Investigation of Elemental Contents in Ore Samples from some Selected Mining Areas of Eastern Shan State, Myanmar

Thida Wynn[1], Soe Soe Naing[2], Nan Moh Moh San[3]

Abstract

Mining ores are generally aggregated in sectors such as base metals, fossil fuels, and precious metals. In this study, gold ore samples from different sites of gold mining area at Mong Lin Village, Tarlay Sub-township and manganese ore samples from Ah Ye mining area in Tachileik Township, Eastern Shan State were collected. Firstly, preliminary investigation of gold present in gold ores samples was carried out by colour detection analysis and qualitative identification of manganese in manganese ore by cation group detection analysis. Additionally, relatively abundant percent of elements present in the analyzed samples was performed by EDXRF spectroscopy. According to EDXRF data, manganese was the most abundant element in the manganese ore samples and the higher amount of iron and silicon was found to be present in gold ore samples. Unfortunately gold content in gold ore samples cannot be detected by EDXRF spectroscopic technique. It can't be confirm whether the analyzed sample contain the trace amount (ppm level) or not.

Keywords: gold ore, manganese ore, preliminary investigation, EDXRF spectroscopy, relatively abundance

Introduction

Gold is widely distributed throughout the world and normally in very low concentration (Gasparrini, 1993). In nature, gold most often occurs in its native state (that is, as a metal), though usually associated with other noble metals, such as silver and other base metals, such as copper and iron. It is almost always associated with pyrite or quartz. It is found in veins and in alluvial deposits. Gold was discovered as shining yellow nuggets and has been highly valued since early civilizations. Gold ores are commonly classified two major categories: free milling and refractory ores. Typically, free-milling ores are defined as over 90 % of gold can be recovered by cyanide leaching (Fleming, 1998). Refractory ores are defined as low gold recoveries or give acceptable gold recoveries only with the use of significantly more reagents or more complex pre-treatment processes.

Manganese minerals are abundant on Earth, especially consists of its impure oxides principally MnO_2, to a lesser extent of carbonates, $MnCO_3$ (Howe. *et. al*., 2004). The silicate, $MnSiO_3$ is also found in deposit but is not mined because its manganese content cannot be recovered economically. MnO_2 (pyrolusite) and $MnCO_3$ (rhodochrosite) are the most common manganese mineral. Manganese is a gray-white, chemically active element. It is a shiny, hard metal and is very brittle. Manganese is one of the most used metals in industry. Around 90 % of all pure manganese produced is used by steel industry. The most important non-metallurgical application of manganese is in the form of manganese dioxide, which is used as a depolarizer in dry-cell batteries.

Elemental analysis is the process of either qualitatively (which element) or quantitatively (concentration levels of each element) identifying composition of sample material. ED-X-ray spectrometry is especially qualified for surveying analyzes because a simultaneous spectrum of all involved elements usually is generated. Compared with other

[1]Associate Professor, Department of Chemistry, Yadanabon University
[2]Associate Professor, Department of Chemistry, Meikthila University
[3]Assistant Lecturer, Department of Chemistry, Kyaing Tong University

elemental analytical techniques it is non-destructive, little or no sample preparation, rapid and straight forward interpretation of X-ray emission spectra acquired from a sample.

The aim of this research is to study elemental contents in gold and manganese ores samples from some selected mining areas of Eastern Shan State, Myanmar. To fulfill this aim the following objectives were carried out.

(i) To perform preliminary investigation of gold and manganese ores by using qualitative analysis

(ii) To investigate the elemental contents in selected ore samples by EDXRF

Materials and Methods

Sample Collection

In the present work, gold ore samples were collected from the four different sites of Nan Kham (2) gold mining area which is situated in Mong Lin village, Tarlay Sub-Township, Tachileik Township (Fig. 1). The satellite image and location areas of selected gold mining area were shown in Fig. 2 and 3.

Site (1)

Site (2)

Site (3)

Site (4)

Figure (1). Four different sites of Nan Kham (2) gold mining area.

