TRANSITION FROM LARAMIDE Cu-Mo PORPHYRIES TO OLIGOCENE Pb-Zn AND Ag-Au EPITHERMAL LOW SULFIDATION SYSTEMS IN THE SOUTHWESTERN SIERRA MADRE OCCIDENTAL, ROSARIO MINING DISTRICT, SINALOA, MEXICO.

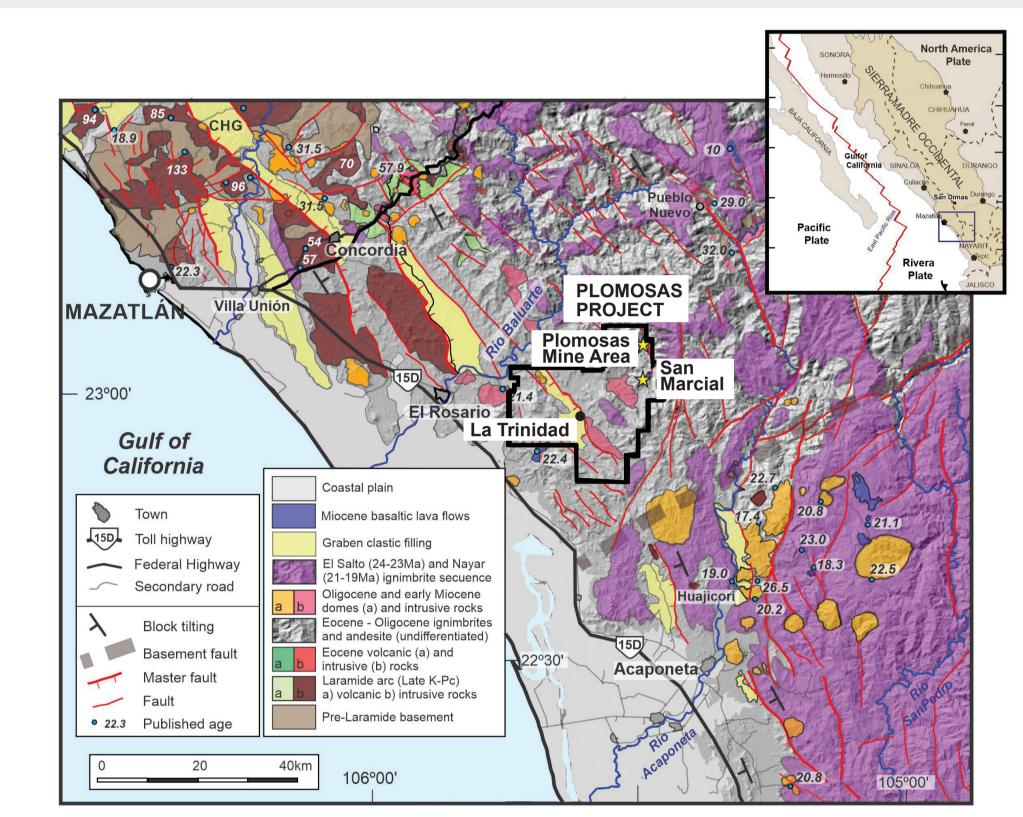
DISCOVERIES CONFERENCE

MAZATLAN, MEXICO, MAY 30 TO JUNE 1, 2023

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THE ROSARIO MINING DISTRICT

The Rosario Mining District (RMD) is host to a series of mineralization events ranging from Cretaceous Cu-Mo porphyries, San Dimas-type Ag-Au epithermal vein systems, to multiple overprinted Oligocene (Pb-Zn), Ag-Au epithermal low sulfidation mineralization, located at the southwestern end of the Sierra Madre Occidental (SMO) in Sinaloa, Mexico. Field observations, detailed petrography, and U-Pb age dating of the entire stratigraphic sequence were used to characterize the paragenesis of mineralizing events and obtain new insights into the evolution of mineralization in the southern extension of the SMO.

