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Head Office: 1069 State Office Bldg., Portland, Oregon - 97201
Telephone: 226 - 2161, Ext. 488

Field Offices

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Baker 97814

521 N. E. "E" Street
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EMERY AND EMERYLIKE ROCKS OF THE WEST-CENTRAL CASCADE RANGE, OREGON*

By

Jack C. White [1], Jerry J. Gray [1], and Joseph W. Town [2]

Abstract

A suite of high-temperature alumina-silica-iron emerylike contact metamorphic rocks containing mullite has been identified from float specimens obtained from the west-central Cascade Range, Oregon. The material is dense, fine-grained, and variable in texture. The emery rocks are composed of corundum-magnetite and mullite-hercynite. Cristobalite-mullite and tridymite-mullite-hercynite occur in associated emerylike rocks. X-ray, chemical, and optical methods were used in the investigation. The rocks evidently were formed by pyrometamorphism of argillaceous and bauxitic materials.

Introduction

A cobble of unusual dense black rock was brought to the Bureau of Mines, Albany, Oregon, for identification (see accompanying map for location). Spectroscopic analyses showed that the sample consisted essentially of aluminum, iron, and silica with trace amounts of alkali metals and calcium. X-ray diffraction data indicated that the rock was composed of mullite and a spinel group mineral. Although the alumino-silicate mineral could not be positively identified as mullite, the authors believe that the evidence justifies use of the term mullite rather than sillimanite throughout the manuscript. Similar black cobbles were found near the bottom of excavations

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[1] Geologist; [2] Extractive Metallurgist.
The first and third authors are with the Albany Metallurgy Research Center, Bureau of Mines, U.S. Department of the Interior, Albany, Oregon; the second author is with the Albany Office of Mineral Resources, Bureau of Mines, Albany, Oregon.

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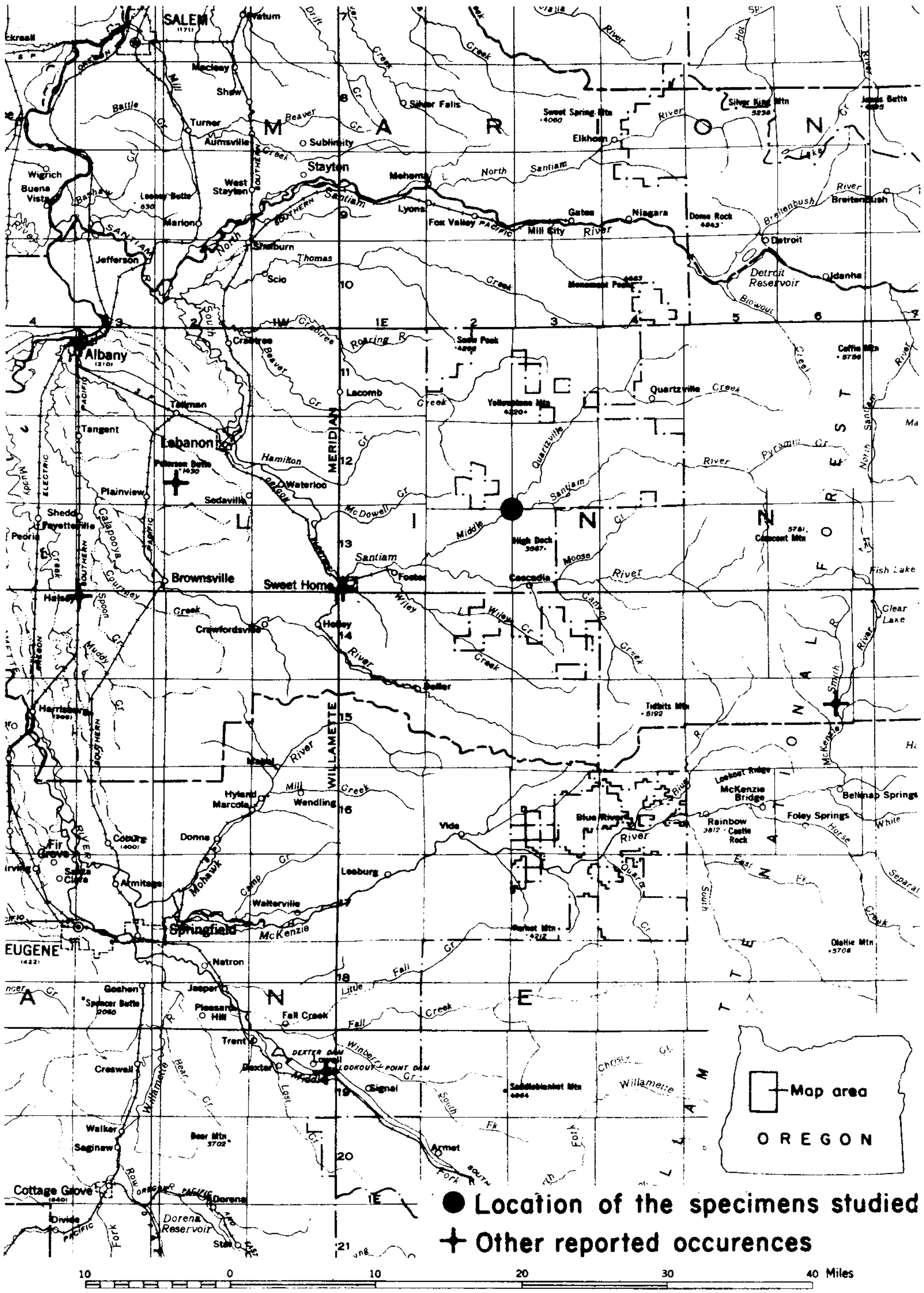

