Mineral Deposit Summary Sheets

by

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The mineral resource assessment of Puerto Rico requires the consideration of a wide spectrum of potential mineral deposit types. These deposit types vary widely in many of their physical attributes including their geology and geologic setting, genesis, mineralogy, and structure. Deposit types also display a unique array of circumstantial evidence, including geochemical anomalies, geophysical signatures, and alteration patterns, which are used to aid in their detection and identification.

Because of the complexity in the description of mineral deposits and their mode of formation, characteristics of the deposits have been summarized on Mineral Deposit Summary Sheets. The Mineral Deposit Summary Sheets are divided into several sections. These sections include:

Deposit type;

Description of deposit type;

Rock units and structures permissive for deposit type;

Example of deposit type;

Known occurrences;

Geophysical signature;

Geochemical signature;

Tract delineation;

Comments

These data sheets provide the physical and circumstantial evidence for the mineral deposit types for Puerto Rico and serve as a quick reference source and comparison guide.

These summary sheets use deposit type numbers and models, and mineral deposit descriptive information from USGS Bulletin 1693, Mineral deposit models (Cox and Singer,

1986). Other information collected on the deposits and occurrences of Puerto Rico is also incorporated into these summaries. From these lines of evidence, the expected patterns of deposits from USGS Bulletin 1693 and recorded characteristics from known Puerto Rico occurrences are compared.

Most of the sections and data are self explanatory. However, the distinction made between "mineral occurrence" and "mineral deposit" is as follows. A "mineral occurrence" is a concentration of mineral (usually, but not necessarily, considered in terms of some commodity, such as copper, barite, or gold) that is considered valuable by someone somewhere, or that is of scientific or technical interest (Cox and Singer, 1986). A "mineral deposit" is a mineral occurrence of sufficient size and grade that it might, under the most favorable of circumstances, be considered to have economic potential (Cox and Singer, 1986).

After discussion of the mineral deposit types and their characteristics, an explanation as to how permissive mineral deposit tracts were delineated is explained. This includes favorable geology, geochemistry, geophysics, and known occurrences.

DEPOSIT TYPE

8A Podiform chromite

DESCRIPTION OF DEPOSIT TYPE

Irregular masses of chromite in ultramafic parts of ophiolite (Albers, 1986).

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

Deposits are restricted to dunite bodies within tectonized harzburgite and (or) the lower portions of ultramafic cumulates. These rocks are commonly serpentinized.

Within Puerto Rico, outline of serpentinite (KJs) defines host rocks. These map units are massive, but previously sheared and internally slickensided. Serpentinite is chiefly altered harzburgite. There is no evidence that serpentine extends very deep.

EXAMPLE OF DEPOSIT TYPE

None

KNOWN OCCURRENCE

None

GEOPHYSICAL SIGNATURE

Magnetic Map - serpentinite antiforms of southwestern Puerto Rico produce large anomalies.

Gravity Map - serpentinite antiforms of southwestern Puerto Rico show gravity lows. Imply extension of serpentinite below Quaternary alluvium into the Valle de Guanajibo.

GEOCHEMICAL SIGNATURE

Within USGS Bulletin 1693, no geochemical signature is recognized for this model.

Our stream sediment geochemical samples show: a suite of element anomalies related to podiform chromite terrane in southwest Puerto Rico.

Nickel anomalies (150-10,000 PPM) present in podiform chromite terrane.

Chrome values (2,000-10,000 PPM) occur in podiform chromite terrane.

Cobalt values (50 - 2,000 PPM).

TRACT DELINEATION

Tract delineation based on outcrop pattern of known serpentinite map units.

DEPOSIT TYPE

17 Porphyry Cu

DESCRIPTION OF DEPOSIT TYPE

Stockwork veinlets of quartz, chalcopyrite, and molybdenite in or near a porphyritic intrusion. The model name and number porphyry copper (17) is used when it is believed the mineral occurrence is part of a Cu porphyry system, but not enough information is available to discriminate between porphyry Cu-Au (20c) or porphyry Cu-Mo (21A).

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

Tonalite to monzogranite stocks and breccia pipes intrusive into batholiths, volcanic or sedimentary rocks.

Within Puerto Rico, these igneous rocks intrude rocks of older age (not comagmatic).

Molybdenum increases with depth of system, which indicates a deeper seated porphyry system.

