming the livestock. An island at the river
          mouth was often utilized when the river was high and the ford dangerous. Pioneer women
          and children were frequently ferried across the stream by native canoemen, who made
          the passage in exchange for bright colored shirts and other trade goods."
                Near the turn of the century the island referred to above was panned by Chinese
          laborers and small amounts of gold were recovered. As recently as 1918, a wooden toll
   (1.7) bridge upstream 3 miles was maintained by a pioneer Scotsman named Moody.

173.5   Note thick dissected high-level gravels at 3 o'clock.

   (1.4) Wishram at 2 o'clock.

Mileage

174.9   Celilo Indian village.   The Celilo Falls of the Columbia were located here before they
were drowned by The Dalles Dam. This was where, from time immemorial, Indians fished
for salmon with dip nets from the rocks above the narrow channel. Large damages for
loss of fishing rights guaranteed by an early treaty were paid by the government. The
falls were originally by-passed by portage, then by a portage railroad, later by a canal,
   (0.8)   which was built at a cost of about 6 million dollars.

175.7   Well-defined terrace gravel deposits across river. Landslide block at 2 o'clock. Note
   (1.2)   hoodoos on cliffs above highway.

176.9   Course of old canal and highway can be seen at lake level.
   (0.4)

177.3   Sand dunes on left. Barchans along here in the early 1900's were photographed by the
   (1.4)   United States Geological Survey and were used as illustrations in several textbooks.

178.7   Note south-dipping scabland basalts from 12 to 2 o'clock, on north limb of the Dalles
   (1.5)   syncline. Mount Hood at 12 o'clock.

180.2   The Dalles Dam (rock fill at this end).
   (0.4)

180.6   Dam entrance. Note south fish ladder and generator plant. Spillway, locks, and north
   (0.8)   fish ladder are at north end.

181.4   Road to viewpoint.
   (0.5)

181.9   Junction of U.S. Highway 197 to Bend.
   (0.3)

182.2   Pillow lavas in quarry and road cuts on left. These are considered to be proof of sub-
aqueous lava flows. The yellow material between the pillows is altered glass called
palagonite.

              Entering The Dalles.

(Road Log to be continued.)
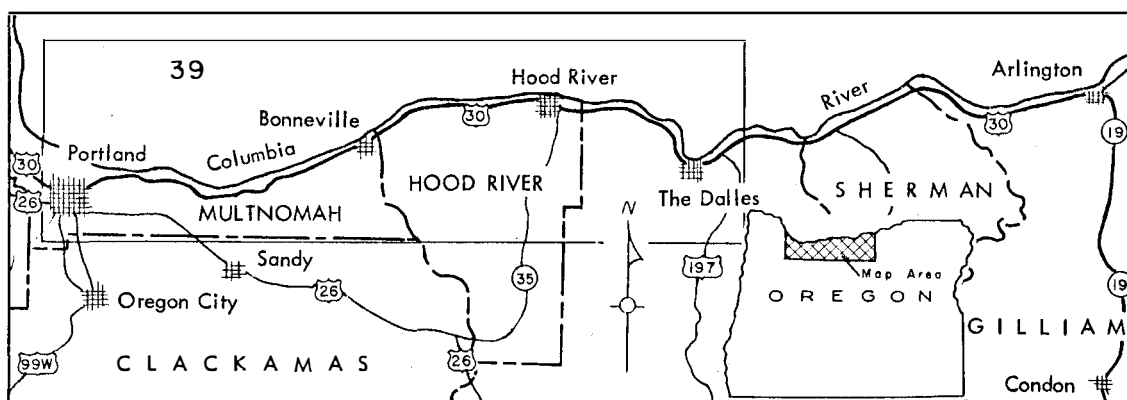
Index map of Columbia River area showing route of trip and position of
geologic map accompanying road log.

STRATIGRAPHIC SEQUENCE FOR COLUMBIA RIVER GORGE AREA

RECENT

Alluvium: Sand and silt in Columbia and Willamette rivers and their tributaries.   Seldom rises above 50 feet elevation.   Some sand dunes.

Terrace deposits: Sand and silt in abandoned channels and benches above the 50-foot elevation.

PLEISTOCENE

Alluvium: Fine sand and silt overlying lacustrine deposits, mostly finely stratified, locally cross-bedded.   Found up to 350 feet in elevation.   Contains some erratics (ice-rafted?).

Lacustrine or estuarine deposits: Unconsolidated deposits of gravel, sand, silt, and clay, especially in the Portland area, which once filled the basin to an elevation of 350 feet, and is now eroded in a series of terraces at 275 feet, 200 feet, and below.   Contains widespread angular erratic boulders.   Deposited in a ponded area around Portland during late Pleistocene by the torrential waters of the "Spokane floods".   Contains boulders up to 7 or 8 feet diameter.   These are the deposits of the "Portland Delta".

Loess: Buff, clayey sandy silt, which mantles the hills west of Portland above an elevation of about 600 feet, conforming to the topography.   Probably middle Pleistocene in age, but may be older.

PLIOCENE OR PLEISTOCENE

Boring lava: Light gray diktytaxitic olivine basalt, scoria and cinders from local vents.   Fills valleys in Troutdale formation, or forms shield or cinder volcanoes upon Troutdale surface, in Portland area.   In gorge, shield volcanoes of similar composition and degree of erosion and weathering may lie in valleys cut in Columbia River basalt (Underwood Mountain and Lost Lake Butte).

