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Mineral Resources of the Caribbean Region

by

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When Jim Case asked me to talk about the mineral resources of the Caribbean Region at this symposium I protested that the subject didn't fit the highly scientific tone of the meeting and that in any event I wasn't the person to discuss them. But he's very persuasive, so I'll try to give a quick rundown of the highlights from both a geologic and an economic point of view. I'll exclude the resources of the Guyana Shield, which fall within the area of the map but have nothing to do with the development of the Caribbean itself.

Deposits and districts will be shown on the maps to follow regardless of their state of exploitation, but I'll try also to bring out the past importance of those that are now worked out or approaching exhaustion.

The principal resources can be categorized as occurring in primary or endogenic deposits related to island-arc or continental margin development, and secondary, exogenic or residual deposits formed on erosion surfaces by chemical weathering. Though I don't want to emphasize the statistical aspects, it is worth noting that the latter far exceed the former in value and world significance.

In this and the remaining illustrations I have not attempted to show the geology--you who have been working in the region no doubt are familiar with at least the general aspects of it, and in any case, it is so complex that to attempt to show it in any detail would only confuse us all!

Here the orange spots are chromite districts and the green, manganese. As you see, Cuba has (I should say <u>had</u>) the great prepondance (actually about 99.8%) of all the chromite of the region, and of this about 95 percent is of the high-alumina refractory type. The principal districts are the Camagüey and the Moa-Baracoa, each refractory. Most metallurgical-grade ore comes from the Mayari District. Production began in World War I and peaked in World War II when Cuba furnished most of our refractory ore.

The deposits are tabular to irregular, are of the podiform type, and range upward to perhaps half a million tons in size. They occur in ultramafic rocks of uncertain age and relations to their surroundings that can be interpreted as either very early island-arc or obducted ocean floor. The chromite itself is early magmatic, undoubtedly cumulus, and must have been concentrated in the mantle prior to the emplacement of its peridotite host into the upper crust.

Small deposits of very good metallurgical grade chromite occur in the peridotites along the Motagua fault in Guatemala.

By far the largest manganese deposits of the region are in eastern Cuba along the northern flank of the Sierra Maestra. Most are lenticular, stratabound, massive to disseminated ore bodies in the upper part of the marine pyroclastic Cobre Formation, of latest Cretaceous(?) to middle Eocene age. Ore minerals are largely hypogene oxides of psilomelane type which have been partly oxidized in place to pyrolusite by supergene action. Unusually clearcut evidence of the nature and timing of the mineralization has been found at several mines: Sharks teeth embedded in the ore prove the submarine environment, while angular ore fragments in overlying intraformational conglomerates show that the water must have been shallow and the mineralization virtually contemporaneous with sedimentation. Nearly all the deposits are in tuffaceous units near or in the uppermost limestone member of the Cobre Formation. Warm springs active during the waning stages of volcanism no doubt discharged directly on the sea floor.

Though not large by world standards, the eastern Cuban deposits were significant suppliers to the United States market for many years. During World War II they furnished 15 to 20 percent of our imports, and for a while in the 50's the Charco Redondo mine was the largest single producer in the western hemisphere. Total Cuban production and reserves are somewhere between 5 and 10 million tons; we believe that mining activity has declined sharply in recent years.

Other far smaller manganese deposits are known in the Greater Antilles from Puerto Rico to western Cuba, and in Central America. Most are associated with Cretaceous volcanic-sedimentary sequences. Production has been small; no mines are active or known to have significant reserves.

Historically, base metals have not been important on a world scale in the Caribbean Region, but this promises to change in the future. Copper (shown in orange on the slide) is widely distributed throughout the Greater Antilles and has been mined on a small scale from colonial days in Cuba, Central America, and northern South America. Porphyry copper deposits have been discovered in recent years in Puerto Rico, Panama, Colombia, and reportedly in the Dominican Republic; though none is yet in operation, their development and exploitation will obviously increase the output of the region enormously.