EXAMPLE OF DEPOSIT TYPE

Site no.	MRDS no.	Name
52	W701159	Rio Cuyon
114	W701043	La Muda

KNOWN OCCURRENCES

Site no.	MRDS no.	Name
98	W701166	Cacao
116	W701044	La Muda
117	W701045	La Muda
119	W701046	La Muda
176	W701091	Quebrada de la Mina
188	WALT003	Rio Santiago copper prospect
189	WALT004	Humaco copper prospect
203	W701109	Barranquitas prospect

GEOPHYSICAL SIGNATURE

Aeromagnetics - linear features and dominantly aeromagnetic high reflect the subsurface.

Bouguer gravity - Utuado and San Lorenzo batholiths reflect lows.

GEOCHEMICAL SIGNATURE

The porphyry Cu model described in USGS Bulletin 1693 contains a geochemical signature of Cu, Mo, Au, Ag, W, B, Sr towards center; Pb, Zn, Au, As, Sb, Se, Te, Mn, Co, Ba, and Rb towards periphery.

Geochemical analysis of Puerto Rico samples show anomalies for Cu, Au, Mo and Sn, contained mostly within the permissive terrain.

TRACT DELINEATION

Known occurrences identify permissive lithologies.

South of Utuado batholith - track delineated based on a combination of known occurrences, linear aeromagnetic signature, and geologic terrane. Aeromagnetics can be either high or low, depending on composition of surrounding lithologies.

COMMENTS

The permissive area for porphyry deposits is very large, containing most of the Tertiary and mixed Cretaceous and Tertiary volcanoclastic lithologies. Within this area of permissive terranes, promising areas are delineated with respect to known occurrences.

DEPOSIT TYPE

18B Cu skarn deposits

DESCRIPTION OF DEPOSIT TYPE

Chalcopyrite in calc-silicate contact metasomatic rocks (Cox and Theodore, 1986).

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

Tonalite to monzogranite plutons intrude carbonate rocks or calcareous clastic rocks.

In Puerto Rico:

Rio Blanco stock (TKh) - intrudes calcareous Tabonuco Formation (Kta) and Hato Puerco Formation (Kh), Fajardo Formation (Kfa), Lomas Formation (Klo).

San Lorenzo batholith (Ksl) and quartz diorite (Kpgq) complex intrudes metavolcanic rocks (TKmv), lava flows and breccias (Kabcj), and calcareous Pitahaya Formation (Kpi), Torrecilla breccia (Kt) and Robles Formation (Kr).

EXAMPLE OF DEPOSIT TYPE

Site no.	MRDS no.	Name
92	W701128	Island Queen (Las Torres)
164	W701050	La Mine, Rio Blanca (Spanish adit)

KNOWN OCCURRENCES

Site no.	MRDS no.	Name
34	W701112	Rio Hondo (36-2)
37	W701115	Escuela prospect (Jaguar vein, Mamey vein)
51	GEM1111	Borinquen
126	W7011049	El Yunque
191	W701101	Rio Hondo (35-1)
192	W701102	Rio Hondo (35-2)
193	W701103	Rio Hondo (35-3)
194	W701104	Rio Hondo (35-4)
195	W701105	Rio Hondo (35-5)
196	W701106	Rio Hondo (35-6)

GEOPHYSICAL SIGNATURE

Rio Blanco area

Magnetics - no coverage in Rio Blanco area.

Gravity - Rio Blanco alteration too small to be seen.

San Lorenzo batholith

Aeromagnetics - only partial coverage of area, therefore, inconclusive.

Gravity - there appears to be a halo (145-155mGal) around batholith, but it is unclear if this is an artifact of the batholith or mineralization.

GEOCHEMICAL SIGNATURE

USGS Bulletin 1693 shows geochemical signatures of Cu, Au, Ag, Pb, Zn, and Co for this model type. In Puerto Rico, geochemical sampling does not show major groupings of the signature elements around the Cu-skarn terrane.

TRACT DELINEATION

Rio Blanco area - tract delineation based on 1:20,000 mapped alteration and pyrite occurrences.

Known Cu skarn occurrences.

Kfa (Fajardo Fm.) & Klo (Lomas Fm.) have very little carbonate material.

Delineated area to northwest of stock based on mapped copper occurrences and implied buried pluton based on 1:20,000 scale mapping.

