Investigation of Metal Contents from Five Different Mineral-Ores in Dawei District, Tanintharyi Region

Khet Khet Tun
Department of Physics
khettun3@gmail.com

Khin Sandar Khaing
Department of Physics
, ksdkhaing@gmail.com

Abstract

The energy dispersive X-ray Fluorescence (EDXRF) system (Shimadzu EDX-720 spectrometer) was applied to investigate the metal contents in mineral-ore samples from different mines: Hermyingyi, Wagone, Kalonta, Heinda and Kanbauk in Dawei district (Tanintharyi region). According to results, it was found that the mineral-ore samples of interest were mainly based on tungsten or wolfram (W), tin (Sn), manganese (Mn) and iron (Fe) metal elements. In addition, some of these samples were composed of other combined metal elements: Pb, Nb, Mo, Ti, Ac, Zr, Bi, Ni, Th, Au and Cr, respectively. Gold mineral (Au) element was observed obviously only in the sample M (3) from Kalonta Mine but not found in elsewhere.

***Keywords**: Mineral-ore samples, elemental concentrations, Energy Dispersive X-ray Fluorescence (EDXRF) method.*

1. Introduction

The mineral occurrences of Myanmar into six geographical groups of regions in which the mineral occurrences were described to be associated with certain types of stratified and igneous rocks. The regions were (1) The Shan-Yunan region with Finc-blende, chalcopyrite, pyrite; (2) The Mogok region with ruby, spinel, sapphire graphite; (3) The Tanintharyi region with wolframite, cassiterite (or tinstone), molybdenite; (4) The Migin group with gold, chalcopyrite, pyrite and other; (5) The Central Belts with petroleum, natural gas, coal and amber; and (6) The Rakhine-Naga region with chromite, native copper, chalcocite, platinum, steatite, and jade.

Dawei (Tavoy) is a city in south-eastern Myanmar and is the capital of the Tanintharyi Region, formerly known as the Tenasserium Division, about 614.3 km (381.7 miles) south of Yangon on the northern bank of the Dawei River. Dawei is a port at the head of the Dawei River estuary, 30 km (18.6 miles) from the Andaman Sea. As a result, the city is prone to flooding during the monsoon season. "Dawei" is also the name of one of Myanmar's 135 ethnic minorities [5].

The Dawei region is home to over 50 historical tin and tungsten mines – although tin production stretches both further north and south, following the granite belt [6]. Natural resources are plentiful in this region. Famous mines in this region are Heinda, Hermyingyi, Kanbauk, Yawa, Kyaukmetaung, Nanthida and Yadanabon where a lot of metal can be found [7] and Kyaukmetaung mine are currently suspended.

2. Materials and Method

2.1. Sample Collection

Dawei Town is located between 14˚05′ North Latitudes and 98˚12′ East Longitudes. In this research study, the three samples of mineral-ores were collected from Hermyingyi mine, Wagone mine and Heinda mine in Dawei Township and the two samples of mineral-ores were collected from Kalonta mine and Kanbauk mine in Ye Phyu Township from Dawei district at Tanintharyi Region, Myanmar. Sample M (1) was collected from Hermyingyi mine (14˚15′ N, 98˚21′ E) which is situated in 64 miles (40 km) north of east of Dawei. Sample M (2) was collected from Wagone mine (14˚11′ N, 98˚24′ E) which is located in 18 miles (11.2 km) away from Dawei Township and this area is about 200,000 square-feet wide. Sample M (3) was collected from Kalonta mine which is located in 23 miles (14.3 km) away from Dawei Township and this area is about 210,000 square-feet wide. Sample M (4) was collected from Heinda mine (14˚7′ N, 98˚26′ E) which is situated in the Tenasserim Hill, 15.5 miles (25 km) north of east of Dawei and covers a concession area of 2110 acres. Sample M (5) was collected from Kanbauk mine (14˚35′ N, 98˚03′ E) which is located in 145 miles (90 km) north of Dawei in a narrow valley surrounded by granite hills [2],[3],[4]. The photographs of wolfram or tungsten, manganese, tin and iron mineral-ores were shown in Figure 1, 2, 3, and 4.

