United States Department of the Interior

Geological Survey

Gold Deposits Along the Río Madera Northern Bolivia

by

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Table of Contents

Illustrations

SUMMARY

Gold has been discovered and is actively being mined from the river channels of the Río Beni, Río Madre de Díos, and the Río Madera in northern Bolivia (figure 1) and neighboring Brazil. Extensive suction dredging, largely concentrated along the Río Madera in the Araras-Manos district has produced an estimated 100 Kg [perhaps much more] of gold over the past five years. During the six month dry season, suction dredges can extract as much as one kilogram per month of 15 to 300 micron size gold. As many as 1,000 dredges are reported in operation during the times when the river's flow is at its lowest and the best conditions for working the river bottom. In addition to dredging the river, productive gold mining has recently expanded to shallow open pit mines (small hydraulic operations) in Brazil and Bolivia adjacent to the dredging operations. These ten-meter-deep hydraulic excavations expose nearly horizontal sand and conglomerate layers with well-to-poorly rounded quartz and feldspar pebbles cemented by a jarosite-rich cement. These ferricretes (iron-cemented conglomerates) apparently contain enough gold to be mined, washed, and the concentrates sold for further possessing. Extensive drilling 10 kilometers north along the banks of Río Madera in Brazil is reported to have discovered several large areas of gold-bearing ferricrete conglomerate apparently similar to others now being mined. Other areas likely contain similar deposits since little systematic exploration has been completed in the region.

Gold is reported in placer deposits from the headwaters of the Madre de Díos in Peru downstream for over 650 kilometers to the Río Madera in northeastern Bolivia. Production, based on current activity, appears to be best in the Río Madera area and from the upper headwaters in Peru (Olsen and Bliss, in preparation). Although these operations appear to be extracting placer gold, exposures in the open pit excavations suggest a different origin for some of the deposits. Exposures in the Goitia mine display a three to eight meter bleached, oxidized, leached zone below the poorly developed 30 to 50 cm thick soil down to the 1-to-3 meter thick gold bearing ferricrete deposits. The sub-rounded nature of some of the brittle minerals in these conglomerates suggest that the source for these fragments is local. Precambrian granites cut by coarse crystalline quartz veins crop out within five kilometers of the open pit mines.

It is possible the gold has been and is being transported in the fluvial systems draining the Andes. However, the local source for some of the conglomerate pebbles and the intense 'laterite' weathering of the gravel, terrace, and Precambrian deposits suggest that the present location of gold mineralization could be a result of chemical transport / enrichment during the oxidization and leaching weathering process that has formed the extensive laterite soils across large areas of the region. Several rock samples have been collected to determine the concentrations of gold and other trace elements, the constituents of the heavy mineral suite, and the size and fineness of the gold. If these deposits prove to have a significant component of chemical enrichment, prospecting for additional deposits could rapidly expand well away from the recent river channels. Analogies might include the Boddington gold deposits of Western Australia.

INTRODUCTION, LOCATION, AND PREVIOUS STUDIES

The Bolivian geological survey, Servico Geologico de Bolivia (GEOBOL) invited the U.S. Geological Survey to assist the national mining company of Bolivia, Corporacion Minera de Bolivia (COMIBOL) in understanding their placer gold concessions along the Rio Beni, Rio Madre de Dios, and the Rio Madera. Their objective is to document effective prospecting techniques and apply these in the search for new gold deposits. Darrell Herd and G.E. McKelvey of the U.S. Geological Survey accompanied Marcelo Claure Zapata of GEOBOL, Luis Vera of COMIBOL, Gustavo Larrea of the Department of Planning, and the mine owner Sr. Goitia on a visit to the excavations of the Goitia mine 65 kilometers north of the town of Guayaramerin, Bolivia. COMIBOL controls nearly 600,000 hectares in two concessions; Madre de Díos (figure 2) and San Antonio del Río (figure 3).