San Lorenzo batholith - interior boundary at edge of plutonic rocks.

Exterior boundary - on northeast side - fault contact buried under Quaternary alluvium (Qa), contact between carbonate bearing Torrecilla Breccia (Kt) and Los Negros Formation (Kln).

Approximately 2 kilometers from plutonic rocks through Kabcj unit.
Barranquitas stock - Pinas stock area - Tract delineated based upon known occurrences, fault-bounded Torrecilla Breccia (Kt)

COMMENTS

Cu and Fe skarn - both deposits usually contain both Fe and Cu, assignment between these two models was based on what was perceived to be dominant metal.

DEPOSIT TYPE

18D Iron skarn deposits

DESCRIPTION OF DEPOSIT TYPE

Magnetite in calc-silicate contact metasomatic rocks (Cox, 1986).

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

For this deposit type, contacts of gabbro, diorite, diabase, syenite, tonalite, granodiorite or granite intrusions and carbonate rocks or calcareous clastic rocks

In Puerto Rico:

Rio Blanco stock unit (TKh) - intrudes calcareous Tabonuco Formation (KTa) and Hato Puerco Formation (Kh), Fajardo Formation (Kfa), Lomas Formation (Klo).

San Lorenzo batholith (Ksl) and quartz diorite (Kpgq) complex intrudes metavolcanic rocks (TKmv), lava flows and breccias (Kgbcj), and calcareous Pitahaya Formation (Kpi), Torrecilla Breccia (Kt) and Robles Formation (Kr).

EXAMPLE OF DEPOSIT TYPE

Site no.	MRDS no.	Name
85	W701123	Keystone mine (La Mina, La Esperanza, Juncos mine)

KNOWN OCURRENCES

Site no.	MRDS no.	Name
39	W701116	Aguayo prospect
41	W701117	Cane Field and Pastor prospects
43	W701118	Santiago and Pastor prospects
45	W701119	Suiza prospect
82	W701120	Mamey limestone deposits
83	W701121	Buen Suceso
84	W701122	La Caridad prospect
87	W701125	Deposit no. 5
89	W701126	Deposit no. 2
91	W701127	Deposit no. 3
94	W701129	Deposit no. 4
96	W701164	Yaurel (Los Cocaos)
97	W701165	Emajagua
143	W701136	Tibes
147	W701138	Barrio Tibes, Rio Portuges
197	W701140	Unnamed (47-1)

GEOPHYSICAL SIGNATURE

Rio Blanco area

Magnetics - no coverage in Rio Blanco area.

Gravity - Rio Blanco alteration too small to be seen.

San Lorenzo batholith

Aeromagnetics - only partial coverage of area, therefore, inconclusive.

Gravity - there appears to be a halo (145-155mGal) around batholith, but it is unclear if this is an artifact of the batholith or mineralization.

GEOCHEMICAL SIGNATURE

USGS Bulletin 1693 shows a geochemical signature of Fe, Cu, Co, Au and possibly Sn for this model.

In Puerto Rico, the geochemical analyses do not show anomalous patterns for these elements.

TRACT DELINEATION

Rio Blanco area - known Fe skarn occurrence.

Tract delineation based on known alteration and pyrite at 1:20,000 scale mapping.

San Lorenzo batholith - coincident tract with Cu skarn.

Mix of both Cu skarn and Fe skarn occurrences.

See Cu skarn for tract delineation description.

Los Panes intrusion - magnetite, resulting from partial replacement of hornblende; occurs along contact of Los Panes intrusion.

Richest concentrations do not exceed 10 percent of rock.

A.D. Frazer aeromagnetic map shows pronounced magnetic anomaly along southeast portion of intrusion (map I-335).

Cerro el Gato - quartz diorite-grandiorite (TKqd) intrudes.

Yauco Formation (TKy) - calcareous.

Lago Garzas (TKl) - calcareous.

Yauco Formation interbedded with Lago Garzas (TKly).

Known Cu and Fe skarn occurrences.

COMMENTS

Cu and Fe skarn - both deposits usually contain both Fe and Cu, assignment between these two models was based on what was perceived to be dominant metal.