Figure 1. Photograph of wolfram or tungsten mineral – ore

Figure 2. Photograph of manganese mineral – ore

Figure 3. Photograph of tin mineral – ore

Figure 4. Photograph of iron mineral – ore

2.2. Sample Preparation

Mineral-ore samples were made to obtain fine power with grinding machine. And then these powders was poured into a mould and pressed by 10 tons Steel Hydraulic Press of model number 25011, SPECAC, Cambridge Electric Industries. The diameter of the pellet is 2.5 cm. The weight of the pellet for each mineral-ore sample is within three to ten grams and the thickness of each pellet is 3 mm.

2.3. Energy Dispersive X-ray Fluorescence Spectrometer (Shimadzu EDX-720)

X-ray spectrometer permits simultaneous analysis of light elements to heavy elements. Instrument operation is simple and intuitive. The EDX-720 is used for determination of Si (14) – U (92). X-ray fluorescence (XRF) uses X-rays to excite an unknown sample. The individual elements comprising the sample re-emit their own ‘Characteristic’ X-rays. The EDX-720 can detect these X-rays and determine what elements are present in the samples. This indicates that X-rays are detected using a semiconductor detector that allows simultaneous multi-element analysis. This enables a rapid analysis of a sample at even the ppm range. The EDXRF design has a number of advantages. Because of the short distance between the sample and the detector, analysis is possible in the atmosphere. Therefore, almost all samples can be measured without preparation for a vacuum environment. This allows the user to measure food samples without the necessary step of dehydration. The EDX-720 allows smaller parts of larger structures to be measure. Furthermore, analysis of waste materials iron machining and the identification of unknown materials are possible [1]. The main components of XRF spectrometer are X-ray generator, X-ray tube, collimators, filters, counting unit, analyzing crystal assembly, measuring electronics and terminal computer. The schematic diagram of a sequential X-ray spectrometer was shown in Figure 5.

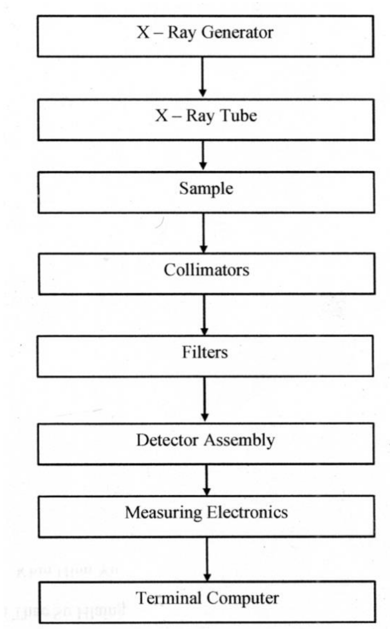

Figure 5. Schematic diagram of X-ray spectrometer

2.4. Determination of Shimadzu EDX-720 System

The EDX-720 system is composed of two parts: the X-ray spectrometer and personal computer (PC). The spectrometer contains: the X-ray generating elements; X-ray tube (Rh), sample chamber, Si (Li) detector, detector electronics, microprocessor controller, liquid nitrogen (LN2) cooling system and associated power supplies. The collected spectra were analyzed using the EDX-720 Qualitative and Quantitative Analysis Software. The Fundamental Parameter (FP) method was used for elemental analysis. The measurement condition of EDX-720 Spectrometer for mineral-ore samples was shown in Table 1. The photograph of X-ray spectrometer (EDX-720) was shown in Figure 6.

Table 1. Measurement condition of EDX-720 spectrometer [8]

Method of measurement	Energy dispersive X-ray analysis
Sample type	Solid
Instrument	Shimadzu EDX-720 spectrometer
Atmosphere	Air
Collimator	10 mm
Spin	Off
Element range	Si – U
X-ray tube target	Rhodium (Rh)
X-ray tube voltage	50 kV
X-ray tube Current	(7 – 24) µA (Auto)
Detector	Si (Li)
Acquire energy range	0 – 40 keV
Analyze energy range	0 – 40 keV
Real time	100 s
Dead time	25 %

Figure 6. Photograph of spectrometer (Shimadzu EDX-720)

3. Results and Discussion

The present work was applied to analyze by using EDX-720 (Shimadzu) spectrometer at Universities' Research Center (URC) in Yangon University. The contents (w %) of metal elements in five mineral-ores samples were listed in Table 2.

