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GEOLOGY OF THE HUMBUG MOUNTAIN STATE PARK AREA

By

J. G. Koch, W. R. Kaiser, and R. H. Dott, Jr.*

INTRODUCTION

The Humbug Mountain area was visited in 1955 by Dott while in the employ of Humble Oil & Refining Company. The presence of a diorite pluton and unmetamorphosed strata containing diorite and phyllite pebbles together with moderate numbers of Cretaceous fossils offered great promise for accurate geologic dating of mountain building, intrusion of diorite, and regional metamorphism in southwestern Oregon. The geology also seemed to provide an opportunity for establishing detailed coastal Cretaceous stratigraphy. Work renewed in 1959 has verified these beliefs, although structural complications are far greater than anticipated. These investigations, the first since J.S. Diller's (1903) description and mapping of the Port Orford quadrangle, are part of a long-range study of the sedimentation in and stratigraphic history of the Klamath mobile belt during its most active periods of post-Paleozoic deformation.

This preliminary summary of the geology of the Humbug Mountain State Park area is based upon investigations made during two field seasons by Koch, one by Kaiser, and parts of three seasons by Dott. Koch has completed a Master's dissertation on the immediate park area (Koch, 1960) and now is extending his studies of late Mesozoic strata southward and eastward. Kaiser currently is investigating in detail the metamorphic and igneous rocks east of the park. Their work, as well as that of other University of Wisconsin students farther south along the coast, is under the general direction of Dott. He also has investigated areas northward as far as Coos Bay. Financial support from the Wisconsin Alumni Research Foundation and the Oregon Department of Geology and Mineral Resources is gratefully acknowledged.

PREVIOUS WORK

Diller (1903) was the first geologist to describe the area in detail. His application of the name Myrtle formation (Diller, 1898, p. 1) to most of the sedimentary rocks was unfortunate in that these are of mixed ages and lithologies. Imlay, et al. (1959), recently recognized the Myrtle as a group in the Roseburg region (80 miles northeast of Port Orford), the type Myrtle area. Two new formations of latest Jurassic and earliest Cretaceous age, respectively, have been designated there. Because of the distance from that area and rather different lithologic characteristics, no formal stratigraphic terminology is being endorsed herein for coastal sequences of similar age. Ages suggested by previous workers for metamorphic and igneous rocks in the Humbug Mountain area are regarded with reservations.

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STRATIGRAPHY

Metamorphic and Igneous Rocks

Characteristics

Rocks assigned to the pre-Cretaceous include metasediments, phyllites, greenstones, and basic to intermediate igneous varieties, chiefly diorite. Their general distribution appears on the accompanying map.

Metasedimentary rocks: The metasediments contain 85 to 90 percent quartz and are characteristically banded. Bands range from 1/4 to one inch in thickness, and they show fine-scale ripple bedding and graded bedding. In thin section one sees incipient growth of mica, a few quartz grains with sutured boundaries, and poorly preserved foraminifera. Among all the sedimentary rocks in the area, these banded metasediments are the most distinctive. They are similar in practically all respects with sediments of the Galice formation observed by the writers along Grave Creek in the Galice quadrangle, 50 miles east of Port Orford (see Wells and Walker, 1953).

Colebrooke schist: Low-grade metamorphic rocks referred to the pre-Cretaceous Colebrooke schist by Diller (1903) are chiefly quartz-mica phyllite. A significant amount of carbonaceous material is also present. The phyllite locally has chevron folds on both a megascopic and microscopic scale.

Greenstones: The most complex group of rocks are those described under the general heading of greenstones. These are greenish, altered basic igneous rocks. The color is principally due to three minerals - chlorite, epidote, and hornblende. Because of the high degree of alteration, it can not be said with certainty whether these are altered intrusive or extrusive rocks. No definite amygdaloidal, pillow, or other volcanic structures were observed except in one example associated with Upper Jurassic strata along the Rogue River, south of the present map area. Basic igneous rocks, other than greenstone, are diabasic in texture and of gabbroic composition. These are found in scattered localities along the Elk River and elsewhere.