Map of the west-central Cascade Range, Oregon, showing locations where emery and emerylike rocks have been found.

for the Green Peter Dam on the Middle Santiam River, and a few specimens have been found on gravel bars along the Willamette River between Albany and Junction City, Oregon. Additional samples have been found on gravel bars of the Willamette River near Lookout Point Reservoir approximately 10 miles southeast of Eugene, Oregon, and at the Karmen-Smith Dam on the upper McKenzie River. One naturally polished boulder weighing approximately 200 pounds was found on the south side of Peterson's Butte approximately 3 miles southwest of Lebanon, Oregon. Further investigation was undertaken because emery has not been reported from Oregon, because mullite is rarely found as a naturally occurring mineral, and because of the widespread occurrence of these unusual mullite-spinel rocks.

The black emery cobbles may be identified in the field by their naturally polished, unaltered surfaces and by their hardness and "heft." The emerylike specimens generally have a light bluish-gray color and a somewhat glossy, unaltered surface. In the field they resemble andesite and other light-colored volcanic rocks and it takes practice to recognize them.

A collection of emery rocks was made from the Green Peter Dam waste dump. Some of the black cobbles contained light-colored inclusions of emerylike material composed of mullite-cristobalite. X-ray diffraction data indicated that some of the black cobbles contained corundum in addition to mullite and spinel. One light-gray cobble consisted essentially of corundum.

The Middle Santiam River drainage above Green Peter Dam is composed of Cascade volcanics, suggesting that the suite of related high-temperature rock types described in this paper was formed by thermal metamorphism of aluminous materials in contact with lava extruded during Cascade volcanism.

Ten rock specimens were selected for analysis. Selection of specimens, based on visual-arc spectroscopic analysis, color, texture, hardness, and specific gravity, was designed to obtain as large a range of rock types as possible.

Petrography and Mineralogy

In general, the 10 rock specimens are very fine grained, and microscopic identification of minerals is difficult or impossible except for a few scattered, larger crystals. Therefore, minerals were identified by X-ray diffraction as shown in table 1.

Specimen 1 is medium-gray rock with a fine-grained, mottled appearance that contains a few small, light-colored inclusions. It is composed principally of corundum with a minor amount of magnetite.

Specimen 2 is a medium-gray, fine-grained, mottled rock with a large light tan to light bluish-gray inclusion. The gray matrix is composed mainly of cristobalite, with a minor amount of tridymite and mullite and trace amounts of quartz. The light-colored inclusion is mullite-cristobalite, with

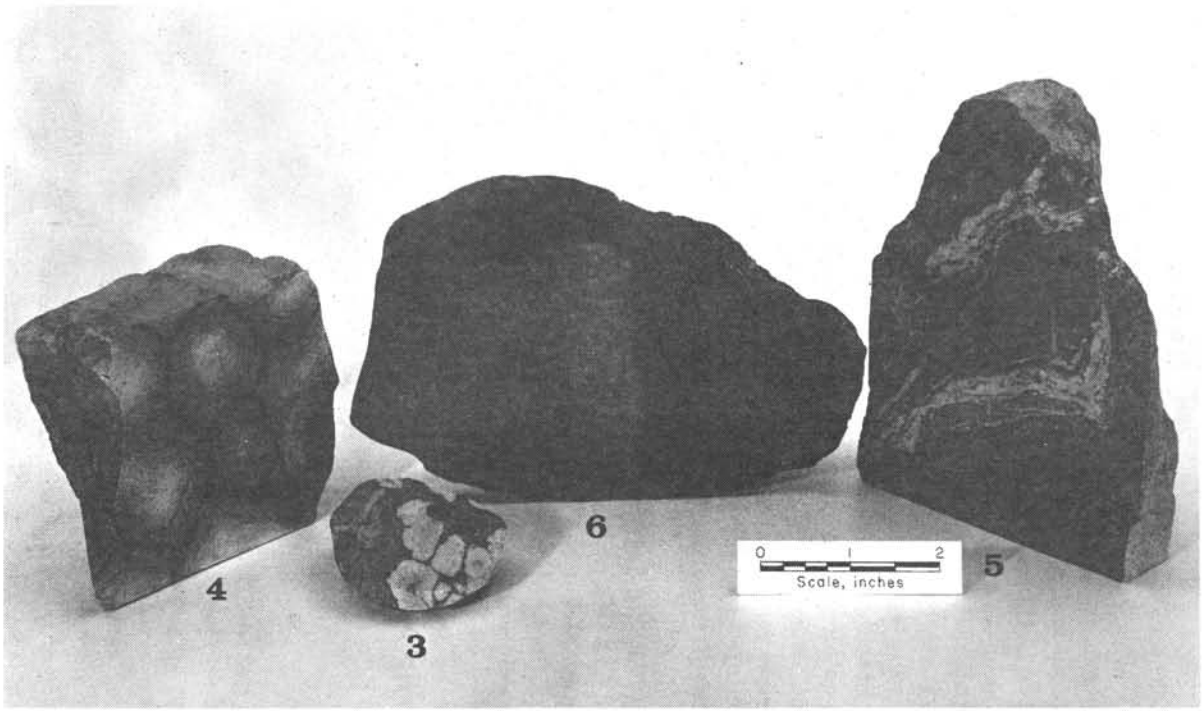

Figure 1. Photograph showing rock textures. Specimen 3 - podlike inclusions; specimen 4 - columnar polygonal blocks; specimen 6 - flow structure; specimen 5 - flow structure.

a trace of tridymite.

