

Visit at the Cam Pha Antimony Plant in 2010, since then greatly enlarged

Antimony Potential in Northern Vietnam

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1. Introduction :

In May 2010 the author of this publication did an assessment and due diligence of the antimony potential of the Cam Pha ore field located some 20 Kilometer north of Cam Pha in Quang Ninh Province in Northern Vietnam. The scientific outcome of this visit was initially published on the website of the author : www.mineral-exploration.com in 2014. Five years later the author came back to this topic and now presents a second report, covering the antimony potential of the whole region of Northern Vietnam.

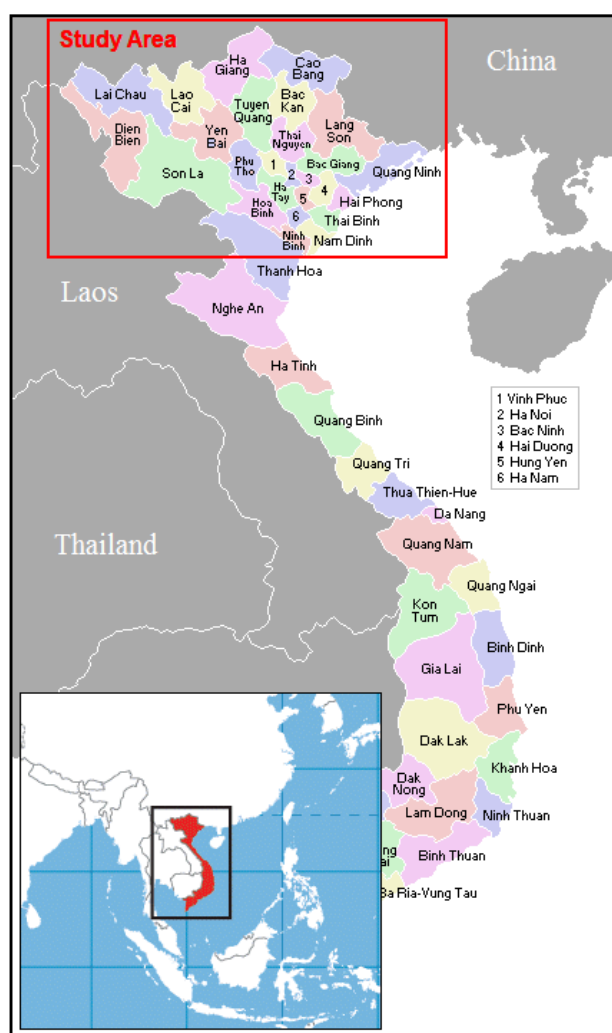
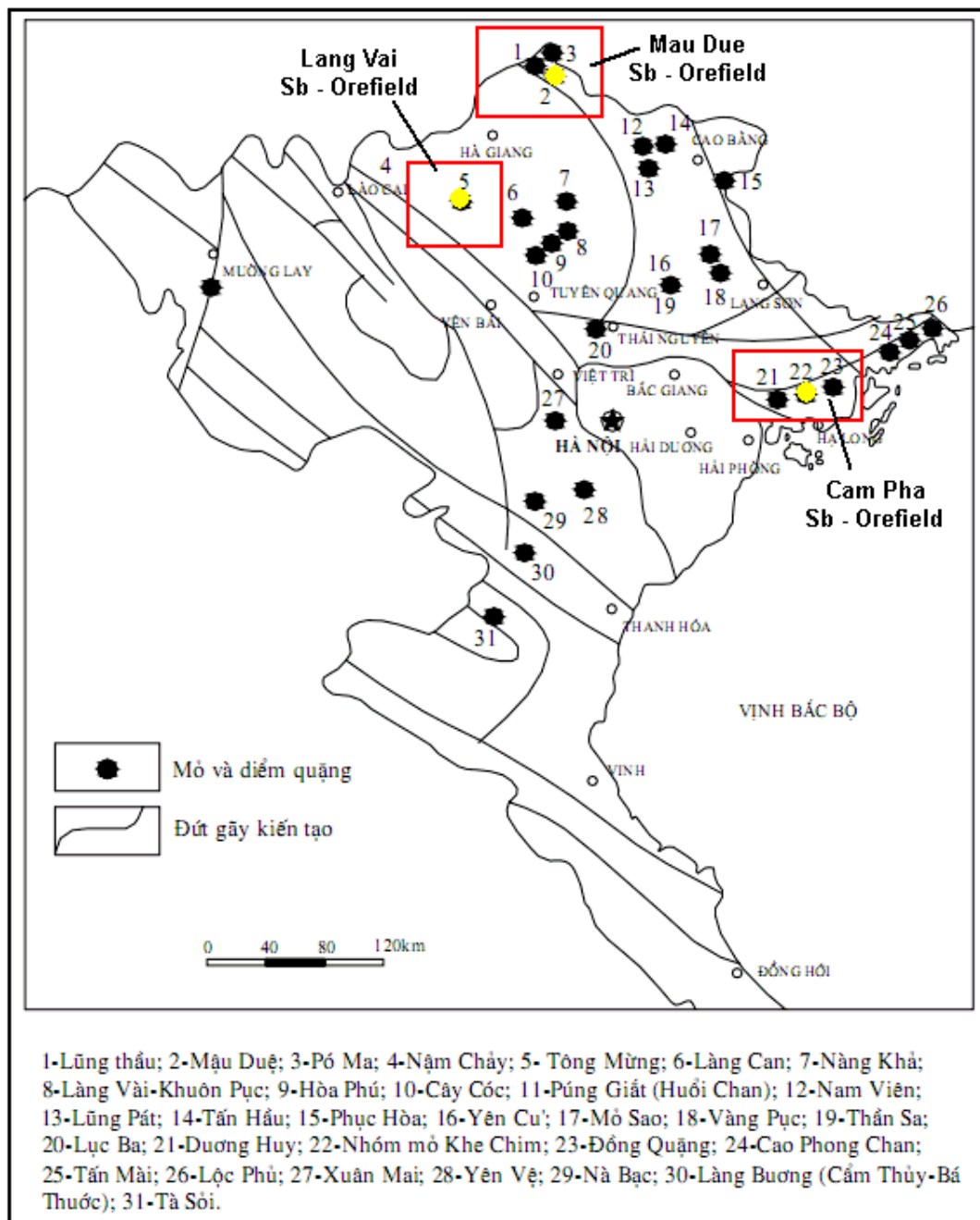


