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DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
Head Office: 1069 State Office Bldg., Portland, Oregon - 97201
Telephone: 229 - 5580

FIELD OFFICES

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Baker 97814

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PLATINUM IN OREGON

Steven R. Munts*

The platinum-group metals have been the subject of considerable discussion in the news media over the past few months, particularly because of their projected use as catalysts in automobile engines. Metals Week of August 27 shows that platinum commands a price of $176.00 per ounce, as compared to $150.00 per ounce last May.

Oregon's platinum production has been tied closely to its gold placer mining activities; therefore, little production has been recorded since 1942 when Executive Order L-208 closed down practically all of the gold mines in the country. The future potential of platinum production in Oregon is difficult to predict. The present high price of both gold and platinum should certainly act as a stimulus for exploration, particularly if the prices remain at their present level or go even higher.

This issue of The ORE BIN discusses the properties of the platinum-group metals and describes areas in the state where platinum is known to occur. We hope this information will encourage new exploration efforts in Oregon.

Introduction

Platinum is classified as one of the "precious metals," although not too long ago it had little value. At the turn of the century, for example, it was considered only a nuisance when found in gold placer deposits. Platinum-group metals are well known, but their occurrence in Oregon is seldom mentioned.

Over 60 percent of the platinum or platinum-group metals consumed in the United States are used in the production of jewelry, electrical contacts, and chemicals. The newest demand for platinum is by the automotive industry for use in catalytic exhaust emission devices.

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* Private geologist, Sweet Home, Oregon

Platinum was first discovered by the Spaniards in Colombia, South America, in 1735, where the metal was collected and taken back to Spain. In Spain, the new metal was named platina, from the Spanish word plata for silver.

Physical Properties

The platinum group of metals comprises six elements: platinum, iridium, osmium, ruthenium, rhodium, and palladium. Platinum, iridium, and osmium have the greatest density, and iridium is now recognized as the heaviest element that occurs in nature. Densities of ruthenium, rhodium, and palladium average only 55 percent as great. Thus, these six elements are divided by their densities into two sets, which are analogous to gold and silver, and just as native gold is invariably alloyed with silver, so all six of these elements are invariably present as native alloys of the platinum metals.

The platinum metals are slightly magnetic as opposed to gold and silver, which are non-magnetic. Palladium has the greatest and osmium the smallest magnetic susceptibility. Palladium has a higher magnetic susceptibility than any other non-ferromagnetic element so far determined.

The natural alloys of the platinum metals occurring in black sand placer deposits are handled differently by producers than the natural alloys of gold and silver. Since native gold is non-magnetic, most of that found in the black sand which is not removed by washing can be reclaimed by magnetic separation of the other minerals, such as magnetite, chromite, and ilmenite. Native platinum cannot be handled by this method. Since the platinum metals are slightly magnetic and a part of the alloys may be ferromagnetic, not all the other minerals of the black sand can be separated magnetically from the platinum.

The usual method for extracting platinum from black sands requires several steps. Crude placer platinum is first separated from the black-sand concentrates by the use of a concentrating table, such as a Wilfley. Screening of the dried metals and magnetic separation, so far as permitted, are then employed. This product is then either further refined by blowing it from a vibrating hopper, as employed by the Goodnews Bay Mining Company, Alaska, or it may be sent directly to the smelter.

Chemical Properties

Pure platinum is not attacked by the common inorganic acids, but is dissolved, though less readily than gold, by aqua regia, from which it can then be precipitated with the addition of ammonium chloride. The precipitate will give platinum metal when heated. Potassium iodide may also be used as a precipitating agent.

On the other hand, pure iridium and rhodium are not appreciably attacked by aqua regia or other inorganic acids, and osmium and ruthenium are quite insoluble in such acids. Palladium is dissolved not only by aqua regia but also by hot nitric or hot sulfuric acid. This vulnerability of paladium to acids is reflected in its inferior ability to withstand the effects of weathering and consequently by its greater tendency to form natural mineral compounds.

Mineralogy

The platinum metals occur in nature in two forms: first, as natural alloys and in intergrowths of alloys; and second, as chemical compounds in which the platinum metals function as cations. The alloys have as wide ranges in composition as their crystallography and other factors permit. The chemical compounds also have variable compositions but within smaller limits, as these are controlled by substitutions of cations and anions requiring comparable radii. Wright and Fleischer (1965, p. A5-A6) have tabulated as compounds, or mineral species, the platinum metals known to be chemically combined with oxygen, sulfur, arsenic, antimony, bismuth, tin, or tellurium, if these elements function as anions. They point out, however, the uncertainty in classifying platinum metals, and suggest that a few of the so-called alloys may be partly or wholly minerals and vice versa.