The deposits are located along the Río Madera and its tributaries. The Goitia open pit gold mines are located 65 kilometers north of the Bolivian city of Guayaramerin. A dense rain forest jungle obscures the nearly flat alluvial plain developed across the Precambrian Brazilian shield; this jungle extends to the edge of the major half-to-one kilometer wide rivers cutting the shield. Travel to these deposits is via a variety of transportation. Our three-day expedition started with a two hour charter airplane ride from La Paz, diverted to Riberalta when the weather at Guayaramerin prevented our landing. A crowded taxi ride along the well-maintained highway number 8 covered the 70 kilometers

in another two hours. From Guayaramerin we crossed to the excellent highway in Brazil. We took yet another taxi north for 65 kilometers to the gold workings near Chocotatal, crossed the kilometer wide Río Madera back to Bolivia, and journeyed another 1.5 kilometers to the open pits of the Goitia gold operations. A quick aerial reconnaissance was completed the following day. An amateur video record of the field and aerial reconnaissance is available for viewing at the USGS CIMRI office, 210 East 7th Street, Tucson, Arizona 85705.

COMIBOL first expressed interest in the placer potential of the San Antonio Del Río and Madre de Díos concessions in 1962 when searching for tin. By 1971, some mapping and limited drilling was completed. During their third phase of exploration, gold was detected in 63 samples from the Río Madera. Subsequent air photo interpretation of the geology and geomorphology focused the exploration toward the identification of paleoplacer deposits. Seismic exploration and drilling in a few areas have helped find several areas which contain detectable gold.

Considerable dredge mining is active on the wide rivers which feed the Rio Madera. Even in December, when the rivers are 20 meters above their dry season levels, many suction dredges are mining the river for gold. Activity during the dry season is reported to be over a thousand dredges in the water at any one time. A Brazilian firm is rumored to have drilled several hundred shallow holes near Pueblo Navel finding gold mineralization over a 1.5 km^2 area. Some undocumented estimates suggest the gold production to date by these dredging operations exceed 100 Kg over the past five years; estimates considered

conservative by many.

The amount of factual geologic and production data from mining and prospecting is limited. A photo interpreted geologic sketch map of the San Antonio del Río region by COMIBOL give the generalized locations of major out-crops and known gold locations. Several summary reports document the local stratigraphic setting. Little systematic exploration has been completed in the region, due in part to the extensive, dense vegetation and the lack of proven, effective, and economic prospecting techniques.

GEOLOGIC SETTING

Precambrian granites, amphibolite gneiss, migmatites, dacite lavas, and quartzites of the Brazilian Shield crop out along the rivers from Guayaramerin north to the confluence of the Río Madera and the Río Abuna. Zones of greisen are mapped (COMIBOL, 1990), and widely spaced 10 to 40 cm-wide quartz veins persist throughout the region. No gold is known in these veins (Charles Thorman, 1991, oral communication). Quaternary and Tertiary sand, gravel, clay, and conglomerate fluvial deposits are developed across the Precambrian shield. These drainages are a result of the uplift and erosion of the Andes 250 - 300 km to the west. Little is known of the basement geology between the Precambrian exposures along the Río Madera and the folded Paleozoic sediments of the eastern foothills of the Andes.

Intense tropical weathering has produced wide-spread oxidized and leached soils. A humic layer rarely a meter thick commonly overlays limonite-bearing muds, clays, sands, and conglomerates up to 10 meters in thickness. A 1-to-3 meter zone of iron-cemented ferricrete conglomerate and sands underlay the laterite soils. Coarser gravels are reported below these ferricretes.

DESCRIPTION OF DEPOSITS

The gold deposits exposed in the Goitia mines and the open pit operations in adjacent Brazil are extensive. Mining appears to be focused on the ferricrete zones below the oxidized and leached laterites. Many open pit mines up to 150 meters in diameter to depths of 10 meters dot the area. Hydraulic mining and concentration of the iron cement portion of the ferricrete produces large amounts of clay, sand, and gravel waste. These fill the previous excavations, making it difficult to determine the true scale of the gold bearing zones. At the Goitia mine, an area nearly one km^2 in size appears to have been mined. There is no obvious evidence that would place any horizontal limits on these gold bearing ferricrete deposits.

