GEOLOGIC MAP GM-2

State of Washington
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Department of Conservation
EARL COE, Director

DIVISION OF MINES AND GEOLOGY
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Geologic Map GM-2

# PRELIMINARY GEOLOGIC MAP OF THE CUMBERLAND QUADRANGLE, KING COUNTY, WASHINGTON

By

HOWARD D. GOWER AND ALEXANDER A. WANEK

U. S. GEOLOGICAL SURVEY

Prepared cooperatively by the U. S. Geological Survey

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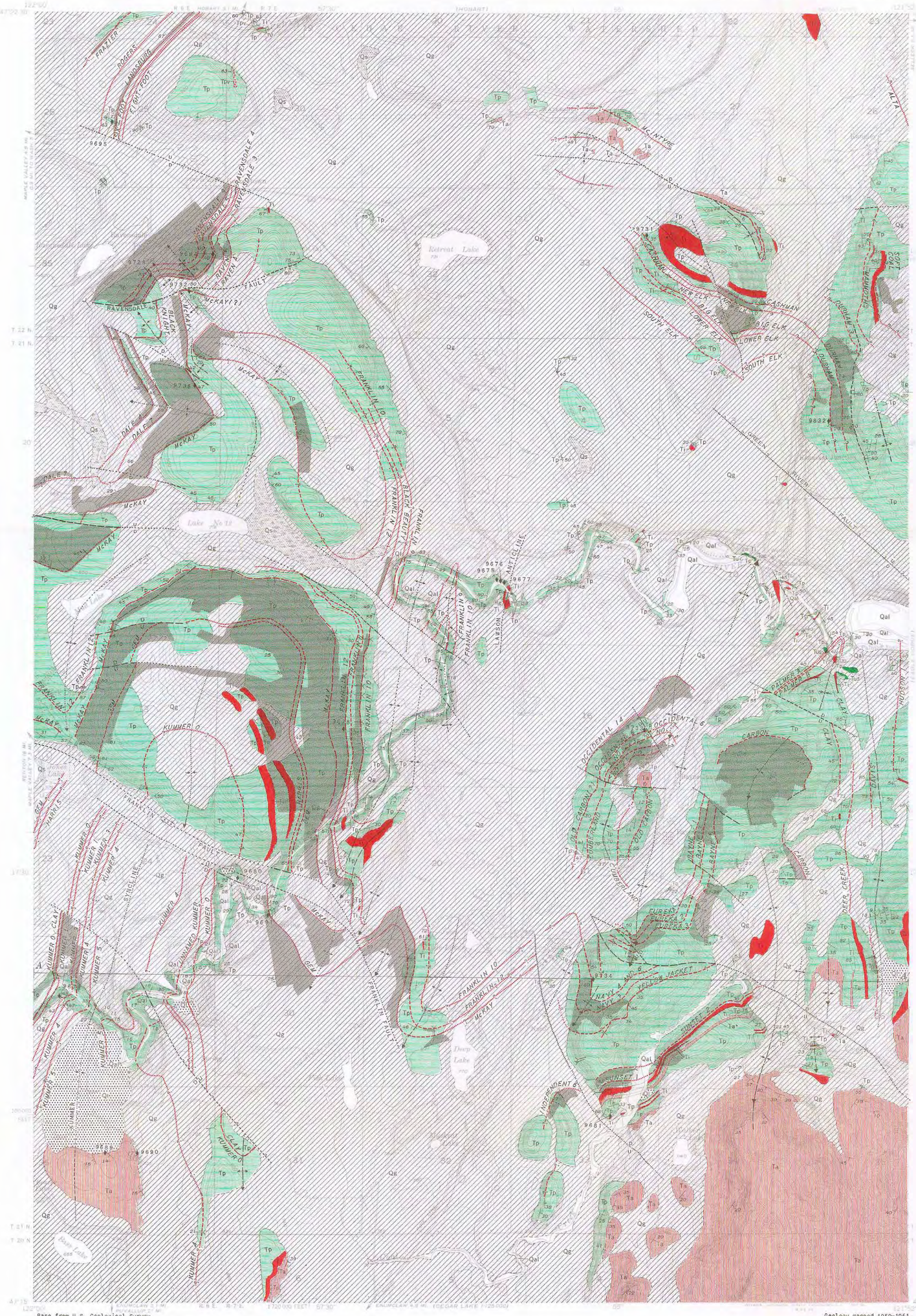
WASHINGTON DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY

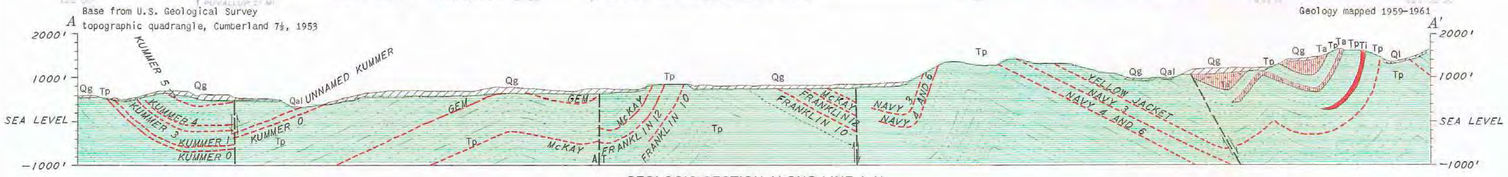
PREPARED COOPERATIVELY BY THE
U.S. GEOLOGICAL SURVEY

GEOLOGIC MAP
GM–2




Base from U.S. Geological Survey
topographic quadrangle, Cumberland 7½, 1953

Geology mapped 1959–1961




GEOLOGIC SECTION ALONG LINE A-A'

## EXPLANATION

**Recent**

Qal — Alluvium

Ql — Landslide debris

Qs — Swamp and lacustrine deposits
*Chiefly organic deposits with some inorganic sediments. Includes some sphagnum peat*

**Pleistocene**

Qg — Glacial drift
*Stratified outwash gravel, sand, silt and clay, and till composed of unsorted clay, sand, cobbles and boulders. Contains some mudflow material*

*UNCONFORMITY*

**Miocene(?)**

Tus, Tuc — Undifferentiated sedimentary deposits
Tus, *gravel, sand, silt, and sandy clay, locally derived from the Puget Group. Includes woody lignite bed 1 to 2 feet thick*
Tuc, *gravel and breccia chiefly composed of basic igneous rocks*

*UNCONFORMITY*

**Eocene to Oligocene**

Ta — Andesitic volcanic rocks
*Volcanic breccia, conglomerate and sandstone, tuff and lava flows. Intertongues with upper part of Puget Group*

**Eocene**

Tp, Tpv — Puget Group
*Arkosic and feldspathic, micaceous sandstone, siltstone, claystone, carbonaceous shale, and coal*
Tpv, *conglomerate composed of basic igneous rocks*

**Eocene(?) to Oligocene(?)**

Ti — Intrusive igneous rocks
*Chiefly porphyritic andesite sills*

**QUATERNARY**

**TERTIARY**

Contact, approximately located
*Short dashed where inferred; dotted where concealed*

McKAY — Coal bed approximately located
*Showing outcrop or trace projected to surface from mine data; short dashed where inferred; dotted where concealed; queried where uncertain. Name or number refers to coal bed*

CLAY — High-alumina flint claystone bed, approximately located
*Short dashed where inferred; dotted where concealed*

U D — Fault, approximately located
*Short dashed where inferred; dotted where concealed; queried where uncertain. U, upthrown side; D, downthrown side; arrows indicate direction of lateral movement. A, relative movement away from observer; T, toward observer (used only in structure sections)*

Anticline
*Showing trace of axial plane and bearing and plunge of axis. Dashed where approximately located; short dashed where inferred; dotted where concealed*

Syncline
*Showing trace of axial plane and bearing and plunge of axis. Dashed where approximately located; short dashed where inferred; dotted where concealed*

20 — Strike and dip of beds

20 — Strike and dip of beds in mine workings

80 — Strike and dip of overturned beds

90 — Strike and dip of vertical beds
*Number shows direction of top of beds where known*