DEPOSIT TYPE

20C Porphyry Cu-Au

DESCRIPTION OF DEPOSIT TYPE

Stockwork veinlets of chalcopyrite, bornite, and magnetite in porphyritic intrusions and coeval volcanic rocks. Ratio of Au (in PPM) to Mo (in percent) is greater than 30 (Cox, 1986).

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

Within Puerto Rico, porphyry Cu-Au deposits are associated with Eocene porphyry intrusions, which are mostly quartz bearing and tonalite in composition.

These Eocene porphyries intrude rocks of same age (comagmatic).

EXAMPLE OF DEPOSIT TYPE

Site no.	MRDS no.	Name
71	W701071	Piedra Hueca deposit
75	W701073	Cala Abajo deposit
161	W701014	Tanama Deposit
179	W701059	Helecho Deposit

KNOWN OCCURRENCES

Site no.	MRDS no.	Name
73	W701072	Sapo Alegre
158	W701012	Laundry Creek Prospect
159	W701013	Copper Creek

GEOPHYSICAL SIGNATURE

Aeromagnetics - linear features and dominantly aeromagnetic highs reflect the subsurface.

Bouguer gravity - Utuado and San Lorenzo batholiths reflect lows.

GEOCHEMICAL SIGNATURE

USGS Bulletin 1693 describes the geochemical signature for the porphyry Cu-Au model as Cu, Au, Ag central to deposit, and Mo, Pb, Zn, Mn peripheral to these models.

Geochemical analyses for Puerto Rico show:

Molybdenum and tin anomalies contained within the permissive areas.

Gold occurs both within and outside of permissive terranes.

Anomalous copper values occur within permissive terranes.

TRACT DELINEATION

Delineated by extent of volcanic clastic belt and known occurrences.

South of Utuado batholith - Track delineated based on a combination of known occurrences, linear aeromagnetic signature, and geologic terrane. Aeromagnetics can be either high or low, depending on composition of surrounding lithologies.

COMMENTS

The model name and number porphyry copper (17) is used when it is believed the mineral occurrence is part of a Cu porphyry system, but not enough information is available to discriminate between porphyry Cu-Au (20c) or porphyry Cu-Mo (21A).

The permissive area for porphyry deposits is very large, containing most of the Tertiary and mixed Cretaceous and Tertiary volcanoclastic lithologies. Within this area of permissive terranes, favorable areas are delineated with respect to known occurrences.

DEPOSIT TYPE

22C Polymetallic veins

DESCRIPTION OF DEPOSIT TYPE

Quartz-carbonate veins with Au and Ag associated with base metal sulfides related to hypabyssal intrusions in sedimentary and metamorphic terranes (Cox, 1986).

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

Near surface fractures and breccias within thermal aureal of clusters of small intrusions. In some areas peripheral to porphyry systems.

EXAMPLE OF DEPOSIT TYPE

Site no.	MRDS no.	Name
66	W701034	Constancia mine
88	W701160	Cerro Avispa

KNOWN OCCURRENCES

Site no.	MRDS no.	Name
4	W701146	Unnamed (48-4)
8	W701148	Unnamed (48-6)
14	W701022	Unnamed (20-3)
25	W701029	Barrio Pasto deposits
26	W701064	Unnamed (32-1)
27	W701065	Unnamed (32-2)
28	W701066	Unnamed (32-3)
29	W701067	Unnamed (32-4)
31	W701069	Unnamed (32-6)
32	W701110	Unnamed (32-10)
36	W701114	Unnamed (37-1)
38	W701150	Unnamed (48-8)
42	W701152	Unnamed (48-10)
44	W701153	Unnamed (48-11)
46	W701154	Unnamed (48-12)
47	W701155	Unnamed (48-13)
49	W701157	Unnamed (48-15)
58	GEM1117	Rio Jajome
63	W701031	Unnamed (20-12)
64	W701032	Unnamed (20-13)
68	W701036	Cuchillos
69	W701070	Pellejas
70	W701037	Collcuchi, Sayre
74	W701039	Unnamed (21-7)
76	W701074	Unnamed (32-11)
77	W701075	Unnamed (32-12)

