Antimony Mineralization in the Sa On Area, Hopong Township, Taunggyi District, Shan State (south)

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Abstract

Sa On area is situated about 30 kilometres east of Hopong, Shan State (South). The major rock units are Mibayataung Group and Plateau Limestone Group. Structurally, the faults are trending NE-SW and NNW-SSE. Two antimony occurrences are found in the research area. Sa On. Antimony Mineralization is hosted by the quartzose sandstonde of Taungmingyi Member. The chief ore mineral is stibnite and associated ore mineral is pyrite. Under ore microscope, stibnite is found in bladed and radial form and also disseminated in quartzose sandstone. Wallrock alterations are mainly silicification and minor amount of pyritization, post-dating the host rock. Ore controls are both structural (faults, fractures and bedding planes) and lithostratigraphic (quartzose sandstone in Taungmingyi Member). Fracture filling and replacement texture are observed in the ore microscopic study. The antimony ore mineralization is controlled by lithologic, stratigraphic and structural. The ore mineralization occurrence is confined to the quartzose sandstone of Taungmingyi Member (of Late Silurian age). The Sa On antimony deposit may be provisionally regarded as quartzose sandstone-hosted and epigenetic in origin as judged by its geological characteristics. Average AAS assay results of metal contents are Sb- 27.61 %, Cu- 13 ppm, Pb- 60 ppm and Zn- 160 ppm. Based on the geological, mineralogical and geochemical signatures, typical features, characteristics of mineralization, the antimoy ore mineralization of Sa On area is quartzose sandstone-hosted, epigenetic and epithermal ore deposit type

Keywords: Sa On, Taungmingyi Member, quartzose sandstone-hosted, epigenetic and epithermal deposits type

Introduction

The research area, Sa On area is located about 30 km east of Hopong, Taunggyi District, Shan State (south) (Fig.1). It covers about 16 square kilometres in Universal Traverse Mercator map sheet no. 2097 05 (Topographic map sheet no. 93H/5). It lies within the vertical grids 47Q 324000 E to 328000 E and horizontal grids 47Q 2298000 N to 23020000 N in Universal Traverse Mercator sheet no. 2097 05. It also lies within the Latitude20˚46´28´´ to 20˚48´40´´and Longitude 97˚18´34´´ to 97˚20´50´´. This paper presents mineralization as well as ore mineralogy, wallrock alteration, and geochemical characteristics of antimony mineralization.

Regional Geology

In regional view, the area was mainly covered with Paleozoic rocks and minor Mesozoic rocks and granite intrusion (Htay Aung, 2007). Lower Paleozoic rocks are well exposed in the northeastern part of the research area. Ordovician, Silurian and Devonian rocks are exposed on Me' Ne' Taung range. Minor amount of granite and other non-basic intrusive rocks intruded the Upper Paleozoic rocks in the northeast of the area (Nu Nu Lwin and Wai Wai Aung, 2007). In the west of the area, Hopong plain is very remarkably prominent, extending to the south. Taunggyi range and Yan Aung range are to the west of Hopong plain. These ranges are composed of Ordovician, Silurian, Devonian rocks and

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Plateau Limestone. Precambrian, Paleozoic and Mesozoic rocks are well exposed in the research area. The research area is located in the northeastern part of Me' Ne' Taung range.