Hg — Mine or prospect entry
*Hg, quicksilver mine or prospect*

Mined areas

9689 — Fossil plant locality

1 ½ 0 1 MILE
SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL
**1963**

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1963

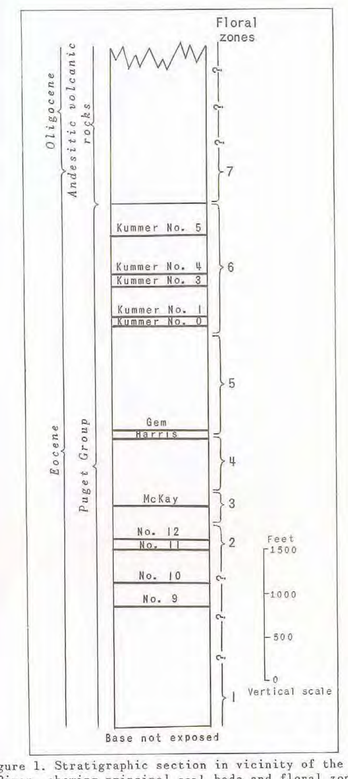
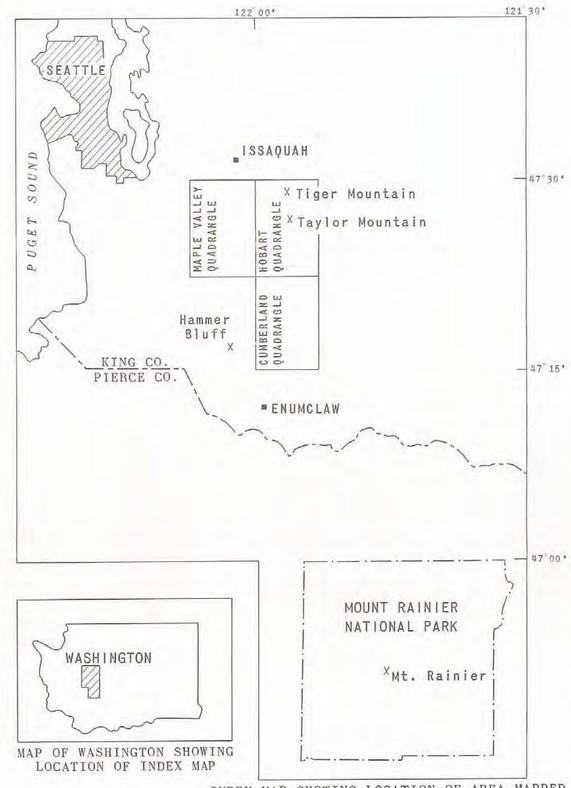



Figure 1. Stratigraphic section in vicinity of the Green River, showing principal coal beds and floral zones.




MAP OF WASHINGTON SHOWING LOCATION OF INDEX MAP

INDEX MAP SHOWING LOCATION OF AREA MAPPED

0 5 10 Miles
Scale

## INTRODUCTION

This preliminary report on the geology of the Cumberland quadrangle, Washington, is part of a cooperative study by the U.S. Geological Survey and the Division of Mines and Geology of the Washington State Department of Conservation to map the bedrock geology and to evaluate the coal resources of the Cumberland, Maple Valley, and Hobart 7½-minute quadrangles. The Maple Valley and Hobart quadrangles are described in another report (Vine, 1962b).

The Cumberland quadrangle lies along the western foothills of the Cascade Range in the south-central part of King County, about 30 miles southeast of Seattle. Most of the area is easily accessible by State, county, and private roads.

Geologic mapping of the Cumberland quadrangle was started by A. A. Wanek in the summer of 1959. He was assisted in the field for parts of the summer by J. D. Vine and P. J. Pattee. H. D. Gower continued the fieldwork during the summer months of 1960 and for 4 weeks in 1961. C. L. Rice assisted in the field for 2 weeks in 1960. Fossil plants collected during the course of this work were identified and dated by J. A. Wolfe.

Evans (1912) made the first comprehensive study of the geology and coal deposits of the Cumberland quadrangle. More recently, the geology of this area was described by Warren and others (1945). The writers had access to the field notes and maps obtained by Warren and his assistants, and most of the details on underground mining were taken from the mine maps that they collected and compiled.

## STRATIGRAPHY

### *Puget Group*

The oldest rocks exposed in the Cumberland quadrangle are the nonmarine coal-bearing sedimentary rocks of the Puget Group. Excellent exposures of these rocks occur in the canyon of the Green River, where a section of about 6,000 feet of the Puget Group is exposed between the axis of the Lawson anticline and the axis of the Kummer syncline. Neither the base nor the top of the Puget Group is exposed in this section, but it is estimated that the uppermost beds of the Puget Group exposed along the Kummer syncline are only about 200 feet stratigraphically below the base of the overlying andesitic volcanic rocks.

The Puget Group is composed of sandstone and siltstone with numerous carbonaceous shale and coal beds and minor amounts of claystone and conglomerate. All gradations between sandstone and siltstone are present, and most of the rocks are either silty sandstone or sandy siltstone. The sandstone beds are typically yellowish gray to light olive gray, fine grained, micaceous, and arkosic or feldspathic. Most of the sandstone beds are cross-laminated and form massive outcrops. Some beds are ripple marked, and convolute bedding and intraformational breccia occur in a few places. The siltstone beds commonly are medium light gray to dark gray and contain varying amounts of finely disseminated carbonaceous fragments.