78	W701076	Unnamed (32-13)
79	W701077	Unnamed (32-14)
80	W701078	Unnamed (32-15)
81	W701079	Unnamed (32-56)
90	W701161	Carmen (50-3)
93	W701162	Carmen (50-4)
95	W701163	Carmen (50-5)
110	W701041	Unnamed (22-2)
118	W701080	Unnamed (32-17)
121	W701081	Unnamed (32-18)
123	W701082	Unnamed (32-19)
125	W701083	Unnamed (32-20)
127	W701084	Unnamed (32-21)
129	WALT001	Monte El Gato
130	W701086	Unnamed (33-1)
131	W701087	Unnamed (33-2)
132	W701088	Unnamed (33-3)
139	W701133	Palmarejo
141	W701135	Minillas, San German
149	W701139	Unnamed (46-2)
156	W701010	Unnamed (14-2)
157	W701011	Unnamed (15-1)
163	W701016	Unnamed (18-1)
178	W701092	Unnamed (33-7)
180	W701093	Unnamed (33-8)
181	W701094	Unnamed (33-9)
182	W701095	Unnamed (33-10)
184	W701097	Unnamed (33-12)
185	W701098	Unnamed (33-13)
186	W701099	Unnamed (33-14)
190	W701100	Unnamed (34-1)
198	W701107	Unnamed (35-7)
204	W701143	Unnamed (48-1)

GEOPHYSICAL SIGNATURE

None

GEOCHEMICAL SIGNATURE

The element Zn, Cu, Pb, Au and Ag are characteristic of this deposit type. These elements are present in the geochemical samples taken throughout the island.

TRACT DELINEATION

No terrane drawn.

The entire island is permissible for polymetallic veins, except the San Lorenzo and Utuado batholiths, and Oligocene or younger sediments.

COMMENTS

The depositional environment for this deposit type is within near-surface fractures and breccias within thermal aureoles of small intrusions or peripheral to porphyry systems.

Due to the high degree of faulting and the abundance of intrusions, most of the island is permissive except for the large batholiths and the Oligocene and younger sediments.

All of these occurrences were identified in Cox and Briggs (1973), and their descriptions used to classify as polymetallic veins.

DEPOSIT TYPE

24C Volcanogenic manganese

DESCRIPTION OF DEPOSIT TYPE

Lenses and stratiform bodies of manganese oxide, carbonate, and silicate in volcanic-sedimentary sequences (Koski, 1986).

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

The marine Tertiary volcaniclastics with carbonates were found to contain all occurrences of manganese

EXAMPLE OF DEPOSIT TYPE

Site no.	MRDS no.	Name
2	W701145	Juana Diaz mine
115	W701009	Aguada
128	W701085	Gatti prospect

KNOWN OCCURRENCES

Site no.	MRDS no.	Name
1	W701144	Unnamed (48-2)
6	W701147	Unnamed (48-5)
10	W701149	Unnamed (48-7)
18	W701060	Unnamed (31-2)
20	W701061	Unnamed (31-3)
22	W701062	Unnamed (31-4)
24	W701063	Monte Guilarte
48	W701156	Santiago
65	W701033	Mayaguez
67	W701035	Corazal
173	W701056	Unnamed (30-1)

GEOPHYSICAL SIGNATURE

Aeromagnetics - incomplete or no coverage over permissive terrane.

Gravity - no detectable pattern over permissive terranes.

GEOCHEMICAL SIGNATURE

The geochemical signature for volcanogenic Mn deposits contained in USGS Bulletin 1693 is Mn, Zn, Pb, Cu and Ba.

These elements do not show related patterns for Puerto Rico samples.

TRACT DELINEATION

Manganese occurrences and deposits.

Area permissive - contains volcaniclastic marine Tertiary lithologies.

COMMENTS

Volcanogenic manganese deposits form most often when there is sufficient structure and porosity to permit subsea-floor hydrothermal circulation and sea floor venting.

The Juana Diaz mine produced manganese oxide from irregular chambers of limestone of the Juana Diaz Formation. Meyerhoff (1933) believes this manganese ore was deposited by meteoric waters that dissolved calcium carbonate and also precipitated manganese oxide.

DEPOSIT TYPE

25E Epithermal quartz-alunite Au

DESCRIPTION OF DEPOSIT TYPE

Gold, pyrite, and enargite in craggy veins and breccias in zones of high-alumina alteration related to felsic volcanism (Berger, 1986).

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

Through going fractures, centers of intrusive activity.

Upper and peripheral parts of porphyry copper systems.

