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RESEARCH ARTICLE

Gold and Other Metals in the Cao Ram Area, Doi Bu District, Hoa Binh Region, Southwest of Hanoi, Vietnam

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Abstract

Mining properties located southwest of Hanoi, Vietnam in the Đồi Bù District, Hòa Bình Region were visited during January, 2014. The key conclusions of the assessment were: 1) The subject areas have not been explored in any detail for decades if not longer. The Chinese (pre-1900s) and then later the French (pre-1960s) conducted basic reconnaissance and produced the early maps of the area. During the 1960s and 1970s, the USSR explored the area in some detail via outcrop sampling programs and some drilling, but many sites within the area of interest remain poorly investigated and untested. The general area has received only superficial investigation to date of the obvious fracture zones and associated outcropping geological structures; 2) Since the late 1980s, the Vietnamese Geological Survey and associated universities have undertaken the systematic assembly and cataloging of all available geological, geophysical, and mining information on the reported minerals present in Vietnam, almost all of which are in Vietnamese; 3) Various Government departments are involved in all mineral exploration and mining programs in Vietnam for the purpose of supporting exploration and mining and for purposes of regulating the exploration and mining activities to ensure that the health and safety of the local inhabitants, farm animals, and the local surface water and groundwater are protected for long-term use by the people of Vietnam; 4) After a review of the available literature and selected translations of the reports relating to the areas of interest (combined with the information gained during the visit of January, 2014), and based on the samples taken from outcrop, evaluated, and tested at an international laboratory, the authors have concluded that the subject areas discussed here have an unusually high potential for world-class ore bodies of precious and base metals present at shallow depths (<600 m); 5) Of the 31 samples obtained from outcrop in the Hop Hoa, Vai Dao, Lang Sen, and Lien Son areas, 42% of the total number of samples analyzed show gold values in excess of 1 gram per tonne (g/t), seven of those contain greater than 5 g/t with two higher than 25 g/t (i.e., 25.6 and 68.9 g/t). Although the high analyses might be the result of the "nugget" effect, they can show nothing about the available volume of mineralized rock surrounding the samples and their metal content until drilling is conducted to determine the horizontal and vertical extent of the zone and grade of associated precious metals and other metals; 6) The type of mineralization present in the area of interest (Au-Mn-As-Pb-Ga-Mo) indicates that other metals of economic significance would likely occur with the gold making any mining and processing design a multi-metal venture; 7) Based on sampling of the tailings at the Cam Vao Processing Plant near Cam Ram, the associated tailings pond, and adjacent creek, all three areas contain high concentrations (in environmental terms) of arsenic, cadmium, mercury, and lead. An environmental assessment should be conducted on and around the processing plant extending to and including the associated down gradient rice paddies.

Keywords: Gold; Silver; Arsenic; Cadmium, Mercury; Lead; Sulfide minerals; Geochemical analyses of whole-rock samples; Thin-section descriptions; Type of mineralization; Exploration guides; North Vietnam

Introduction

The objective of the I2M Associates, LLC (I2M) investigations was to provide an independent and impartial assessment of the mineral potential of the subject area of interest including the current mining operations that were being operated by a local gold mining company as part of a potential joint venture with an I2M client (Wishbone Gold, plc [WBG]) within the lease areas Hop Hoa and Vai Dao (Appendix I), the Lang Sen deposit, an area of recent potential interest to the south, and a developing project to the southwest, Lien Son, among other areas introduced during the I2M field visit of January, 2014. The general area of the projects of interest is shown in Figure 1.

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Figure 1 - PROJECT AREA MAP
Vietnam Project 7244

Information (reports, maps, etc.) was obtained during I2M's visit to Vietnam in January, 2014 from various Vietnamese governmental mining agencies (Appendices E-K), from the available geoscience literature available online, and from the files of I2M in Houston, Texas, and Seattle, Washington. Also, geological samples were obtained during the field visit and were subsequently examined and described in the field macroscopically by hand lens and in hand specimen, in the laboratory via analysis for their elemental content, and by thin-section petrological investigations to reveal the mineralogical and geophysical associations related to the associated precious- and base-metal mineralization.

I2M personnel carried out the following primary tasks while in Vietnam:

- Held initial discussions with WBG management regarding their perspectives, with special emphasis on the purpose of the visit and the role of the I2M investigation.
- Held continuing discussions during the period with in-country geological consultants, Nguyen Dac Lu, Ph.D., General Director, Saonam Mineral Group, and Hai Thanh Tran, Ph.D., Associate Professor of Geology at the Hanoi University of Mining and Geology, and associated interpreters and industry and governmental officials.
- Obtained information via maps and other reports regarding the subject areas of interest where gold mining operations are currently occurring, and where gold and other metals have been reported in outcrop in the past.
- Held meetings with district and local Government officials regarding the available geological and geophysical mapping and associated reports covering other subject area.
- Obtained geological samples for laboratory and petrographic studies to assess elemental and mineralogical content of selected rock samples.
- Assessed and evaluated the degree and stage of the mineralization involved in gold deposition and the potential for hosting orebodies of economic significance in the area.
- Assessed the potential for expanding the current mining operations.

The principal reason for publishing the results of the investigations is to provide some impetus to follow-up investigations by others with an interest in developing Vietnam resources and the national and local economy for the benefit of Vietnam. As concluded herein, the area has substantial potential to become a major mining district. An expanded project with greater resources and a new processing plant would benefit the local economy and increase Vietnam's gold production. This would stimulate additional exploration in the general area [1,2].

Climate and Seasonal Operations

The areas of interest are located in a tropical climate and experience two distinct seasons: dry and rainy seasons. The rainy season extends from April to August each year with a high of 300 mm. Heavy flooding or landslides can be expected from time to time that will occasionally obstruct or delay traffic until roads are repaired. Because local inhabitants generally live in the hills surrounding the rice paddies and fields of the valleys, limited assistance is readily available. Temperatures range from a high of 34°C in April to a low of 14°C in December [3].

The highest temperature can reach 36°C, with the lowest anticipated to be approximately 16°C during the rainy season. The dry season begins in September and extends to March of the next year. The dry and coldest period extends from October to December, with temperatures down to about 5°C during this season, and warming up from December to March, usually including drizzle and fog. A light orange haze is common in the area during parts of the year resulting from wood burning by local residents for meal preparation and heating. Birds and mammals were noticeably absent from the field.

Accessibility to the Areas of Interest

The area of interest is located approximately 40 kilometers southwest from Hanoi. Access to the properties is possible by roads ranging from highways to improved roads along rice paddies (Figure 2) to dirt roads in the mountainous areas that must be repaired by bulldozers from time to time after heavy rains. The topography of the areas along the access

Figure 2: Valley Rice Paddies and Limestone Inselbergs.

Figure 3: Secondary Roads Showing Isolated Communes in the High Valleys.

roads varies from gentle slopes in the high valleys (Figure 3) via switchbacks, to inclined roads often requiring four-wheel drive vehicles.

Source of Geological and Mining Data

The technical documents made available for review during this investigation are, for the most part, in Vietnamese and required translation by I2M personnel. Summary reports in English were obtained by WMG management and passed on to I2M for review, e.g., Nguyen Dac Lu, "Brief Outlines on Gold of Vietnam," [4-19] provides general information on the subject areas. Dr. Lu also provided a number of maps and reports, sections of which have been translated for use in the I2M investigations.

A number of reports were also identified during meetings with the local government's district geological and mining survey officials, who were especially helpful in providing introductions to the local geology and previous mining activities in the area (Figure 4) [20-31]. The Vietnamese documents reviewed (and translated in part) have been cited in Section 13.0 References [32-42].

Gold Mining in Vietnam

Gold mining has been conducted in Vietnam for more than 2,000 years. Over the years, gold was mainly mined from so-called placer deposits within some local streams and rivers. The data on such operations prior to the 1950s are scarce or incomplete. From 1962, new gold occurrences have been discovered and mined on a limited scale by local miners. Recently, under State management and funding, the Geological Survey of Vietnam and other State agencies have funded and conducted reconnaissance geological mapping and outcrop sampling, along with geophysical programs in some areas, mostly by ground magnetic surveys.

Figure 4: Meetings at the Vietnamese District Geological and Mining Survey Offices.

The use of the magnetic surveys in exploration is illustrated in Appendices E-J. Leu [16] reports that at least 10 new so called "gold zones" or outcrops have been located to date in the area of interest, in addition to those already known from previous mining activities. Of course, the grades, and horizontal and vertical extent of the mineralization in these areas remain to be tested by drilling but funding has not been available. Some of these zones are apparent in the maps in Appendices E-J.

Previous Exploration and Mining

The general area of interest has experienced only superficial exploration for gold and other commodities. This is partly because the heavily oxidized zones exposed at the surface in a number of areas contain micro-fine gold that went unrecognized by local inhabitants and the earlier exploration activities by the French. Even after excavating below or into the oxidized zone, the sulfide-gold mineralization contained refractory ore that could not be processed without advanced metallurgical methods of extraction. Only gold eroded from these types of deposits made its way into streams and rivers forming placer gold deposits recognized and recovered by simple gravity methods.

The two areas of interest offered to Wishbone Gold, plc as a joint venture (i.e., Hop Hoa and Vai Dao) were originally discovered by Division 8 of the Vietnam Geological Survey in 1987 [35].

Geological mapping and geophysical surveys were subsequently conducted and indicated shallow mineralization of potential economic value. A few exploration holes were drilled and these intersected highly dipping mineralized zones that extended some distance in the subsurface from that sampled in outcrop nearby. Once the strike and dip of the zone were defined, adits were driven into the side of the hills. Once the mineralized zone was encountered mining began by a Vietnamese mining company.

Mining operations at the Hop Hoa mine were underway in January, 2014 during the I2M field visit, which allowed sampling of the ore being produced at that time. The Vai Dao Mine has not been in production for many years with current company management [40]. Samples from the Vai Dao Mine were obtained from the dump of the old mine (Section 7.0 for additional information on the I2M sampling of the mine areas and of other areas).

Other Exploration and Mining

There is no other known gold or other metals exploration or mining operations currently underway in the immediate area. There are four projects that I2M personnel have become aware of that are in various stages of development. One is the Nam Thuong Mine that produces gold via adit development on a reportedly small scale. Another project is the Ban Phuc Nickel in Son La Province located more than 50 kms to the west. It is near production status. Asian Mineral Resources Limited (AMR) is developing the Ban Phuc Nickel Mine Project, an underground mine using modern mechanized equipment that will feed a process plant incorporating conventional sulfide flotation technology for the production of a Ni-Cu rich concentrate [2 and 25].

Another prospect is the Ba Dinh Gold Project located about 8 kms east of the Hop Hoa Mine. It is a project by the Ba Dinh Investment and Construction Consultancy JSC (Hanoi) in an area that has been mined by artisan miners for many years on a limited scale. An expanded project with greater resources and a new processing plant would benefit the local economy and increase Vietnam's gold production.

Mineralization is associated with the Devonian limestones that have been fractured and faulted and invaded by hydrothermal solutions. Gold and silver as well as lead and zinc occurrences are common in this area [1].

The fourth project is the Lien Son gold project located about 20 kms to the south, which is in an advanced stage of planning and permitting. The largest gold mining operations in Vietnam were being conducted in 2013 by Besra Gold [6]. The group was producing gold and byproducts of silver, lead, and zinc from their Phuoc Son Mine, an underground operation located southwest of Da Nang in central Vietnam [7]. An open-pit operation at their Bong Mieu Mine located south of Da Nang was not producing at the time of the I2M field visit.

Geology of the Area of Interest

The large-scale Son Da structure dominates the geology of northwest Vietnam (Figure 5). The Cao Ram area lies east of the Doi Bu village, which lies on the eastern edge of a large circular structure visible at high altitude [8 and 29].

East of the village of Cao Ram is an area characterized by a smaller oval structure covering an area of about 15 km^2 located about 40 kms from Hanoi (Figure 6).

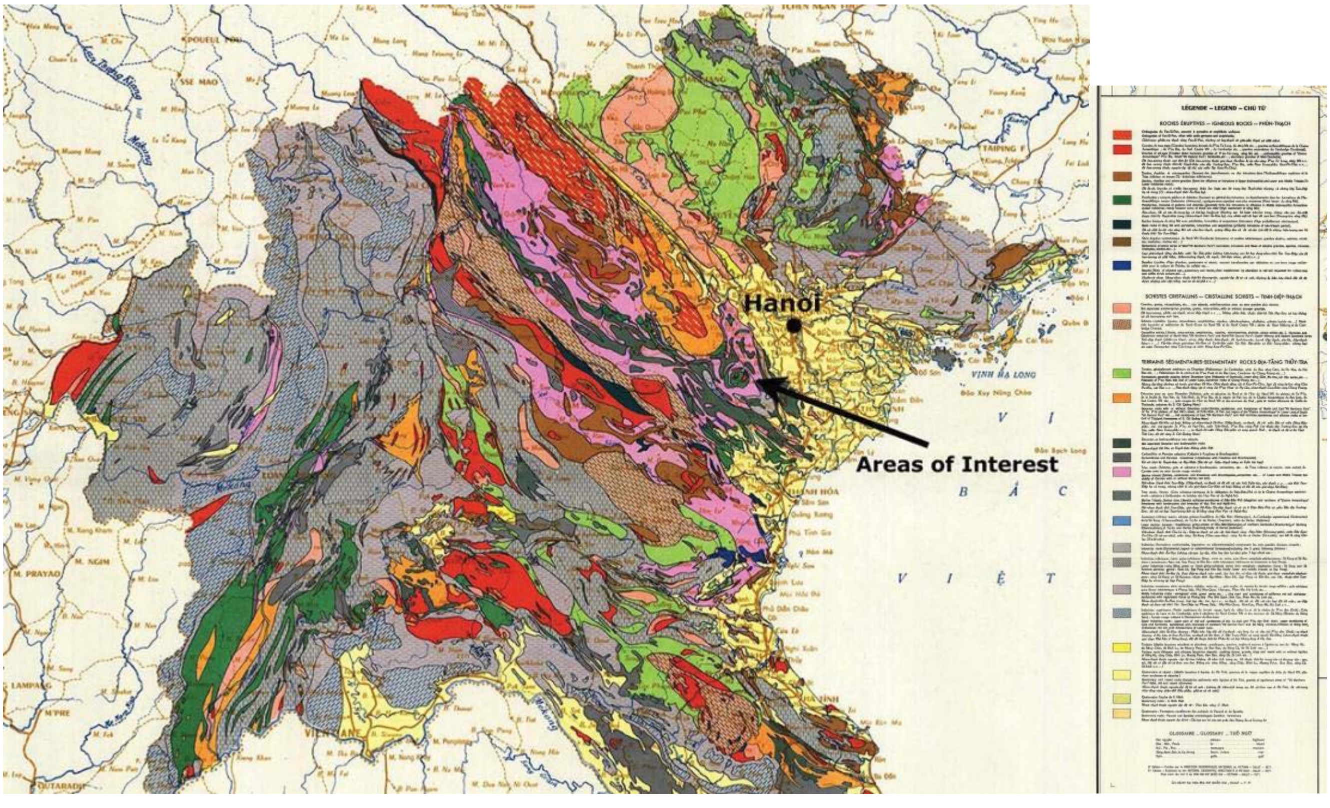

Figure 5: The Song Da Structure and General Geology of Subject Properties Investigated (for expanded view, see[44]).

In general, the central part has been uplifted into a domal structure and is composed of volcanic rocks surrounded by faulted sedimentary rocks. The volcanics are mapped as the South Vien Nam Formation (designated as T1VN on geological maps of the area, Figures 7A, 7B and 7C) see Reference [44] for expanded view.

Gold-bearing quartz and sulfide veins have been associated with the principal NW system but also with minor associated faults off of the main faults (Figure 7A, 7B and 7C). To view the figures in greater detail and for explanatory legends of terms and symbols in the maps, click on the figures to load these large files. The two areas of interest (Hop Hoa and Vai Dao) are shown on both figures.

Gravity surveys indicate that this uplifted dome is reflected by basement structures. According to the interpretation of geophysicists, there are intrusive bodies of mafic and mafic-intermediate composition at depth intersected by fault systems of NW-SE and conjugant NE-SW strike.

Based on information provided by Nguyen Dac Lu, Ph.D., and Hai Thanh Tran, Ph.D., geological information produced by the Vietnamese Geological Survey and affiliated government offices that covers the Doi Bu District, and that includes the subject Cao Ram area of interest, a number of reports and maps are available covering the following topics:

- Geological mapping (1/50,000 scale) and published as Ha Dong – Hoa Binh Map Sheet, 1989), [44]
- Petrographic-Structural Sketch-Map (1/10,000 scale) of Vai Dao Mine location, 1992, [45]
- A report on the composition and ore processing of sulfide-gold ore from Cam Vao Plant, Hoa Binh province, 1992, [46]
- Reports on the sulfide-gold ore of the Cao Ram Area - Doi Bu District and Luong Son District, Hoa Binh Province, 1993, [46]

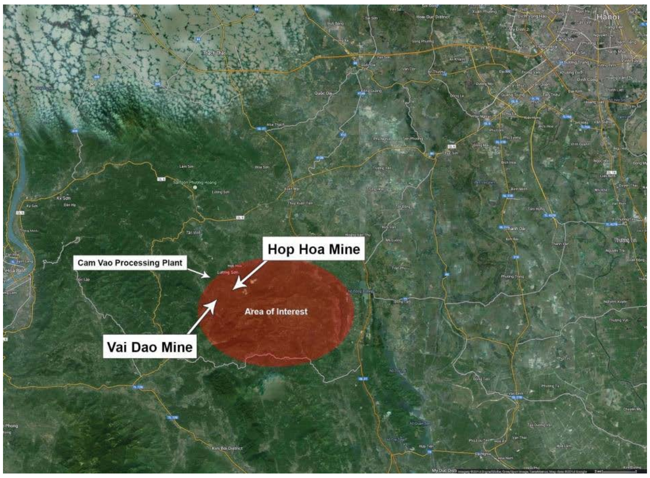

Figure 6: General Location of Primary Area of Interest.

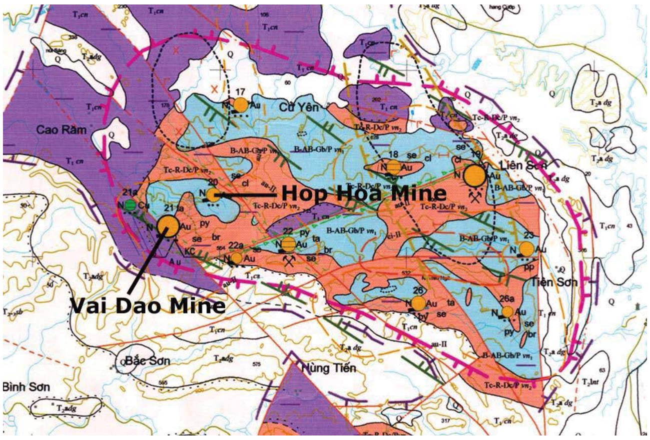

Figure 7A: Metallogenic Map of Subject Mining Properties. (For Expanded View, see [44]).

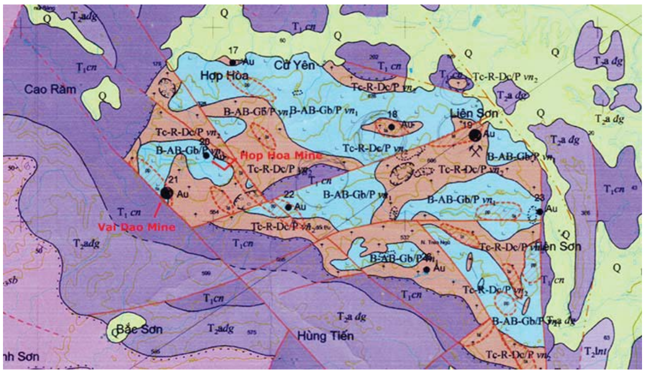

Figure 7B: Geologic Map of Subject Mining Properties [44].