Alloys and compounds of platinum metals are too numerous to list here, but they are tabulated by Wright and Fleischer (1965) and also by Mertie (1969). The alloys are referred to in terms of their mixtures and intergrowths with other elements, for example "cuproplatinum" or "ferroplatinum." The compounds, in contrast, are given specific names ending in "ite" denoting a mineral species, for example "sperrylite." A number of the platinum alloys and minerals are unnamed.

Sperrylite ($PtAs_2$) is the most common of the platinum minerals; it is a tin-white, brittle, cubic, has a black streak, a hardness of 6-7, and a specific gravity of 10.58.

Geologic Occurrence

Platinum rarely forms compounds and occurs in basic and ultrabasic rocks, where it has been concentrated by magmatic processes. These magmatic concentrations are subdivided into two groups by Bateman (1942): the early magmatic phase, and the late magmatic phase. In the early magmatic phase, platinum occurs as sparse disseminations with chromite in dunites. The erosion of such deposits yields platinum placers such as are found in the Ural Mountains of Russia, Alaska, and Colombia. Platinum may also be concentrated in this stage by segregations or fractional crystallization. Such deposits include those at Merensky Reef, Rustenburg, South Africa.

In the late magmatic phase, platinum concentration can occur as immiscible liquid segregations, as is found at Vlackfontein, South Africa. Concentration may also occur as an immiscible liquid injection. Deposits at the Frood mine at Sudbury, Ontario, may have formed in this manner. Platinum can also occur in contact metasomatic deposits, as in Tweetfontein, South Africa, or as hydrothermal deposits, as at Sudbury, Ontario (Bateman, 1942).

Platinum often occurs as a mineral constituent of peridotite, serpentine, dunite, norite, olivine gabbro, and of less importance, in pyroxene, especially olivine pyroxenites. Platinum is commonly associated with olivine, chromite, pyroxene, magnetite, and nickel.

Platinum, as sperrylite, is present in some high-temperature sulfide deposits. Chalcopyrite, pyrrhotite, and quartz veins may contain varying amounts of the platinum-group metals. Replacement ores of copper and gold and some base-metal veins may also contain the platinum-group metals.

Classification

The classification of platinum deposits is best described by Mertie (1969) as follows:

"The platinum metals occur in workable deposits mainly as platinum minerals in nickel-copper and copper lodes and as platinum alloys in placers, but they occur also in other environments that are of more scientific than economic interest. The principal workable lodes are in Ontario and Manitoba, Canada, in the central Transvaal, Republic of South Africa, and in several areas of northwestern Siberia, U.S.S.R. To these should be added the lithified placers of the Witwatersrand, Republic of South Africa. Most of the workable lodes are characterized by platinum and palladium minerals, but some of them, notably in the Transvaal, also yield small amounts of the native metals or alloys.

LODES

"The platinum metals occur as lodes in several different environments. The more significant deposits are related to the basic or ultrabasic rocks, but these metals are also found in ores that are related to granitic rocks, as shown in the following classification:

<u>Classification of platinum lodes</u>

"A. Platinum-bearing nickel-copper, copper, or copper-cobalt sulfides that are related genetically to basic or ultrabasic rocks, commonly the former, but are not magmatically segregated ores. The workable lodes occur principally as secondary concentrations of ore minerals rather than as magmatic minerals in situ, though the secondary ores appear to grade into disseminated ore minerals in the associated igneous rocks. The ore bodies occur either along the contact of the basic intrusives with country rock, or at variable distances up to 5 miles from the basic intrusives. These ores may or may not be associated with igneous rocks, of which some are considered to be related genetically to the parent basic rocks. By some geologists, the sulfides of these secondary deposits are thought to have originated as immiscible fluids of magmatic character; by others, these sulfides are considered to be epigenetic hydrothermal deposits. The ores of the Sudbury district, Ontario, exemplify such deposits. Native platinum metals or their alloys are commonly absent from deposits of this type.

"B. Platinum-bearing nickel-copper ores that are magmatically disseminated or concentrated in gabbroic and ultrabasic rocks. Pyroxenite and anorthosite the principal source rocks are commonly associated with norite and all of these may have the outlines of dikes, sills, pipes, lenses, or schlieren. These rocks are petrographically homogeneous along their major structures for long distances, but they vary locally and produce layers and lenses of peridotite and chromite. The platinum metals occur mainly in sperrylite, cooperite, and other platinum and palladium minerals, but smaller amounts of the native platinum metals or alloys are commonly present. The platinum minerals occur in the sulfides and in lesser amounts in the silicates and may be sufficiently plentiful to constitute the principal value of the ores, with byproducts of nickel copper, and other metals. The Merensky zone, in the Bushveld igneous complex of the Transvaal, illustrates this type of deposit. The ratios of platinum to palladium are significantly greater in the ores of class B than in those of class A.