GEOLOGICAL CONTEXT

The RMD, based on studies of the Plomosas Mine and San Marcial Areas, does not demonstrate a typical SMO stratigraphic column. Jurassic units occur as roof pendants overlying a series of Cretaceous and Paleocene plutonic and hypabyssal intrusive units in the district. Sequences of early Oligocene ignimbrites and lavas, from felsic to intermediate affinity, lie directly over the Jurassic basement in erosional contacts, typically dipping to the west (Montoya-Lopera et al., submitted; this study). Late Oligocene bimodal extrusive sequences rest on top of the early Oligocene successions by way of an angular unconformity tilted to the east (Montoya-Lopera et al., submitted; and this study).

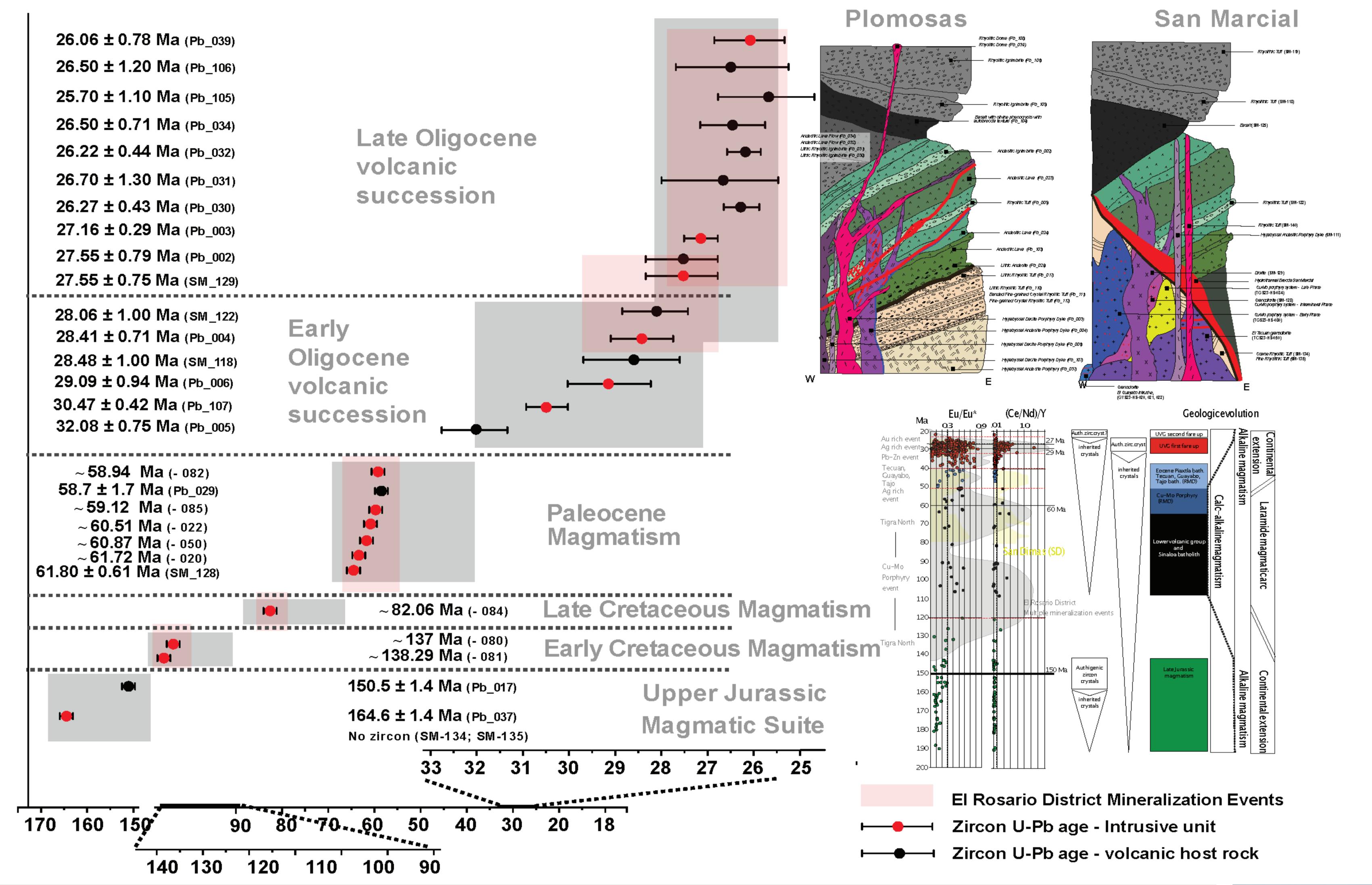
MAGMA FERTILITY EVENTS

In the central SMO, the magma fertility or mineralizing events are recognized as: (i) late Cretaceous, at the end of the Mazatlan batholith formation; (ii) at the end of the Eocene Piaxtla batholith formation (Ag-San Dimas deposit [Montoya et al., 2019, 2020]); and (iii) at the end of the Rupelian volcanic sequence (Au-San Dimas district [Montoya et al., 2019, 2020]).

The absence of Cretaceous to Eocene outcrops in the Plomosas Mine Area indicates that those mineralizing events are not present in that part of the southwestern SMO. However, the inherited zircons collected by the Oligocene volcanism, and the resulting new age dates received from the