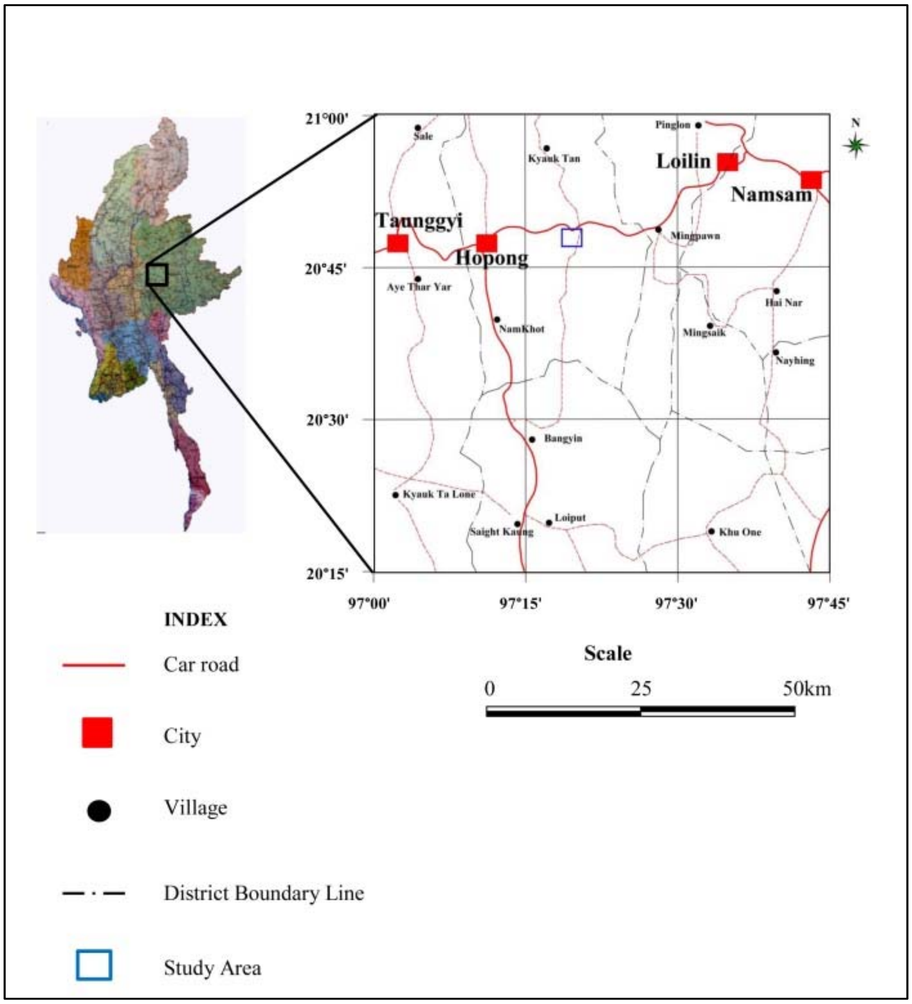

Figure (1). Location Map of the Sa On area.

Geology of the research area

The research area is located in the northeastern part of Me' Ne' Taung range. The area comprises Mibayataung Group (Silurian age) and Plateau Limestone Group (Middle Permian to Early Triassic age). The stratigraphic classification of the research area is adopted from Myint Lwin Thein (1973) for Lower Paleozoic rocks. In the research area, Linwe Formation (Early Silurian), Taungmingyi Member (Late Silurian) of Mibayataung Group, and Thitsipin Formation (Middle Permian), Nwabangyi Formation (Middle Permian to Early Triassic) of Plateau Limestone Group have been observed. Most of trends are N-S and NNE-SSW with dipping toward the E. Major lineament, Sa Ngaw fault, trends NE-SW and some lineaments trend NNW-SSE that oblique this major lineament. The present work deals with the rocks of the Taungmingyi Member of the Late Silurian age. Geological map of the study area is shown in Figure (2) and stratigraphic succession of the present research area is shown in Table (1).