Specimen 3 has a fine-grained, mottled-gray groundmass, containing white pod-shaped inclusions noted in figure 1. The gray groundmass is cristobalite-mullite, with a minor amount of magnetite. The white inclusions are mullite-cristobalite. Flow structure is evident in the groundmass adjacent to the white inclusions.

Specimen 4 is a light-tan to light-gray, fine-grained rock composed of columnar polygonal blocks with black interstitial fracture fillings. The texture of this sample varies from polygons about 1 cm across, defined by a network of fracture fillings less than a millimeter thick, to polygons 5 cm across, defined by fracture fillings 1 to 3 millimeters thick (figure 1). Light-colored centers of the larger polygons are mullite-cristobalite, and the black fracture-fillings are tridymite-hercynite, with a minor amount of magnetite and traces of corundum and mullite. Gray concentric-diffusion bands similar to liesegang bands and presumably of higher iron content occur along the margins of the larger polygons (figure 1). Scattered crystals of perovskite approximately 40 microns in diameter were identified in the mullite-cristobalite portion of the sample by electron microprobe X-ray analysis.

Specimen 5 contains streaks of white, fine-grained material and pods and stringers of mottled fine-grained, medium-to-dark gray material. The banding appears to be a flow structure. The sample is essentially tridymite, with minor amounts of mullite and hercynite (figure 1).

Specimen 6 is composed of mottled dark-gray irregular podlike inclusions in a black matrix. Flow structure is evident in the matrix (figure 1). The sample is principally mullite-hercynite with a trace of cristobalite.

Specimen 7 is a mottled, dark-gray, fine-grained rock with indistinct darker bands along one side. It is composed chiefly of mullite-hercynite and quartz, with a minor amount of cristobalite.

Specimen 8 is a fine-grained black rock with a few percent of large magnetite grains. It is composed principally of hercynite, with a minor amount of mullite and cristobalite, and a trace of tridymite.

Specimen 9 is a megascopically textureless black rock, composed essentially of hercynite, with minor mullite. Thin sections show fine, very contorted vermicular banding (figure 2).

Specimen 10 is a dense black rock with faint macroscopic and pronounced microscopic banding (figure 2). It is composed mainly of corundum and magnetite, with a trace of mullite and alpha quartz. Small clusters of corundum crystals, intergrown with minute, green crystals of a spinel group mineral of unknown composition, can be identified in thin sections. The bulk of the rock, however, is too fine grained for microscopic mineral identification.

Specimens 1 and 10 are considered to be emery; 6, 8, and 9, spinel emery; and the lighter colored emerylike specimens, 2, 3, 4, and 5, are buchites. The classification and association of sample 7 are uncertain.

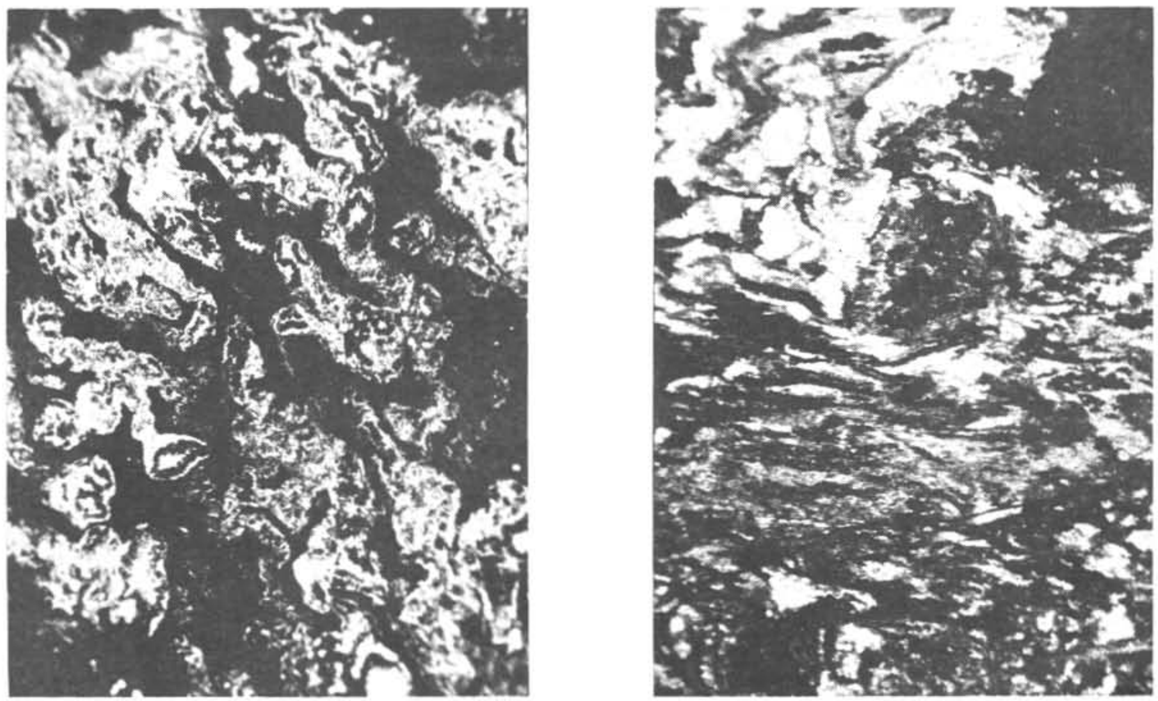

Figure 2. Photomicrographs (60X). Left: specimen 9, showing vermicular banding; right: specimen 10, showing contorted banding.