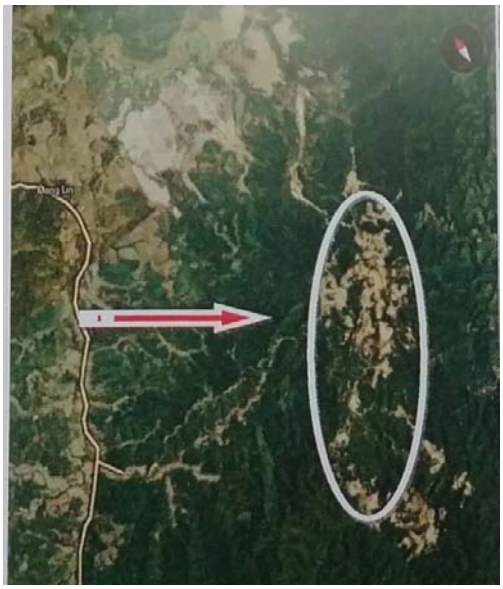


Figure (2). Satellite image of study area showing gold ore sampling sites of Mong Lin Village, Tar Lay Sub-Township

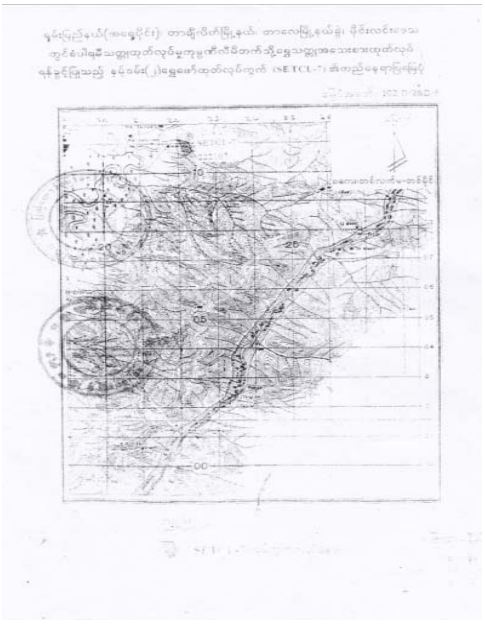
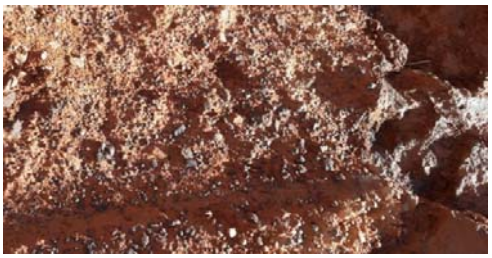


Figure (3).Location map of gold mining area at Mong Lin Village, Tarlay Sub-Township

Manganese ores were collected from Ah Ye mine which is situated between Celingout and Mawdwee in Tachileik Township. The four different samples: nodules, flakes, raw manganese ores (before production step) and the waste materials (after production step) were collected from different sites in mining areas (Fig. 4). The geographical location of Ah Ye mine was shown in Fig. 5 and 6. All the samples were collected Sanparame Mining Co. Ltd., in the month of June, 2016.



Nodule

Flake

Raw manganese

Waste material

Figure (4). Four diffenerent manganese ore samples.