San Marcial area, suggest the existence of a hydrated and oxidized late Cretaceous magmatic event in the RMD, 10 Ma younger than mineralization dated from the San Dimas district. Paleocene and Eocene rocks remain reduced and hydrated in the RMD, which is associated with Cu-Mo porphyry intrusions, as well as the "San Dimas" Ag-rich epithermal system. The Oligocene event has a comparable hydration rate but much higher oxidation than the San Dimas mineralization. The peak in fertility is estimated at 27 Ma in the RMD, which corresponds with the recognized Ag-rich and Au-mineralizing dome and structures.

During the Eocene-Oligocene period, the zircon chemistry indicates that two periods from 45 to 31 Ma and from 31 to 27 Ma are represented. At around 30 Ma, the magma evolves from being a hydrated and reduced environment, to a more oxidized regime. These two time periods correspond with the transition from the Pb-Zn mineralization event to a period of Ag-rich, Au epithermal veins, respectively.

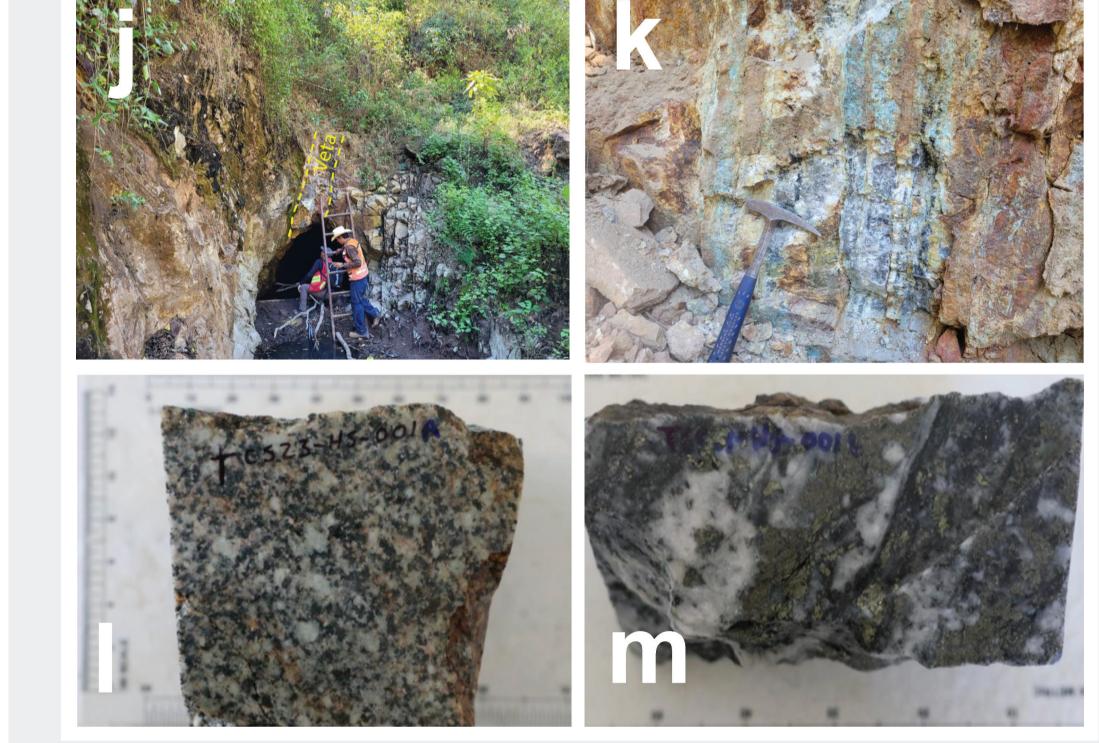
From a regional perspective, the mineralization events studied in the RMD represent the southern continuity of the Cretaceous Cu-Mo magmas, and indicate that the Ag-Au epithermal style mineralization is younging from north to south. This observation is in general agreement with the southward migration of magmatism during the Cretaceous, and through the Eocene and Oligocene periods.