Table 1. Mineralogical composition of the specimens.

Mineral [1]	Specimen number 1	2 gray	2 white	3 black	3 white	4 black	4 white	5	6	7	8	9	10
Corundum	A					D							B
Cristobalite		B	B	B	B		B		D	C	C		
Hercynite (spinel)						B		C	B	B	A	A	
Magnetite	C			C		C							B
Mullite		C	B	B	B	D	B	B	B	B	C	C	D
Quartz		D								B			D
Tridymite		C	D			B	D	A			D		
Unidentified	C	D	D	C	D		D						

[1] Estimated amounts of constituents: A - 40 to 100 percent; B - 20 to 60 percent; C - 5 to 30 percent; D - less than 10 percent

X-ray diffraction results indicate that the predominant spinel phase has unit cell dimensions that vary from 8.20A to 8.22A as determined from the (400) peak on diffractometer traces. This spinel-group mineral probably is a solid solution between hercynite and magnetite (Heinrich, 1956). It is not certain whether the green spinels identified in thin sections of sample 10 correspond to this hercynite-magnetic composition. A separate magnetite phase was identified microscopically in some samples.

Preliminary X-ray diffraction results indicated that several rock samples contained either mullite or sillimanite. An attempt was made to determine which of the two minerals was present. An essentially pure sillimanite concentrate was made by means of heavy-liquid and magnetic separation of sillimanite-magnetite rock from Benson Mines, N.Y. A portion of the relatively pure sillimanite was converted to mullite by heating for 4 hours at 1650° C. Diffractometer traces of the sillimanite and mullite were made and were compared with diffractometer traces of the rock samples. Calculation of accurate lattice parameters of mullite-sillimanite in the rock samples was impossible because of weak diffractometer peaks in the back reflection region. It was noted, however, that the relative intensity of the 5.4A peak was 18 for pure sillimanite and 64 for mullite made from sillimanite. The relative intensity of the 5.4A peak ranges from 13 to 29 for rock samples containing from 20 to 60 percent mullite (table 1). This intensity is greater than would be expected if the mineral in question were sillimanite.

In addition, a 3.84A peak with a relative intensity of 40 was observed

Table 2. Semiquantitative spectrographic analyses of the specimens.

Sample number	Estimated ranges, percent										
	> 10	3-30	1-10	0.3-3	0.1-1	0.03-0.3	0.01-0.1	0.003-0.03	0.001-0.01	0.0003-0.003	0.0001-0.001
1	Al, Fe			Mg, Si, Ti			Cr, Ga, Mn, V, Zr	Cu, Ni			
2 Gray	Al, Si	Fe		Ti		Mg, Na	Ca, Mn, Ni, V, Zr	Ga	Cr, Cu		Ag
2 White	Al, Si		Fe			Ca, Mg, Na	Mn, Ti	Cu	Ga, Ni, V		
3 Black	Al, Si	Fe		Ca, Mg, Ti	Na		Zr, Ga, Mn	Ni, V	Cr, Cu		
3 White	Al, Si		Fe	Mg	Ca	Mn, Na	Ga, Ti	Zr	Cu, Ni		Ag
4 Black	Al, Fe, Si			Mg, Ti		Ni	Na, Zr	Mn, V, Cu, Ga	Cr		
4 White	Al, Si		Fe	Ti		Mg	Ga, Na, V	Cr, Cu, Mn, Ni, Zr			
5	Al, Si	Fe		Mg, Ti		Mn, Ni	Na, V, Zr	Ga	Cr, Cu		
6	Al, Si	Fe		Ti		Mg, Ni	Mn, Na, V, Zr	Cr, Ga	Cu		
7	Al, Fe, Si			Mg, Ti		Mn, Ni	Na, V, Zr	Ga	Cr, Cu		
8	Al, Fe, Si			Mg, Ti		Ni	Mn, Na, V, Zr	Cr, Ga	Cu		
9	Al	Fe, Si		Mg, Ti	Mn		Cr, V, Zr	Cu, Ga, Ni			
10	Al	Fe, Si		Ti		Mg	V, Zr	Cr, Cu, Ga, Ni	Ag, Mn		