Fig.1 : Location of Study Area in Northern Vietnam

Map Source : unknown

Northern Vietnam is richly endowed with antimony deposits, mainly in the form of generally steeply dipping hydrothermal stibnite = antimonite veins or shear zones. Figure 2, taken from Nguyen Van Binh (2008), show an overview map of the known antimony deposits in the area with the most important ore fields highlighted by red boxes. According to USGS information detailed antimony exploration in the last two decades resulted in the recent discovery of new antimony deposits in Northern Vietnam, which are not shown in this map.



**Fig. 2 : Overview of Antimony Mines and Deposits in Northern Vietnam.
with more important ore fields highlighted by red boxes**

Image Source : Nguyen Van Binh (2008)

Apart from a number of recent geological and mineralogical publications - mostly in vietnamese language - the most comprehensive publication on antimony deposits and mines is the 250-page book published in 2008 by Nguyen Van Binh titled *"Antimony in Northern Vietnam"*, detailing the geology and mineralogy of all antimony deposits known at that time. In the following chapters we will go into more detail of the three major antimony deposits in Northern Vietnam : Cam Pha, Mau Due and Lang Vai ore fields.



2.1 Cam Pha Ore Field :

The following map gives an overview about the Cam Pha antimony ore field with important mineral deposits, which is located about 25 – 40 kilometer north of the world renowned scenic Halong Bay, "hidden" behind a number of giant open pit coal mines. As shown in figure 2 above, there appears to be a continuation of the Cam Pha ore field to the east with more antimony deposits, namely Cao Phong Chan, Tan Mai and Loc Phu.

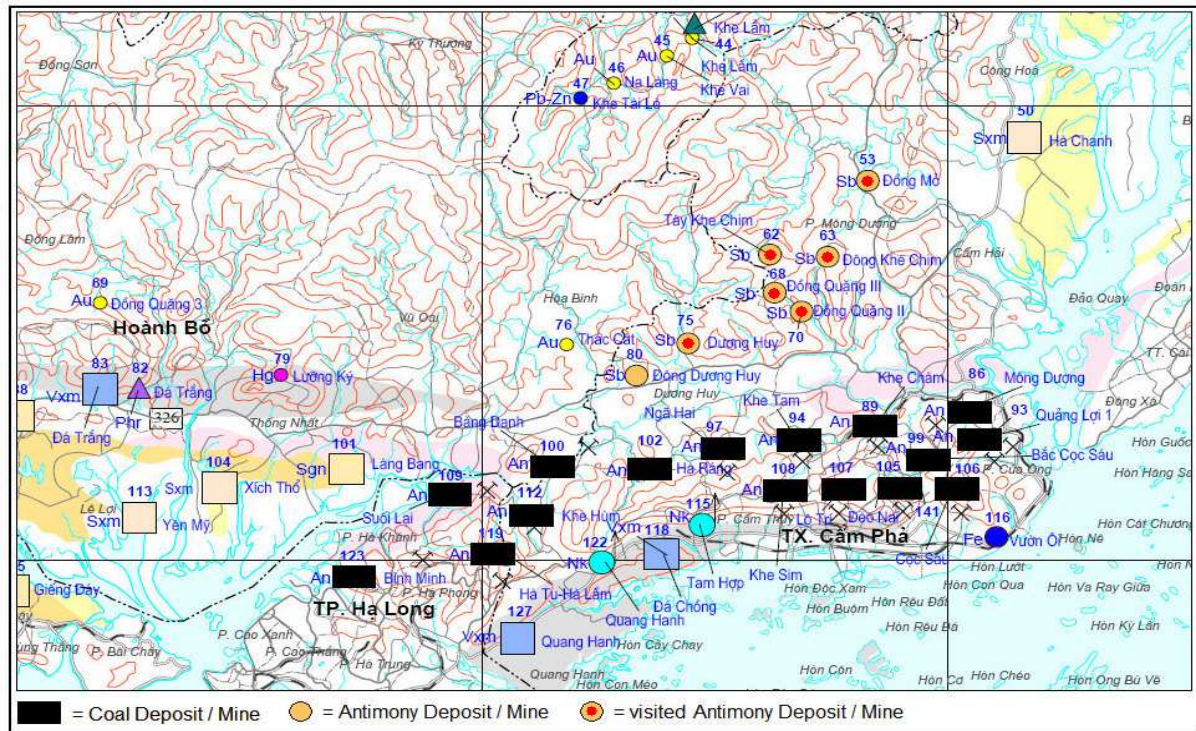


Fig. 3 : Map of Cam Pha Area indicating important antimony deposits

Map Source : Vietnam Geological Survey

The antimony deposits and mines of the Cam Pha ore field are located in a hilly to mountainous area, which rises up to roughly 300 meter above sealevel and which are heavily vegetated by subtropic dense jungle, rapidly overgrowing any disused road, track, mine structure and exploration trenches within short time. The major mines can be reached by dirt roads in dry season, but may become totally inaccessible during rainy season.

