DESCRIPTIVE MODEL OF LATERITE-SAPROLITE Au

By Gregory E. McKelvey

BRIEF DESCRIPTION

SYNONYM: Eluvial gold placers (Boyle, 1979), Au-bearing saprolite (Becker, 1895).

DESCRIPTION: Au disseminated in laterite and saprolite that developed under conditions of tropical weathering (fig. 32) over a wide variety of bedrock types but distal to known bedrock gold deposits.

TYPICAL DEPOSITS: Boddington, Mt. Gibson, Edna May, Western Australia; Akaiwang, Arakaka, Guyana; Lumpkin and White Counties, Georgia.

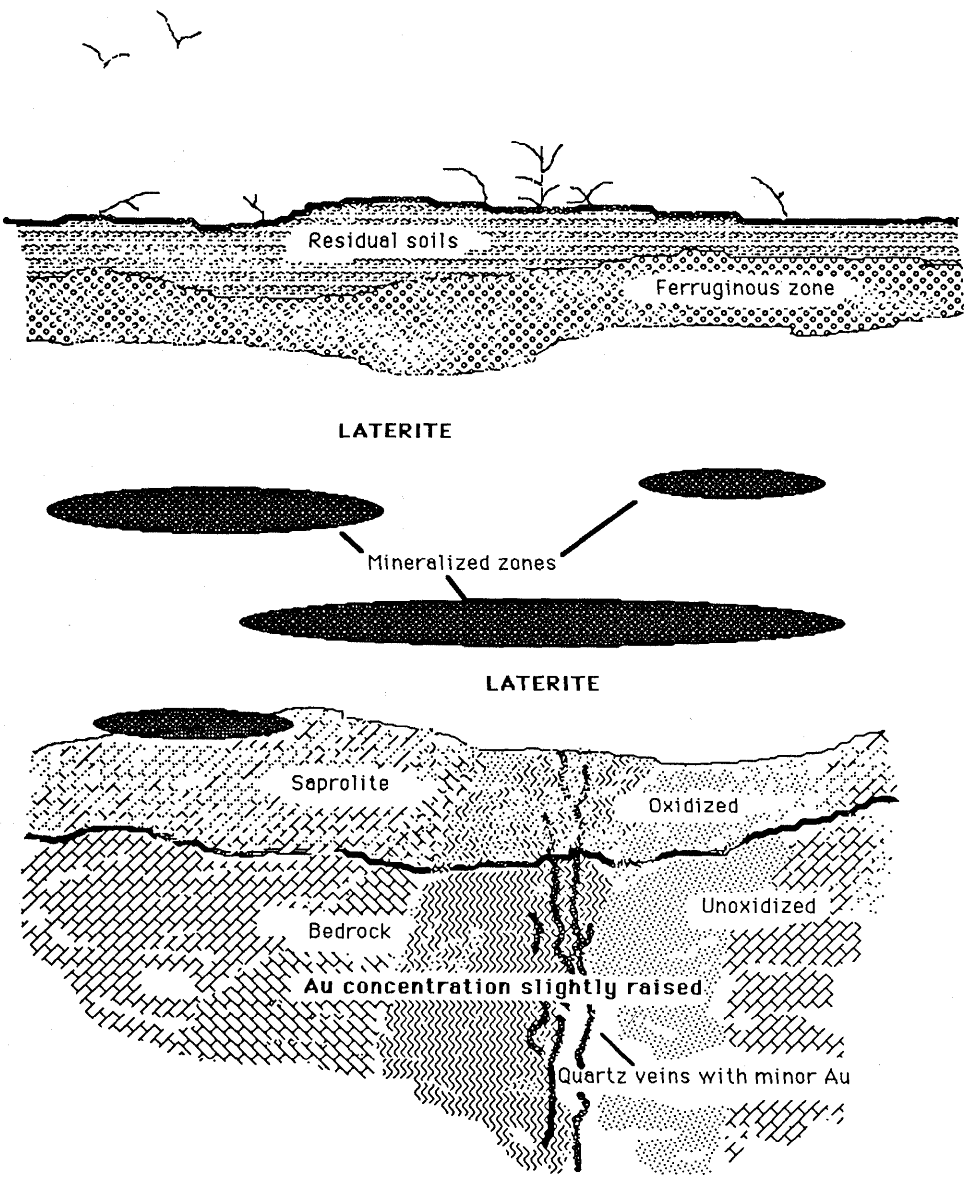

Figure 32. Idealized cross section of laterite-saprolite Au deposit. Vertical scale is in terms of meters; horizontal scale is in terms of kilometers.

