A Petrographic Study of Jasperoids from Sepon Gold Deposits, Laos

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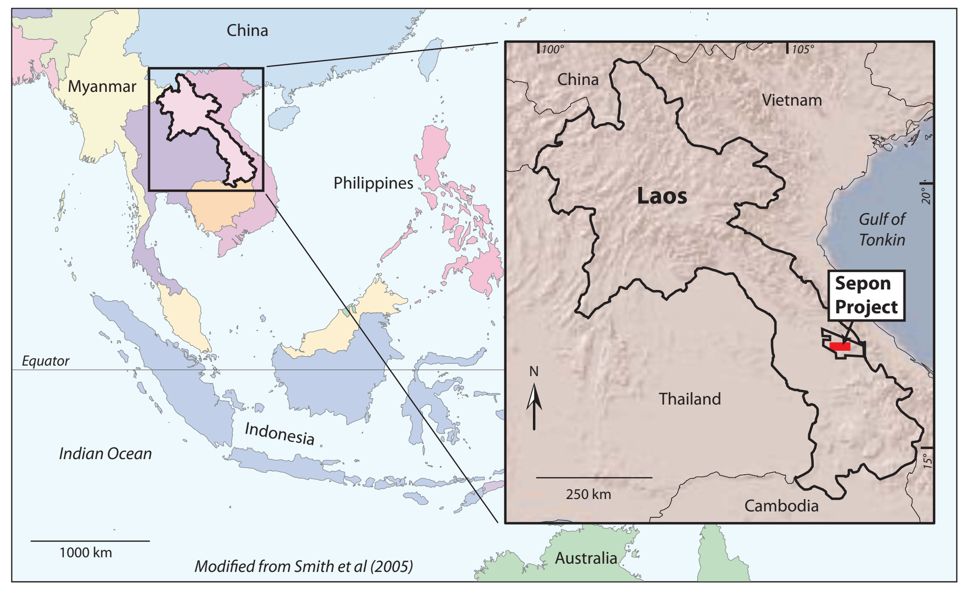
Introduction

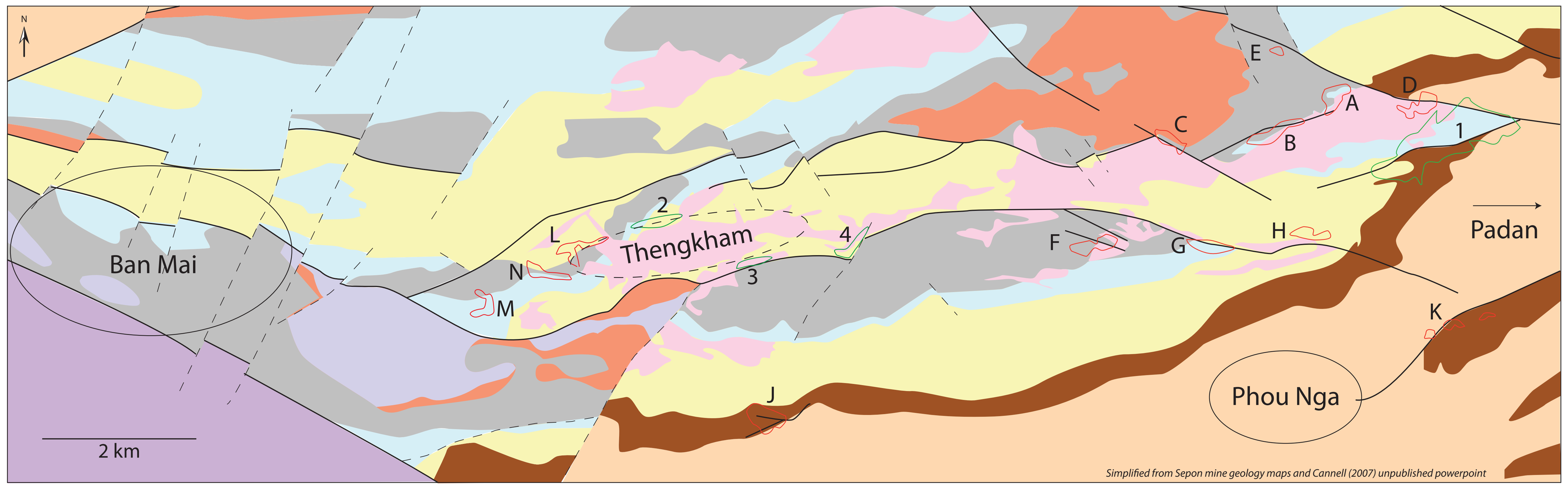
The Sepon Cu-Au deposits are located in south central Laos and include a spectrum of mineral deposit types that range from porphyry and skarn to sediment-hosted gold with affinities to Carlin-type gold deposits. Like Carlin-type gold deposits, the main gold mineralization is hosted within calcareous shales and carbonates, and jasperoids are closely associated with gold mineralization. A petrographic-based study of jasperoids from different locations within the district was conducted to:

1) characterize mineralized jasperoids,
2) compare mineralized versus barren jasperoids, and
3) determine the origin of "chert-like" siliceous layers within the sedimentary units.

A range of primary textures is preserved within the silicified rocks. Textures of silicification varied from reticulated to mosaic in both homogenous and irregular patterns. The presence of dolomitization, decalcification, silicification, brecciation veining, and a variety of base-metal (Zn, Pb, Cu) and pathfinder (As, Sb, Ag) sulfide assemblages suggest that multiple mineralization and alteration stages occurred.



Modified from Smith et al (2005)



Simplified from Sepon mine geology maps and Cannell (2007) unpublished powerpoint

Gold Pit/Mineralization: *Discovery Main (A), *Discovery Colluvium (B), *Discovery West (C), Discovery F (D), *Luang (E), *Nalou (F), Namkok West (G), Namkok East (H), *Houay Yeng (J), Vang Ngang (K), Dankoy (L), Phavat (M), Phavat North (N)
*** Sampling Locations**

Copper Pit/Mineralization: Khanong (1), Thengkham North (2), Thengkham South (3), Thengkham East (4)

Barren Jasperoids: Ban Mai, Phou Nga

Intrusive Centers: Padan (east of map area), Thengkham

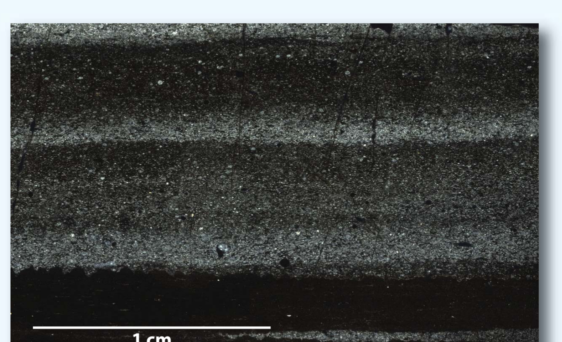
Formations:

Period	Formation	Sequence
Cretaceous	**Khorat Basin:** Sandstone to conglomerate	
Permian	**Rhyodacite Porphyry (RDP)**	
Devonian	**Phabing:** Pale grey Limestone	Carbonate Sequence
Devonian	**Nam Kian:** Black thinly laminated, calcareous siltstone	Carbonate Sequence
Devonian	**Discovery:** Nodular calcareous mudstone	Carbonate Sequence
Devonian	**Nalou:** Bioclastic to Laminated Dolomite Unit	Carbonate Sequence
Devonian	**Kengkeuk:** Dolomitized grainflows, carbonate breccias, mud/siltstone	Carbonate Sequence
Silurian	**Vang Ngang:** Graptolitic shale, shale/siltstone, limestone	Siliciclastic Sequence
Ordovician	**Highway:** Siltstone, claystone, limestone, micaceous massive sandstone	Siliciclastic Sequence

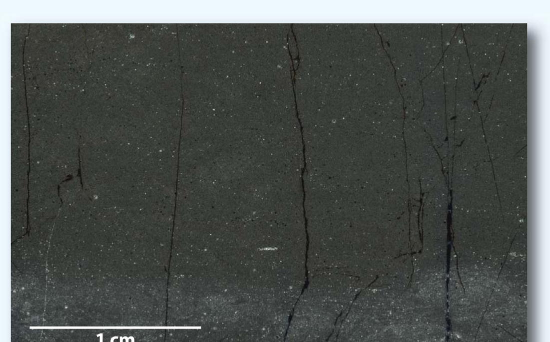
Unmineralized Silicified Rocks

Chert

Both the Discovery Trend and Houay Yeng deposits have associated "cherty" beds proximal to mineralization. Mine geologists have interpreted these as primary chert or possibly secondary silicification related to surficial supergene processes. The silica matrix is microcrystalline to cryptocrystalline. Cherty layers with crude bedding of calcareous to shale components transition into adjoining lithologies. Spherical and tabular microfossils are concentrated parallel to bedding. Identifying these siliceous beds as either primary chert or later silicification is inconclusive.