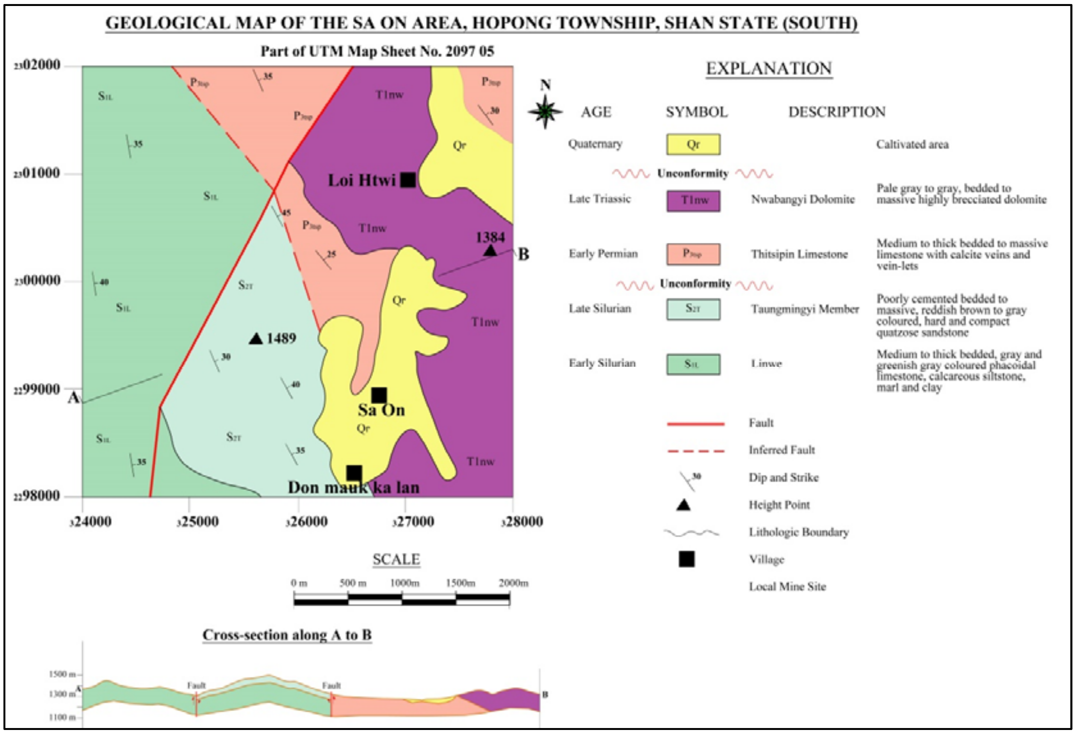

Figure (2). Geological Map of the Sa On Area.

Table (1). Stratigraphic succession of the research area (After Myint Lwin Thein, 1973).

Age	Group	Formation	Lithology
Quaternary to Recent		Alluvium	Reddish and yellowish soils
Middle Permian to Early Triassic	Plateau Limestone	Nwabangyi Formation	Pale gray to gray coloured brecciated dolomite
Middle Permian		Thitsipin Formation	Gray coloured limestones
Late Silurian	Mibayataung	Taungmingyi Member	Gray to milky white coloured quartzose sandstone
Early Silurian	Mibayataung	Linwe Formation	Gray coloured phacoidal limestones, calcareous siltstone,marl and clay

Mineralization

In the research area, antimony mineralization is generally found as veins, veinlets, and disseminations in the fractures of brecciated quartzose sandstone of Taungmingyi Member. Stibnite is associated with microcrystalline quartz. Quartzose sandstone is occurred as fine- to medium-grained crystalline, thick-bedded to massive. In the research area, the ore mineral is mainly stibnite and pyrite is an associate mineral. The gangue mineral consists of quartz.

Nature of Antimony Mineralization

In the research area, antimony ore occurs as types of fracture fillings, disseminations and bladed form, and found in quartzose sandstone of Taungmingyi Member (Late Silurian age). Antimony ore minerals are hosted in quartz vein of tabular shape and disseminated in silicified rocks of quartzose sandstone in the research area. Antimony mineralization occurs as; 1) dissemination, 2) fracture-filling, 3) radiating form and 4) replacement as shown in Figure (3).

There are two occurrences of antimony mineralization in the research area; 1) Sa On antimony Occurrence-1 and 2) Sa On antimony Occurrence-2 as shown in Figure (4). In Sa On Antimony occurrence 1 and 2, Four stibnite bearing quartz veins and six stibnite bearing quartz veins have been observed respectively.

In the present research area, the major linearments are predominantly N-S and the trend of antimony ore veins is NNW-SSE. The ore bearing quartz veins occur generally as sills intruded conformably along the bedding planes of host quartzose sandstone. So these antimony occurrences occur under both structural and lithostratigraphical controls.

