The characterization of breccias at the Iska Iska silver-tin polymetallic Project, Bolivia

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Geological Setting

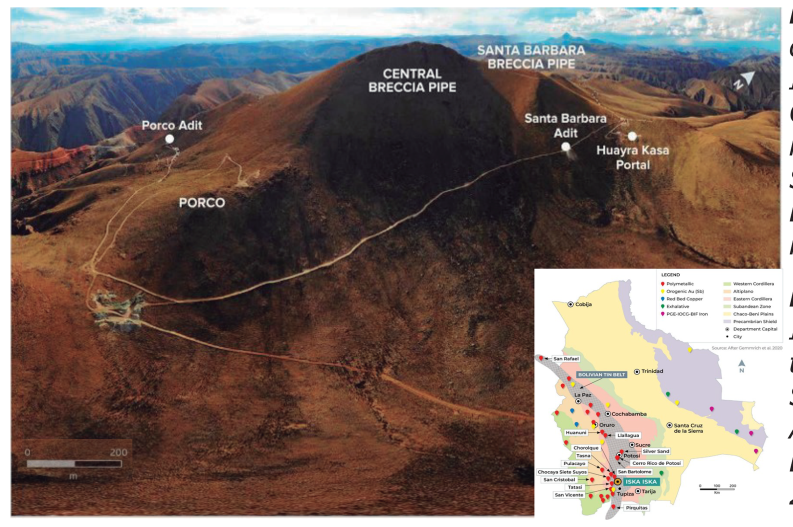


***Fig. 1:** View of the Iska Iska Caldera Complex looking NW, Source: Eloro Resources.*

***Fig. 2:** Iska Iska location, Source: After Arce-Burgoa O., 2020.*

The Iska Iska silver-tin polymetallic project is a resurgent collapsed caldera that was intruded by dacitic domes and was cut by brecciation events.

The igneous complex is interpreted as a porphyry-xenothermal-epithermal deposit with a telescoping component.

Several mineralizing pulses were evidenced along the deposit in which the geochemical polymetallic signature includes Ag, Sn, Au, Zn, Pb, Cu, Bi, In.

Part of the main high-grade mineralization is hosted whitin the breccias as a result of pre-, syn-, and post- events.

Methodology

- Despite more than two years of logging experience at Iska Iska, the relationship between breccia type and mineralization remains elusive.
- The entire logging database was reviewed and ~60 drill holes that contain significant breccia intersections were selcted.
- Detailed observations were recorded from the photographic records and logs leading to a representative description for 16 breccia sub-types.
- The best examples of each breccia sub-type were compiled into a characterization report and summary table reviewed by Minera Tupiza.
- Type samples (51) were collected for each breccia sub-type during a review of 30 drill holes to ground truth the classification.
- The sub-types were reduced to 12 based on primary observations and discussion with other geos.
- Nine of the 12 sub-types host significant mineralization at Iska Iska.
- A training dataset of 11 drill holes from Santa Barbara was selected for GeologicAI to provide automated breccia classification.

***Fig. 3:** Field work at Iska Iska, Source: Minera Tupiza, 2023.*

Breccias Classification

TPMB

CMT-01 (161.65m)
Ag 58ppm, Sn 0.17%

CMT-06 (397.05m)
Sn 0.13%, Au 0.16ppm, Cu 0.02%

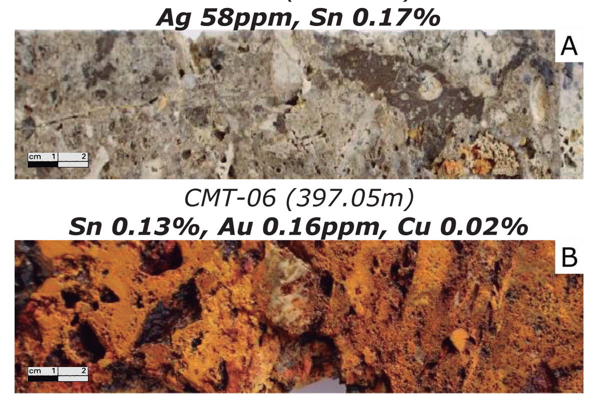


***Fig. 4 (A-B):** Clast-supported polymictic breccia with subrounded/irregular clasts cemented by silica-tourmaline matrix (**TPMB-1**).*