"C. Native alloys of the platinum metals that are magmatically disseminated in peridotites, less commonly in perknites, and rarely in gabbros. If concentrated, they are commonly intergrown with chromite. Most of these deposits are in dunites, which range in composition from hortonolite dunite to olivine dunite. The dunites at some localities may be partly or wholly altered to serpentinite. The platiniferous hortonolite or iron-rich dunites are exemplified by the Onverwacht and Mooiheep properties in the Bushveld igneous complex of the Transvaal. Platiniferous dunites, perknites, and their alteration products are the sources of the Uralian placers; dunite and serpentinite are the sole sources of the placers of the Goodnews Bay district, Alaska; and so far as known, similar peridotites and perknites are the sources of most placers that are known in the world. Platinum and osmiridium lodes have been discovered in dunite or serpentinite, principally in the Urals and in South Africa, but generally they have proven to be either too small or too low grade for profitable mining. Some masses of chromite, however, have been found in dunite that had high tenors in the platinum metals.

"D. Platinum minerals or native platinum alloys in copper and related ores indigenous to contact metamorphic and other types of ore bodies, including vein systems.

"E. Native platinum metals in the gold ores of quartz veins and in other ores of free gold.

"F. Platinum-bearing meteorites.

"G. Secondary platinum metals:

1. Recovered in purification of blister copper and copper mattes that produced on a large scale.
2. Recovered at the U.S. Mint and other mints, in the refining of metallic gold. The U.S. Mints make no payment to the producers of gold bullion for such platinum metals, claiming them as seignorage.
3. Recovered from industrial wastes and from jewelry.

PLACERS

"Platinum placers consist of alluvial deposits that contain in workable amounts the alloys of the six platinum metals, and it is worthy of note that no analagous deposits of platinum minerals have ever been found. The platinum metals occur commonly in two alloys of variable composition, of which one consists dominantly of platinum with varying amounts of the other five elements, whereas the other consists dominantly of iridium and osmium, less ruthenium, still smaller amounts of platinum and rhodium, and with little or no palladium. Much of the placer platinum consists of two intergrown or intermixed alloys, each of variable composition, as exemplified by the product recovered in the Goodnews Bay district....

"Some of the alluvial platinum comes from placers that yield both gold and platinum. The stream placers of Colombia and of California,... are excellent examples. Commonly the gold and platinum are separate alloys, one of gold and silver and the other of five or six platinum metals. This fact is not generally clarified by analyses of placer platinum, as small amounts of gold are reported merely as a part of the contained precious metals. Hence such analyses, in order to be comparable with others which show no gold, have to be recomputed free of gold as well as free of "impurities." Examples will later be given, however, of placer gold with which small amounts of the platinum metals are alloyed.

"The densities of the platinum alloys found in placers and the sizes of their grains are generally similar to those of alluvial gold; hence, the geologic classification of platinum placers is exactly like that of the gold placers, as heretofore used by the writer:

A. Residual and eluvial placers.

B. Stream placers.

1. Present stream valleys.
2. Older stream valleys.
   a. Terrace deposits.
   b. Buried deposits.

C. Beach placers.

1. Present beaches.
2. Ancient beaches.
    a. Elevated beach deposits.
    b. Buried beach deposits.

D. Deltaic and outwash deposits.

E. Glaciofluvial (glaciofluviatile) deposits.

F. Aeolian deposits.

G. Lithified placers.

"Placers of the platinum metals are commonly derived from dunite or serpentinite, less commonly perknite, in which these metals are sparsely and irregularly distributed. In nonglaciated regions, it may be inferred that the original lodes could be discovered by tracing the alluvial deposits upstream. Commonly the general country rock may thus be recognized, but workable lodes can rarely be located. This may result from one or more of the three following causes:

1. The original rocks from which the placers were derived may have been completely eroded, so that no platiniferous source rocks remain in the area.
2. The present country rock may be platiniferous, but may represent the uneroded low-grade roots of lodes that were much richer in their apical horizons.
3. All the original source rocks may have been of extremely low grade, and the placers may have been concentrated from such sources over a very long period of time. Under such circumstances, representative source rocks, even if preserved, would not constitute workable lodes and are not likely to be discovered.

"The formation of placers is possible under any of these conditions. But workable lodes can rarely be located in placer fields, and it is therefore concluded that the platinum metals in placers have been concentrated generally from source rocks wherein these metals were sparsely and widely disseminated.

"Heavy metals, such as platinum or gold, rarely migrate far downstream from their bedrock sources, unless they are so fine grained as to be moved by swift water or floated by surface tension. Flour gold, for example, may move downstream for many miles, in fact to the ocean. Generally, however, ordinary detrital grains of platinum or gold work rapidly downward through alluvial deposits, and come to rest either near, on, or within bedrock. If the bedrock has a well-developed cleavage or fracture, the precious metals may penetrate 10 feet or more. Only very high water that cuts to bedrock, or rejuvenation of a stream, will again move these metals, and even under these conditions, their downstream migration is not great. Hence, excepting some special environment, such as glaciation, placers of the precious metals may be assumed to lie within a few miles of their bedrock sources. If placer paystreaks are very long, it may be suspected either that several bedrock or proximate sources are present in a valley, or that the metals have been distributed downstream by repeated lowering of the base level of erosion or as result of glaciation."