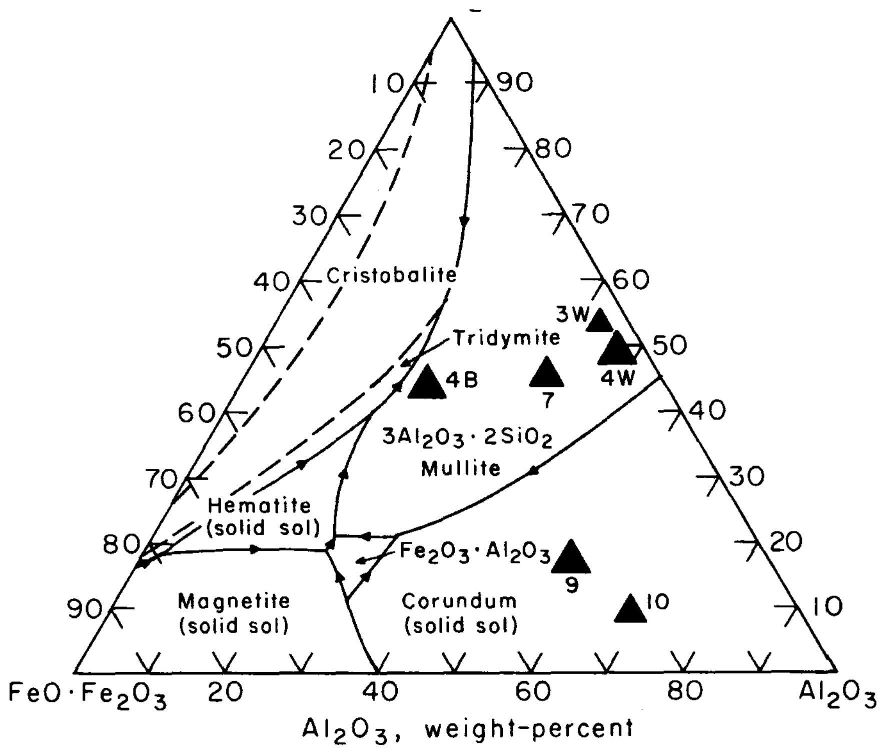

FIGURE 3.–Six Partial Rock Analyses Plotted on Morey's (1964) Iron Oxide-Al_2O_3-SiO_2 Phase Diagram.

3W White (mullite and cristobalite) 7 (mullite, hercynite and quartz)
4B Black (tridymite and hercynite) 9 (hercynite and mullite)
4W White (mullite and cristobalite) 10 (corundum and magnetite)
Area of triangles corresponds to titania plus constituents not accounted for by chemical analyses

66-73X

Table 3. Partial chemical analyses of specimens 3, 4, 7, 9, and 10.

	3 White	4 Black	4 White	7	9	10
SiO_2	51.9	42.3	47.6	43.9	15.4	7.62
TiO_2	0.40	1.50	1.62	1.90	3.25	2.79
Al_2O_3	42.6	23.3	45.6	38.7	55.6	67.3
Fe_3O_4	1.96	29.4	2.60	13.3	24.2	20.7
MgO	0.18	0.03	0.04	0.04	0.59	0.01
Total	97.04	96.53	97.46	97.84	99.04	98.42

in diffractograms of pure sillimanite. No 3.84A peak was observed for either the prepared mullite or in any of these rock samples.

The authors consider the X-ray results to be a strong indication, but not absolute proof, of the presence of mullite in the samples. Other evidence tending to substantiate the presence of mullite includes occurrence in a volcanic terrain, high-temperature mineral associations, and mullite-cristobalite inclusions with the approximate Al/Si ratio of kaolinitic clay.

Chemistry and Petrogenesis

Individual minerals could not be mechanically separated for analysis because of the very fine-grained nature of these rocks. Spectrographic analyses of all samples are shown in table 2, and partial chemical analyses of six samples are shown in table 3. Analyses show all specimens are principally composed of SiO_2, Al_2O_3, and iron oxide.

The six chemically analyzed samples from four specimens were plotted on the iron-oxide, SiO_2, Al_2O_3 phase diagram of Muan (1957b) as modified by Morey (1964) and as noted in figure 3. Magnesium was included with iron, and titanium was excluded from the plot. Iron oxide was calculated as Fe_3O_4. Mineralogical composition determined by X-ray diffraction (table 1) corresponds reasonably well with that predicted by the phase diagram.

Temperature of initial fusion of these naturally occurring materials is uncertain. Muan (1957b) states that, "At low O_2 pressures, a liquid phase may appear at temperatures as low as 1088° C., whereas liquid is present only at temperatures above 1380° C, when the atmosphere is air." Water vapor pressure may provide the oxygen required to maintain the higher fusion temperatures; whereas, other constituents would tend to lower the initial fusion temperature.

Sample 4 appears to represent an initial stage of thermal metamorphism. The authors interpret the polygonal structure of this sample as dessication cracking of clay followed by metamorphism of the clay to mullite-cristobalite and the introduction of iron and silica as fracture fillings. Concentric bands are better defined farther from polyhedra surfaces; and the size of dark crystals increases inward, suggesting liesegang banding caused by diffusion of iron into the polyhedra (figure 1).

Sample 3 represents a more advanced stage of thermal metamorphism in which flow structure is evident in the groundmass adjacent to the well-rounded white inclusions.

White portions of samples 3 and 4 have alumina-to-silica ratios of 0.82:1 and 0.96:1, respectively, compared to 0.85:1 for kaolinite, indicating that these materials could have been kaolinitic clays before thermal metamorphism. Samples 9 and 10 have alumina-to-silica ratios of 3.6:1 and 8.8:1 , respectively, indicating that these black specimens were ferruginous bauxites before metamorphism.

All evidence indicates that these emery and emerylike rocks were formed by pyrometamorphism of argillaceous and bauxitic materials by contact with volcanic heat sources. Future discovery of the outcrop sources may allow a more detailed account of the origin of these unusual rocks.

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Glossary of Mineral and Rock Names

Buchite - A type of partially fused rock resulting from the contact of clay or shale with molten magma.

Corundum - Aluminum oxide: Al_2O_3.

Cristobalite - Silicon dioxide: SiO_2 - a stable form of silica at high temperatures.

Emery - A tough rock composed of a mixture of corundum, hercynite, and magnetite. Domestic emery does not necessarily contain corundum.

Hercynite - Iron spinel: $FeAl_2O_4$.

Mullite - Aluminum silicate: $3Al_2O_3 . 2SiO_2$ - Forms from sillimanite above 1600° C. Found in fused argillaceous inclusions in Tertiary lavas on the island of Mull, Scotland.