Table 2. List of contents (w %) of metal elements in five mineral-ores samples

Samples	M (1)	M (2)	M (3)	M (4)	M (5)
Elements	Concentrations (w %)				
W	61.089	10.936	6.403	6.155	4.425
Mn	14.172	8.214	2.439	2.135	1.529
Sn	11.331	62.753	74.559	76.762	79.728
Fe	9.511	14.261	6.674	8.087	12.557
Pb	1.424	0.171			
Nb	0.833	0.215		0.108	0.221
Mo	0.124	0.101			
Ti		1.539	2.607	3.053	
Ac		0.468	0.249		
Zr		0.375	2.679	2.524	0.091
Bi		0.362	0.615		
Ni		0.316	0.289		
Th		0.081	0.217	0.239	
Au			2.770		
Cr			0.498	0.399	

Sample Name

M (1) – Hermyingyi mine in Dawei Township
M (2) – Wagone mine in Dawei Township
M (3) – Kalonta mine in Ye Phyu Township
M (4) – Heinda mine in Dawei Township
M (5) – Kanbauk mine in Ye Phyu Township

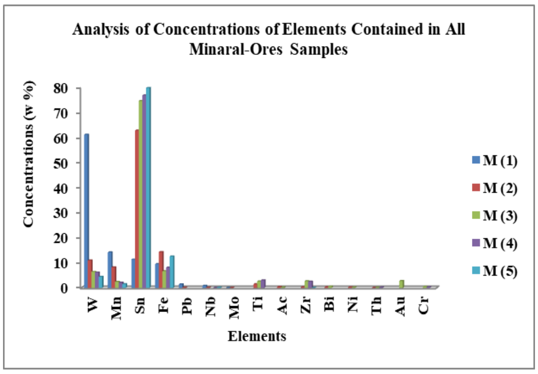

Figure 7. Analysis of concentrations of elements contained in all mineral-ores samples

According to Figure 7, the contents of wolfram or tungsten (W), manganese (Mn), tin (Sn) and iron (Fe) elements were observed as major elements in all mineral-ore samples of interest in this work. The contents of lead (Pb), niobium (Nb), molybdenum (Mo), titanium (Ti), actinium (Ac), bismuth (Bi), nickel (Ni), gold (Au), and chromium (Cr) elements were observed as minor elements and thorium (Th) and zirconium (Zr) were as trace elements in some samples.

In the sample M (1) from Hermyingyi mine, lead (Pb) was observed as next major element and niobium (Nb) and molybdenum (Mo) were as found minor element. In the sample M (2) from Wagone mine, in which titanium (Ti) as next major element and lead (Pb), niobium (Nb), molybdenium (Mo), actinium (Ac), zirconium (Zr), bismuth (Bi), nickel (Ni) as minor elements and thorium (Th) as trace element were found.

Moreover, titanium (Ti), zirconium (Zr) and gold (Au) were observed as another major element and actinium (Ac), bismuth (Bi), nickel (Ni), chromium (Cr) and thorium (Th) were observed as minor elements in sample M (3) from Kalonta mine. Then titanium (Ti) and zirconium (Zr) as next major elements and niobium (Nb), chromium (Cr) and thorium (Th) as minor elements were found in sample M (4) from Heinda mine. In sample M (5) from Kanbauk mine, the minor element was niobium (Nb) and zirconium (Zr) was trace element.