Platinum in Oregon

The occurrence of platinum in Oregon is thoroughly discussed by Mertie (1969), from which the following is quoted:

"The platinum metals found on the beaches of Oregon and California appear to have originated in bodies of peridotite and serpentinite. The great dike of serpentinite that crops out in the valley of the Applegate River, a north-flowing tributary of the Rogue River, and continues northward may be such a source rock. Platinum was located in the Highland mine, about 12 miles south of Gold Hill, in the Gold Hill quadrangle, Oregon. According to Kellogg (1922, p. 1000), this metal was finally traced to a bluish quartz that was taken from the 100-foot level of the Gold Hill mine. The tenor in platinum, as given by smelter returns, was 0.32 ounce per ton of ore. Serpentinite, however, is probably the major source.

PLACERS

"Platinum-bearing gold placers have been found and mined at three localities in Oregon. The most important of these was the Takilma-Waldo district, in Josephine County, about a mile northeast of Waldo and about 30 miles southwest of Grants Pass. Gold was discovered in 1853 on Althouse Creek and thereafter was mined for many years, particularly before 1917 but also up to 1930. A second but less important site was on Applegate River, about 25 miles northeast of Waldo. The third locality consisted of the Pacific beaches of Curry and Coos Counties, which were discovered in 1852 and were worked intermittently for many years. According to Shenon(1933, p. 179), the minimum production of the platinum-bearing gold placers of the Takilma-Waldo district up to 1930 was $4 million, but no estimate is available for Applegate River and its tributaries. No record was kept of the early production of gold and platinum from the ocean beaches of Oregon, but according to Pardee (1934, p. 26), quoting from the U. S. Bureau of Mines, the production of gold between 1903 and 1929 was about $60,000, of which about $2,000 was platinum.

"The production of platinum from Oregon in the period 1880-1903, with 9 years not recorded, is given by Quiring (1962, p. 254) as 675 troy ounces, with a maximum output in 1895 of about 130 ounces. Using a gold-platinum ratio of 100:1 for the Takilma-Waldo district, and rating platinum at twice the value of gold at that time, this district may have produced about 1,000 ounces. An unknown part of this output should be added to that given by Quiring for the period 1880-1903, so that the production of platinum metals from Oregon may have been as much as 1,500 ounces.

Takilma-Waldo district

"The deposits of the Takilma-Waldo district include both Tertiary and Quaternary placers. The Tertiary placers, which are in Tertiary conglomerate, are composed of large, greatly altered, boulders of greenstone, granite, argillite, and other rocks in a well-indurated sandy matrix. Gold and platinum are distributed throughout the conglomerate and are only slightly concentrated near bedrock, which suggests local sources. Well-known deposits in the Tertiary conglomerate that were worked at a profit were the High Gravel, Cameron, and Platerica mines. The ratio of gold to platinum is reported to have ranged from 75:1 to 100:1, but no assays or analyses of the platinum appear to have been made. The principal heavy and semi-heavy minerals recovered with the precious metals were chromite, magnetite, limonite, hematite, ilmenite, epidote, and zircon.

"The more valuable deposits of the Takilma-Waldo district were gravel deposits on terraces or in the present valley floors. One of the best known properties of this group was the Logan mine, later known as the Llano de Oro mine, but best known perhaps as French Flat. This was a terrace from 15 to 20 feet high, on the west side of the East Fork of the Illinois River, about a mile northeast of Waldo. The deposit consisted of imperfectly sorted gravel, sand, and clay ranging in thickness from a foot at its outer edge up to 50 feet. The gold was angular and was associated with chromite, magnetite, ilmenite, hematite, limonite, epidote, and zircon. The ratio of gold to platinum was reported to have been about 50:1. According to Shenon (1933, p. 187), a sample of the platinum was analyzed by E. T. Erickson, of the U.S. Geological Survey, who reported that it consisted largely of platinum and ruthenium, less iridium and osmium, and very small amounts of palladium and rhodium. This analysis differs from any other known to the writer, and if reliable, is indeed unique.

"Other deposits worked in the Takilma-Waldo district were the Deep Gravel mine, and those on Fry, Waldo, Allen, Butcher, and Sailor Gulches. These properties were mainly in the valley floors of the present streams and were concentrated from the Tertiary conglomerate, which constituted a proximate source rock. Platinum was undoubtedly recovered from these deposits but its presence was not mentioned either by Horner (1918) or by Shenon (1933).