Cascade andesite: Light-colored andesite, basalt, and trachyte of many kinds and varieties, and associated minor pyroclastics composing the wide shield volcanoes which cap the Troutdale and Columbia River basalt south of the gorge, but do not extend far north of the gorge.   Flows are generally thin (less than 50 feet) and initial dips are low.   Beacon Rock, Wind Mountain, and Shellrock Mountain may be feeders to these flows.   Nesmith Point is a dissected cone exhibiting its vent.   These volcanoes are pre-dominantly Pliocene in age, but some of them, such as Mt. Defiance and Larch Mountain, may be early Pleistocene.

PLIOCENE

Dalles-Troutdale formation: Mudstone, sandstone, and conglomerate representing a lower Pliocene basin fill in structural depressions and tributary valleys on the Columbia River basalt and Rhododendron agglomerates.   Underlies most of the Portland Basin, occupies a large area around The Dalles, and is found in the south wall of the lower gorge occupying valleys cut in the basalt.   The basal mudstone member (300 feet thick) is found south of Portland; in the gorge only the upper conglomeratic member appears, with a maximum thickness of 750 feet above Bridal Veil.   Percentage sampling at fifty localities (Allen, 1932), involving a count of 1500 pebbles, showed that the average composition in the gravelly phase of pebbles below 3 inches in diameter was 40 percent basalt, 30 percent quartz, and 30 percent andesite.   Size range was as follows: Boulder beds with sizes above 6" 11%
Boulder beds with sizes from 3 to 6" 11

Pebble beds with sizes below 3"   27
Beds of pebbly grit   9
Beds of clear grit   33
Beds of tuffaceous sandstone   9
Beds of clay or fine tuff   1

Rhododendron formation: East of Tanner Creek to beyond Herman Creek (about 8 miles) the interval between the Columbia River basalt and the Cascade andesite is occupied by beds of tuff, cinders, and agglom erate. Maximum thickness is 600 feet. Similar rocks occur extensively to the south and west in Bull Run River, where they are overlain by Troutdale formation, although the explosive volcanism which produced them may have been in part contemporaneous.

MIOCENE

Columbia River basalt: Dense black, glassy, low-olivine basalt, in flows up to several hundred feet in thickness totaling 2,100 feet in the gorge. Includes soil zones between flows, pillow lavas at Crown Point and west of Hood River. West of Hood River, the basalt does not extend beyond 10 miles north of the gorge, and the total areal extent of basalt is less than 50 square miles.

OLIGOCENE TO MIOCENE

Eagle Creek formation: Poorly sorted volcanic sediments; agglomerates, breccias, conglomerates, tuffs, and some interbedded thin lavas. Largely torrential and mud flow, some lacustrine origin, Source from at least two vents north of gorge, where Eagle Creek formation rises to 4,200 feet elevation in Big Huckleberry Mountain. More than 90 percent of the unit may be classified (Allen, 1932) into five types: 1. dense, fine-grained tuffs, 2. coarse tuff-breccia, 3. crystal grit to fine-grained breccia (1 to 5 mm), 4. boulder conglomerate (1" to 5' boulders), 5. tuff to fine-grained tuff conglomerate, pebbles less than 1 cm. Lower Miocene and possibly upper Oligocene in age.

SEQUENCE OF EVENTS

1. Accumulation of volcanic debris from Eagle Creek volcanoes, ash falls, mud flows, and fluvial debris, from volcanoes north of gorge.

2. Outpouring of Columbia River basalt flood, lapping around the Eagle Creek volcanoes and cover- ing the bajadas extending from them towards the south. Long time-intervals between flows, some of which were subaqueous.

3. Period of long-continued erosion to a mature surface. Extensive weathering in western Oregon of this surface with production of laterites and deep soil profile.

4. Invasion of area by ancestral Columbia River, depositing Dalles or Troutdale mudstones, siltstones, sandstones and conglomerates as a basin fill of a wide area. Folding of the area was probably initiated during and continued after Troutdale time, since the formation rises to elevations of over 2,400 feet in the center of the gorge, yet forms the main part of the fill of the Portland Basin, to depths of at least 1,000 feet below sea level. According to Hodge (1938) the ancestral aggrading river flowed through a structural downwarp to the south of its present course.

5. Pouring out of lavas from shield volcanoes of Cascan-Boring age. Hodge believes that the river maintained its southern course until Pleistocene times, when Mt. Hood and other Pleistocene volcanism diverted it to the north around the main area of Cascade lavas, temporarily forming "Lake Condon" in central Oregon. This is the "consequent" theory of origin for the present course of the channel.

6. Rapid down-cutting, largely in soft Eagle Creek formation, of the gorge as Lake Condon drained. Erosion of much of the lake deposits and the Dalles formation. Superposition of the stream across Windshell intrusive (Wind Mountain-Shellrock Mountains), dissection of Nesmith volcano, and steepening on the south side of the gorge as a result of numerous landslides in soft Eagle Creek sediments from the north, forcing the stream to the south, with undercutting of the basalt.

7. Eruption of late Pleistocene volcanoes north of the gorge, producing intracanyon flows which filled the gorge to elevations of over 900 feet at Wind River, forming the high bench across the mouth of Herman Creek east of Cascade Locks; and 600 feet opposite Little White Salmon River. Underwood Mountain, north of Hood River, temporarily dammed the river to at least 1,300 feet, and a later flow down the White Salmon River had a surface elevation of about 500 feet.

8. Ponding of the Portland Basin and Willamette Valley by eustatic rise in sea level (or damming of the lower Columbia) filled the basin to about 350 feet with lacustrine or estuarine sediments. Other evidences of these "Spokane floods," first postulated by Bretz (1917, 1925), in the area of the trip consist of the channelling around Rocky Butte, giant erratics in the Portland area and as far south as Eugene in the Willamette Valley, scabland channels at Oswego and farther southwest, floodwater bars along the Columbia Gorge hundreds of feet above present water level, scablands developed on benches high above The Dalles, the final oversteepening of the south wall of the gorge, and the stripping of most of the extensive intra-canyon flows from Wind, Little White Salmon, and White Salmon rivers.