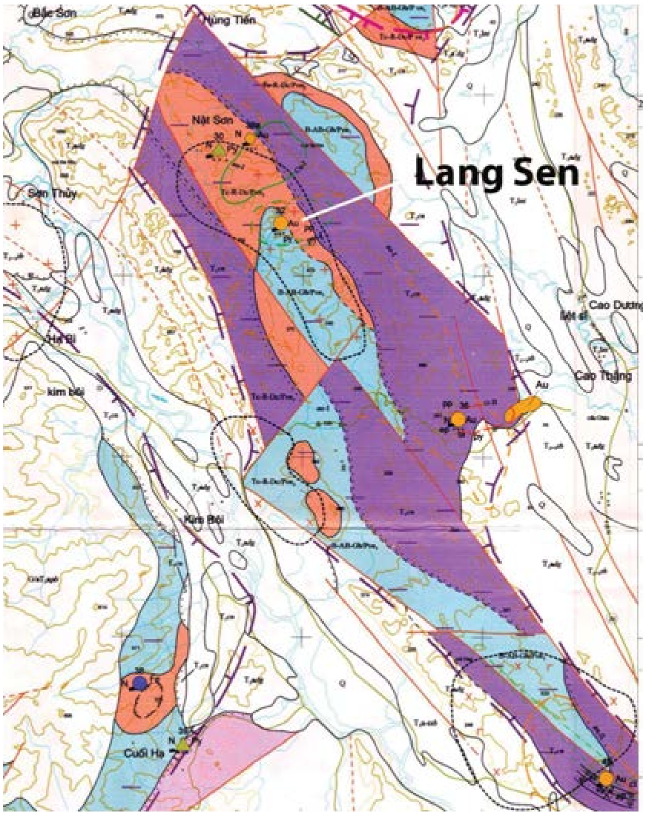

Figure 7C: Geologic Map of Subject Mining Properties [44].

- Supplemental investigations of sulfide-gold ore in the Doi Bu, Luong Son, Hoa Binh Province, with an emphasis on composition, origin and distribution of sulfide-gold ore in the Doi Bu area, 1998, [34,35],
- Reports on the geochemical modeling of gold mineralization of the Doi Bu area, with an emphasis on modeling of geochemical anomalies for use in geological mapping and mineral resources investigation in Vietnam, 2000, [47,48]
- Reports on the relation between volcanic rocks within the Song Da Structure, Vien Nam area and gold and copper ore mineralization, 2005, [49]
- Reports on the composition, genesis and distribution law of gold ore in the Doi Bu – Suoi Chat area, 2007 [50]
- Russian report by Narxev, 1989, on mineralization involving silver-lead-antimony and zinc-copper-cobalt mineralization in the general area [51] and
- Russian report by Grigorian X.V., 1980, on silver-lead-zinc and copper-cobalt-bismuth [52].

The above maps and reports are in Vietnamese, sections of which have been translated and cited in References. The latter two references are in Russian but were not available for review by I2M personnel. Some Russian-produced maps and sections are available in Appendices E-J.

The available publications provide a foundation for understanding the geological conditions that have produced mineralization of potential economic value. Area-wide and local geological and geophysical (magnetics) mapping programs have been conducted in the Doi Bu area by the government on selected areas, two of which were on the Hop Hoa and Vai Dao areas, which have resulted in the current small-scale mining operations in one of these areas.

Appendix G, H, and I include examples of the results of the programs for the subject areas as well for other areas that illustrate the potential for gold mineralization at or near the surface. To view the figures in greater detail, click on any of those figures. There are comprehensive drill logs for some of these areas. They are all in Vietnamese, but gold grades, depths, and locations can be ascertained by an English reader although an experienced Vietnamese translator is an invaluable asset [52-55].

The reports by Russian geologists (Narxev [51], and Grigorian XV [52]) cited above and in Section 13.0 References, indicate that the mineralized zones in the Doi Bu area have been only partially eroded, while in areas nearby, the mineralized zones have been eroded more deeply into the zones than in the Doi Bu area. This indicates that the sulfide mineralized zones are in place and available in the shallow subsurface in the Doi Bu area. Of course that also shows that because the subject areas have been uplifted as a dome more so than surrounding areas, they likely have been exposed to a tropical, high-rainfall, climate for millions of years that has eroded the topography into the steep and unstable hillsides that could restrict access during the rainy seasons.

The thickness of the oxidized mineralized zones has been extensively eroded in some areas, resulting in the widespread occurrence of placer gold down gradient in streams and nearby rivers of the area. This is one indication that potentially economic sulfide, quartz vein, and oxide ore could be present in significant tonnage and grade to justify major exploration programs in the area at depths not yet explored in the Doi Bu District.

Target Formations in the Cao Ram Area

The geological formations in the Cao Ram area covered in Figures 7A, 7B, and 7C involve the following formations, such as:

The Vien Nam Volcanic Complex (Gb-B-AB-Tc-R-Dc/Pvn)

Various units of the Vien Nam Volcanic Complex occupy parts of the Doi Bu uplifted dome (65% of the area), occurring mostly near or at the top part of the dome [36, 39, 43, 48]. These are the oldest formations in the region. According to Lu [19], based on geological relation and composition, the Vien Nam Complex can be divided into two phases:

• **The First Phase**: Consists of basalt, tuffaceous basalt, diabase and gabbrodiabase including:

Extrusive Units: include fine-grained basalt, massive basalt and basalt porphyry.

A. **Extrusive Eruption Units:** The rocks of this phase are not well developed, but include tuffaceous basalt, and a tuff with andesite basalt. The outcrop debris consists of angular fragments of basaltic composition, with plagioclase crystalline scree. The rock consists of fine-grained volcanic fragments with chlorite, epidote, and chalcedony.

B. Subvolcanic Units: Large veins penetrating basalt and tuffaceous rocks are of subvolcanic origin, usually ranging from 2-3 up to 30 meters thick and have penetrated surrounding rocks. These bodies are mainly composed of diabase, gabbrodiabase, and their oxidation products.

- **The Second Phase**: Rocks of this phase occur at the top of the dome, the rest of the units appear to radiate from the higher elevations. They consist of alkaline felsitic rocks (with trachyte, rhyolite, trachyandesite, trachydacite, and trachyrhyolite).

Extrusive Units: include tuffaceous trachyte, tuffaceous rhyolite, and tuffaceous trachyrhyolite.

A. Conduit-Eruption Units: include agglomerate, tuffaceous agglomerate, trachyte porphyry, and rhyolite porphyry.

B. Subvolcanic Units: include trachyte porphyry, rhyolite porphyry, and trachyrhyolite porphyry.

Nguyen Dac Lu [19] also indicates that the gold occurs in both the volcanic rocks of basic composition and in those of subalkaline composition (trachyte) of the Vien Nam Formation (Pvn unit).

Co Noi Formation (T1cn)

This rock unit is exposed in the form of narrow belts surrounding the flanking parts of the domal structure (see **Figures 7A, 7B, and 7C**). Typical lithologies consist of thick-bedded (20-40 cm) sandstone tuff, argillite tuff, violet brown clayey schist mixed with thin-bedded, fossiliferous limestone.

The Dong Giao Formation (T2adg)

This unit is of limited distribution in the SW, E-SE corner of the domal structure (Figures 7A and 7B), and includes black, and grey to light grey, thin-to-thick-bedded limestone, which grades into the Co Noi Formation above.

Quaternary Formation (Q) Undifferentiated sediments.

Impact of Structural and Tectonic Forces

The impact of the structural and tectonic forces are of major importance in localizing any intruded metals, whether that be gold, silver, zinc, nickel or other metals that have been reported in the general area [28]. According to Lu [20] and Hosng, *et al*., [21], the geographical location of the region is within a major rift zone associated with the Song Da structure mentioned earlier (Figure 5).

Lu [19] suggests that significant gold mineralization occurs in veins of tension fractures developed at the same time the target units were extruded as brittle-pliable (viscous) to pliable ore sub-brittle sliding zones (Figure 8 showing fault zone). Also figure 15 shows the hanging wall fault at the working face of the adit in the Hop Hoa mine.

Although differentiation zones would be expected to be present at deformation depths (from brittle to pliable), these high deformation zones occur in association with normal faults in the areas (Figure 8 and 9). Such zones typically play an important role in the injection of mineralizing fluids containing gold and other metals in tension-fracture vein systems in other similar deposits in the world. This is significant because other gold-producing areas in the world exhibit similar geological and tectonic conditions [26, 27].

Pulses of hydrothermal solutions circulating in the rocks when encountering tension fractures and their feather extensions into the host rock, under favorable P-T conditions, can be re-crystallized to form large scale stockworks in the faulting zones. Gold occurrences in the subject areas are mainly concentrated along reverse fault zones and strike-slip fault zones primarily along a NW-SE direction with some occurrences along NE-SW and sub-parallel directions. (Figures 7A, 7B, 7C and K-26**)**.

Further, Leu [16] reviewed gravimetric surveys and suggested that they indicate that very high-density rocks exist at shallow depths in the domal area east of Cao Ram. This includes very large positive magnetic anomalies indicative of intrusive rocks, such as granodiorite or granite, likely exist at shallow depths and such units provided the gold and other metals to the volcanic eruptions on land or to the bottom of a shallow marine environment.

Figure 8: Lang Sen Pit. Note Personnel in Pit at Fault Trace.

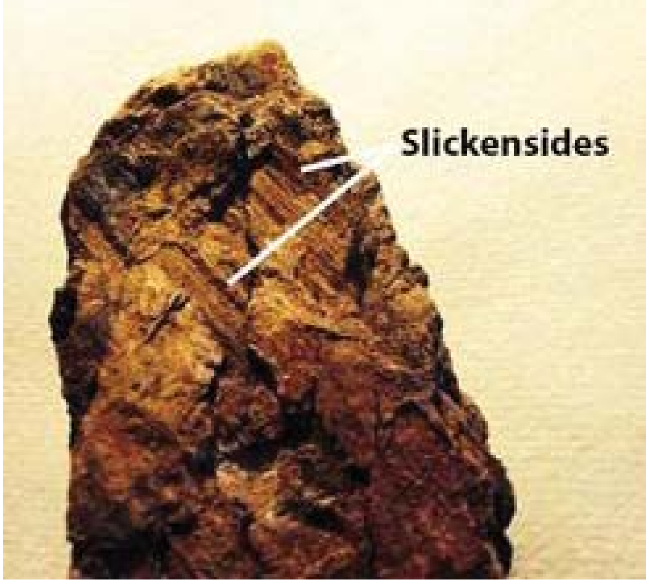

Figure 9: Sample with Slickensides Recovered from Pit.

Some evidence of shallow intrusives has been discovered in the Lang Sen pit (Appendix K). Figures K-26 through 30 show the subject "intrusive" mass with the appearance of "pillow lava" and an oxidized rind. See the Lang Sen sample descriptions for 2-3-1 and others.

Applying such information to the Doi Bu and Cao Ram area would be particularly appropriate and useful in assisting future exploration, albeit each region often has its own unique characteristics.

Sample Collection in the Areas of Interest

Gold ore in the Doi Bu area has been described as vein-form gold-quartz-sulfides including two types of mineralization: as gold-pyrite (Figure 10) and gold-sulfides in quartz breccia in stockworks (Figure 11).

Previous Geological Sampling of Mineralized Zones

In the Vai Dao area, eight (8) veins, with ore trends of 80 to 365 meters in length have been reported with a thickness of 0.6 to 4.5 meters in width [40]. Average gold content in the ore zones from this area were reported to range from 1 to 7.6 g/t. Because there are limited drilling data for the area, any estimate of the resource base is preliminary by nature. The basis for the estimates of Vai Dao, Hop Hoa, and other areas are provided in Appendices E-J.

Figure 10: Quartz Vein with Euhedral and Anhedral Pyrite (From Vai Dao Mine Dump).

Figure 11: Gold-Sulfide (Pyrite and Pyrrhotite) in Quartz Breccia of Fault Zone in Pit and Stockworks (in Lang Sen area), mostly oxidized.

Mineralized Zones		Gangue Minerals	
Primary	Secondary	Hydrothermal Minerals	Dike Minerals
Pyrite Arsenopyrite Galena Sphalerite Chalcopyrite Native gold Electrum Pyrrhotite Bornite Bronze(?)	Goethite Hydrogoethite Anglesite Coveline Chalcosine Malachite Azurite Bromite Svanbergite Pyromorphite	Chlorite Epidote Sericite Ankerite Calcite Feldspar	Quartz Calcite Chlorite Epidote

Table 1: Minerals Associated with Mineralized Zones in the Doi Bu Area [19].

Another type of ore exhibits a stockworks of quartz breccia with partially weathered sulfide ore. This type of ore was likely formed by rapid injection of mineralizing fluids containing gold and other metals and iron-rich constituents into fault zones. The minerals associated with the mineralized zones are indicated in Table 1.

Geological Sample Collection by I2M – 2014

The sampling program by I2M personnel is summarized in the following discussions. These include the samples obtained from the Hop Hoa, Vai Dao, Lang Sen, and Lien Son areas, and tailings from the Cam Vao Processing Plant. Thirty-two (32) rock samples and six (6) tailings samples were evaluated, selected, transported by I2M personnel to the ALS Minerals Laboratory in Reno, Nevada, and Vancouver, Canada for a 48-element scan, trace-mercury analysis, and gold-grade analysis. The results are presented in the ALS Minerals Certificate of Analysis #RE14018921, dated February 24, 2014 (Appendix D).

There have been no revisions/corrections of the data by ALS to date. Sample locations are indicated on the topographic maps in Appendix B and C. Laboratory results for all gold values are illustrated in Figure 10 in grams/ton (g/t). Please note that the samples were selected to represent a range of conditions in and around the mineralized zones that are being mined or were visited, and hence do not represent either the mine's output or the mineralized zones visited.

Systematic sampling at the mine face and across the zones visited at a number of locations would be required to appropriately represent the mineralized zones at those locations. Drilling would be required to develop the horizontal and vertical dimensions of any particular mineralized zone before a sense of a mine's reserves and resources could be established. However, the random sampling by I2M does indicate that gold is present at grades of potential economic interest.

To assess the extent of mineralization (of all metals, etc.), each sample selected for detailed evaluations below included: 1. field photos of the samples, 2. field descriptions of the samples, 3. the number of geochemical anomalies (relative to samples analyzed) and a list of anomalous elements with the

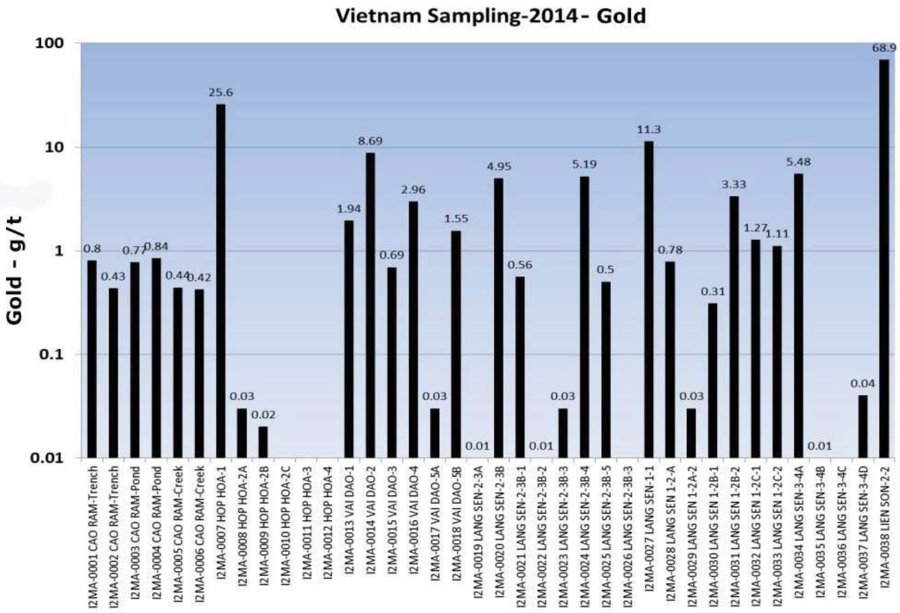

Figure 12: Vietnam Sampling 2014 Gold.

associated concentrations, and 4. the petrographic descriptions of selected samples with photomicrographs.

Geochemical Anomalies

The laboratory results of the 48 element scans (plus mercury, and gold in terms of grams/ton (g/t)) have been evaluated by I2M personnel to identify any geochemical anomalies present in the samples. Such anomalies are of use in assessing the relative value of exploration projects. The anomalous values were identified relative to the I2M sample population only. The raw laboratory data are available in Appendix D.

The number of anomalies in any particular sample is a guide to the proximity of the primary mineralizing fluids when the hydrothermal systems originally injected the fluids containing the metals and associated constituents in solution into the fractures and joints. Subsequent alteration of the metals by later hydrothermal fluids of especially low pH dissolved the metals again, and/or changed the valence of the elements, but the metals would typically remain in place or be dispersed nearby.

Erosion at the surface, of course, would re-distribute the gold and silver (if in the form of electrum) and other heavy minerals such as magnetite in placer deposits of streams and rivers downgradient. Certain alteration features found in outcrop are especially important indications of subsurface mineralization and of the possible local magnitude of precious-metal mineralization. Such processes that affect volcanic rocks as propylitization (from heated solutions given off by intrusives such as granodiorite or granite below) are often involved in post-volcanic vein formation.

When combined with the other features of the rock in faulted zones, such as the alteration of feldspars and chlorites, and other silica flooding of the vugs in the volcanic rocks, those features serve to indicate ore proximity. All of these features have been reported in the area of interest, some of which have been reported in the samples evaluated for this investigation.

Figure 13: Inside Hop Hoa Mine Adit.

Geological Sampling Sites

Certain rock samples were selected by I2M personnel for petrographic analysis of the mineralized rock samples or various "ore" grades. The samples also represent a range of rock types and degrees of mineralization and associated alteration. For the Hop Hoa (Figures 14 and 15, a working face showing "ore" within fractures in quartz filled with pyrite and pyrrhotite?), and Vai Dao samples (from the dump), the first two samples in the series were selected as likely gold ore samples (e.g., Appendix D - Lab # I2MA-0007-0008 (Field Name: HOP HOA-1 and -2); and Lab # I2MA-0013-0014 (Field Name: VAI DOA-1 and -2)).

For sampling sites, Appendix A showing the topography of the area of interest. Appendix B shows the mine and sample sites in the Northern area and Appendix B shows the sampling sites and approximate location of the new pit in the Southern area.

For the Lang Sen area, the site's recently constructed pit exposed fault-related mineralization. At least 10 truckloads of what appeared to be high-grade mineralization in samples that had been removed from an otherwise potentially hazardous pit with unusually high headwalls to staging areas near the top of the hill. I2M personnel selected a number of samples for elemental analysis and thin-section study (Figure 7C, especially the attached aerial photograph showing the general area of the pit, and K-26).

In Figure 13, the mineralized veins of pyrite and pyrrhotite contains gold in part. The assemblage

is similar in composition but not in form (i.e., veins at Hop Hoa to "intrusive mass" at Lang Sen (Appendix K-26 to K-30).

Petrology of Selected Samples

The results of the petrographic study are presented below on 13 polished thin sections and on associated samples.

In general, the sample suite is dominated by strong silicification and lesser iron oxidation. Most of the rocks show one or more of three types of veining, including 1. quartz-pyrite, 2. carbonate, and 3. chlorite, in order of decreasing abundance. Sulfide minerals include pyrite, the most abundant by far, followed by chalcopyrite, pyrrhotite, and covellite. Free gold (electrum) was noted in Lab # I2MA-0007 (Hop Hoa-1) - a grain less than 150 microns in length. Several sections also contain finely disseminated magnetite, generally oxidized to hematite. The original parent rock was difficult to determine because of the strong silicification. The exceptions include Hop Hoa-2A and Hop Hoa-4:

Hop Hoa-2A is a strongly foliated and limonite-stained metamorphic rock lacking mineralization. This is significant because the metamorphic rocks could have been rifted up from great depths where rising mineralizing fluids from intrusives and extrusives would have collected metals to be injected into fractures and joints in the rocks above, now exposed at the surface from faulting and erosion.