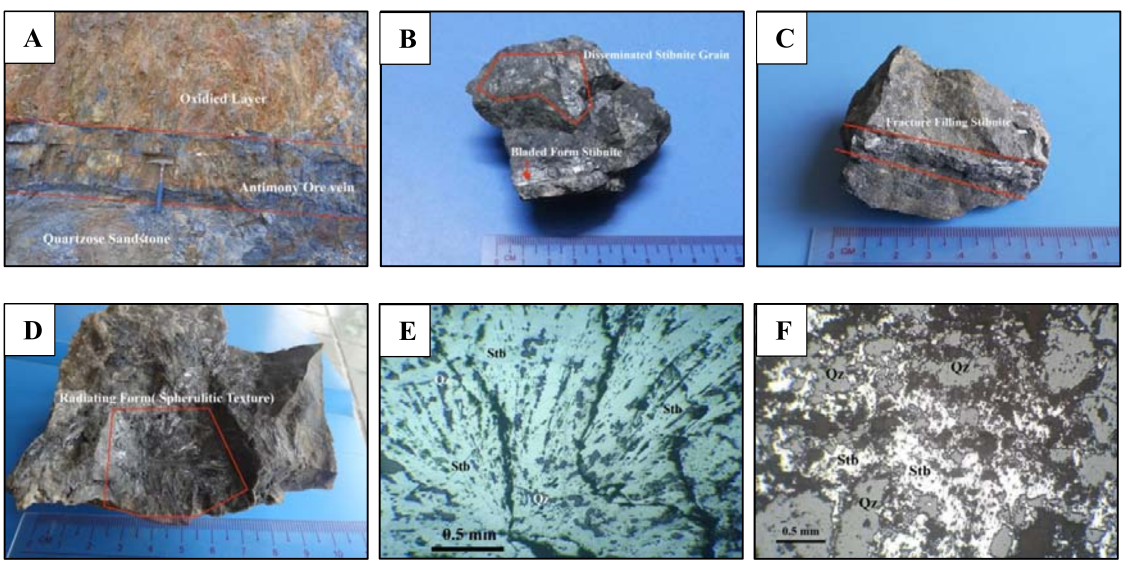

Figure (3). (A) Antimony ore vein (B) Bladed form & disseminated stibnite grain (C) Fracture filling type (D) Radiating form (Spherulitic texture) (E) Radial form of stibnite (Polished Section) (F) Anhedral stibnite replacing along the quartz grains (Polished section).

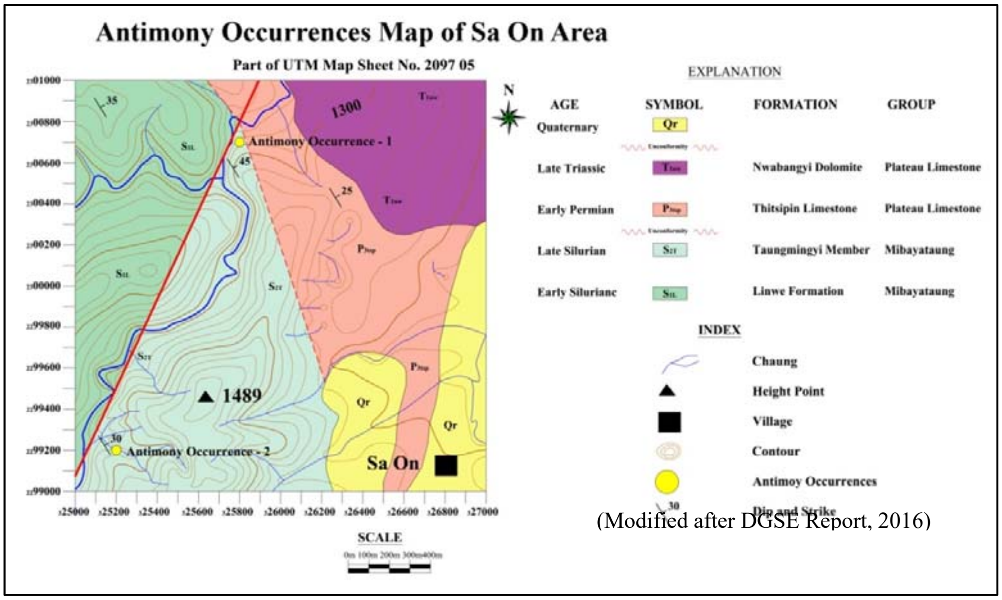

Figure (4). Antimony Occurrences Map of the Sa On Area.

Ore mineralogy

The ore mineral is mainly stibnite and pyrite is an associate mineral in the research area. The gangue mineral consists of quartz. The primary antimony ore as stibnite can be observed in the Taungmingyi Member of Mibayataung Group. Following the works of Craige *et al*., and Marshall *et al*., the following ore minerals are identified;

[1] ***Stibnite*** is the most important antimony ore mineral. Stibnite in polished section under ore microscope is characterized by brilliant white and very high reflectivity. Reflection pleochroism is very slight and recognized positively only along grain boundaries. The grain shape is quite varied; radial, needle-shaped as found in primary occurrences. Bladed form and radial form of stibnite are shown in polished section under ore microscope (Figure.5A and B).

[2] ***Pyrite*** is a common minor mineral and the crystal habit is not only cubic, and faces may be striated, but also octahedral. It is the most common of the sulphide minerals and is usually found associated with other sulphides or oxides in quartz veins and metasedimentary rock. Under the ore microscope, it shows yellowish colour usually appearing very bright and subordinate amounts are intergrown with stibnite (Figure.5C).