Applegate district

"Applegate River is a northwest-flowing tributary of Rogue River. Mining was carried on in the Applegate district for years after mining ceased in the Takilma-Waldo district. A nonfloating dredge, probably mounted on skids and moved by a caterpillar, was operated on the Applegate River in 1944, and two others were operated in the Applegate drainage. In addition, some mining was in progress on Forest and Poorman Creeks, tributaries of the Applegate River. The following analysis of platinum, made by the Wildberg Smelting and Refining Co. of San Francisco, was given to the writer by an operator on the Applegate River: platinum 29.70, iridium 31.96, osmium 25.56, ruthenium 12.78, rhodium not determined, total 100 percent. This is clearly a mixture of osmiridium with ordinary platinum, wherein osmiridum is a major component.

Pacific beaches

"The beach deposits of Oregon have been well described by Pardee (1934). In Curry County the principal localities, named from south to north, were the mouth of Chetco Creek, Ophir Creek, the mouth of Pistol River, Gold Beach at the mouth of the Rogue River, Eucher Creek, Port Orford, and Cape Blanco near the mouth of the Sixes River; in Coos County, Bandon at the mouth of the Coquille River, Old Randolph on South Slough, and Coos Bay at the mouth of Coos River. These deposits were discovered in 1852, and those of higher grade were soon exhausted, yet many of them were worked intermittently for years afterwards.

"The coastal ranges of Oregon are bounded on the west by a narrow Pacific coastal plain that ranges in width from a quarter of a mile to 4 miles and in altitude from sea level to 100 feet, with numerous low marine terraces. There are also higher terraces at or about 170 feet above sea level and one higher terrace at an altitude of 800 feet. Deposits at the 170-foot level were worked at two mines east of Cape Blanco and at four mines north of Cut Creek. The Peck mine, at an altitude of 800 feet, was on a spur north of the Sixes River, and still other terraces up to an altitude of 1,500 feet are present, though none of these was mined. The terrace deposits, however, proved not to be as high grade as those in the coastal plain or low terraces. Probably the richest deposits were found south of Coos Bay, but the beaches at Whisky Run, Cape Blanco, Port Orford, and Gold Beach were also remunerative.

"The platinum metals and the gold are extremely fine, rounded, flat grains from 0.8 to 0.05 millimeter in diameter and from 0.05 to 0.005 millimeter in thickness, but range downward to grains of microscopic size. The ratio of gold to platinum varied from 100:1 to 160:1. The heavy and semi-heavy minerals on the Port Orford and adjacent beaches were found to be mainly magnetite, chromite, ilmenite, garnet, and olivine. Some zircon and monazite were also found at Coos Bay.

"Two chemical analyses, which are believed to represent the platinum of the littoral deposits, have been published and are presented in Table 43. It may be assumed that most of the "osmium plus iridium" recorded in Table 43 is iridium, but these analyses, owing to the high percentage of

Table 43. Analyses, in percent, of platinum metals from Pacific beaches of Oregon
(N.D., no data)

	A	B
Platinum	53.37	57.20
Iridium	.42	.45
Osmium	N.D.	N.D.
Osmium plus iridium	38.69	41.46
Ruthenium	N.D.	N.D.
Rhodium	.67	.72
Palladium	.16	.17
Iron	4.46	N.D.
Copper	2.23	N.D.
Total	100.00	100.00

A. Deville and Debray (1859); republished by Kemp (1902, p. 19)
B. Deville and Debray (1859)

platinum, do not represent osmiridium alone. On the other hand, the high tenors in osmium plus iridium indicate that much osmiridium is present. If these analyses represent an alluvial mixture of two alloys, as may well be true, they suggest that the ratio of osmiridium to platinum is high. Owing to the low percentage of rhodium, these two analyses do not correspond closely with any of those recorded for California.

"Platinum metals have been found, generally as traces, in many other counties of Oregon, and from Baker County there was a small production in 1925. Platinum has been identified in Jackson, Douglas, Lincoln, Linn, Clatsop, Washington, and Multnomah Counties, in the western part of the State; Wheeler and Grant Counties, in the central part; and Union County, north of Baker County, in the eastern part of the State."

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MORTON NAMES DAY AS MESA CHIEF

Secretary of the Interior Rogers Morton has appointed James M. Day, director of Interior's Office of Hearings and Appeals since its creation in 1970, to be administrator of the new Mining Enforcement and Safety Administration (MESA), effective immediately.

"Mr. Day's excellent legal training, his keen knowledge of mining issues and mine safety, and his exceptional administrative talent are prime qualifications for this new assignment," the Secretary said. "He has demonstrated outstanding competence in the area of mine safety enforcement."

Morton pointed out that Day had conducted public inquiry into general problems of coal mine health and safety on the Secretary's behalf, and also had conducted a comprehensive investigation into the cause of the disaster which claimed 91 lives at the Sunshine Silver Mine in Idaho.