An organic-rich soil (figure 4), 0.3 to 0.5 meters thick is developed under the dense rain forest jungle. Under these gray to dark brown soils is a 3-to-8 meter thick zone of bleached, oxidized, and leached clays, sands and grit deposits. Commonly this interval is intense white near the top and composed almost entirely of clay. With depth the zone, the clays become sand bearing and contain rare lenticular zones of goethite-limonite staining (figure 5). In several of the open pit mines are 10-to-20 meter long lenses of dark gray pyritic clay. The gold-bearing zone, as reported by the owner, are at the base of the 3-to-8 meter thick oxidized and leached zone. One exposure in the Goitia Mine displays a 40 cm thick coarse sand unit, somewhat lenticular, cemented with a mixture of 50 % Goethite and 50 % Jarosite. A 1.5 meter zone of poorly sorted sand, grit, and an occasional 1-to-5 cm thick lens of conglomerate separate the upper sand ferricrete from the zone actively being

mined below. The pay zone is a 1-to-3 meter thick iron cemented poorly bedded and poorly sorted gravel layer. The layer appears to have remarkable lateral continuity while varying in thickness from less than a meter to over 3 meters. It is also possible there is another layer below those exposed in the abandoned pits.

The gold-bearing ferricrete-cemented conglomerates are composed of 5 mm to 10 cm sized rounded to subrounded pebbles of quartz and rare feldspar (photo 1). The cement appears to take two forms: jarosite / goethite limonite surrounding the sand and the pebbles, and a silica-rich rind that persists as 5 mm to 1 cm wide bands and concretion rims. No exposures reveal the underlaying stratigraphy. It is possible that additional ferricrete zones are present.

DISCUSSION

Gold is mined from the channels of the major, fast water rivers from Peru to well in to Brazil. The size range reported (COMIBOL) is from 15 to 300 microns. Gold in epithermal systems is known in the Andes Mountains nearly 450 km to the west of the intense gold mining activities in the Araras-Manos district along the Río Madera. The major rivers; Río Beni, Río Madre de Díos, and Río Madera transport a heavy suspended silt/sand load, especially during the rainy season. The fluvial transport of gold is apparently important.

The present distribution of the major stream channels is apparently superimposed on the deeply and well-developed laterite-saprolite soils on Tertiary fluvial deposits and the precambrian shield. The gold-bearing ferricrete deposits contain numerous poorly rounded pebbles of fractured quartz, feldspar, and in one case an angular fragment of biotite-bearing feldspar granite. The source for these pebbles appears to be the local Precambrian outcrops of granites, gneiss, lavas, and quartzites.

Square casts of goethite, likely after cubic pyrite, the near horizontal nature of the gold bearing ferricrete deposits, and their position at the base of the intensely leached laterite zone suggest that these deposits have been chemically enriched from either fine grained fluvial gold carried as far as 450 km from the west or from 'local' Precambrian sources. The source of gold could be local or distant for both. In either case, the concentrations may not have been high enough to form ore. Chemical redistribution of gold

in the weathering cycle is documented by Gray (1989) and is the process that best explains the 'laterite' gold deposits at Boddington, Australia.

Additional data are necessary to document that chemical enrichment of gold is the principle ore-forming process in these ferricrete deposits along the Río Madera, . Work is presently under way to determine the amount of gold present in the total sample, the sites the gold resides within the ferricrete-cemented conglomerates (pebbles, iron cement, silica bands, etc.), and the fineness of the gold (gold, silver and platinum content of the gold). Additionally, it will be useful to determine the associated trace element suite and the heavy mineral suites. These laboratory analyses are limited at this time to the two samples collected during the visit.

Samples of the potential source areas, and from the leached laterite profile above the gold-bearing ferricrete deposit, will be useful in determining the source or sources of the precious metals, and the processes that have concentrated them in their present locations.

ACKNOWLEDGMENTS

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Photograph 1. Gold bearing ferricrete from the Goitia Mine, Araras-Manos District, Northern Bolivia.