TIB

CMT-17 (721.77m)
Sn 0.11%, Au 0.21ppm, Cu 0.19%, Zn

CMT-12 (660.36m)
Ag 263ppm, Sn 1.53%, Au 1.2ppm, Cu

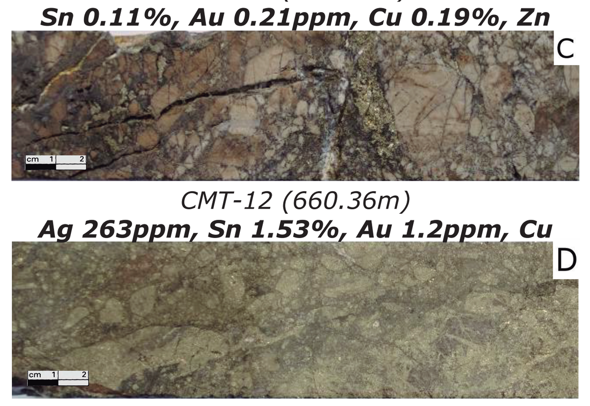


***Fig. 5 (C-D):** Clast-supported polymictic breccia with subangular/subrounded clasts cemented by fine-grained rock flour with silica-tourmaline matrix (**TIB-1**).*

TPB

CMT-29 (216.68m)
Pb 0.30%, Zn 0.69%

CMT-32 (757.13m)
Au 0.31ppm, Ag 287ppm, Sn 0.18%, Cu 0.19%, Pb 1.12%, Zn 11.5%

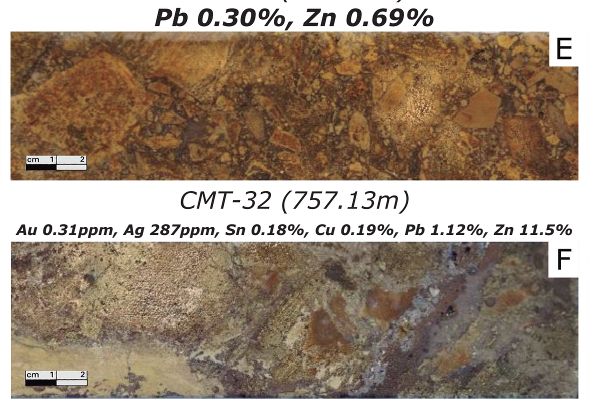


***Fig. 6 (E-F):** Clast-supported monomictic/polymictic breccia with subangular clasts cemented by fine-grained rock flour matrix (**TPB-1/TPB-2**).*

TISB

CMT-47 (133.29m)
Ag 303ppm, Pb 9.33%, Zn 6.79%

CMT-62 (142.38m)
Au 0.87ppm, Ag 1495ppm, Cu 0.33%, Pb 0.49%

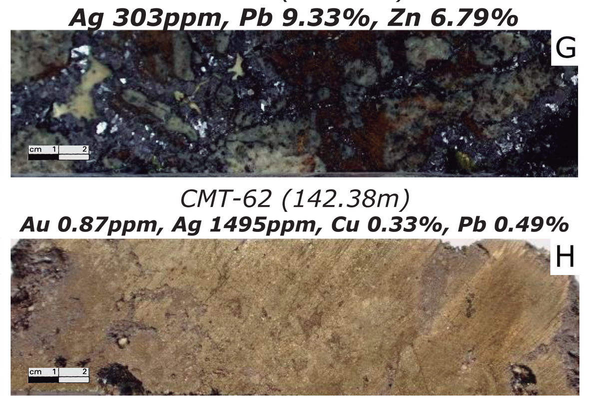


***Fig. 7 (G-H):** Clast-supported monomictic breccia with mostly subrounded sulphides clasts cemented by sulphides matrix (**TISB-2**).*

