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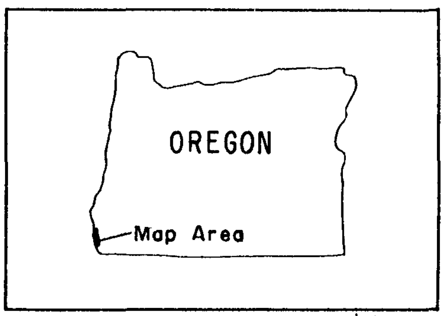
GEOLOGY OF CAPE SEBASTIAN STATE PARK AND ITS REGIONAL RELATIONSHIPS*

By

J. K. Howard and R. H. Dott, Jr.**

INTRODUCTION

The Cape Sebastian-Crook Point area of the southwest Oregon coast is unique in being one of the few areas in the Klamath-Siskiyou geologic province with preserved Late Cretaceous deposits. Because rocks of this age are only mildly deformed, they provide an important means for bracketing the age of the very severe deformation suffered by all older rocks of this region. At least two major late Mesozoic orogenic pulses can be recognized, the most severe of which affected pre-Lower Cretaceous rocks as demonstrated clearly in the Humbug Mountain area, 30 miles to the north and reported on in the March, 1961, Ore.-Bin (Koch and others, 1961). A subsequent disturbance deformed the Lower Cretaceous strata as well throughout the northern Siskiyou region. Study of the few scattered areas of post-orogenic, Upper Cretaceous deposits, such as those at Cape Sebastian and Crook Point, is not only of importance in unraveling this complex geologic history in detail, but is also important because strata of this age contain some of Oregon's most promising potential petroleum reservoir sandstones. A third, unexpected reward from the present work, has been the delineation of a relatively clear-cut structural pattern which provides a valuable clue to the probable dominant pattern for the whole coastal region, even for areas containing only the more obscure older rocks.



The area comprises all of Cape Sebastian State Park at the north and extends in a narrow belt south along the coast (straddling U. S. Highway 101) to the northernmost part of the presently undeveloped Samuel H. Boardman State Park (see accompanying geologic map). Private land intervenes. Coastal outcrops are excellent, but those inland are very sparse and generally deeply weathered. Results of investigation of the Upper Cretaceous strata and their structure have been used by Howard (1961) for a thesis subject for the Master of Science degree at the University of Wisconsin. Continuing doctoral research studies by J. M. Widmier, a graduate student at the University of Wisconsin, in the adjacent Brookings region to the south (including Harris Beach and Samuel Boardman Parks), and by Dott in the upper Pistol River area, hopefully will reveal more concerning the age and structure of the older rocks as well as extrapolation of regional structural patterns. It is hoped that within a year preliminary geologic mapping of the coast will be completed from Port Orford to the California border. Partial financial aid for the present study from the Oregon State Department of Geology and Mineral Industries and from the Wisconsin Alumni Research Foundation is gratefully acknowledged.

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*A progress report of continuing field work in the area.

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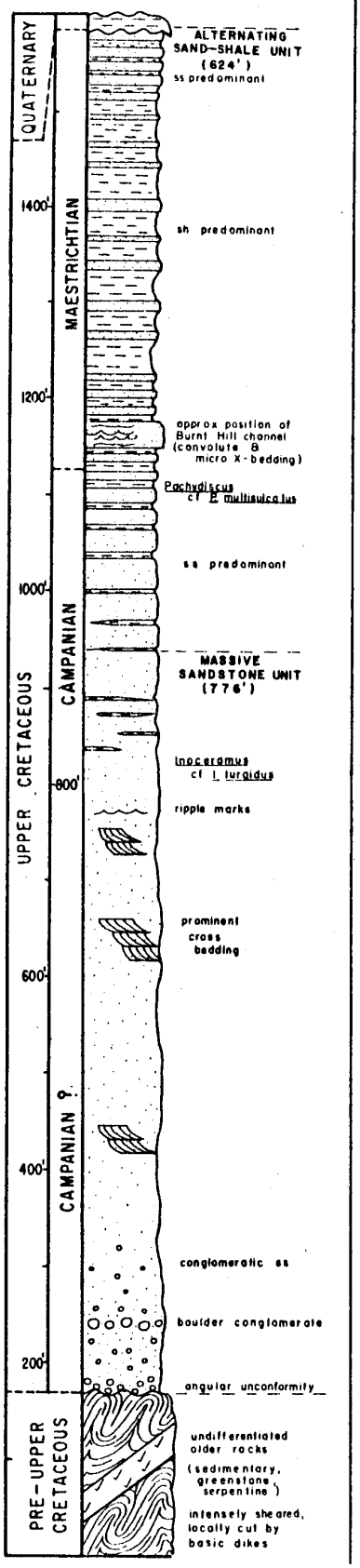
COMPOSITE COLUMNAR SECTION
CAPE SEBASTIAN AREA, OREGON