EXAMPLE OF DEPOSIT TYPE

Site no.	MRDS no.	Name
35	W701113	Cidra
160	D002191	Cerro la Tiza

KNOWN OCCURRENCES

Site no.	MRDS no.	Name
86	W701124	Unnamed (39-1)
124	W701048	Unnamed (23-7)
187	WALT002	Rio Anasco

GEOPHYSICAL SIGNATURE

Aeromagnetics - coverage not available for large units.

Gravity - inconclusive.

GEOCHEMICAL SIGNATURE

The USGS Model book, Bulletin 1693, shows geochemical presence of Au, Ag, and Cu higher in the system, and base metals increasing with depth.

These elements did not define the permissive area for this deposit type.

TRACT DELINEATION

Terranes drawn based on known 1:20,000 alteration.

Called advanced argillic alteration associated with plutons.

Known occurrences in most tracts.

All hydrothermal alteration (TKha) and meta-volcanic rocks (TKmv) included that are related to dacite, quartz latite, rhyodacite or rhyolite.

DEPOSIT TYPE

28A Kuroko massive sulfide

DESCRIPTION OF DEPOSIT TYPE

Copper- and zinc-bearing massive sulfide deposits in marine volcanic rocks of intermediate to felsic composition (Singer, 1986).

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

Eocene island arc volcanics

Cherts present

Dacitic domes

EXAMPLE OF DEPOSIT TYPE

None

KNOWN OCCURRENCES

None

GEOPHYSICAL SIGNATURE

Aeromagnetics - incomplete or no coverage over permissive terrane.

Gravity - no detectable pattern over permissive terrane.

GEOCHEMICAL SIGNATURE

Copper and zinc anomalies with scattered gold anomalies occur in the western part of the massive sulfide terrane.

TRACT DELINEATION

Area permissive delineated by intermediate to felsic marine Tertiary volcano-clastic lithologies.

Associated occurrences of volcanogenic Mn.

COMMENTS

While no known occurrences of Kuroko massive sulfide deposits have been described, there is a high probability that they are present in Puerto Rico. The permissive features include: marine volcanic rocks of intermediate to felsic composition; marine rhyolite, dacite, subordinate basalt and associated sediments; hot springs related to marine volcanism; island arc tectonic setting; evidence of associated deposits (volcanogenic Mn).

DEPOSIT TYPE

38A Lateritic Ni

DESCRIPTION OF DEPOSIT TYPE

Nickel-rich, in situ lateritic weathering products developed from dunites and peridotites. Ni-rich iron oxides are most common (Singer, 1986).

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

Relatively high rates of chemical weathering (warm-humid climate) of ultramafic rocks and relatively low rates of physical erosion.

KJs - serpentinite is host rock

Dunite source = good chrome resource

Harzburgite source = poor chrome resource

Host lithology is outline of laterite accumulation.

EXAMPLE OF DEPOSIT TYPE

Site no.	MRDS no.	Name	Reserves and Grades
166	W701051	Punta Guanajibo	1.03% Ni, 0.07% Co, .63% Cr, 2,100,000 ST, 19.03% Fe
201	W701052	Guanajibo	0.08% Co, 20.54% Fe, 0.51% Cr, 46,800,000 ST, .88% Ni
169	W701053	Las Mesas deposit	28.39% FE, 0.75% Cr, 25,000,000 ST, .81% Ni, .12% Co
171	W701054	Rosario north deposit	20.76% Fe, .58% Cr 4,800,000 ST, .85% Ni, .07% Co
172	W701055	Rosario south deposit	12.47% Fe, .34 Cr, 1,100,000 ST, .71% Ni, .06% Co
175	W701057	Maricao west	22.05% Fe, .59% Cr, 5,000,000 ST, .98% Ni, .10% Co
177	W701058	Maricao east	29.45% Fe, .67% Cr 5,600,000 ST, 1.08% Ni, .11% Co

KNOWN OCCURRENCES

None

GEOPHYSICAL SIGNATURE

Gravity - serpentinite antiforms produce large anomalies.

Aeromagnetics - coverage incomplete.

GEOCHEMICAL SIGNATURE

Enriched Ni, Cr, and Co represent geochemical signatures for this model.

These elements and Mg are anomalous in the permissive terrane for this deposit type.

TRACT DELINEATION

Known occurrences.
All laterites contained within Serpentinite (KJs).
Ni laterites mapped at 1:20,000.