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Figure 1. Location map of the Rio Madera Gold mining region, Bolivia

Rio Madera Gold Mining Region

Bolivia

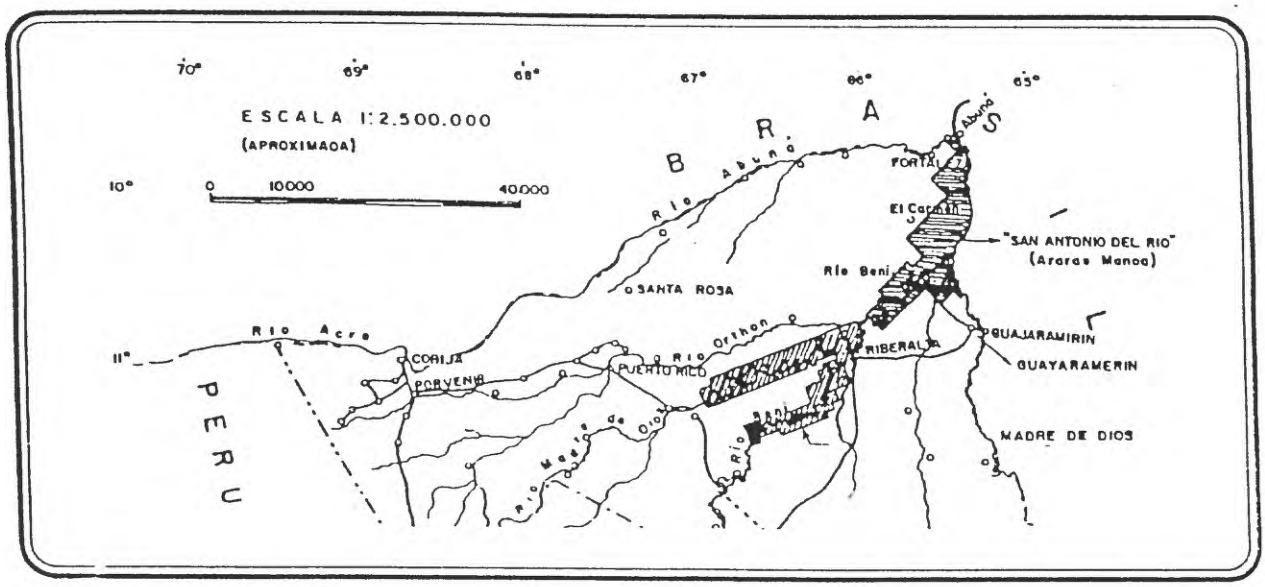

Figure 2. San Antonio del Rio Mining Concession

"San Antonio del Rio"