9. Late Pleistocene and Recent terracing of the Portland "delta" deposits, Bonneville landslide (Bridge of the Gods), lowering of sea level to permit erosion to depth several hundred feet below sea level, and recent submergence.

CONTINUATION OF ROAD LOG

PICTURE GORGE TO PORTLAND VIA ARLINGTON

(Begin Fig. 39)   (C o l u m b i a   G o r g e   S e c t i o n)

Mileage

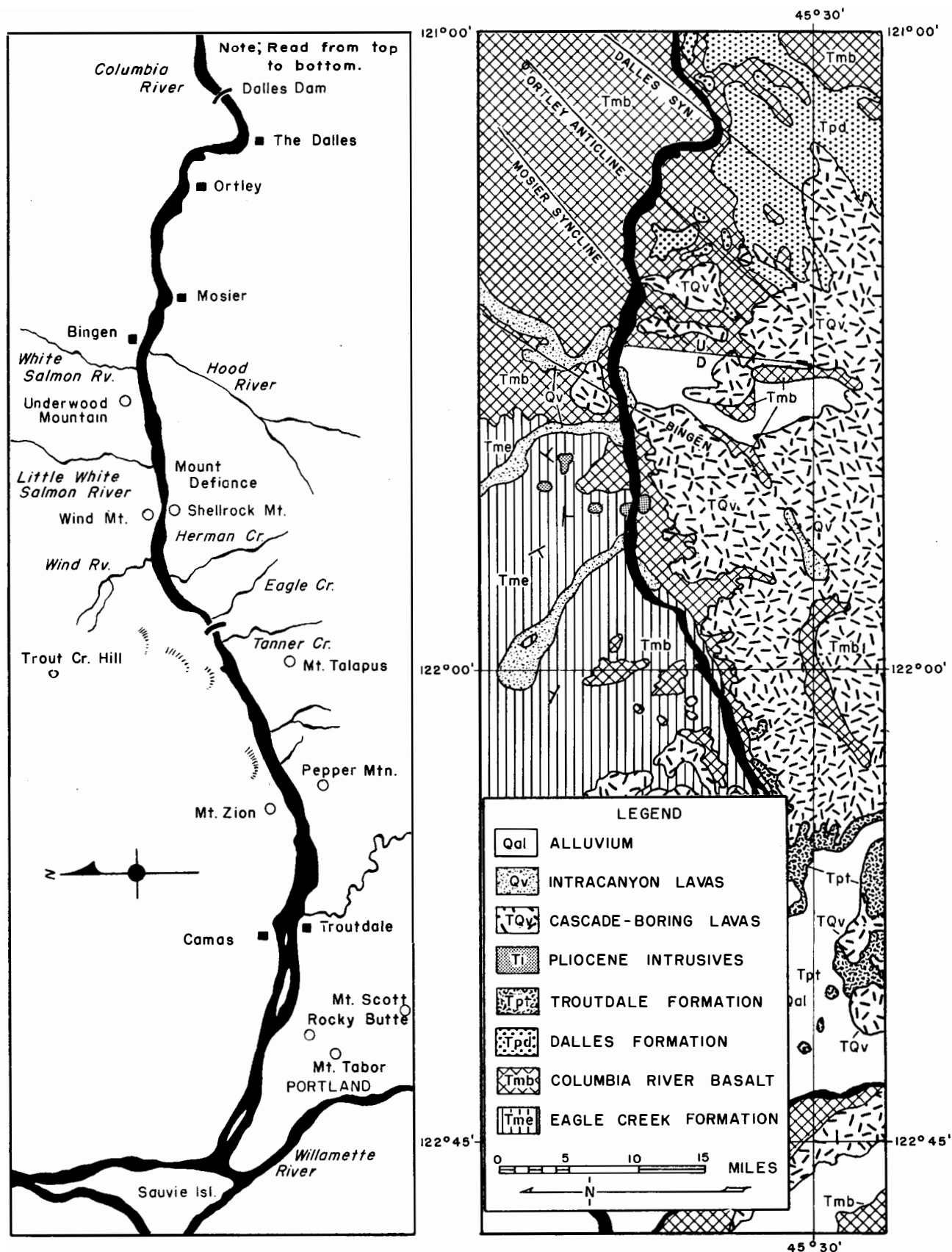|		
182.2		Entering <u>The Dalles</u>. The name was first used in Oregon by Franchere, in his 1814 narrative describing the Long Narrows of the river here, from the French word meaning flagstone gutter. The Dalles lies in a syncline in Columbia River basalt, originally filled with the Dalles formation, first described by Thomas Condon in 1874, as a remnant of an old lake bed. The beds were dated as Pliocene on the basis of vertebrate fossils, many of which were collected by Condon himself. The Dalles syncline originally filled with Dalles beds to an elevation of 850 feet near the river. Traced southward, the beds rise to 2,000 feet. Still farther south and west, they can be traced to an elevation of 3,000 feet before they are covered with Cascade lavas.
	(0.9)	
183.1		Union Pacific Depot and The Dalles Hotel
	(2.1)	
185.2		Harvey Aluminum Company plant at 3 o'clock; at 9 o'clock flat-topped cliffs of the Dalles beds. At 12 o'clock extensive area of landslide blocks and talus from west side of Dalles syncline in basalt.
	(0.7)	
185.9		Leaving The Dalles, keep left on U.S. Highway 30.
	(0.3)	
186.2		Scablands on both sides of Highway. Golf course on left underlain by flood gravels deposited on curve of big bend. Gravels exposed in quarries on right of Highway.
	(0.4)	

Figure 39

Mileage

186.6   Leaving scabland area, and entering west flank of Ortley anticline. The Dalles beds have
    (0.9)   been stripped off the crest of the anticline to the south, except for a few patches.