ii) Paleocene San Dimas-type Ag-rich epithermal veins

San Dimas-type Paleocene Ag-rich veins are hosted in east-west oriented structures limited by the El Tecuan granodiorite intrusive (Figures j, k, l). Granodiorite containing this style of veins is observed outcropping in the Tebaira area. The distribution of veins is restricted to within the intermediate intrusive.

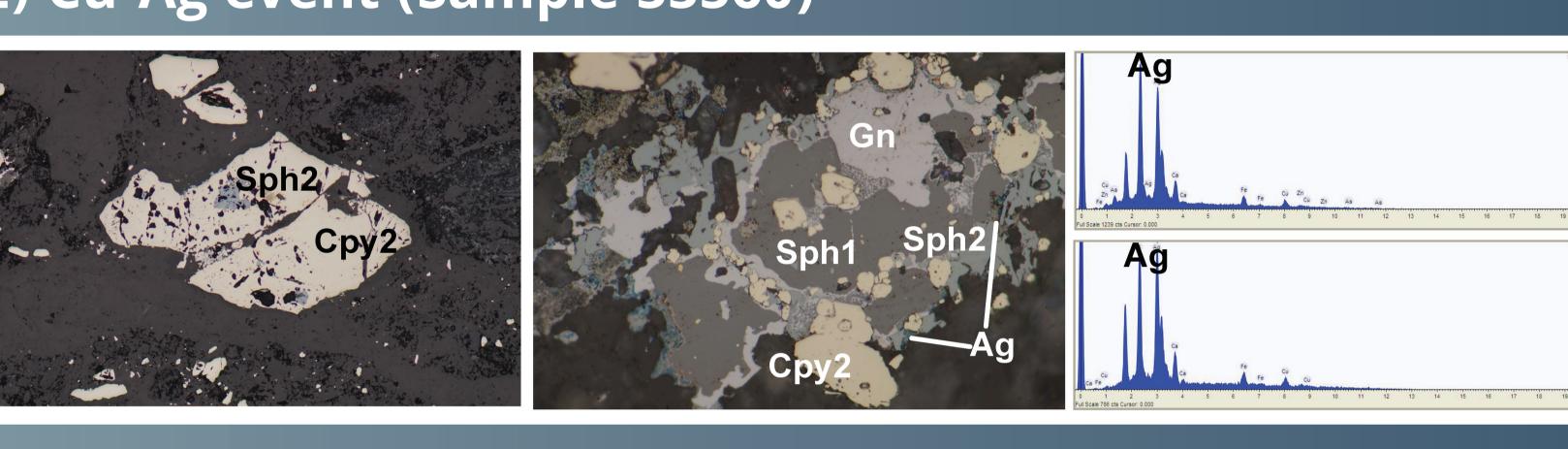
Displaying similarities with the San Dimas district, polymetallic vein systems in the RMD appear to be developed in three main settings: i) open space filling; ii) crack and seal, coincident with the main polymetallic deposition; and iii) closure, with adularia+rhodochrosite ± sericite as the alteration assemblage (Figure k, m).