Hop Hoa-4 appears to represent a granitic intrusive rock, which is significant because earlier gravimetric surveys showed the possible presence of plutonic (or intrusive) rocks at depth below the outcropping rocks discussed above. These would serve as likely sources of the metals reported in the shallow subsurface and confirms that the area is a significant metallogenic location with the potential of offering multiple sites of precious and base metal mineralization of economic importance.

Paragenesis of Mineral Deposition

The sequence Paragenesis, or the sequence of mineral deposition, was very difficult to determine in the I2M suite of samples, owing to the lack of cross-cutting relations exhibited in the samples selected for evaluation. Additional samples would need to be examined before the paragenesis of the mineral formations can be determined. For the one section containing chalcopyrite and covellite together, it is clear that the covellite has replaced the chalcopyrite, and therefore, is younger. Pyrrhotite and chalcopyrite were observed together in one section, but the paragenesis of that pair is inconclusive, again because of a lack of mineral contacts. Magnetite and hematite are commonly associated together, and hematite almost universally is an oxidation product of magnetite in hydrothermal deposits.

A Vietnamese paragenesis study, however, confirms, in part, what the preliminary I2M study indicates. The Hop Hoa mineral assemblage is showing high-temperature formation, which implies deep connections, while the Vai Dao mineral assemblage formed at lower temperatures, which includes sulfide formation. The samples containing oxides of iron and other metals formed at even lower temperatures near the surface. Note that the gold (Figure 14) accumulates over a range of temperatures in the mineralizing fluids.

Supporting Data on Mineral Deposition Sequence

Lu [20] conducted a series of studies using lead-isotopes, sulfur-isotopes dating δ^{34}SCdt, δ^{18}OSMOW, composition of CO_2, NaCl, temperature (T) and pressure (P) in mineral inclusions show that the gold mineralization in the Doi Bu-Suoi Chat area was formed 155 to 123 Ma ago during the Late Jurassic to Early Cretaceous. This was a result of hydrothermal activity occurring over a temperature range from 315 C to 216 C at pressures from 1070to 1090 bar. The research results also indicate that the gold.

Figure 14: Mining Face at Hop Hoa Mine. Note Pyrite Reflections.

This was a result of hydrothermal activity occurring over a temperature range from 315°C to 216°C at pressures from 1070 to 1090 bar. The research results also indicate that the gold mineralization was formed in a compression, orogenic setting. This is consistent with the mineral paragenesis summarized in Figure 14 from sample areas in the Doi Bu District, and with the petrographic descriptions and mineral assemblages of the samples collected by I2M discussed below.

The above information on paragenesis, combined with the other data in this paper, forms the basis of a comparison with other known major gold ore bodies in the world, which in turn helps to determine if the Cao Ram area mineralization has the potential to be of economic significance.

Macroscopic, Petrographic, and Geochemical Characterization of Four Mines

The Geochemical Index Rank has been established in this paper for each of the 38 samples analyzed for common and trace elements. Those samples exhibiting the highest rank represent the relative level of mineralization exhibited by the sample defined by the number of elemental anomalies. Those samples with the highest number of anomalies within the specific sample population are considered to be more highly mineralized than those with fewer anomalies.

Both areas of principal interest (i.e., Hop Hoa and Vai Dao) are clearly mineralized to a significant extent, while Lang Sen, a prospective area to the south, ranks even higher. The Lien Son Area sample was taken from an area being considered for mining Appendix C for general area and Figure 7C).

Hop Hoa Mine Area

Hop Hoa Site: Macroscopic Descriptions: Rock is brecciated, silicified, and contains patches of yellow-brown limonite. Silicification is dominant, with at least two generations of quartz veins containing pyrite. Much of the pyrite, euhedral to anhedral, is highly fractured and broken that yields a poor polish. This sample contains visible gold - one grain approximately 147 microns in length. Locally, intergrown chalcopyrite (cp) and covellite (cv) are present. The chalcopyrite is altered and replaced by covellite. Samples range in hand samples from fully oxidized to sulfides (pyrite/arsenopyrite, and other sulfides):

- Heavily oxidized rock showing boundary between oxidized/unoxidized material. Unoxidized zone showing massive fine-grained silver arsenopyrite(?). Reasonably sharp boundary. Oxidized zone contains heavy limonite/goethite with goethite veining.
- As above with massive pyrite/arsenopyrite within dark gray quartz. Quartz contains medium-gray, dark gray and white varieties, might be quartz breccia, vuggy in part.
- As above with extremely fine-grained silver arsenopyrite(?) in dark quartz surrounded by white quartz, pseudomorphs on face of sample, no fillings.
- Quartz breccia, small fragments of quartz in ground mass of limonite, some oxidized goethite, apparent in the Hop Hoa Mine.
- Heavy quartz breccia, medium angular quartz fragments with massive limonite, goethite, fault groove evidence, ends show quartz breccia. White quartz, pyrite tarnished, small crystals, may contain internal metals (heavy).
- Quartz breccia, heavily altered, limonite/goethite, quartz light/medium gray to dark gray, minor pyrite/arsenopyrite? cubes, veining of goethite and stringers of white quartz at end of sample.
- Heavily oxidized, tuffaceous(?), very light weight sample, goethite/limonite and brick red mineral/altered goethite(?), no apparent mineralization, striated dark gray quartz, faces next to heavily fractured white quartz, heavily altered quartz breccia (3 small samples in total).
- Quartz breccia, small to medium angular quartz fragments, heavily fractured, vuggy, limonite common, very minor apparent goethite, some white mineral (zeolite?).
- White quartz, light, vuggy with manganese coating, minor goethite/limonite, no apparent mineralization.
- Heavily altered rock, aphanitic, volcanic (? not basalt), massive limonite/goethite, red mineral (altered goethite?).
- Quartz breccia, limonite, white mineral (zeolite?), some quartz has light pink covering (iron-rich fluid staining?), no apparent mineralization.
- Similar to first sample with zeolites(?), heavily altered around rim, light translucent quartz in dark ground mass of sample interior, possibly volcanic rock originally.

For thin sections microphotographs, see (Figures 15-18).

Geochemical Anomalies: 5

Geochemical Index Rank: 11th

Au = 25.6 g/t Ag = 1.12 ppm As = 199 ppm Mo = 25.1 ppm S = 10,800 ppm

Hop Hoa-2A Thin-Section Descriptions: Consists of a low-grade metamorphic rock with strong foliation that features augens of microcrystalline quartz, or chert, some of which has recrystallized to individual quartz grains. The rock has been strongly oxidized by yellow–brown limonite, resulting in streaks of FeOx (goethite?) and disseminated grains of hematite (Figures 19 and 20). Note the veining/inherited bedding/banding in this thin section

Geochemical Anomalies: 18

Geochemical Index Rank: 2nd

Al = 9.10% Ce = 245 ppm Cr = 54 Cu = 136.5 ppm Fe = 20.1% Ga = 34.5 ppm Hf = 4.2 ppm K = 3.39 ppm La = 94.2 ppm Mo

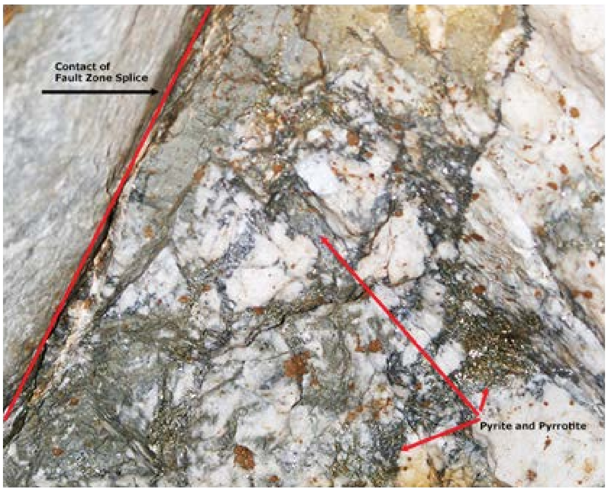

Figure 15: Hop Hoa Mining Face. Note Mineralized Veins in Quartz and Sulfides.

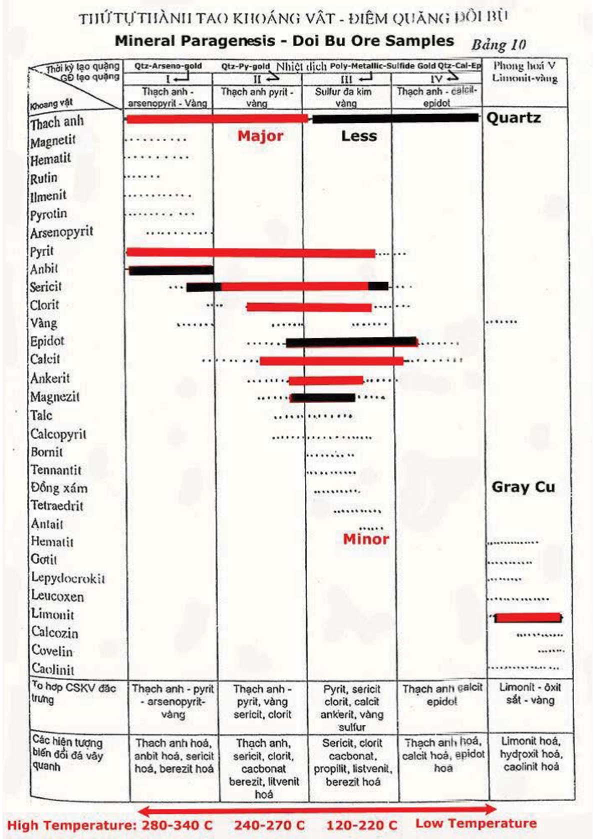

Figure 16: Mineral Paragenesis – Dui Bu Area.

Figure 17: Hop Hoa Hand Samples.

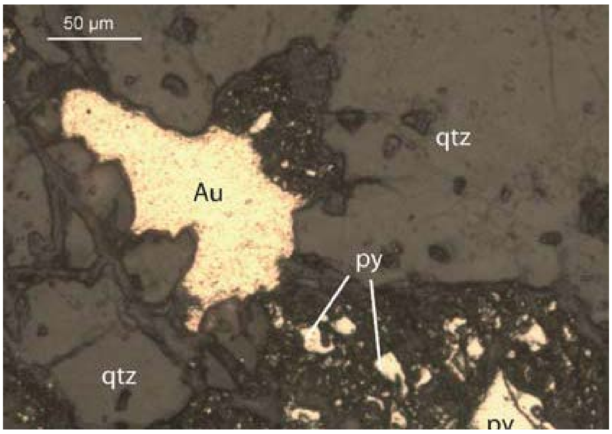

Figure 18: Hop Hoa-1. Grain of native gold, about 147 microns in length. With pyrite fragments in granular iron-stained clay. Reflected light, uncrossed polars.

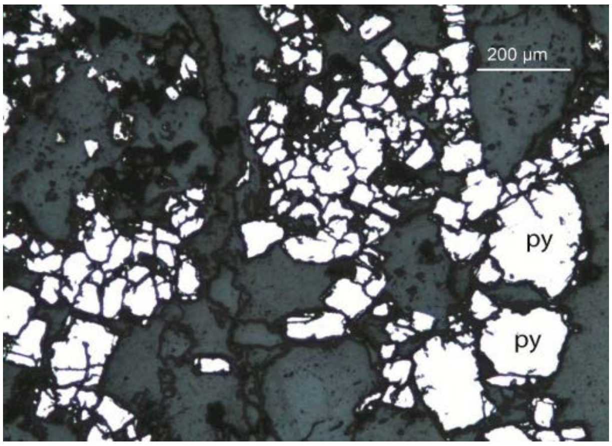

Figure 19: Hop Hoa-1. Veinlets of pyrite; reflected light, uncrossed polars.

= 12.8 ppm Nb = 24.0 ppm Ni = 50.1 ppm P = 2,060 ppm Rb = 136.0 ppm Sb = 25.4 Th = 13.1 ppm Y = 24.1 ppm Zr = 202 ppm

Hop Hoa-2B: Macroscopic Descriptions: Fractured and sheared light brown felsic material in breccia with matrix of quartz and fine grained muscovite (sericite) in small fractures or selvages on lithic fragments; oxidized with abundant iron oxides.

Geochemical Anomalies: 12

Geochemical Index Rank: 5th

Ba = 280 ppm Ce = 195 ppm Co = 41.6 ppm Cu = 147.0 ppm Fe = 17.3% La = 82.9 ppm Mn = 991 ppm Mo = 8.80 ppm P = 1,750 ppm Sb = 26.1 ppm Th = 10.8 ppm Zr = 164.5 ppm

Hop Hoa-2C

Geochemical Anomalies: 4 Geochemical Index Rank: 12th Cs = 6.59 Ga = 33.1 Sr = 192.5 ppm V = 397 ppm

Hop Hoa-3 Macroscopic Descriptions: Vuggy, amphibole-rich (tremolite?) rock with accessory quartz, and widely

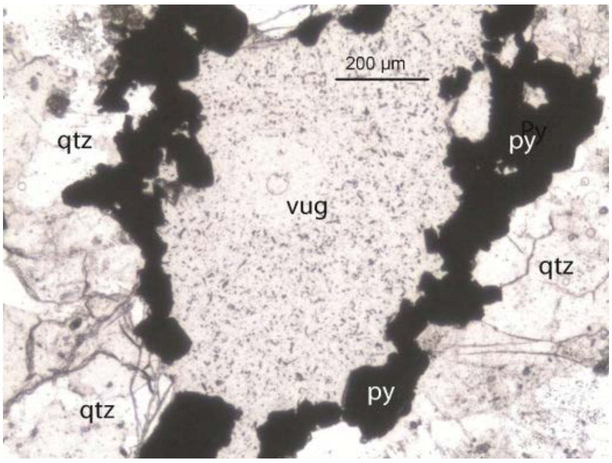

Figure 20: Hop Hoa-1 Vug-lined with pyrite (py) and quartz (qtz)Transmitted light, uncrossed polars.

Figure 21: Hop Hoa-2A Hand Samples.

Figure 22: Hop Hoa-2A Thin Section.

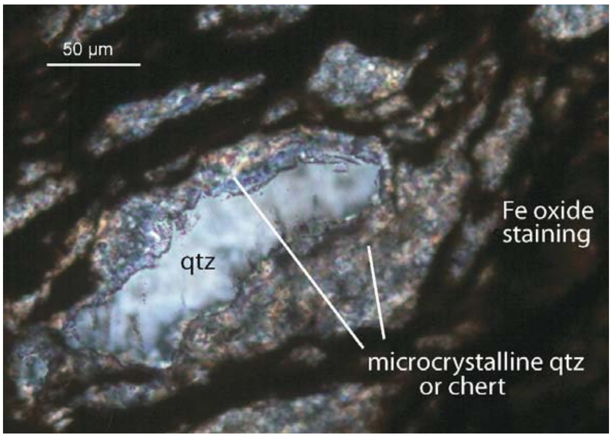

Figure 23: Hop Hoa-2A. Enlarged view of an augen structure showing recrystallization of microcrystalline quartz or chert inward to a single coarse grain of quartz; transmitted light, crossed polars.

Figure 24: Hop Hoa-3 Hand Samples.

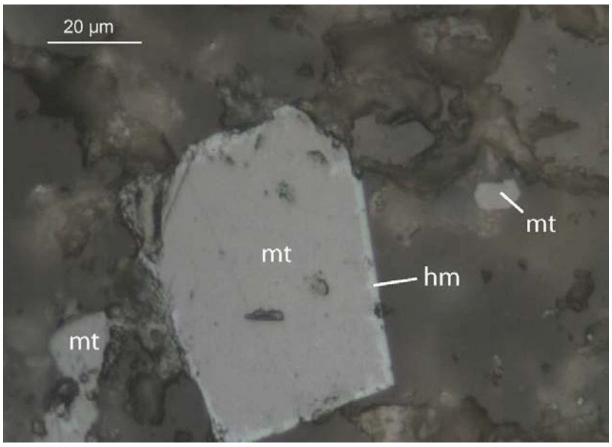

Figure 25: Hop Hoa-3C. Disseminated grains of magnetite (mt), with rims oxidized to hematite (hm). Reflected light, uncrossed polars.

disseminated grains of magnetite-hematite, generally less than 20 microns in size (Figures 21-25).

Geochemical Anomalies: 5 Geochemical Index Rank: 11th

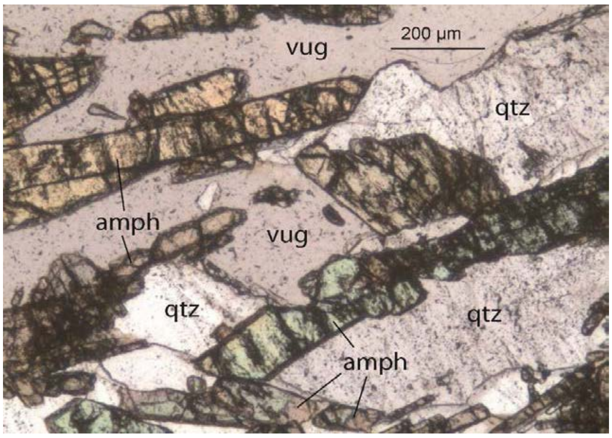

Figure 26: Hop Hoa-3A. Vuggy, amphibole-rich rock (tremolite?), with accessory quartz.

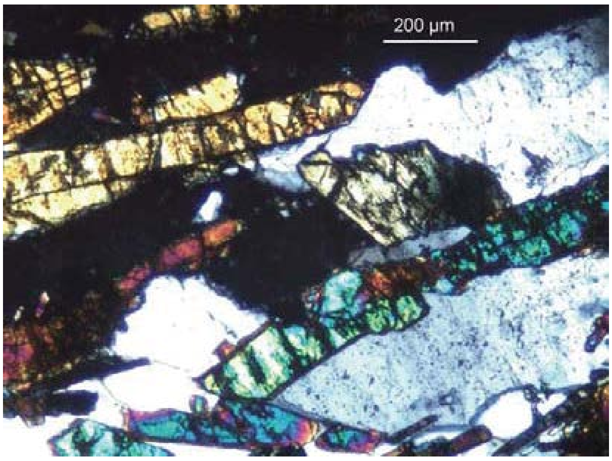

Figure 27: Hop Hoa-3A. Same as above; crossed polars. plane-polarized light.

Figure 28: Hop Hoa-4 Hand Samples.

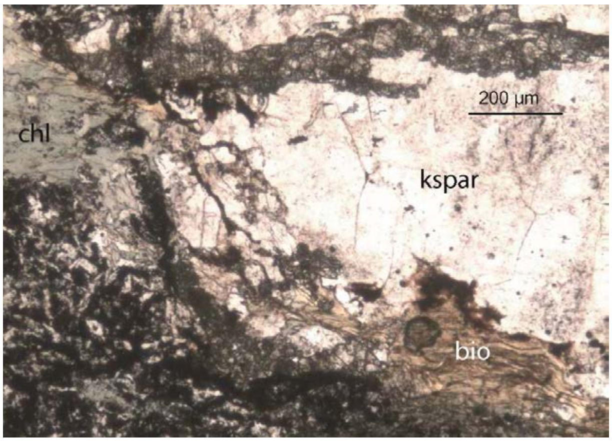

Figure 29: Hop Hoa-4A. View of argillized kspar, rimmed by chlorite (chl), biotite (bio), and volcanic inclusion, lower left; transmitted light.

Cd = 1.59 ppm Cs = 4.80 ppm Ga = 28.4 ppm Sr = 1,485 ppm V = 331 ppm

Hop Hoa-4 Macroscopic Descriptions: Felsic rock with argillized (clay-altered) Kspar, and lesser amounts of quartz, shredded biotite, and chlorite. Small inclusions of mafic volcanic rock with randomly oriented plagioclase microlites. Finely disseminated intergrowths of magnetite (mt) and hematite (hm) are also present (Figures 26-29).