The Campha Antimony ore field consists of 40+ larger antimony ore veins, of which about 30 are of economic ore grade. Most of the steeply dipping ore veins and +/- vertically shear zones are typically between 0.5 and 1.0 meter wide, locally swelling up to 6 meter width. The antimony grades of the stibnite ores vary considerably between 3 % and 12 % antimony with occasional shoots of much richer ore. Most of the veins also show interesting gold grades, with up to 6 g/t Au in individual veins.

Antimony mining in the whole Cam Pha area is done by extensive underground development and many veins are accessed by short adits, followed by more development work along the vein structures. In some cases declines were constructed to gain access to deeper vein levels. No mine shafts – not even for exploration or ventilation - seem to be present in the whole area. Also as of 2010 none of the veins have been explored by systematic exploration drilling for deeper continuations.



There is however a good potential to delineate further and possibly even large antimony reserves by a systematic exploration program, as most ore veins have so far been mined just close to the surface. Also there is a good chance to discover more lateral extensions of known antimony ore veins as well as discover hitherto completely unknown antimony ore veins.

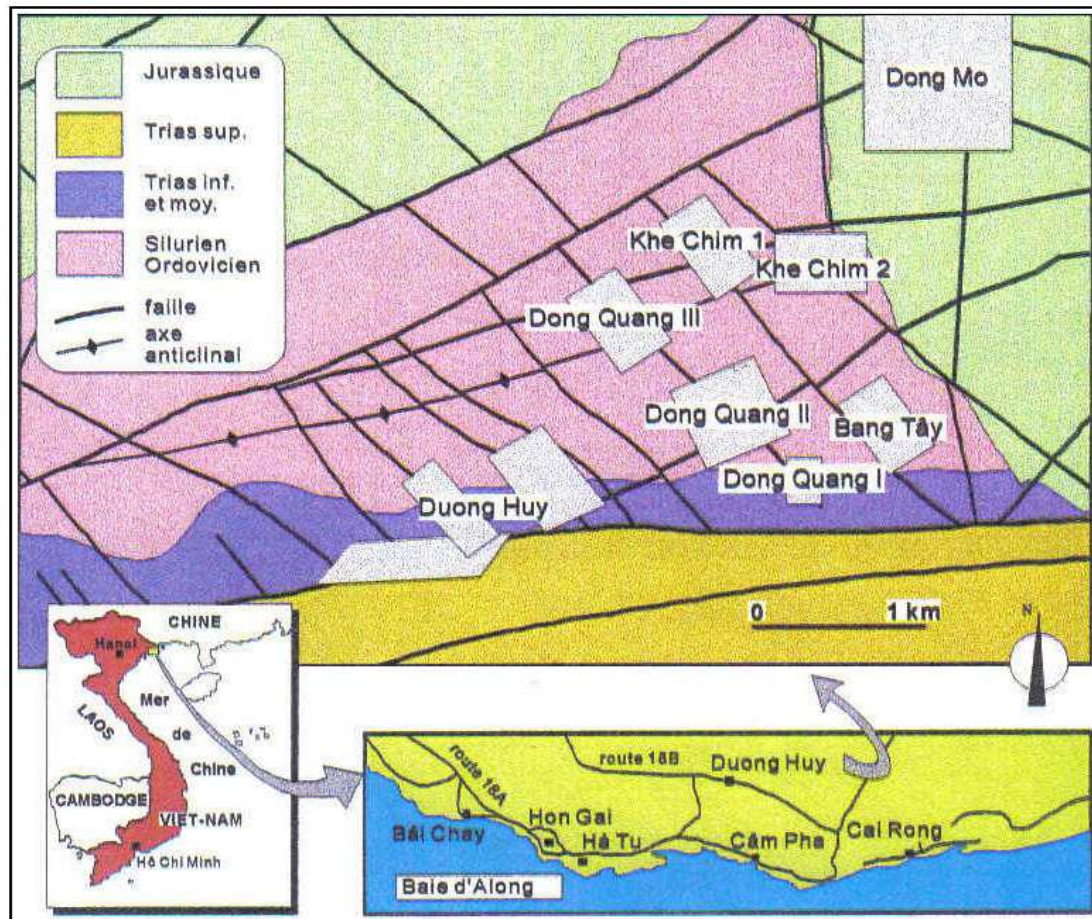


Fig.4 : Schematic geological map with fault pattern and main antimony mines in the Cam Pha ore field, Source : Dinh Moc, N. & Dejonghe, L. (1996)