Most of the rocks of the Puget Group in the Cumberland quadrangle appear to have been derived chiefly from a plutonic or metamorphic terrain, but they also contain some volcanic detritus. A few of the coal beds that underlie the McKay coal bed contain tuff and tuffaceous sandstone partings up to 1½ feet thick. A 20-foot-thick bed of volcanic conglomerate composed of subangular to subrounded pebbles and cobbles of porphyritic andesite (?) crops out north of Georgetown in the northwest part of the quadrangle. This bed also appears to lie stratigraphically below the McKay coal bed.

The upper part of the Puget Group intertongues with the base of the overlying andesitic volcanic rocks. In the southeast part of the quadrangle, tongues of tuff and lapilli tuff of the andesitic volcanic rocks occur as much as 500 feet stratigraphically below the top of the Puget Group. Many of the sandstone beds in the upper 300 feet of the Puget contain volcanic detritus, and some are difficult to distinguish from the overlying andesitic volcanic rocks. The contact between the Puget Group and the andesitic volcanic rocks is drawn at the top of a hard claystone bed that crops out in a roadcut and quarry in the NW¼ sec. 6, T. 20 N., R. 7 E., just south of the map area. Elsewhere the contact is drawn at the top of the highest stratigraphic occurrence of micaceous, quartz-bearing sandstone.

*Age and correlation.*—The Puget Group contains abundant well-preserved fossil leaves and a limited assemblage of brackish- and fresh-water mollusks. The leaves have been studied by J. A. Wolfe, and they provide the principal basis for dating these rocks. In the Cumberland quadrangle the flora of the Puget Group has been subdivided into six zones ranging in age from early to late Eocene (Wolfe and others, 1961). The stratigraphic positions of these zones are shown on figure 1.

Wolfe and others (1961) have correlated these floral zones with the standard marine megafaunal stages of the Pacific Coast (Weaver and others, 1944). The flora from zone 1 is correlative with the Chalk Bluffs flora of California and is considered to be of the "Capay" Stage (early Eocene). Floral zone 2 is correlative with the flora of part of the Clarno Formation of Oregon and is assigned to the lower part of the "Domengine" Stage. Floral zone 3 has been recognized near Elkton, Oregon, in predominantly marine beds assigned to the upper part of the "Domengine" Stage. Floral zone 4 has not been recognized elsewhere, but on the basis of its stratigraphic position it is tentatively assigned to the "Transition" beds Stage. Floral zone 5 has been recognized in the Cowlitz Formation of southwest Washington and is assigned to the "Tejon" Stage. Floral zone 6 is correlative with the Comstock flora of Oregon and is considered to be in the upper part of the "Tejon" Stage and the lower part of the Keasey Stage.

About 8 miles north of the Cumberland quadrangle, in the Tiger Mountain-Taylor Mountain area, the Puget Group is underlain by a thick section of marine sedimentary rocks of probable middle Eocene age (Vine, 1962a). These marine rocks appear to correlate with floral zone 2 and possibly with part of floral zone 3 of the Puget Group in the Cumberland quadrangle. Vine (1962a) has divided the Puget Group in the Tiger Mountain-Taylor Mountain area into the Tiger Mountain, Tukwila, and Renton Formations. Wolfe (written communication, 1961) has correlated fossil leaf collections from these formations with the floral zones of the Puget Group in the Cumberland quadrangle. The Tiger Mountain Formation, of middle (?) and late Eocene age, is approximately correlative with floral zone 3. The Tukwila Formation, a thick section of volcanic rocks of late Eocene age, is correlative with floral zone 4 and part of zone 5. The Renton Formation, of late Eocene and Oligocene (?) age, is approximately correlative with floral zones 5 and 6 and locally extends above zone 6.

### *Andesitic volcanic rocks*

Overlying and intertonguing with the upper part of the Puget Group in the Cumberland quadrangle is a heterogeneous assemblage of volcanic and volcanic sedimentary rocks. These rocks were first referred to as the Enumclaw Volcanic Series (Weaver, 1916, p. 232-235). This term was not precisely defined, and it has not been used by subsequent workers. Warren and others (1945) referred to these rocks as the Keechelus Andesitic Series. Waters (1961) has pointed out that the term Keechelus Andesitic Series has been inconsistently used to include rocks varying in age from Eocene to Pliocene, and he states: "Perhaps the best way out of this confusion is to abandon the name Keechelus Andesitic Series and make use of the better defined formations . . ." In the vicinity of the Cumberland quadrangle no better defined name is applicable to these rocks, and it is felt that the volcanic rocks in question are not sufficiently extensive or well enough exposed in the mapped area to warrant assigning them a formal name on the basis of the current work; therefore, in this report these rocks will be informally referred to as andesitic volcanic rocks.

