Cabaçal Belt, Southern Amazonian Craton, a Vast Camp for Exploration of Gold Associated With Massive Sulfide Deposits.

Pinho, Francisco E. C.[1], Fernandes, C. J.[2] and Santos, C. A. R. R.[3]

1. DRM/UFMT, Brazil. egidio@cpd.ufmt.br
2. UNB, Brazil. carlosjfe@bol.com.br
3. UFPE, Brazil. caroladlersantos@yahoo.com.br

Introduction

The Cabaçal Belt, in the southern portion of the Amazon Craton, state of Mato Grosso, mid-west Brazil consists mainly of a Paleoproterozoic volcano-sedimentary sequence, intruded by tonalites, granites and sill-dike of gabbro. It was covered by the end of the Mesoproterozoic by sediments of the Aguapeí Group. A VHMS genesis with later shear is considered to the Cabaçal Belt Cu-Au and Zn-Pb-Cu-Au mineralizations. Ore bodies are located in the transition from the felsic metavolcanic rocks to the tuffaceous sediments from the Manuel Leme Formation. Alteration zones adjacent to mineralizations in Cabaçal Belt are sericitic, chloritic and silicious. Ore are disseminated, banded, veined, breccioid and massive types.

Geological setting

The Cabaçal Belt covers an area of approximately 350 square kilometers. It is a narrow NNW trending belt of metamorphosed volcano-sedimentary rocks. To the west a Metamorphic Complex (gneissic basement terranes) separates it from the Araputanga Belt. To the East the Aguapeí Group bound it. In the volcano-sedimentary rocks of the belt are a bimodal suite characterizes the volcanic rocks, whereas the sediments are of detritical and chemical sources. In this paper only the unit that hosted mineralizations will be described.

Dacites, rhyodacites and felsic tuffs as well as clastic and chemical sediments are the main components of the **Manuel Leme Formation (MLF)**. Monteiro et al. (1986) estimated a thickness between 500 and 1,000 meters for this formation. In the Cabaçal Belt it occurs in a NW/SE trending elongated areas in the core of synforms, overlying basalts.

Dacites and rhyolites consist of quartz, oligoclase, biotite, muscovite and chlorite. Accessory minerals are zircon, titanite, apatite and opaques. These lithologic types and felsic tuffs occur at the base of the MLF. Sometimes the volcanic textures are preserved in dacites and rhyodacites. Phenocrysts of oligoclase are common feature in these rocks. In contrary, the felsic tuffs show a well-developed schistosity, with intercalations of quartz/plagioclase and micaceous minerals. Well-preserved tuffs are rare. The upper portion of the MLF shows metassediments (clastic and chemical) as the most common rocks. Detrital sediments consist of sericit schists or chlorite-sericite schists, both containing biotite. Titanite, zircon, apatite, rutile and opaques are accessory minerals. Weathering, making difficult to distinguish them from the felsic volcanic rocks. Chemical sediments are metacherts that consist of quartz with some sericite and chlorite. Thin layers rich in magnetite also occur in tha MLF.

The Cabaçal Cu-Au Deposit

The Cabaçal Deposit represents a volcanogenic massive sulfide ore system. Well-defined features bound this mineralized area on at least three sides. A NE fault defines the southwestern boundary, a gabbro sill bounded the northeast limit, a transition between altered mineralized rock to a weakly altered rock defines the southwest boundary (Mason and Kerr, 1990), and finally the northwest limit that is not well defined by a NE fault system.

Three ore zones with irregular shape and undulating outlines have been defined (Mineração Santa Marta S.A. 1987). These three zones are coincident with the principal schistosity S_1, and plunge in two directions (coincident with S-SW with variable dip, and S-SE dipping about 20^o). The second plunge is coincident with the axial zone of D_2 foldings. Mason and Kerr (1990) associated the three ore zones with three hydrothermal centers called South Copper Zone (SCZ), Central Copper Zone (CCZ), and East Copper Zone (ECZ). The stringer zones from these three hydrothermal centers become gradually weaker in terms of mineralizations and hydrothermal alteration towards northwest (Mason and Kerr, 1990).

The three zones show different characteristics with respect to alteration, mineral composition and gold grades. Only the CCZ shows massive sulfide mineralizations. The massive sulfide ore occurs capping the alteration pipe, and a banded tuff (chert), separates these mineralization from the stringer zone in the CCZ.

The Zn zoning in the CCZ shows a bare core coincident with the ZCL, surrounded by a broad zone of anomalous values, which has been interpreted as typical zoning with a hotter zone in the throat of the pipe, and cooler areas around it (Mason and Kerr, 1990).

Gold distribution is erratic to the different zones. However, the highest grades are related to the SCZ. Locally, different structural features or paragenetic associations show grades up to 50 g/t Au. Such as, in one specific level in the SCZ, where gold in visible grains is associated with a chlorite zone rich in garnet. In terms of remobilization related to structural features, sulfides rich in gold occur in the core of the F_2 folds, all over the area.

Hydrothermal alteration at Cabaçal

Alteration zones adjacent to mineralizations in the Cabaçal Belt are sericitic, chloritic and silicious. Sericite and chlorite are minerals common in wallrocks, however there is a dense chlorite alteration related to sulfide concentration. Alteration consists of an inner chloritized core surrounded by a sericitic zone similar to others VMS systems.