DISTINGUISHING FEATURES: Residual and chemical enrichment of gold in tropical areas with laterites and bauxites. Deposit type develops under near-surface conditions of temperature and pressure, and unlike most gold placers it lacks significant detrital gold. Presence of laterite is essential precondition for deposit type.

COMMODITIES: Au±Ag.

OTHER COMMODITIES: Al, PGE, Fe, Sn, W.

ASSOCIATED DEPOSIT TYPES (*suspected to be genetically related): *Laterite-type bauxite, lateritic Ni, *alluvial Au-PGE placers. All Au-bearing lodes may be found in the bedrock, including low-sulfide Au-quartz veins, Homestake Au, polymetallic replacement and vein deposits, kuroko or Cyprus massive sulfides, porphyry Cu, and rarely lithified placers (Boyle, 1987). By definition, lode mineral deposits should not be present directly under this deposit type.

REGIONAL GEOLOGIC ATTRIBUTES

TECTONOSTRATIGRAPHIC SETTING: Stable weathering zone commonly above greenstone belts and all other gold-bearing terranes.

REGIONAL DEPOSITIONAL ENVIRONMENT: Stable craton, prolonged weathering. If like laterite-type bauxite, deposits should occur commonly along erosional boundaries of old plateau remnants (Patterson, 1986).

AGE RANGE: Cenozoic; late Oligocene to early Miocene in Western Australia (Monti,1987)

LOCAL GEOLOGIC ATTRIBUTES

HOST ROCKS: Regoliths, most are lateritic. Others enriched in aluminum (bauxite) (Boyle, 1979). Also, less frequently, deposits found in saprolites, as in the southern Appalachians (Becker, 1895).

ASSOCIATED ROCKS: Greenstones with Au-bearing veins and disseminations. Bedrock may contain various lode deposits and mineralized occurrences typical of stable craton areas (see Associated Deposit Types). Iron-formation or itabirite (Brazil). Other gold-bearing terranes.

ORE MINERALOGY: Finely divided Au. May be splendent, hackle, unworn, rough, and irregular in form. Nuggets are rare. No nuggets are found at Boddington but are identified at Edna May (Monti, 1987). Au as flakes, wire, and specks in canga (see Structure and Zoning). Au is between 1 and 10 μ with an average of 3–5 μ at Boddington (Symons and others, 1988). Ag and other metals usually higher than in alluvial Au placers (however, no Ag was detected in Au grains from Boddington (Monti, 1987), but small amounts of Cu (1.4 to 1.7 percent) and Fe (0.04 to 0.06 percent) were). Saprolitic Au very rough, with masses of wire Au (Becker, 1895). At the Boddington deposit, the following minerals are recognized: malachite, chalcocite, cuprite, chrysocolla, pyrite, chalcopyrite, arsenopyrite, native Cu, and electrum (Monti, 1987).

GANGUE MINERALS: Fe, Al oxides and hydroxides, and Mn oxides. Limonite. Disintegrated bedrock fragments, including iron formation and kaolinite (Boyle, 1979).

STRUCTURE AND ZONING: Mature laterites. Au mineralization may be localized in the laterite or displaced at depth into the underlying saprolite; mineralization in laterites likely to have same texture as that of laterite-type bauxite, which includes pisolitic, massive, nodular, and earthy (Patterson, 1986). Limonite-cemented fragments of iron formation—called apanhoancango or canga in Brazil (Boyle, 1979). At the Boddington deposit, hematitic nodules, clay with Liesegang rings, and ferruginous and bauxitic laterites occur that are locally indurated (Symon and others, 1988). Three broad mineralized levels (average 5 m thick) recognized at this deposit, with individual levels hosted by one or more of the following: (1) a 4- to 12-m-thick ferruginous zone consisting of a hardcap subzone and a B-subzone with nodular and rubbly clay; (2) a 20- to 100-m-thick clay zone; and (3) an up to 5-m-thick saprolite zone. Au found in pisoliths at Edna May but not at Boddington (Monti, 1987).