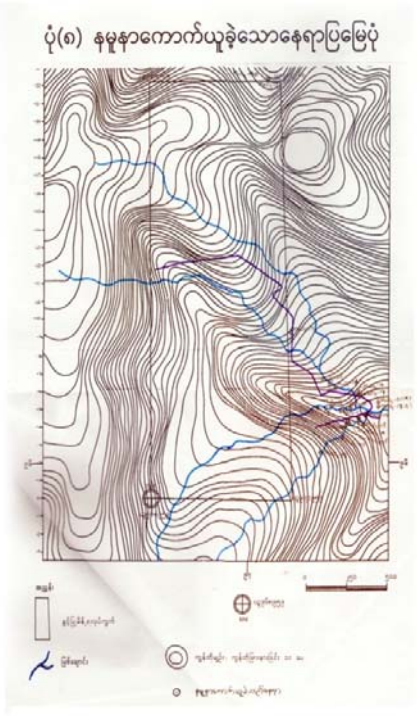


Figure (5). Location map of manganese sample collection at Ah Ye Mine

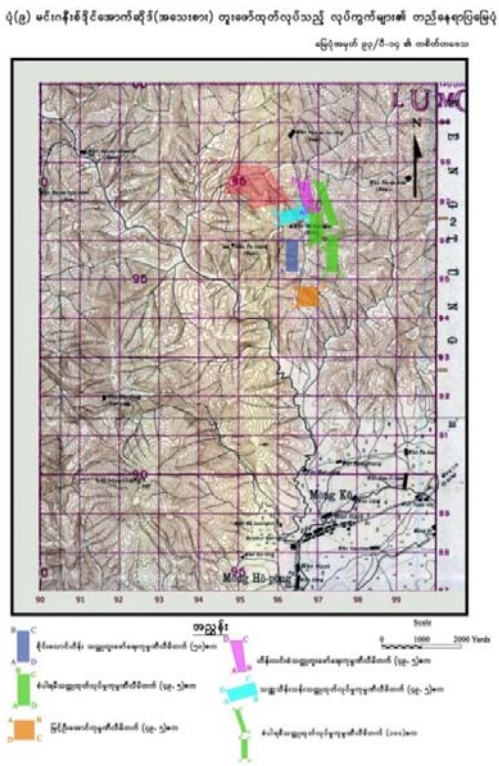
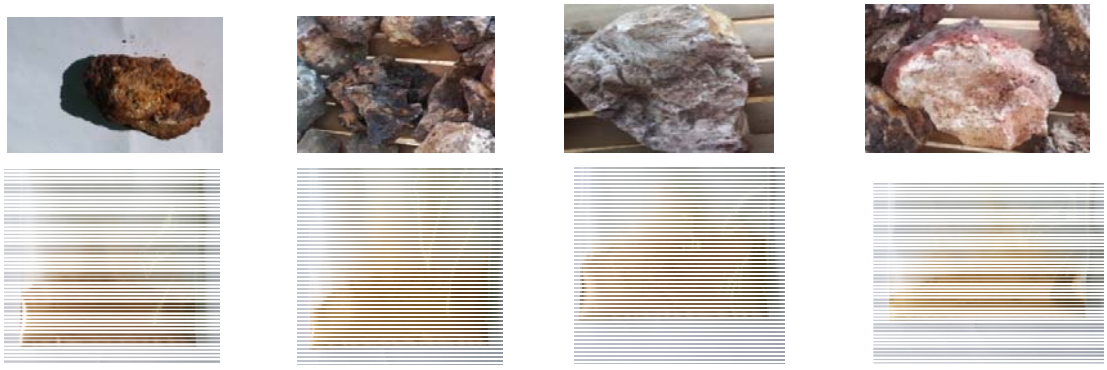


Figure (6). Location map of manganese dioxide small scale production area at Mong Lin Village, Tarlay Sub-township

Preparation of Samples

Each of collected samples was cleaned with water and pounded into fine powder. Fig. 7 (a), (b), (c), (d) and Fig. 8 (a), (b), (c), (d) showed the collected gold ore and manganese ore samples and prepared powder samples, respectively.



(a) (b) (c) (d)

Figure (7). Gold ore samples and prepared powder samples: (a) sample 1, (b) sample 2, (c) sample 3, and (d) sample 4 collected from Nan Kham (2) Gold Mine

(a) (b) (c) (d)

Figure (8). Manganese ore samples and prepared powder samples: (a) nodule, (b) flake, (c) raw manganese ore (d) waste material collected from Ah Ye Mine

Qualitative Identification of Gold in Gold Ore Samples by Colour Detection Technique

Apparatus Used

Beakers, porcelain basins, syringe (25 mL), test tubes and waterbath were used.

Reagents Used

30 % Hydrogen peroxide solution, concentrated hydrochloric acid, sodium ethanoate, EDTA, urea, and thiomichler ketone (TMK) were used.

Procedure

Powdered sample (1 g) was placed in a test tube and 2.5 mL of concentrated hydrochloric acid, 2.5 mL of distilled water and 30 % hydrogen peroxide (2.5 mL) were added into it (Maulsby, 1957). The mixture was stirred and heated in a waterbath until bubbles were evolved. The heated sample was cooled in container containing water. EDTA solution (2 mL) was added into cooled solution and diluted with 10 mL of diluted water and then a piece of sponge was added to this solution. It was vigorously shaken about 5 minutes by hand and washed repeatedly with tap water after that the sponge was separated out. Urea solution (2 mL) was sprayed onto the sponge by using syringe and then this sprayed solution was again withdrawn by syringe. Spraying and removing steps were repeatedly carried out. After that a piece of tissue was used to ensure the complete removal of spared regent. Sodium ethanoate solution (2 mL) was sprayed onto the sponge and then this sprayed solution was withdrawn and thoroughly removed by tissue. Finally, 2 mL of thiomichler ketone was sprayed onto the sponge by using syringe and change in colour of the sponge was recorded.

Preliminary Investigation of Manganese from Manganese Ore Sample by Cation Group Detection Test

Apparatus Used

Beakers, porcelain basins, hot plate and glass rod were used.

Reagent Used

Sodium carbonate, potassium nitrate and concentrated hydrochloric acid were used.

Procedure

Test with Sodium Carbonate and Potassium nitrate

Powdered sample (0.3 g), sodium carbonate (0.3 g) and potassium nitrate (0.3 g) were mixed and fused and then cooled in a porcelain basin. The green color of the fused solid was obtained (Indian Standard, 2004).

