U. S. DEPARTMENT OF THE INTERIOR

U. S. GEOLOGICAL SURVEY

PORPHYRY GOLD: A SUPPLEMENT TO U.S. GEOLOGICAL SURVEY BULLETIN 1693

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DESCRIPTIVE MODEL OF Porphyry Au
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BRIEF DESCRIPTION

DEPOSIT TYPE: Porphyry Au MODEL NUMBER 20d (Replaces model number 25j, Lihir Island Au)
OTHER NAMES FOR SAME TYPE: Stockwork Au, Lihir Island Au
DATE OF COMPILATION: JANUARY 1991
PRINCIPAL COMMODITY: Au
RELATIVE IMPORTANCE: A newly recognized type of deposit containing large tonnages of low-grade gold ore.
DESCRIPTIVE/GENETIC SYNOPSIS: Au is present in a stockwork of quartz veinlets within subvolcanic diorite, tonalite, and dacite porphyry emplaced in the core or flank of a stratovolcano. Potassic (biotite) and (or) sericitic alteration in the ore zone is locally overprinted from above by alunite-kaoline alteration. Ore bodies are tabular and steeply dipping or subhorizontal (Lihir) and display remarkably consistent grade. Ore bodies formed within 1 km of the paleosurface and grade upward into precious and or silver-base metal veins and near-surface hot-spring Hg and or S deposits.
ASSOCIATED OR RELATED DEPOSITS: Porphyry Cu-Au; epithermal quartz-alunite Au, hot-spring Hg-S.
GENERAL REFERENCES:
R. H. Sillitoe, 1990, Intrusion-related gold deposits *in* R. P. Foster, ed,: Gold Metalogeny and Exploration: p. 166-209.
Tomas Vila, R. H. Sillitoe, Jorge Betzhold, and Enrique Viteri, The porphyry gold deposit at Marte, northern Chile, Economic Geology Monograph 8, in press.
D. P. Cox and J. J. Rytuba, 1987, Lihir Island gold: a supplement to U. S. Geological Survey Bulletin 1693: U. S. Geological Survey Open-File Report 87-272a, 4 p.
Other sources include site visits and presentations by geologists at La Pepa, Alderberan, Marte and Lobo Mines, Chile.

REGIONAL GEOLOGIC ATTRIBUTES

TECTONIC SETTING: Stratovolcanoes associated with a volcanic arc-trench system developed along a continental margins, Figure 1, or island arc, Figure 2.
REGIONAL DEPOSITIONAL ENVIRONMENT: Within remnants of stratovolcanoes that may have summit craters or calderas.
AGE RANGE: Quaternary, Miocene, Jurassic, and Archean.

LOCAL GEOLOGIC ATTRIBUTES

HOST ROCKS: Gold occurs in porphyritic, fine-grained diorite and tonalite as well as in the wall rock into which diorite intrudes, mainly andesitic and dacitic flows, breccias and tuffs that form the stratovolcano edifice. Intrusions characteristically are crowded porphyries with aplitic groundmasses. The Lihir Island deposit is associated with fine-grained equigranular monzonite and syenite intrusions and higher level alkaline volcanic rocks.

ASSOCIATED ROCKS: Dacitic domes and flows, intermediate ash-flow tuffs.

ORE AND GANGUE MINERALOGY: Native gold and electrum in a quartz stockwork. Magnetite is commonly present. In sulfide ore; pyrite up to 8%, with minor chalcopyrite and molybdenite. Anhydrite is common in and adjacent to ore. In oxidized ore; goethite, jarosite, hematite and gypsum. Specular hematite is locally abundant (Caseli). Marcasite is the most abundant sulfide mineral at Lihir.

ORE TEXTURES: Gold is finely disseminated along subparallel veinlets and locally in stockworks (see Figure 3) and breccias. At Lihir, the highest ore grades follow a subhorizontal open-textured breccia at the interface between potassic and overlying argillic alteration (Figure 4).