Deposits worked to date include veins associated with Cretaceous and early Tertiary intrusives, skarns in Cretaceous limestones in contact zones of intermediate to acid intrusives, volcanogenic massive sulfides in later Mesozoic eugeosynclinal sequences, some at least near hypabyssal intrusives, and vein or replacement deposits of uncertain affiliations. Only a few are shown.

At El Cobre, near Santiago de Cuba, copper was mined intermittently from 1540 to the present century from steep veins cutting the Cobre Formation that are genetically related to the final pulses of the magmatism that produced the extrusives and intrusions of the Sierra Maestra. Production may have been several hundred thousand tons of metal. The other principal copper mine of Cuba is Matahambre in Pinar del Rio, discovered just before World War I. Steeply plunging massive to stockwork-like bodies of pyrite and chalcopyrite, some of which also have economic amounts of sphalerite and galena, occur at or near intersections of faults and joints in the Jurassic San Cayetano, a formation of sandstones and graywackes without volcanic components and not intruded by igneous rocks. The deposits are clearly epigenetic; structural evidence seems to favor a late Eocene age, but the source of the metals is a mystery. Production has been upwards of half a million tons of metal from ore said to average over 5 percent copper; remining reserves are believed to be small.

Meme, in Haiti, is a skarn deposit in Cretaceous limestone cut by quartz monzonite of Maastrichtian age. Rosita, in Nicaragua, is a disseminated copper-gold-silver deposit, also in Cretaceous limey sediments in the contact zone of a Laramide intrusive. Each has had production of a few thousand tons a year, but the Haitian mine may now be on standby.

The porphyry copper deposits are much like those elsewhere in island-arc environments. Eugeosynclinal volcanic rocks are intruded by late, are shown. Colombia has had the largest output, which has amounted to at least $1.5 billion at the $35 price and continues to be around 500,000 ounces per year worth, at present prices, 50 to 100 million dollars. Two-thirds or more of the production is from placers.

A new mine is being develped at Pueblo Viejo in the Dominican Republic where more than 20 million tons of ore running about 0.15 ounce gold, an ounce of silver, some zinc, and a little copper is available for open pitting. The deposit apparently consits of veins and veinlets in lower Cretaceous volcanic rocks. The mining press has stated that annual output will be 225,000 ounces of gold, making it the second largest gold mine in the Western Hemisphere.

Geologically the deposits of the region may be divided into those consisting almost entirely of gold or of gold and silver, and those with substantial base-metal sulfides. The latter will assume increasing importance in the future.

The deposits and metals discussed as far, plus some magmatic and skarn iron deposits of small to moderate size and a few very small deposits of tungsten, antimony, mercury, and other minor metals may all be considered as more or less normal products of geosynclinal development or, if you prefer, of convergent plate margins. In the Greater Antilles most formed in late Cretaceous and in early Tertiary time, during or at the close of the major orogenic pulses. In Central America, and probably in Colombia, mineralization continued well into the Tertiary.

Weathering has produced the most important mineral resources of the region that are being exploited at present. In the Greater Antilles several periods of uplift and erosion resulted in peneplanation, breakdown of the ferromagnesian minerals of the extensive peridotite massifs and concentration of some elements, especially iron and nickel, into deposits that cover large areas in eastern Cuba and elsewhere to depths that range up to several tens of feet. The processes, though simple in broad terms, are complex in detail. Regardless of the intermediate steps, which include incorporation of nickel originally present in the olivine lattice into magnesian serpentine minerals and ferrous nontronite, the end products are ferruginous laterites with one to over two percent nickel, minor amounts of cobalt, several percent of chromic oxide, and up to about 50 percent iron. Nickel increases downward; most is near the bottom of the laterite profile or in the uppermost foot or two of the underlying serpentine.

Evidence for two principal weathering epochs, one in late Cretaceous, pre-Maastrichtian time and a second in the Oligocene, has been advanced for the Cuban deposits, which have been sharply uplifted and are undergoing erosion at present. Present day lateritization is advocated by some; however, it seems probable that the net balance must be negative.