Perovskite - Calcium titanate: $CaTiO_3$.

Sillimanite - Aluminum silicate: Al_2SiO_5.

Tridymite - Silicon dioxide: SiO_2 - a stable form of silica at medium temperatures.

* * * * *

SUMMARY STATEMENT OF PRINCIPLES AND RECOMMENDATIONS CONCERNING LAWS RELATING TO MINING

Presented by the American Mining Congress
Before the Public Land Law Review Commission*

1. The maximum benefit to the public will be obtained by continuing the basic principle of the present mining laws, namely, the right of individuals to go on public lands and search for, discover, develop and acquire title to metals and minerals lying within the public domain.

2. One who discovers a buried and unknown mineral deposit in the public domain should have, as a reward for discovery of this resource of our Nation, the right to acquire for a nominal price, title to the mineral deposit, together with the right to use so much of the surface as may be needed for mining and related purposes.

3. The mining laws should be amended to provide one kind of mining claim for exclusive use in locating all locatable minerals; the existing distinction between lode and placer claims should be abolished.

4. The mining laws should be amended to require that (a) boundaries of new claims on surveyed land conform as nearly as practicable to the lines of the public survey and the claims be described by legal subdivision, and (b) boundaries of new claims on unsurveyed land be tied by courses and distances to a corner of a public survey or a United States mineral monument or some natural object or permanent monument.

5. The mining laws should be amended to eliminate extralateral rights in future mining locations.

6. The mining laws should be amended to specify requirements in making a location to the exclusion of all state location requirements.

7. Documents relating to unpatented mining claims should be required to be filed or recorded in only one office and that is the recording office for the county in which the mining claims are located.

8. The mining laws should be amended to provide for payment (at fair market value) of nonmineral surface resources when title to the surface is acquired by the patentee.

9. Because mineral exploration today is chiefly directed to discovery of nonoutcropping and often deeply buried mineral deposits and to encourage the expenditure of large sums necessary to carry forward needed mineral explorations, the existing mining laws should be amended to provide reasonable prediscovery protection.

* The complete statement, as presented to the Public Land Law Review Commission by the American Mining Congress, has been published in a booklet entitled "The Mining Industry and The Public Lands." Copies may be obtained from the American Mining Congress.

10. The mining laws should be amended to provide a simple way to clear the public domain of abandoned mining claims, i.e., to provide that a mining claim is conclusively presumed abandoned if notice is not filed in the appropriate county office at least once every three years.

11. The law permitting geological, geochemical and geophysical surveys to be used as assessment work should be amended so as to remove requirements for public disclosure of confidential information obtained in such work and unwarranted limitations on use of surveys as assessment work.

12. As the Nation's hidden mineral resources cannot be developed and their value to the Nation determined until they are discovered, and because constantly improving tools and techniques of mineral exploration and mining are resulting in mineral discoveries in lands heretofore considered nonmineral in character, the public domain should be kept open to mineral exploration and location of new discoveries except in those cases where there is a compelling national interest for closing them.

13. Congress should not, nor should it permit administrative agencies to, lock up buried and unknown mineral deposits by patenting surface rights and then withdrawing mineral deposits from location under the mining laws or leasing under the mineral leasing laws.

14. One who discovers a mineral deposit should have the right to acquire, adjacent to a mineral discovery, a reasonable acreage of ground for plant facilities and waste disposal areas on paying the fair market value for the ground.

15. Existing federal statutes authorizing land exchanges should be amended in order to facilitate exchanges of public lands required for uses incidental to mining for other lands acceptable for government use.

16. The Classification and Multiple Use Act, as amended, should be permitted to expire on December 31, 1970, and, as of that date, all classifications and segregations made under the act should be terminated except to the extent that they meet criteria recommended by the Public Land Law Review Commission.

17. Congress should explicitly and with care spell out the limits within which administrative agencies are permitted or required to act in administering public lands, and, to the extent possible, make all mining and mineral leasing laws self-executing (applicable to all legislation).

18. In order to encourage exploration for and development of leasable mineral resources in public lands, the federal mineral leasing laws should be amended in the following respects:

(a) To prohibit imposition of new and burdensome obligations on lessees whether by regulation or by amendment of the lease contract.

(b) To establish legislative guidelines requiring classification of public lands for issuance of prospecting permits except where workability and minability of a valuable commercial deposit is known.

(c) To make reasonable increases in acreage limitations where required to provide an adequate resource base to justify the required investment.

(d) To require that the preference right outlined in a prospecting permit set forth fully the terms and conditions of the lease which will be issued under the permit, and to provide that these terms and conditions cannot be subsequently changed except with consent of the permittee.

(e) To establish reasonable statutory time limits for adjudication of applications for permits, and require the Secretary to issue permits and leases on vacant lands not withdrawn or otherwise appropriated if the application is in order.

19. Interior Department procedures and practices in public land matters should be changed in the following respects:

(a) A full Administrative Procedure Act-type hearing be made available in every public land case where there is a genuine issue of material fact.

(b) Appeal to the director of the Bureau of Land Management be abolished.

(c) All judicial functions, both trial and appellate, be placed directly under a judicial officer within the office of the Secretary of the Interior, entirely separate from the office of the solicitor.

(d) The Rules of Practice of the Department of the Interior be modernized along the lines of the present rules of procedure of federal courts, as interpreted by those courts.