COMMENTS

Laterite accumulation is restricted to the outcrop pattern of the serpentinite (KJs) zone.

This area is believed to have been exhaustively explored for this type of deposit.

DEPOSIT TYPE

38C Karst Type Bauxite

DESCRIPTION OF DEPOSIT TYPE

Residual and transported material on carbonate rocks. Transported material may be felsic volcanic ash from distant source or any aluminous sediments washed into the basin of deposition (Patterson, 1986).

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

EXAMPLE OF DEPOSIT TYPE

Kennedy bauxite concession.

KNOWN OCCURRENCES

Not plotted.

GEOPHYSICAL SIGNATURE

None

GEOCHEMICAL SIGNATURE

Aluminum and Ga not examined.

TRACT DELINEATION

Based on Kennedy bauxite concession granted in 1961. Tract extends farther east and west and is restricted to the Lares Limestone. Bauxite sampled from sinkholes.

DEPOSIT TYPE

39A Placer AU-PGE

DESCRIPTION OF DEPOSIT TYPE

Elemental gold and platinum-group alloys in grains and (rarely) nuggets in gravel, sand, silt, and clay, and their consolidated equivalents, in alluvial, beach, and eolian deposits (Yeend, 1986).

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

Oligocene and Quaternary sedimentary clastic deposits which have drained gold bearing lithologies and alteration.

EXAMPLE OF DEPOSIT TYPE

None

KNOWN OCCURRENCES

Site no.	MRDS no.	Name
72	W701038	Palos Blancos
100	GEM1120	Luquillo Mountains gold placers
200	W701108	Rio Caliente

GEOPHYSICAL SIGNATURE

None

GEOCHEMICAL SIGNATURE

Some Au anomalies define drainage permissive for placer Au-PGE mineralization in the northeast part of the island.

TRACT DELINEATION

Known occurrences.

High-energy drainage areas below known gold occurrences.

COMMENTS

Gold placers were exploited by both the Indian and then Spanish colonists during colonization. Gold placers were also exploited during the 1900's to 1930's.

Remaining gold resources lie both in undiscovered remnant placer deposits, veins of gold-bearing quartz, and placers offshore are possible.

DEPOSIT TYPE

39C Shoreline Placer Ti

DESCRIPTION OF DEPOSIT TYPE

Ilmenite and other heavy minerals concentrated by beach processes and enriched by weathering (Force, 1986).

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

Rock types included in this deposit type consist of well-sorted medium-to fine-grained sand in dune, beach, and inlet deposits commonly overlying shallow-marine deposits.

These deposit types typically are elongated 'shoestring' ore bodies parallel to coastal dunes and beaches.

EXAMPLE OF DEPOSIT TYPE

None

KNOWN OCCURRENCES

Site no.	MRDS no.	Name
105	W701003	Hatillo
106	W701004	La Marina
107	W701005	La Boca
111	W701007	Rio Cocal

GEOPHYSICAL SIGNATURE

None

GEOCHEMICAL SIGNATURE

Ti anomalies in the volcaniclastic rocks in the western part of the island may indicate the possibility of placer Ti deposits along the west coast.

TRACT DELINEATION

Occurrences are restricted to individual beach dunes that are not visible at 1:200,000 scale.

DEPOSIT TYPE

Copper Manto

DESCRIPTION OF DEPOSIT TYPE

Mantos (horizontal) and pipes (vertical) found in association as brecciated areas, small in two dimensions and long in the third dimension. Brecciation allows the flow of fluids and deposition of minerals.

ROCK UNITS AND STRUCTURES PERMISSIVE FOR DEPOSIT TYPE

Small lenses and veins found in the Blacho Tuff Member of the Pozas Formation. Subaerial volcanic lithologies are preferred host lithologies.

EXAMPLE OF DEPOSIT TYPE

None

KNOWN OCCURRENCES

Site no.	MRDS no.	Name
15	W701023	Unnamed (20-4)
16	W701024	Unnamed (20-5)
17	W701025	Unnamed (20-6)

GEOPHYSICAL SIGNATURE

A few scattered anomalies for Cu occur in this terrane.

GEOCHEMICAL SIGNATURE

TRACT DELINEATION

Tract delineated for copper-silver Manto deposits of Puerto Rico is controlled by surface exposure of subaerial volcanic rocks of the Pozas Formation (Kpo).