WALLROCK ALTERATION: Fine-grained hydrothermal biotite and biotite as stable phenocrysts are common in diorite porphyry and associated intrusive phases. In some deposits sericitic alteration is pervasive in and adjacent to the ore zone with potassic alteration at depth (biotite). Veins of anhydrite and its near surface alteration product, gypsum, are ubiquitous. Overprinting by kaolinite-alunite above sericitic-potassic alteration zone is common in late stage breccias and veins and becomes pervasive above the deposits. Structurally-controlled zones of vuggy silica alteration and associated hypogene alunite-kaolinite alteration are characteristic of vein systems developed above the ore zone and late-stage veins up to 1 m in width that cut the ore zone. These veins may be gold-enargite or base metal-Ag dominant and can locally be traced to the paleosurface. Sinter and subsinter hot-spring deposits containing cinnabar and/or sulfur are characterized by pervasive leaching of the rock leaving only residual silica (opalite).

STRUCTURAL SETTING: Porphyry intrusions emplaced along regional fault zones where the fault zone transects a stratovolcano. Both vertical and horizontal movement on faults occurs during porphyry crystallization and is important in development of subparallel veinlets and stockwork type ores. Mineralized porphyry is located within the core or flank of the stratovolcano edifice. Summit craters and small calderas are present and caldera fill breccia are important host rocks at Lihir.

DIMENSIONS OF ORE IN TYPICAL DEPOSITS: Tabular ore bodies: 50-150 m width, 500-600 m in length, and 250-500 m vertical thickness. At Lihir subhorizontal ore zone 800 by 200 m over a vertical interval of 50-100 m.
DIMENSIONS OF ALTERATION OR DISTINCTIVE HALOS: Anomalous Au in soil 200 by 600 m and up to 1000 by 2000 m. Advanced argillic alteration above deposit covers large areas: 1 by 2 km.
EFFECTS OF WEATHERING: Oxidation of sulfide minerals in quartz stockwork important in making low-grade ores amenable to heap leaching.
GEOCHEMICAL SIGNATURES: Anomalous As, Hg, Cu, Pb, and Mo. Ag:Au ratio is low, generally less than one. Overlying advanced argillic zone is also anomalous in Sb, Bi, and Zn.
FLUID INCLUSIONS: No data
GEOPHYSICAL SIGNATURES: Magnetite rich zones may be reflected by aeromagnetic anomaly.
ORE CONTROLS/EXPLORATION GUIDES: Zoning of near surface hot-spring Hg-S deposits to zones of vuggy silica and advanced argillic alteration at depth hosting gold and/or silver quartz-chalcedony veins may indicate presence of porphyry gold system at depth of 0.5-1.0 km below paleosurface. Zoning may have a lateral component of 1-3 km. Ore bodies may extend upward from porphyry Cu-Au style mineralization.

EXAMPLES

Marte, Chile 46,000,000 mt; 1.43 gpt Au, 549 ppm Cu, 46 ppm Mo
Lobo, Chile 90,000,000 mt; 1.50 gpt Au, 0.1-0.2% Cu.
Caseli, Chile
Caravancha, Chile
El Refugio, Chile 130,000,000 st; 1.03-1.51 gpt Au, 0.2-0.3 percent Cu
Young-Davidson, Canada
Lihir, Papua New Guinea 137,000,000 mt; 2.66 gpt Au
Park Premier, UT, USA
Racey, OR, USA 200,000,000 mt; 0.68 gpt Au