PREVIOUS WORK

The area was originally mapped superficially by Butler and Mitchell in 1916 during a preliminary survey of the resources of Curry County, later by Treasher (1943), and finally by Wells (1955). None of these determined the structural relationships nor did they recognize the strata as being Upper Cretaceous. Instead, they classified them either as the Myrtle formation (Jurassic-Cretaceous) or as the Eocene Arago formation. The bulk of the Arago is now included in the Coaledo formation of the Coos Bay district, 60 miles north. Upper Cretaceous fossils were found at three localities near Cape Sebastian (see accompanying geologic map) by Howard during the summer of 1960. Soon thereafter Popenoe and others (1960) re-classified these rocks as Upper Cretaceous on the basis of fossils collected by J. S. Diller about 1900 while mapping the Port Orford quadrangle. Diller's fossils, although in the U. S. Geological Survey collections, were unknown to any workers during the intervening years.

STRATIGRAPHY

Pre-Upper Cretaceous

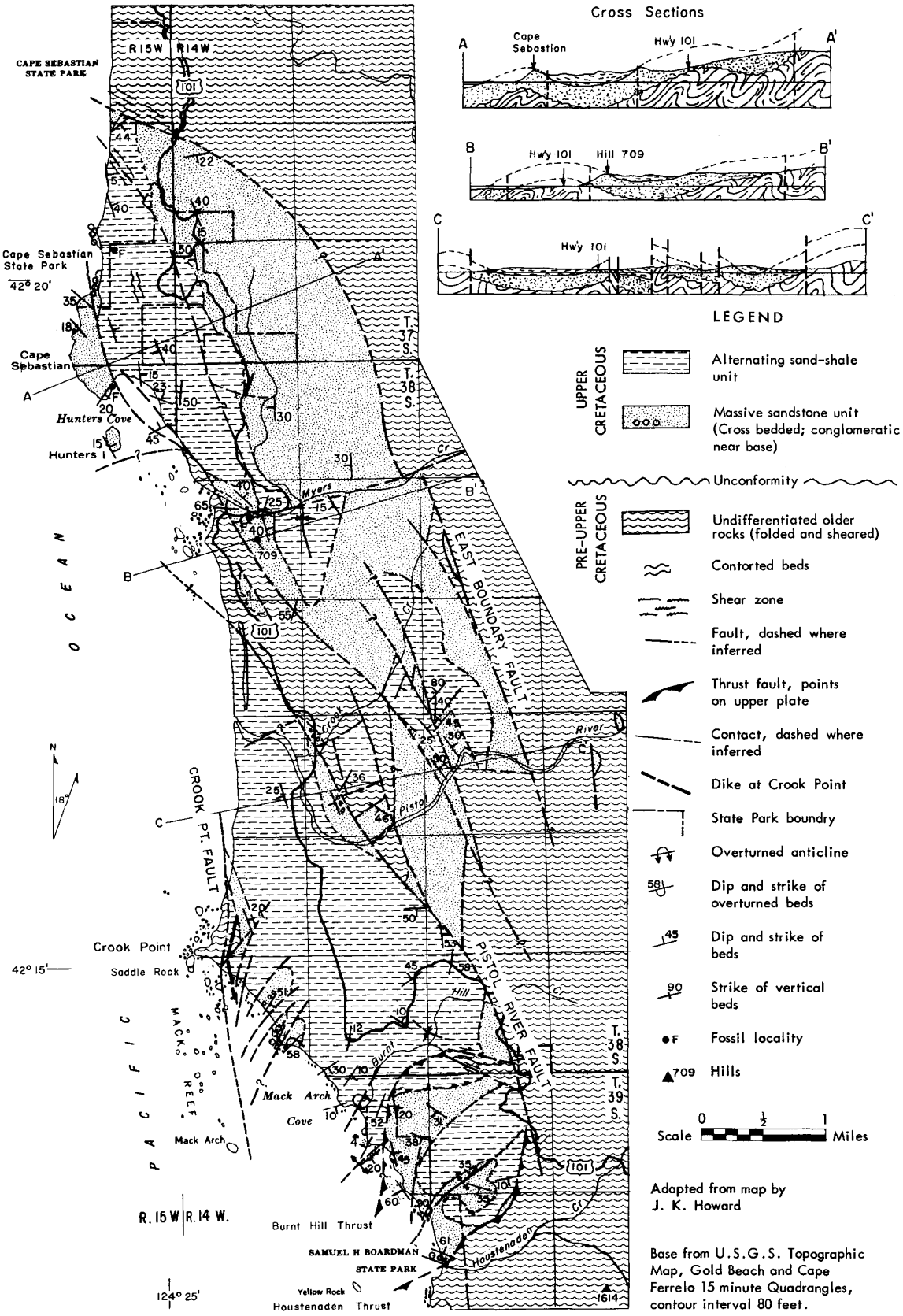
The oldest rocks recognized in the Cape Sebastian-Crook Point area are intensely sheared and folded sandstone and mudstones mixed with greenstone and serpentine. A pillow lava occurs within these strata in NW¼ sec. 22, T. 38 S., R. 14 W. Their age is probably Late Jurassic or Early Cretaceous, but no fossils were found to substantiate this inference. Correlation is based solely upon similarity to sedimentary rocks of this age in the Humbug Mountain-Port Orford area 30 miles to the north (Koch and others, 1961).