(e) The right of review of the final decisions of the Secretary of the Interior by the United States District Court in accordance with existing venue statutes be clearly affirmed and modified in certain respects.

(f) The time for decision by the Secretary be limited to not more than one year from the date of the examiner's decision.

(g) The status of public land matters under the Administrative Procedure Act be clarified so that it can no longer be contended that they are exempt from that act.

(h) The practice of selective certification in connection with appointment of hearing examiners be abolished.

20. The rule for discovery of a valuable mineral deposit is the prudent man test. In applying this test the Department of the Interior and the courts should give major weight to the prospective value of the deposit.

21. A correct definition of "common varieties," as used in section 3 of the Surface Resources Act (30 USC § 611), means a common variety of one of the classes enumerated in section 3, for example, stone, and does not mean a common variety of a particular type of stone, such as limestone.

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The following published and unpublished reports on Oregon geology and mineral resources were added to the Department's library during 1967. The list does not include papers appearing in technical journals or trade magazines.

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Vallier, Tracy L., The geology of part of the Snake River Canyon and adjacent areas in northeastern Oregon and western Idaho: Oregon State Univ. doctoral diss.

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UNDERGROUND EXCAVATION METHODS URGED

Two of America's greatest challenges -- resource conservation and the urban crisis -- cannot be met fully without a technological revolution in underground excavation methods, according to a report prepared for the U.S. Bureau of Mines.

The report, written by the National Academies of Sciences and Engineering, recommends a $200 million government effort to promote new excavation methods that would save the land surface from mining operations, allow access to deep mineral deposits now out of man's reach, and provide a "third dimension" for urban expansion.

Today surface excavation methods are much more economical and efficient than underground techniques, the report points out. As a consequence, 85 percent of America's mineral output now comes from surface mines, many of which have undesirable environmental effects. But the volume of surface operations will continue to increase (if underground mining becomes no more attractive) because the nation's mineral needs are growing, and because depletion of high-grade deposits will require bigger surface mines to exploit large, low-grade ore bodies. Meanwhile, deeper and perhaps richer deposits will lie idle because they cost too much to mine.

The 10-year research effort recommended by the Academies would aim at making underground excavation three times faster and 30 percent cheaper than it is today. Areas in which basic research is needed, declares the report, include tunneling through hard rock, underground materials handling, advance determination of underground geological conditions, ground support, and measurement of stresses in underground rock formations.

Copies of the report can be purchased for $2.50 each from the National Academy of Sciences, Printing and Publishing Office, 2101 Constitution Avenue, Washington, D.C. 20418. (American Mining Congress News Bulletin, August 30, 1968).

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EXPLORATION INCENTIVE ANNOUNCED

The Department of the Interior will accept requests for oil and gas development contracts in areas in the Western public land States which are relatively unexplored for these minerals. This program is similar to the program for remote areas of Alaska. This 'special treatment' is an incentive for exploration in high risk areas. The contract program gives an operator temporary exemption of a large block of Federal leases from the acreage limitation on holdings and control. The operator must commit a definite program of exploration, a performance timetable, and a substantial expenditure. (AGI Report, November 4, 1968).

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NIXON CALLS FOR NATIONAL MINERALS POLICY

Richard M. Nixon, in an October 18 CBS radio address entitled "A Strategy of Quality: Conservation in the Seventies," touched on several points of interest to the mining industry.

The President-elect pointed out that we are actually faced with the task of preserving our environment and at the same time preserving our high standard of living. "It is a battle which will have to be fought on every level of government, not on a catch-as-catch-can basis, but on a well-thought-out strategy of quality which enlists the aid of private industry and private citizens."

Nixon emphasized the need for a national minerals and fuels policy. "...we must create a national minerals and fuels policy if we are to maintain production needed for our economy and security. The strategy of quality looks upon the oil well and the mine as vital parts of the American economy and of American power. There is no contradiction between preserving the natural beauty of America and assisting the mineral industries which are the primary sources of American power. Economic incentives, including depletion allowance, to encourage the discovery and development of vital minerals and fuels, must be continued."

Also of interest was his reference to public lands and related resources. "...federal laws applicable to public lands and related resources should be brought up to date. These lands will be managed to ensure their multiple use as economic resources and recreation areas." (American Mining Congress News Bulletin, November 8, 1968.)

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PROPOSED SAFETY STANDARDS TO BE PUBLISHED

Under Secretary of the Interior David S. Black has designated a three-man steering committee to expedite preparation of proposed standards under the Federal Metal and Nonmetallic Mine Safety Act. The Department's stated intent is to publish notice of the proposed rule making on or before December 31, 1968.

Members of the committee are Dr. Earl Hayes, deputy director, U.S. Bureau of Mines; Julian Feiss, staff geologist, Office of the Assistant Secretary of the Interior (Mineral Resources); and Bruce Wright, associate solicitor, Mineral Resources and General Legal Services. (American Mining Congress News Bulletin, November 8, 1968.)

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OCEAN MINING LAW CONFERENCE TO BE HELD IN OREGON

The coastal states conference on "A Multiple Use Approach to Offshore Mining Law" will be held in Portland, Oregon December 11, 12, and 13.

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AVAILABLE PUBLICATIONS

(Please include remittance with order. Postage free. All sales are final and no material is returnable. Upon request, a complete list of the Department's publications, including those no longer in print, will be mailed.)

