



THE ROLE OF THE HOST ROCKS ON THE MINERAL ASSEMBLAGE OF ZINC ORE FROM THE VAZANTE NONSULFIDE Zn DEPOSIT, MG, BRAZIL

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The Vazante Zn-(Pb-Ag) mine is the major nonsulfide zinc deposit in the world, with estimated total resources of 60 Mt at 20% Zn. It is hosted by the Mesoproterozoic Vazante Group, in the Brasília Fold Belt, central Brazil. The nonsulfide zinc mineralization of the Vazante mine is epigenetic and structurally controlled, linked to the development of the Vazante Shear Zone (N50E/60NW). The willemite ore, the main zinc ore type at Vazante, is chiefly composed of willemite, Fe-dolomite, saddle dolomite, hematite, franklinite, quartz, zincian chlorite, zincian talc, sphalerite, and galena. Minor sulfide-rich orebodies, formed mostly by sphalerite and galena, occur mainly within willemite ore. Hydraulic dolomitic breccia and subordinate hematitic breccia, metabasite, and dolomitic breccias with metapelite layers are the host to zinc orebodies. In order to measure the effect of the host rock nature on ore mineralogy and quality, representative ore samples hosted in different rock types were systematically sampled and analyzed using reflected and transmitted light microscopy and MEV-EDS. Commonly, willemite is the main Zn-bearing mineral in willemite ore, followed by franklinite. However, in ore samples close to or hosted by metabasic rocks, the content of franklinite is considerably higher if compared to other samples. Franklinite may counts to 25% of the modal mineralogy and may outgrow the willemite content. Franklinite crystals are subhedral to euhedral and up to 0.5 mm in size. Willemite crystals exhibit granoblastic polygonal texture and may reach 1.5 mm, reflecting the thermal effect exerted by metabasic dykes. In addition, these willemite crystals contain significant amounts of franklinite inclusions, which may impact negatively on flotation processes. In ore samples close to or hosted by metapelite layers, zincian talc contents are considerably greater, representing up to 15% of the mineral content. Quartz and aluminous phases, such as zincian chlorite and muscovite/phengite are common in ore spatially related to metapelite. When hosted by hematitic breccias, besides containing up to 60% hematite, willemite ore is, commonly, replaced partially by hematite that acts as matrix in ore breccia samples, as vein infilling or is interstitial among willemite crystals. This study revealed specific mineralogical and textural characteristics of Zn ore and Zn-bearing minerals from the Vazante mine related to different host rocks. These changes and specific characteristics when mapped may assist in explaining poor quality ore and metallurgical responses. Therefore, the results of this study might assist in better planning strategies on the production of high-quality blends and tracking deleterious elements and minerals.



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Introduction

The Vazante Zn(-Pb-Ag) Mine is the major nonsulfide zinc deposit in the world, with estimated total resources of 60Mt @ 20% Zn (Baia, 2013). It is hosted by the Mesoproterozoic Vazante Group, in the Brasília Belt, central Brazil, and located in the city of Vazante, NE Minas Gerais. The nonsulfide zinc mineralization of the Vazante Mine is epigenetic and structurally controlled, linked to the development of the Vazante Shear Zone (N50E/60NW; Fig. 1).

The Vazante nonsulfide Zn ore

The mineralization is represented by willemite orebodies varying from about couple centimeters to 5 meters in width. The larger orebodies are anastomosed and continuous for meters along the strike of the Vazante Fault. Commonly, orebodies are intercepted by brittle structures, mainly NW oriented. Veins and veinlets are lesser continuous, and may assume slightly distinct directions. Sulfide-rich ore occurs chiefly as anastomosed or rounded bodies ranging from 2 centimeters to around 2 meters, and late-vein infillings of sulfide-rich ore, mainly comprised of sphalerite and galena, frequently within the willemite ore, but also within host rocks. The willemite ore, the main zinc ore type at Vazante, is chiefly composed of willemite, Fe-dolomite, saddle dolomite, hematite, franklinite, quartz, Zn-chlorite, Zn-talc, sphalerite, and galena. Tectonic-hydrothermal dolomite breccia and subordinate hematite breccia, metabasite, and metapelite associated with dolomite breccia host the ore. This study aimed to investigate how different host rocks affect willemite ore quality and mineral assemblage at Vazante.