Upper Cretaceous

Massive sandstone unit: A massive sandstone unit overlies the older rocks with marked angular unconformity. This relationship can be seen in lower Myers Creek and with less certainty along U. S. Highway 101 near Wildwood Inn and just north of Pistol River. The massive sandstone unit is typically quite conglomeratic in its lower part, but local conglomerate lenses may occur higher as well. Small fossil oysters suggest shallow, near-shore and beach environments of deposition. It seems likely that the conglomerate was formed essentially in place and that the sands infiltrated around beach pebbles and cobbles as the area became submerged. This unit grades upward from the conglomeratic base into a well-sorted, fine-grained sandstone 150 feet above the lower contact (see accompanying columnar section). Thin section studies of this rock indicate that it is a feldspathic wacke (Williams and others, 1954). The massive sandstone forms all of Cape Sebastian proper and crops out extensively along U. S. Highway 101, but particularly in the vicinity of Myers Creek bridge. Cross stratification, ripple marks and sole marks are numerous throughout the upper part of this unit, indicating that it was deposited in a current-agitated environment. The cross stratification is best seen on the sea cliffs on the northwest side of Hunters Cove. The fossil clams Inoceramus turgidus? and Cucullaea? were found within this unit on the south side of Cape Sebastian and on U. S. Highway 101, about 100 feet west of Myers Creek bridge.

Alternating sand-shale unit: The massive sandstone unit grades upward into an alternating, olive to gray, sand-shale unit which can easily be seen on the sea cliffs around Hunters Cove on the southeast side of

GEOLOGIC MAP OF THE CAPE SEBASTIAN—CROOK POINT AREA, OREGON



Looking northwest toward Cape Sebastian State Park from a point just south of the mouth of Myers Creek on U.S. 101. Stacks in foreground are pre-Upper Cretaceous sediments and greenstone; Cape Sebastian in background is Upper Cretaceous massive sandstone. Head of cove to right is Upper Cretaceous shale.

(Photo by Dott)

Cape Sebastian. It is also well exposed in a U. S. Highway 101 roadcut at the south end of the Pistol River bridge (sec. 19, T. 38 S., R. 14 W.). The contact between the two units was chosen at the first well-developed shale stratum, though shale lenses occur some distance below the contact. A true alternating sequence is developed within the first 100 feet of the second unit, and is characterized by sandstones averaging 3 inches in thickness, each separated by one foot of shale. Locally, however, the shales and sandstones range up to 10 feet in thickness. The sandstones contain fine cross-stratification throughout. Animal burrows and current sole markings occur on many stratification surfaces. A large, well preserved ammonoid, Pachydiscus multisulcatus? was found within this unit on the north side of Cape Sebastian (sec. 36, T. 37 S., R. 15 W.). It, together with Inoceramus turgidus? below, indicates a Late Cretaceous age. Additional fossils are also reported by Popenoe and others (1960), but most of the listed localities do not agree with the present land survey network so cannot be rechecked.

