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ATLAS OF METAL AND NONMETAL MINERAL PROVINCES, CONTERMINOUS U.S.
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PAGE AND TOOKER—PLATINUM

Planimetric base from National Atlas 1:7 500 000, 1970

SCALE 1:5 000 000

100 0 100 200 300 400 500 MILES

100 0 100 200 300 400 500 600 700 KILOMETRES

PRELIMINARY MAP OF PLATINUM AND PLATINUM-GROUP METAL PROVINCES IN THE CONTERMINOUS UNITED STATES

BY

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Introduction

Platinum and platinum-group metals are essential to industry because of their special catalytic, electrical conductivity, and corrosion resistance properties. The United States produces only a very small portion of the platinum materials that it uses: imports of about 1,700,000 troy ounces valued at more than $260 million in 1976, largely from south Africa and the U.S.S.R., accounted for 80 percent of primary metal requirements (Butterman, 1976), 1-2 percent was produced from one placer mine in Alaska and as a byproduct from copper refining, and the remainder (325,000 troy ounces) was obtained by recycling because the use of platinum is largely nondissipative. Substitution for platinum-group materials in some manufacturing processes is also possible where the cost of platinum becomes prohibitive. The U.S. Bureau of Mines predicts increasing demand through the year 2000 of about 3 percent annually (Butterman, 1976). Knowledge about the domestic habitat and the identity of potentially minable possibilities for materials of this important strategic and industrial metal will be of long-term interest to the nation in view of the uncertain political situations in the present foreign source areas.

The map of platinum and platinum-group metals provinces locates areas where platinum has been found and where still the best potential lies for finding hypothetical deposits. The map shows the distribution of ultramafic and mafic rocks and geologic structures with which platinum-group metals seem to have affinity.

The map was compiled mostly from the report by Blair, Page, and Johnson (1977) and unpublished records of platinum resource specialists of the U.S. Geological Survey. Geologic information used on the maps is from the Geologic Map of the United States (King and Beikman, 1974). The rationale for province maps and some of the technical terms used, which may be unfamiliar, are discussed and defined in a companion background report by Tooker (1979).

Characteristics of platinum provinces

The map shows the distribution of several reasonably defined platinum-group metal provinces or areas containing or expected to contain useful amounts of platinum-group metals. The boundaries delimit areas of known deposits ranging in size from a single mine to a broad regional mining district or belt, presently known subeconomic occurrences as well as unevaluated evidence of anomalously large geochemical accumulations, and favorable geologic and geophysical environments for platinum-group metal deposition. The data are too fragmentary in other places, where in most cases the analytical information is not available for us to draw significant province boundaries. The few existing data points, however, identify areas needing a systematic closer assessment for these metals.

Only two of three possible classes of deposits and occurrences of platinum and platinum-group metals are shown on the map, following the size/activity classification of Tooker (1979), which is based on demonstrated or expected size of production and level of current activity determined by the deposits' listing in the international mining survey (Mining Mag., 1976) as operating at a significant level of world production in 1975. The minimum size selected for a large platinum deposit in the conterminous United States was the production of minable minerals or evidence of potentially minable material in excess of 400 troy ounces. This production, valued in 1976 dollars and prices, represents about $60,000 (Shishko, 1976). The reader should note that this deposit size represents about 0.02 percent of one year's consumption of platinum materials. Because the level of domestic production is insignificant in terms of world production of these metals, there were no domestic type A active platinum or platinum-group metal mines listed in the 1975 international mining survey (Mining Mag., 1976). Type B includes large past domestic producers, now inactive, mined out, or producing currently at a much reduced level. It also includes a number of occurrence areas that, on the basis of known potentially minable materials and geologic projections, are estimated to contain resources sufficient to place them in the large domestic if not the large world class, when developed. Type C includes all deposits smaller than the 400 troy ounce minimum as well as unevaluated occurrences having essentially no recorded production.