Geochemical Anomalies: 16

Geochemical Index Rank: 3rd

Ce = 62.6 ppm Co = 60.8 Cr = 53 ppm Cu = 141.5 ppm Hf = 3.2 ppm La = 34.9 ppm Mn = 2,480 ppm Nb = 25.9 ppm Ni = 103 ppm Sc = 29.9 ppm Sr = 737 Th = 2.7 ppm V = 313 ppm Y = 29.8 ppm Zn = 172 ppm Zr = 111.5 ppm

Vai Dao Mine Area Vai Dao-1 to 5 Macroscopic Descriptions

The rock is strongly altered to carbonate (calcite?), with quartz-pyrite veining and disseminated grains of chalcopyrite. Pyrite, less than 0.5 mm in diameter, occurs both as disseminations and in veinlets, and is widely fractured. The Vai Dao samples are characterized in hand samples as follows:

- Large sample, white quartz, fractured throughout, veining, dark gray quartz veining with fields of heavy pyrite ranging in size from very small crystals to masses, 1 or 2 fine-grained pieces of gold(?) in dark gray quartz. No other minerals around it and no gold-colored pyrite.
- Another mineralized sample, has widespread pyrite mineralization, slightly tarnished, sitting in dark gray quartz vein, associated with limonite/goethite pseudomorphs with pyrite still present but altered somewhat. Rock sample fractured throughout.
- Second smaller rock sample, heavily tarnished pyrite in places, heavy goethite (dark red) in masses, pseudomorphs without minerals (empty).
- Heavy mineralization with silver-colored cubic

mineral (arsenopyrite?). Empty pseudomorphs, filled pseudomorphs with pyrite, abundant mineralization, dark gray quartz is ground mass with light brown quartz vein next to a linear pattern of pyrite mineralization following fractures. Reference: See macrophoto: vai-dao3.jpg)

- Smaller sample shows pseudomorphs with medium brown coating, pyrite has striations, cubic in places, masses in other places.

Other samples from site:

- Groundmass light-medium brown, fine-grained, thin veins of quartz (medium-grained), light orange coating of quartz, slightly calcareous, dolomitic?
- Banded quartz veins from light gray to dark gray, specular (many small faces), few empty pseudomorphs in dark gray quartz, minor limonite masses, goethite, iron mineralization(?) with tarnished pyrite(?). On edge of sample, massive pyrite (mostly tarnished) is part of white quartz (pyritic intruding into white quartz).
- Groundmass dark gray quartz, brecciated, quartz heavily fractured, empty pseudomorphs, minor veining of limonite with few patches of limonite/goethite, no apparent sulfides.
- White quartz massive with small-grained pyrite, some tarnished, heavy tarnish on pyrite in places.
- Quartz breccia (classic example), goethite vein dark brown with both yellow tarnished pyrite and silver-colored pyrite/arsenopyrite(?).
- Sheet of heavily tarnished pyrite (chalcopyrite?) within black mineral (quartz?). Fine-grained ground mass (extremely small crystals that flash yellow), some limonite in patches.
- Quartz with black mineral veining containing second veinlet (~1 mm), minor fractures, silver pyrite or arsenopyrite.

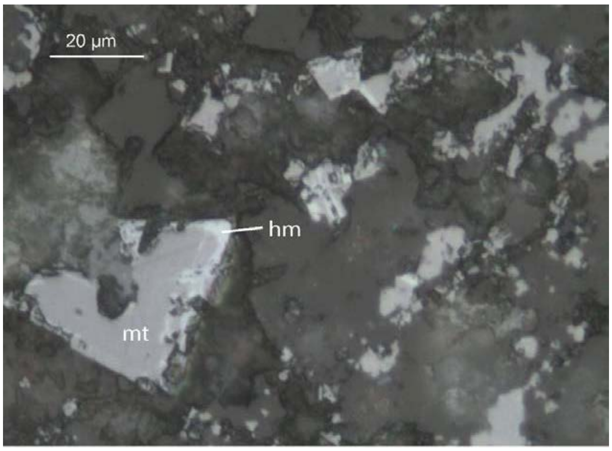

Figure 30: Hop Hoa-4B. Disseminated grains of magnetite-hematite intergrowths in altered granitic rock; reflected light, uncrossed polars.

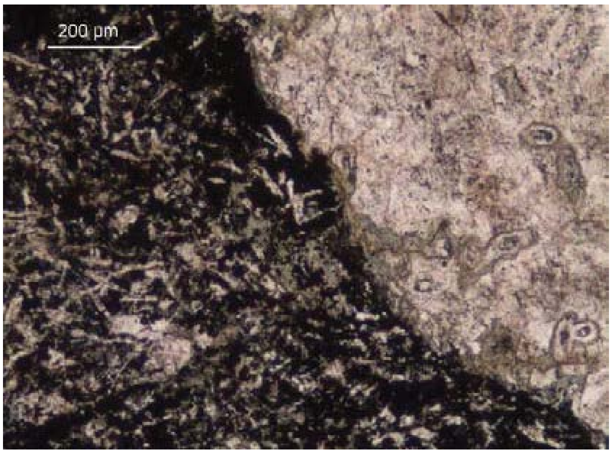

Figure 31: Hop Hoa-4C. View of volcanic rock inclusion Left: sericitized alkali feldspar (Kspar), right: transmitted light.

Figure 32: Vai Dao-1 Mine Hand Sample.

- Massive quartz, not very fractured, vuggy with tarnished pyrite and goethite in pseudomorphs.
- Large quartz vein with tarnished pyrite and goethite at the bottom.

For thin sections and photomicrographs (Figures 30-32).

Geochemical Anomalies: 2

Geochemical Index Rank: 14th

S = 5.12% Sb = 13.35 ppm

Vai Dao-2 Macroscopic Descriptions: Rock has been silicified producing an interlocking quartz mosaic. Quartz is "dusted" by very fine clay particles. Veins of quartz containing carbonate, pyrite, and very fine-grained mica, sericite, and minor alkali feldspar (Kspar). (Much of the carbonate is probably calcite; staining would determine the true variety of carbonate). Pyrite is anhedral to euhedral, and shows nearly right-angle striation patterns. Traces of a light-gray mineral are also present, possibly sphalerite or a copper mineral? (Figures 33-34). Geochemical Anomalies: 6

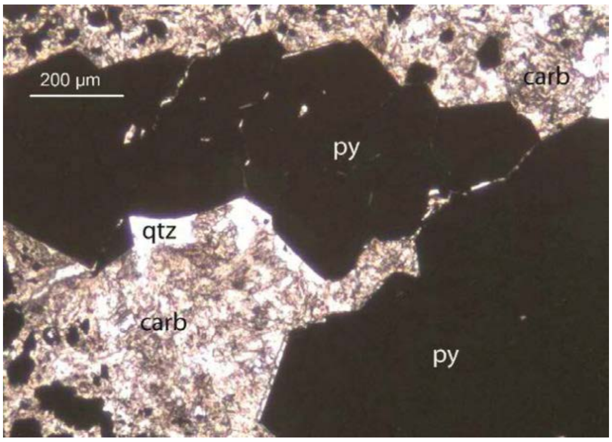

Figure 33: Vai Doa-1. Pyrite-quartz-carbonate (carb) veinlet: transmitted light, uncrossed polars.

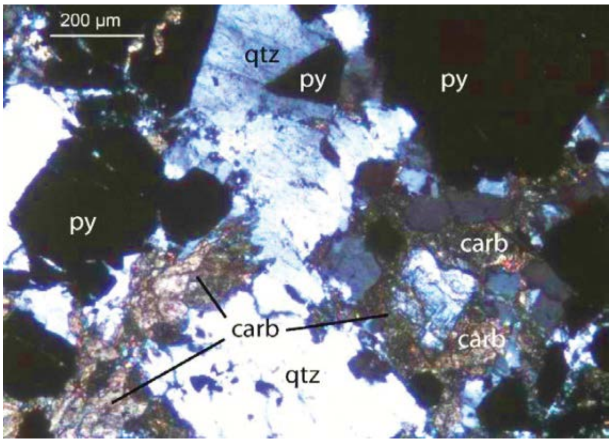

Figure 34: Vai Dao-1. Vein containing pyrite-quartz-carbonate; transmitted light, crossed polars.

Geochemical Index Rank: 10th Au = 8.69 g/t As = 2,430 ppm Cu = 459 ppm Fe = 21.9 %

Ni = 127.5 ppm S = > 10%

Vai Dao-3 Macroscopic Descriptions: Rock consists of thin quartz-carbonate veinlets containing pyrite and sericite, and unidentified gray finely granular material (copper mineral?). Some of the quartz veinlets also contain disseminated chalcopyrite (Figures 35-37).

Geochemical Anomalies: 8

Geochemical Index Rank: 8th

Ba = 110 ppm Ca = 3.15% Li = 11.1 ppm Mg =2.04% Mn = 2,420 Rb = 59.1 ppm Sn = 18.8 ppm

W = 9.6 ppm

Vai Dao-4 Macroscopic Descriptions: Consists of a fine grained grey brecciated and silicified mafic wall-rock fragment adjacent to quartz vein, the latter containing minor pyrite, and a brown opaque mineral resembling sphalerite. Also contains very small grains of a metallic grey mineral (copper?). Hand sample only (Figure 38).

Geochemical Anomalies: 5

Geochemical Index Rank: 11th

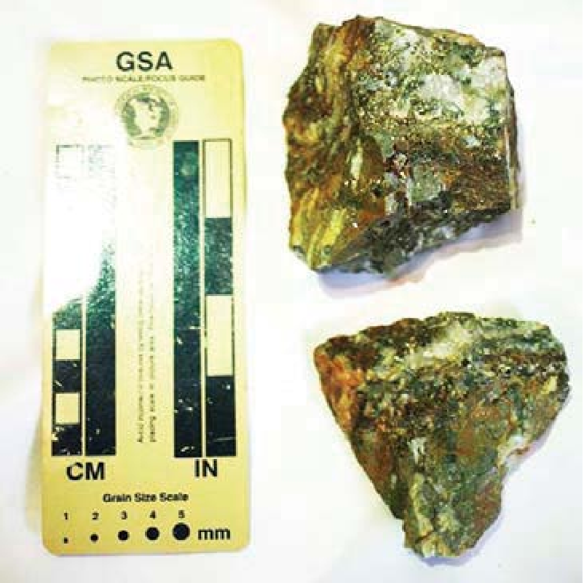

Figure 35: Vai Dao -2 Hand Samples.

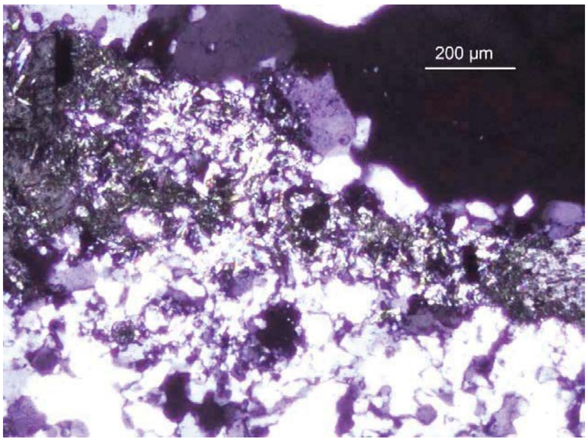

Figure 36: Vai Dao-2. Quartz-carbonate veinlet with fine mica; transmitted light, crossed polars.

Figure 37: Vai Dao-3 Hand Samples.

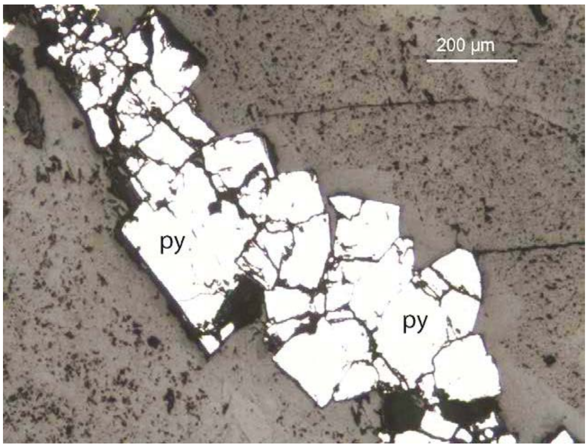

Figure 38: Vai Dao-3. Pyrite veinlet in quartz (gray) with disseminated fine-grained sericite (a phyllosilicate): reflected light, uncrossed polars.

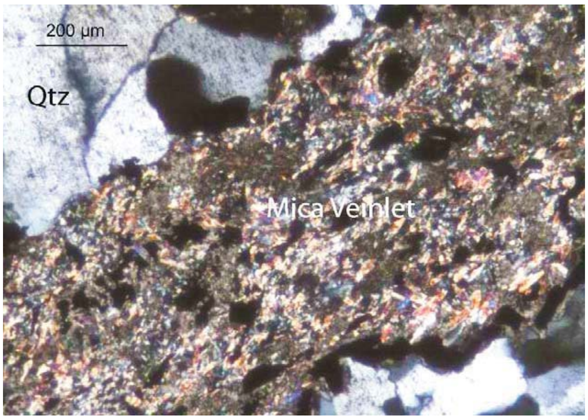

Figure 39: Vai Dao-3A. Veinlet of fine-grained mica, or “sericite” with embedded pyrite (dark opaque); transmitted light, crossed polars.

Figure 40: Vai Dao-4 Hand Samples.

Au = 2.96 g/t As = 1025 ppm S = 8.89% Sb = 23.0 ppm Tl = 2.29 ppm

Vai Doa-5A Macroscopic Descriptions: Rock is silicified producing a quartz mosaic, with narrow pyrite veinlets and fracture fillings. Coarse pyrite is also disseminated throughout the section. Several vugs contain coarse pyrite, sericite, and fine-grained carbonate (Figure 39-40).

Geochemical Anomalies: 14

Geochemical Index Rank: 4th

Ba = 300 ppm Ca = 5.93% Ga = 19.6 ppm K = 2.64% Mg = 2.55% Mn = 1870 ppm Nb = 15.7 ppm P = 2270 ppm Rb = 132 ppm Sc = 22.8 ppm Sr = 255 pmm V = 262 ppm W = 2.5 ppm Y = 18.0 ppm

Vai Doa-5B

Geochemical Anomalies: 2

Geochemical Index Rank: 15th

Au = 1.55 g/t As = 3,260 ppm

Lang Sen Area

A series of samples were taken from a newly excavated, high-wall pit that exposed a normal fault and associated mineralization. The pit walls well too steep for I2M personnel to safely spend any time climbing the mineralized zones at the bottom of the pit along the fault zone to obtain metered sampling (Figure 8). Prior to the I2M visit, the mining company personnel who excavated the pit obtained a series of mineralized samples and stored them in sequence at the pit sample storage site (Figure 7C plus).

Lang Sen 1-1 Site - Macroscopic Descriptions: Dense to vuggy highly oxidized and leached, mostly quartz, breccia. Precursor material was silicified breccia, and degree of oxidation indicates original high sulfide content, mostly pyrite. A few remnant striated euhedral pyrite crystals and rare chalcopyrite occurs, One grain of what appears to be gold is present (circled on hand specimen).

Larger samples are heavily oxidized with limonite/goethite and contains a mass with gold-colored mineralization (gold?). Goethite is botryoidal from melting(?). Some places within botryoidal forms are showing limonite scattered over top of goethite. A blue mineral is very fine-grained (4 little masses), vug interior with iridescent (oil-sheen like) coloring from goethite (dark greens, purples with large yellow/gold-colored mass on surface).

Pseudomorphs with limonite surrounding pseudomorphs in part. White mineral might be K-spar, fractured. One end of sample showing dark gray quartz/light gray quartz. Smaller sample, limonite/goethite, light gray quartz with mass of pyrite (arsenopyrite (silver mineral?)) with striations, botryoidal structures in goethite panel, vuggy with open areas similar to above. The arsenic geochemical analyses should confirm.

Of particular interest in the Lang Sen pit, aside from the wide alteration zone next to the fault is what appears to be an odd "intrusive" mass best characterized as a quartz breccia with a groundmass of pyrite (arsenopyrite?)-pyrrhotite-chalcopyrite that occurs in one mass on the periphery of the alternation zone, some 10 meters from the fault contact (Lang Sen-2-3B-1 descriptions of thin-sections and field photographs in Appendix K-26-K-39).

Hand sample only (Figure 41-43).

Geochemical Anomalies: 11

Geochemical Index Rank: 6th

Au = 11.30 g/t Ag = 2.25 ppm As = >1% Ba = 390 ppm Fe = 24.5% P = 1,950 ppm Pb = 63.8 ppm S = 1.86% Sb = 201 ppm Te = 5.70 ppm V = 210 ppm

Lang Sen-1-2 Site - Macroscopic Descriptions: Very vuggy, leached pyrite-rich rock that contains a network of pyrite veinlets. Patches of very coarse-grained pyrite are also present.

Figure 41: Vai Dao-5 Hand Samples.

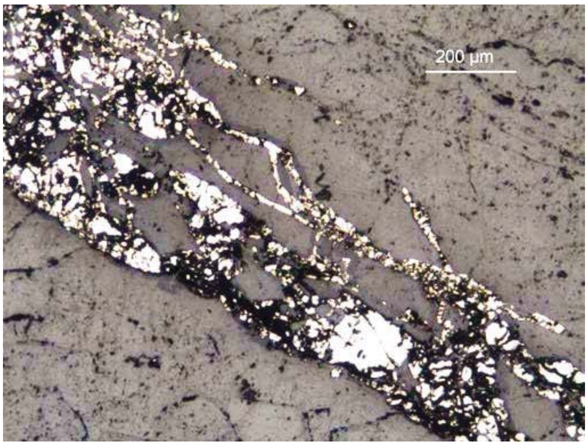

Figure 42: Vai Dao-5A. Micro-veinlets of pyrite (white) in quartz (gray) with disseminated sericite (black); Reflected light, uncrossed polars.

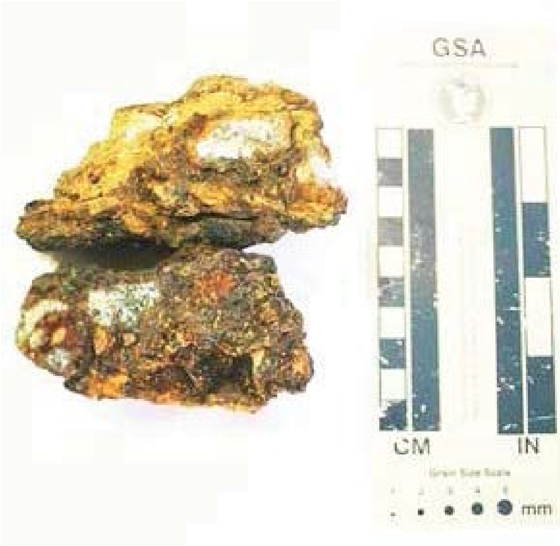

Figure 43: Lang Sen Hand Samples (from fault zone in pit).