MESA's responsibilities include enforcement of the Federal Coal Mine Health and Safety Act and the Federal Metal and Nonmetallic Mine Safety Act. Mine health and safety, assessment and compliance, education and training functions were transferred to MESA from the Bureau of Mines in May.

Day, 43, whose selection concludes an exhaustive search for the best qualified person to head the new agency, was a private attorney in Washington, D.C. before his 1970 appointment to the Interior post. Donald P. Schlick, acting administrator, will remain as depty administrator.

* * * * *

OUR OTHER MINERAL RESOURCES ARE ALSO SCARCE

For many months we have been hearing reports on an energy crisis - and there really is one, as the demand for energy of all sources continues to grow faster than the supply of energy from all sources. Now, a new threat to the strength of our economic society has been highlighted as the U.S. Geological Survey has released a comprehensive report showing that for most of our mineral needs the United States already is a major importer and faces further critical shortages in the next twenty years.

U.S. Geological Survey Professional Paper 820, "United States Mineral Resources" reviews more than 60 mineral commodities which are essential resources in our industrial society and finds that we possess less than half a dozen commercial minerals in major quantities. For the rest, we face fast increasing shortages which will call for (1) even more imports than we have now, (2) revised industrial technology, (3) developing substitutes, (4) increased recycling, (5) intense new exploration, and (6) improved mining and mining technology.

As one looks ahead in the energy "crisis," solutions appear on the horizon in various forms, such as: new oil discoveries, coal liquifaction and gasification, oil shale development, tar sands development, acceptable nuclear energy, geothermal energy, etc.

Ironically, with much less fanfare and ballyhoo about our other minerals shortages, they may actually be more serious to our society, inasmuch as realistic solutions to their shortages are not on the horizon. Among our existing critical shortages are ores of aluminum, chromium, manganese, mercury, silver,tungsten, asbestos, and nickel. But joining the critical list soon will be lead, zinc, titanium, uranium, barite, high-quality clays, and many others.

While most people can translate energy shortages into person impacts such as lack of heat or transportation fuel, most persons don't relate to a widespread industrial minerals shortage. Yet the impact of such shortages will be tremendous, ranging from high-priced imports which will seriously affect our balance of payments, to a need to alter and even curtail our voracious, mineral-consuming technology as we find ourselves running short of one item after another.

The U.S. Geological Survey has done a real service in highlighting the problem of mineral shortages in Professional Paper 820, "United States Mineral Resources." This 722-page report is available from U.S. Government Printing Office, Washington, D.C. 20402 for $9.15. A 19-page summary is available free from the U.S. Geological Survey,Washington, D.C. 20244; it is listed as Geological Survey Circular 682, "Summary of the U.S. Mineral Resources."

(By Arthur A. Socolow, in Pennsylvania Geology, v. 4, no. 3, 1973)

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GEODETIC SURVEY MAP SHOWS CRUSTAL MOVEMENT

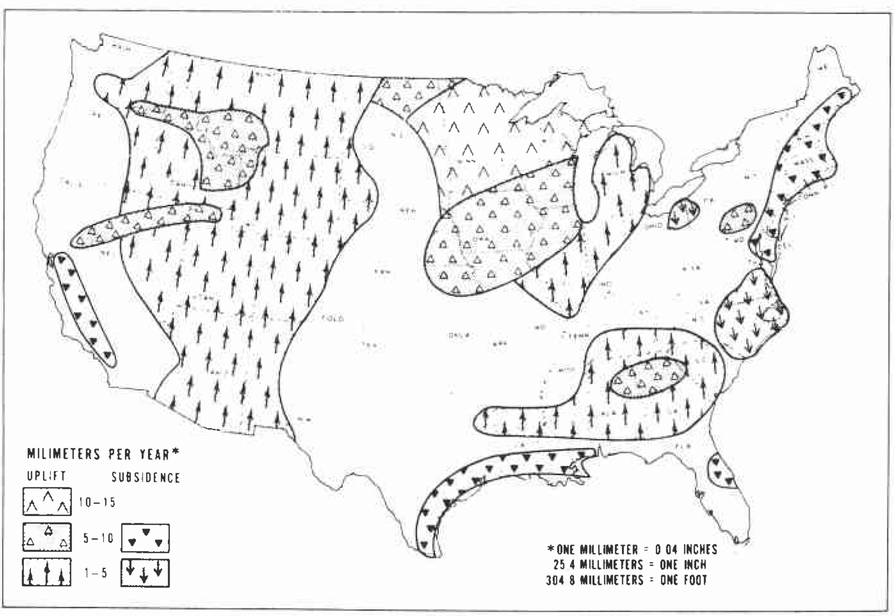
A new map of the United States showing vertical movements of the earth's crust indicates that the land in much of the country is slowly rising or falling and that very few really stable areas exist.

The first compilation of its kind for the United States, the map reveals probable annual rates of crustal movement over large regions.