Diorite and metasedimentary rocks: The most common igneous rock is diorite that shows local variations toward a more basic composition. It occurs in a small intrusive pluton, here designated the Pearse Peak diorite. The best exposures are along the Elk River, just north of Pearse Peak. The diorite contains andesine with well-developed zoning, hornblende, quartz (5 to 10 per cent), and biotite, with alkali feldspar, sphene, and magnetite as accessories. It has a granitic texture. The presence of sphene, euhedral mineral grains, and well-developed zoning of the plagioclase all point to a magmatic origin.

Age and Sedimentary Relationships

The stratigraphic position of the Pearse Peak diorite is considered as Upper Jurassic. Dikes and sills of the diorite intrude banded metasediments on the east and west sides of the pluton, for example, at Purple Mountain Creek (NE$\frac{1}{4}$ sec. 23, T. 33 S., R. 14 W., near its junction with the Elk River) and on Beartrap Creek (SW$\frac{1}{4}$ sec. 32, T. 33 S., R. 14 W.). At both localities foraminiferal-bearing banded metasedimentary rocks were collected near the contacts. The foraminifera have been identified by Professor R. L. Batten of the University of Wisconsin (personal communication) as belonging to the families Buliminidae, Heterohelicidae, Lagenidae, Polymorphinidae, and Rotaliidea, and they are of probable Late Jurassic or Cretaceous age. A Late Jurassic age seems more likely because the metamorphic-igneous complex is unconformably overlain by Early Cretaceous (Valanginian) conglomerate containing diorite and metasedimentary pebbles. Furthermore, there is the striking similarity of the banded metasediments to the early Late Jurassic (Oxfordian-Kimmeridgian) Galice formation (Wells and Walker, 1953). It is also unlikely that the foraminifera could be older than Late Jurassic (personal communication, R. L. Batten). The Pearse Peak diorite, therefore, is regarded as post-early Late Jurassic and pre-Early Cretaceous (Valanginian). (It is hoped that a radio-active date by the potassium-argon method can be established, but no biotite that has escaped chloritization has been found.

The history of the phyllite is poorly documented. The presence of phyllite fragments in Lower Cretaceous conglomerate near the head of Brush Creek (sec. 4, T. 34 S., R. 14 W.) and at the mouth of Mussel Creek (sec. 19, T. 34 S., R. 14 W., just south of the map area) indicates a pre-Early Cretaceous (Valanginian) age. Wells (1955) mapped the Colebrooke schist as a metamorphosed phase of the Late Jurassic (Oxfordian-Kimmeridgian?) Rogue formation. The typical Rogue (Wells and Walker, 1953), where seen by the writers inland on the Rogue River below Grave Creek bridge, consists of fine- to coarse-grained sediments rich in volcanic detritus, tuffs, agglomerates, flow breccias, flows, and their metamorphic equivalents. The mineralogy of the Colebrooke does not suggest a close similarity. Extremely high quartz content plus carbonaceous material suggest a more normal sedimentary rock as the parent, for example, the Galice formation. Foliation transecting relict bedding also was found in the phyllite; however, in most cases the bedding has been destroyed. Perhaps the banded metasedimentary rocks are the parent, for the mineralogy and scale of compositional layering or banding are compatible with that of the phyllite. Chemical analyses of both lithologies should aid in identifying the parent of the phyllite.