Of special note within the alternating sand-shale unit are channel-like sandstone bodies of fluvial or shallow marine origin. They are best exposed on the headlands north and south of Burnt Hill Creek (NW¼ sec. 5, T. 39 S., R. 14 W.). This channel is composed of light tan, well-sorted, fine-grained sandstone quite similar to that of the underlying massive sandstone unit, but is characterized by prominent current features such as fine cross-stratification, sole markings, convolute laminations, and rolled-up sandstone balls. Convolute laminae have been recorded elsewhere only in the finer grain sizes and, where associated with cross lamination, have been attributed to intense hydraulic deformation, in particular to turbidity current action (Ten Haaf, 1956). This latter assumption is apparently unjustified, for no graded bedding or other evidence of turbidity current deposition was found in any of the local deposits. In fact the environment and mechanism envisioned for deposition of the sequence is hardly favorable for any significant turbidity current activity in spite of superficial similarities to known "turbidites". (See Dott and Howard, 1961). At least one channel-like body in the alternating sand-shale unit on the east side of Hunters Cove contains a thin zone of coarse conglomerate.

STRUCTURE

The fault system of this area is composed of two nearly perpendicular sets, the dominant one trending northwest, the other northeast. (See accompanying structure map.) Three major northwest-trending faults are herein named the East Boundary, Pistol River, and Crook Point faults. Movement along them is speculative, but on the Pistol River fault zone, which is half a mile wide, there is evidence of right lateral, strike slip movement. A fold axis truncated by this fault constitutes a piercing point (or displacement reference point) as defined by Crowell (1959). Offset of this fold axis suggests right lateral movement on this fault (that is, the northeast side apparently moved to the right or southeast). Offset on the northeast-trending set is more

clearly defined. In the vicinity of Myers Creek, a synclinal fold axis is truncated by the fault paralleling Myers Creek (sec. 8, T. 38 S., R. 14 W.). The continuation of this axis on the north side of the fault is located west of U. S. Highway 101, indicating left lateral displacement of about one-half mile. Employing the strain ellipsoid concept, left lateral displacement on the northeast-trending set should produce right lateral movement on the northwest-trending set and vice versa. (See stress diagram on structure map). Such seems to be the case.

At the south end of the area two small thrust faults have been recognized and named the Burnt Hill and Houstenaden thrusts. Together with several small folds, they indicate northward compression in that area, and as they lie on the west side of the Pistol River fault zone, this evidence tends to substantiate right lateral movement on that fault.

The lineation of stacks offshore from major shear zones is an interesting feature of this area. This is most noticeable south of Crook Point where large stacks are parallel and adjacent to the submerged portion of the Crook Point fault. Though less obvious, stacks of the older rocks are also present offshore to the northwest of the East Boundary and Pistol River faults. The relationship between the faults and aligned stacks is not entirely clear, but their association has proven valuable in locating offshore extensions of faults in the mapping of other coastal areas both to the north (see Koch and others, 1961) and to the south where J. M. Widmier is working.

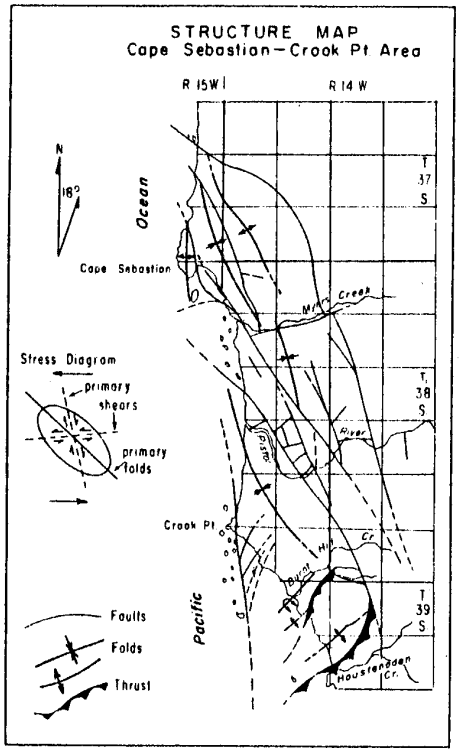
The Upper Cretaceous strata of this area are folded into a series of doubly-plunging anticlines and synclines with a general trend of N.30°W. The relationship between the fold and fault patterns is not clear. The folds may be primary structures formed simultaneously by the same forces that produced the fault system. This pattern also could be produced by secondary forces set up by a rupture with fold trends at an angle between 5° and 30° to a major fault (Moody and Hill, 1956).

REGIONAL HISTORICAL AND STRUCTURAL SYNTHESIS

Scattered Late Cretaceous deposits of the whole Klamath-Siskiyou province represent eroded remnants of a once far more extensive overlapping sequence which apparently blanketed much of the region after the last strong mid-Cretaceous orogenic pulse. The writers envision a rise in relative sea level in the Cape Sebastian area in Late Cretaceous (Campanian?) time resulting in a series of embayments into which rivers debouched sands and mud that accumulated on deltas and shallow shelves. As the sea level rose further, the energy level of the depositional environments decreased, and near the close of the Campanian epoch periodic influxes of mud produced the rythmic alterations of sand and shale. The cyclic deposition presumably continued into the Maestrichtian epoch.