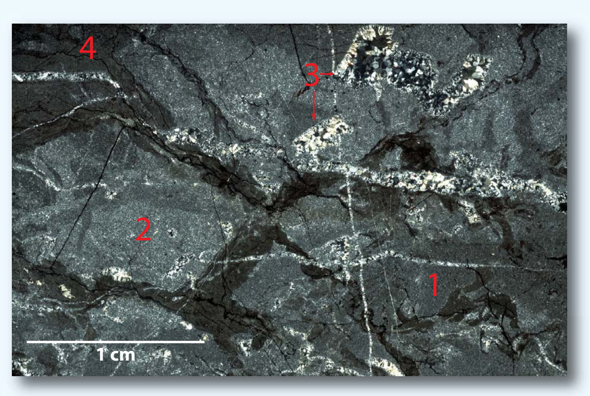
Crossed nicols: Discovery Trend chert sample from Nam Kian Formation.



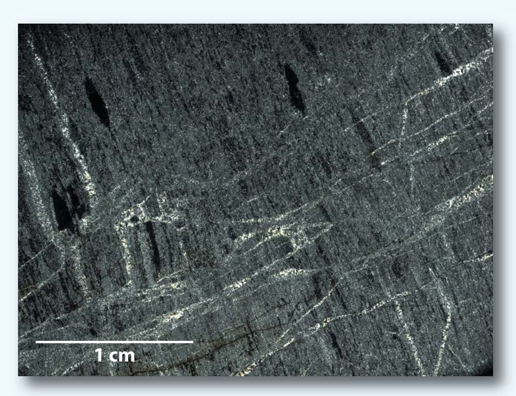
Crossed nicols: Houay Yeng chert sample from Vang Ngang Formation.

Barren Jasperoids

The samples taken from unmineralized jasperoids are composed of fine-grained mosaic silicified texture similar to the Discovery Trend. One sample has relict bedding defined by preserved organic material. Only trace euhedral pyrite is found within the matrix, and no other sulfide minerals were observed. Zoned and feathery textures of the euhedral vuggy quartz veins crosscut the silicified matrix.



Crossed nicols: Ban Mai jasperoid displays four main domains: (1) darker fine-grained silicified host rock, (2) lighter fine-grained silicified host rock (3) hematite stained quartz along fractures. (4) coarse quartz veins with zoned growth horizons

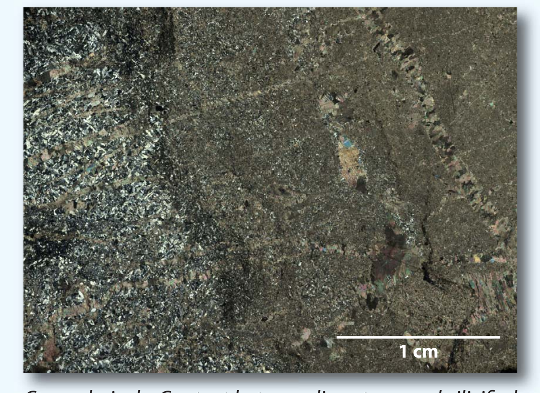


Crossed nicols: Phu Nga jasperoid displays preserved bedding and near perpendicular quartz veinlets.