187.5   Approaching faulted axis of Ortley anticline, visible across river at 2:00 o'clock. Fault
             zone is occupied by a multiple fault or intrusive breccia forming vertical hogbacks. Drag
             on east side of fault suggests down drop on west. Axis of fold about $\frac{1}{2}$ mile east of fault.
    (2.4)   Note number of flows (at least 15) in cliffs at 3 o'clock.

189.9   Rowena. Old highway ascended to crest above the river by a famous series of loops
    (0.3)   across landslide area in basalt talus and blocks.

190.2   Bridge overpass. Note high gravel bar with pit at 3 o'clock across river.
    (1.6)
191.8   Entering southeast flank of Mosier syncline, the axis of which here lies across the river.
             Structural terraces on basalt scoured by floodwaters. Mouth of White Salmon River at
    (1.6)   3 o'clock.

193.4   Memaloose Island viewpoint. This was an Indian burial ground until 1957, when the
    (1.2)   graves were removed by the government.

194.6   Note high gravel benches from 8 to 12 o'clock, formed in lee of promontory to the east.
    (0.4)
195.0   Memaloose Island at 3:30 o'clock. Axis of Mosier syncline goes up valley at 4 o'clock
    (0.3)   and parallels river ahead.

195.3   Outcrop of gravels on left. Note scablands up to 500 feet above river on dip slopes
    (0.6)   across river.

195.9   Axis of Mosier syncline at 12 o'clock, parallels Highway. Landslides along Highway
    (0.7)   here continually in motion.

196.6   Mosier Creek bridge. Mazelike Indian fortifications appear on talus slopes at 10 o'clock.
    (1.3)
197.9   The fences along the railroad track for the next mile are designed to automatically set
    (1.2)   the block signals should large boulders break the wires.

199.1   Approaching Bingen anticline, named for hamlet at 2 o'clock. Dalles gravels continue
             over crest of anticline at 1400 feet elevation to the south of the Highway near Grand-
    (2.0)   view Hill. The base of the Dalles beds in the Mosier syncline is at about 350 feet elevation.

201.1   Cliffs and high bench across the river from 1 to 3 o'clock are lavas of olivine andesites.
             Source was a small intracanyon volcano of early Pleistocene age near the town of Under-
             wood, at 2 o'clock. These lavas unconformably overlie steeply dipping basalt a few
    (2.7)   hundred feet above river level.

203.8   Bridge across Hood River. Thick quartzitic gravels, probably equivalent to the Dalles
             formation to the east and the Troutdale formation to the west. These gravels rest upon
             west-dipping basalt at the east approach to the upper bridge (across the old highway)
             south of this point. U.S. Highway 30 crosses the axis of the Hood River-White Salmon
             rivers syncline, which flanks the easternmost exposures of the Eagle Creek formation
             several miles to the north. This downwarp has been suggested as a pre-Cascade-lava
             course for the ancestral Columbia River. The syncline extends for nearly 20 miles to
             the south with an average width of 5 miles. The east wall of the valley is probably a
             fault escarpment, although definite proof is lacking. Abundant glacial till and outwash

(0.2) occupies the valley bottom, exposed in road cuts and in the youthful canyon of the river, incised 200 to 300 feet below the wide-valley surface.

204.0 Hood River junction and overpass. In the next few miles, notice the sharp change in vegetation, dictated by the Cascade Mountains rain shadow, from sagebrush and juniper to Douglas fir and hemlock, by way of oak and jack pine. The annual rainfall at The Dalles
(0.7) is 20 inches, as compared with nearly 40 inches at Portland.

204.7 Glacial deposits in road cuts. Some geologists believe that glaciers from Mount Hood
(0.6) actually reached the Columbia.

205.3 Note intracanyon lava bench across river
(0.7)

206.0 Underwood volcano on skyline at 3 o'clock.
(0.7)

206.7 Unconformable contact of Underwood lava over basalt well exposed across river.
(0.5)

207.2 Thick deposit of east-dipping palagonite tuff with abundant volcanic bombs, probably from Underwood volcano or from a still nearer vent. Overlain in cliffs above Highway
(0.3) by Underwood lavas.

207.5 Contact with underlying, steeply dipping Columbia River basalt. At 12 o'clock, Mitchell Point. Basalt is dipping 30° to the southeast. It is capped by 100 feet of quartzitic
(1.5) gravels, in turn unconformably overlain by Cascade lavas with low initial dip.

209.0 Rounding Mitchell Point, the windiest spot in the gorge. The old highway got around the cliff by means of a tunnel above. Across the river at 3 o'clock are the intracanyon flows of the Little White Salmon River, which came from vents 20 miles up the valley to the north and west. The bench elevation is at about 500 feet above river level. The high peak at 1 o'clock is Dog Mountain (2989 feet), structurally an anticline in basalt,
(2.3) and the westernmost river-level exposure of basalt for many miles.

211.3 At 3 o'clock notice dips in basalt on either side of Dog Creek; eastward on the east side, and 11° to 15° W. on the west side. The basalt of Dog Mountain is possibly faulted up on the west. The wide basin farther west is landslide underlain for the most part by the
(0.7) Eagle Creek formation of Clarno and John Day age.