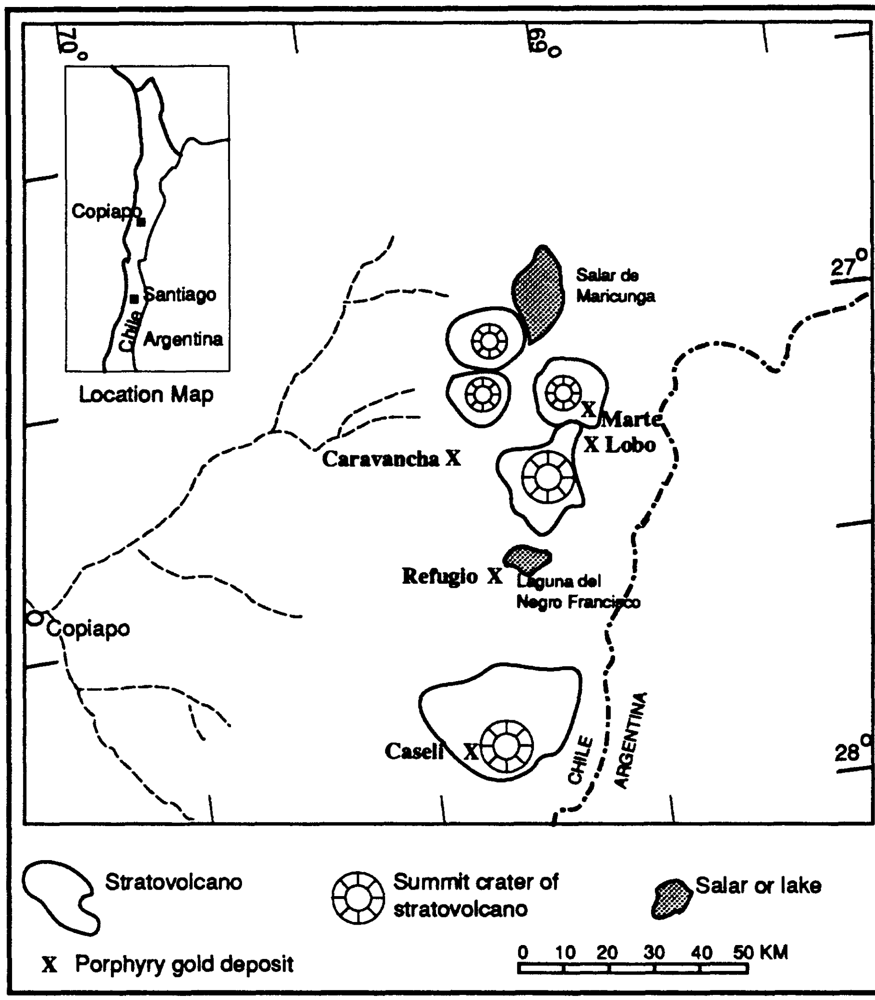

Figure 1 Map showing location of Miocene porphyry gold deposits in the Maricunga area of the Miocene Andean volcanic arc, Chile.