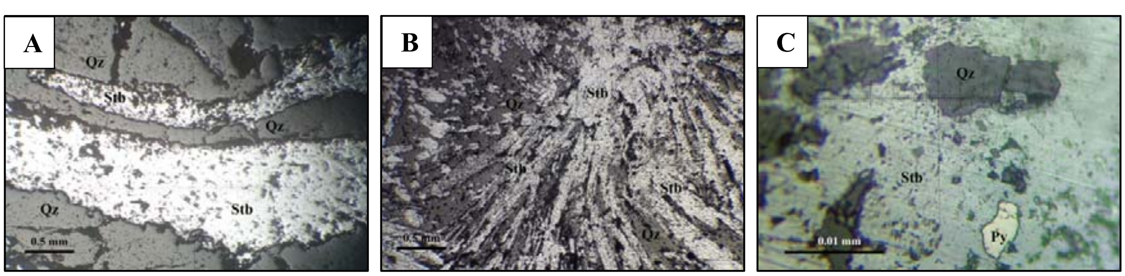

Figure (5) (A) Bladed form of stibnite, (B) radial form of stibnite and (C) Pyrite associated with white coloured stibnite are observed under reflected light.

Ore texture

In the research, the most common textures revealed are; fracture filling or vein filling and replacement texture (Figure.6A and B).

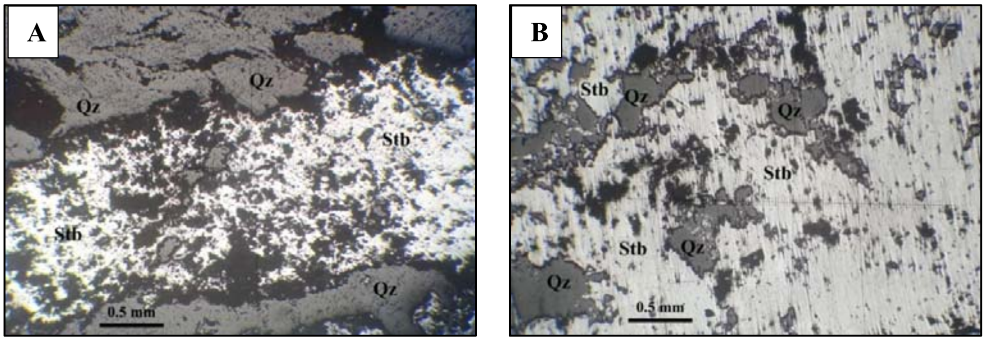

Figure (6). (A) Fracture fillings of anhedral stibnite mineral and (B) stibnite minerals replacing the gangue mineral quartz are observed under reflected light.

Wallrock Alteration

By the field observation and microscopic study, alteration may be recognized as silicification and pyritization. The nature of alteration depends on the character of original rocks, invading fluids, temperature and pressure at which reaction took place (Evans, 1993).

Silicification

Under microscopic study, quartz grains are altered in three stages of silicification. In the first stage, the single quartz grain is mechanically broken down to the internal fracture (Figure.7). Marginal granulation of quartz grain is caused in the second stage (Figure.8) and the grain boundary partial melting and fracture filling (silicification) is formed in the last stage (Figure.9). Minute quartz grains occurring as inter granular grains are anhedral and show wavy extinction. Silicification is commonly associated with the mineralization.

Pyritization

Pyrite is the most abundant sulphide mineral and one of the alteration products of antimony mineralization. Sulphide (pyrite) occurs as anhedral to irregular grains in quartz veins and fractures. Disseminated pyrite crystals intergrowth with small irregular shape stibnite particles are found along the outer margin of quartz veins (Figure.10).

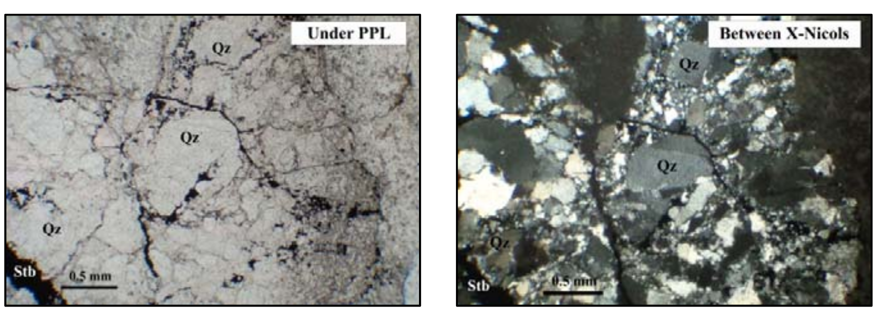

Figure (7). The quartz grains mechanically broken down to the internal fracture (Thin-section).

