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# WALL ROCKS AND HYDROTHERMAL ALTERATION ASSOCIATED WITH THE POJUCA AND FURNAS DEPOSITS, CARAJÁS PROVINCE

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## INTRODUCTION

The Pojuca Cu-Zn deposit (58 M t@ 0.87% Cu and 0.9% Zn), located in the northern part of the Carajás Province (Fig.1), has been considered since its discovery as a VMS deposit of Archean age, metamorphosed to amphibolite facies (Docegeo 1988). Late veins or remobilization ascribed to the Pojuca Granite or to the superimposition of an IOCG system to the syngenetic mineralization have been admitted (Winter 1994; Schwartz & Frantz 2013). The main reasons for classifying the Pojuca ore in the VMS model include its association with metavolcanic-sedimentary rocks of the Itacaiúnas Supergroup, the strata-bound nature of the ore as well as the presence of alteration zones that are typical of volcanogenic deposits.

The study of drill cores of Pojuca (Corpo Quatro) and of the Furnas Cu-Au deposit (500 Mt @ 0.6% Cu and 0.28 g/t Au), situated in the northeastern part of Carajás (Fig.1) indicates significant similarities between these two deposits.

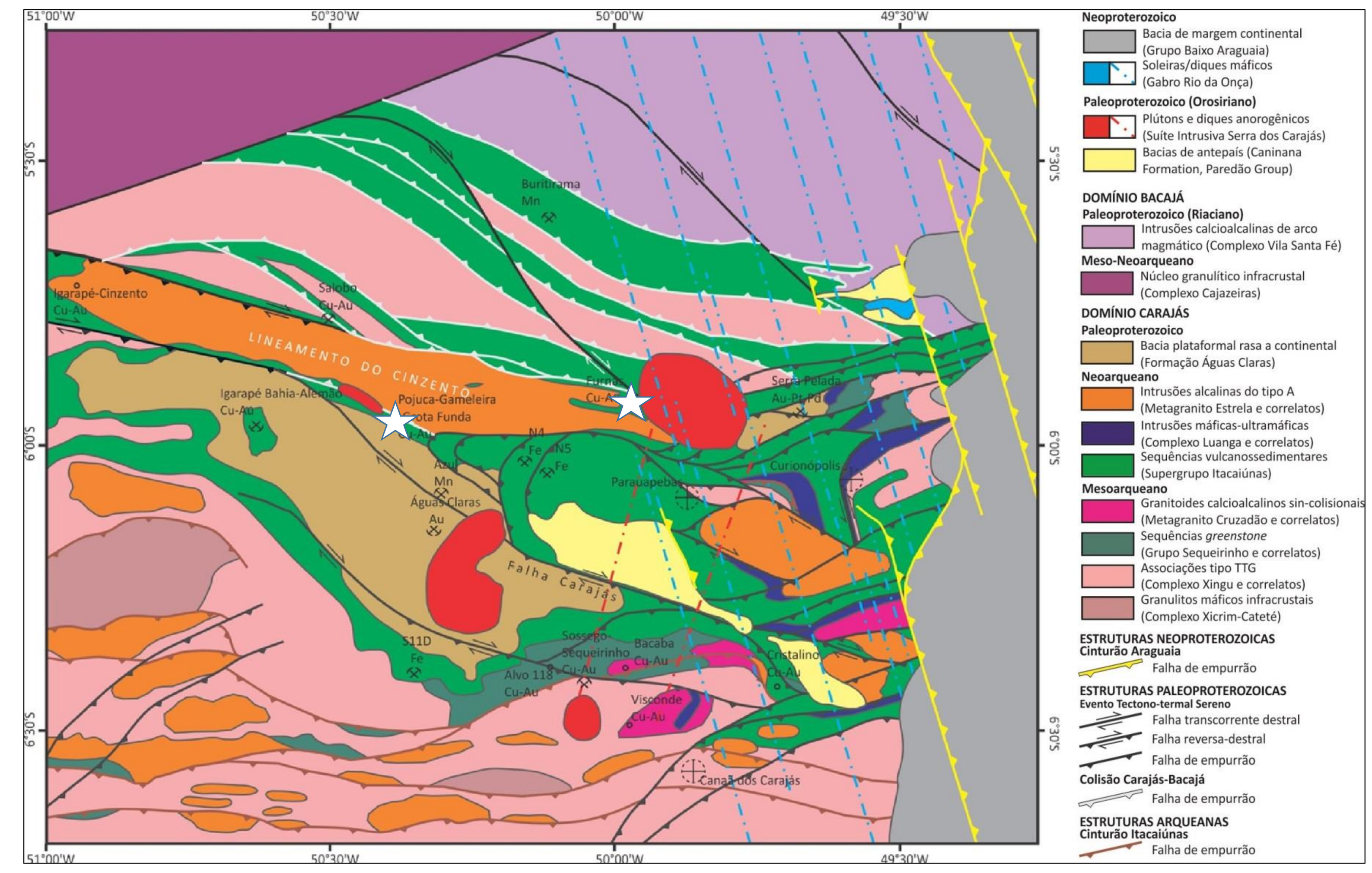

Figure 1 – Geological map of the Carajás Province with location of the Pojuca Cu-Zn and Furnas Cu-Au deposits. From Tavares (2015).

## WALL ROCKS AND FOOTWALL ALTERATION ZONES

Considering their wall rocks, both the Pojuca and Furnas deposits are hosted in steeply dipping, metamorphosed and tectonically inverted volcanic-sedimentary rock piles (Figs.2,4). The stratigraphic footwall to the ore comprises alteration rocks derived in their majority from ancient basalts, composed of chlorite, amphiboles, quartz, ilmenite and syntectonic garnet, which locally develop cordierite-cummingtonite-anthophyllite assemblages.

At Pojuca this alteration constitutes authentic dalmatianites made up of large rounded cordierite porphyroblasts (Figs.3a,b,c). At Furnas the cordierite-cummingtonite-anthophyllite alteration extends for more than 100 m below the mineralized zone constituting strongly foliated and crenulated schists with lens-like cordierite porphyroblasts (Figs.5a,b,c,d,e). In several VMS deposits worldwide the cordierite-cummingtonite-anthophyllite alteration typically occurs below the orebodies and has been interpreted as the amphibolite facies equivalent of chloritic alteration.