212.0 Viento Creek. Although Viento is Spanish for windy, and this region is certainly windy enough, the name has an entirely different origin, derived from the first two letters of the names of three railroad men, Henry Villard, William Endicott, and Tolman. Ira Williams (1916) reports 500 feet of Troutdale gravels in Viento Creek between the elevations of 2000 and 2500 feet. This is an unusual thickness, approaching that at Bridal Veil,
(0.9) at the lower end of the gorge.

212.9 Starvation Creek picnic area. Creek named by an early pioneer party who "suffered a defection in their commissary." The falls here are 186 feet high and are the easternmost of the spectacular series in the gorge. The Dog Creek anticline is visible across the
(0.1) river at 3 o'clock.

213.0 Quarry at 9 o'clock is in unsorted debris which does not appear to be normal talus; rather it is more probably a flood deposit in the lee of the point we have just rounded. Note
(1.1) fine columnar structures in basalt at base of cliff.

214.1 Lindsey Creek bridge. Upper contact of the Columbia River basalt in the creek bed 2
(0.4) miles south is at 2300 feet.

Sheep Rock near Picture Gorge on the John Day River. Tuff beds of the John Day formation capped by Columbia River basalt. (Oregon State Highway Commission photo)

214.5   Wind Mountain at 1 o'clock. This is the northern of two large intrusives (the southern,
             on the Oregon side, is Shellrock Mountain) which have been called the "twin guardians
             of the Columbia." They rise to nearly 2,000 feet on either side of the river. Both are
             composed of andesite porphyry, with labradorite feldspar dominant in the phenocrysts,
             and oligoclase-andesine feldspar dominant in the groundmass. Baked contacts with the
             intruded Eagle Creek formation have been found on both sides of the river. Xenoliths
             of basalt in the andesite and a baked, amygdule-filled contact breccia in the saddle
             south of Shellrock Mountain indicate the post-basalt age of the intrusive. Similar circular
             bodies of about the same areal extent (1 square mile) were found 2, 4, and 6 miles north
             of Wind Mountain, indicating a line of central intrusions, probably feeders to now-eroded
    (0.6)   Cascade volcanoes, lying on the Mount Hood-Mount Defiance axis.

215.1   Highway follows around base of Shellrock Mountain. The angle of repose of the talus
             slopes is about 42°. Mount Defiance, 2 miles south of Shellrock Mountain, is the highest
             peak, after Mount Hood, in the entire gorge area, reaching 4960 feet elevation. Like
             Larch Mountain to the west, it is one of the later (possibly early Pleistocene) volcanoes,
             and still retains much of its shieldlike original surface. There is some evidence that a
    (1.2)   flow from Mount Defiance came down one of the valleys towards the Columbia.

216.3   Look for brick-red exposures in cuts south of Highway. These are outcrops of the eastern-
             most exposure of the Eagle Creek formation on the south side, baked by the nearby Shell-
             rock intrusive. Tuff has been changed to a brittle, red jaspery material, and pebbles of
             volcanic conglomerate have been sheared and contorted.
                 Note how the cliffs are retreating on both sides of the gorge, as the relatively non-
             resistant Eagle Creek formation rises above river level. To the north, the Eagle Creek
             and older rocks continue for many miles, only patches of Columbia River basalt cap the
             crests of the ridges for a few miles north of the gorge. The outstanding physiographic
             feature for the next few miles is landsliding, which has been and still is the dominant
             process of erosion in this part of the gorge. Recent sliding north of Wind Mountain caused
             relocation of the Bonneville power line. Several square miles are still in motion in this
    (0.7)   area.

217.0   Gorton Creek bridge at Wyeth Station. Note flood gravels at 12 o'clock in reentrant,
             with high scabland channel behind bench at 11 o'clock. This high bench on the south
             side of the river is a narrow but flat-topped ridge which extends for 3 miles, and has
             diverted Herman Creek to the west for a mile and a half. It is a south-side remnant of
             intracanyon lava from Wind River valley in Washington. The surface of the bench can
             be seen across the river. Two flows, the older and upper reaching an elevation of 1,000
             feet, and the younger and lower reaching an elevation of 600 feet, are exposed on both
             sides of Wind River, where a narrow canyon has been cut to a depth of more than 300 feet
             in the lower flow. The Columbia River was undoubtedly dammed at least twice by the
             Wind River (sometimes called Herman Creek) flows, which came from a small volcano,
             Trout Creek Hill, 15 miles up the valley to the northwest. The legend of the "Bridge of
             the Gods" undoubtedly post-dates these flows and resulted from more recent damming by
    (0.6)   the great Bonneville landslide rather than from lava damming.

217.6   Wind River intracanyon lavas exposed in road cuts, and from 2 to 3 o'clock across river.
    (1.2)
218.8   Active landslide area, frequently displacing Highway and railroad.
    (0.4)
219.2   High cliffs at 9 o'clock in Wind River lavas. These are olivine andesites.
    (0.5)

Mileage

219.7   The highest exposure of exotic gravels in the gorge were found by the writer at an eleva-
tion of 2700 feet due south of here. A sample of 20 pebbles consisted of 7 quartzite,
4 dense red rhyolite, 8 weathered andesite, and 1 granite. This is the highest point
(0.9)   reached by the Columbia River basalt in the south wall of the gorge.

220.6   The low isolated knobs at 3 o'clock are dissimilar in composition from other intrusives
in the Eagle Creek formation, being dense, uniform pyroxene trachyte. Active land-
sliding along here has repeatedly disturbed the Highway and railroad right of way. Low
cliffs across the river are in part landslide blocks and in part dikes in the Eagle Creek
(1.1)   formation.