Platinum-group metals occur as natural alloys and as sulfides and arsenides associated mainly with chromite or nickel-copper and copper lodes in mafic and ultramafic rocks, and in residual weathering placer deposits (Page and others, 1973). Although the chemistry of platinum-group metals in their source geologic environments is not well known, they seem to be associated mostly with mantle-derived igneous rocks formed at high temperatures. Very low grade platinum-group metals are also recovered domestically as a refinery byproduct of porphyry and other copper deposits, from lode and placer gold deposits, copper-gold ores in contact metamorphic rocks, and copper associated with syenitic rocks. Differentiation of these deposits as to type of occurrence, such as lode, placer, or unknown; status of production, where appropriate; and literature citations are reported by Blair, Page, and Johnson (1977).

The major primary platinum-group metal deposits occur in mafic and ultramafic rock complexes, and are of three geologic types: (1) stratiform, tabular, well-layered cumulate sequences intrusive into stable Precambrian shield areas or basaltic terranes, in which the platinum-group minerals occur mainly in chromite zones, but also in basal copper-nickel sulfides, and sparsely disseminated horizons in overlying gabbroic layers; (2) concentrically zoned ultramafic complexes, where the platinum-group occurs as small masses and disseminations closely associated with copper and (or) chromite; and (3) alpine complexes, irregular discordant and deformed rocks formed in eugeosynclinal orogenic belts and island arc areas commonly associated with chromite, titaniferous magnetite, and copper. Platinum-group metal alloys occur as placer-type concentrates derived from the weathering of adjacent primary deposits. The placers commonly also contain gold.

Platinum provinces

The map shows a generally positive spatial geologic correlation of platinum and platinum-group metals with ultramafic rocks associated with Mesozoic rocks overlying the oceanic crust along the western margin of the Cordilleran belt, and with mafic and ultramafic rocks associated with Precambrian rocks of the old continental crust block in the Cordilleran and Appalachian belts and the Precambrian shield areas. These associations are clearest along the Pacific Coast where the metals have been sought most actively. The correlation is less certain in the Appalachian region, probably because of insufficient data. For example, these metals probably were not looked for in assaying analyses. Also placer mining for gold antedated the time when platinum-group metals were of sufficient value to recover for assay. The deposit in Montana occurs in the Stillwater Complex, a Merenski reef-type structure in a Precambrian ultramafic complex. It is the major potential source for platinum and platinum-group metals in the United States. A second potentially large source is coproduct platinum, which occurs in mafic rocks of the Duluth Complex associated with copper and nickel. The geophysical magnetic signature of mafic rocks in the Duluth Complex persists southwestward into Kansas (Chase and Gilmer, 1973; the resource implications of this geophysical anomaly should be investigated at a later time). Favorable Precambrian terranes elsewhere in the conterminous United States, where traces of platinum are reported, need to be systematically examined, sampled, and analyzed for platinum.

Paleozoic and Mesozoic mafic intrusive rocks are not yet known to host platinum lode deposits in the United States (an important geologic association in Russia, where the Noril'sk differentiated copper-nickel sulfide deposit is a major producer). This geologic environment also should be closely examined in the conterminous United States. A diffuse group of primary and placer deposits and occurrences of platinum-group metals, mainly coproducts and byproducts of gold and (or) copper mining, and particularly the porphyry-type deposits in the Cordilleran region, also have not yet been completely sampled for platinum and platinum-group metals.

Fifteen platinum and platinum-group metal provinces or poorly defined potential province regions have been identified on the map of the conterminous United States and in table 1 as containing the geologic, geochemical, or geophysical evidence for the occurrence or the potential for occurrence of these materials. The relative importance of at least the first five provinces is indicated by the order of numbering; ordering is uncertain beyond five, and subsequent numbers have been assigned arbitrarily. Some tentative estimates of future resource potential are made in table 1 where existing data permit. However, the relative magnitudes of high, medium, and low (except where noted in table 1) are in terms of generally low-yield deposits currently known in the conterminous United States. Table 1 also shows the generally poor status of sytematic platinum and platinum-group resource information.