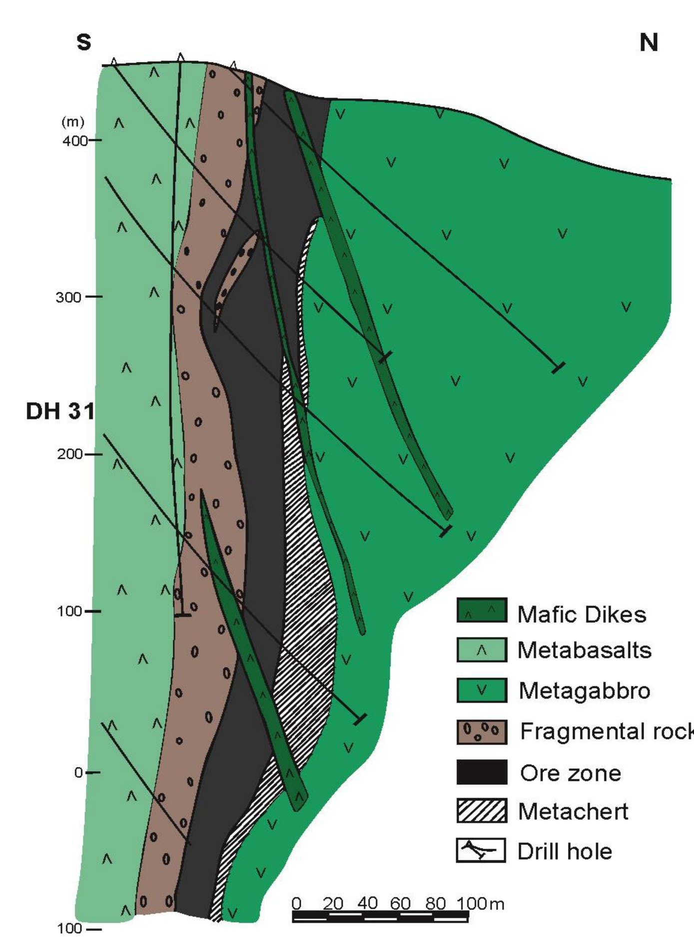


Figure 2 – Geologic section of the Pojuca Cu-Zn deposit. Modified from Saueressig (1988).

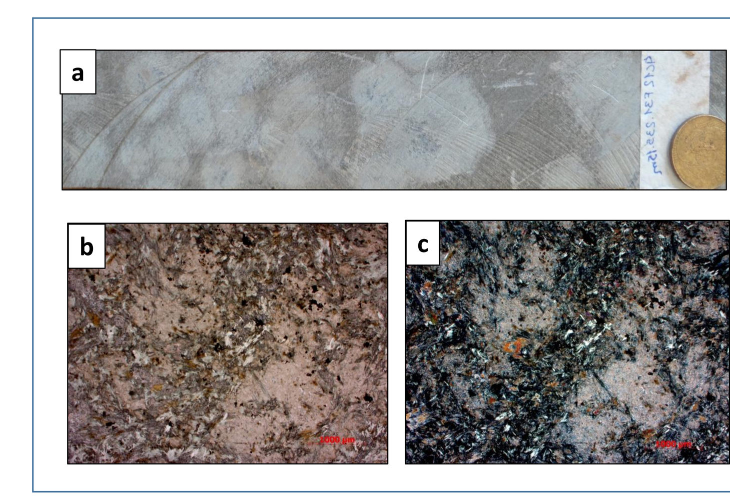

Figure 3 - Dalmatianite from the Pojuca deposit; (a) Rounded cordierite porphyroblasts; (b,c) Sericite-altered cordierite surrounded by amphiboles.

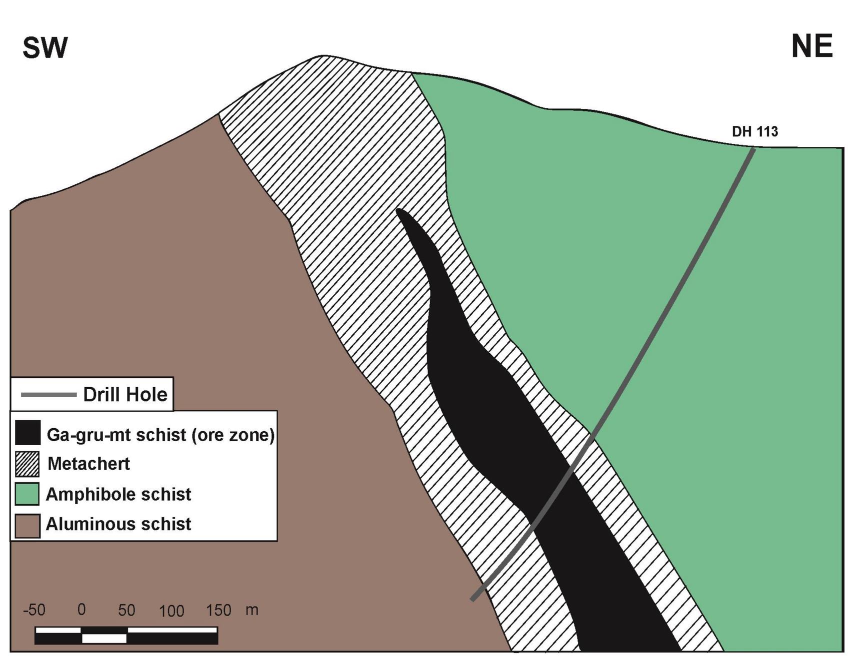


Figure 4 – Geologic section of the Furnas Cu-Au deposit. Modified from Santos (2014).