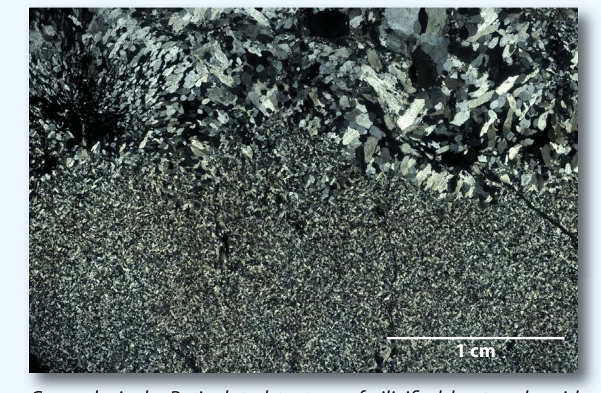
Mineralized Jasperoids

Houay Yeng

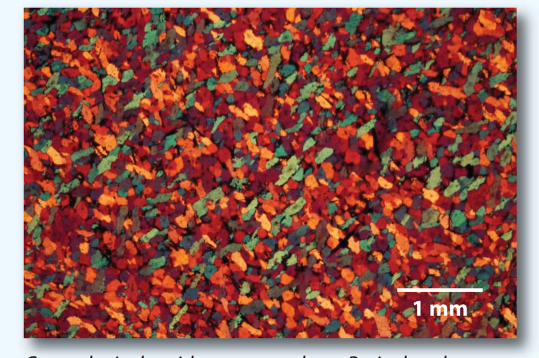
At the Houay Yeng deposit, mineralized jasperoid developed in a carbonate protolith containing minor fine-grained euhedral pyrite. The textures interpreted to reflect silicification within the mineralized jasperoids at this location are coarser grained and reticulated, defined by elongated quartz grains with a preferred orientation creating a cross hatched appearance.



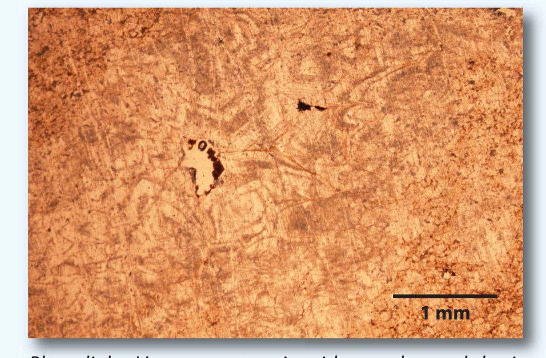
Crossed nicols: Contact between limestone and silicified domain. Late calcite veins cut through both domains.



Crossed nicols: Reticulated texture of silicified host rock, with later quartz veins infilled with stibnite (opaque).

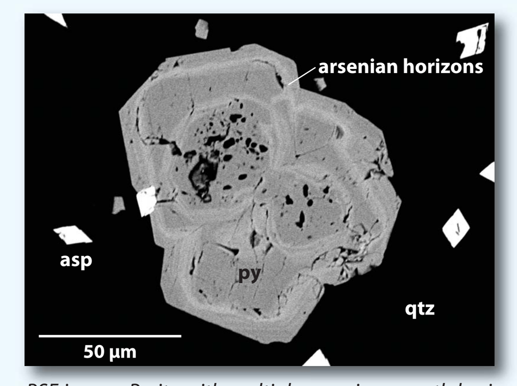


Crossed nicols with gypsum plate: Reticulated texture with arsenopyrite along grain boundaries (opaque).

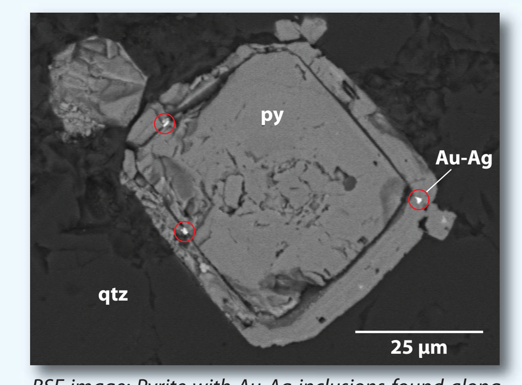


Plane light: Vuggy quartz vein with zoned growth horizons.

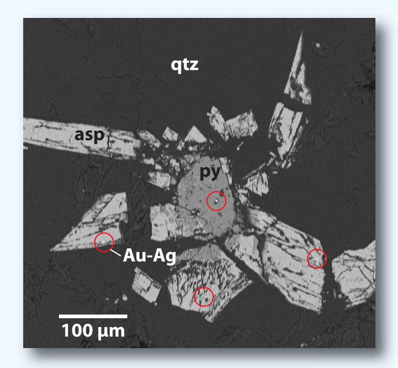
Mineralization within the reticulated silicified matrix is a combination of euhedral pyrite and arsenopyrite with inclusions of gold, electrum, and tennantite/tetrahedrite. Locally, larger euhedral pyrite displays arsenic zoning , but gold was not identified in these instances. Stibnite is found locally filling vuggy quartz veins that have multiple growth zones and is interpreted to be part of a later stage of mineralization.