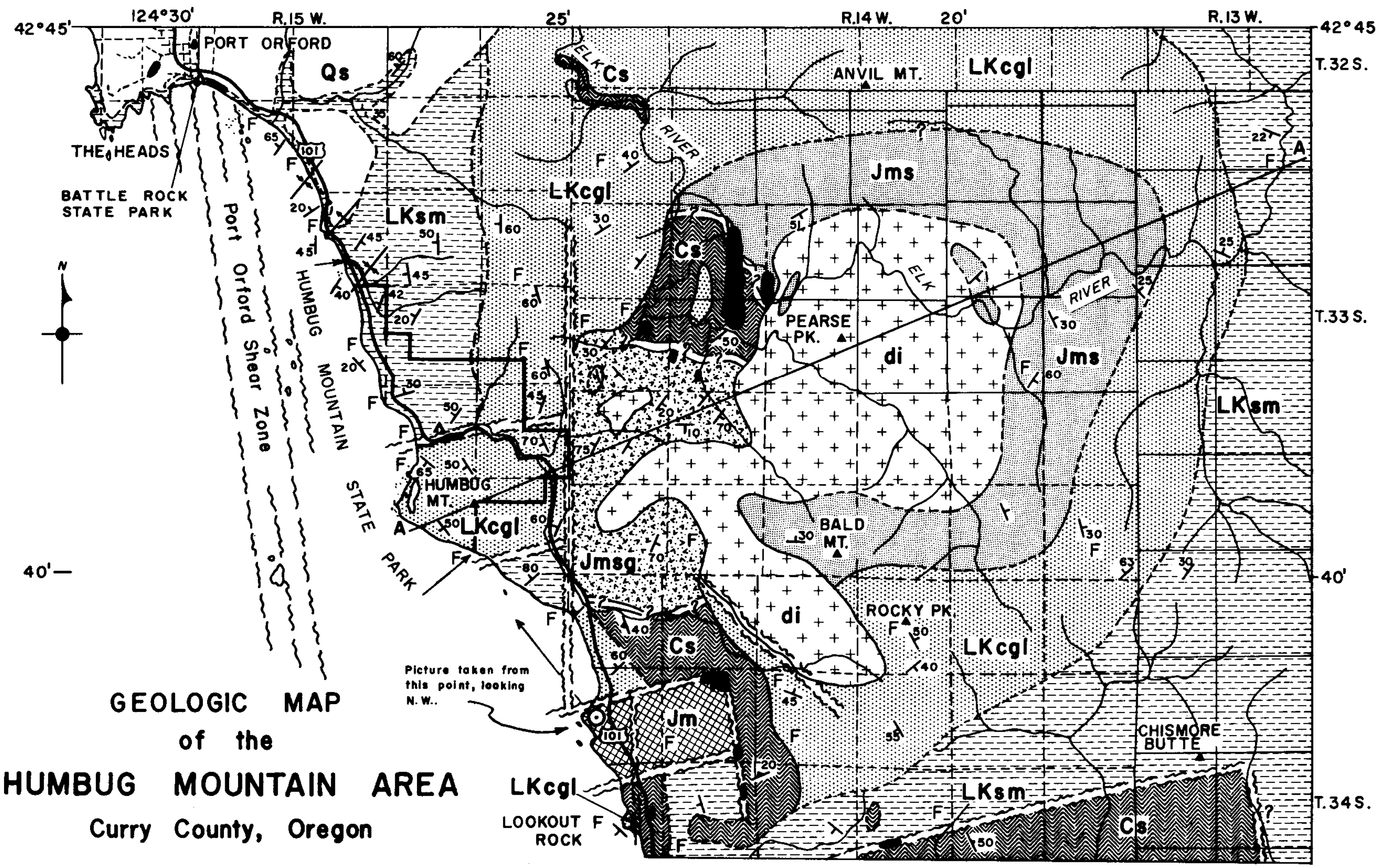
A pre-Cretaceous age for most, if not all, of the greenstone is suggested by abundant fragments of this lithology in the Lower Cretaceous conglomerate. Study of inclusions found in the diorite to ascertain whether they are basic rock may be helpful in further restricting the age of the greenstones and other basic rocks exposed near the Elk River. But greenstone masses along the coast in areas of Cretaceous outcrops cannot be dated adequately. Diller (1903) believed that these (e.g., Silver Butte, just north of Port Orford) were Cretaceous? volcanic necks. This area lies in what now is regarded as the Port Orford shear zone ~~(fig. 1)~~, and it is entirely possible that these masses are in-faulted pre-Cretaceous bodies. Intensely sheared greenstones as well as serpentinites are present due west, but not east, of the diorite pluton. A possible explanation of this relationship, in view of the general northeast strike and southeast dip of the banded metasediments, is that faulting on the west has brought up basic rocks, now greenstones, that were stratigraphically below or low within this sequence. Because of the easterly dip, the greenstones would be buried more deeply on the east, thus explaining why they are not exposed east of the pluton (~~figs. 1 and 2~~). Faulting may also explain the greenstones scattered locally within the phyllite. If basic igneous rocks were interbedded in the phyllite, they probably were better able to withstand dynamic metamorphism because of their relatively greater competence. The fact that many of the greenstones also are associated intimately with banded metasediments makes it important to determine if they are extrusive or intrusive. At present the writers have insufficient petrographic data to give a definite answer. If they are extrusive, we would consider them as interbedded within the banded metasediment sequence and its possible phyllitic phase.