221.7   Herman Creek Bridge. Herman Creek canyon lies nearly 2 miles to the east; here the
contact of the Eagle Creek formation rises to a maximum of 620 feet, the highest on
the south side of the gorge. The high Benson Plateau west of Herman Creek has a summit
elevation of 4,200 feet; beneath the Cascade lavas, from 3,100 to 2,500 feet, lies a
bed of cinders, red ash, and volcanic bombs believed to be correlative with the Rhodo-
dendron formation, a pyroclastic and volcanic breccia unit which lies between the
Columbia River basalt and the Troutdale formation along the Sandy River and its upper
(1.7)   tributaries west of Mount Hood.

223.4   Entering <u>Cascade Locks.</u>   Basalt landslide blocks on left.
(0.8)

224.2   "Bridge of the Gods" to Washington, leaving Cascade Locks. This is the site of the old
cascades, caused by the Bonneville landslide from the north. This great slide heads in
Archer, Hamilton, and Table mountains from 1 to 2 o'clock, capped by small remnants
(1.2)   of Columbia River basalt, at 2300 feet elevation.

225.6   Trail to Sheridan Viewpoint above Bonneville Dam on right.   Note irregularities of
(0.6)   structure and composition caused by landsliding.

226.2   <u>Bonneville Dam</u> at 2 o'clock.
(0.4)

226.6   Eagle Creek bridge. Elevation of the top of the Eagle Creek formation here is nearly
500 feet; two miles to the south it is 400 feet. The southward dip of the Eagle Creek
is greater than this. The first good outcrops of the formation appear at the west end of
(0.2)   the bridge.

226.8   Tunnel in landslide block of Columbia River basalt. Note large area of landslide across
the river, extending 3 miles back from the river to the base of Table Mountain. River
was diverted nearly 1½ miles from its straight course by the slide, and now forms a large
loop. The surface of this landslide exhibits undrained depressions, numerous recent low
(0.8)   scarps, tilted trees, as evidence of recency of movements.

227.4   The Highway here is cut in a great compound feeder dike of diabase, upon which the
(0.4)   south end of the dam and the powerhouse is based.

227.8   Tanner Creek Bridge. Road junction to Bonneville Dam. Four miles south up Tanner
(0.1)   Creek, Troutdale exposures appear between the Columbia River basalt and overlying
Cascade andesites from 1950 to 2100 feet elevation.

227.9   Entering best exposures of Eagle Creek formation along the Highway. Beds dip 6° to 9°
(0.3)   southeast. Numerous petrified logs and leaves in volcanic conglomerate and tuff.

228.2   Upper end of road cuts in Eagle Creek formation. Beacon Rock at 2 o'clock, is the

eroded vent of a Pliocene volcano, rising 840 feet above the river. Actually it is only
the southernmost of a series of bosses or necks (or a great north-south dike?) which ex-
tends to the north for more than 2 miles. It is red, scoriaceous, and vesicular near the
summit, and baked contacts with Eagle Creek formation are found on the south and south-
west sides. The columnar structure on the east side is horizontal, lying east and west; on
the west side the columns are vertical. The rock was named by Lewis and Clark in 1806.
The high summit of Hamilton Mountain rises to 3,000 feet elevation; the basalt capping
rests on Eagle Creek at an elevation of 1,550 feet, and the contact rises steeply to the
(0.8)   north for 3 miles, beyond which basalt is eroded away.

229.0   Moffett Creek bridge. Joseph LeConte (1874) collected fossil leaves from a carbonaceous
layer beneath the west abutment of the railroad bridge in 1871 and 1873. J. S. Diller
collected leaves here (1896) that were determined by Knowlton (1900) to be Miocene in
age. Chaney (1918) and Bretz collected a fossil flora of 72 species in 1916. Both Chaney
(1918) and Berry (1929) consider this portion of the Eagle Creek to be Miocene, and
Chaney (1944, p. 12) calls it lower Miocene. It has been suggested that much of the
(0.4)   John Day ash came from Eagle Creek volcanoes.

229.4   Good exposures of Eagle Creek formation, dipping 5° to the southwest (apparent dip
(0.7)   horizontal).

230.1   McCord Creek Bridge. A trail leads from the east end of the bridge up McCord Creek
½ mile to Elowah Falls, where the contact of the basalt overlying the Eagle Creek forma-
tion is exposed at an elevation of 220 feet. These falls have a vertical drop of 289 feet,
the lower part of the cliff being undercut in the soft pebbly tuffaceous Eagle Creek forma-
tion. The basal columnar portion of the lowermost flow is well exhibited here. A few
steps east of the bridge in the road cut a vertical trunk of petrified wood 2½ feet in diameter
stands just above highway level. This tree stood up nearly 10 feet 40 years ago (Williams,
1916), but vandal erosion has now reduced it to a stump. Note the poor sorting of the
(1.0)   mudflow debris in which it is enclosed.

231.1   Good view of Beacon Rock at 9 o'clock. At 4 o'clock Hamilton Mountain. Pinnacles on
the skyline to the south have been given various names (St. Peter's Dome is a round erosion
remnant of basalt 1500 feet above the river). Nesmith Point immediately to the east
exposes a cross section of a Cascade vent. More than 100 feet of Troutdale gravels were
found at an elevation of 1700 to 1800 feet, below Nesmith Point and on the ridge above
St. Peter's Dome. The numerous thin flows of Cascade andesite can be differentiated in
(0.9)   the upper cliffs from the thicker basalt flows below.