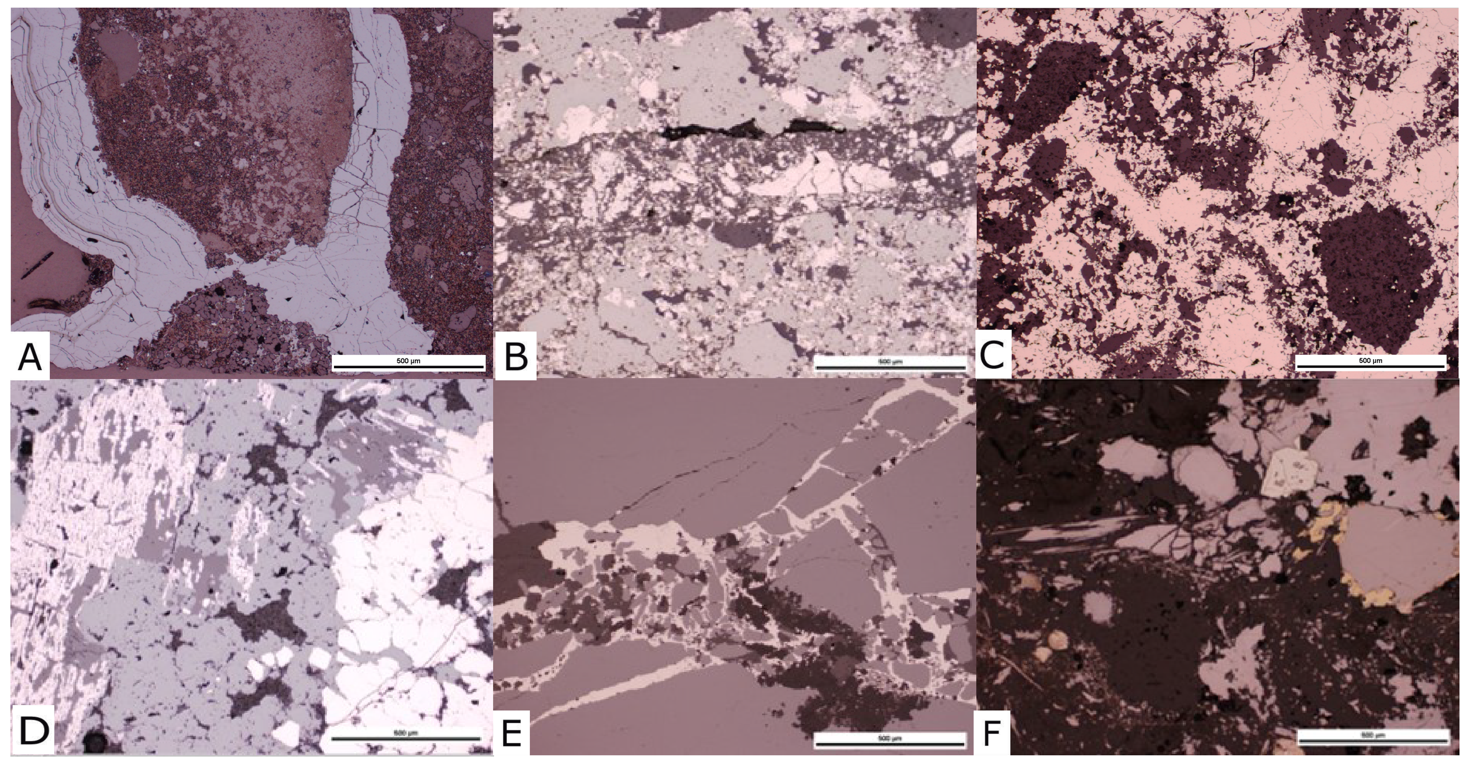


***Fig. 8:** Reflected PPL photomicrographs of breccia samples. **A:** Colloform goethite and probably cassiterite? around microcrystalls of other oxides and quartz. (**TPMB-1**, CMT-06 at 397.05m). **B:** Fragmented anhedral pyrite and sphalerite as the first event of brecciation cutted by fragmented subhedral pyrite and arsenopyrite as the second event of brecciation. Also, anhedral tennantite/tetrahedrite? as a post-deposition event. (**TIB-1**, CMT-12 at 660.36m). **C:** Anhedral pyrite and arsenopyrite replacing rock-flour matrix with traces of subhedral tennantite. (**TIB-1**, CMT-17 at 721.77m). **D:** Skeletal pyrite, marcasite and possibly pyrargyrite? partially replaced by sphalerite. Also, fragmented subhedral arsenopyrite. (**TPB-2**, CMT-32 at 757.13m). **E:** Euhedral fragmented sphalerite with pyrite matrix and traces of subhedral tennantite. (**TISB-2**, CMT-56 at 359.90m). **F:** Fragmented subhedral pyrite with possible gold? in open spaces and anhedral chalcopyrite in the borders. Subhedral pyrargyrite replacing early pyrite. (**TISB-2**, CMT-62 at 142.38m).*