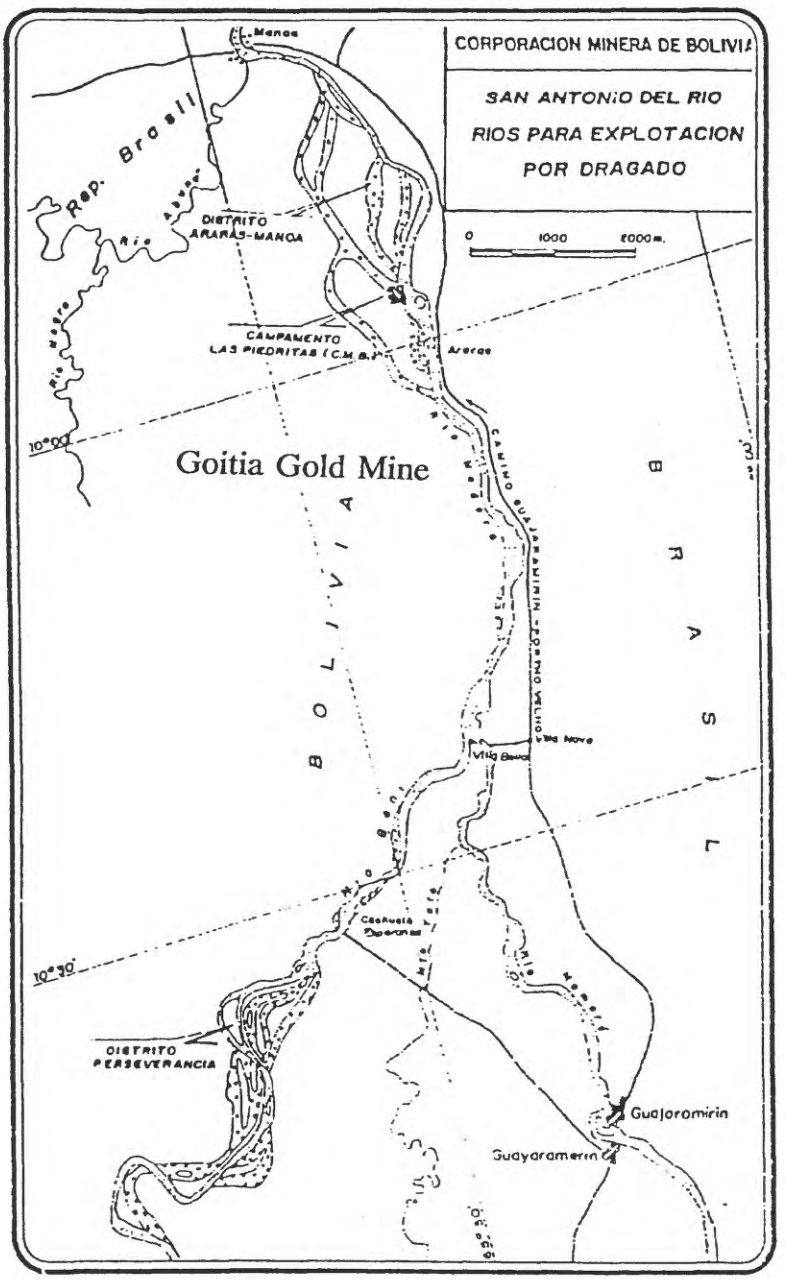

Figure 4 Stratigraphyc column of the Araras-Manoa gold deposits

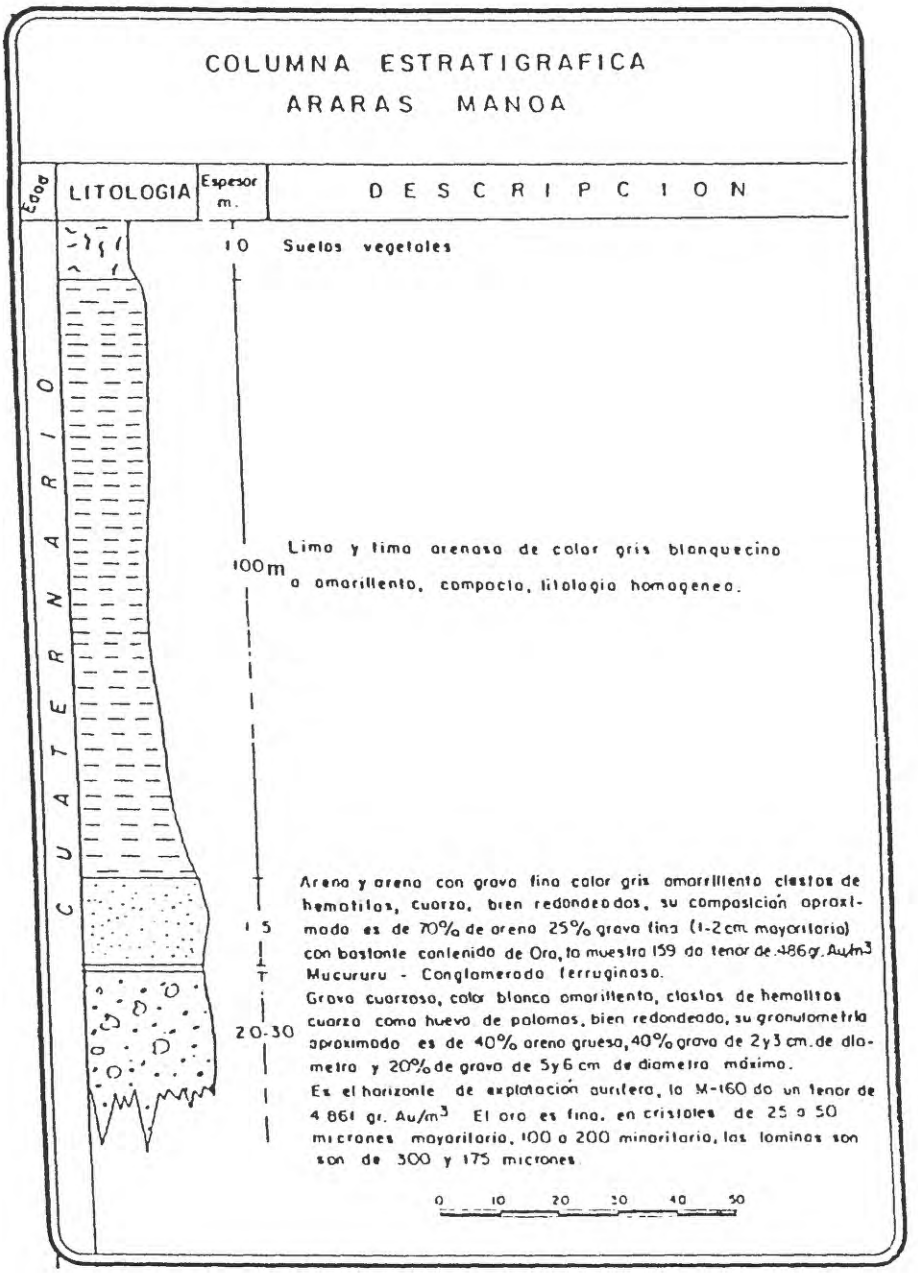
COLUMNA ESTRATIGRAFICA
ARARAS MANOA
Edad
LITOLOGIA
Espesor m.
D E S C R I P C I O N
CUATERNARIO
10
Suelos vegetales
100m
Limo y lima arenosa de color gris blanquecino a amarillento, compacto, litologia homogenea.
15
Arena y arena con grava fina color gris amarrillento clastos de hematitas, cuarzo, bien redondeados, su composición aproximado es de 70% de arena 25% grava fina (1-2 cm mayoritario) con bastante contenido de Oro, la muestra 159 da tenor de .486 gr. Au/m3
T
Mucururu - Conglomerado ferruginoso.
20-30
Grava cuarzosa, color blanco amarillento, clastos de hematitas cuarzo como huevo de palomas, bien redondeado, su granulometria aproximado es de 40% arena gruesa, 40% grava de 2 y 3 cm. de diametro y 20% de grava de 5 y 6 cm de diametro máximo.
Es el horizonte de explotación aurifera, la M-160 da un tenor de 4.861 gr. Au/m3 El oro es fino, en cristales de 25 a 50 micrones mayoritario, 100 a 200 minoritario, las laminas son son de 300 y 175 micrones.
0
10
20
30
40
50