Ground mass of white fractured quartz, vuggy, intruded by massive tarnished pyrite in places and fresh silver-colored pyrite (arsenopyrite?) filling vugs in places. Minor limonite coating, pyrite crystals fine to medium grained (no large-grained pyrite/arsenopyrite observed in thin-section samples), predominately empty pseudomorphs. The sample series are characterized in hand samples as follows:

- Large goethite patch in outer boundary zone of thick goethite. Vuggy with massive pyrite tarnished with adjacent arsenopyrite. Gold-colored mass (not pyrite or arsenopyrite), heavily fractured, massive pyrite/arsenopyrite, central core of sulfide minerals surrounded by limonite/goethite.
- Quartz vein, highly fractured, masses of limonite/goethite up to 1.5 cms long containing botryoidal structures, covered with light brown to light orange limonite. Large mass of massive goethite with botryoidal structures in part filling vugs.
- Quartz breccia with cross veining, quartz fragments in ground mass of dark brown iron material (goethite?), large box-work structures with smaller empty pseudomorphs, no sulfides (sample is heavily oxidized), light coating of limonite. Size of quartz fragments is large (cms) to very small angular quartz fragments (fine-grained size). Far end of oxidation.
- Heavy limonite and some goethite, heavy pyrite mineralization from ground mass size to boxes of pyrite/arsenopyrite (color is silver) up to fine-grained in size. Goethite shows some botryoidal structure, blue crystal(?), rock type is quartz breccia with thick veining of light to dark gray quartz veins. Some white quartz. Isolated medium-sized cubed pyrite. With arsenopyrite(?) surrounded by box boundary that indicates earlier mineralization (sharp boundary of limonite/goethite).
- Quartz medium gray with groundmass pyrite/

arsenopyrite with goethite masses, vuggy, floor covered by pyrite/arsenopyrite with inclusions of dark gray angular quartz in ground mass of goethite. Rock type is quartz breccia(?) with massive pyrite/arsenopyrite(?) and other sulfides.

- Quartz breccia in groundmass, altered botryoidal goethite, eroded(?) to flat box-work, pyrite/arsenopyrite scattered and poking through goethite. Rock type is quartz breccia with angular fragments of white quartz among groundmass of pyrite/arsenopyrite. Quartz breccia with box-work, fractured quartz, hematite rind around quartz, significant limonite, some empty pseudomorphs, no pyrite, minor silver sulfide (arsenopyrite?). Foundation of medium cube pyrite, goethite veining, angular fragments and veining of quartz. Groundmass of arsenopyrite/pyrite (extremely fine-grained) on floor covering goethite.
- Metamorphosed limestone(?) with massive quartz next to mineralized zone of arsenopyrite/pyrite with little limonite and the pyrite is fresh to slightly tarnished cubes. Fine-grained cubes are more tarnished than larger ones.
- Quartz breccia with extremely large pseudomorphs, massive coating of pyrite.

For thin section and photomicrograph, see Figure 43.

Geochemical Anomalies: 7

Geochemical Index Rank: 9th

Co = 109 ppm Fe = 37.8% Ni = 169 ppm Pb = 293 ppm S = > 10% Se =18 ppm Tl = 15.2 ppm

Lang Sen-1-2B-1 Macroscopic Descriptions: Silicified rock with veinlets of pyrite, some with coliform borders (indicative of supersaturated fluids and rapid crystal growth) (Figure 44).

Geochemical Anomalies: 4

Geochemical Index Rank: 12th

As = 3,140 ppm Cu = 519 ppm Fe = 18.65% S = >10%

Figure 44: Lang Sen-1-2A Hand Samples.

Lang Sen 1-2B-2: Macroscopic Descriptions: Red to brown highly oxidized vuggy silicified quartz breccia, and clay altered wall rock fragments. Minor remnant pyrite occurs where encapsulated in quartz in breccia matrix. Iron oxide after pyrite occurs in box works.

Geochemical Anomalies: 3

Geochemical Index Rank: 13th

Au = 3.33 g/t Ag = 6.7 ppm Fe = 10.05%

Lang Sen-1-2C Macroscopic Descriptions: Rock sample contains two separate mineral assemblages, one dominated by pyrite veinlets, the other characterized by chalcopyrite, CuFeS2, replaced by covellite, CuS (Figure 45-48).

Geochemical Anomalies: 1

Geochemical Index Rank: 14th

Au = 1.27 g/t

Lang Sen-1-2C

Geochemical Anomalies: 2

Geochemical Index Rank: 13th

Au = 1.11 g/t S = >10%

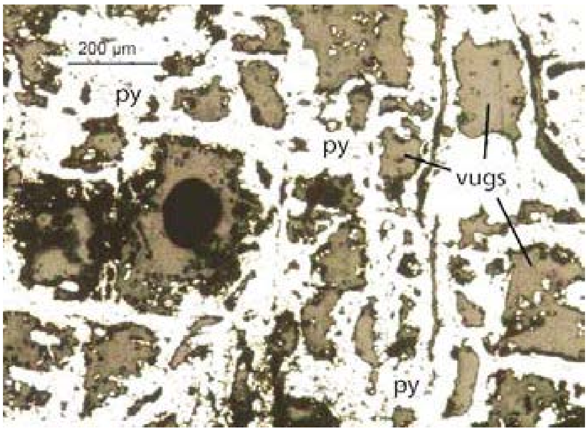

Figure 45: Lang Sen-1-2A. Leached, porous rock with veinlet network of pyrite; reflected light, uncrossed polars.

Figure 46: Lang Sen-1-2B-1 Hand Samples.

Figure 47: Lang Sen-1-2B-2 Hand Samples.

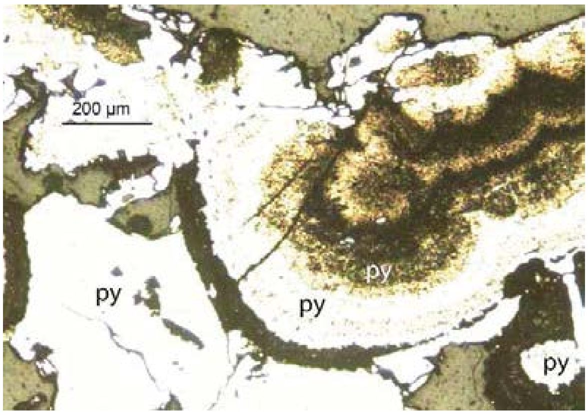

Figure 48: Lang Sen-1-2B. Pyrite with both crystalline and coliform texture. Fine gold within the pyrite (?).

Lang Sen 2-3A: Macroscopic Descriptions: Massive white quartz vein in highly oxidized selvage of greenish to white altered vuggy material. Box works of fine silica containing small grains of unknown metallic mineral. Hand sample only. Massive quartz vein with massive green mineral (chlorite?), vuggy, botryoidal crystals near vugs, empty pseudomorphs, goethite inside chlorite(?) vugs. Sharp contact between quartz and chlorite(?). (Figure 49-51)

Geochemical Anomalies: 3

Geochemical Index Rank: 12th

As = > 1% Sb = 281 ppm Zn = 171 ppm

Lang Sen 2-3B Site

Geochemical Anomalies: 9 Geochemical Index Rank: 7th Au = 4.95 g/t Ag = 1.55 ppm As = >1% Cu = 388 ppm Pb = 86.1 ppm S = 7.25% Sb = 515 ppm Se = 11 ppm Te = 3 ppm

Lang Sen-2-3B Samples - Macroscopic Descriptions: Consists of silicified and vuggy material of veinlets of pyrite and carbonate. Local minor grains of chalcopyrite and

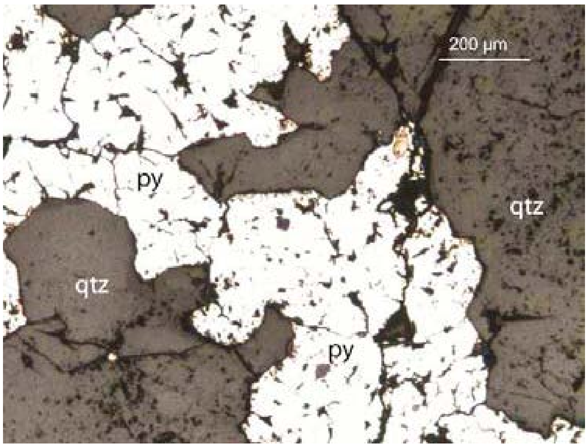

Figure 49: Lang Sen-1-2C. Pyrite vein in quartz; small remnant, yellow mineral in pyrite unknown (?gold); reflected light, uncrossed polars.

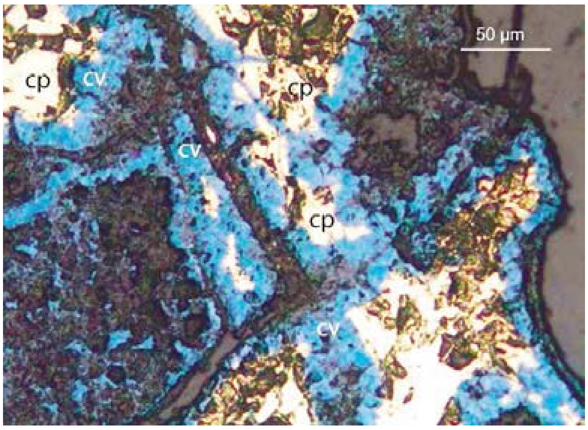

Figure 50: Lang Sen-1-2C. Stockwork veining of chalcopyrite (cp) replaced by covellite (cv) in a matrix of brecciated quartz fragments of later stage of quartz veins after the cp; reflected light, uncrossed polars.

Figure 51: Lang Sen-2-3A Hand Samples.

pyrrhotite, up to 0.6mm, occur. The range of rocks in this series of Lang Sen samples is only slightly different from the Hop Hoa and Vai Dao areas. This sample series are characterized in hand sample as follows:

- Heavy sample of mostly massive pyrite/arsenopyrite, with occasional tarnished crystals of pyrite/ arsenopyrite(?), actually a breccia with angular quartz fragments. Quartz white to light gray, minor inclusions of dark mineral(?), 70% metal. Only minor oxidation noted, mostly sulfide.
- Quartz breccia with angular quartz fragments, box-work, interior with massive arsenopyrite with quartz fragments, vuggy, fresh pyrite next to arsenopyrite / pyrite (silver colored?), arsenopyrite(?) occurs massive to fine-grained cubes. Massive pyrite as well next to arsenopyrite(?). Fine-grained crystalline yellow mineral. Vuggy, vugs are filled in part with goethite/ limonite, and in part by pyrite/arsenopyrite. Example of sulfide minerals in process of oxidation.
- Quartz breccia, oxidized, no apparent arsenopyrite/ pyrite but sample is heavy, perhaps pyrrhotite.
- Quartz massive, vein with small arsenopyrite/pyrite within quartz. Goethite/ limonite areas, no fresh arsenopyrite/pyrite.
- Very light, small sample of volcanic country rock(?), very porous, non-calcareous, possible manganese coating on one sample face, aphanitic, slightly friable.
- Quartz vein material with fresh arsenopyrite/pyrite, nearby oxidation indicated by limonite/goethite, possible gold(?) masses, slightly vuggy.
- Massive goethite with botryoidal structures, massive both sides, vuggy with some scattered limonite, pink mineral and dark green mineral and dark blue mineral around botryoidal heads (not iridescent so is actual color of pink, green and blue minerals).
- Partly oxidized rock, primarily quartz with scattered limonite, minor arsenopyrite/pyrite masses, not crystalline, few empty pseudomorphs boxes.

For thin sections and photomicrographs (Figures 52-56).

Lang Sen-2-3B-1 Macroscopic Descriptions: Massive blocky white quartz floating in a groundmass of chalcopyrite, pyrite, and pyrrhotite, with veinlets and small agglomerations of carbonate. The rock sample is heavy and magnetic (Figures 52-56).

As indicated earlier, this odd "intrusive" mass, best named a quartz breccia with a groundmass of pyrite-pyrrhotite-chalcopyrite, occurs on the periphery of the fault alternation zone, some 10 meters from the fault contact (see Lang Sen-2-3B-1 descriptions of thin-sections (Figures 52-56) and field photographs in Appendix K-26 - K-39).

Geochemical Anomalies: 3

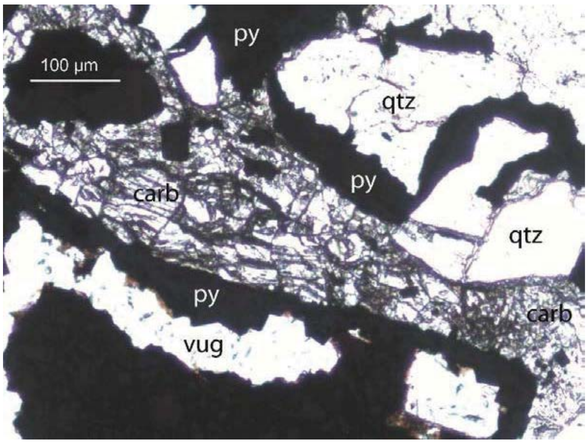

Figure 52: Lang Sen-2-3B-1. Carbonate veinlet (carb), with quartz and pyrite; transmitted light, uncrossed polars.

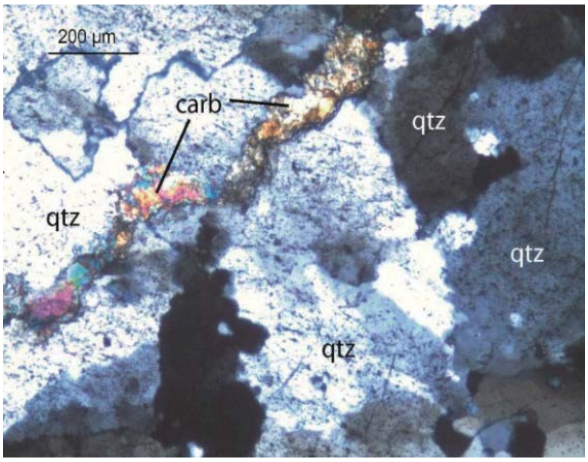

Figure 53: Lang Sen-2-3B-1. Silicified material cross-cut by carbonate veinlet; black mineral also quartz(at angle of extinction); scattered with very small grains of sericite in quartz; transmitted light, crossed polars.

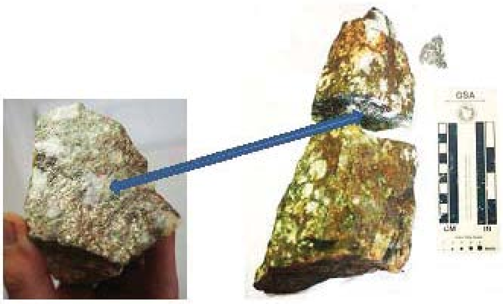

Figure 54: Lang Sen-2-3B-1 Hand Samples.

Geochemical Index Rank: 13th

Cu = 647 ppm Fe = 36.9% S = > 10%

Lang Sen 2-3B-2 Macroscopic Descriptions: Red to brown partially oxidized quartz breccia containing fresh to partially oxidized massive coarse crystalline pyrite. Multiple generations of pyrite coarse to fine, occur where the latter more readily oxidizes to iron oxides. Hand sample only (Figure 57).

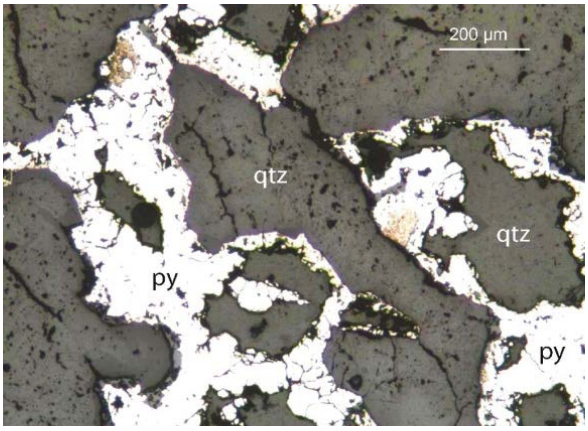

Figure 55: Lang Sen-2-3B-1. Irregular quartz-pyrite veining; reflected light, uncrossed polars. Small remnant, yellow mineral within pyrite (chalcopyrite or gold?).

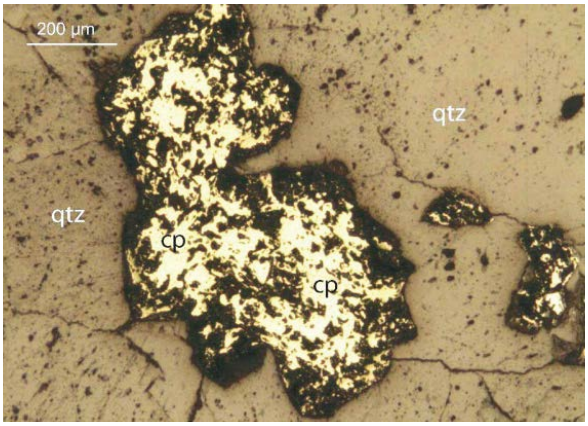

Figure 56: Lang Sen-2-3B-1. Disseminated chalcopyrite (cp) in quartz; reflected light, uncrossed polars.

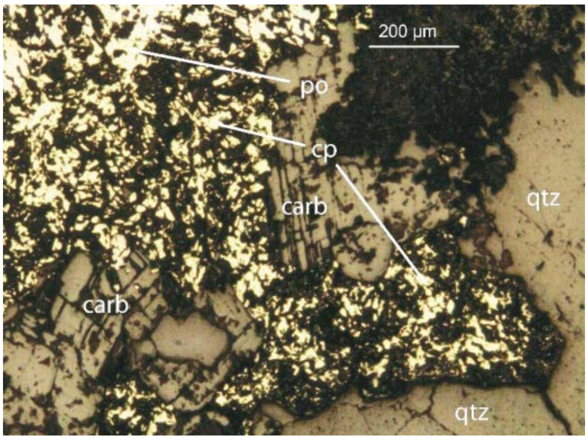

Figure 57: Lang Sen-2-3B-1. Intergrown chalcopyrite, pyrrhotite, and carbonate (calcite); reflected light, uncrossed polars.

Geochemical Anomalies: 19

Geochemical Index Rank: 1st

Ba = 700 ppm Be = 5.38 ppm Ce = 81.5 ppm Cr = 53 ppm Cu = 171 ppm Fe = 16.85% Ga = 41.3 ppm K = 3.31% La = 34.9 ppm Li = 24.1 ppm Mo = 3.42 ppm Nb = 10.8 ppm P = 2,500 ppm Rb = 148 ppm Sc = 34.6 ppm Sn = 15.9 ppm V = 387 ppm W = 6.5 ppm Y = 23.6 ppm

Lang Sen 2-3B-3

Geochemical Anomalies: 2

Geochemical Index Rank: 15th

As = 743 ppm S = 3.51%

Lang Sen 2-3B-4 Macroscopic Descriptions: Fractured and sheared quartz and partially oxidized coarse pyrite.

Geochemical Anomalies: 6 Geochemical Index Rank: 10th Au = 5.19 g/t Ag = 2.42 ppm Cu = 946 ppm Fe = 22.7% Mo = 8.41 ppm S = >10% **Lang Sen 2-3B-5** Geochemical Anomalies: 1 Geochemical Index Rank: 15th As = 2,850 ppm

Lang Sen-3-4 Site - Macroscopic Descriptions: Siliceous rock containing sericitized Kspar and veinlets of chlorite. Oxidized massive and fractured quartz, locally showing vugs. Small spherical black concentric (1 mm) masses, and coalescing spheres of the latter locally occur in the quartz. The latter also contains fine-grained hematitic material. This sample series are characterized in hand sample as follows:

- Quartz breccia, quartz white with goethite/limonite coatings abundant near the few vugs. Pink ground mass in some depressions. Few empty pseudomorphs with limonite in floors.
- Heavily oxidized quartz vein material with heavy goethite/limonite, also quartz breccia; vein has microbreccia aspects. Quartz medium gray to white. At end of sample is abundant pyrite, massive to crystalline, one large cube observed with pseudomorphs surrounding. Dark to medium green mineral showing masses, non-crystalline.
- Quartz vein, white quartz with limonite coatings, fractured in one direction only longitudinal to sample. Some manganese coatings on surface of sample.
- Rock with medium brown coloration on one side with brick red hue with manganese coating (tuffaceous?). Similar to sample from pit (2-3B). Could be heavily oxidized country rock. Aphanitic and slightly friable.

For thin sections and photomicrographs (Figures 58-61).