Because the topography was moderately irregular, and because marine transgression spanned practically all of Late Cretaceous time, the exact age of the basal "post-orogenic" deposits varies considerably from place to place. Judging from rather incomplete fossil evidence, transgression apparently began in "middle" Cretaceous time (Albian to Cenomanian) in the eastern Siskiyou region from Roseburg southeast through upper Grave Creek, Medford, and Ashland to Hornbrook, California, and south to Redding as it did in central Oregon (Popenoe and others, 1960). On the west, however, transgression did not commence until later Cretaceous time (probably Campanian) as evidenced around Cape Sebastian (this paper), just north of Port Orford (Koch and others, 1961), and at Dement Creek about 25 miles northeast of Port Orford (Popenoe and others, 1960).

The Cretaceous near Takilma and Waldo, Josephine County (near Oregon Caves), remains an enigma. Meager fossil evidence suggests an Early Cretaceous age (Hauterivian to Barremian) which would compare most closely with the Myrtle group of the Roseburg region (Popenoe and others, 1960). These strata have been examined by Dott, and their practically undeformed character as well as their lithology suggests that they are in fact "post-orogenic" and more akin to the later Cretaceous overlapping sequence. All known Myrtle strata were severely deformed during the mid-Cretaceous, but it is of course possible that this area, deep in the interior of the Siskiyou province, escaped effects of the last orogeny. This is unlikely, however, for the nearby Ashland batholith was apparently formed simultaneously or slightly after Myrtle deposition (102 million years ago according to Jaffe and others, 1959). Like practically all of the younger localities, this area contains a coarse basal conglomerate grading up through a thick massive sandstone unit to an upper rhythmically-alternating sandstone-shale unit. The similarity of all these sequences is indeed striking. Dott



feels that all physical stratigraphic evidence favors a later Cretaceous age in spite of biostratigraphic evidence. He suggests that those deposits should be compared to the Albian-Cenomanian ones of the Grave Creek and Medford areas.

Apparently most of Oregon was affected by the "middle" Cretaceous orogeny, and soon thereafter was invaded widely by the transgression of the sea eastward to the Mitchell-Blue Mountains region (Popenoe and others, 1960) and into half or more of the Klamath-Siskiyou region. "Middle" Cretaceous transgression is evidenced on all continents and is thought to represent a world-wide rise in sea level. The sea apparently covered the western two-thirds of Oregon and Washington. Therefore, Upper Cretaceous marine strata probably underlie practically all of that region. General regression of the sea occurred during the early Cenozoic as evidenced by complete absence of known Paleocene deposits and unconformable overlap of basal Eocene strata in the northern Siskiyou region.

Severe faulting occurred on the coast prior to deposition of Upper Cretaceous strata, but the faults discussed above have also been active during the Cenozoic. At Crook Point and north of Port Orford, Upper Cretaceous strata are in clear fault contact with older rocks. Scattered dikes and sills of rhyolitic and basaltic composition between Crook Point and Brookings are unaltered and appear to be relatively young; they are assumed to be related to the regional fault system.

Great shear zones along the coast are in marked contrast with the typical northeast-trending structural and metamorphic pattern of the interior Siskiyou province as indicated by Koch and others (1961). The present coastal structure, which is nowhere so clear as in the Cape Sebastian-Crook Point area, is regarded as a profound pattern superimposed upon the older structure along the western fringe of the province. Similarity of trends, similar apparent movement, and prevalence of large-scale shearing suggests a genetic relation with the San Andreas-Mendocino fault system and an extension of California "coast range structure" north well into Oregon. Dott believes that this structural pattern persists as far north as Bandon, 50 miles north of Cape Sebastian. It has been suggested that these great fault systems have resulted from counter-clockwise rotation of the Pacific Ocean basin relative to the continent (St. Amand, 1957); to gigantic twisting and shearing of blocks of the crust within the whole of western North America, and the great arcuate bend of Pacific Coast fold trends in the Klamath region (Carey, 1958); and to differential movement and tension within large "oceanic blocks" on the flanks of the recently-discovered East Pacific Rise. The Rise presumably passes from the equatorial Pacific beneath western California and out to sea again off southwestern Oregon (Menard, 1960). The present study clarifies the extent, pattern, probable types of movement and partial age of the great California fault systems in Oregon, but can not shed light upon their ultimate cause.