There are no type A deposits of platinum or platinum-group metals in the United States. Type B lode and placer deposits occur in central California (no. 8), south-central Wyoming (no. 6), and southern Nevada (no. 11). The outlook for potentially minable materials is believed to be greatest in the Stillwater Complex, Mont. (no. 1), deposit. Coproduct platinum from the Duluth Complex and its possible extensions may prove to be an important hypothetical source. The porphyry copper deposits at Bingham, Utah, and Ely, Nev. (Beal, 1965), also rank as type B deposits because of byproduct platinum-group metal production, but we do not have data from other deposits of this type. The Appalachian region seems to be virtually untested as a source area is spite of the large numbers of potential platinum-bearing source rocks located there.

Thus, a few of the type B deposits undoubtedly contain a substantially larger potential of minable materials than the 400 troy ounce size limit implies, which suggests the possibility that the domestic industry can expand in the future. While domestic production of platinum-group metals to date has been almost insignificant, largely because it has been more advantageous to obtain these materials abroad, the map demonstrates that they do occur in a variety of unevaluated geologic enviroments in widely separated parts of the nation. Thus it is fair to conclude that the potential for recovery of platinum and platinum-group metals has not been fully examined, particularly where they may exist as coproducts or byproducts of the recovery of associated metals.

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Table 1.--*Locations, type of deposits, resource potential estimates, and status of resource information of platinum and platinum-group metal provinces*

Province			Geologic types of deposits	Preliminary estimates of resource potential			Status of geologic information for resource assessment	
No.	State	Area		High	Medium	Low	Adequate	Insufficient
1	Montana	Stillwater Complex	Mafic and ultramafic rocks.	X[1]	--	--	X	--
2	Montana, Idaho, Utah, Nevada, Colorado, Arizona	Cordilleran states with gold and copper deposits	Quartz veins, placers, porphyry copper byproduct.	X	--	--	--	X
3	Minnesota	Duluth Complex	Mafic rocks.	X[1]	--	--	--	X
4	Oregon and California	Klamath Mountains	Ultramafic rocks, placers.	--	X	--	--	X
5	Washington	Pacific Northwest Coast	Placer deposits.	--	--	X	X	--
6	Wyoming	New-Rambler - Centennial (Albany Co.)	Mafic and ultramafic rocks	--	X	--	X	--
7	California	Coast Ranges	Ultramafic rocks, placers.	--	X?	--	--	X
8	California	Sierra Nevada foothills	Ultramafic rocks, placers.	--	X?	--	--	X
9	Washington	Canadian border	Metamorphic belt, ultramafic rock sources, placers.	--	--	X	--	X
10	Oregon	John Day area	Ultramafic rocks, placers.	---unknown---			--	X
11	Nevada	Goodsprings - Key West	Ultramafic and granitic rocks.	---unknown---			--	X
12	Texas	Llano uplift	Ultramafic and metamorphic rocks.	---unknown---			--	X
13	Alabama, Georgia, Pennsylvania, North Carolina, S. Virginia	Southern Appalachian Mountains	Mafic and ultramafic rocks, placers.	--	--	X?	--	X
14	Northern Virginia, Maryland, Pennsylvania, New Jersey	Central Appalachian belt	Mafic and ultramafic rocks, placers.	--	--	X?	--	X
15	New England States	Northern Appalachian Mountains	Mafic and ultramafic rocks	--	--	X?	--	X

[1]Potential may be considered extremely high in comparison with other domestic sources.

Background information relating to this map and others in the Atlas of Metal and Nonmetal Provinces in the Conterminous United States is published as U.S. Geological Survey Circular 792 (Tooker, 1979), available free of charge from the U.S. Geological Survey, Reston, VA., 22092