ORE CONTROLS: Mature laterites. Bauxites and saprolites occur in areas where geomorphology allows sufficient drainage, so that oxidation is both extensive and deep[1] to promote extensive leaching. Develops under conditions of strong chemical weathering with mean annual temperatures greater than approximately 10 °C and rainfall greater than

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[1] Observed to 90 m in Nigeria (Thomas, 1965) and to 500 m in Hawaii (S.H. Patterson, written commun., 1978).

approximately 140 cm (Peltier, 1950). Deposition of gold at Boddington believed to be controlled by the position of the water table. Multiple mineralized horizons are products of fluctuations resulting from several climatic regimes (Monti, 1987).

STRUCTURAL SETTING: Bedrocks sufficiently fractured and (or) faulted (or have other types of porosity) so that ground water is below weathered horizon.

ORE DEPOSIT GEOMETRY: Blanketlike on flat terrains or fanlike on gentle slopes (Boyle, 1979). The area of the Boddington, deposit is 4.5 km^2 with an average thickness of 35 m. Deposits are roughly parallel to the land surface and have thicknesses of tens of meters. Pay streaks nonuniform and erratic (Boyle, 1979). Three mineralized zones separated by barren or weakly mineralized zones recognized at Boddington (Monti, 1987). At this deposit, gold is homogeneously distributed when mineralized zones are in laterites and erratic when in saprolites (Symons and others, 1988).

TYPICAL ALTERATION/OTHER HALO DIMENSIONS: Iron oxide and clay mineralogy may indicate chemical enrichment.

EFFECT OF WEATHERING: Main processes of Au concentration include residual enrichment of Au, chemical precipitation of Au, and a combination of both (Boyle, 1987).

EFFECT OF METAMORPHISM: No metamorphic equivalents known.

GEOCHEMICAL SIGNATURES: ±Al±Ga (if contained in a laterite-type bauxite) (Patterson, 1986). Au is signature for some but not all deposits. A study of enrichment/depletion of elements at Boddington shows that Sc is enriched with the Au, and that Fe, Al, Ga, As, Pb, and Sn are enriched as part of the ferruginous zone (Monti, 1987).

GEOPHYSICAL SIGNATURES: Unknown. May be used to identify bedrock features associated with protore. Electrical properties of deposit may prove to be useful. Shallow seismic may be useful in deposit-shape determination.

OTHER EXPLORATION GUIDES: Vegetation may be useful either in identifying areas of poor fertility or in biogeochemical exploration; oxide mineralogy may change systematically from background to adjacent and over the deposits.

OVERBURDEN: Mineralization in saprolite may have a cover of unmineralized laterite or a thin "A" horizon as at Boddington (Symons and others, 1988), which includes loose pisolites (maximum diameter of 2 cm) with gibbsite (45 percent), goethite (20 percent), hematite (20 percent), and maghemite (Monti, 1987).

OTHER: Dissected deposits with very fine gold (several microns) may not have been recognized in the past by placer miners. Some bauxites and laterites have been known to contain Au (Boyle, 1979). Deposit type should not include the weathered horizon of lode deposit types.

GRADE AND TONNAGE MODEL OF LATERITE-SAPROLITE Au

By James D. Bliss

COMMENTS Deposits with data are few and likely subject to revision. Most of the data for laterite-saprolite Au deposits are from one area, and this may bias the model. Deposits are under active investigation and have the following qualifications: (1) data on deposit sizes and grades are for unworked deposits, (2) deposits may be underlain by unrecognized mineral deposits in the bedrocks, and (3) deposits may be placer deposits, not laterite-saprolite Au. One such deposit (Omai, Guyana) has residual mineralization at the surface and mineralization in the bedrock and is excluded in conformance with the descriptive model. The general pattern in the mining of mineral deposits is that the total tonnage (production plus reserves) continues to increase over a portion of the mine life. Therefore, deposit tonnages used in the model are very likely minimum values when compared with tonnages at deposit exhaustion. See appendix B for locality abbreviations. See introduction for explanation of the grade and tonnage model as shown in figures 33 and 34.