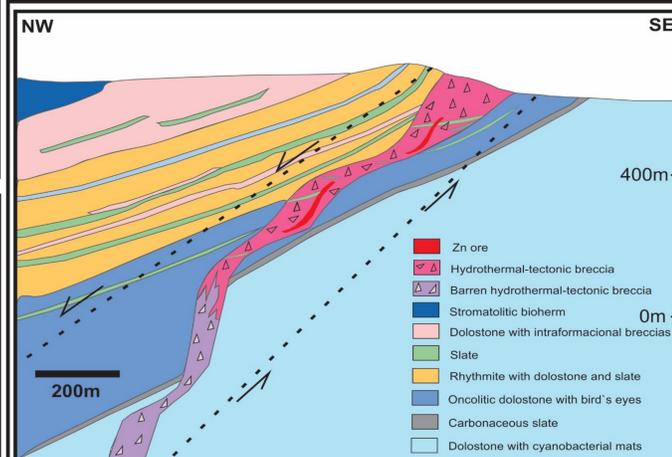
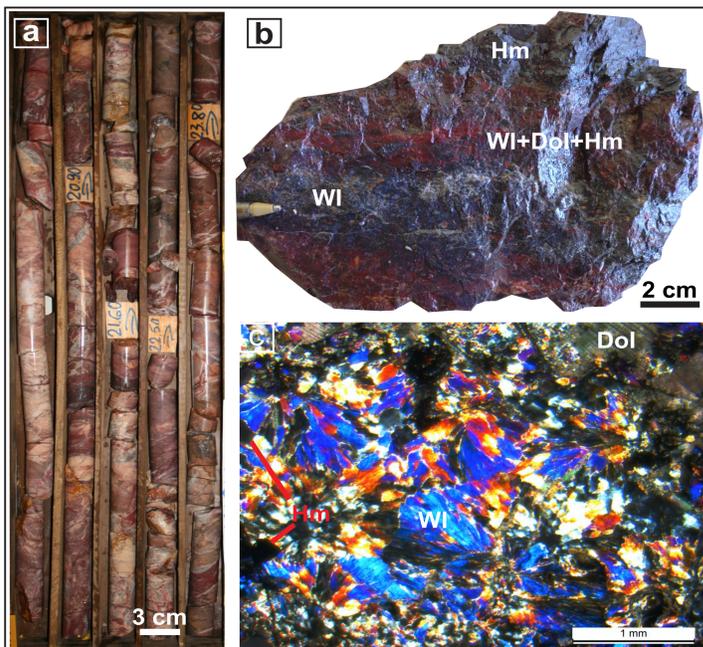


Figure 1. Geological cross-section of the Vazante Mine, showing the structurally controlled mineralized trend and breccia zone inserted in the Vazante fault area, and the stratigraphic sequence of Vazante Group sediments in the mine area (modified from Oliveira, 2013).

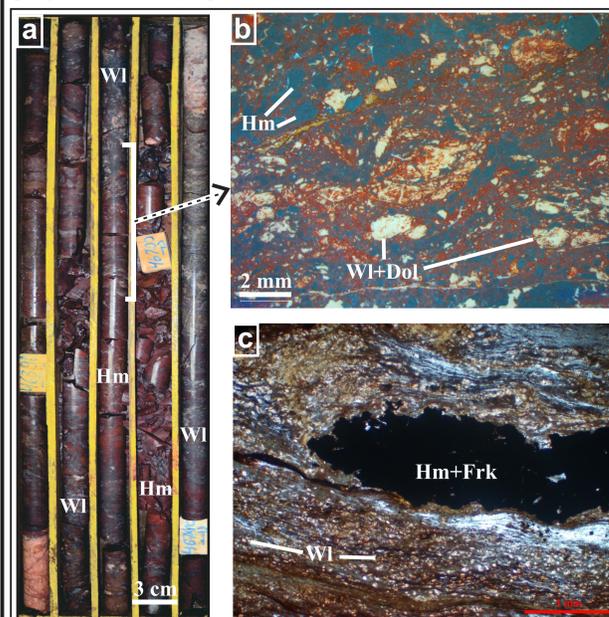
The main host rocks at Vazante are gray to deep red dolomite breccias, essentially comprised of dolostone fragments and Fe-dolomite cement (Fig. 2a). The zinc richest willemite samples, known as 'Carijó ore' including massive or banded varieties (Fig. 2b) are mostly found hosted by dolomite breccias. Those samples are characteristically, composed of willemite (up to 75%), dolomite, and



hematite (Fig. 2c), and minor franklinite, quartz. Willemite assumes fibrous-radiated or granoblastic textures, less common very fine-grained, granular and needle-like.