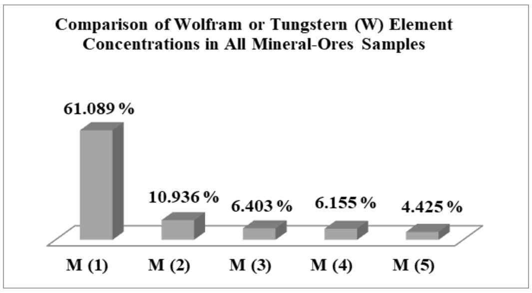

Figure 8. Comparison of wolfram or tungsten (W) element concentrations in all mineral-ore samples

According to Figure 8, it was found that the contents of tungsten or wolfram (W) were the highest in the sample M (1) from Hermyingyi mine and the lowest in the sample M (5) from Kanbauk mine. The chief use for tungsten is for making high speed cutting steel which retain their hardness even at red heat. The tungsten steel is used for various cutting tools and hardware-related materials. It is widely used in Satellite, on alloy of tungsten, chromium and for hard facing materials. Tungsten filaments for electric light bulbs are familiar to everyone. Tungsten is also used for electrical contact parts, electrical apparatus, radio, X-rays, pigments, textiles, armor plate, guns and projectiles [9].

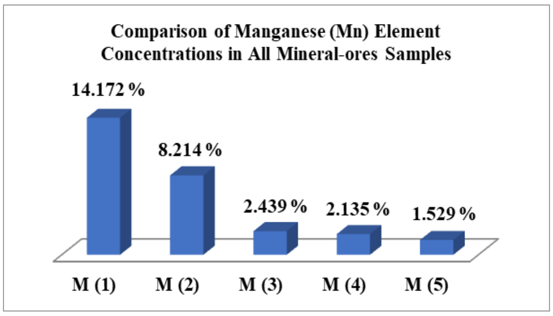

Figure 9. Comparison of manganese (Mn) element concentrations in all mineral – ores samples

According to Figure 9, it was found that the contents of manganese (Mn) were the highest in the sample M (1) from Hermyingyi mine and the lowest in the sample M (5) from Kanbauk mine. Manganese is a grey-white, hard and very brittle metal. It is used to produce a variety of important alloys and to deoxidize steel and desulfurize. It is also used in dry cell batteries and as a black-brown pigment in paint. Steel contains 1 % manganese to increase the strength and improve the workability. Manganese steel has 13 % manganese which is very strong and used for railway tracks, rifle barrels, safes and prison bars. Manganese phosphate is used for rust and corrosion prevention on steel [10].

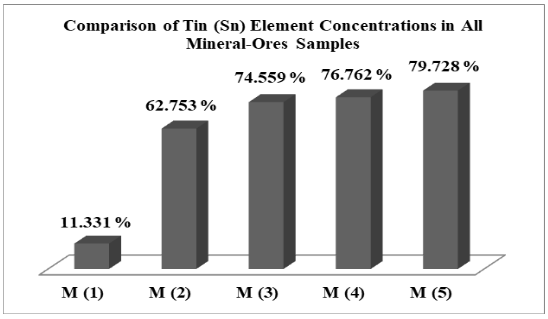

Figure 10. Comparison of tin (Sn) element concentrations in all mineral – ores samples

According to Figure 10, it was found that the contents of tin (Sn) were the highest in the sample M (5) from Kanbauk mine and the lowest in the sample M (1) from Hermyingyi mine. One of the most important uses of tin is to make bronze which is an alloy of tin and copper. Bronze was first made over 5,000 years ago and helped early humans to survive because they used it to create tools and weapons. Mix with tin and lead might be pewter which is used to make dishes. Pure tin is relatively weak; it is not put to structural uses unless alloyed with other metals. In the past, the most consumers were widely used for tin-plated steel containers (tin cans) for conserving foods and beverages. Today, most of the tin is used for making food and other storage containers [11].