The serpentinites present yet another problem of stratigraphic relationships. Faulting, undoubtedly a significant factor in regard to their present positions, greatly hinders any age assignment for these rocks. Furthermore, serpentinite fragments are apparently absent from the Lower Cretaceous conglomerates.

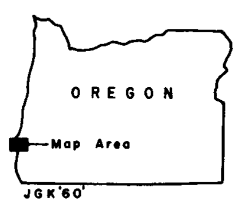
Sedimentary Rocks

Upper Jurassic (Portlandian) Sedimentary Rocks

An unmetamorphosed sequence of sediments containing the late Jurassic (Portlandian) pelecypod *Buchia piochii* (Gabb) was found north of Gold Beach during 1960 (south of the map area of the present report). These are somewhat similar lithologically to the Early Cretaceous sediments. Pillow basalts exposed along the Rogue River about five miles above its mouth may be interbedded with Upper Jurassic strata, but no other known volcanics have been seen associated with them. Detailed petrologic distinctions between the Upper Jurassic and Lower Cretaceous sediments have not been established, but obvious differences exist between conglomerates in the two sequences.



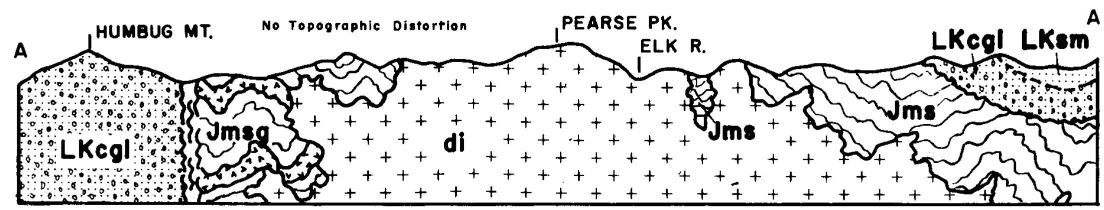
GEOLOGIC MAP
of the
HUMBUG MOUNTAIN AREA
Curry County, Oregon



Geologic Map by R.H. Dott, Jr., W. R. Kaiser, J.G. Koch; U. of Wisconsin, 1960

Base from U.S.G.S. Topographic Map, Port Orford 15' Quadrangle

Scale 0 1/2 1 2 Miles



HUMBUG MOUNTAIN, in the background, is composed of Lower Cretaceous conglomerate. The foreground is of the same material. The light-colored area between is a down-faulted block of younger Cretaceous sandstone and mudstone.

EXPLANATION

PLIO-PLEISTOCENE

- Qs — ELEVATED MARINE TERRACE DEPOSITS. SOME EXPOSURES OF PLIOCENE SEDIMENTS.

ANGULAR UNCONFORMITY

LOWER CRETACEOUS

- LKsm — CHIEFLY GRADED SANDSTONES AND MUDSTONES
- LKcgl — CHIEFLY MASSIVE CONGLOMERATE

ANGULAR UNCONFORMITY

JURASSIC ?