2) Cu-Ag event (Sample 55560)

1) Pb-Zn event (Sample SM-105)

relationship with events (1) and (2).



(1) an early low-grade Plomosas-type Pb–Zn event, highlighted by low abundance of chalcopyrite

(Cpy1) – sphalerite (Sph1) – galena (Gn), quartz – chlorite – carbonates - Fe-poor sphalerite

(Sph2) at shallow depths, (); (2) the main Cu-Ag event, containing chalcopyrite (Cpy2) - bornite

- silver (Ag) – sphalerite (Sph1) – sphalerite (Sph2) – galena (Gn), with quartz – chlorite – epidote

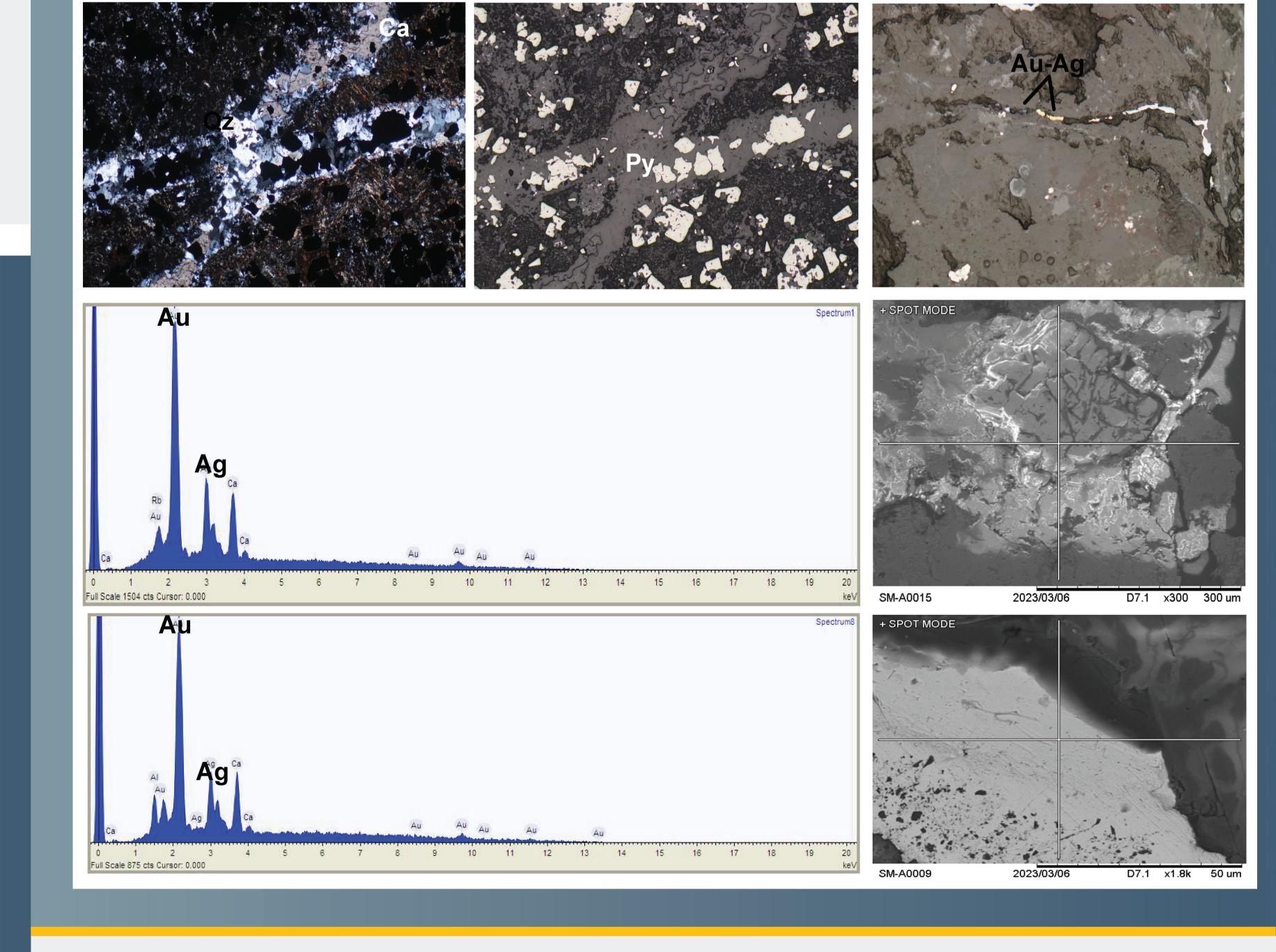
– amphiboles reabsorbing the earlier Pb-Zn event. High silver values increase at depth within the