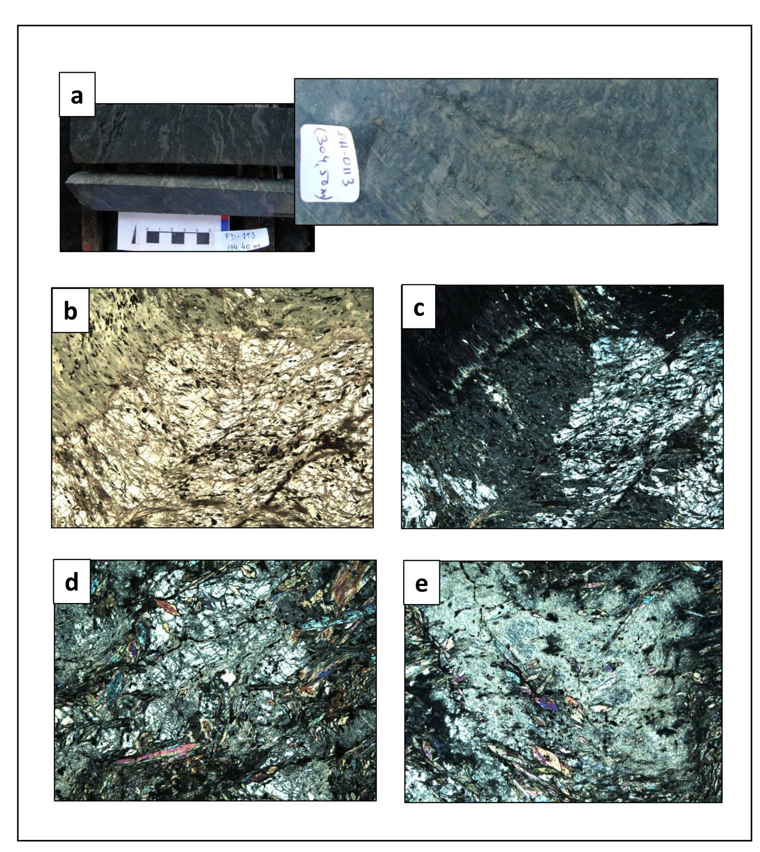

Figure 5 – Cordierite – cummingtonite - anthophyllite alteration from the Furnas deposit. (a) Macroscopic aspect; (b,c) Twinned cordierite porphyroblast; (d,e) Sericite - altered cordierite including and being surrounded by amphiboles.