Geochemical Anomalies: 16

Geochemical Index Rank: 3rd

Au = 5.48 g/t Ag = 18.60 ppm Co = 116 ppm Cr = 56 ppm Cu = 2,370 ppm Fe = 21.9% Ga = 18.95 ppm Li = 27.3 ppm Mg = 1.05% P = 1,760 ppm S = 2.71% Sc = 23.1 ppm V = 278 ppm Y = 21.3 Zn = 1,120 ppm Zr = 41.4 ppm

Lang Sen 3-4C

Geochemical Anomalies: 15

Geochemical Index Rank: 4th

Al = 9.66% Ce = 89.3 ppm Fe = 14.3 % Ga = 33.6 ppm La =

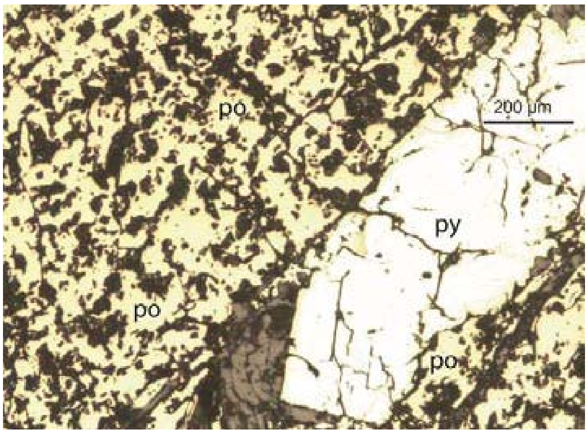

Figure 58: Lang Sen-2-3B-1 Pyrite grain enclosed by pyrrhotite (po); reflected light, uncrossed polars. Dark gray carbonate mass at terminus of pyrite.

Figure 59: Lang Sen-2-3B-2 Hand Samples.

Figure 60: Lang Sen-3-4A Hand Samples.

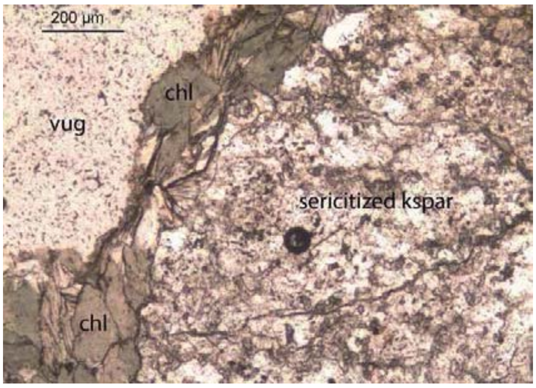

Figure 61: Lang Sen-3-4A. Sericitized kspar with chloritized rims; Transmitted light, uncrossed polars.

49.4 ppm Li = 66.7 ppm Mn = 2,480 ppm Nb = 29.3 ppm Ni = 119.5 ppm P = 1,660 ppm Sc = 36.2 ppm V = 453 ppm Y = 66.4 ppm Zn = 350 ppm Zr = 57.4 ppm

Lang Sen 3-4D

Geochemical Anomalies: 3

Geochemical Index Rank: 13th

Ag = 11.35 ppm Fe = 2.4% Zn = 163 ppm 9.4

8.4 Lien Son Area – (Appendix K for field photographs).

Macroscopic Field Descriptions:

- Heavy iron staining up to 1” thick with black cubic mineral in ground mass of light tan. Some box-work structures apparent. No noticeable pyrite, arsenopyrite or other mineralization.
- Large box structure bounded by quartz vein with black mineral (not pyrite), some box-work noted, ground mass light brown, iron veining as before. (Lien Son 1-2 - lien-son1-2.jpg)
- Various types of metamorphic rocks, mostly medium gray slates (for example).
- Light gray ground mass intruded by iron-rich veins, some tremolite (?), some limonite/goethite on surfaces with black minerals, looks melted (high temp), structures not pyrite but pseudomorphs with boxwork patterns, heavily oxidized in part.
- Fragments with deep orange color ground mass, therefore oxidized.
- Altered basalt(?), HCL test: 0% carbonate, former minerals left voids, ovoid inclusion of white mineral with small pseudomorphs that were not cubic, medium to dark gray/black ground mass, very fine-grained ground mass.
- Heavily oxidized fine grained ground mass, limonitic with iron veining, dark brown to reddish brown, same white mineral within circular iron-stained box structure, same box-work character. Limonite/ goethite widespread. Rock type generally of fine-grained groundmass intruded by altering minerals, now limonite/goethite (geothermal), no sulfides, all oxides. (Lien Son 1-3 - lien-son1-3.jpg and Lien Son 2-1 - lien-son2-1to2-3.jpg
- Fine-grained medium gray material Lien Son 2-2 - lien-son2-1to2-3.jpg
- Large quartz fragments, light brown fine-grained material in zone. Limonitic in part, no apparent sulfides. Lien Son 2-3 - lien-son2-1to2-3.jpg\
- White quartz, limonitic in part, oxidized in part.

Lien Son 2-2 (see Figure 7A for location).

Geochemical Anomalies: 6

Geochemical Index Rank: 10th

Au = 68.9 g/t Cr = 87 ppm Fe = 4.48% Sr = 165 ppm Th = 5.3 ppm Zr = 70.7 ppm

Geochemical Characterizations

There are strong geochemical associations between the Hop Hoa and Vai Dao samples and the Lang Sen and Lien Son samples. The first two areas and the last two areas are about 20 kms apart (Appendix A). The geochemical trace elements have been used by others to provide some idea of the depth and physical conditions (temperature and pressure) of the intrusives and extrusives as they emerge from magma chambers below. Pyrite is of particular use in that it carries a variety of geochemical markers with it at different stages of its formation.

Large [15] and Wang [31] have shown that in looking at individual pyrite grains they have specific geochemical markers for each stage of development, e.g., deep-seated mineralizing fluids, intermediate depths, and shallow, late-staged mineralization. They indicate that Pb, As, Mo, Ga, Ge, V, and Sb, metals are commonly referred to as medium- to low-temperature elements. In contrast, they found that these elements are present in low concentrations in the chalcopyrite grains. Selenium, considered a typically high-temperature metal, is enriched in chalcopyrite, whereas Ag and Sn are enriched only in some silicified massive sulfides.

As within chalcopyrite, elements precipitated with pyrite also show distinct trace-element associations in grains with different configurations. The low-temperature association of elements (Pb, Mo, Mn, U, Mg, Ag, and Tl) is typically present in colloform/ framboidal pyrite, whereas the high-temperature association (Se, Co, and Bi) is enriched in euhedral pyrite. Others minerals like sphalerite are characterized by relatively high concentrations of Ga, Ge, Pb, Cd, As, and Sb, indicating that sphalerite in these sample groups likely precipitated at intermediate temperatures.

In the study by Wang, et al: (2017) they found that seafloor weathering processes or mixing of hydrothermal fluids with seawater during the waning last stages of hydrothermal fluid flow result in significant redistributions of trace elements in sulfide minerals, like pyrite.

Using a similar approach to Wang [31] in their Figures 8 and 9, we used whole-rock sample analyses instead of results from individual grains of pyrite and other sulfides to generate plots of trace-earth concentrations in samples from the four sites. The purpose is to characterize the gold mineralization and suite of associated trace elements from the areas of interest to determine if a unique pattern would be apparent. This also would provide information on whether any pattern would persist between sample sites (some 20 kms) indicating that mineralization is derived from similar igneous bodies at depth with similar trace-element characteristics.

The trace-element plots shown in Figures 67-69 illustrate the similarity of the contents in the samples from Hop Hoa, Vai Dao, and Lang Sen and Lein Son. Gold, in the center of the plot, shows a range of values of 68 ppm (g/t) to Detection

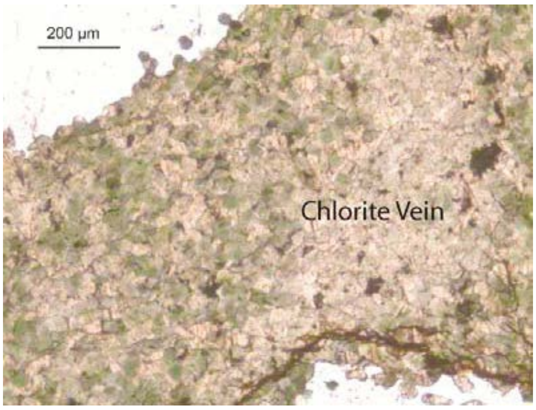

Figure 62: LangSen-3-4A. Chlorite vein; transmitted light, Uncrossed polars.

Figure 63: Lang Sen-3-4B Hand Samples.

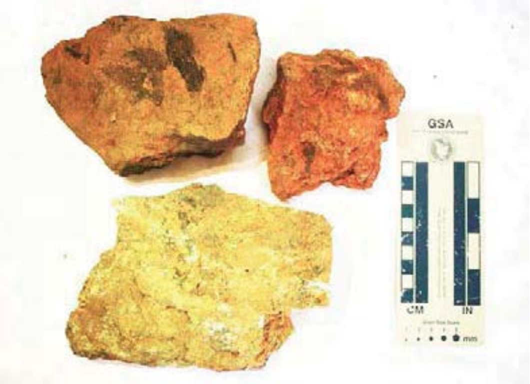

Figure 64: Lang Sen-3-4C Hand Samples from fault zone in pit.

Figure 65: Samples from Outcrop at the Lien Son Site.

Limit. The geochemical pattern for the combined samples from the four areas of interest shows a distinctive distribution with enrichments in As, Mn, Pb, Mo, and Ga, but variable concentrations in other elements in the plot. The individual plots show some variations.

The objective of the plots is to also identify potential pathfinder elements that would indicate the type of gold mineralization in the area. Having identified pyrite (and arsenopyrite), chalcopyrite, and other sulfides and oxides, we have concluded the enriched trace elements are likely contained within the sulfides, which infers the timing of the injection of mineralizing fluids from below and formation of such minerals (and subsequent oxidization of the associated rocks, both volcanic and sedimentary).

Figure 66: Outcrop site Site at Lien Son.

The Hop Hoa samples are enriched in Mo and Ga and Vai Dao area samples less so as shown in Figure 67. Most of the Vai Dao samples are enriched in As and Mn, whereas Hop Hoa samples show less enrichment in As, but are equally enriched in Mn. The depleted elements are In, Ge, Cd, and Tl. These are only preliminary conclusions because additional samples across available ore zones and peripheral alteration zones need to be obtained and evaluated to assess the conditions in greater detail than possible during our short visit to the four sites.

A particularly interesting suite of trace elements are those present in the “Intrusive Rock” (the silicified quartz breccia) of Sample: Lang Sen-2-3B-1 (from outcrop shown in Appendix K-26 - K-30). The trace element pattern is a bold red line. This indicates that the content of the “rock” occupies intermediate positions in plot for all elements but Cd and Tl, which are the most depleted of all samples.

Lithologically, the sample consists of silica and milky quartz, in a groundmass of various metal sulfides, i.e., pyrite, chalcopyrite, and pyrrhotite. All of the other Lang Sen samples are generally described as being oxidized or having been formed as alteration products.

The Lien Son sample is from a highly altered, oxidized zone carrying high gold (69 g/t (ppm), but low silver) see figure 66. The trace elements are represented by the heavy black line. This sample shows depleted Se, Ge, and low As but elevated V, all relative to the subject sample population (Figure 68).

The plot in Figure 69 reflects the ore samples in similar pattern but not in some detail. Gold and silver have been removed by processing, whereas In, Pb, Sb, and As (to some extent)

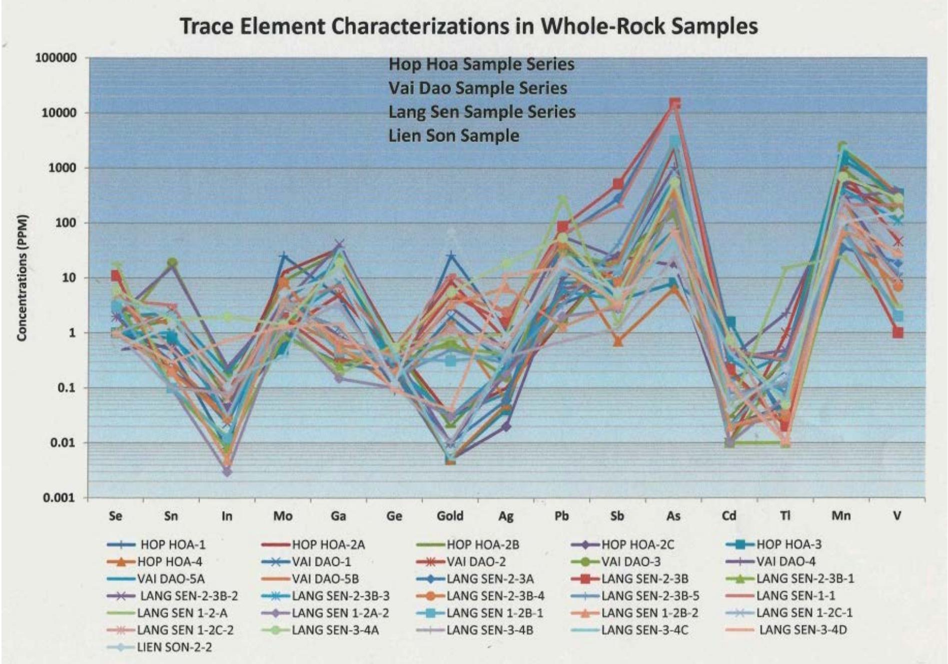

Figure 67: Trace Element Characterizations – Four Sites.

have been enriched by processing in the tailings. Significant leaching of elements is not indicated in Figure 68 as shown by changes in the trace-element concentrations when comparing the tailings sample data from the pond to the tailing material data exposed in the creek samples (Figure 68). These would have been exposed to further oxidation and the creek water, assuming the material has been in the creek during at least one “wet’ season.

We consider the use of trace-element patterns to have some merit in characterizing whole-rock analyses for classifying mineralized zones in northern Vietnam and perhaps elsewhere. We are considering the remainder of the trace-element database of analyses obtained from our sampling in 2014. These elements were not used by Wang, et al., [31]. In the event the other data show promising results we will revise this paper accordingly (or publish the new results separately, if merited).

Mineralization

Models, based on the samples obtained and on a review of the information available, show two principal types of mineralization are prevalent in the Cao Ram area. These will include either epithermal and/or intrusion-related styles of mineralization. Figure 71 captures the variations to these classes of mineralization by illustrating the extent of known gold occurrences of well-known mines in the world.

Current Concepts

During the past 15 years, there has been renewed emphasis on the diversity in deposit types within provinces containing orogenic gold deposits (e.g., [23, 24], with emphasis on intrusion-related gold deposits. Sillitoe [26] grouped these deposits into five distinct classes:

Class 1: Stockworks and disseminated ores in porphyritic and non-porphyritic intrusions; (e.g., representative deposits: Lepanto, OK Tedi, Boddington as examples of the former and the Zortman-Landusky, Salave, Gilt Edge, Kori Kollo deposits as representatives of the latter type of intrusion). Class 2: Skarns and replacement ores; (e.g., Fortitude, McCoy, Nickel Plate, Red Dome as skarn deposits and Barney’s Canyon, Ketza River, Yanicocha deposits in carbonate rocks as replacement ores).

Class 3: Stockworks, disseminated ores, and replacement bodies in country rocks as intrusions (e.g., Porgera, Muruntau, Mount Morgan, Quesnel River deposits).

Class 4: Breccia pipes in country rocks (e.g., Montana Tunnels-Golden Sunlight, Kidston, and Chadbourne deposits, and Mount Wright and the Welcome Deposits, NE Qld.).

Class 5: Mesothermal and low-sulfide, epithermal veins in intrusions and country rocks (e.g., Charters Towers, Jiaodong Peninsula, Majara, and Ravenswood and Christian Kruck Deposits, NE Qld.).

The classes obviously reflect many different types of gold deposits that indicate a relatively local zonation within and surrounding a contributing pluton. With some exceptions (e.g., Charters Towers (Queensland, Australia) being one exception), there is little debate that most of these gold

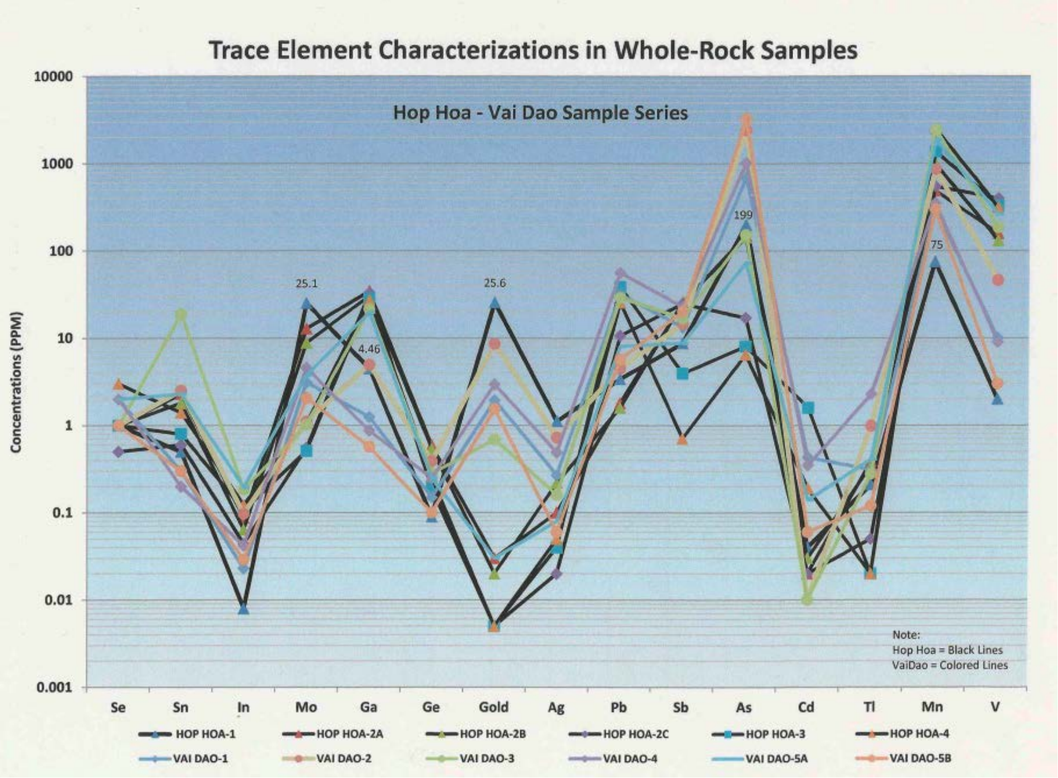

Figure 68: Trace Element Characterizations – Hop Hoa and Vai Dao Samples.

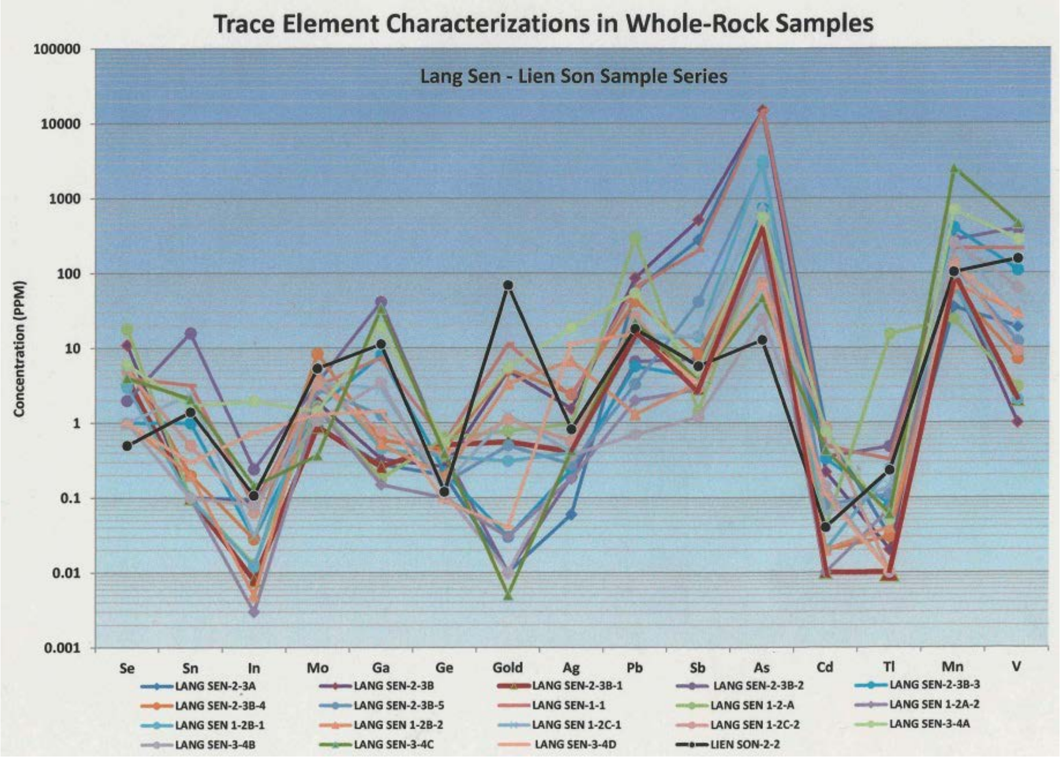

Figure 69: Trace Element Characterizations – Lang Sen and Lien Son Samples.

deposits are genetically associated with a well-defined igneous body and are, therefore, properly classified as intrusion-related deposits [27]. However, Class 5 of intrusion-related gold vein deposits might have many characteristics similar to orogenic gold deposits [12].