Similar nickeliferous laterites are present in the Dominican Republic, Guatemala, Colombia, Venezuela, and Puerto Rico.

Cuban laterites were mined for iron ore years ago; the nickel and chromium produced a natural alloy that had a vogue for heavy rails, but as a precise composition could not be maintained, increasingly stringent specifications brought production to a close. In the 1940's and 50's, two plants were constructed in Cuba to separate nickel (and the accompanying cobalt) from the ores; another has recently been completed in the Dominican Republic, and a fourth plant is planned for Guatemala. Production in 1973 was 66,000 tons of nickel, worth about $200 million. This is about 9 percent of the world total. As reserves of the region are conservatively estimated at nearly 10 million tons of nickel, some $28 billion at present prices and 20 percent of the known world reserves, the future looks bright. The USSR has promised a third plant in Cuba, to raise output to roughly 100,000 tons per year, and both Venezuela and Colombia are thinking about exploiting their deposits.

Extensive areas in Jamaica and smaller ones in southern Hispaniola have surficial deposits of bauxite overlying Eocene-Oligocene limestones on karsted erosion surfaces developed in mid-Tertiary time. The material strongly resembles normal reddish soil and was not recognized as a potential ore of aluminum until the early 1940's when samples from Jamaica were analyzed to determine the cause of its low fertility. Chemically the material consists of about 50 percent Al_2O_3, less than 2 percent SiO_2, 16-20 percent Fe_2O_3, and 2-3 percent TiO_2. Mineralogically it is gibbsite with some boehmite. Although originally thought to be simply a residuum from the limestones, the latter are so pure that it seems very unlikely that they could have been the source rocks. Goldich has shown that the ratios of the oxide constituents resemble those in intermediate igneous rocks and that the sparse quartz grains have the features of those from volcanic rocks, suggesting that the bauxite was derived from pyroclastic material. The provenance of this volcanic rock, if indeed it was the source of the bauxite, would make an interesting subject for research. Zircons are present. It seems pertinent to note that all the deposits of the Caribbean proper are situated in a fairly narrow belt, and that, incidentally, the areas of nickel laterites and aluminous laterites are mutually exclusive.