The andesitic volcanic rocks are confined largely to the southeast and southwest parts of the Cumberland quadrangle. Volcanic rocks that are assigned to this sequence also crop out in a small area west of Bayne and in several isolated areas north and northwest of Sugarloaf Mountain. However, the rocks in these small isolated areas may be either volcanic tongues within the upper part of the Puget Group or part of the main volcanic mass that overlies the Puget Group. In the southeast part of the quadrangle the andesitic volcanic rocks are estimated to be more than 5,000 feet thick and the top is not exposed.

The andesitic volcanic rocks are composed chiefly of stratified tuff, lapilli tuff, tuff-breccia, and platy to massive flow rocks with lesser amounts of volcanic sandstone, siltstone, and conglomerate. Most of the clastic rocks have been altered to chloritic minerals and are grayish yellow green, dusky yellow green, or pale olive in color. The flow rocks are porphyritic with laths of plagioclase set in a fine-grained or aphanitic groundmass. The andesitic volcanic rocks exposed along the axis of the Kummer syncline are largely fluvial deposits of conglomerate and sandstone apparently derived from the center of volcanism to the east.

*Age and correlation.*—Fossil leaves collected from the andesitic volcanic rocks along the axis of the Kummer syncline and along Coal Creek, about half a mile east of the Cumberland quadrangle, contain a zone 7 flora and are assigned a late Eocene to early Oligocene age (Wolfe and others, 1961). However, all these fossils were from the lower part of the sequence, and the age of the upper part is unknown. On the basis of the age assigned to these rocks, their lithologic characteristics, and their stratigraphic position, they are tentatively considered to be, at least in part, correlative with the Ohanapecosh Formation of Mount Rainier National Park (Waters, 1961, p. 56). They also correlate with the uppermost part of the Renton Formation west of the Tiger Mountain area (Wolfe and others, 1961).

### *Undifferentiated sedimentary deposits*

Along the Green River west of Kanaskat and southeast of Palmer are several small outcrops of flat-lying to gently dipping strata that unconformably overlie the Puget Group and are unconformably overlain by deposits of glacial outwash. West of Kanaskat these beds reach a thickness of about 25 feet and are mostly breccia and gravel made up almost entirely of basic igneous rocks. One 4-foot-thick friable fine- to medium-grained sand bed occurs in the lower part of the unit. These deposits rest upon an irregular surface of a porphyritic andesite and steeply dipping sandstone beds of the Puget Group. Many of the clasts in the breccia and the gravel appear to have been derived locally from the underlying andesite.

Southeast of Palmer the undifferentiated sedimentary deposits are composed of gravel, sands, silt, and sandy clay. A woody lignite bed about 1 to 2 feet thick occurs in the upper part. These deposits are about 20 feet thick where exposed in cuts along the Northern Pacific Railway, but they were deposited on an irregular surface of the Puget Group and may locally reach a greater thickness. The gravel is composed of angular to subrounded cobbles of friable arkosic sandstone. The gravel, sand, and sandy clay were apparently all derived locally from the underlying Puget Group.

Warren and others (1945) and Glover (1941, p. 150) included the deposits southeast of Palmer in the Hammer Bluff Formation and considered them to be of Pliocene or Pleistocene age. However, more recent work by Mullineaux and others (1959) indicates a late Miocene age for the Hammer Bluff Formation in the vicinity of Hammer Bluff, about 8 miles southwest of the Palmer locality. Because the deposits southeast of Palmer are similar in composition and appear to occupy the same stratigraphic position as the deposits at Hammer Bluff, they are here tentatively also assigned a late Miocene (?) age. Although the deposits at Hammer Bluff and those near Palmer are here considered to be contemporaneous, there is no indication that they were ever coexistensive, and the extension of the term Hammer Bluff Formation to include the deposits at the Palmer locality is not warranted. The deposits immediately west of Kanaskat, although different in lithology, appear to occupy a stratigraphic position similar to those near Palmer, and they are also tentatively assigned a late Miocene (?) age.