Of the five geochemical associations that they identify within this class of vein-type deposits, only the deposits with the gold-tellurium-lead-zinc-copper and gold-arsenic-bismuth-antimony associations have features resembling, and can be confused with, orogenic gold deposits. The mineralization within the Cao Ram area Đồi Bù District consists of both quartz-dominated and sulfide-dominated mineralization.

The geochemical associations of a) gold with tellurium-lead-zinc-copper and b) gold with arsenic-bismuth-antimony do not compare with those of Robert [23] in Figure 70, and indicate that no clear distinctions can be made in the Cao Ram Area, Đồi Bù District because both structural conditions and an intrusion-related source of mineralizing fluids at depth are apparent. Furthermore, geochemical log-log plots of gold vs. arsenic and gold vs. sulfur also illustrate such intermixing of geothermal mineralizing fluids in the area (Figures 71 and 72). Note that the Lang Sen samples plot widely in the figures with a generally positive correlation between gold and arsenic and sulfur because the samples represent a range of mineralization associated with faulting and differential heating at various depths (distance from a magma source), from pure sulfides to a variety of oxidized metamorphosed volcanic and sedimentary units, including limestone. The Hop Hoa samples, having such low gold values (ND), are also insufficient in number to show any correlation beyond a scattered pattern. The Vai Dao samples show only a minimal correlation between gold and arsenic, and with sulfur in the few samples obtained during our brief field visit.

Based on the above trace-element assessments of samples from the four areas of interest and in comparing the geochemical patterns with those of other major deposits in the world, the types of mineralization show the following characteristic associations for the Hop Hoa / Vai Dao and Lang Sen / Lien Son Area Samples:

Enrichment: Au-Mn-As-Pb-Ga-Mo (in order of abundance)

Depletion: Tl-Cd-In (in orde

Characteristics of Intrusion-Related Deposits

In perhaps the clearest refinement of their defining characteristics, Lang [14], utilizing the studies of Sillitoe [26] and others, have summarized the major characteristics of intrusion-related gold deposits, illustrated in Figure 69 above. According to Sillitoe, intrusion-related gold mineralization has the following characteristics:

1) Metaluminous, subalkalic intrusions of intermediate to felsic composition that span the boundary between ilmenite and magnetite series;
2) CO_2-bearing hydrothermal fluids;
3) A metal assemblage that variably includes gold with anomalous bismuth, tungsten, arsenic, molybdenum, tellurium, and/or antimony, and typically carries non-economic base-metal concentrations;

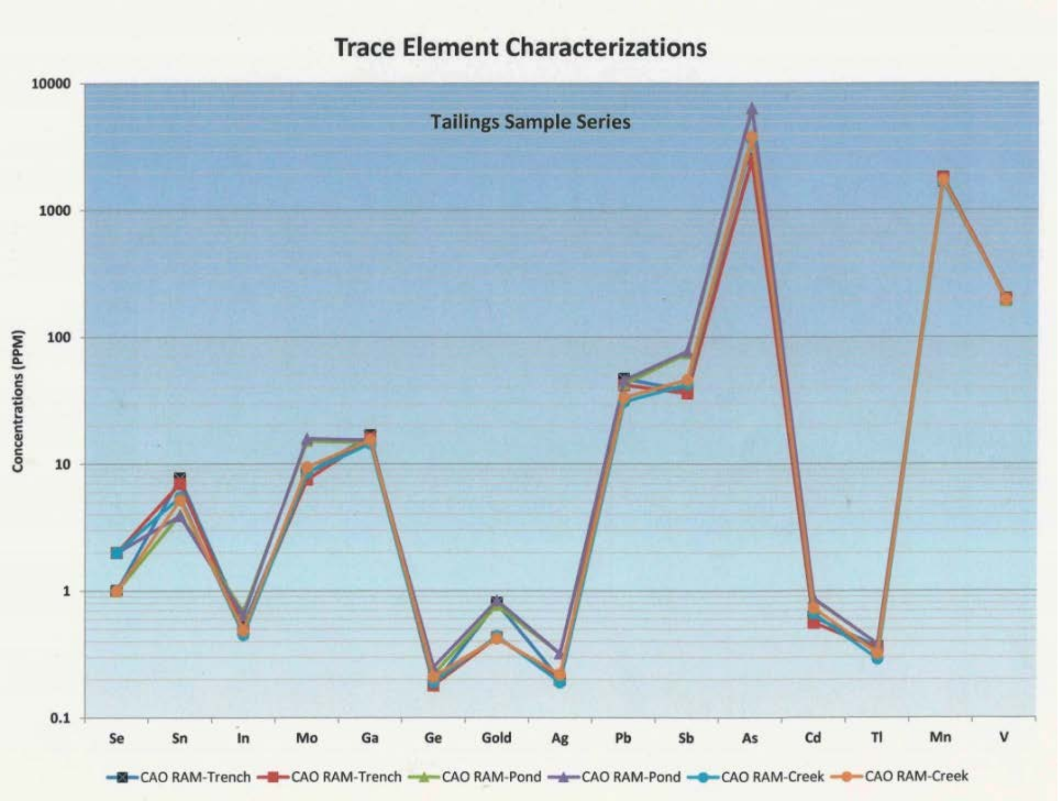

Figure 70: Trace Element Characterizations – Eight Tailings Samples.

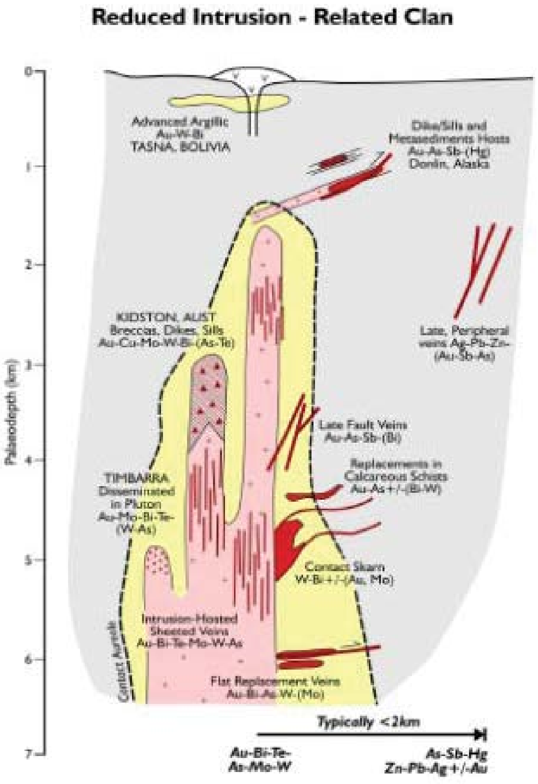

Figure 71: Typical Types of Intrusion-Related Mineralization [23].

4) Comparatively restricted zones of hydrothermal alteration within granitoids; illustrated in log-log plots (Figures 72 and73), and 5) A continental tectonic setting well inboard of inferred or recognized convergent plate boundaries, although the area was still part of Pangea, the Song Da Structure could have been part of the break-up (Figure 5).

Roberts [24] and Poulsen and Dube [22] have recognized two broad groups of deposits based on precious metal composition: silver (Ag) rich deposits, in which the concentration of silver exceeds that of gold, and gold-rich deposits, the concentration of gold exceeds that of silver (gold and silver concentrations of both types being at the ppm level). The latter, gold-rich group of deposits is subdivided further into two styles of mineralization: quartz-carbonate vein-hosted and disseminated sulfide replacement type mineralization. With time, a variety of types has been identified (Figure 74).

These show that a large number of mines report gold grade from just above 1g/t to 10 g/t or less, with the exception of a few mines with grades >10 but less than about 40 g/t.

Orogenic gold deposits (also referred to as mesothermal, greenstone, shear zone related or lode gold deposits) are characterized by gold-bearing quartz veins and veinlets with minor sulfides (< 35% sulfide minerals) developed within a wide variety of host rocks, and largely localized along high-order dilational structures related to major regional faults

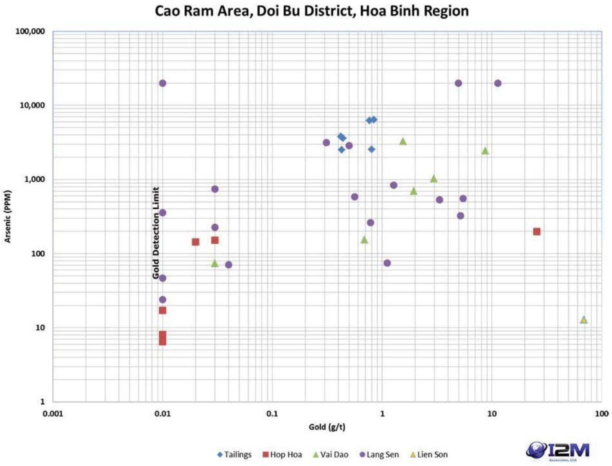

Figure 72: Log-Log Plot of Gold and Arsenic Concentration in Rock and Tailings. (click to enlarge)

within a predominantly compressional to transpressional environment.

Wall-rock alteration typically is composed of silica pyrite muscovite within a broader carbonate alteration halo. Quartz-carbonate altered rock forms the most commonly recognized alteration assemblage. Gold is deposited at crustal levels within and near the brittle-ductile transition zone at depths between 6 km and 12 km, pressures between 1 and 3 kilobars, and temperatures from 200°C to 400°C. Such deposits have a vertical extent of up to 2 km, demonstrate extensive down-plunge continuity, and lack pronounced zoning.

Orogenic gold deposits are commonly associated with late syntectonic intermediate to felsic magmatism. The vein systems tend to occur as a system of *en echelon* veins on all scales. Tabular veins occur within less competent lithologies, whereas veinlets and stringers forming stockworks occur in more competent lithologies. Vein systems are often spatially associated with contacts between lithologies displaying competency contrasts. Lower-grade bulk tonnage styles of mineralization develop in areas marginal to veins with gold associated with disseminated sulfides in the host rock.

The ore mineralogy is dominated by gold, pyrite (and arsenopyrite?) with subordinate galena, chalcopyrite, pyrrhotite, sphalerite, tellurides, scheelite, bismuth, and stibnite. Sulfide mineralogy commonly reflects the litho-geochemistry of the host rock with pyrite the most common sulfide mineral in metasedimentary host rocks and pyrite or pyrrhotite more typical in metamorphosed igneous hosts. The gangue and alteration mineralogy is dominated by quartz and carbonate (ferroan dolomite, ankerite, siderite, calcite) with subordinate albite, fuchsite, sericite, muscovite, chlorite, and tourmaline.

Other Deposits in Vietnam

Gosselin and Dube [10] in their review of world gold deposits, listed two locations in Vietnam. Case 4037 Pac Lang is a Late Jurassic, probable turbidite-hosted quartz-carbonate vein (Bendigo type) Au-Ag deposit with a total gold resource of 137 metric tons. It is located in the Ngan Son township, in the Song Hiem continental rift zone, North Indochina gold metallogenic province, Vietnam. NS-trending faults are the dominant regional tectonic structure in the area. Quartz-vein mineralization is hosted by shale, coaly shale and sandstone of the Middle Triassic Song Hiem Suite. Quartz is the dominant gangue mineral, together with common calcite and barite. Work on the giant Sukhoi Log sediment-hosted gold deposit in Russia illustrates pyrite growth over a range of conditions and stages of gold remobilization and final emplacement [17].

Ore mineralogy is dominated by pyrite, with lesser sphalerite, galena, chalcopyrite and arsenopyrite?, and minor argentite and gersdorffite. Mineralization is structurally controlled by NW-SE-oriented faults, and their intersections with the regional NS-trending faults. No hydrothermal alteration is reported for the Pac Lang mine area, although volcanic rocks at the Na Pai mine are affected by propylitic alteration and silicification. The metallic signature of the bulk of the ore (inferred from its mineralogy) is Au-Ag-Zn-Pb-Cu-As-Ni.

At the second location, Case 4038 Bong Mieu is a Late Triassic to Early Jurassic, intrusion-related, batholith-associated quartz vein (Korean type) Au-Ag-Pb deposit with a total gold content of 4 metric tons. It is located in the Tam Ky district, on the northern margin of the uplifted Kontum Massif, South Indochina gold metallogenic region, Viet Nam. Regional structure is dominated by two parallel WNW-ESE-trending anticlinal structures. Mineralization is structurally controlled by six fault and shear systems. The two main fault systems are: 1) a SW-trending, shallowly-dipping fault system that is heavily mineralized, and 2) a NW-SE-oriented, moderately to steeply-dipping fault system.

Ore mineralogy is dominated by pyrite and arsenopyrite in places, with lesser galena, hematite, magnetite, chalcopyrite, pyrrhotite, sphalerite, molybdenite, and cassiterite. Hydrothermal alteration consists of chloritization and sericitization. The metallic signature of the bulk of the ore

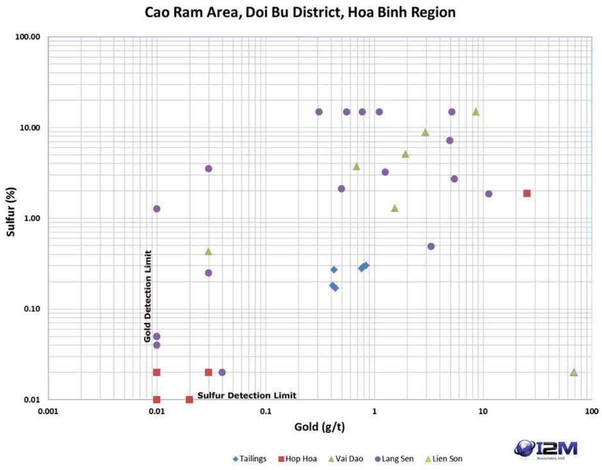

Figure 73: Log-Log Plot of Gold and Sulfur Concentrations in Rocks and Tailings. (click to enlarge)

(inferred from its mineralogy) is Au-Ag-As-Pb-Cu-Zn-Mo-Sn. Quartz-vein mineralization is hosted by Lower Proterozoic quartz schists, gneisses and quartzites. Quartz is the dominant gangue mineral, with minor calcite, muscovite, and graphite.

Other deposits have been summarized by Manaka*, et al*., (2010) as the Phuoc Son gold deposits located approximately 90 km southwest of Da Nang [17]. The area is part of the Truong Son Fold Belt, which is topographically and geologically characterized by a regional NW-SE trend from northern Laos to central Vietnam. It is one of the most metallogenically significant regions in mainland SE Asia, hosting significant gold-copper resources (Phu Kham, Sepon, Phuoc Son [13, and 17]).

Besra's Phuoc Son area is underlain by a medium-to-high-grade metamorphic complex and lies within the Phuoc Son-Tam Ky shear zone [30]. The location is also recognized to be near the intersection of two regionally-developed faults (i.e., N-S trending Po Ko and NW-SE trending Kham Duc-Tra Bong faults) [4].

Manaka [17] indicate that gold resources at Phuoc Son consist of two orebodies (i.e., North and South deposits), which are located in the southern end of the license area and are currently being mined (2009). Several undeveloped gold prospects are also recognized within that license area and an exploration program targeting these and extensions of North and South deposit orebodies was underway in 2009.

Gold resources at Phuoc Son delineated from the North and South deposits were estimated in 2009 to be 2.6 million tonnes at 7.76 g/t gold with significant lead and zinc. These deposits are still being developed by Besra Gold Inc., formerly known as Olympus Pacific Minerals [6]. Besra also developed the Bong Mieu and other deposits [7].

Preliminary petrological, geochemical, mineralogical, and stable isotopic studies indicate that the gold mineralization at Besra's North and South deposits occurs as quartz-carbonate-sulfide veins which are structurally-hosted in meta-sedimentary rocks (mainly phyllite to schistose carbonaceous shale). LA-ICPMS zircon U-Pb geochronology reveals that the meta-sedimentary rocks (derived from a protolith of carbonaceous black shale) were probably deposited c.a. 500Ma, as interpreted from detrital zircon ages. These were intruded by a series of plutonic rocks including gabbro (484±7 Ma; now occur as meta-gabbro), rhyodacite (442 ±4 Ma), and different generations of granites (472 ±6 Ma, 348 ±7 Ma, 300 Ma, 255 ±4 Ma and 240 ±4 Ma) [30].

Of particular note is that mineralization paragenesis at the North and South deposits was established based mainly on pyrite textures, which imply at least three different types of pyrite including diagenetic, metamorphic and hydrothermal generations. The diagenetic pyrites, which are characterized by aggregated fine-grained texture, occurred only in hinge zones, but are rarely preserved, and might represent the earliest stage as they generally occur as inclusions of metamorphic pyrite. The metamorphic pyrite is identified from its coarse-grained, euhedral shape with sponge textures, and is the most abundant and common type of pyrite at Phuoc Son.

Wang, *et al*., [31] indicate that as with chalcopyrite, pyrite also shows distinct trace element associations in grains with different habitus. The low-temperature association of elements (Pb, Mo, Mn, U, Mg, Ag, and Tl) is typically present in colloform/framboidal pyrite (Figure 46), whereas the high-temperature association (Se, Co, and Bi) is enriched in euhedral pyrite.

The late-stage hydrothermal pyrites are mainly hosted in the quartz-carbonate-sulfide veins, which are paragenetically identified to be the latest stage as clasts of meta-sedimentary rock are commonly included in the vein. Gold occurs as free gold in the latest stage hydrothermal vein, closely associated with other sulfides such as pyrrhotite, pyrite, galena, sphalerite, and chalcopyrite. These characteristics are comparable to an orogenic sediment-hosted gold system proposed by Large, *et al*. (2009), who indicated that gold mineralization is commonly present in carbonaceous black shale which forms both as source and host of some gold deposits [15].

In addition to the North and South deposits, several gold prospects have been identified at Phuoc Son, and in general they show a close spatial relation with Triassic granitic bodies [28]. In terms of the style of mineralization, the prospects are likely to be different (e.g., skarn at Khe Rin) from the North and South deposits as shown by previous studies [9]. They are all associated with and controlled by the dominant structural conditions in the area present as major faults and associated splinter faults, which are the case with the mineralization discussed in this paper.

Of particular note in this paper is the presence of a coherent, albeit small, mass of sulfide minerals, termed herein as the "intrusive mass" found along the periphery of the heavily oxidized, mineralized zone adjacent to the Lang Sen fault (see Figure 26). Additional work is recommended in the form of systematic sampling and analysis of the mineralized zones in the Hop Hoa mine and at the Lang Sen pit (once excavation has reduced the high walls in the latter to safe dimensions).

Sulfides, similar to those occurring in the "intrusive mass" in the Lang Sen pit are also present at the Hop Hoa mine (Figure 13), that show extensive oxidized zones containing gold in significant grades accompanied by gold-bearing sulfide zones that have escaped oxidation to date, and, are present in the areas of interest and quite likely in the areas between the Hop Hoa area and the Lang Sen area.