232.0   Dodson Station
(0.5)
232.5   Junction of old Scenic Highway with freeway. Turn right off main highway onto Scenic
Highway. The Cascade summit surface south of here lies at elevations from 3,000 to 4,000
feet. Numerous small glaciated cirques on the east sides of the ridge crests and volcanic
(1.6)   cones, at elevations above 3500 feet.

234.1   Horsetail Falls drop 221 feet over one flow. Although not exposed, the Eagle Creek forma-
(0.3)   tion probably extends this far west at river level.

234.4   Oneonta Falls in gorge 900 feet south of Highway. This vertical-walled youthful gorge
is cut in two flows of basalt, each nearly 100 feet thick. A few feet above Highway level
is the contact with a third underlying flow. Along this contact, which drops to creek level
as one goes upstream, the writer mapped 65 holes, from 6 inches to 3 feet in diameter, repre-
senting molds of trees overwhelmed by the upper flow. Most of the holes are aligned east

Columbia River at Celilo Falls, Oregon. South-facing escarpment on Washington side extends 80 miles to the east. (Oregon State Highway Commission photo)

Mileage

| | and west. In them are remnants of carbonized, opalized, or otherwise silicified wood which once constituted the tree material. The word "Oneonta" is of New York origin, but for many years before 1887 a sidewheel river steamboat named "Oneonta" plied the river, and it is possible that the creek derived its name from some incident connected |
| | |

(1.7) with the boat.

236.1 Note landslide high above at 9 o'clock and debris in river around navigation marker at 3 o'clock. In 1946, when the new highway was under construction, this talus was being used as borrow pit material by the State Highway Department. Spring rains caused a slide which carried down an estimated 300,000 cubic yards of material, the talus breaking away for 1000 feet up to the bedrock cliffs above, temporarily blocking the highway and railroad. The navigation marker now visible was raised 20 feet out of the water and tilted

(0.6) 30° by the toe of the slide.

236.7 Multnomah Falls. The highest and best-known falls in Oregon. The main falls drop 541 feet, the lower falls 69 feet, with a drop of 10 feet in the interval between; all in all 620 feet. The main falls drop across three basalt flows, a fourth causes the lower falls. The top of the Troutdale formation in cliffs to the south lies at 1600 feet elevation. Above it are lavas from Larch Mountain shield volcano. Multnomah is an Indian tribal name, first used by Lewis and Clark in their journals for November 3, 1805, as "Mulknoma," applied to the river now called Willamette (with the accent on the second syllable). Lewis and Clark later applied it to a tribe on the lower Columbia. Ethnologists believe

(0.6) it originally meant "down river."

237.3 Wahkeena Falls. A multiple fall, 242 feet high. Trail leads ½ mile across a foot bridge to the top of the falls. The name is said to be a Yakima Indian word meaning "most

(1.0) beautiful," and the falls lives up to its name.

238.3 Note basalt cliffs at head of 500-foot talus slopes on the left. Western pinnacle has been called Angel's Rest; eastern pinnacle Devil's Rest. Base of Troutdale formation lies at 600 feet above Bridal Veil, at 965 feet; top of formation at 1450 feet above Bridal Veil, and 1000 feet here. It has been suggested that the gravels filled a north-south "Troutdale

(1.5) valley" which crossed the area in pre-Columbia Gorge times.

239.8 Bridal Veil Junction; keep to the left. Cape Horn across the river at 3 to 4 o'clock. Lower part of cliff is Columbia River basalt, dipping gently to the southwest, and upper

(0.6) part is Troutdale gravels, capped by lava from small Mount Zion volcano.

240.4 As we round the bend, Bridal Veil Falls are below the road at 1 o'clock.

(0.3)

240.7 At 3 o'clock erosional pillars ("Pillars of Hercules") in brickbat basalt. Called "cucumber

(0.6) structure" by Hodge.

241.3 Brickbat basalt overlying basal columnar basalt forms "mushroom" effect along the high-

(0.2) way cuts.

241.5 Shepperds Dell, with falls at 11 o'clock.

(1.1)

242.6 Latourell Falls, 249 feet high. Named for a pioneer settler in the vicinity. Talbot State Park was donated to the State in 1929 by the lumber baron Guy W. Talbot. Note that the falls apparently drop over a single flow of brickbat basalt with curved columns

(0.7) toward the base; the recent notch at the top is only 20 feet deep.

Mileage

243.3   Entering the famous "Figure-Eight Loops" of the old scenic gorge highway. This highway
   (1.2)   was finished in 1916, and was then considered a remarkable feat of highway engineering.

244.5   Pillow lavas in uppermost flow of Columbia River basalt, lying above brickbat basalt.
   (0.2)

244.7   Troutdale outcrops above road on left.
   (0.3)

245.0   Crown Point Vista House. Elevation 720 feet. Rest rooms inside. Note gently west-
               sloping surface on the Troutdale formation across the river, capped by Mount Pleasant
   (0.2)   (western) and Mount Zion (eastern) shield volcanoes of Boring age (Pliocene).

245.2   Troutdale volcanic sediments and pyroclastics, with steeply southwest-dipping foreset
               bedding exposed in road cuts. Note large anomalous boulders in fine-grained matrix,
   (0.3)   and poor sorting.

245.5   Baked contact of lava flow of Boring lava lying above Troutdale gravels.
   (0.3)

245.8   Larch Mountain road junction, keep straight ahead. Thirteen miles of paved road to
               lookout at 4056 feet elevation on summit of large shield volcano. The western larch
               does not grow on Larch Mountain. Early lumbermen called the noble fir (Abies nobilis)
   (0.4)   larch.

