Petrographic Characterization and Interpretation of the Cinta Colorada Marker Bed, Boleo District, Santa Rosalia, BCS, Mexico

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Abstract

The Cinta Colorada is a prominent red marker bed found across much of the late Miocene sequence of conglomerates and tuffaceous sandstones and mudstones hosting the Cu-Mn-Zn-Co ore depositions (mantos) of the Boleo mining area. The Boleo Formation contains four main mantos and several minor ones for a total of nine mineralized beds. The Cinta Colorada lies above Manto 3 but below Manto 2, and is an excellent stratigraphic marker used for exploration in the sequence of ore horizons. A petrographic investigation was conducted to better characterize the Cinta Colorada unit. X-ray diffraction analyses indicate the bulk mineralogy of the Cinta Colorada is uniform over its range. The bulk mineralogy includes intermediate sodian anorthite (andesine), augite, hypersthene, hematite (providing the red color of the Cinta Colorada), and smectite (altered glass). The mineralogy is consistent with a volcanic source. Polarized light microscopy and SEM/EDS confirm the XRD results, showing the smectite has replaced volcanic glass, and that the rock is made of sand- to silt-sized crystal and lithic fragments of andesitic to basaltic volcanic rocks. Crystal fragments of andesine and clinopyroxene are broken, but extremely fresh with no observed weathering or alteration. All of the lithic and crystal fragments have a thin, rough coat of very fine ash that appears to be sintered to the larger clasts. That rind likely accumulated on the clasts as they were erupted through the hot ash cloud. The rock is grain-supported, and the interstices are empty—other than the sintered rinds, no very fine-grained material is present. Late Mn oxides cement some of the grains, occasionally filling interstices. The Cinta Colorada appears primarily to be an air-fall tuff at its base with a possible density debris flow at the top. Later introduction of hydrothermal fluids (probably associated with ore deposition in the basin) and oxidation led to replacement of volcanic glass with smectite clays and deposition of the Mn oxide cement, producing the Cinta Colorada in its present state.

Field Methods

Data collected in the field includes 31 samples from various points on the Minera Boleo mining complex (Figure 4). The samples were all from different sections of the Cinta Colorada only. Although the "red ribbon" varied in thickness (Figures 5-9), the basal 6 cm were always constant. The thickness was measured by a 100cm Jacobs's staff and a GSA 10cm ruler. The 31 samples covered an area of over 1.5 million m^2 and were from different altitudes. To document data collection, Field MOVE Clino and MOVE software was installed through cell phone app and downloaded to a Microsoft Surface Pro 2 tablet. A rock hammer was used to extract each sample then placed in a sample bag and labeled appropriately.

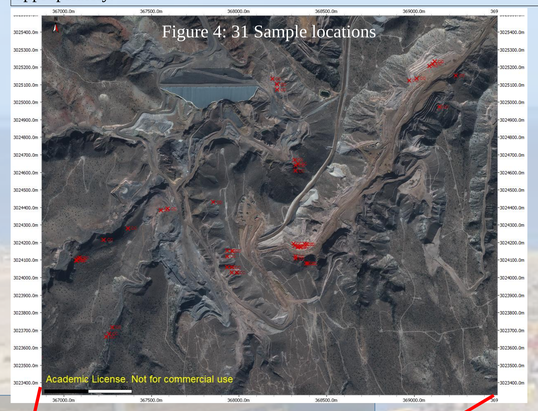

Figure 4: 31 Sample locations


Figure 5: 8cm

Figure 6: 25cm

Figure 7: >200cm


Figure 8: 30cm

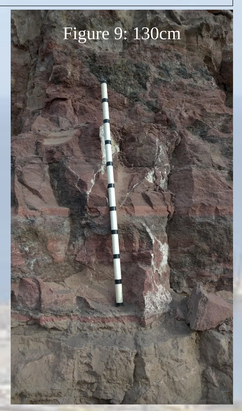
Figure 9: 130cm

Location Background

The Santa Rosalia Basin is on the west coast of the Gulf of California in Baja California Sur, Mexico (Figure 1). Baja California Sur is a micro plate that is rifting away from the North American plate for the past 12 million years. The rifting extends from the East Pacific rise through the Gulf of California to the San Andreas fault. Associated with these extensional tectonics is mineral deposits, magmatism, volcanology. On the property of Minera Boleo in Santa Rosalia, exhibits of these three processes can be seen all together. Ore deposits are represented by the extraction of copper. The area is also rich in Cobalt, Zinc and has the world's 6th largest manganese resource. Magmatism is represented by alkali basalts viewed in the Boleo basalts at the base of the Boleo formation (Figure 2). The volcanology can be viewed all throughout the basin. In the Wilson stratigraphy column shows 8 layers of volcanic related sediment. The area of my concentration is Cinta Colorada (Figure 3).