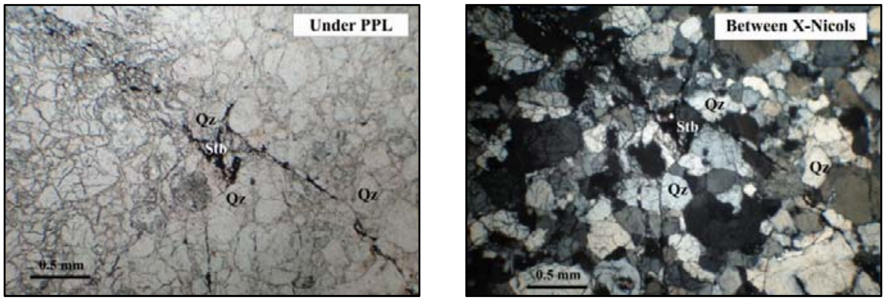

Figure (8). Marginal granulation of quartz grain (Thin-section).

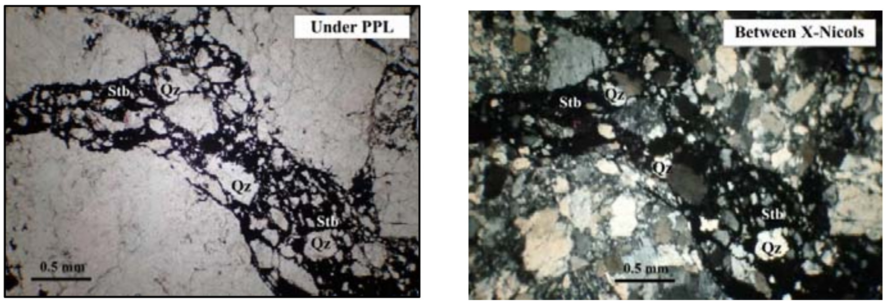

Figure (9). The grain boundary partial melting and fracture filling (silicification).

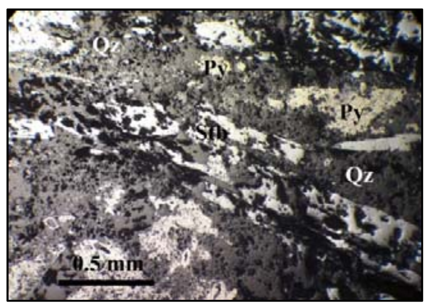

Figure (10). Pyritization of antimony mineralization (Polished section).

Paragenetic Sequence

The paragenetic sequence of ore minerals of the research area is based upon the ore microscopic study. Under reflected light, the gangue mineral of quartz is found to have formed first. And then the early stage mineralization of sulphide mineral such as pyrite is formed as small irregular shape stibnite particles along the quartz veins. The paragenetic sequence of ore minerals in the research area is shown in the Table (2).

Minerals content

In the research area, Sb values range from 0.24 % to 27.61 % in Sa On Antimony Occurrences 1 and 2. The content of Pb values range from 20 ppm to 60 ppm, Zn values range from 20 ppm to 160 ppm, Cu values range from 5 ppm to 13 ppm. The AAS results of some ore minerals in the research area are shown in Table (3).

Table (2). Paragenetic sequence of ore and gangue minerals.

Mineral	**Sequence**	
	Early	**Late**
Quartz		
Pyrite		
Stibnite		

Table (3). AAS results (% & ppm) of some ore minerals in the research area.

No	Sample Name	Sb (%)	Cu (ppm)	Pb (ppm)	Zn (ppm)
1	SO- O – 01A	10.23	13	60	160
2	ST- O – 01B	0.24	5	18	20
3	ST- O - 12	2.92	10	20	23
4	ST- O - 13	27.61	5	30	25

Comparison of Ore Deposit Characteristics between the Antimony Mineralizations of the Research Area and Natsan Antimony Prospect

The comparison of ore deposit characteristics between antimony mineralizations of the research area and Natsan Antimony Prospect (Mon State) (Sandar Aye, 2017) is shown in Table (4).