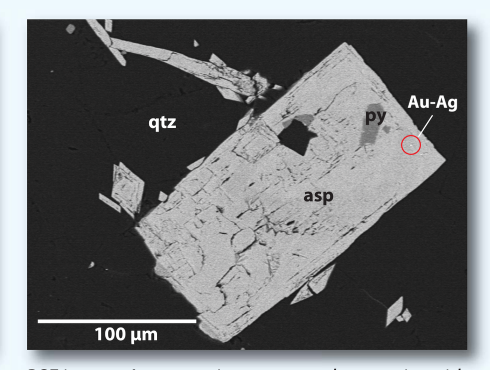
BSE image: Pyrite with multiple arsenian growth horizons and smaller arsenopyrite grains disseminated in the silicified matrix.



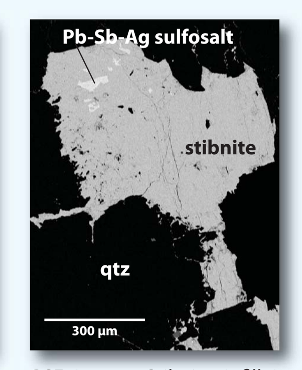
BSE image: Pyrite with Au-Ag inclusions found along overgrowth.



BSE image: Arsenopyrite overgrowth on pyrite with Au-Ag inclusions within both.



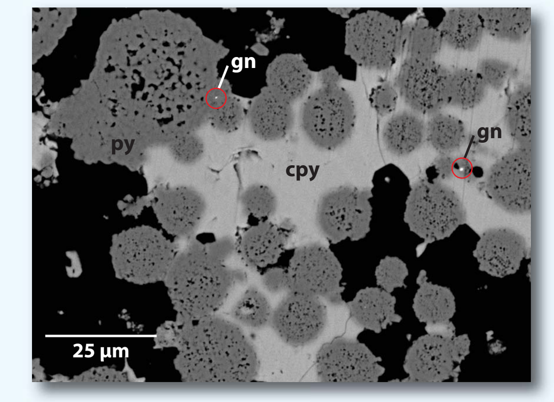
BSE image: Arsenopyrite overgrowth on pyrite with Au-Ag inclusions within arsenopyrite.



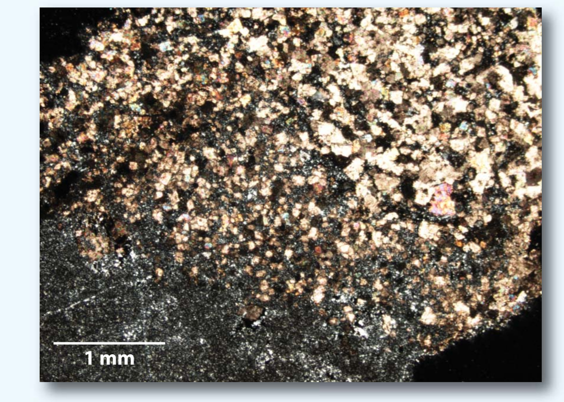
BSE image: Stibnite infill in quartz vein with Pb-Sb-Ag sulfosalt inclusions.

Discovery Trend

Within the Discovery Trend, mineralized jasperoid developed in both calcareous shale and dolomite. Disseminated framboidal pyrite is found in the calcareous shale of the Discovery Formation, with clusters of pyrite displaying textural zoning of porous, inclusion-rich cores to solid rims with circular to incipient subhedral morphologies. The framboids contain minor galena and sphalerite inclusions. Rarely, chalcopyrite replaces carbonate and framboids.

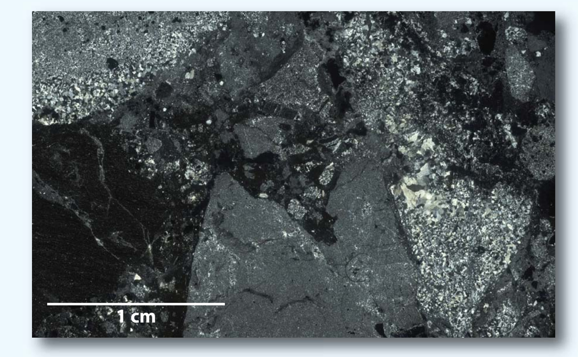


BSE Image: Framboid cluster within Discovery Formation calcareous shale.