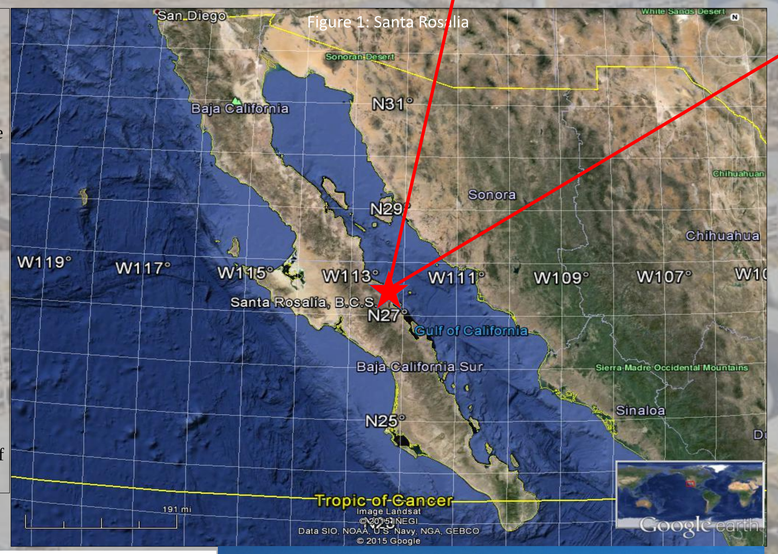

Figure 1: Santa Rosalia

Figure 2: Boleo Strat. Column

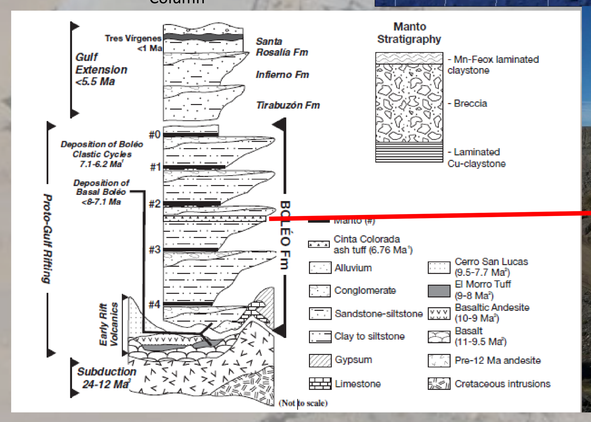


Figure 3: Cinta Colorada

Laboratory Analysis

The samples were made into thin sections and divided into 13 areas (Figure 10). Petrographic microscopes, XRD and SEM/EDS were used to examine and identify mineral assemblages and bulk mineralogy.

Figure 10: 13 Data Analysis Locations

XRD

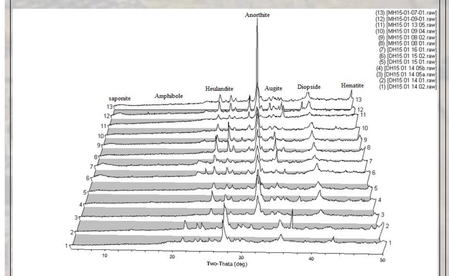

Figure 11: Bulk mineralogy of the 13 Locations

Optical Petrography

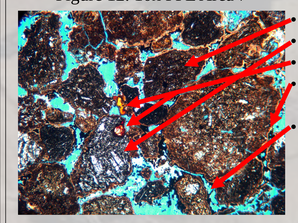

Figure 12: 10x PPL Area 7

- Pumice
- Plagioclase
- Volcanic Glass
- Ash/Clay coating
- Pore space

SEM/EDS

Figure 13: Altered pumice w/ clay rind
Figure 14a: (22) Hypersthene
Figure 14b: Hypersthene Elemental analysis
Figure 15a: (49) Fibrous MnO cement
Figure 15b: MnO Elemental analysis

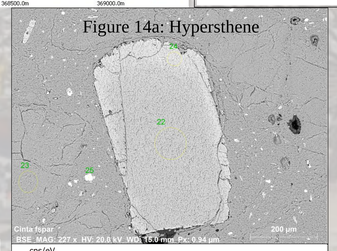

Figure 14a: Hypersthene

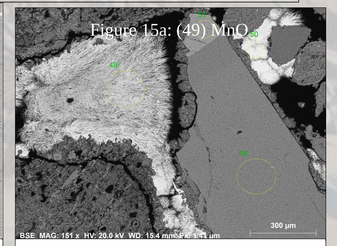

Figure 15a: (49) MnO

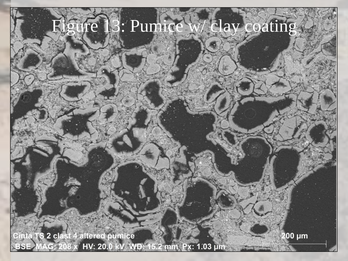

Figure 13: Pumice w/ clay coating

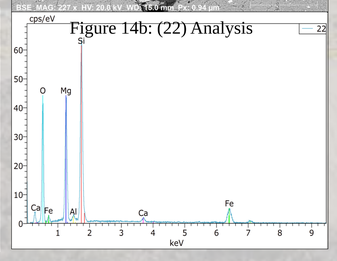

Figure 14b: (22) Analysis

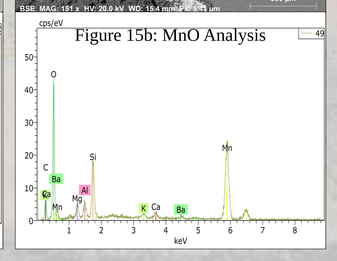

Figure 15b: MnO Analysis

Conclusions

- The Cinta Colorado contains well preserved lithic fragments that is encompassed by a smectite clay being altered from volcanic glass. This indicates a volcanic origin.
- Well defined evenly distributed pumice layer within the base point to an air fall deposition.
- Bulk mineralogy of the Cinta Colorada over the area shows major similarities.

References

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Acknowledgements

Thank to the National Science Foundation for providing support; UMKC faculty; Minera Boleo for providing hospitality; a special thanks to Valente Salgado for your tremendous guidance, knowledge and expertise.