### *Glacial drift*

Most of the Cumberland quadrangle is covered by deposits of glacial outwash and till. The outwash is composed of stratified gravel, sand, silt, and clay. The till consists of unsorted clay, sand, cobbles, and boulders. The outwash is confined largely to the lowlands, where locally it is more than 250 feet thick. Till also occurs in the lowlands, but it is most common on the hillsides. Some of the hillside areas shown as bedrock on the map are partly covered by a thin veneer of glacial drift that is not extensive enough to be differentiated on the map.

Crandell and others (1958) have subdivided the Pleistocene sequence in the southwestern part of the Puget Sound lowland into four glaciations separated by nonglacial intervals. The glacial deposits in the Cumberland quadrangle probably belong to the Vashon Stage of Wisconsin time. These Vashon glacial deposits were laid down by a continental glacier that moved south through the Puget Sound lowland during early Wisconsin time (Waldron and others, 1957, p. 1850).

The lower ends of two lobes of the Osceola mudflow, a Recent mudflow originating from Mount Rainier, are shown by Crandell and Waldron (1956, p. 350) to extend into the Cumberland quadrangle. One lobe extends south from Fish Lake and the other covers the low areas west and south of Bass Lake. These lobes were not mapped by the authors and are shown as glacial drift on the geologic map.

### *Recent swamp and lacustrine deposits*

Several Recent swamp and lacustrine deposits are shown north of the Green River. They occur in areas of closed or poorly drained depressions in the glacial drift and were outlined on the basis of topographic expression and their vegetation cover. These deposits are not exposed and their lithologic characteristics were not studied by the writers, but presumably they are chiefly swamp deposits composed of organic material with lesser amounts of inorganic debris. Some of these deposits are known to contain peat. The western part of the swamp deposit that borders the east side of Lake No. 12 has been cored and described by Rigg (1958, p. 83). According to Rigg, the western part of this deposit is as much as 30 feet thick and is composed chiefly of peat. It contains as much as 3 feet of lake mud at the base and 5 feet of sphagnum peat at the top. A thin pumicite bed occurs in the middle part of the deposit.

### *Landslide debris*

Landslide debris occurs at a number of places in the Cumberland quadrangle, but only a few areas are large enough to be shown on the geologic map. Most of the slides are along the Green River and are the result of slumping along the steep valley walls formed by the postglacial downcutting of the river. The largest area of landslide debris is south of the Green River along the axis of the Kummer syncline. This slide is confined largely to the andesitic volcanic rocks. Much of the base of the steep slope east of Walker Lake is covered with debris that has slid or fallen from the overlying cliffs, but the deposits are not well enough exposed to be outlined on the map. Most of the landslides are marked by hummocky topography and some, such as the large slide along the Kummer syncline, have distinct breakaway scarps.

### *Alluvium*

Alluvial deposits of gravel, sand, and silt occur along all the larger streams. These deposits include modern alluvium in the river channel and the bordering low-lying terraces. Only those deposits along the Green River and Coal Creek were extensive enough to differentiate on the map.

### *Intrusive igneous rocks*

Igneous rocks intrude the Puget Group in the Cumberland quadrangle. Most of the intrusives are porphyritic andesite sills ranging from 5 to 100 feet in thickness. The emplacement of these intrusives postdates the deposition of the Puget Group and probably predates the major period of deformation. The intrusives are similar in composition, and are presumably genetically related to the andesitic volcanic rocks that overlie the Puget Group. Therefore, they are tentatively assigned a probable late Eocene to Oligocene age.

### *Structure*

Throughout most of the mapped area the early Tertiary rocks are highly folded and faulted. The principal deformation occurred after the extrusion and deposition of the andesitic volcanic rocks and before the deposition of the late Miocene (?) sediments. The age of the upper part of the andesitic volcanic rocks is unknown, but in the nearby area, west of Issaquah, marine sedimentary rocks of early Miocene age have been involved in the principal deformation (Warren and others, 1945). Therefore, in the Cumberland quadrangle the major period of deformation is assumed to have occurred during Miocene time. Only gentle warping occurred after the deposition of the late Miocene (?) sediments.

### *Folds*

The rocks in the central and southern part of the Cumberland quadrangle have been folded into a series of north- and northeast-trending folds. Most of these structures are south-plunging asymmetric folds with east-dipping axial planes. The strata most commonly dip 50° to 70° on the steeper limbs and 25° to 50° on the opposite limbs. In the northern part of the quadrangle the structures are less well defined, but most of the known fold axes trend and plunge to the northwest.