structure. At San Marcial this event is Ag-rich with only rare Cu whereas at the Plomosas Mine Area

Cu is more prevalent; and (3) a later free Au event, associated with crustiform quartz veinlets,

calcite filling fractures, strong pervasive sericitization and disseminated pyrite in a crosscutting

3) Au free event (Sample SM-110)

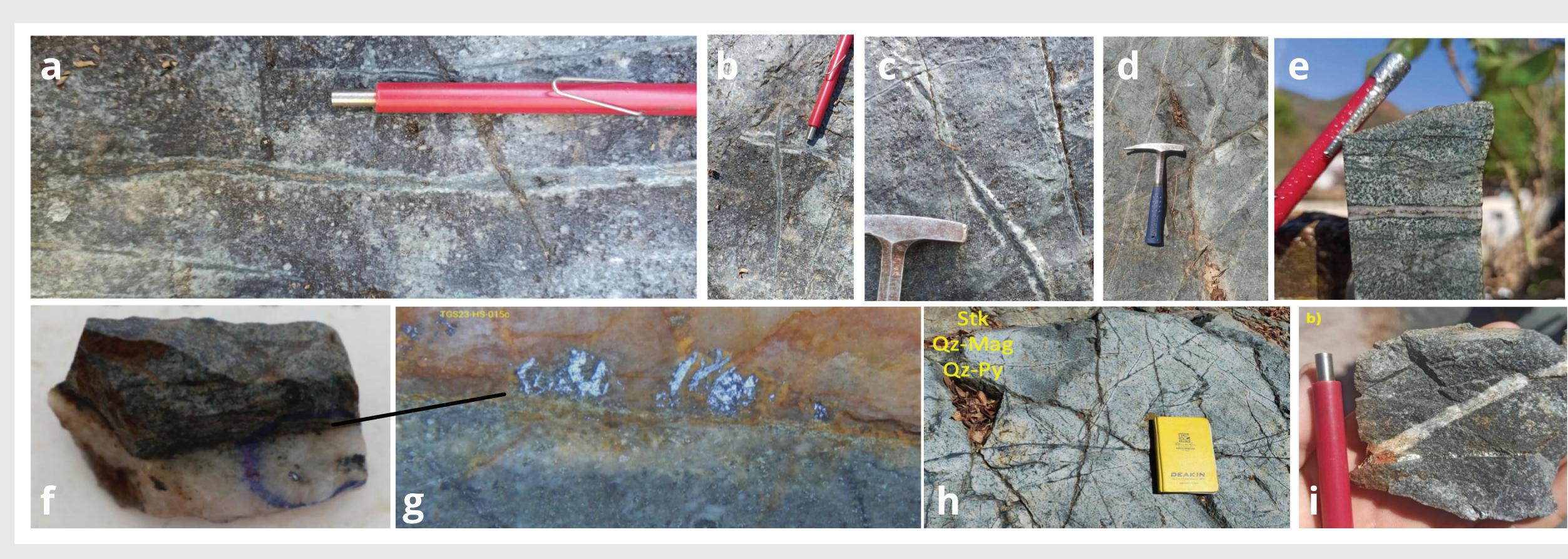


MINERALIZATION CONTEXT

The mineralization in the RMD can be split into five main mineralization events: i) the oldest is associated with the Laramide magmatic event developing Cu-Mo porphyry deposits; ii) classic Eocene San Dimas-type Ag-rich epithermal veins hosted, and limited by the El Tecuan granodiorite; iii) Plomosas-type Pb-Zn epithermal breccias (Montoya-Lopera et al., submitted); iv) late Oligocene San Marcial-type epithermal Ag enrichment, hosted by fault breccias crosscutting the early Oligocene volcanic sequence, and limited by the late Oligocene sequence; and v) epithermal Au-rich veining which crosscuts the full stratigraphic column.