- di — DIORITE
- sp — SERPENTINITE
- Jm — MIXED ROCKS; SEDIMENTS, METASEDIMENTS, SCHIST, GREENSTONES.
- Jms, Jmsg — METASEDIMENTS WITH FORAMINIFERA, Jms; ALSO WITH GREENSTONES, Jmsg.
- Cs — COLEBROOKE SCHIST; QUARTZ-MICA, GRAPHITIC PHYLLITE TO SCHIST WITH GREENSTONES, UNDIFF.

Symbols

- 30 — STRIKE AND DIP OF BEDS
- 40 — STRIKE AND DIP OF FOLIATION
- CONTACT
- INDEFINITE CONTACT
- ? — POSSIBLE LATERAL GRADATION
- SHEAR ZONE
- F — FOSSIL LOCALITY
- ▲ — MOUNTAIN PEAKS
- △ — STATE PARK CAMPING OR PICNIC AREAS
- BOUNDARIES OF HUMBUG MOUNTAIN STATE PARK

Upper Jurassic conglomerates are dominantly of argillite, quartz, and chert fragments that are all less than four inches in average diameter. In contrast, Lower Cretaceous conglomerates contain numerous phyllite, metasediment, greenstone, diorite and other igneous rock clasts, and are generally coarser, having individual fragments to one foot or more in diameter, and more poorly sorted.

Where one sequence is exposed the other is absent. Thus their inter-relationship remains unknown, neither supporting nor denying the possible presence in this area of an unconformity between the Upper Jurassic and Lower Cretaceous strata such as that suggested in the Roseburg area by Imlay, et al. (1959). Although the sequence appears to be equivalent at least in part to the Riddle formation of Imlay, et al. (1959), it is deemed presently inadvisable to apply that term in this area.

Lower Cretaceous (Valanginian) Sedimentary Rocks

A dominantly coarse-grained clastic Lower Cretaceous sequence rests with marked unconformity on pre-Cretaceous rocks exposed along the Elk River (SW¼ sec. 8, T. 33 S., R. 14 W.). This sequence, temporally equivalent to part of the Days Creek formation (Imlay, et al., 1959), has been subdivided into two mappable units by Koch (1960), a lower massive conglomerate unit overlain gradationally by a dark-gray sandstone-mudstone unit. Humbug Mountain consists of southwest-dipping massive conglomerate, whereas north of it the sandstone-mudstone unit is exposed and dips westward. Their relative stratigraphic positions are revealed north of the Humbug Mountain camp ground where the coarse unit appears to dip west beneath the other in an unfaulted relationship. The Lower Cretaceous sequence is believed to be at least 9,000 feet thick. Fragments of pre-Cretaceous rocks are abundant in the conglomerates, and the graywacke sandstones also consist predominantly of lithic fragments. *Buchia crassicolis* (Keyserling) and other early Cretaceous (Valanginian) fossils have been found at several places (see map), notably near the junction of Butler Creek and the Elk River (NE¼ sec. 17, T. 33 S., R. 13 W.).

A study of these strata and their sedimentary structures by Koch (1960) indicates that the Lower Cretaceous is a geosynclinal sequence reflecting the denudation of nearby, easterly source areas. Active erosion and rapid deposition of gravels in close proximity to a very rugged, perhaps faulted, shoreline occurred during the early part of the sedimentary cycle. As erosion and marine transgression proceeded, turbidity current deposition apparently was favored as is evidenced by abundant graded bedding in sandstones and granule to pebble conglomerates. Flute, groove and load casts, contorted bedding, and other sedimentary structures, together with mascerated plant debris mixed with displaced shallow-water pelecypods also typify this sequence. Finer and finer sediments were deposited as the sea progressively transgressed the waning source areas. Absence of contemporaneous extrusive igneous material from the sequence is significant, indicating at least a temporary volcanically-quiescent period. Tectonic instability was extreme, nonetheless, judging from the character and thickness of the Lower Cretaceous sediments and the fact that subsequent faulting and folding have deformed them severely.