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GEOPHYSICAL EXPLORATION AUTHORIZED ON CONTINENTAL SHELF

The Department of the Interior announced on August 3 approval for permitting geophysical exploration by oil companies on the outer continental shelf of the Pacific Ocean off the Oregon and Washington coasts. Oil companies interested in doing exploratory work in federal offshore waters of these states must comply with the following conditions:

1. To obtain a permit from the regional oil and gas supervisor of the U.S. Geological Survey, Los Angeles, California.
2. To confine operations to such areas as are designated in the permit.
3. To file a stipulation with the regional supervisor to comply with requirements protecting and conserving the aquatic life in the designated area.

Companies authorized to conduct geological and geophysical explorations are not empowered to drill exploratory wells under a federal exploration permit, nor does the permit confer preference in obtaining oil and gas leases.

The announcement by the Department of the Interior will allow companies operating off the Oregon and Washington coasts to extend their geophysical surveys beyond the 3-mile limit. Shell Oil Company, Gulf Oil Corporation of California, and Union Oil Company of California have obtained exploration permits to explore in Oregon waters. State permits differ from federal in allowing core-hole drilling to a depth of 500 feet; no drilling can be done under the federal permit.

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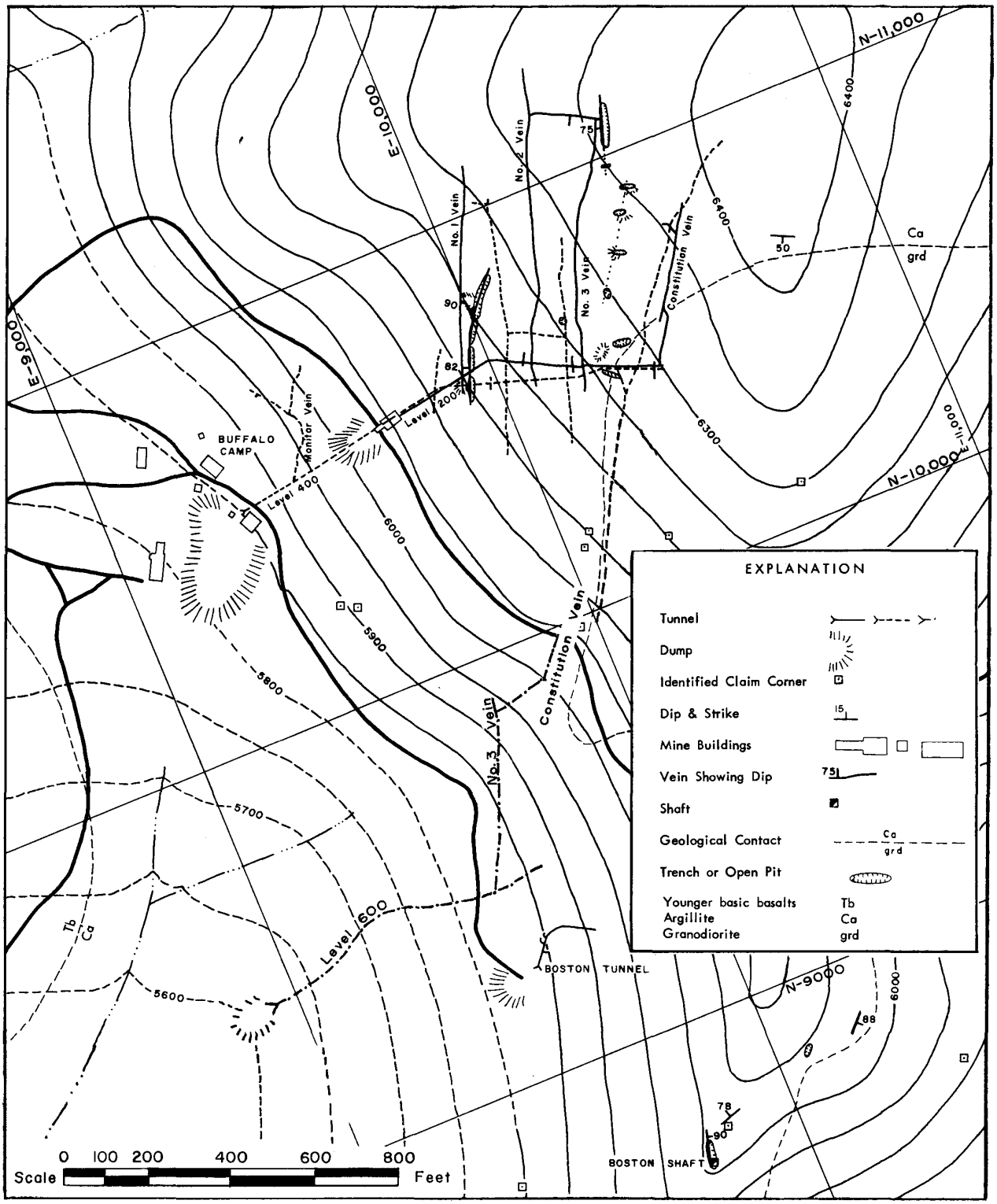

Buffalo mine, Grant County, Oregon.
Map of surface and principal underground workings, August, 1961.