Apparently exactly this have happened in the years since 2010, as the recently enlarged Bang Tay antimony plant has now a reported capacity of 250.000 t ore throughput per annum, which indicate recent antimony exploration successes in the Cam Pha ore field.

The operating company constructed a central antimony beneficiation plant and antimony smelter with 50.000 t annual capacity prior to 2010 at Bang Tay in the Cam Pha ore field, which was visited by the author in May 2010, see title image of this publication and figure 5 below. Since then the capacity of the beneficiation plant and antimony smelter at Bang Tay was greatly enlarged, see following Google Earth satellite images taken in 2011 and 2018 respectively.



Fig.5 : Antimony Trioxide Condensation Columns inside the BCC owned Bang Tay / Cam Pha Antimony Smelter in 2010

The current annual capacity of the Bang Tay beneficiation plant is reported at 250.000 t antimony ore throughput per annum (USGS 2011, 2012). Apart from that the infrastructure of the once fairly remote Cam Pha ore field was substantially improved with the opening of a new 4 - lane motorway just a few hundred meters from the Bang Tay antimony plant.

Concluding it appears that the Cam Pha antimony ore field have been systematically developed by the owners into a modern and well organized integrated antimony unit during the last few years.



Fig.6a/b : Google Earth Satellite Image of the Cam Pha Antimony Smelter: a) in 2011, b) in 2018



2.2 Mau Due Ore Field and Smelter :

The second of the major antimony ore fields of Northern Vietnam comprises the Mau Due antimony mine in Northern Ha Giang Province in proximity to the Chinese border (Coordinates : 23° 4'38.49"N, 105°14'57.61"E, 400 meter above sealevel) as well as several lesser mines such as Lung Thau further to the north and Po Ma further to the east, see map in figure 2.

In contrast to the rather small underground operations of the Cam Pha antimony ore field the Mau Due Mine is a substantial open pit mine - see figure 7 - mining a number of flat to steeply dipping stibnite ore bodies, which run for several hundred meters and reach a width of 4 to 10 meter. Different from many other antimony deposits, the antimony ores of Mau Due have a very low arsenic content ! For more geological and mineralogical information we refer to Ishihara, Sh. & Xuan Pham, T. (2013), see literature section further below.



Fig.7 : Recent Photo of Mau Due Antimony Open Pit Mine

Image Source : laodong.vn

The Mau Due mine is operated by vietnamese company HGM - Ha Giang Mineral Mechanics JLC, which also owns and runs an antimony plant and smelter in Mau Due village, see figure 8. According to a 2010 company report HGM is the leading antimony producer in Vietnam, producing antimony concentrates of 99,95 % purity.



Fig.8 : Antimony Trioxide Condensation Columns at the Mau Due Plant in 2009

Image Source : Ha Giang Mineral Mechanics JLC



Fig.9 : Google Earth Satellite Image of the Mau Due Antimony Smelter in 2016

Antimony resources for Mau Due Mine were given in 2010 as 371.000 tonnes for ore body / vein 2 with about the same antimony resource estimated for ore bodies / veins 1 and 3. Another nearby antimony potential of HGM is said to be the close Mo Boi Mine, with antimony exploration in progress in 2010.



2.3 Lang Vai Antimony Ore Field :

A third cluster of antimony deposits is located in Tuyen Quang Province and comprise the Lang Vai Mine, the Lung Luong Mine, the lead rich Pu Bo Mine as well as some smaller deposits in the vicinity, see following map.