The map is based on measurements made over the past 100 years by surveyors and geodesists of the National Geodetic Survey. Only the larger areas of land subsidence and uplift are shown on the map; much of it is based on interpolation between widely-spaced lines of elevation that have been measured by geodetic field parties.

Some of these movements are minute, detectable only by painstaking and repeated measurements over a period of years. Others are large enough to be of concern in the design and maintenance of engineering structures, and in some areas land subsidence is sufficiently rapid to cause alarm. Samuel P. Hand, Chief of the National Geodetic Survey's Vertical Network Division, which developed the map, cited as one example of this the Houston-Galveston area in Texas which has subsided as much as 5 feet in 20 years. In the New Orleans area, a subsidence of more than 1 foot has been detected in a 25-year period.

These cities lie in a large area of subsidence which extends along the entire coastal plain of Texas and Louisiana. Hand said this rapid subsidence,



CRUSTAL MOVEMENT MAP SHOWING PROBABLE VERTICAL MOVEMENTS OF THE EARTH'S SURFACE and subsidence of the Central Valley in California, are largely the result of the removal of underground resources.

The NOAA geodesist pointed to Terminal Island at Long Beach, Calif., as an outstanding example of large-scale subsidence. Subsidence there reached more than 25 feet before it was checked by the injection of fresh water.

In such flat coastal areas, subsidence increases drainage problems and the danger of storm inundation. Among other areas so affected are the eastern shores of Delaware, Maryland, and Virginia, and the vicinity of Atlantic City, N.J.

Whereas some subsidence is caused by man, widespread vertical movements are due to natural internal forces which are forcing the earth's crust up or down.

(NOAA, v. 3, no. 1, p. 55, Jan. 1973)

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COOS COUNTY BULLETIN AVAILABLE

Specialists in several fields have collaborated in producing the Department's newest bulletin, no. 80, "Geology and mineral resources of Coos County, Oregon." Ewart M. Baldwin, University of Oregon, and John Beaulieu of the Department's staff authored the sections on geology and geography. Mineral and fuel resources were the responsibility of staff members Len Ramp, Jerry Gray, Vernon C. Newton, Jr., and Ralph S. Mason.

The descriptions of more than 20 geologic units and their map distribution are the product of many years of geologic mapping in southwestern Oregon by Dr. Baldwin and graduate students working under his direction. Such comprehensive coverage has not previously been available for this area, which is the most complex geologically of the Oregon Coast.

Mineral production has not been as important economically in Coos County as elsewhere in the state, but metallic minerals in the black sands deposits and the coal deposits are of interest. Lists of mines and prospects are included. Twelve wildcat holes have been drilled in the search for oil, several of which had gas shows.

The 82-page bulletin is illustrated by numerous photographs; a three-part multicolored geologic map and a mineral resource map accompany the report. This report and its maps should serve as a useful guide for intelligent land-use planning and zoning in this region during the coming years.

Copies of Bulletin 80 are available from the Department offices in Portland, Baker, and Grants Pass and sell for $5.00.

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DEEP WELL INFORMATION RELEASED

Two new publications recently added to the Department's Oil and Gas Investigations series (O&G 3 and O&G 4) provide fossil information and age of sediments on two deep wells drilled by oil companies in western Oregon. The author is Weldon W. Rau, geologist with the Washington Geology and Earth Resources Division.

"Preliminary identifications of foraminifera from General Petroleum Corp. Long Bell No. 1 well" (O&G No. 3) contains identifications of fossils found at depths ranging from 4,500 to 9,000 feet in the Douglas County well; age range is from middle to lower Eocene; Ulatisian to Penutian stages.

"Preliminary identifications of foraminifera from E. M. Warren Coos County 1-7 well, Oregon" (O&G No. 4) covers samples found at depths of 100 to 6,400 feet and of late Eocene age.

Each of the new reports is a two-page chart showing depths at which the particular specimens were found and whether their occurrence was rare, few, or common. Copies are available at the Department's offices at Portland, Baker, and Grants Pass for $1.00 for either O&G 3 or O&G 4.

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WASHINGTON ISSUES COASTAL GEOLOGY REPORT

"Geology of the Washington Coast between Point Grenville and the Hoh River," a new publication published by the Washington Geology and Earth Resources Division, reviews the geologic processes which formed the rock formations and scenic features along one section of the Washington coast. The author is Weldon W. Rau.

The report is divided into two parts: Part I covers rock formations and their geologic history, and Part II gives geologic observations and interpretations of the four coastal segments. Most of the features described are accessible by roads and trails. The oldest rocks found in the area of the study are middle Eocene volcanics formed 45 to 50 million years ago, which were dated from microfossils contained in interbeds of marine siltstone. The youngest are Pleistocene sand and gravel and present-day beach deposits.