Figure 2. Dolomite breccia host rock and aspects of willemite ore hosted by dolomite breccias. (a):dolomite breccia host drill core. Note dolostone clasts cemented by dolomite and complex net of saddle and Fe-dolomite veins and veinlets. (b): hand sample of banded willemite-rich sample from Vazante Mine, known as Carijó ore. (c): Photomicrograph under transmitted light with crossed polars of willemite ore, comprised of willemite, dolomite and hematite, willemite crystals are fibrous-radiated and might be partially replaced by dolomite and hematite. WI: willemite, Hm: hematite, Dol: dolomite.

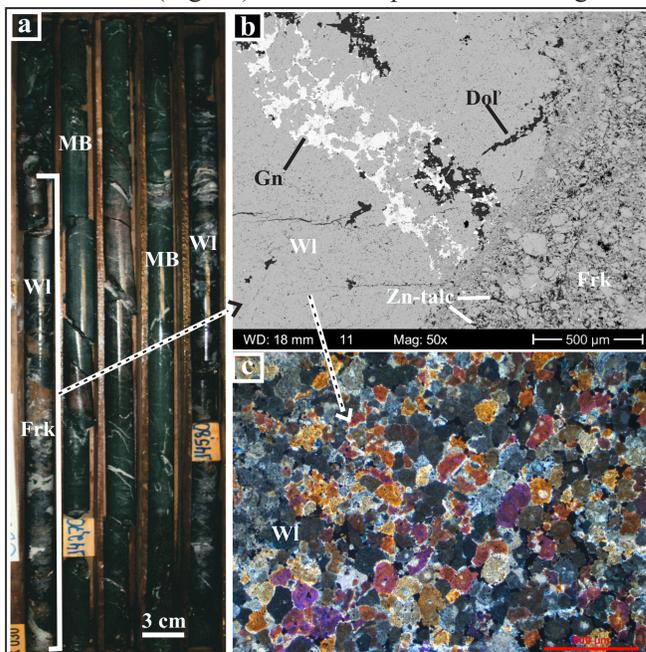
Willemite ore might also be enveloped by deep red hematite breccias that are composed by hematite, as fragments and cement (Fig. 3a). Cataclastic willemite ore is observed along the contact between hematite breccias and massive willemite ore, due to variable quantities of willemite and dolomite fragments the breccias may assume grayish colors (Fig. 3a,b). Willemite ore, when hosted by hematite breccias, might be



deformed by brittle mechanisms, generating cataclastic breccias (Fig. 3b), or by brittle-ductile mechanisms, thus, creating shear bands (Fig. 3c), in both cases hematite, in part, replaces willemite.

Figure 3. Hematite breccia and willemite ore associated. (a) hematite breccia host and willemite ore drill core. Hematite breccia exhibits red colors, grayish colors are representative of willemite ore and interface portions. (b) Photomicrograph under transmitted light of cataclastic willemite ore. (c) Transmitted light photomicrograph of deformed willemite, forming shear bands, willemite crystals are comminuted and present rounded forms. WI: willemite, Hm: hematite, Dol: dolomite, Frk: franklinite.

Metabasite bodies (Fig. 4a) are 1 to 5 meters wide, interpreted as dykes, and occur tectonically imbricated within tectonic-hydrothermal breccias. In ore hosted by metabasite, franklinite may count to up 25% of modal mineralogy, and outgrow willemite. Franklinite occurs, mainly, in millimetric to centimetric lenses (Fig. 4b), with minor Zn-talc and dolomite, in contact with willemite ore (Fig. 4b). Franklinite portions are recognized due to its brownish colors (Fig. 4a).



Willemite crystals are darker (Fig. 4a, c), in comparison with other ore samples, due to abundant franklinite inclusions, and exhibit reequilibrium texture, such as granoblastic (Fig. 4c) due to the thermal effect exercised by the dykes.