### *Faults*

The rocks in the Cumberland quadrangle have been displaced by numerous faults. Strike-slip, normal, and high-angle reverse faults have been recognized, but the type of movement along most of the faults is unknown. Where data are insufficient to determine whether the principal displacement is vertical or lateral, the apparent direction of vertical displacement is shown on the map. Most of the faults trend to the northwest, and the majority are apparently downthrown on the northeast side. Displacements range from a few inches to possibly as much as several thousand feet.

The Franklin fault is the best known fault in the area. Detailed stratigraphic and structural control obtained chiefly from coal mine maps indicate that it is a strike-slip fault with nearly 1,000 feet of right-lateral displacement.

The Green River fault is inferred to explain an apparent right-lateral offset of the contact between the Puget Group and the overlying andesitic volcanic rocks about 1 mile east of the Cumberland quadrangle. If the movement on this fault was horizontal, the south side was moved nearly 3,000 feet to the west. If the movement was vertical, the south side has been downdropped about 1,400 feet. The continuation of this fault in the Cumberland quadrangle is uncertain. If the principal movement along the Green River fault was horizontal, it is possible that the fault continues to the northwest and that the thick section of overturned Puget north of Georgetown may have resulted from drag along the south side of the fault. The northwest-trending fault through Georgetown was struck in mining the Ravensdale No. 5 coal bed. It is inferred to the northwest to explain the apparent offset of the Ravensdale coal beds and their supposed correlatives to the northwest. If the principal movement of the Green River fault is vertical, it may be a continuation of the fault at Georgetown.

The northwest-trending fault west of Walker Lake is inferred to explain the apparent large lateral offset of the contact between the Puget Group and the andesitic volcanic rocks. The presence of this fault is also suggested by the steepening of the strata in the vicinity of the fault. However, because of the incomplete exposures and the intertonguing and gradational character of the contact between the Puget Group and the andesitic volcanic rocks, the apparent large lateral offset may be due largely to the correlation of different stratigraphic horizons on opposite sides of the fault.

The north-trending fault east of Durham appears to dip to the east and, because the strata to the east are overturned, it is assumed to be a reverse fault.

## ECONOMIC GEOLOGY

### *Coal*

The Cumberland quadrangle lies within one of the most productive coal-bearing areas in Washington, the Green River coal district. Coal was first mined in this district in about 1883. Annual coal production reached a peak of 925 thousand short tons in 1903, but in recent years the annual production has fallen to less than 100 thousand short tons. About 25 million short tons of coal have been mined in the Green River district, and most of this production has come from the Cumberland quadrangle (Beikman and others, 1961, p. 53).

In 1962 the Palmer Coking Coal Co. was mining coal from the Rogers bed in the S½ sec. 24, T. 22 N., R. 6 E. and from the No. 12 (Fulton) seam at the Franklin No. 2 mine in the NE¼ sec. 19, T. 21 N., R. 7 E., and Coal Inc. was mining coal at the Black Knight mine in the S½ sec. 36, T. 22 N., R. 6 E.

The coal beds range in rank from subbituminous B to high volatile A bituminous, but most commonly they are high volatile B bituminous. In general, the rank increases with the age of the coal. The coal beds in the upper part of the Puget Group are all subbituminous, and most of the beds in the middle and lower part of the Puget are bituminous. Most of the coal beds have a high ash content and require washing before being used. The ash content ranges from 2.2 to 31.8 percent and averages about 14 percent (Beikman and others, 1961, p. 53).

The stratigraphic positions of the principal coal beds exposed in the Green River Canyon are shown on figure 1. The McKay coal bed has been the most productive bed in the area, and because of its importance it has been recognized over a wider area than any other coal bed in the quadrangle. It has been traced from Deep Lake, in the south-central part of the quadrangle, north to the Ravensdale fault. Preliminary studies of the flora from the rocks exposed north of this fault tentatively indicate that the Raven No. 4 coal bed in the Ravensdale area and the Rogers coal bed northwest of Georgetown are approximate stratigraphic equivalents of the McKay bed. Further examination of the physical characteristics and stratigraphic and structural relationships of these coals is necessary before more definite correlations can be made.

The coal reserves for the area are tabulated in a report by Beikman and others (1961). Mines that have produced coal and other nonmetallic mineral resources in the area are listed and briefly described by Valentine (1960).