Test with Concentrated Hydrochloric Acid

Powdered sample (1.0 g) was taken and 1 mL of concentrated hydrochloric acid was added into it. Then the mixture was heated and it was turned from black to greenish colour (Indian Standard, 2004).

Test with Sodium Carbonate

Powdered sample (0.5 g), sodium carbonate (0.5 g) and a few drops of water were mixed in a porcelain basin and it was heated on the hot plate. After a few minutes, the black solid (moist) was turned into blue or faint-blue (Indian Standard, 2004).

Determination of Content of Elements in Ore Samples by EDXRF

For qualitative and quantitative determinations of elements in great variety of materials, EDXRF method is used. The major advantage of X-ray spectrometry is that it offers economy speed, ease of operation and directly analyzing a solid sample without pretreatment and essentially non-destructive. Elemental analysis of collected samples was performed by EDXRF spectrometer.

Propose of Sampling and Analysis of Manganese Ore for Production of Manganese

Before the production of manganese, based on the limit and space of warehouse, the manganese ore samples were collected 3 kg each from the top of bags from total 1000 bags and total sample were mixed and divided by 20 portions division method. The net representative sample was determined at SGS in Bangkok, Thailand.

Results and Discussion

Qualitative Identification of Gold from Gold Ore Samples

Preliminary detection of gold present in gold ore samples was carried out by colour detection procedure (Table 1). It was found that sample 1, 2, and 4 except 3 show pink colour on sponge. It can be said that all the analyzed samples except sample 3 contain gold.

Table (1). Preliminary Detection of Gold from Gold Ore Samples.

Sample	1	2	3	4
Observation	pink	pink	yellow	pink
Remark	+	+	-	+

(+) = present (-) = absent

Energy Dispersive X-ray Fluorescence (EDXRF) Analysis of Gold Ore

Contents of elements present in gold ore samples were measured by EDXRF. The results are shown in Table 2. It was found that nearly the same amount of iron (47.748 %) and silicon (47.116 %) was observed in sample 1. Silicon content, 66.528 %, 64.775 %, and 70.516 % was abundance element relative to that of other elements in samples 2, 3 and 4, respectively and iron was the second most abundance. The microelements such as Al, K, Sb, As, Mn, Cu, Ca, Zr, Zn, Se, S, Ti, Cr, Sr, Bi, Pb and Ba were also found.

Table (2). Relative abundance of Element for Gold Ore Samples by EDXRF.

Element	Relative abundance (%)			
	Sample 1	Sample 2	Sample 3	Sample 4
Si	47.116	66.528	64.775	70.516
Fe	47.748	31.698	21.829	26.262
Al	3.416	-	0.543	1.195
K	0.872	0.416	0.186	0.435
Sb	0.278	-	0.155	-
As	0.176	0.092	0.100	0.364
Mn	0.164	0.081	0.073	0.048
Cu	0.142	0.138	3.364	0.117
Ca	0.036	0.256	0.239	0.188
Zr	0.032	-	-	-
Zn	0.012	-	-	-
Se	0.007	0.004	0.008	0.008
Ti	-	0.243	0.124	0.620
S	-	0.543	7.595	-
Ba	-	-	o.623	0.225
Ru	-	-	0.386	-
Pb	-	-	-	0.014
Bi	-	-	-	0.011

Qualitative Detection of Manganese from Manganese Ore Samples

Qualitative inorganic analysis is done by branch or method of analytical chemistry which seeks to establish elemental composition of inorganic compounds through various reagents. The group of cations including Zn^{2+}, Ni^{2+}, Co^{2+} and Mn^{2+} are the fourth analytical group of cations. Of these, zinc salts are colorless, manganese salts are faint pink or colorless, and nickel and cobalt salts may be brightly colored, often blue-green (Zoller, *et. al*., 1974)

In this study, preliminary investigation of manganese was carried out by using different reagents. Table 3 showed preliminary tests for manganese from manganese ore. From the qualitative analysis of cation group, blue and green color represent Mn^{2+} cation in the collected manganese ore samples, A, B and C. The sample D was shown indistinct signal because of the waste of manganese ore.

Table (3). Preliminary Tests for Manganese from Manganese Ore.