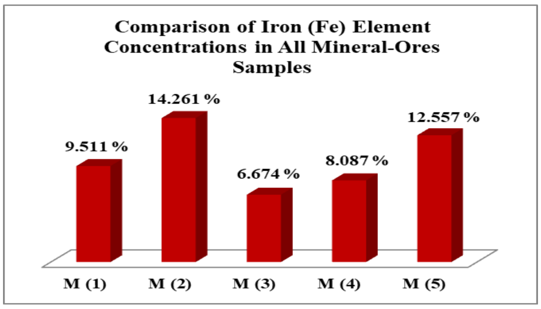

Figure 11. Comparison of iron (Fe) element concentrations in all mineral – ores samples

According to Figure 11, it was found that the contents of iron (Fe) were the highest in the sample M (2) from Wagone mine and the lowest in the sample M (3) from Kalonta mine. Although iron is the second most abundant metal in the earth, the nature of its compound prevents the use of it as early as some other metals. Iron is essential for the production of steel which is essential to maintain a strong industrial base. As the basic raw material made of iron and steel, its supply is critical for any industrial country. Iron can also be made into a nail. Few are aware to what extent people have become dependent upon it in homes, farms, cities, machines, automobiles, trains and ships [12].

3. Conclusion

Although quartz veins are closely related to tin and tungsten, the Sn-W lode mines have a distinct zone between cassiterite (tin) and wolframite (tungsten). In general, tungsten and W-rich Sn-W deposits are very close to granite pierce and are relatively close to the tin. Sn-rich Sn-W deposits are located far away. Mixed ore (Sn + W) deposits occur in between these two end-members. Locally, cassiterite (tin) occurs more abundantly in the southern parts (Myeik and Kawthaung districts) of the Tanintharyi region and tungsten minerals (wolframite and scheelite) are more abundant to the north in the Dawei distinct [3].

According to the results, all mineral-ore samples in different mines: Hermyingyi, Wagone, Kalonta, Heinda and Kanbauk in Dawei district (Tanintharyi region) have mainly wolfram (W) and tin (Sn) (the close association of tin and tungsten).

In addition, it was found that rich concentrations of wolfram in Sn-W deposits in the sample M (1) from Hermyingyi mine and Sn-rich Sn-W deposits in other mineral-ore samples. The Hermyingyi mine utilizes a quartz-cassiterite-wolframite vein system which extends 1400 m in long and 550 m wide situated north of the Central Range Granite [3].

Wolframite [formula (Fe^{2+}) WO_4 to (Mn^{2+}) WO_4], chief ore of tungsten, are commonly associated with tin ore in and around granite. Wolframite consists of a mixture in varying proportions of the tungstate of iron and manganese, Fe WO_4 and Mn WO_4; varieties with dominant iron (Fe:Mn$\leq$ 4:1) are called ferberite, and those with dominant manganese (Mn: Fe $\leq$ 4:1) are called hubnerite [13].

From the results, wolfram (W), tin (Sn), manganese (Mn) and iron (Fe) elements were observed as major elements with the combination in all mineral-ore samples in this work. Especially, the metal content of sample M (1) from Hermyingyi mine was good deals with wolframite mineral and some other mineral such as Cassiterite (SnO_2), Ferberite ($FeWO_4$), Hubnerite ($MnWO_4$), Columbite (Fe) ($Fe^{2+}Nb_2O_6$) and Columbite (Mn) ($Mn^{2+}Nb_2O_6$).

Moreover, cassiterites (tinstone), heavy, metallic and hard tin dioxide (SnO_2) are the major ores of tin. Today, most of the world's cassiterite is mined in Malaysia, Indonesia, Bolivia, Nigeria, Myanmar (Burma), Thailand, and parts of China; other countries produce smaller amounts. Common Impurities: Fe, Ta, Nb, Zn, W, Mn, Sc, Ge, In, Ga, is usually combined in cassiterite mineral [14], [15]. Hence, cassiterite (SnO_2) is contained in all mineral ore samples of interest in this work.

In fact, it was obvious that the results obtained were good agreement with above information of literature. Next, gold mineral (Au) element was observed obviously only in sample M (3) from Kalonta mine. Early, most samples of mineral-ores were investigated by geological view and determined the mineral group. But the comparisons of mineral content and concentration were not found in description. Thus, this investigation was carried out to compare in metal content and concentration of mineral-ore samples from different mines in Dawei district (Tanintharyi region).

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