Table (4). Comparison of Ore Deposit Characteristics between the Antimony Mineralizations of the Research Area and Natsan Antimony Prospect

	Sa On Antimony Occurrences (Hopong Township, Shan State South) (Research Area)	**Natsan Antimony Prospect (Kyaikmaraw Township, Mon State (Sandar Aye, 2017)**
Host Rock Lithology	Quartzose sandstone (S_{2t} Unit) Fine- to medium-grained, Medium- to thick- bedded	Slightly metamorphosed Sandstone and Graywacke (C_1-P_1t^2 Unit) Medium- to coarse-grain Medium- to thick- bedded
Ore Mineral	Stibnite, Pyrite	Stibnite, Stibiconite, Jamesonite, Pyrite, Arsenopyrite, Chalcopyrite, Tetrahedrite
Gangue Mineral	Quartz	Quartz, Feldspar, Mica
Wall rock Alteration	Silicification, Pyritization, Oxidation	Silicification, Sericitization, Pyritization, Oxidation
Structure	Small scale fault and fracture (Brecciation)	Small scale fault and fracture (Brecciation)
Ore Texture	Vein fillings, Massive, Radial Disseminated, Replacement	Vug fillings, Pore space fillings, Vein fillings, Massive, Disseminated, Replacement
Range of Antimony Content	0.08 wt% - 15.02 wt%	2.043 wt% - 76.45 wt%

Geochemical Investigation

The XRF results from geochemical analysis were treated by statistical method using geostatistical software by calculating the values of Mean ($\overline{X}$) and Standard Deviation (S) that shown in Table (5) and regression diagrams showing the relationship between antimony and associated minerals are shown in Figure (11) respectively.

Table (5). Mean ($\bar{X}$), Standard deviation (S) and Threshold ($\bar{X}$+2S) values of Elements from Sa On Anyimony Occurrences 1 and 2 (%).

No	Element	Mean ($\bar{X}$) Value	Standard deviation (S) value	Threshold ($\bar{X}$+2S) value	Range	
					Minimum	Maximum
1	Sb	6.47	6.12	18.71	0.00	15.02
2	Fe	0.41	0.28	0.97	0.23	0.88
3	Ca	0.69	0.76	2.21	0.03	1.85
4	S	4.07	3.165	10.4	0.22	8.35
5	Si	36.84	7.313	51.466	26.96	46.58
6	Al	0.90	0.629	2.158	0.51	2.16
7	Mg	0.08	0.125	0.33	0.00	0.33