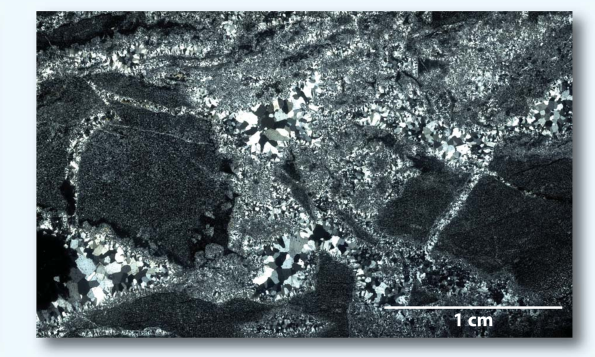


Crossed nicols: Transitional boundary between Nalou Formation dolomite and silicified area.

Jasperoids within the Discovery Trend have a silicified-mosaic texture with finer grain sizes found in organic-rich areas. Relict textures of bioclasts, bedding, or dolomite crystals are defined by unaltered organic material, but other samples are intensely silicified with no relict textures. Sharp contacts between carbonate and silicified areas are found along stylolites, and microscopic gradational zones show finer grained dolomite crystals interfingered with a very fine-grained silicified matrix. Quartz veins appear transitional with the silicified matrix of breccias. Breccias contain jasperoid clasts as well as vein-quartz clasts suggesting multiple stages of silicification and quartz veining. Locally, euhedral quartz within veins displays feathery extinction similar to epithermal textures (Adams, 1920; Dong et al., 1995).

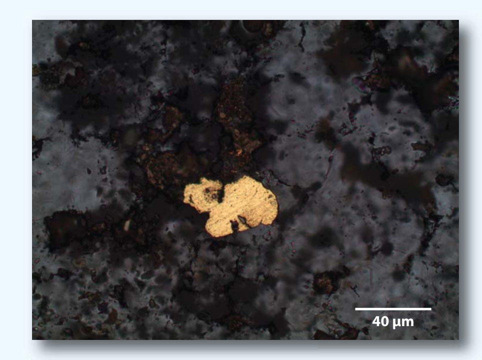


Crossed nicols: Shear zone breccia from Discovery West - multiple silicification events inferred. Base metal mineralization is found within the matrix and in coarse veins.



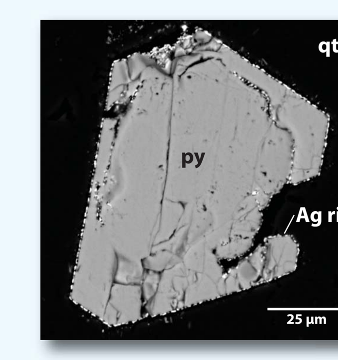
Crossed nicols: Vein breccia from Discovery West - multiple silicification events. Gold occurs within silicified organic-rich domains.

Base metal mineralization (galena, sphalerite, chalcopyrite), stibnite, tennantite/tetrahedrite and lead and silver sulfosalts are found within the quartz vein event. This paragenetic relationship is also found in brecciated mineralized clasts. Veins range from single thin quartz veinlets to thicker veins displaying multiple fluid inclusion growth horizons and vuggy pocket textures. Gold in the breccia sample is associated with silicified organic-rich host rock clasts. Visible gold at Discovery Colluvium occurs within finer grained vuggy quartz veins without zoned growth texture.