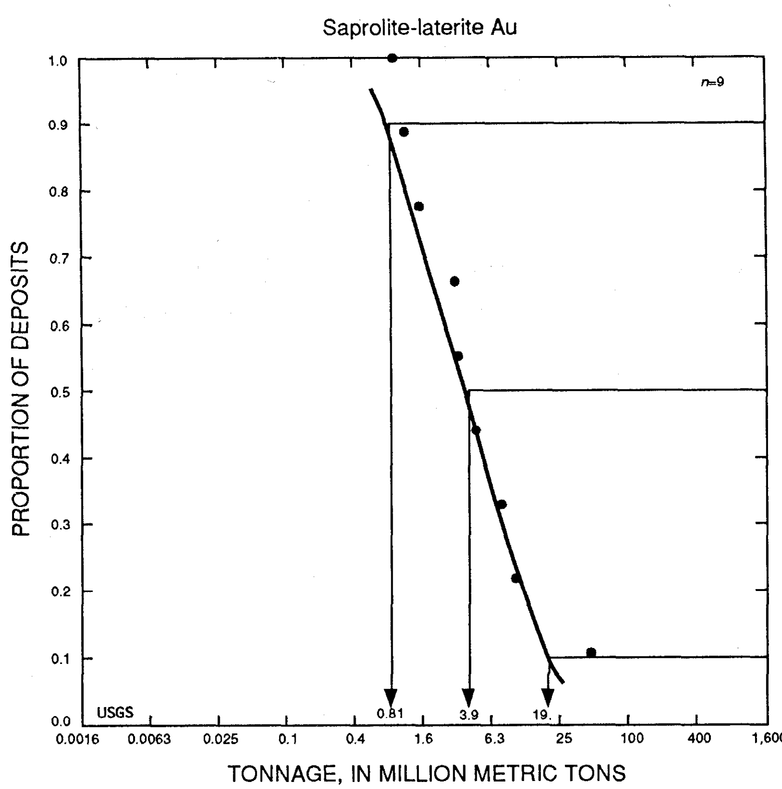

Figure 33. Tonnages of laterite-saprolite Au deposits.

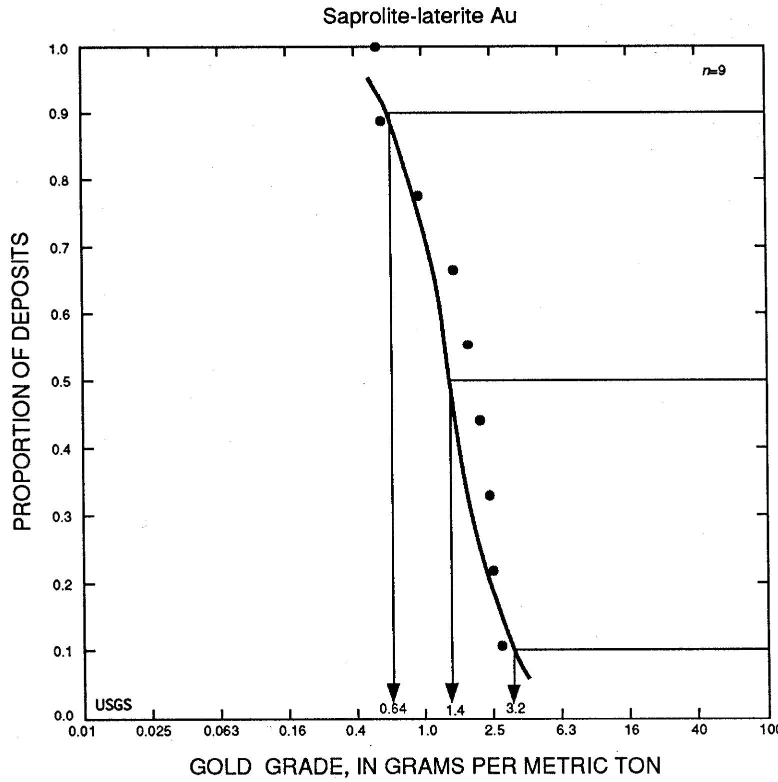

Figure 34. Gold grades of laterite-saprolite Au deposits.

DEPOSITS

Name	Country	Name	Country
Akaiwang	GUYN	Millionaire	GUYN
Arakaka	GUYN	Mt. Gibson	AUWA
Baramita	GUYN	Royal Hill Gold	SRNM
Boddington	AUWA	Tassawine	GUYN
Bullabuling	AUWA		