The coal beds in the eastern half of the quadrangle can rarely be correlated from one mine or outcrop to the next. No doubt some of these beds have correlatives in the Green River section (fig. 1), but at present no definite correlation can be made. However, the results of a preliminary examination of several flora from the eastern part of the quadrangle suggest approximate correlations with the Green River section. The Cashman bed in the southwest side of Sugarloaf Mountain contains a zone 5 flora and appears to be approximately equivalent to the Gem bed. The Durham No. 1 bed contains a zone 2 flora and appears to be approximately correlative with the No. 12 bed in the Green River section. The Occidental No. 6 bed northwest of Bayne contains a flora that is tentatively assigned to zone 3 or 4 and is considered to be approximately equivalent to the McKay bed.

### *Clay*

High-alumina claystone beds suitable for refractory ware have been mined at two localities within the Cumberland quadrangle. These are the Kummer clay deposit in sec. 26, T. 21 N., R. 6 E., and the Blum clay deposit in the NW¼ sec. 31, T. 21 N., R. 7 E. High-alumina claystone also occurs southeast of Palmer in secs. 14 and 15, T. 21 N., R. 7 E. All these beds have common physical characteristics not found in other areas in western Washington. The claystone beds are made up of hard, brittle, flint clay that breaks with a conchoidal fracture and does not slack upon exposure to the atmosphere. They are most commonly light gray to very dark gray, but locally they are reddish brown. X-ray diffractometer analyses of these clays indicate that they are high in kaolinite and alumina.

The claystone beds at all three localities lie in the upper part of the Puget Group. The claystone beds at the Kummer and Blum deposits are considered to be correlatives. The stratigraphic position of the claystone that crops out southeast of Palmer is uncertain, but it appears to lie several hundred feet stratigraphically below the top of the Puget Group and may also be correlative with the bed at the Kummer and Blum localities.

The claystone bed at the Kummer deposit is 5 to 10 feet thick. It fires to a buff color and has a cone fusion of 32+ (Glover, 1941, p. 130). It has been extensively mined for use in making refractory brick and other ware. The Blum deposit has similar firing characteristics and is currently being mined for the same purpose.

The claystone bed that crops out southeast of Palmer, 650 feet east and 1,150 feet south of the NW. cor. sec. 14, T. 21 N., R. 7 E., is estimated to be about 17 feet thick. The refractory properties of three samples collected from the northernmost exposure of this bed were analyzed by the U.S. Bureau of Mines Northwest Experiment Station, Seattle, Washington. These clays fired to a dark-brown color and had cone fusions ranging from 23 to 31+ (H. H. Harris, written communication, 1961). They are classed as low- to intermediate-duty refractory flint clays. All three samples had a high iron content, which adversely affects their usefulness for refractory purposes. However, it is possible that in other localities the clay may have a lower iron content, and further examination of this bed is warranted.

A deposit of plastic clays suitable for making brick and terra cotta occurs in the late Miocene (?) deposits southeast of Palmer. They are soft, gray, sandy clays that fire to a buff color and have a cone fusion of 20 to 23 (Glover, 1941, p. 150-151). Most of the better quality and most accessible clay in this deposit has been mined out.

### *Silica Sand*

Silica sand suitable for making amber glass was being mined from an open pit in 1963 from the SE¼NW¼ sec. 30, T. 21 N., R. 7 E., by the Smith Brothers Silica Sand Company, Inc. The deposit is a semifriable to friable, fine- to medium-grained quartz-rich sandstone with a silt and kaolinite matrix. It occurs in the Puget Group approximately 450 feet stratigraphically above the Gem coal bed. This sandstone is similar in composition and character to the silica sand deposit at Hammer Bluff about 3¼ miles to the west.

### *Quicksilver*

Cinnabar closely associated with realgar and orpiment occurs at two localities in the Puget Group in the canyon of the Green River: one along the axis of the Lawson anticline (the site of the Royal Reward mine) and the other along the northwest-trending fault in the NE¼ sec. 17, T. 21 N., R. 7 E. (the site of the Cardinal Reward mine). A few flasks of quicksilver were produced at these two localities in 1957 and 1958 by Washington Mining Corp. The rocks at both localities have been fractured and brecciated, and the cinnabar occurs chiefly as pods and veins in the brecciated zone. At the Royal Reward locality the mineralized zone is located in sandstone and carbonaceous shale under an andesitic sill along the crest of the Lawson anticline. In the vicinity of the Cardinal Reward mine the mineralization is chiefly confined to a brecciated zone along a northwest-trending fault.

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GEOLOGIC MAP
GM–2

# PRELIMINARY GEOLOGIC MAP OF THE CUMBERLAND QUADRANGLE, KING COUNTY, WASHINGTON

By
Howard D. Gower and Alexander A. Wanek
U.S. Geological Survey

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