PORPHYRY-RELATED CARBONATE BASE METAL GOLD SYSTEMS: THE TRANSITION BETWEEN THE EPITHERMAL AND PORPHYRY ENVIRONMENTS

Leach T M (1)* and Corbett G J (2)

1. CMS New Zealand Ltd. 11 Blake St., Ponsonby, Auckland 1, New Zealand.
2. Corbett Geological Services, 29 Carr St., North Sydney, 2060 Australia.

The classification of porphyry-related carbonate base metal gold deposits, groups a number of significant low sulphidation SW Pacific Rim gold systems which are neither shallow level, precious metal, quartz vein hosted epithermal (adularia-sericite) nor deep seated, Cu/Au porphyry in character. Handley and Bradshaw (1986) and Sillitoe (1988) allude to the existence of this class of deposits in emphasising the magmatic association and noting an overlap between the epithermal and porphyry environments in relation to Porgera.

Characteristics of the porphyry-related carbonate-base metal gold systems are:

i) gold mineralization is closely associated with iron and base metal sulphides and carbonate deposition within vein through to breccia settings,
ii) commonly hosted within, or at the margins of, intrusive rocks,
iii) high base metal contents typically as Zn>Pb>Cu
iv) carbonates exhibit a wide range in chemistry; with Fe-, Mn-, Mg-, and Ca-carbonates having distinct spatial zonations,
v) carbonate-base metal-gold deposition may be preceded either by porphyry-related quartz stockwork or epithermal quartz-adularia-sericite veining depending on the depth of the system,
vi) mineralizing fluids are transitional between those of low temperature dilute epithermal systems and high temperature, saline porphyry systems.

Some significant SW Pacific Rim gold deposits which are classified within this porphyry-related carbonate base metal type are: in Indonesia, Kelian (>4 M oz Au); in Papua New Guinea, Porgera mineralization types A, B and E (>6 M oz Au), Mt Kare, the Morobe Goldfield group of deposits (past production with alluvial 3.7 M oz Au) including Wau, Edie Creek, Kerimenge (1.8 M oz Au), Hidden Valley (2.4 M oz Au) as well as Busai and Kulumadau on Woodlark Island and Maniape at Kainantu; in the Solomon Islands, Gold Ridge. This mineralization is distinct from the structurally controlled type D roscoelite-bearing and locally bonanza gold grade mineralization described from Porgera by (Handley and Bradshaw 1986) as post carbonate-base metal; and which at Kare is tentatively interpreted to be contemporaneous with the more widespread carbonate-base metal gold event.

Mineralization forms within these systems through the mixing of hot, gaseous, relatively saline mineralized fluids from buried porphyry bodies at depth, with cool, dilute condensate or ground waters from near surface environments. Thus, major structures such as the graben bounding structures of the Bulolo Graben, Morobe Goldfield in PNG, provide an important control to the setting of these deposits. Regional structures may also control the setting of diatreme breccia intrusive bodies which commonly predate the formation of these deposits. As phreatomagmatic explosive events, derived from the same intrusive source, these breccias are not in themselves mineralized but provide valuable ground preparation for the following mineralized fluids. Local dilational settings within subsidiary structures may facilitate the formation of banded, in places crustiform, veins which, in a manner similar to adularia-sericite epithermal gold systems, may account for local bonanza gold grades.

Mineral zonations of the carbonate-base metal gold systems with time and space reflect the initiation of degassing of a porphyry source and the gradual cooling and influx of surficial waters. A similar paragenetic sequence which is evident for many deposits may be represented as:

1. An initial quartz event which varies from porphyry-related quartz stockwork mineralization, to quartz adularia-sericite veining in shallower environments, depending on the level within the hydrothermal system.

3. The carbonate base metal event is the main phase of gold deposition by the progressive mixing of magmatic fluids with ground waters. In places gold mineralization partially predates deposition of carbonates and base metals, elsewhere they are totally contemporaneous. The resultant differing mineral assemblages which reflect the distance from the porphyry source, as exemplified at Kelian (van Leeuwen et al 1990) and present with variations in other deposits are:

DISTAL to the porphyry source or COOL

Vein type	Carbonate Type	Base Metals	Sphalerite	Fe-Sulphides
Quartz>carbonate	Fe (siderite)	Zn>Pb>Cu	Zn>Fe	Marcasite-pyrite
carbonate >quartz	Mn (rhodochrosite)			
	Mn Mg (kutnahorite)			Pyrite
	Mg Ca (dolomite)			
Carbonate	Ca (calcite)	Cu≥Zn>Pb	Fe>Zn	Pyrrhotite-pyrite

PROXIMAL to the porphyry source or HOT

3. Late stage either dominated by surficial fluids with kaolin, interlayered clay, gypsum, quartz deposition; or dominated by deep fluids with calcite deposition. Locally gold mineralization may persist into the initial stages of this late event.

Economic gold mineralization occurs where optimum mixing conditions were present, generally within the Mn-Mg carbonate zone and in structurally favourable environments while bonanza grades occur where sudden quenching of the upflowing hottest mineralized fluids has taken place. Identification of feeder structures and zonations in the above mineralogy and mineral chemistry can provide vectors which point towards the more significantly mineralized portions of a porphyry-related carbonate base metal gold system. Furthermore, projecting the fluid flow direction down dip can identify a possible location of the porphyry source. Thus a careful analysis of these systems represents a valuable exploration tool.

Handley G. A. and Bradshaw P. M. D. 1986. The Porgera Gold Deposit, Papua New Guinea in *Proceedings of Gold '86 Symposium Toronto pp 416-424.*

Sillitoe R. H., 1989. Gold Deposits in the Western Pacific Arcs: The Magmatic Connection in *The Geology of Gold Deposits: The Perspective in 1988, Econ Geol Mono 6 p. 274-290.*

Van Leeuwen T. M., Leach T. M., Hawke A. A. & Hawke M. M. 1990. The Kelian disseminated gold deposit, East Kalimantan, Indonesia. *Jour Geochem Explor 35 pp 1-61.*