Figure 5. Diagrammatic cross section of the Goitia Gold Mine

Diagramatic Cross Section
Giotia Mine, Bolivia

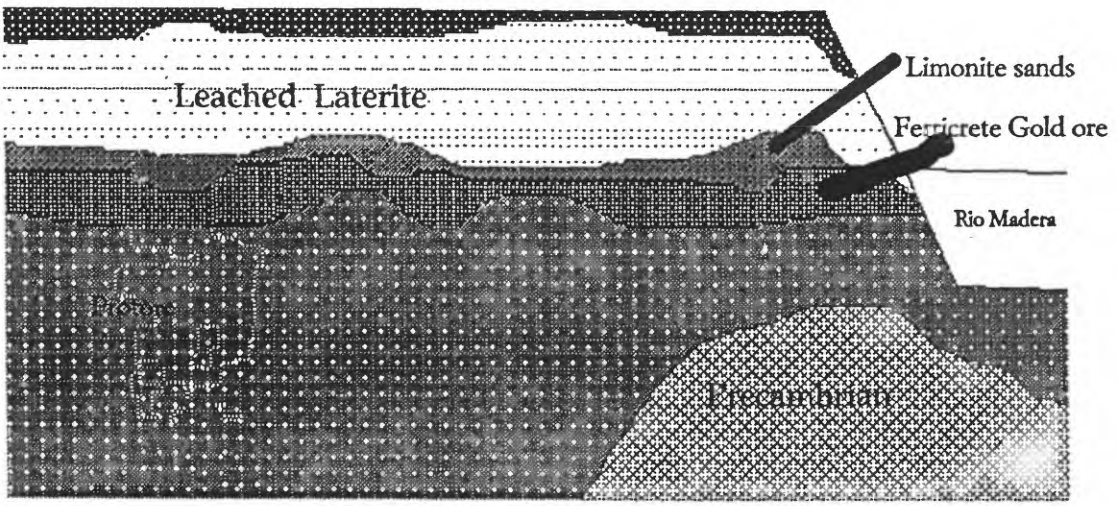

Figure 3. Madre de Díos Mining Concession

"Madre de Dios"