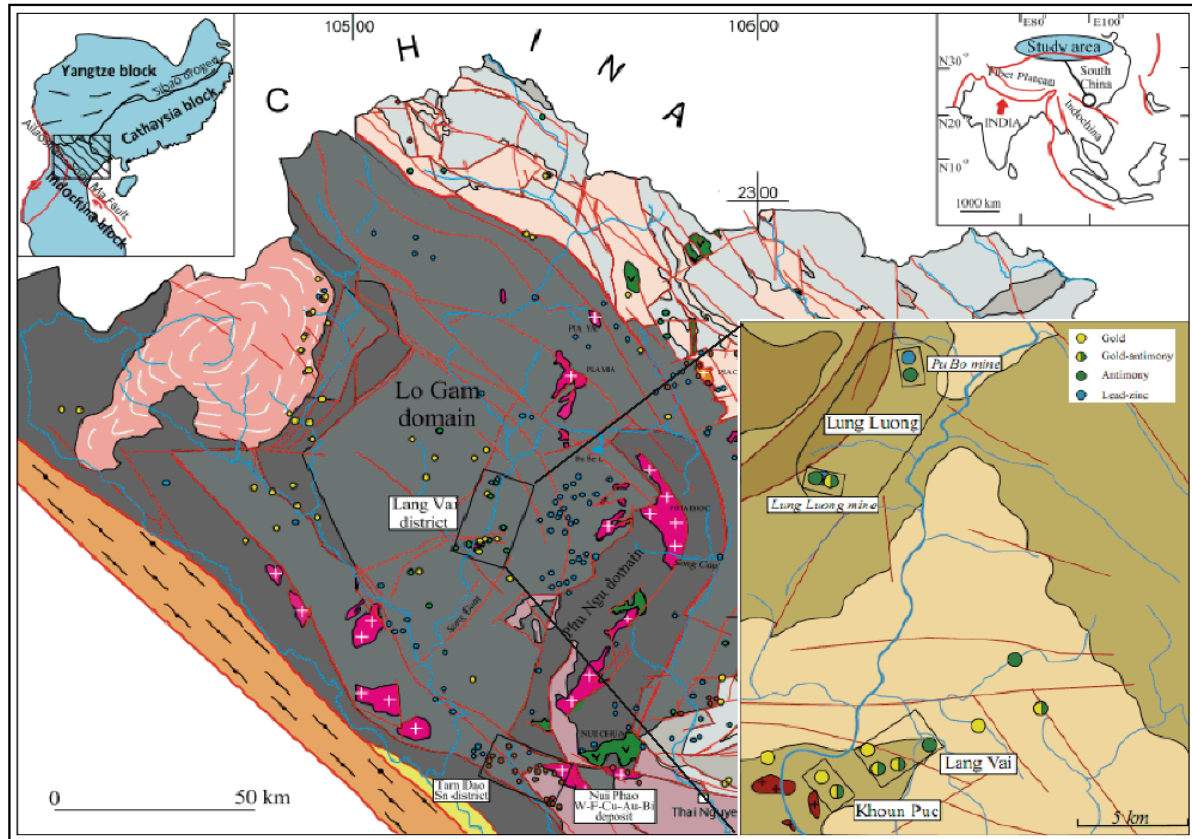


Fig.10 : Geology and Antimony Mines in the Lang Vai Ore Field, Tuyen Quang Province
compiled from Nevolko P. et al (2019)

The arsenic rich antimony mineralization of the Lang Vai Deposit at the approximate coordinates $22^{\circ}22'59.24''$ N, $105^{\circ} 3'31.60''$ E consists of several up to 100 meter wide antimony ore zones, which can be traced for 500 to 1400 meter. Exploration drilling confirmed at least 200 meter depth continuation (Nevolko et al. 2016, 2018, also see figure 12), indicating a possibly very large antimony deposit. The overall average antimony grade for Lang Vai is reported (USGS 2011, 2012) at 15 % Sb with 100 tons of Silver and 10 tons of Gold as recoverable byproducts. The overall antimony metal content is given as 100.000 tons Sb metal, making the Lang Vai deposit the largest single currently known antimony deposit in Northern Vietnam.

