Economic Geology
Vol 95, 2000, pp. 113-130

Layering and Precious Metals Mineralization in the Rincón del Tigre Complex, Eastern Bolivia

M. D. PRENDERGAST
1 Carson Close, Greendale, Harare, Zimbabwe

Abstract

Geologic investigations supporting recent, technically successful, platinum exploration of the Rincón del Tigre Complex—a ca. 4.6-km-thick layered sill—have provided significant new understandings of the layering, development, and precious metals mineralization of one of South America's largest maficultramafic intrusions. Three macrocyclic units are recognized—from the base up, Basal unit, Unit 1, and Unit 2—each most likely the product of a major replenishment with mafic magma of one compositional type. The ultramafic rocks of all three macrocyclic units largely comprise repeated minor cyclic units of poikilitic harzburgite, granular harzburgite (olivine bronzitite) each a few meters thick, with occasional development of bronzitite at the top. Mafic rocks, absent from Unit 1 and present only locally in the Basal unit, form a welldeveloped norite, gabbro, magnetite gabbro sequence in the upper half of Unit 2.

Associated with the base of the magnetite gabbro is the Precious Metals zone, a persistent zone of low-grade (subeconomic) sulfide and precious metals mineralization, 80 to 185 m thick. The Precious Metals zone comprises an upper Cu sulfide-rich portion, its base (the sulfide phase boundary) about 23 to 70 m above the magnetite phase boundary, and a lower precious metals-rich portion, the lower part straddling the magnetite phase boundary. The individual precious metals are concentrated in separate, sulfide-poor subzones, each up to many tens of meters thick, in the stratigraphic order (Rh) Pt, Pd, Au, with peak offsets at the same scale. Modal layering of silicates and magnetite is well developed in the mafic rocks as is modal and cryptic (precious metals) layering of the sulfides in the Precious Metals zone, all at three different superimposed scales from about 3 m to several tens of meters. A possible interpretive framework for the cryptic layering (and perhaps for much of the other layering, including the meterscale layering of the ultramafic rocks) is provided by the likely compositional stratification of the resident magma initiated by the fluid dynamics of the replenishment and mixing processes and, in the magnetite gabbro, by repeated convective overturns caused by the onset of magnetite precipitation.

The characteristics of the Precious Metals zone fit an orthomagmatic model. The composition, stratigraphic relations, and modal correlation (with magnetite) of the sulfides all imply that S saturation was induced by loss of FeO to magnetite precipitation. This took place after prolonged closed-system fractionation (following the last major magma injection at the base of Unit 2) during which crystallization of olivine, pyroxene, plagioclase, and (finally) magnetite precipitation led to overall S, Cu, and precious metals enrichment, and Ni and (finally) Fe depletion of the magma. The development of the mineralization and its complex layering was controlled by sulfide segregation, Rayleigh fractionation, the different but generally very high partition coefficients (Dsilicate/sulfide) for each precious metal, and repeated convective overturns at three different superimposed scales.

The decoupled metals distribution is analogous and similar in origin to that of the Main Sulfide zone of the Great Dyke (Zimbabwe) and of the Main Sulfide layer (offset portion) of the Munni Munni Complex (Western Australia), but the stratigraphic order of metal enrichment peaks is different (Pt, Pd, Au vs. Pd, Pt, Au). This suggests a reversal in the relative magnitudes of the partition coefficients D_{Pt} and D_{Pd} that was possibly brought about by changes in the temperature and O, S, and Fe activities of the magmas between the middle and late stages of crystallization. Constancy of D values during fractionation of mafic magma should not be assumed.

The Precious Metals zone is one of several Skaergaard-type strata-bound precious metals zones associated with magnetite gabbros in the upper levels of many layered intrusions, and the origin of the Skaergaard mineralized zone itself—including the potentially economic Platinova reefs—can be explained in terms of the Precious Metals zone model presented here. The very low grade, great thickness, and wide separation of individual metal subzones in the Precious Metals zone are similar to those of the subeconomic axial facies of the Main Sulfide zone in the wider parts of the Great Dyke (cf. the economic, more compact, marginal facies). On the basis of the lateral and vertical thermal model of the Great Dyke magma chamber, the subeconomic status of the Precious Metals zone may be in large part a function of the specific fluid dynamics of the Rincón del Tigre magma chamber.