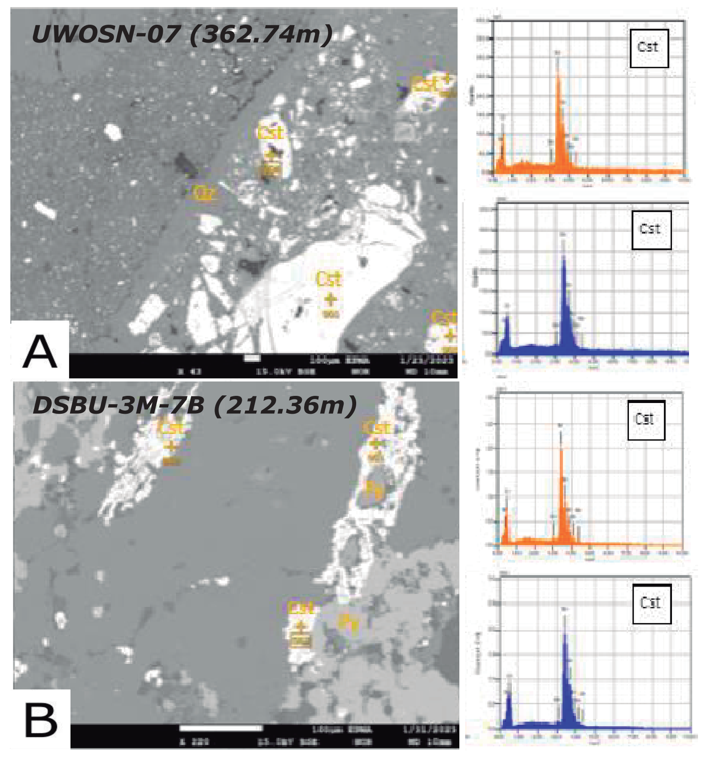


***Fig. 9:** EPMA data showing BSE (Back-Scattered Electron) images with their corresponding EDS (Energy Dispersive Spectrometry) graphs of the selected points in cassiterite within the TPMB. **A:** Elongated boytriodal cassiterite filling open space and formed around anhedral disseminated pyrite. **B:** Fragmented anhedral cassiterite with quartz crystals in phreatomagmatic breccia sample. Abbreviations: cassiterite (Cst), quartz (Qz), pyrite (Py).*
Source: Goszczynski N., 2023.

Discussion & Future Implications

- Textural characteristics are the main feature to differentiate the subtypes of breccias.
- Based on the first phase of the petrographic study, fragmented and fractured sulphides were evidenced showing more than one event of brecciation after deposition.
- Sphalerite, galena, chalcopyrite, cassiterite, Ag minerals (pyrargyrite) and gold are the representative minerals showing the polymetallic signature of the Iska Iska deposit.
- Adding the breccias classification into the AI data had succesfully results evidencing few wrong matches related to specific types of breccias.

•• Paragenetic sequence of the system will be devoloped.

•• EPMA, geochemical analysis and cluster mineralogical study will complement the characterization and improve the AI prediction.

•• The breccias characterization is meant to be applied to the entire Iska Iska data to create a predictive model to help selecting future promising targets.

Core Scanning

Core scanning at Iska Iska had helped to determine hydrothermal alterations and mineral concentrations for an accurate core logging process. The ongoing work added the breccia classification into the AI applying SWIR (Short Wave Infrared) through the hyperspectral raw wavelengths and the customized mineral maps as well as XRF (X-Ray Fluorescence) information to predict the breccia types according to the assigned interval that were provided based on the human textural characterization. The preliminary results of this first dataset show an excellent match between human logging and the AI tool with the promise of improvement.

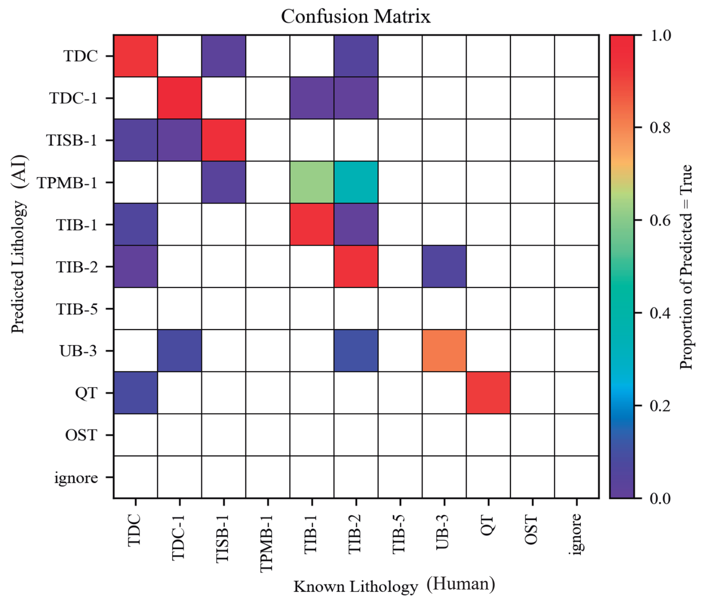


***Fig. 10:** DHK-27 confusion matrix visualizing the performance of supervised learning algorithm versus the geologist selected intervals used in the Ai training, Source: GeologicAI.*