Despite these impressive figures there are few other information published on the Lang Vai deposit and the area in question is heavily covered by vegetation, obscuring details and the exact position of the mine in Google Earth satellite images.

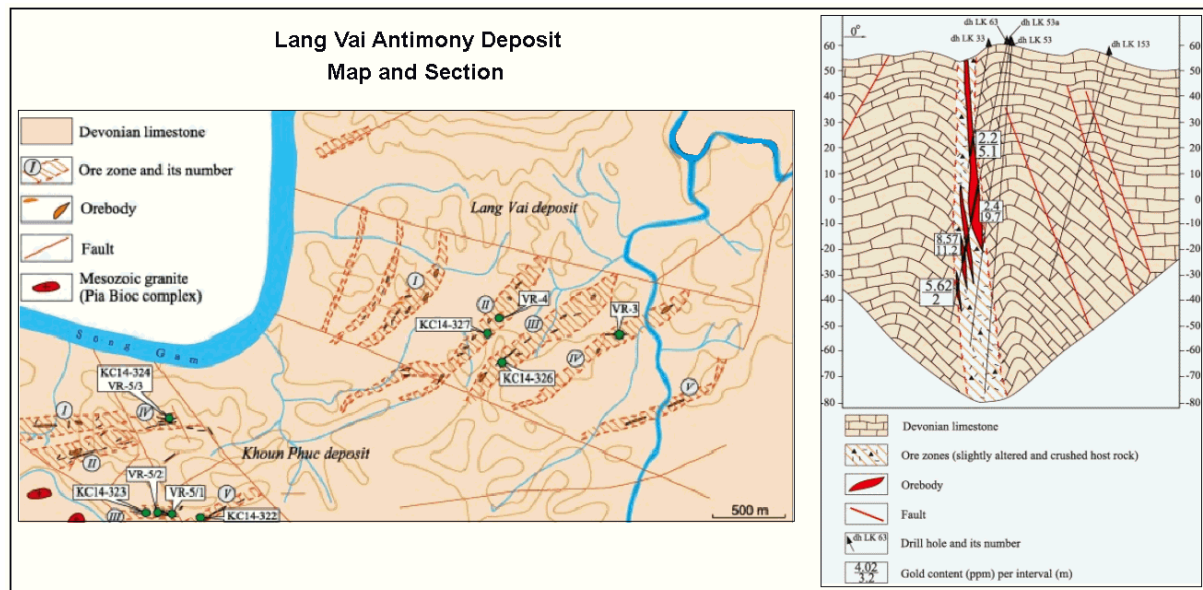


Fig.11 : Geology and Antimony ore zones of the Lang Vai Deposit, Tuyen Quang Province
compiled from Nevolko P. et al (2018)

Other Antimony Potential in Northern Vietnam :

As already shown in the overview map in figure 2, there are a number of other antimony deposits in Northern Vietnam, some of which are currently mined. However it is difficult to obtain reliable information about most of these deposits and mines, as most information is either in vietnamese language only or / and not readily obtainable.

A notable exception is the Hat Nan antimony - gold deposit near Ha De at the border of the Ha Giang and Cao Bang Provinces (approximate coordinates : 23° 4'50.22"N 105°31'2.29"E). The Hat Nan deposit forms a 200 meter long, vertical dipping vein of considerable width - see figure below - with massive stibnite ore in the core region, grading into a gold and antimony rich outer ore zone. For more details of the Hat Nan deposit please refer to Nevolko P. et al. (2016).