246.2   Chanticleer Lookout, 850 feet elevation. Excellent view up the gorge across landslide
               amphitheatre in the foreground. With the Vista House on Crown Point at 12 o'clock,
               Beacon Rock plug lies directly above; Mount Pleasant and Mount Zion shield volcanoes
               lie across the river at 10:30 and 11 o'clock; Rooster Rock dike (or landslide block?) is
               at river level at 10:30 o'clock; Larch Mountain shield volcano on the skyline at 12:30
               o'clock; Pepper Mountain volcano at 1 o'clock. Beneath Crown Point, the contact of
               the south-dipping Columbia River basalt with the overlying Troutdale gravels may be
               easily seen. Road cuts along the highway just west of Crown Point are in Troutdale
               gravels, overlain by a 50-foot flow of Boring lava, from 1 to 2 o'clock. The gorge here
               trends N. 70° E., hence the apparent westward dip of the south-dipping Columbia River
   (0.1)   basalts.

246.3   Highway is passing over the summit level of the Troutdale formation, possibly a terrace,
               at about 800 feet elevation. It will drop in a series of steps, at about 100 feet to the
   (0.5)   mile.

246.8   Dropping down to 600-foot terrace toward Corbett.
   (1.0)

247.8   Corbett Junction.   Just north of this point the Columbia River basalt drops below river
               level on the east flank of the Willamette syncline. Basalt crops out at one spot in the
               bed of the Sandy River about 3 miles south of this point, possibly on the south side of an
               east-west downwarp which has been suggested as the Troutdale-time course of the Columbia
   (1.0)   River. Note the youthful stage of erosion of this upland surface.

248.8   Road junction. Keep to the right. Highway has been dropping down across several ter-
   (1.5)   raced surfaces carved by the Sandy River.

250.3   Springdale Junction. Keep left.
   (0.2)

250.5   Highway now on 200-foot terrace of the Sandy River.
   (1.1)

Mileage

251.6   Dabney State Park. Note incised meanders and terraces at several levels.
     (0.4)
252.0   Upper Sandy River bridge. Keep straight ahead, and park at good spot beneath Troutdale
                cliffs. Note channel-cutting at base of conglomerate beds just west of bridge. Numerous
                exotic quartzite pebbles, probably derived from the Belt pre-Cambrian terrane of British
     (0.3)   Columbia, characterize much of the Troutdale conglomerates.

252.3   Excellent exposures of Troutdale gravels. Approaching Big Bend, an incised meander, of
     (1.4)   the Sandy River.

253.7   Note "arches" at 2 o'clock. These are joint structures of unknown origin in lavas from a
                small shield volcano, called Chamberlain Hill, which cap the cliffs above the Troutdale
                formation about 100 feet above the river. They occur for a considerable stretch between
     (0.6)   here and the town of Troutdale at the mouth of the Sandy River.

254.3   Talus along road from the overlying Chamberlain Hill flows.
     (0.2)
254.5   Turn sharp left (narrow bridge) across Sandy River.
     (0.3)
254.8   "Arches" visible at 3 o'clock in upper cliffs.   Entering <u>Troutdale</u>.
     (0.6)
255.4   Turn sharp right on access road to main highway; cross overpass and turn left (U.S. Highway 30).
     (0.4)
255.8   Enter Freeway. Turn right toward Portland.
     (0.3)
256.1   Reynolds Aluminum Company plant at 3 o'clock. The 275-foot (here actually above 300 feet)
     (0.4)   terrace is on the skyline at 9 o'clock with lower terraces below.

265.5   Rising from Recent alluvium onto 75-foot terrace.
     (0.6)
257.1   Arata Road Junction.
     (0.2)
257.3   Rising to 100-foot terrace, underlain by Pleistocene alluvium.
     (0.7)
258.0   Overpass.
     (1.9)
259.9   181st Avenue overpass. The new leveling project on the left is "Railroad Park" an industrial
     (1.6)   development on the 100-foot terrace. Camas, Washington, a paper-mill town, is at 4 o'clock.

261.5   Quarry at 9 o'clock in lacustrine gravels. As in nearly all quarries in the Portland "delta,"
                these sands and gravels are steeply foreset-bedded to the west and southwest, and are poorly
     (0.6)   sorted.

262.1   Rocky Butte at 11:30 o'clock. This is a Boring volcano, eroded to a stump, in large part
     (2.2)   by floodwaters which have steepened the east face and carved a channel around it.

264.3   102nd Avenue overpass. Traveling just below the edge of the 275-foot terrace on the left.
     (1.2)
265.5   Approaching and paralleling the flood scour channel which sweeps around the south and
                east side of Rocky Butte. The Butte is composed largely of vesicular and diktytaxitic gray
                olivine andesite, as exposed in the county rock pile (quarry) on the east side of the Butte.
                Red cinders are exposed in road cuts on the south crest of the Butte. An abandoned quarry

(1.9)   on the west side exposes a feeder plug cutting up through Troutdale conglomerate, the bedding of which appears to have been arched by the intrusion.

267.4   60th Avenue underpass, and well into east Portland. The Freeway will follow the scour channel, which began at Rocky Butte, all the way to the Willamette River. The well-defined terraces cut by the Willamette and Columbia rivers at 200 and 100 feet elevations are not visible from the Freeway.

West Portland is underlain by the west flank of the Willamette syncline. Basalts dip eastward as much as 30°. Overlying the basalts are a few patches of Troutdale gravels, masked by a mantle of possibly upper Pliocene silts called the Portland Hills silts. The crest of the Portland Hills to the west is capped by lavas from a shield volcano of Boring age, Mount Sylvania. A few flows from this volcano came down valleys almost into Portland.

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