Regression Diagram

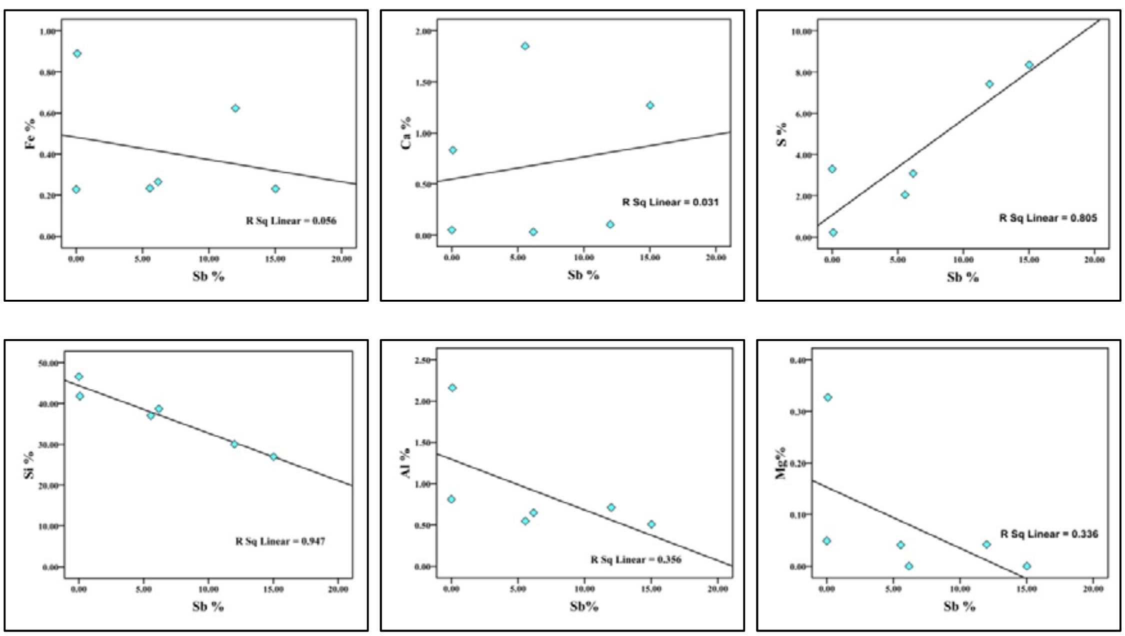

Figure (11). Regression diagrams showing the relationship between antimony and respectively associated minerals

According to the geochemical analysis, Ca and S are positively correlated with Sb and Fe, Si, Al and Mg are negatively correlated with Sb in Sa On Antimony Occurrences 1 and 2.

Cluster Analysis of Sa On Antimony Occurrences

Cluster analysis of elements in ore samples is performed by the weighted pair group method. This investigation is based on six representative ore samples assay results of X.R.F analysis from Sa On Anyimony Occurrences 1 and 2, as shown in Table (6).

Table (6). Proximity Matrix of Correlation Coefficient of Elements

	Sb	Fe	Ca	S	Si	Al	Mg
Sb	1						
Fe	-0.237	1					
Ca	0.175	-0.143	1				
S	0.897	-0.284	-0.103	1			
Si	-0.973	0.061	-0.297	-0.813	1		
Al	-0.597	0.851	-0.051	-0.617	0.437	1	
Mg	-0.58	0.852	0.081	-0.629	0.4	0.987	1

According to the cluster analysis of Sa On Antimony Occurrences, Al and Mg are more closely associated and Sb and S are moderately correlated than other elements in antimony mineralization. The constructed dendrogram is shown in Figure (12).

Dendrogram

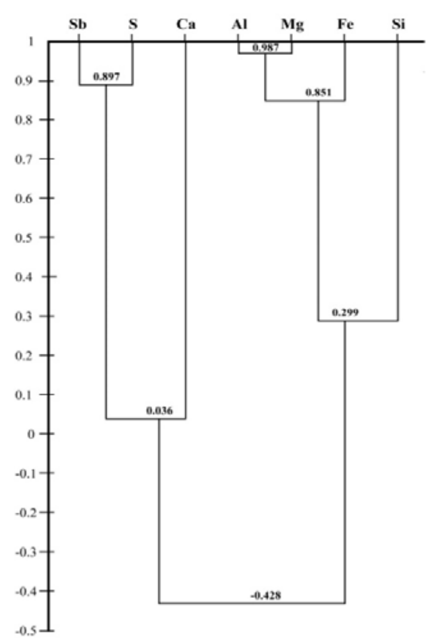

Figure (12). Dendrogram constructed by weighted pair group method of Sa On Antimony Occurrences 1 and 2.

Discussion and Conclusions

The present research work involves the quartzose sandstone of the Taungmingyi Member (Late Silurian age) which hosts the antimony ore mineralization. The host rock of the Taungmingyi Member occurs in the middle part of the research area which is passed through by Sa Ngaw Fault. Antimony ore mineralization extensively occurred in Me' Ne' Taung range and near Sa On village, in four distinct styles, namely, disseminations, fracture fillings (veinlets), radiating form and replacement. The ore mineralogy is relatively simple, and the major constituent being stibnite and its associated mineral is pyrite, and quartz is gangue mineral. Fracture filling and replacement textures are identified by ore microscope. Wallrock alterations are mainly silicification and minor amount of pyritization, post-dating the host rock. By a quantitative result of XRF analysis, the antimony is found closely associated with sulphur. Average AAS assay results of metal contents are Sb- 27.61 %, Cu- 13 ppm, Pb- 60 ppm and Zn- 160 ppm. Both structural and lithographical controls are important parameters for antimony mineralization in the research area. Due to the types of alteration, structural and lithostratigraphical controls, from the ore occurrence habit as confined to the quartzose sandstone of Taungmingyi Member (of Late Silurian age). The Sa On antimony deposit may be provisionally regarded as quartzose sandstone-hosted and epigenetic in origin. According to above data, result, interpretation and previous research works, the antimony mineralization in the Sa On area is quartzose sandstone-hosted, epigenetic origin and epithermal deposit type.

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