RECENT DEVELOPMENT WORK AT THE BUFFALO MINE

Recent development work at the Buffalo mine, long-time Grant County gold producer, has exposed the Constitution vein on the 600 level, 253 feet below the south end of the last known drift on the 400 level. The discovery followed two years of tunneling from a new hillside portal, in part following an old adit driven years ago. As shown on the accompanying map, about 1500 feet of tunnel have been driven on the new low level.

The Constitution vein was reached on the 600 level in early July, 1961, and by August 1 some 265 feet of drift had been driven on the vein, which is two to three feet wide and of generally good grade, carrying both gold and silver. The vein is similar in appearance to that stoped on the two levels above and contains, besides the gold and silver, pyrite, pyrrhotite, sphalerite, chalcopyrite, and galena in a gangue of quartz and calcite.

Prior to encountering the Constitution vein, the tunneling exposed several stringers and a narrow but well-defined vein in the drift marked "No. 3 vein" on map. These stringers and the vein improve markedly to the north and probably correspond to the No. 3 vein on the 400 level. Mr. James P. Jackson, Jr., mine owner and manager, plans to drift northward on the Constitution vein before starting stoping.

Of particular significance in the discovery is the demonstration that these veins, and presumably some of the other gold veins of northeastern Oregon, persist at depth and can be located and mined profitably.

Earlier work at the Buffalo and nearby mines was described in Department Bulletin 49, Lode mines of the central part of the Granite mining district, Grant County, Oregon, published in 1959.

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EDEN RIDGE COAL EXPLORATION SLATED

A coal exploration crew has been assigned by Pacific Power & Light Company to conduct core drilling this summer in the Squaw Basin area near Eden Ridge in southeastern Coos County. Geological explorations by the company on Eden Ridge in 1956 and 1957 mapped two veins of subbituminous coal. Mining rights were subsequently obtained on 5,000 acres in connection with plans for a future steam-electric power plant to serve southwest Oregon. (Ore.-Bin, August, 1956.)

The Eden Ridge coal field is adjacent to the site of a proposed hydroelectric development on the South Fork Coquille River. The power company has a license application pending before the Federal Power Commission for the two-dam $23,000,000 project. A 77,000 kilowatt powerhouse would be located at the north side of a 12-mile long bend in the river. It would be at the foot of a penstock which would drop the water 1600 feet down the side of Eden Ridge to drive the turbines and generators.

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HANDBOOK ON TERTIARY STRATIGRAPHY AVAILABLE

A very useful addition to the literature has just been published in the form of a handbook of western Oregon and Washington stratigraphic units, consisting of 92 pages and 2 correlation charts. Original descriptions, supplements, and revisions heretofore widely scattered are brought together in a concise form in this handy reference booklet. Author and publisher is Walter Youngquist, Professor of Geology, University of Oregon, Eugene. The booklet, entitled "Annotated Lexicon of Names Applied to Tertiary Stratigraphic Units in Oregon and Washington West of the Cascade Mountains, with Bibliography", may be obtained for $3.00 (postpaid) from the author, Box 5201 University Station, Eugene, Oregon.