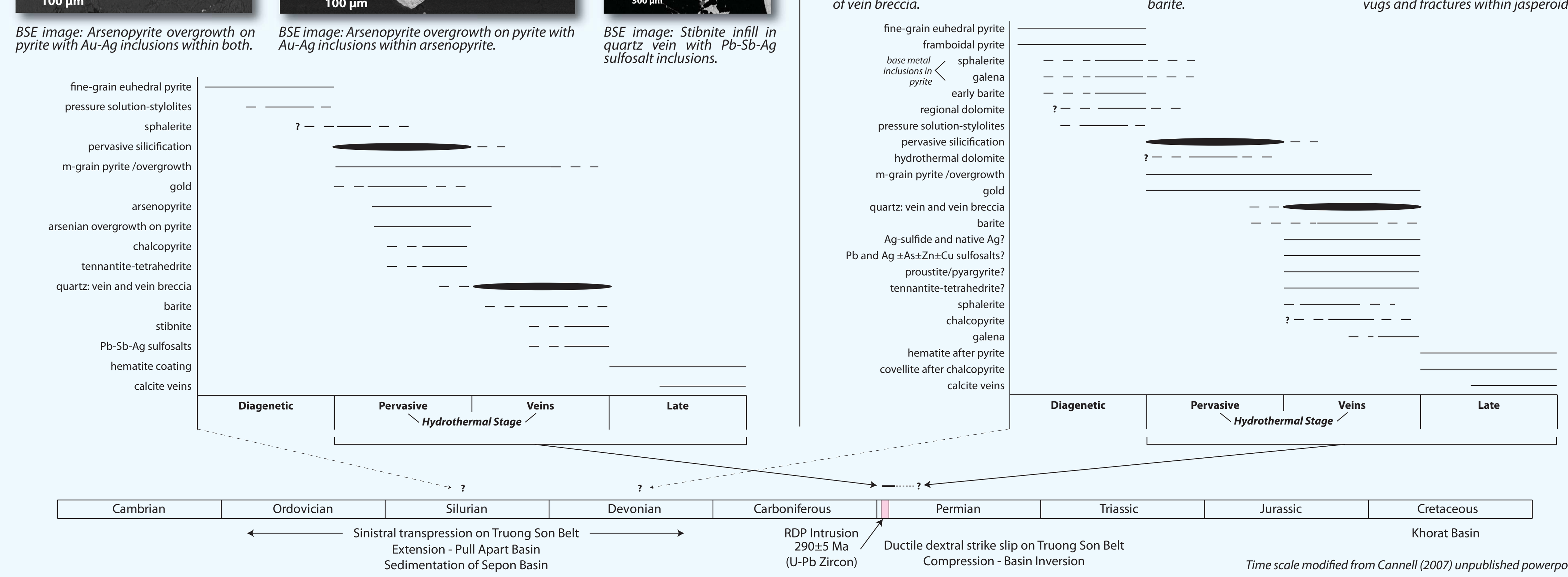


Combined reflected/plane light: Microscopic visible Au-Ag found in silicified organic-rich domain of vein breccia.

BSE image: Visible gold in vuggy quartz vein with associated barite.



BSE image: Pyrite rimmed with Ag-sulfide beads. Other silver found filling vugs and fractures within jasperoid.



Time scale modified from Cannell (2007) unpublished powerpoint

References:

Adams, S.F., 1920, A microscopic study of vein quartz: Economic Geology, v. 15, p. 623-664.
Cannell, J.B. 2007, Sepon Exploration Presentation: Oxiana Limited, unpublished powerpoint.
Cromie, P.W., Smith, S.G., and Khin, Z., 2006, New insights through LA-ICP-MS and sulphur isotope investigations into the occurrence of gold in the Sepon gold deposits, Laos: ASEG Extended Abstracts 2006, 3 p.
Dong, G., Morrison, G., and Jaireth, S., 1995, Quartz textures in epithermal veins, Queensland – Classification, origin, and implication: Economic Geology, v. 90, p. 1841-1856.
Smith, S.G., Olberg, D., and Manini, A.J., 2005, The Sepon gold deposits, Laos: Exploration, geology, and comparison to Carlin-type gold deposits in the Great Basin: in Rhoden, H.N., Steininger, R.C., and Vikre, P.G., eds., Geological Society of Nevada Symposium 2005: Window to the World, Reno, Nevada, May 2005, v. 2, p. 899-916.

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Conclusions

A primary conclusion of this study is that the Sepon jasperoids are characterized by multiple stages of silicification including early pervasive jasperoid silicification and later quartz veins and vein-quartz breccias. At the Discovery Trend deposits, base metal mineralization is associated with fine-grained quartz veins. Rare visible gold is found within quartz veins at Discovery Colluvium deposit and in organic-rich pervasive silicified wall rock in vein breccia samples. At the Houay Yeng deposit precious metal mineralization is associated with medium-grained reticulated silicification as inclusions within pyrite and arsenopyrite.

An early diagenetic stage is better documented at the Discovery Trend deposits by early framboidal pyrite and regional dolomitization. Arsenic and antimony mineralization is better represented at Houay Yeng with fine-grained arsenopyrite and arsenian horizons within pyrite and later stibnite. At the Discovery Trend deposits, arsenic and antimony is present at a lesser extent as inclusions of sulfosalts, tennantite-tetrahedrite and stibnite within pyrite.

This study has only touched on the complexities of gold mineralization at Sepon. Additional research understanding the relationship to the RDP intrusions, the Cu-Au-Mo porphyry and skarn mineralization within the district would be well warranted.

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