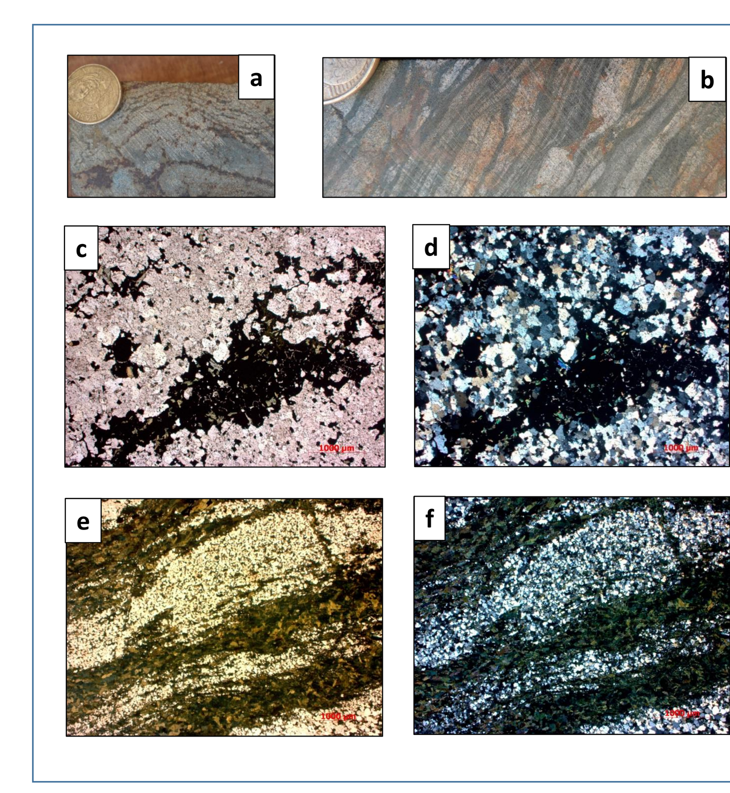

Figure 6 – Metaexhalites from the Pojuca deposit. (a,c,d) Fe-rich metachert containing sulfide layers; (b,e,f) Banded actinolite metachert.

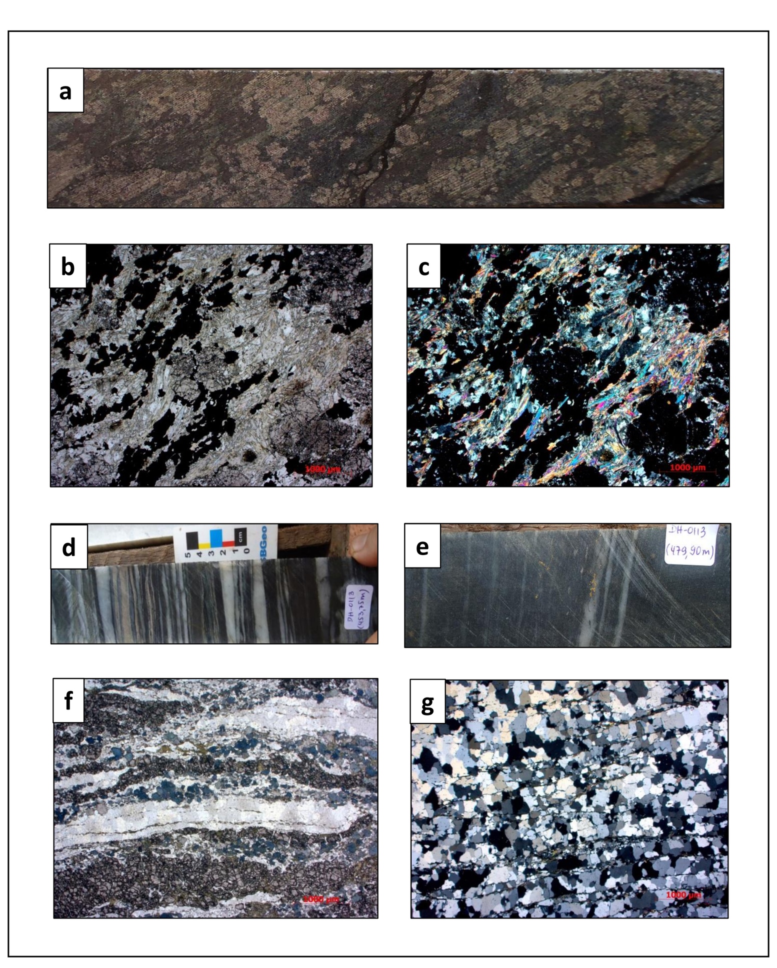

Figure 7 – Metaexhalites from the Furnas deposit. (a,b,c) Garnet-grunerite-magnetite schist with disseminated sulfides; (d,f) Finely banded garnet-tourmaline metachert; (e,g) Impure metachert.