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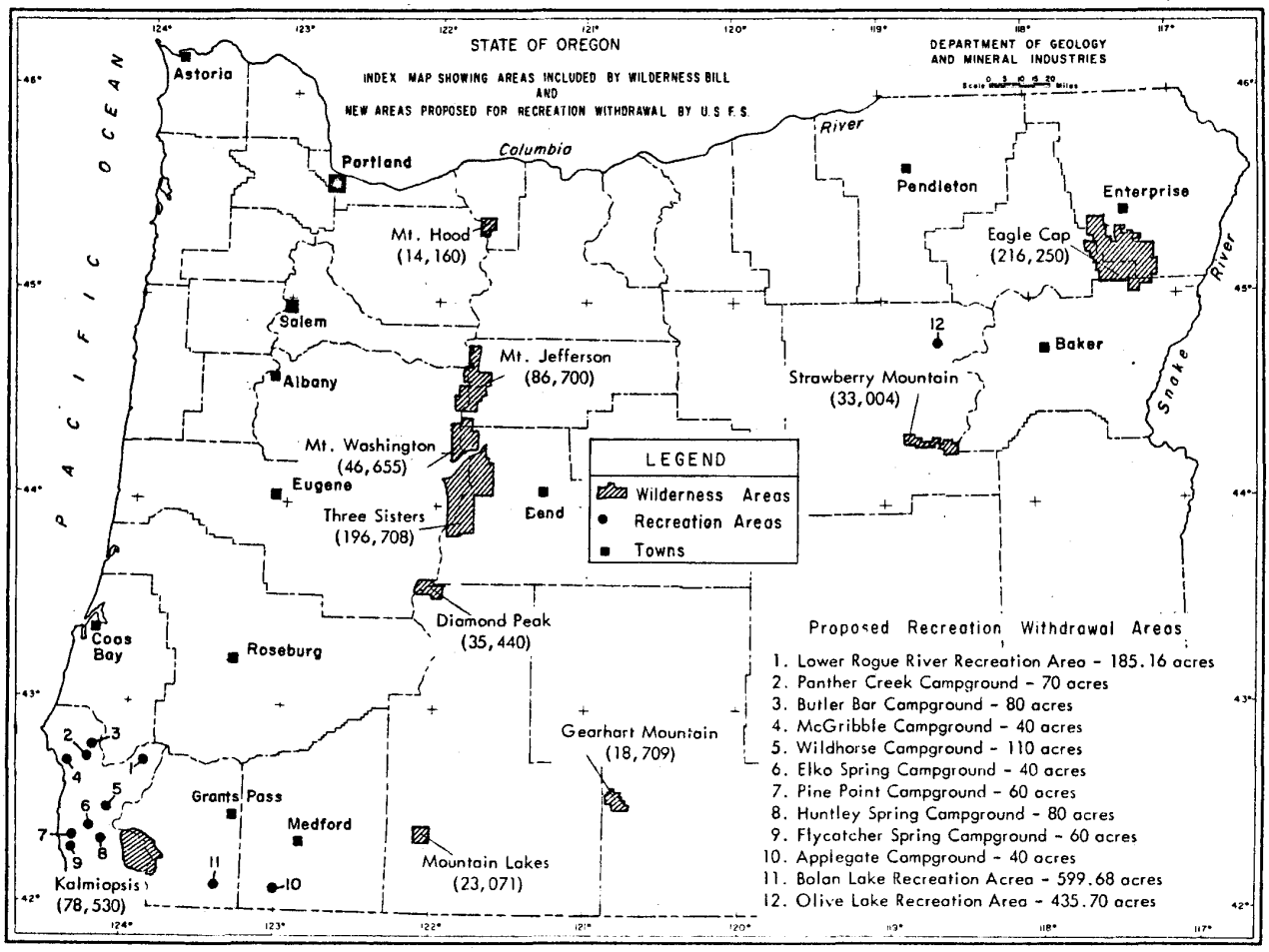

WILDERNESS BILL NEARS SENATE ACTION

The highly controversial national wilderness bill, S 174, has been approved by the Senate Interior Committee and is nearing Senate action. As noted in the February, 1961, Ore.-Bin, this bill would exclude from mineral exploration millions of acres of national forest and public domain lands formerly subject to the general mining laws. The American Mining Congress points out that although an amendment to the bill empowers the President to authorize mining in an area if it be of greater public good than preservation of the wilderness, the bill would still prevent modern scientific prospecting, which is the first step in locating hidden mineral deposits, and would thus preclude the discovery of important mineral deposits in extensive unexplored areas holding great geologic promise.

Passage of the bill would affect 10 areas in Oregon totalling 749,227 acres (see wilderness-type areas on map above), and would make certain other areas subject to consideration for future inclusion in the wilderness system.

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U. S. FOREST SERVICE ADDS TO RECREATION WITHDRAWALS

The U.S. Forest Service, through the Bureau of Land Management, has filed two applications for withdrawal of 12 parcels of land totalling 1,800 acres exclusively for recreation use. These lands are mainly in Curry, Jackson, and Josephine Counties and are noted on the above map. The withdrawal application states that the land is withdrawn "from all forms of appropriation under the public land laws including the general mining laws but excepting the mineral leasing laws". Those wishing to file objections on the withdrawals have 30 days from July 26 to file their statements with the Bureau of Land Management, 710 N. E. Holladay Street, Portland 12, Oregon. If circumstances warrant it, a public hearing will be held.

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