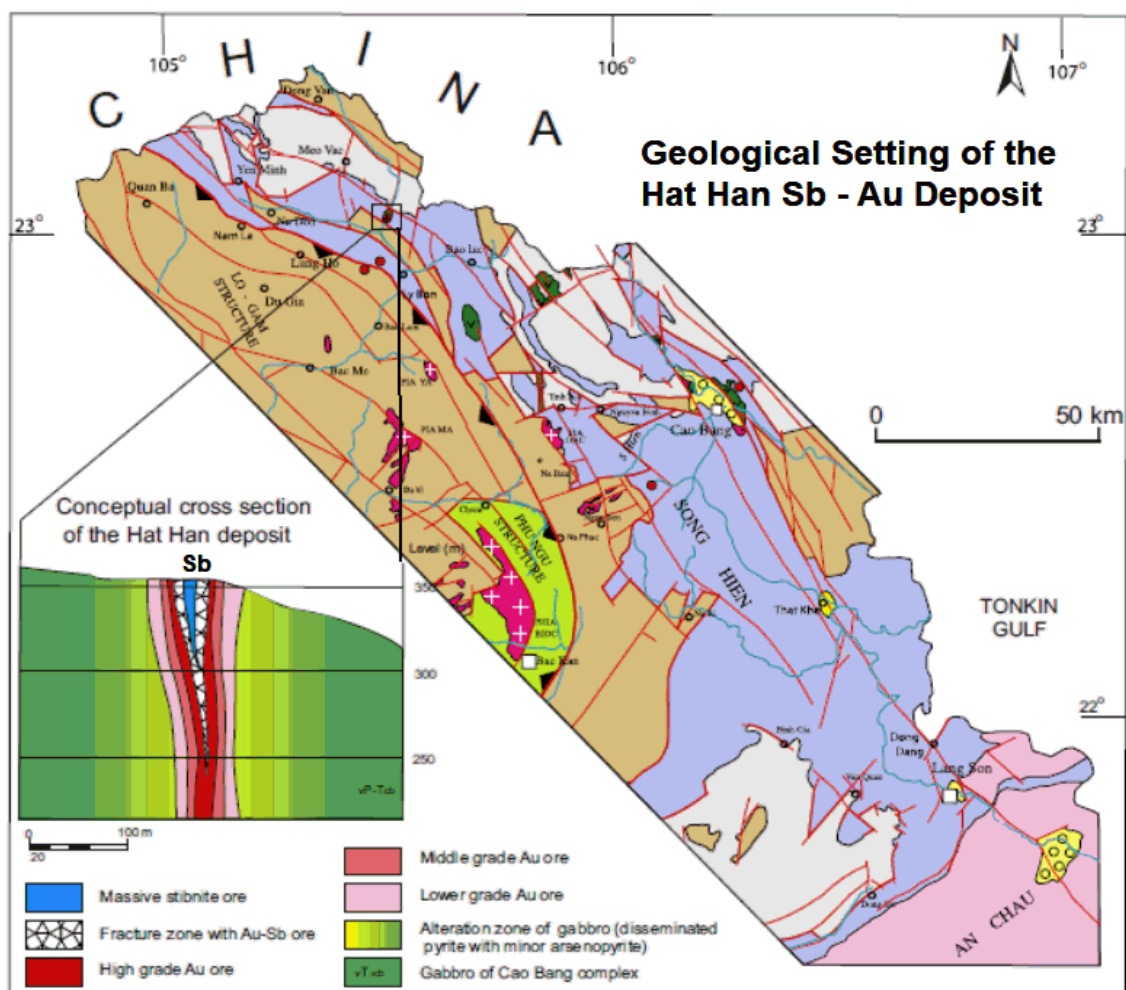


Fig.13 : Geological Setting of the Hat Han Antimony - Gold Deposit, Northern Vietnam
adapted from Nevolko P. et al. (2016)



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