Based on the mapping work into the mine and in an alteration model proposed by Mason and Keer (1990), a schematic alteration model has been developed for the mine. In this model, the hydrothermal centers produced pipe-like features with sericitic, chloritic, and siliceous alterations.

Genesis of the ore concentrations

Most of the time during the mine operations, the genetic process involved in Cabaçal Deposit creation was not an important issue. During that time, the idea that structural features controlled the ore was the only one in ”fashion”. Only after disappointments with ore reserve estimations, this topic returned to discussion.

Even though the area represents an exploration target with many occurrences of Cu-Au and Pb-Zn-Cu-Au concentrations, uncertainty about the genetic processes involved in ore formation created a taboo about the area and its exploration possibilities. A definition about the genesis of mineralization of Cabaçal Belt may help in the return of exploration programs to the region.

A model for ore concentration in the Cabaçal Belt must explain the following:

- Association of ore with volcanoclastic and felsic volcanic rocks;
- Intensive alteration of the footwall, contrary to the hangwall;
- Inversion of the stratigraphic sequence;
- Occurrence of massive sulfide bodies;
- High grades of gold related to some structural features.

In this paper it is suggested that the Cabaçal Deposit is syngenetic with the activities that created the Manuel Leme Formation. After the syngenetic process, the Cabaçal Deposit, and most of the Cabaçal Belt were affected by a NNW-SSE trending ductile shear deformation that caused gold reconcentration.

Sometime after the deposition of the volcanogenic massive sulfide and the TAC/VAP unit, the volcanic package was structurally inverted. Mason and Kerr (1990) suggested that the present position of the Cabaçal Deposit is in the lower limb of a recumbent fold. This inversion is confirmed by the existence of inverted graded bedding. Others features that support this theory are the occurrence of massive sulfide bodies, and of zinc concentration in the lowest levels of the mine. They commonly occur on top of the VMS deposits. Also, the TAC/VAP units represent the volcanic cap that was deposited on top of the massive sulfide bodies, allowing the preservation of them on the oceanic floor.

Gold grades are highest when compared with other VMS deposits from elsewhere. There are some gold rich veins that are related to the stringer zone of the VMS system. Huston and Large

(1989) related a wide variation of gold grades in volcanogenic massive sulfide deposits. For instance, for Rosebery deposit is reported a variation from 0.1 to 40 g/t Au in the stringer zone. However, high gold grade portions in the mine, as the garnet zone and concentrations in F_2 fold cores, are related to enrichment caused by fluid circulation during the shear activity.

Taking into account the possibility that the Cabaçal Deposit represents a VMS affected by later shear, genesis of the gold is attributed at least to the following events:

- Volcanism (related to the Manoel Leme Formation), a convective circulation of seawater during this process probably occurred;
- NNW-SSE trending ductile shear that redistributed nearby gold into structural features;
- Cabaçal Tonalite intrusion. Although there is no proof about the participation of these intrusions, it is important to report that in the Ellus Farm and Pau-a-Pique garimpos (SW of the mine area), tonalites show some portions rich in gold (Pinho et al., 2001).

Conclusions

The Cabaçal Belt is a potential target for gold-rich Cu and Zn-Pb deposits. The Cabaçal Deposit represents a deformed gold-rich volcanogenic massive sulfide deposit. Pinho and Fyfe (1996) based on petrographic and stable isotopic studies have demonstrated that the Cabaçal Deposit has its genetic process related to volcanogenic activities that generated the Manuel Leme Formation. The characterization of the volcanic sequence in the Cabaçal Belt as related to volcanic arc environment was suggested by Pinho et al. (1997), from geochemical studies.

There are indications to justify exploration for volcanogenic deposits in the Cabaçal Belt. However, the "taboo" created during the Cabaçal Mine operation has to be abandoned.

We would like to acknowledge the CNPq and PADCT/FINEP for financial support and RTZ Mineração for open data during our research.

References

Huston, D. L. and Large, R. R. 1989. A chemical model for the concentration of gold in volcanogenic massive sulphide deposits. Ore Geol. Ver. 4:171-200.

Mason, R. and Kerr, D. 1990 – Cabaçal 1 Mine – Mato Grosso State, Brasil. Definition of ore zones and potential for new ore reserves. On behalf of Mineração Santa Marta. Rio de Janeiro, Brasil.

Mineração Santa Marta S.A., 1987 – Cabaçal I Mine – Brazil. Internal company report.

Monteiro, H.; Macedo, P. M. de; Silva, M. D. da; Moraes, A. A. de; and Marchetto, C. M. L.,1986. O Greenstone Belt do Alto Jauru. In: Cong.Bras.Geol. 34. Goiânia-Go.SBG. V.2: 630-647.

Pinho, F. E. C. and Fyfe, W. S. 1996 – Origem dos Fluidos relacionados ao depósito do Cabaçal – MT. XXXIX Cong.Bras.de Geol. Salvador – Ba. 576-579.

Pinho, F. E. C and Fyfe, W. S. and Pinho, Marcia A. S. B. 1997 – Early Proterozoic evolution of the Alto Jauru Greenstone Belt, Southern Amazonian Craton, Brazil. Int.Geol.Review. Vol. 39:220-229.

Pinho, F. E. C. and Van Schmus, W. R. 2001 Cabaçal Belt: more complications about the evolution of the Southern Amazonian Craton. Wokshop "Geology of the SW Amazonian Craton: State-of-the-art. P.75-78.