Upper Cretaceous Sedimentary Rocks

Upper Cretaceous foraminifera have been identified in rocks exposed along the coast several miles north of Port Orford, but their relationship to older rocks in that area has not been established. They are rather similar lithologically and structurally to Upper Cretaceous deposits about 30 miles south of Port Orford, in the Pistol River and Cape Sebastian area (Popenoe, et al., 1960). The latter area is under study by John K. Howard, graduate student at the University of Wisconsin.

Plio-Pleistocene Sediments

Unconformably overlying the Lower Cretaceous north of Humbug Mountain are Plio-Pleistocene sediments, the most prominent of which are marine terrace deposits of tan sand and gravel. An exposure of fossiliferous sediments, tentatively regarded as the Pliocene Empire formation, was found at the mouth of Hubbard Creek, about one mile southeast of Port Orford. Fossils there include large, coarse-ribbed Pecten and other molluscs, as well as coaly material. A thin terrace veneer of Plio-Pleistocene sediments is also visible approximately 300 feet up on the west or seaward face of Humbug Mountain, just above the sea cliffs.

GEOLOGIC STRUCTURE

Faults of various trends, including almost due north and due east shear zones, have sliced the area into a number of discrete blocks (figs. 1 and 2). The dominant trend, and also the one that has apparently the most intensive deformation, is northerly. Some of the shear zones are at least half a mile wide. Such zones are characterized by intensely sheared rocks, calcite and quartz veining, and commonly by greenstones and ultramafic rocks of indefinite affinities. Also typical of the shear zones are landslides and valleys, for example, the Brush Creek valley at the Humbug Mountain camp ground. Due south of Port Orford, serpentinite masses of indefinite age and origin are present within the Port Orford shear zone. This zone is believed to be coincident offshore with the greenstone islands and to pass west of Humbug Mountain. It apparently re-enters the coast south of the map area. Movement along this and the other shear zones is unclear and requires further study. Their pattern and magnitude of deformation are quite similar to the fault systems of northern California. Distinct contrasts are the more regular northeast-trending structural pattern in the interior Klamath-Siskiyou province farther east (Wells, 1955) and the less intense deformation of Tertiary rocks in the Coast Range farther north.

In general, poor exposures and widespread shearing mask that area's fold patterns. Small folds present in beach exposures north of Humbug Mountain trend northeast, but these may be only the result of movement along the Port Orford shear zone. Mapping, however, does indicate a north to northeast trend in the inland portions of the Lower Cretaceous, a trend somewhat similar to the general northeast structural pattern of most of southwest Oregon. Structures within the pre-Lower Cretaceous, besides those due to shearing, are but imperfectly recognized, as are possible northeast trends in the metasediments.

HISTORICAL SUMMARY

The Humbug Mountain area was subjected to the same severe mountain-building forces that pervaded the whole Klamath region during late Mesozoic time, and presumably earlier as well. The Pearse Peak diorite, a product of this activity, is the most westerly body of like composition in the whole Klamath province. It is notable in that its age can be fixed rather precisely as intra-Late Jurassic or classic Nevadan. Dioritic plutons of this age have proved to be rare indeed, and, in general, these are confined to the westerly side of the Pacific Coast batholithic belt. By far the bulk of the batholiths are of Cretaceous age. Very soon after the diorite was intruded and the most intense deformation had ceased, at least by Early Cretaceous time, the Pearse Peak diorite and surrounding metamorphic and igneous rocks were being eroded in a very rugged terrain, providing abundant coarse gravels to the sea. Topographic conditions then changed, however, and deposition gave way to sandstones and mudstones apparently deposited considerably by turbidity currents.