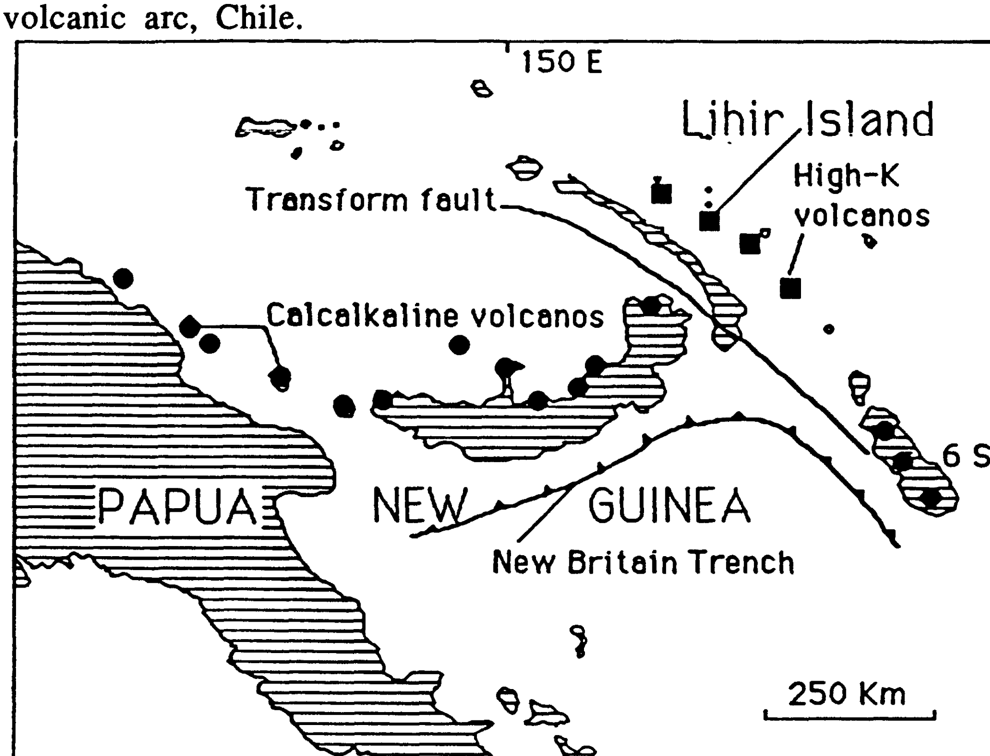

Figure 2 Map showing the tectonic environment of Lihir Island.