Figure 4. Metabasic rock dyke host and willemite ore aspects. (a) metabasic rock dyke host and willemite ore drill core. Metabasic rock is strongly altered to chlorite, it exhibits greenish colors and is sectioned by several saddle dolomite and hematite veins and veinlets. Willemite ore is dark gray and shows franklinite concentrations of brown color. (b) SEM backscattered image of willemite dominated portion of willemite ore in contact with franklinite-rich lens. (c) Photomicrograph under transmitted light with crossed polars of granoblastic willemite mass. WI: willemite, Frk: franklinite, MB: metabasite, Gn:galena, Dol: dolomite

Metapelite might occur as subparallel layers (Fig. 5a), or as metric fragments imbricated within dolomite breccias, and may be in contact with willemite ore. When associated to metapelitic rocks, willemite ore comprises considerably greater Zn-talc contents, representing up to 15% of the modal mineralogy (Fig. 5b, c). Moreover, quartz and aluminous phases, such as Zn-chlorite and muscovite/phengite, are more abundant. In this case willemite ore assumes lighter colors due to Zn-talc, quartz, muscovite/phengite, and light gray willemite (Fig. 5c)

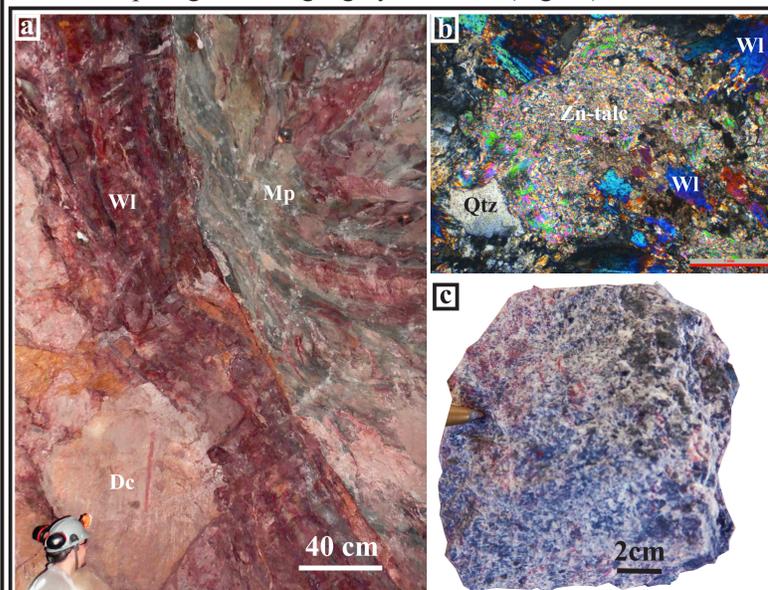


Figure 5. Metapelitic host rocks and willemite ore. (a) tabular willemite orebody hosted by dolomite breccia and metapelite. (b) Photomicrograph under transmitted light with crossed polars of willemite ore hosted by metapelite. (c) willemite ore hand sample, note its lighter colors, when compared to others ore samples. De: dolostone clast, WI: willemite, Mp: metapelite, Qtz: quartz.

Final remarks

Willemite ore at Vazante is hosted by different host rocks. Zn-richest ore is commonly found hosted by dolomite breccias, owing to willemite is the main Zn-bearing mineral and its filling textures are preserved. Hematite breccias are result of late fluid circulation, when hosted by hematite breccias willemite ore is partially remobilised, willemite crystal are comminuted, and hematite, frequently, replaces willemite. Metabasites, besides to affect willemite ore thermally, contribute somehow to franklinite and Zn-talc formation. Metapelite layers have an important role in the formation of Al-, Mg- and K-bearing minerals, such as Zn-chlorite, Zn-talc, and muscovite/phengite in the willemite ore.

The host rocks influence Zn ore from Vazante in regard to willemite texture, and the extent of orebodies, but mainly in respect of Zn-bearing mineral assemblage, that impacts willemite content and, thus, zinc recovery. Since processing in Vazante was designed to concentrate willemite. The results of this study might assist in explaining poor quality ore and metallurgical responses, tracking deleterious elements and mineral phases, and in better planning strategies.

References: Baia, F.H., 2003. Brechas hidrotermais da mina do Cercado e das ocorrências Olho D'água, Mata II e Pamplona: implicações metalogenéticas e prospectivas para zinco na região de Vazante, MG. Master's Dissertation. Instituto de Geociências, Universidade Estadual de Campinas. 181 p.
Oliveira, G.D. (2013) Reconstrução paleoambiental e quimiostратigrafia dos carbonatos hospedeiros do depósito de zinco silicatado de Vazante, MG. Master's Dissertation. Universidade de Brasília, DF. 95 p.