After Early Cretaceous and until relatively recent time, there was renewed mountain building characterized chiefly by long-continued intense shearing along great fault zones. Broad vertical warping that has taken place still more recently is evidenced by elevated flat-topped and wave-notched sea stacks and by marine terraces veneered with conspicuous tan sands and gravels exposed along Highway 101 between Humbug Mountain and Port Orford.

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UNDERWATER WELL COMPLETION

The petroleum industry's first underwater well completion was announced early in November by Peruvian Pacific Petroleum Company. The wellhead of the pioneer project is located under 130 feet of water on the ocean floor about a mile off the coast of northern Peru. Oil now is flowing from the well to a tank farm ashore through a string of 3-inch-diameter aluminum pipes anchored to the ocean bottom. Success of the technique used could eliminate the need for costly platforms in offshore oilfield development. The unique ocean-floor well utilized a Peruvian Pacific-Richfield Oil Corporation "Christmas tree" made of aluminum piping that is expected to minimize operating and maintenance difficulties at the 130-foot depth of the wellhead. The flow line from well to shore is actually a bundle of aluminum pipes made up of 50-foot lengths welded on shore into two continuous 3250-foot segments. These were then plugged and the lines launched parallel to the shoreline and (pulled through 90 degrees of arc without the use of a pipe-laying barge) floated into position. (From Compressed Air Magazine, January, 1961)

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MINERALOGIST MAGAZINE UNDER NEW OWNERSHIP

The Mineraolgist Magazine, which for over 30 years was owned and managed by the Dake family of Portland, with Dr. H. C. Dake as editor, transferred ownership in September, 1960.

New owner and publisher is Don MacLachlan of Mentone, California, editor of the magazine Gems and Minerals. Mr. MacLachlan states that the editorial policy of The Mineralogist has been altered to make it primarily a magazine for mineral collectors and that very little gem or gem-cutting material will be included, because this type of information is now covered adequately by other periodicals.

The Dakes will continue to handle the publication and distribution of their many popular and helpful booklets on prospecting and gem cutting from their home in Portland.

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STATE LEGISLATIVE NEWS

The following bills of direct interest to the mining industry have been introduced since the report made in the February Ore.-Bin:

House Bill 1668: Introduced by Representatives Haight, Eymann, Kelsay, and Leiken: establishes regulations for perfection of placer mining claims upon the public domain of the United States. Sec. 1 defines "legal subdivision" as a subdivision of a state survey or of a United States survey which has been extended over the geographic area to be described. Sec. 2 requires that location notice shall contain the name of the claim, name of the individuals locating claim, date of location, and description of area to be located. Sec. 3 requires that boundaries of claim be marked within 30 days after posting of location notice. Sec. 4 requires that within 60 days after posting of location notice an open cut be made of not less than five cubic yards in volume and exposing the placer deposit. Sec. 5 requires that within 60 days from posting of location notice the claim shall be filed for record with the County Recorder of Conveyances. Sec. 6 states that all locations or attempted locations of placer mining claims made after the effective date of the act that do not comply with the provisions of secs. 1-5 are void.

House Joint Memorial 11 - Introduced by Representatives Haight, Eymann, Kelsay, Leiken, and Senator Flegel: states the importance of Oregon's mineral resources to the state and nation and the need for maintaining a healthy mineral industry and calls upon the federal government to foster and encourage the development of an economically sound and stable domestic mining and mineral industry, the orderly development of domestic mineral resources and reserves necessary to assure satisfaction of industrial security needs, and research to promote the wise and efficient use of our mineral resources. Recommends that this policy be implemented by more effective enforcement of anti-dumping laws and the imposition of adequate duties on metals and mineral imports.

House Joint Memorial 12 - Introduced by Representative Cannon: urges Congress to decline passage of Senate Bill 174 (the National Wilderness Bill), decline passage of any legislation which would encourage extension of or increase the rigidity of regulation of existing wilderness, wild, or primitive areas, and decline passage of any legislation which would set aside any area of federally owned land for limited and restricted use.