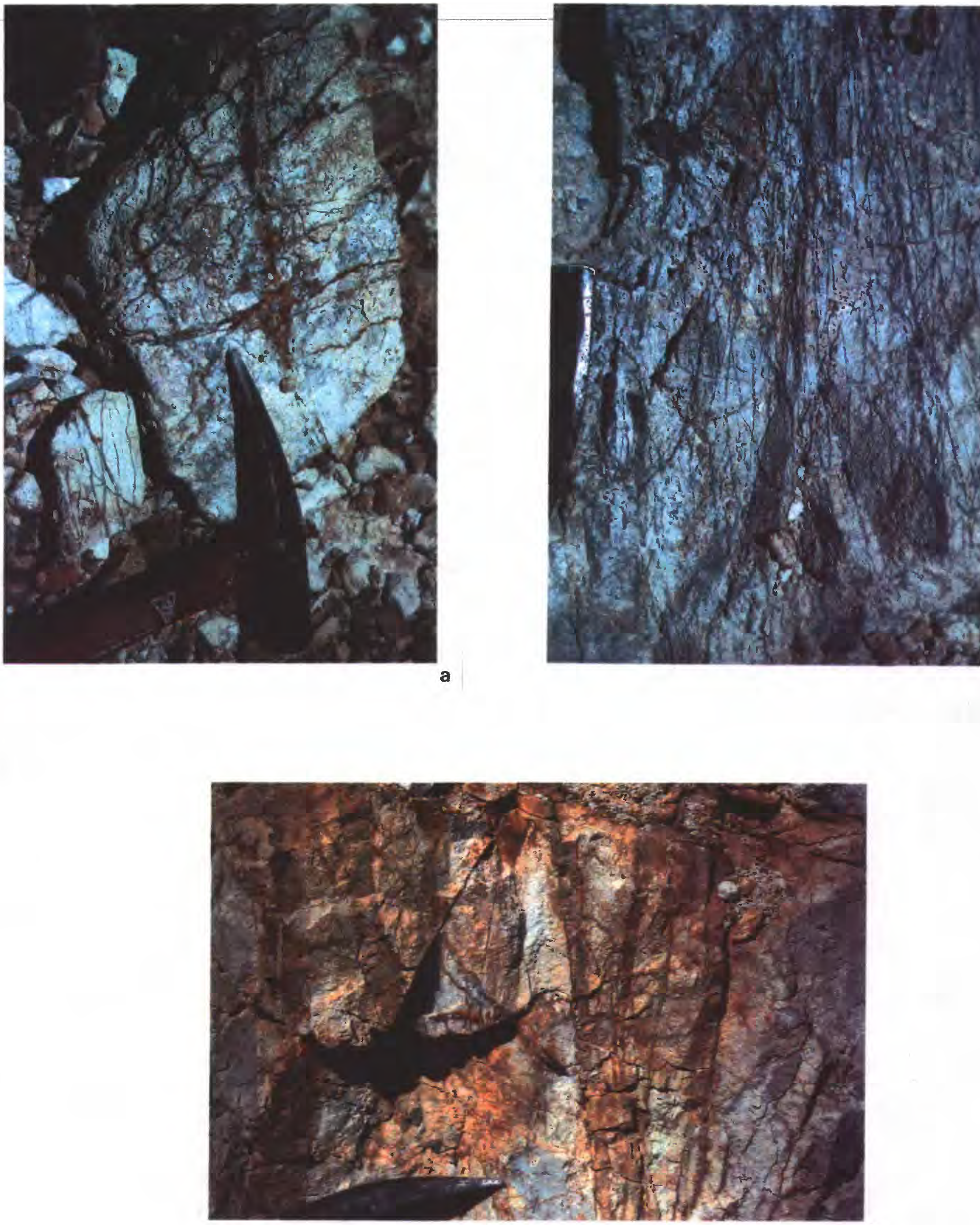

Figure 3 Quartz stockwork in oxidized ore: 3a, Lobo, Chile; 3b, quartz and specular hematite stockwork, Caseli deposit at Alderberan, Chile; 3c, Caravancha deposit at La Pepa, Chile.

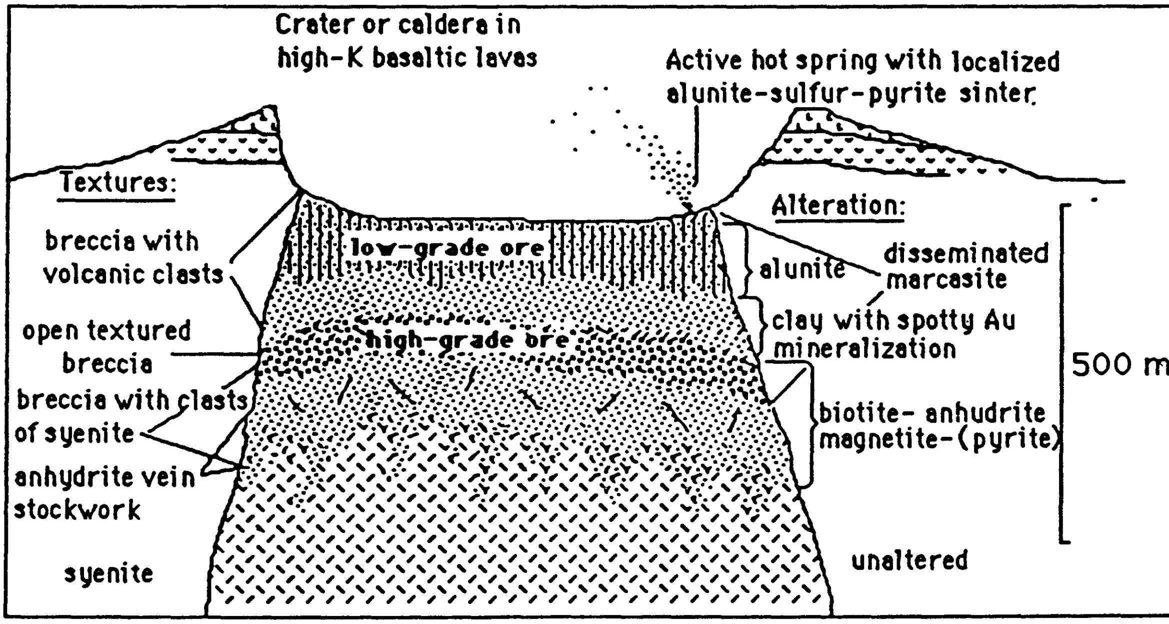

Figure 4 Idealized cross section showing distribution of breccia textures and zoning of ore and alteration at the Lihir Island gold deposit.