Geologic Risks

In assessing a project's geological risks in terms of whether there is present sufficient ore grade and tonnage to economically mine, it is important to emphasize that most if not all major centers of gold mineralization in the world have been mined down the trend dip for more than 900 meters. Earlier exploration located most of the shallow deposits by identifying surface expressions of oxidation, which made such ore amenable to cyanide-heap leaching. However, most of these deposits have roots in the transition to sulfide gold (as electrum and native forms), where gold typically occurs within the mineralogical structure of pyrite (and arsenopyrite?), and some other minerals that must be roasted (oxidized) before the metals can be recovered.

Drilling has intersected mineralization grading over 10 g/t gold at depths of over 1,200 meters in some mines in Australia, for one example. Exploring for deep zones is cash-intensive and of high risk (Figure 66 and [18], but the rewards can be profitable for all stakeholders, i.e, stockholders, local and national government, and local communities, as confirmed by the number of companies that are currently active in gold mining regions around the world.

Value of Gold Deposits

As discussed earlier, each significant gold deposit has its own uniqueness but it also has similarities to nearby deposits along known trends, and to other deposits in the world. But each gold deposit also has its own intrinsic value to the mining companies developing the project, to the surrounding inhabitants in terms of potential jobs and potential environmental issues, and to the local and national governments who stand to receive considerable royalties. They also are charged with regulating the mining industry to protect human health and the environment.

The price of gold, of course, has a significant impact on when or if a particular deposit will be mined. The principal objective of most mine managers is to reduce the cost to produce each ounce of gold as much as reasonably possible. Any decreases in the run-of-mine ore grade have dramatic impacts on the economic viability of any gold mining projects. Insufficient drilling in the early stages of a project has been the cause for shutting down many mines after only a few years. The difficulties introduced by the "nugget effect" must be avoided in reserve assessments. The quality of the assessment and production drilling of the resource, with the principal objective of defining reserves, must be implemented by insuring that the mineable reserves have been defined in the context with the mine-site specific economics to a reasonable degree, as characterized by JORC/NI 43-101 standards and other governmental requirements. The grade and ore tonnage of a mining prospect are also important factors that impact project economics. Note in Figure 75 that most economic deposits exhibit gold ore grades of 1 g/T, but very large tonnage projects operate with less than 1 g/T gold. Mining tonnage range from one to 10 million tonnes of gold ore grading more than 1 g/T.

Project Risk Assessment

The degree of geological risk involved in any particular project depends to a large extent on the caliber of the professional and supporting personnel that are available to guide exploration in determining the gold resources/reserves. In multi-metal deposits, this responsibility becomes even larger because the investment required increases rapidly with complex metallurgy and processing.

Because the areas southeast of Cao Ram (the subject and the surrounding areas of the Đồi Bù District, Hòa Bình Region have only recently received significant attention by the mining industry in the past 10 years, two of the known sites have been mined on a limited scale for a number of years and the ore zones are known to be rather continuous to the extent drilling has defined them to date. However, the area of interest has been investigated only superficially.

On the basis of geological potential alone, the area of interest has not received the attention it deserves on technical grounds, although Russian efforts provides much of the early exploration data on these areas, including geochemical surveys, geophysical surveys, and drilling shallow anomalies.

New regulations have been implemented in Vietnam to streamline mine permitting at both the local and national levels, combined with appropriate environmental controls, for example, tailings management, and waste water and expected acid-rock drainage to protect human health, groundwater and surface water, and the environment. Once the new regulations from the federal government are finalized and implemented, these actions will go a long way toward improving the climate for investing in mining projects in Vietnam and in bolstering Vietnam's economy to provide improved infrastructure and education for the people of Vietnam. In the meantime, Vietnam is ranked poorly in investment popularity by much of world media in 2017 [11]. This will have to change if Vietnam is to broaden its economic base.

Cam Vao Gold Ore Processing Facility

During the I2M visit to the subject area, the mine owners conducted a tour of the Cam Vao gold processing plant (Figure 76, 77). The plant contains a circuit for crushing (Figure 77) and one for removing metals by flotation (Figure 78), followed by a cyanide recovery system to recover gold. Primary and final filtration systems (Figure 79) have been employed to remove the ultrafine-grained material creating gold matte that is then dissolved in acid, and with the aid of a flux, the matte is fired and gold dore is poured containing mostly gold but likely containing silver and other metals as well [45, 46]. The main plant road leads down to the area road bordering rice paddies (Figure 80).

Ore from the Hop Hoa mine, for example, is a mixture of unoxidized sulfide with pyrite, but some ore contains free gold that is only available via fine crushing followed by either gravity separation or cyanide treatment after roasting the ore [40]. This liberates the gold in ultrafine particles which is trapped via filtration and subsequently fire-fluxed to produce dore. Based on the reported fineness of the gold, the electrum contains about 80% gold and less than 20% silver and other metals (e.g., lead, zinc, nickel, antimony, and a few other metals).

The Cam Vao processing plant was not in operation during the I2M visit and was reported to have been shut down a few months earlier for environmental reasons. The plant systems were apparently constructed in the 1ate 1990s and appeared to be operational, but approaching the end of their usefulness by having only a few years remaining without requiring

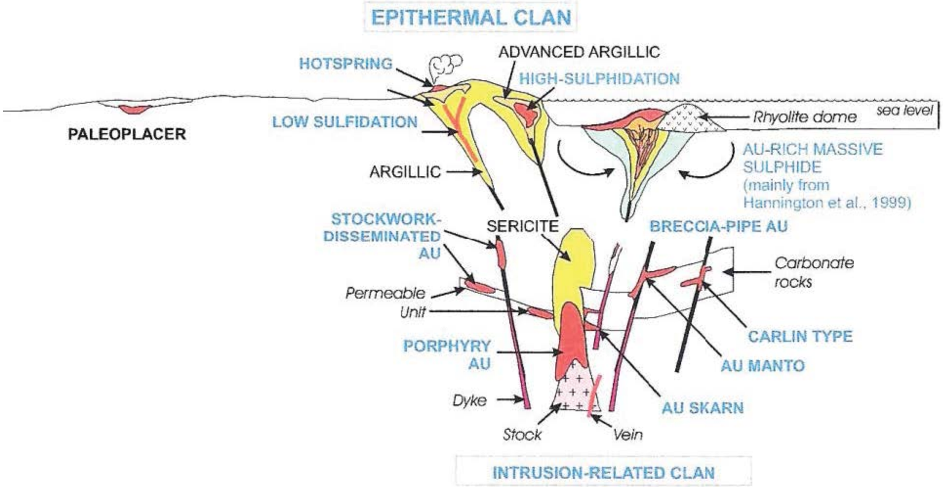

Figure 74: Epithermal and Intrusion-Related Mineralization [23].

major overhaul of motors, seals, transfer piping, and waste detainment ponds, pits, or lagoons.

Environmental Issues

While touring the plant property, the tailings pond area was observed by I2M personnel. There was no water in the pond

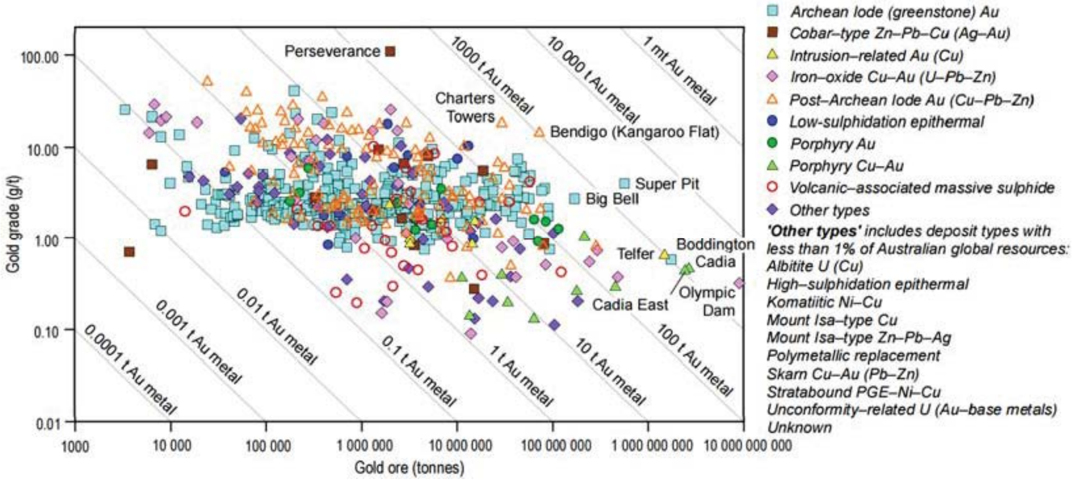

Figure 75: Gold Grade / Gold Ore Tonnage w/ Deposit Characterization [10].

Figure 76: At the Processing Plant.

Figure 77: Primary Crusher in the Processing Plant.

Figure 78: Flotation Cells at the Processing Plant.

and a breach in the detainment berm was noted. The pond was constructed adjacent to a dry stream, which indicated that fine-grained material could have drained from the tailings pond into the stream creating the mounds shown in Figure 81.

Sample Collection of Tailings

I2M personnel sampled a recent tailings pile in back of the processing plant, the empty tailings pond area, and the stream sediment adjacent to the tailings pond for the purpose of laboratory analyses via elemental scans and other methods to determine the content of the tailings. Duplicate samples were taken at each site. Further, two water samples were obtained from the rice paddies in front of the plant entrance (Figure 80), but these were confiscated in Hong Kong by security personnel (for safety reasons) in transit prior to shipment to the U.S.

One trench was excavated to a depth of approximately two feet at each of the three sites (Figures 83-84). Composite samples were collected by I2M personnel from the trench walls to represent the vertical exposure. After splitting the samples down to a representative size, two samples weighing approximately 1 kilogram each from each site were submitted to the laboratory for analysis.

Figure 79: Final Filtration System at Tailing Pond (Dry).

Analyses of Tailings

The analyses show that the sediments of all three tailings sites exhibit high concentrations of arsenic, and exhibit elevated concentrations of cadmium, mercury, and lead (shown in Table 3 below). Whether these elements have been dissolved out of the tailings by rainfall and have entered the surface water (during the wet season) and local groundwater in solution are unknown. Further, although cyanide solutions were used in the plant for gold recovery, this soluble anion can degrade in the environment and does not typically persist in surface water or in groundwater and can form ion pairs with soluble iron (which was abundant in the tailings), lowering the toxic free cyanide to near zero and was thus, would be no threat to human health and the environment.

It should be noted however that the arsenic levels in the tailings sample reflect those of the mineralized rock samples taken from outcrop in the areas of interest. The same is likely true of the other elevated elements in the tailings samples as well. In general, the more highly mineralized the ore, the greater the metal content and the greater concentrations in the tailings. This is indicated in Table 3. Low pH of water produced from

Figure 80: Road Down from Plant toward Main Road and Rice Paddies.

Figure 81: Sample Site at Pond Breach into Creek (Dry).

Figure 82: Behind Plant Tailings.

Figure 83: Sampling Dry Creek Sediments.

sulfide-bearing ores (i.e., ARD) and tailings, will provide some transport potential of metals and metalloids in surface and groundwater with elevated concentrations, and must be controlled at the source to prevent environmental degradation.

Conclusions and Recommendations

Gold in the Doi Bu District southeast of the Cao Ram area of interest was formed in part in a compressive, orogenic setting, but its occurrence also shows characteristics of intrusion-related, epithermal mineralization. The gold occurs in quartz veins and in sulfides in fault-related mineralization, the latter primarily in association with massive amounts of pyrite and pyrrhotite.

The structural setting has played a major role in the formation of the gold deposits. The major Song Da Structure outcropping to the NW of the area of interest (Figure 5) has served to create a complex system of strike-slip and thrust faults that are highly favorable for trapping gold and other metals in hydrothermal mineralizing fluids.

We conclude that the resulting uplifted dome structure that characterizes the area of interest was formed within and after volcanic formations of the Vien Nam complex were injected during Late Jurassic to Early Cretaceous. During this period, a series of feather faults, fractures, and cataclastic zones containing quartz breccias, for example, were formed in these volcanic rocks around the margins of the uplifted dome and perhaps along favorable fault zones, especially those striking NW (Figures 7A, 7B and 7C).

Furthermore, geophysical data from gravity surveys indicate that there is indeed a large intrusive body of granodiorite or granite at relatively shallow depths in the area of interest that would have provided the fluids containing gold and other metals.

We have also concluded that the area of interest exhibits all the geological and geophysical features required to justify a major exploration program. Furthermore, the data available on the Hop Hoa mine and associated areas such as the old Vai Dao mine area in the northwest of the area of interest, and the Lang Sen deposit and Lien Son mineralized zones south of the areas of interest, indicate that the properties are of sufficient merit to initiate such activity in these areas.

Figure 84: Sampling Tailings' Pond Sediments.

With the appropriate drilling programs to test the numerous zones at or near the surface, open-pit designs would likely be feasible to increase production well beyond that of current operations at the underground Hop Hoa mine. Open-pit mines usually have lower grades but produce far greater ounces of gold than underground operations [5].

However, the Hop Hoa mine production could probably be expanded by adding production shifts, additional personnel, trucks, etc., but with the processing plant currently closed by government order, this is not possible unless another processing plant can be located for possible contract processing. A new ore processing plant could be designed and built possibly within 5 years, but a substantial exploration program consisting of geological mapping and outcrop sampling, and a series of ground magnetic surveys, followed by drilling and coring of

Sampling Sites Reference #	Name & Area of Mineralized Zones	Average Gold Content (g /T)	Length of Mineralized Zones (m)	Thickness of Mineralized Zones (m)	References & Source of Data
1		4.04	120	4.50	Hào:17,33,79 Điểm lộ: ĐL.1,2 LK. 2
2		3.55	138	0.85	Hào 47,91
3		1.00	80	0.92	Hào 53
4	Vai Đào 2km2	7.64	365	2.28	Hào 6,7,52,93; lò 1 G.1; LK. 1
5		2.90	82	0.87	H.83
6		1.00	94	0.63	H.93
7		2.20	54	1.00	H.82
8		1.00	90	0.57	H.76
9		2.75	52	2.00	ĐL.2826; H.439
10		4.60	120	0.79	H.406
11		8.18	127	1.16	H.408; 412
12		6.70	32	0.78	H.419
13	Làng Sen 2.3 km2	2.30	31	0.67	H.409
14		6.80	87	0.60	H.409
15		3.23	84	2.03	H.409
16		4.32	117	0.80	H.409
18	Hop Hòa 2.0 km2	2.30	94	0.88	H.118
Near-By Area					
1		0.50	100	3.74	H.45
2		8.00	100	1.20	H.45
3	X. Vần 3.5 km2	2.79	530	9.62	H.22; G.19; 9 VL.10-3; 11; 4029 L.6; 50
4		4.29	400	2.11	H.22; G.19; 9 VL.10-3; 11; 4029 L.6;50

Table 2: Previously Reported Characteristics of Mineralized Zones. * Note: Modified from table in Nguyen Dac Lu, No Date, "Brief Outlines on Gold of Vietnam".

Sample ID#	**Sample Area**	**Arsenic** (ppm)	**Cadmium** (ppb)	**Mercury** (ppb)	**Lead** (ppm)
I2MA-0001	CAO Ram Trench	2,530	620	178	47.0
I2MA-0002	CAO Ram Trench	2,510	560	182	41.9
I2MA-0003	CAO Ram Pond	6,250	860	346	42.7
I2MA-0004	CAO Ram Pond	6,420	870	342	45.8
I2MA-0005	CAO Ram Creek	3,610	660	158	30.9
I2MA-0006	CAO Ram Creek	3,790	730	177	33.5
Detection Limit		0.2	20	5	0.5

Table 3: Tailings Geochemistry,Plant Trench, Tailings Pond and Stream Sediments Arsenic, Cadmium, Mercury, and Lead.

one or more mineralized zones, would be required before the construction of a new plant would be justified economically.

The long-term outlook of the gold price indicates that gold will remain above $1,000.00/ounce for the foreseeable future. Of course any major political instability and/or catastrophic economic or environmental cataclysmic event could cause a fundamental change in business decisions. This would likely drive the gold price even higher, possibly lasting decades, whereas stability and improved production methods will contribute to lower costs. The issues of the mid-1970s and of 2008 show the impact on gold and silver prices in Figure 85.

Engaging geology professors as consultants, graduates, and students as field assistants from the major universities in Vietnam would be beneficial as a training program for the company and for Vietnam. The local inhabitants would also be engaged to support the operations.

To minimize fiscal risk to foreign companies interested in investing in the mining industry, the Government of Vietnam should be in a position to provide some form of guarantees and insurance against unforeseen malfeasance or misrepresentation by in-country business partners. Wishbone Gold management did not proceed further in the development of this project

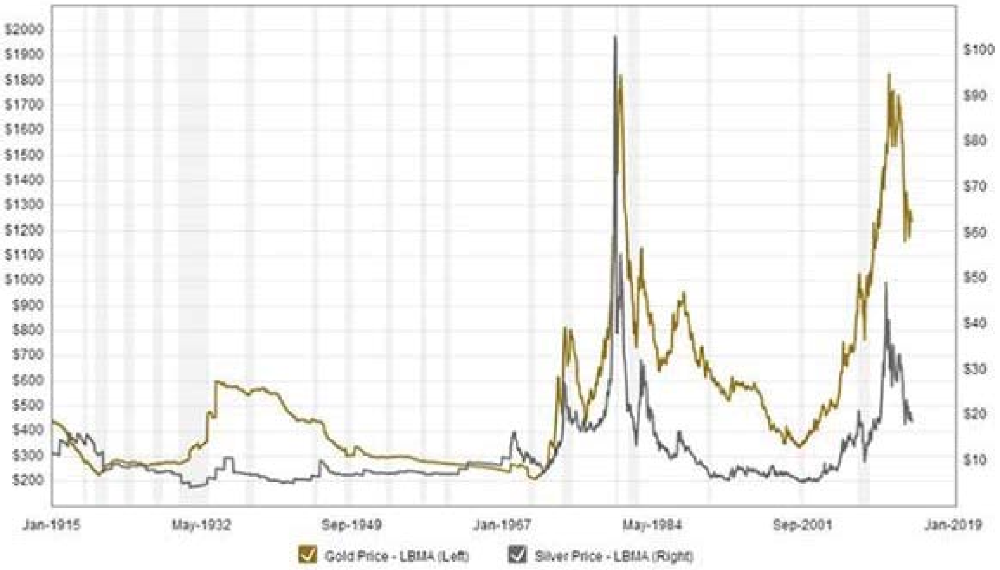

Figure 85: Gold Price Trends since 1915.

because of ownership and title issues in the areas of interest.

There are international agencies that also could be interested in assisting Vietnam to build its economy by investing in the Vietnam's mining industry. The development of natural resources creates value for the companies involved, for the local businesses and workers, and for the district and national governmental agencies. With new regulatory controls in effect, and with such operations monitored closely by the companies and regulatory agencies involved, any environmental issues surrounding such operations can be controlled.

The areas downstream where the subject creek empties into the valley and rice paddies should also be evaluated for elevated arsenic, cadmium, mercury, lead, and other metals and metalloids. The United Nations, World Bank, or other international agencies might also have an interest in underwriting the funding of the environmental assessment or other similar projects in northern Vietnam.

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Appendices:

Appendix A – Topographic Map of General Area

Appendix B – Northern Sampling Sites

Appendix C – Southern Sampling Sites

Appendix D – ALS Laboratory Data

Appendix E – Hop Hoa Section

Appendix F – Hop Hoa and Vai Dao Map

Appendix G – Vai Dao Section: Drill Holes and Geophysics:

Drill Holes
Geophysics

Appendix H – Vai Dao Fault Mapping and Geophysics

Appendix I – Luon Son Geologic Mapping and Fault Mapping

Appendix J – Luon Son Mapping and Geophysics

Appendix K – Field Photographs

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