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UNDERSECRETARY FOR MINERALS APPOINTED

On February 14, President Kennedy announced the appointment of John M. Kelly of Roswell, New Mexico, as Assistant Secretary of the Interior for Mineral Resources.

Kelly, a native of Chelsea, Mass., is a mining and petroleum engineer. As assistant secretary, he will discharge the duties of Secretary Udall in the field of natural resource development. He will also be responsible for the activities of the Bureau of Mines, the Geological Survey, the Oil Import Administration, the Office of Mineral Exploration, the Office of Minerals Mobilization, the Office of Coal Research, the Office of Oil and Gas, and the Office of Geography.

For the past 25 years Kelly has been active in the field of petroleum conservation, and at the time of his appointment, was the president of his own oil-producing firm in New Mexico. He is a graduate of the New Mexico School of Mines with bachelor of science degrees in mining engineering and petroleum engineering. (American Mining Congress Bulletin Service, Feb. 18, 1961).

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MINERALS CONFERENCE TO BE HELD AT SPOKANE

The Pacific Northwest Metals and Minerals Conference for 1961 will be held at the Davenport Hotel in Spokane on April 13, 14, and 15. W. D. Nesbeitt, Spokane, is chairman of the conference.

The meeting will be sponsored jointly by the Columbia Section of AIME and the Spokane Section of the American Society for Metals. Scheduled for April 13 and 14 are 11 technical sessions on mining, geology, industrial minerals, minerals beneficiation, geophysics, and primary and secondary metal working. A panel discussion "Gold and the Monetary System" will be held Thursday evening, April 13. The program will include two luncheons with speakers and a buffet dinner. Field trips will be made on Saturday, April 15.

Some of the papers to be presented at the two-day sessions are as follows:

"Cement Operation in the Pacific Northwest" by Lawrence C. Miller, Portland Cement Association, Spokane, Washington.

"Precast and Prestressed Concrete" by J. Gordon Fenton, Central Pre-Mix Concrete Company, Spokane, Washington.

"An Airborne Magnetometer and Scintillometor Survey in Ferry and Okanogan Counties, Washington" by Marshall T. Huntting, Washington State, Division of Mines and Geology, Olympia, Washington.

"Iron Ore Occurrences in Idaho" by David W. Young, Idaho Bureau of Mines and Geology, Moscow, Idaho.

"Engineering Geologic Studies as an Aid in Urban Development" by Herbert G. Schlicker, State of Oregon Department of Geology and Mineral Industries, Portland, Oregon.

"Sawtooth Mountains Aquamarine and Other Beryllium Deposits in Idaho" by Eldon C. Pattee, U. S. Bureau of Mines, Spokane, Washington.

"Stratigraphy of the Belt Series, Northwest Montana" by Willis M. Johns, Montana Bureau of Mines and Geology, Butte, Montana.

"Electron Beam Zone Refining of Tungsten" by Lloyd Bazant, U. S. Bureau of Mines, Albany, Oregon.

"Geology of the Hunters Quadrangle and Vicinity, Washington" by Arthur B. Campbell, U. S. Geological Survey, Denver, Colorado.

"Geochemical Studies in Pend Oreille County, Washington" by James W. Crosby 111 and Richard E. Cavin, Division of Industrial Research, Washington State University, Pullman.

"Permian Limestones in Northeastern Washington" by Joseph W. Mills, Department of Geology, Washington State University, Pullman, Washington.

"Progress Report on the Washington State Geologic Map" by Wayne Moon, Washington State Division of Mines and Geology.

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QUICKSILVER INSTITUTE ELECTS OFFICERS

At the annual meeting of the American Quicksilver Institute, S. H. Williston was elected president, C. Hyde Lewis, vice-president, and S. R. Smith, James Bradley, and C. O. Reed, directors.

Within the past year the number of active quicksilver mines in the United States has dropped by 30 percent because of the lowest price in ten years. As a result, exploration and development for new mines has slowed considerably and current operating mines have had to increase their cut-off grade of ore to remain in operation. This has reduced materially the proven reserves of the industry.

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