BULLETINS

2.	Progress report on Coos Bay coal field, 1938: Libbey	$ 0.15
8.	Feasibility of steel plant in lower Columbia River area, rev. 1940: Miller	0.40
26.	Soil: Its origin, destruction, preservation, 1944: Twenhofel	0.45
33.	Bibliography (lst supplement) of geology and mineral resources of Oregon, 1947: Allen	1.00
35.	Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1963: Baldwin	3.00
36.	(1st vol.) Five papers on Western Oregon Tertiary foraminifera, 1947: Cushman, Stewart, and Stewart	1.00
	(2nd vol.) Two papers on Western Oregon and Washington Tertiary foraminifera, 1949: Cushman, Stewart, and Stewart; and one paper on mollusca and microfauna, Wildcat coast section, Humboldt County, Calif., 1949: Stewart and Stewart	1.25
37.	Geology of the Albany quadrangle, Oregon, 1953: Allison	0.75
46.	Ferruginous bauxite deposits, Salem Hills, Marion County, Oregon, 1956: Corcoran and Libbey	1.25
49.	Lode mines, Granite mining dist., Grant County, Ore., 1959: Koch . .	1.00
52.	Chromite in southwestern Oregon, 1961: Ramp	3.50
53.	Bibliography (3rd supplement) of the geology and mineral resources of Oregon, 1962: Steere and Owen	1.50
56.	Fourteenth biennial report of the State Geologist, 1963-64	Free
57.	Lunar Geological Field Conference guide book, 1965: Peterson and Groh, editors	3.50
58.	Geology of the Suplee-Izee area, Oregon, 1965: Dickinson and Vigrass	5.00
60.	Engineering geology of the Tualatin Valley region, Oregon, 1967: Schlicker and Deacon	5.00
61.	Gold and silver in Oregon, 1968: Brooks and Ramp	5.00
62.	Andesite Conference Guidebook, 1968: Dole, editor	3.50

GEOLOGIC MAPS

Preliminary geologic map of Sumpter quadrangle, 1941: Pardee and others . . .	0.40
Geologic map of the St. Helens quadrangle, 1945: Wilkinson, Lowry & Baldwin .	0.35
Geologic map of Kerby quadrangle, Oregon, 1948: Wells, Hotz, and Cater . .	0.80
Geologic map of Albany quadrangle, Oregon, 1953: Allison (also in Bull. 37) .	0.50
Geologic map of Galice quadrangle, Oregon, 1953: Wells and Walker	1.00
Geologic map of Lebanon quadrangle, Oregon, 1956: Allison and Felts	0.75
Geologic map of Bend quadrangle, and reconnaissance geologic map of central portion, High Cascade Mountains, Oregon, 1957: Williams	1.00
GMS-1 - Geologic map of the Sparta quadrangle, Oregon, 1962: Prostka . . .	1.50
GMS-2 - Geologic map, Mitchell Butte quad., Oregon, 1962: Corcoran et al. .	1.50
GMS-3 - Preliminary geologic map, Durkee quad., Oregon, 1967: Prostka . .	1.50
Geologic map of Oregon west of 121st meridian: (over the counter) . . . . . folded in envelope, $2.15; rolled in map tube, $2.50	2.00
Gravity maps of Oregon, onshore and offshore, 1967: [Sold only in set]: flat . . folded in envelope, $2.25; rolled in map tube, $2.50	2.00

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Available Publications, Continued:

SHORT PAPERS

2.	Industrial aluminum, a brief survey, 1940: Leslie L. Motz	$ 0.10
18.	Radioactive minerals the prospectors should know (2nd rev.), 1955: White and Schafer	0.30
19.	Brick and tile industry in Oregon, 1949: J.E. Allen and R.S. Mason .	0.20
20.	Glazes from Oregon volcanic glass, 1950: Charles W. F. Jacobs . . .	0.20
21.	Lightweight aggregate industry in Oregon, 1951: Ralph S. Mason . . .	0.25
23.	Oregon King Mine, Jefferson County, 1962: F.W. Libbey and R.E. Corcoran	1.00
24.	The Almeda Mine, Josephine County, Oregon, 1967: F. W. Libbey . .	2.00

MISCELLANEOUS PAPERS

2.	Key to Oregon mineral deposits map, 1951: Ralph S. Mason	0.15
3.	Facts about fossils (reprints), 1953	0.35
4.	Rules and regulations for conservation of oil and natural gas (revised 1962)	1.00
5.	Oregon's gold placers (reprints), 1954	0.25
6.	Oil and gas exploration in Oregon, rev. 1965: Stewart and Newton . .	1.50
7.	Bibliography of theses on Oregon geology, 1959: H. G. Schlicker . .	0.50
7.	(Supplement) Bibliography of theses, 1959 to Dec. 31, 1965: M. Roberts	0.50
8.	Available well records of oil & gas exploration in Oregon, rev. 1963: Newton	0.50
10.	Articles on Recent volcanism in Oregon, 1965: (reprints, The ORE BIN) .	1.00

MISCELLANEOUS PUBLICATIONS

Oregon mineral deposits map (22 x 34 inches), rev. 1958	0.30
Oregon quicksilver localities map (22 x 34 inches) 1946	0.30
Landforms of Oregon: a physiographic sketch (17 x 22 inches), 1941	0.25
Index to topographic mapping in Oregon, 1961	Free
Index to published geologic mapping in Oregon, 1960	Free
Geologic time chart for Oregon, 1961	Free

OIL and GAS INVESTIGATIONS SERIES

1.	Petroleum geology of the western Snake River basin, Oregon-Idaho, 1963: V. C. Newton, Jr., and R. E. Corcoran	2.50