No.	Test	Sample			
		A	B	C	D
1	Na_2CO_3 and KNO_3	yellowish green	yellowish green	yellowish green	indistinct
2	Concentrated HCl	green	green	green	indistinct
3	Na_2CO_3	blue	blue	blue	indistinct

A = Nodule B = Flake C= Raw manganese ore D = Waste material

Energy Dispersive X-ray Fluoresence (EDXRF) Analysis of Manganese Ore

In this work, qualitative and quantitative investigations of elements present in four different manganese ore samples were carried out by EDXRF spectrometric method and the resultant data were shown in Tables 4. It was found that 47.538 %, 82.906 %, 80.733 % and 5.290 % manganese in nodule, flake, raw manganese ore and waste material, respectively.

Table (4). Relative Abundance of Element for Manganese Ore Samples by EDXRF.

Element	Relative abundance (%)			
	Sample A	Sample B	Sample C	Sample D
Mn	47.538	82.906	80.733	5.290
Fe	27.342	0.700	0.839	24.978
Si	8.359	12.585	13.927	45.497
Al	7.986	1.723	2.248	9.841
Tb	5.322	-	-	-
Ba	1.248	-	-	-
Zn	0.613	-	-	0.189
Cu	0.477	-	-	0.184
K	0.439	-	-	1.314
Ti	0.338	0.060	0.077	1.563
Os	0.136		-	-
Ca	0.090	1.904	2.034	8.773
Sr	0.047	0.073	0.061	0.152
Y	0.037	-	-	0.029
Zr	0.029	0.008	-	-
V	-	0.032	-	-
Br	-	0.009	-	-
Cr	-	-	0.081	-
S	-	-	-	2.191

Analysis Results of Manganese Ore Samples

Analysis results of manganese ore (Table 5) were performed by SGS (Thailand Ltd.,). This report represents yield percent of components and methods of determination. Manganese (43.19 %) was obtained by volumetric method.

Table (5). Analysis Results of Manganese Ore from SGS Report in Bangkok

No.	Description(s)	Method	Results (%)
1	Mn	Volumetric	43.19
2	Fe	Volumetric	2.45
3	SiO_2	Gravimetric	7.19
4	Al_2O_3	ICP	4.10
5	P	Colourimetric	0.03
6	S	ICP	0.01
7	Moisture	Air oven, 105℃	28.93

Conclusion

To perform this research work, gold ore samples were collected from the four different sites of Nan Kham (2) gold mining area and four different manganese ores samples: A (nodule), sample B (flake), sample C (raw manganese ore) and sample D (waste material) were collected from Sanparame Mining Co. Ltd., in Tachileik Township on 10 July 2016. The preliminary qualitative investigation of the collected gold ore samples showed that gold is present in sample 1, 2 and 4 except sample 3. By using EDXRF, the highest content of silicon was found in all gold ore samples except sample 1 which contains nearly equal amount of silicon and iron. Iron was the second most abundant element in analyzed samples. Unfortunately gold were not identified by EDXRF. It can't be confirm whether the analyzed sample contain the trace amount (ppm level) or not. The preliminary investigation of the collected manganese ore samples showed that Mn (II) ion present in sample A, B and C except sample D. According to the analysis of EDXRF, it was found that manganese was the most abundant element in all of the analyzed samples except sample D. From the survey report of SGS, 43.19 % of manganese was found in manganese ore samples.

Acknowledgements

We would like to thank Dr Maung Maung Naing, Rector, Dr Si Si Khin and Dr Tint Moe Thu Zar, Pro-rectors, Yadanabon University, for their kind permission for this work. We wish to represent our sincere thanks to Dr Hlaing Hlaing Myat, Professor and Head of the Department of Chemistry, Yadanabon University, for her enthusiastic reading and invaluable suggestions for this work. Special thanks are given to U Kyaw Lynn, Managing Director, Sanparame Mining Company Limited for his numerous support and help.

References

Fleming, C.A., 1998. "Cyanization of Gold and Silver", Royal Melbourne Institute of Technology, Gold Symposium, Melbourne, Australia, 53-66

Gasparrini, C., 1993. "Gold and other Precious Metal", Springer Verlag, Berlin, Heidelberg, .336-343

Howe. P.D., H.M., Malcolm and S. Dobson., 2004. "Manganese and Its Compound: Environmental Aspect". Monks Wood, United Kingdom. Concise International Chemical Assessment, **63**, 243-249.

Indian Standard., 2004. "Methods of Chemical Analysis of Manganese Ores", New Delhi

Petruk, W., 2000. "Applied Mineralogy in the Mining Industry", Elsevier, Ottawa, Ontario, Canada

Zoller, W.H., S., Venetskii, Mary Elvira and S., Saul., 1974. "Process of Treating Manganese Nodules", **3(5)**, 402-410

Maulsby R. H., 1957. "Duke's Quick Qualitative Analysis", 3rd Edition, **2**(3), 18