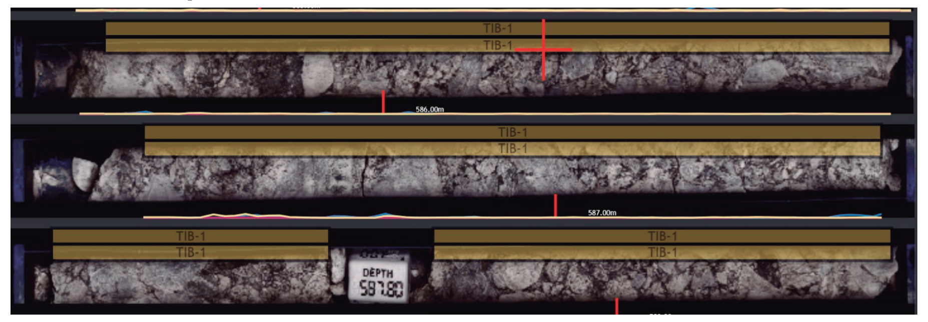
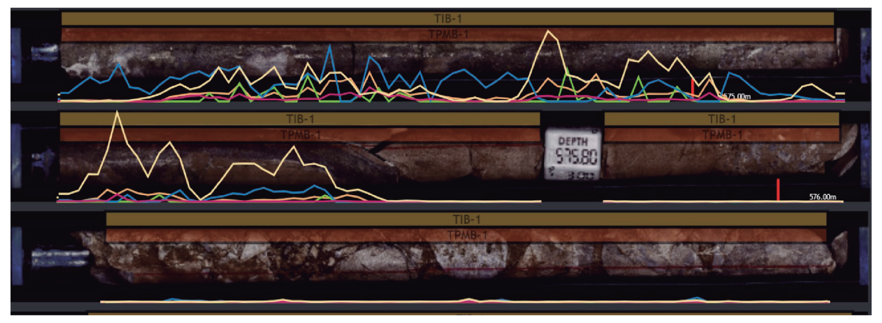


***Fig. 11:** DHK-27 (587.80m approx.) showing the **TIB-1** given lithology (top) versus the **TIB-1** predicted lithology (bottom).*
HIGH ACCURACY
Element concentrations in color lines (Pb, Zn).

***Fig. 12:** DHK-27 (575.80m approx.) showing the **TIB-1** given lithology (top) versus the **TPMB-1** predicted lithology (bottom).*
MISMATCH
Element concentrations in color lines (Pb, Zn, Sn, Cu, Ag).



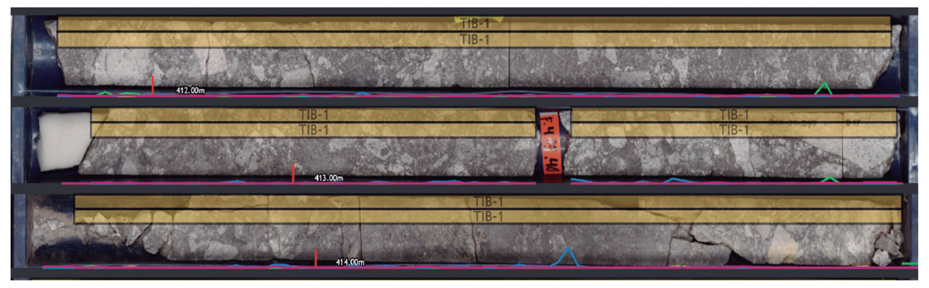


***Fig. 13:** DCN-04 (413.40m approx.) showing the **TIB-1** given lithology (top) versus the **TIB-1** predicted lithology (bottom).*
HIGH ACCURACY
Element concentrations in color lines (Pb, Cu).

***Fig. 14:** DCN-04 (421.40m approx.) showing the **TIB-1** given lithology (top) versus the **TPMB-1** predicted lithology (bottom).*
MISMATCH
Element concentrations in color lines (Pb, Sn, Cu).

Acknowledgment

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