Photographs, both black and white and colored, liberally illustrate the report, and small maps locate the areas described in Part II. Copies of the report, Bulletin 66, are available from the Geology and Earth Resources Division, Department of Natural Resources, Olympia, Washington for $3.00.

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<u>Notice:</u> The ERTS (Earth Resources Technology Satellite) map of Oregon reproduced in color with geographic overlay and explanatory text will be available from the Department's offices late in November. The price will be announced.

AVAILABLE PUBLICATIONS

(Please include remittance with order; postage free. All sales are final - no returns. Upon request, a complete list of Department publications, including out-of-print, will be mailed)

BULLETINS

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 (1st suppl.) geology and mineral resources of Oregon, 1947: Allen	1.00
35.	Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1963: Baldwin	3.00
36.	Papers on Tertiary foraminifera: Cushman, Stewart & Stewart. vol. 1 $1.00; vol. 2	1.25
39.	Geology and mineralization of Morning mine region, 1948: Allen and Thayer	1.00
46.	Ferruginous bauxite deposits, Salem Hills, 1956: Corcoran and Libbey	1.25
49.	Lode mines, Granite mining district, Grant County, Oregon, 1959: Koch	1.00
52.	Chromite in southwestern Oregon, 1961: Ramp	3.50
57.	Lunar Geological Field Conf. guidebook, 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 Tualatin Valley region, 1967: Schlicker and Deacon	5.00
61.	Gold and silver in Oregon, 1968: Brooks and Ramp	5.00
62.	Andesite Conference Guidebook, 1968: Dole	3.50
64.	Geology, mineral, and water resources of Oregon, 1969	1.50
66.	Geology, mineral resources of Klamath & Lake counties, 1970: Peterson & McIntyre	3.75
67.	Bibliography (4th suppl.) geology and mineral industries, 1970: Roberts	2.00
68.	The Seventeenth Biennial Report of the State Geologist, 1968-1970	1.00
69.	Geology of the Southwestern Oregon Coast, 1971: Dott	3.75
70.	Geologic formations of Western Oregon, 1971: Beaulieu	2.00
71.	Geology of selected lava tubes in the Bend area, 1971: Greeley	2.50
72.	Geology of Mitchell Quadrangle, Wheeler County, 1972: Oles and Enlows	3.00
73.	Geologic formations of Eastern Oregon, 1972: Beaulieu	2.00
74.	Geology of coastal region, Tillamook Clatsop Counties, 1972: Schlicker & others	7.50
75.	Geology, mineral resources of Douglas County, 1972: Ramp	3.00
76.	Eighteenth Biennial Report of the Department, 1970-1972	1.00
77.	Geologic field trips in northern Oregon and southern Washington, 1973	5.00
78.	Bibliography (5th suppl.) geology and mineral industries, 1973: Roberts, et al.	in press

GEOLOGIC MAPS

Geologic map of Oregon west of 121st meridian, 1961: Wells and Peck	2.15
Geologic map of Oregon (12" x 9"), 1969: Walker and King	0.25
Geologic map of Albany quadrangle, Oregon, 1953: Allison (also in Bulletin 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 portion of High Cascade Mtns., 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 and others	1.50
GMS-3: Preliminary geologic map, Durkee quadrangle, Oregon, 1967: Prostka	1.50
GMS-4: Gravity maps of Oregon, onshore & offshore, 1967: Berg and others [sold only in set] flat $2.00; folded in envelope	2.25
GMS-5: Geology of the Powers quadrangle, 1971: Baldwin and Hess	1.50

OIL AND GAS INVESTIGATIONS SERIES

1.	Petroleum geology, western Snake River basin, 1963: Newton and Corcoran	2.50
2.	Subsurface geology, lower Columbia and Willamette basins, 1969: Newton	2.50

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19.	Brick and tile industry in Oregon, 1949: Allen and Mason	0.20
21.	Lightweight aggregate industry in Oregon, 1951: Mason	0.25
24.	The Almeda mine, Josephine County, Oregon, 1967: Libbey	2.00

MISCELLANEOUS PAPERS

1.	Description of some Oregon rocks and minerals, 1950: Dole	0.40
2.	Key to Oregon mineral deposits map, 1951: Mason	0.15
	Oregon mineral deposits map (22" x 34"), rev. 1958 (see M.P. 2 for key)	0.30
4.	Rules and regulations for conservation of oil and natural gas (rev. 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
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7.	(Supplement) Bibliography of theses, 1959 to Dec. 31, 1965: Roberts	0.50
11.	A collection of articles on meteorites, 1968, (reprints, The ORE BIN)	1.00
12.	Index to published geologic mapping in Oregon, 1968: Corcoran	.25
13.	Index to The ORE BIN, 1950-1969, 1970: Lewis	0.30
14.	Thermal springs and wells, 1970: Bowen and Peterson	1.00
15.	Quicksilver deposits in Oregon, 1971: Brooks	1.00

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