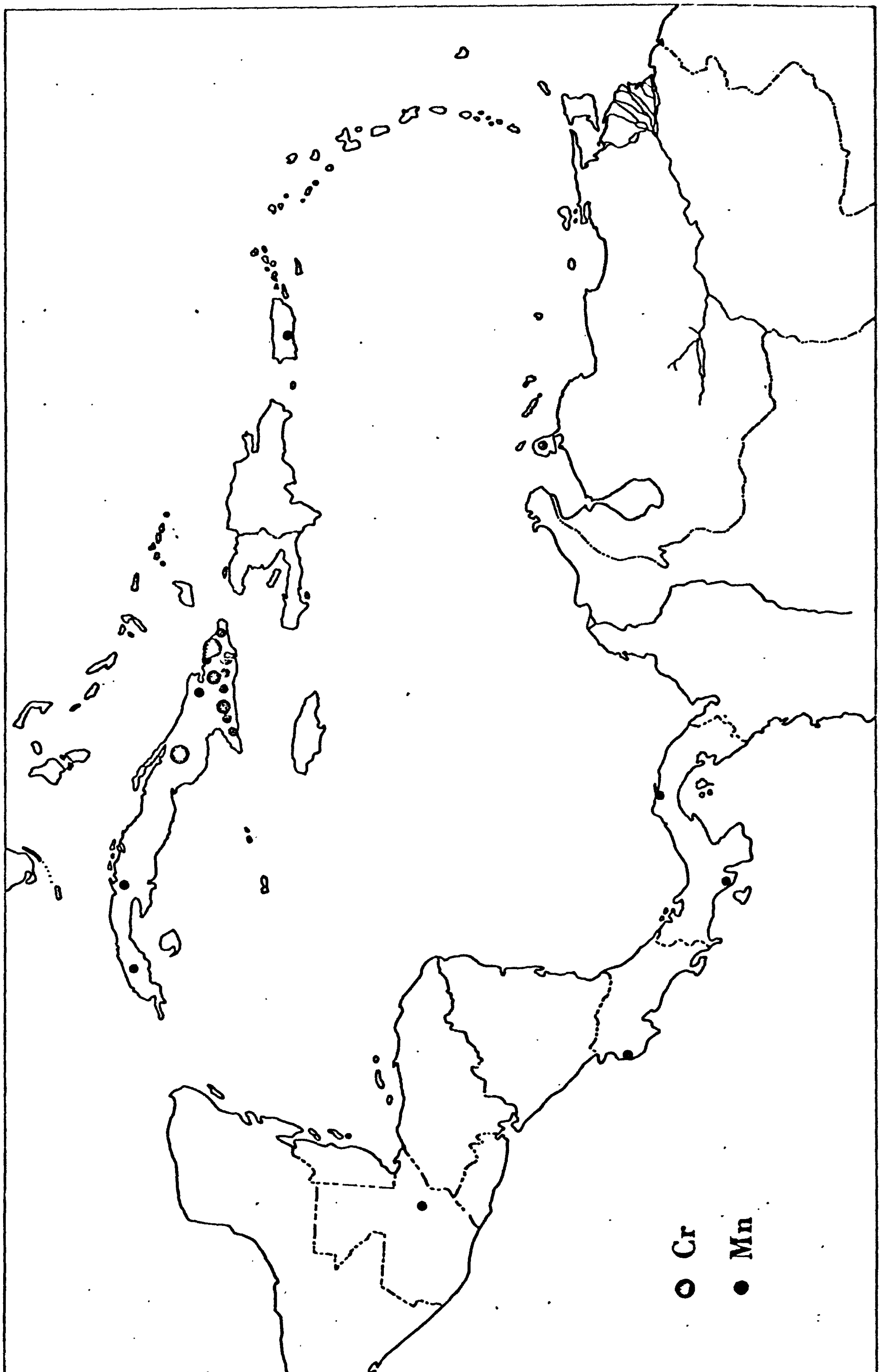
Jamaica is the second largest bauxite producer of the world and was the leader for a number of years. In 1973, Jamaica, Haiti, and the Dominican Republic produced 23 percent of total world production. Reserves are less than 10 percent of the world total, but are large enough to last many years at the present rate of extraction. Their value is some 10 to 15 billion dollars at today's prices.

In southern Central America substantial quantities of lower grade bauxitic material have developed by lateritic weathering of volcanic detritus eroded from rising mountains during Pliocene-Pleistocene time and deposited in continental basins. Alumina content is said to be only about 43 percent, and both silica and iron are rather high, but construction of a plant in Costa Rica to produce about 450,000 tons per year of alumina from 1.5 million tons of bauxite is under consideration.

Other mineral resources of essentially local significance are gypsum deposits near Kingston, Jamaica, in northern Guatemala, Colombia, and elsewhere; salt in various places, phosphate in Colombia and Venezuela, and so forth. Extensive black sand deposits of titaniferous magnetite are known on many beaches.

I hope this extremely rapid, once-over-lightly review will serve to orient you on the major aspects of the mineral resources of the Caribbean region.