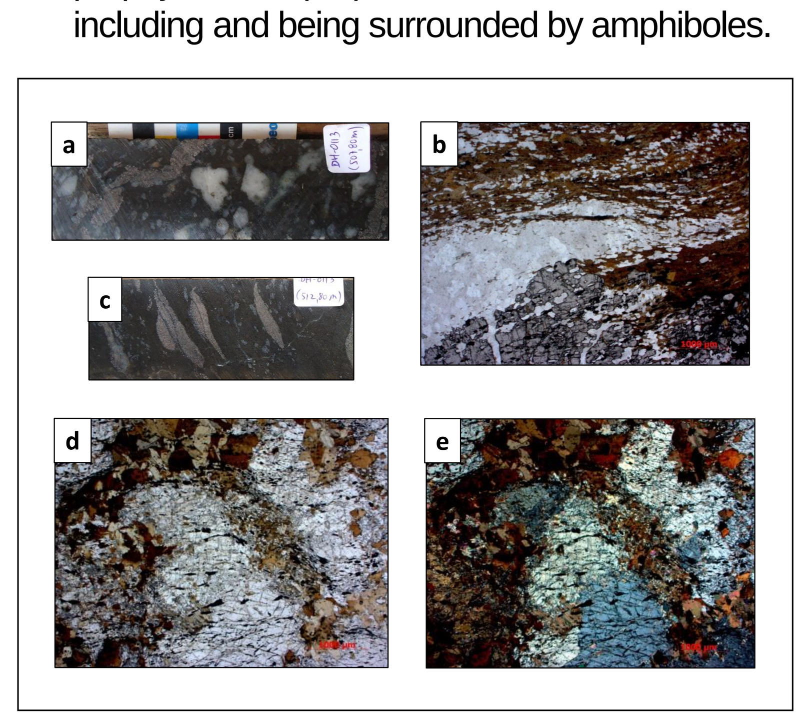

Figure 8 – Clastic hangingwall rocks from Furnas. (a,b) Garnet-biotite schist containing chert fragments; (c,d,e) Garnet-biotite schist containing andalusite porphyroblasts.

## METAEXHALITES

Another feature shared by the Pojuca and Furnas deposits is the presence of metaexhalites associated with the mineralized horizons. Exhalites are finely-banded, gennerally iron-rich chemical sedimentary rocks, including BIF, chert, tourmalinite and garnetite, which occur in the immediate vicinity of VMS mineralization and typically lie above, below, within or along strike from exhalative ore deposits. They have been interpreted as direct precipitates from hydrothermal fluids deposited on the seafloor with a variable contribution of clastic / volcanoclastic material (Spry et al. 2000).

In the Pojuca deposit the ore is associated with iron-rich metacherts composed of quartz bands intercalated with layers containing chalcopyrite, magnetite, pyrrhotite, sphalerite and actinolite (Figs.6a,c,d). Distinctly banded actinolite metacherts intercalate with and overlie the mineralized horizon (Figs.6b,e,f). In the Furnas deposit most of the ore is associated with a thick BIF horizon made up mainly of grunerite, almandine, magnetite and quartz, with disseminated bornite, chalcopyrite, chalcocite and molybdenite (Figs.7a,b,c). Stratigraphically above this horizon lies a package of laminated metaexhalites consisting of alternate beds of chert, tourmaline and garnet (Figs.7d,f) which grades into an impure metachert (Figs.7e,g) and from this on into dominantly clastic metasedimentary rocks.

## HANGINGWALL ALTERATION ZONE

At both Pojuca and Furnas deposits the hanginwall clastic metasediments incoporate in their lower levels chert fragments (Figs.8a,b) derived from the underlying chert exhalites. At Furnas the metasedimentary rocks are quite rich in garnet, porphyroblastic andalusite, sillimanite, containing staurolite, quartz and biotite as well (Figs.8c,d,e), suggesting that they were affected by a strong aluminous alteration, perhaps of the advanced argillic type. This kind of alteration has been recognized in auriferous volcanogenic deposits, possibly produced from strongly acidic hydrothermal fluids (Galley et al. 2007).

## CONCLUSIONS

The above-exposed characteristics show that, despite being affected by late mineralizing events, the Pojuca and Furnas deposits preserve hydrothermal alteration zones and other features that are typical of VMS deposits, indicating that they evolved from primitive volcanogenic systems.

**ACKNOWLEGDEMENTS**

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