i) Late Cretaceous Cu-Mo porphyry mineralization

Early and intramineral porphyry bodies outcrop for more than 3 km along creeks within the RMD. Early hypabyssal intrusions are characterized by strong and pervasive secondary biotite alteration of the matrix (Figures a to i). Intramineral porphyry intrusions crosscut the early intrusive bodies, and demonstrate pervasive, but moderate intensity chlorite alteration, superimposed on secondary biotite (Figure h). Typical Cu-Mo porphyry mineralization is observed as thin and sinuous quartz-magnetite ("A-type") veinlets (Figure b), disseminated and veinlet chalcopyrite (Figure i), chalcopyrite and magnetite veinlets (Figure h), tourmaline veinlets with chalcopyrite in sutures, and albite halos (Figures a, b, c), albite and chlorite veinlets (Figure d), quartz-molybdenite veinlets (Figure f, g), and quartz veinlets with sulfides in sutures (Figure e, i).



iii) Plomosas-type Pb-Zn epithermal breccias

The Plomosas deposit is an overlapping event of Pb–Zn, Ag and Au epithermal low sulfidation mineralization located in the NE of the RMD. The overlapping events consist of the earlier Pb–Zn rich hematitic fault breccia, superimposed by a Cu–Ag rich event and poorly developed Au veins. The Pb–Zn hematite fault breccia is hosted by ~30 Ma Oligocene volcanic units, structurally controlled by a low angle N-S fault dipping west. Zircon geochemistry results indicate a genetic link between Pb–Zn veins and intermediate Oligocene intrusive bodies and the relation of Ag and Au veins with the end of Late Oligocene volcanism (see Stratigraphic column) [Montoya-Lopera et al. (Mineralium Deposita submitted), and Montoya-Lopera et al. (manuscript)].

iv) Late Oligocene San Marcial-type Ag-rich hydrothermal fault breccia and epithermal Auveins

The mineralization at the San Marcial Area is controlled structurally by a northwesterly oriented high angle (60°) normal fault, dipping to the northeast. The hanging wall to the structure is typically a green volcanoclastic rock, whereas the footwall is characterized by a Ag-rich hydrothermal polymictic fault breccia, with an average width of 10 metres and 1,500 metres long. The paragenesis of the three key mineralization events can be summarized as:

REFERENCES

Montoya-Lopera, P., Ferrari, L., Levresse, G., Abdullin, F., and Mata, L. (2019). New insights into the geology and tectonics of the San Dimas mining district, Sierra Madre Occidental, Mexico. Ore Geology Reviews. https://doi.org/10.1016/j.oregeorev.2018.12.020

Montoya-Lopera P, Levresse G, Ferrari L, Orozco-Esquivel T, Hernández-Quebedo G, Abdullin F, and Mata L. (2020) New geological, geochronological and geochemical characterization of the San Dimas mineral system: Evidence for a telescoped Eocene-Oligocene Ag/Au deposit in the Sierra Madre Occidental, Mexico. Ore Geology Reviews 118: 1-15.

Montoya-Lopera, P., Levresse, L., Ferrari, L., Catchpole, H., Coto, L., Mar, F., and Cárdenas-Castro, A. (). Magmato-tectonic Events in the Development of Mineralization in the Southwestern Sierra Madre Occidental, Plomosas Deposit, Sinaloa, Mexico. (Mineralium Deposita - Submitted)

Montoya-Lopera, P., Levresse, G., Catchpole, H., Coto, L., Woolfe, T., Mar, F., Cárdenas-Castro, A., and Gabriel, G. () Plomosas Project: Evolution from Cretaceous to Oligocene mineralization and the significance for exploration in the Rosario Mining District, Sinaloa, Mexico. (Manuscript in edition)