Thank you.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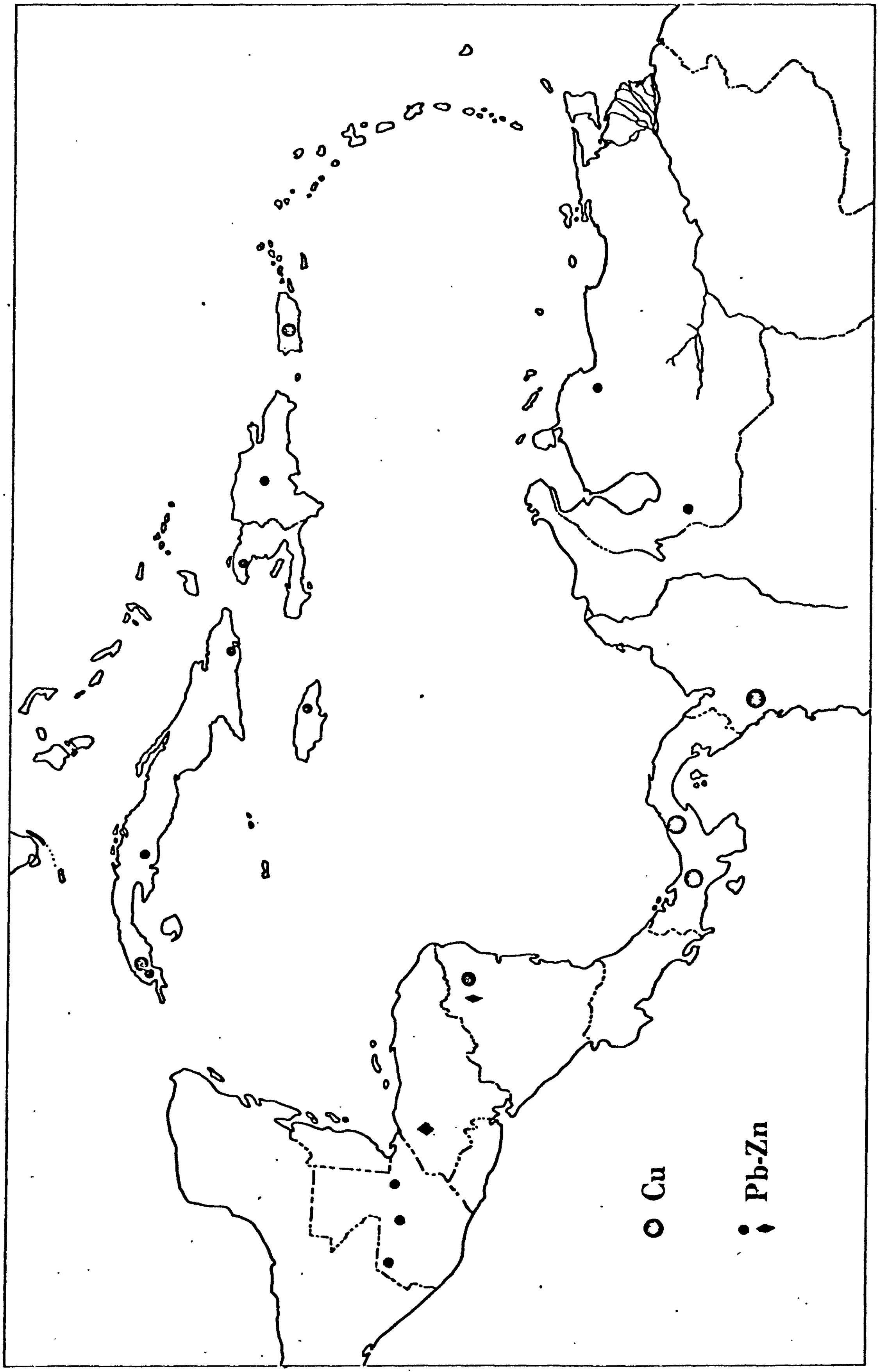
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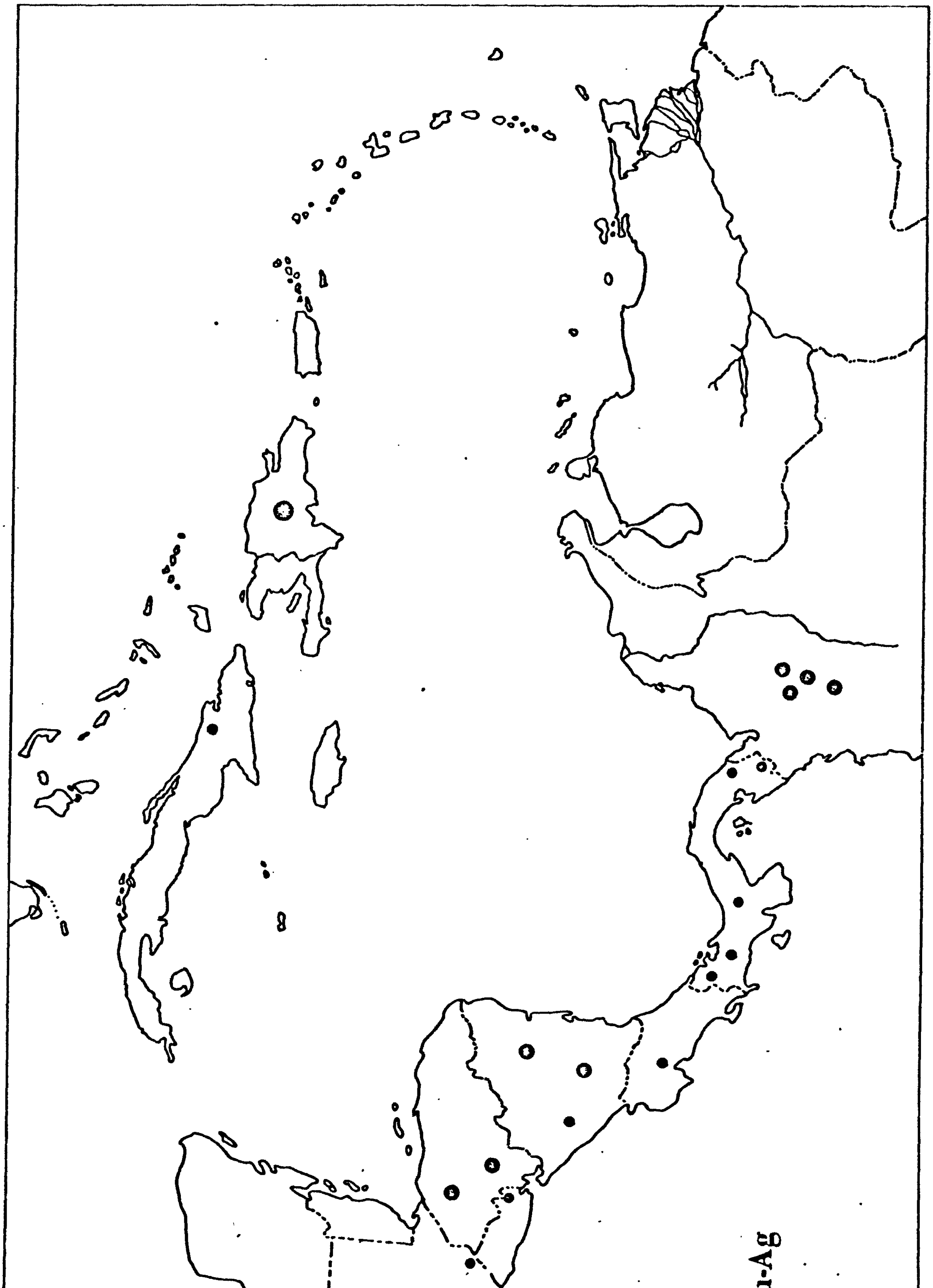
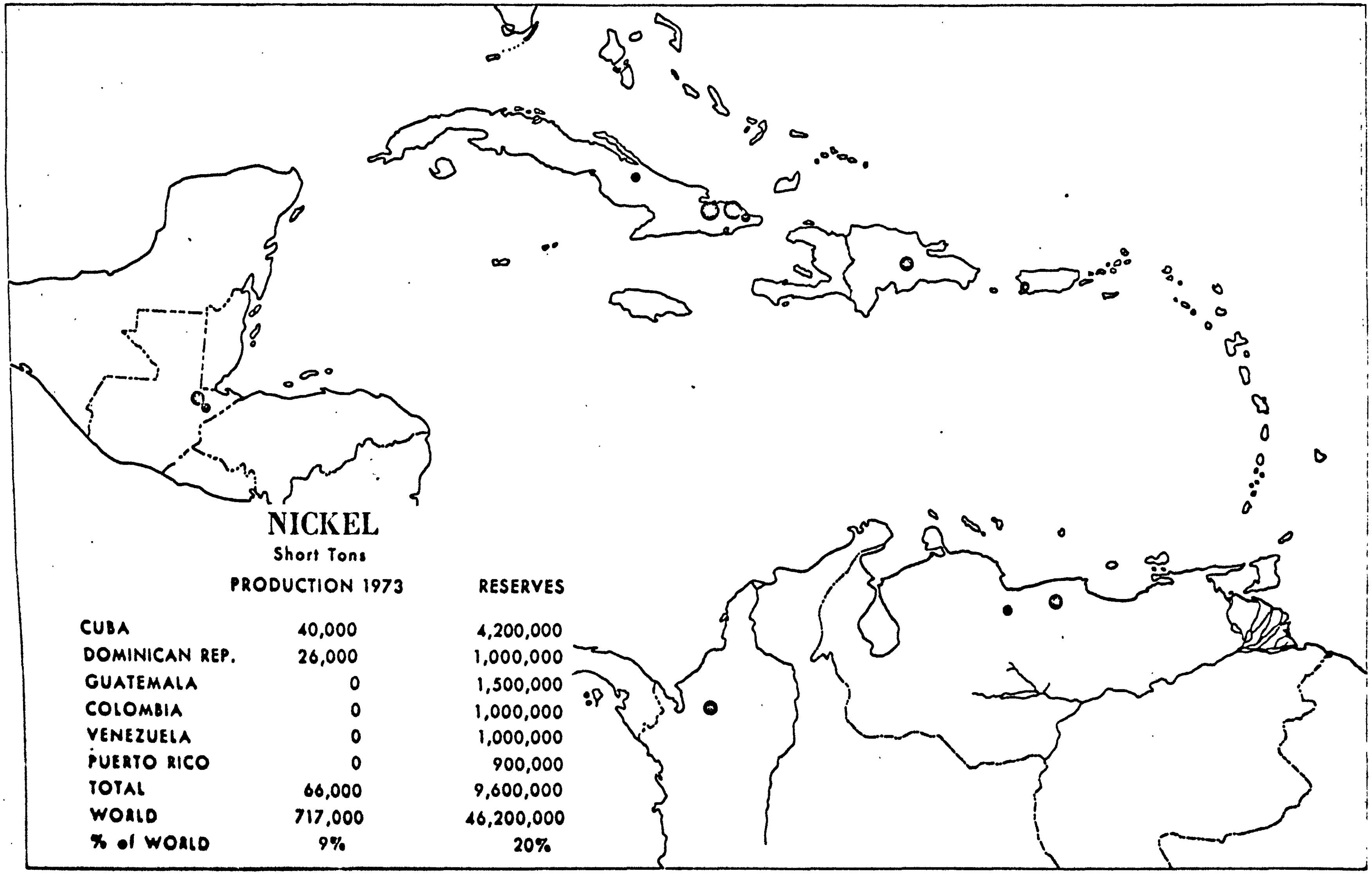
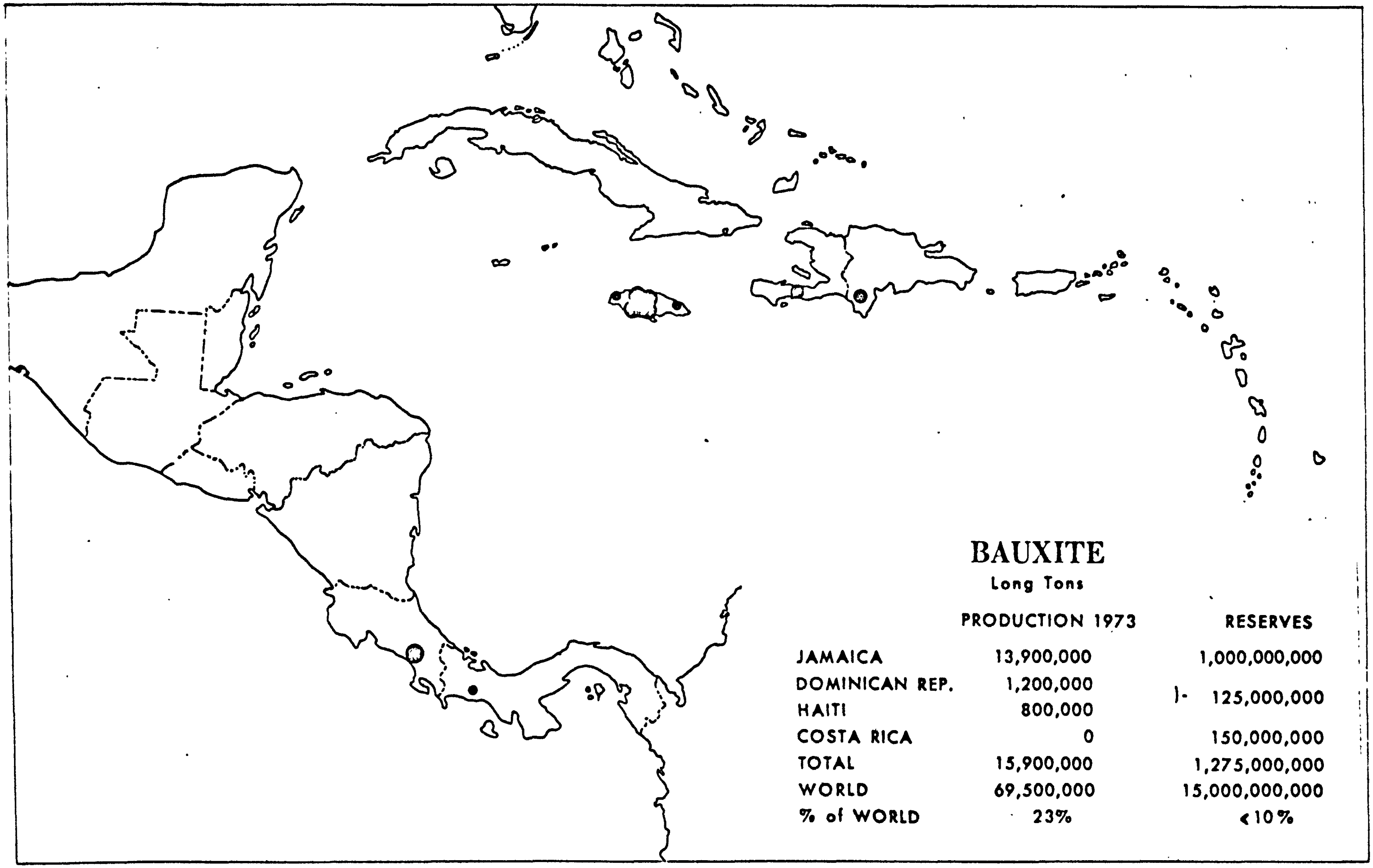

Au-Ag



NICKEL
Short Tons

	PRODUCTION 1973	RESERVES
CUBA	40,000	4,200,000
DOMINICAN REP.	26,000	1,000,000
GUATEMALA	0	1,500,000
COLOMBIA	0	1,000,000
VENEZUELA	0	1,000,000
PUERTO RICO	0	900,000
TOTAL	66,000	9,600,000
WORLD	717,000	46,200,000
% of WORLD	9%	20%



BAUXITE

Long Tons

	PRODUCTION 1973	RESERVES
JAMAICA	13,900,000	1,000,000,000
DOMINICAN REP.	1,200,000	} 125,000,000
HAITI	800,000	
COSTA RICA	0	150,000,000
TOTAL	15,900,000	1,275,000,000
WORLD	69,500,000	15,000,000,000
% of WORLD	23%	<10%