Qualitative Analysis of Trace Elements in the Conglomerates of Tyrsad-Weiloi Area, Meghalaya, North-East India by using Energy-Dispersive X-Ray Spectroscopy

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Abstract

The intraformational and polymictic conglomerates exposed in the Tyrsad-Weiloi area have been analyzed using the Energy-Dispersive X –ray Spectroscopy. For the present study 8 conglomerates sample were analyzed for 9 major elements C, O, Na, Si, K, Ca, Fe, Mg, Al and 23 trace elements Br, Sr, Dy, Ge, Th, U, Sb, W, Hf, Sr, Zr,Zn, Mn, Ce, Pr, Sm, Eu, Nb, Cu, Hg, Sc,Lu and Tc and the result obtained is discussed. Traces of REEs (Ce, Pr, Sm, Eu, Dy and Lu) were inferred in 7 conglomerate samples. The study is based on the preliminary work carried out and is the first reporting of REEs traces present in the conglomerates of the area.

Key words: Conglomerates, Trace Elements, Rare Earth Elements, Energy-Dispersive X-ray Spectroscopy, Tyrsad, Weiloi

1. Introduction

The present work carried out is a preliminary research done on the conglomerates of Tyrsad-Weiloi area of Meghalaya. To determine the trace elements present in the conglomerate samples by using Energy-dispersive X-ray spectroscopy (EDS) which is an analytical technique used for the elemental analysis or chemical characterization of a sample. It can be used to determine which chemical elements are present in a sample, and can be used to estimate their relative abundance. In the present study qualitative elemental analysis has been carried out to determine the elements present in the conglomerates.

The main objective of this paper is to determine the qualitative elemental composition present in the conglomerate samples. Since trace elements are those which occur in very low concentrations in common rocks usually less than 0.1% by weight. They are present in most rocks of the earth's crust and the concentrations of these elements in rocks depend upon the type of rock (acidic or basic) such as acid eruptive rocks like granite, rhyolite etc which are rich in alkaline and alkaline earth elements, boron and tin and poor in chromium, cobalt, copper and nickel.

Contents of the trace elements in metamorphic rocks (gneiss and schist) and some sedimentary rocks like clays fall between those of basic eruptive and acid eruptive rocks. Moreover, these rocks are richer in iodine, molybdenum and lead, as are sandstone and carbonated rocks. These two latter types of rocks are generally poorer in trace elements than crystalline rocks (H.Aubert and M.Pinta, 1980).

Also the second objective is to determine whether there are any traces of rare earth elements (REEs) in the conglomerates of Tyrsad-Weiloi area transect. Since REEs are a unique group of elements that exhibit a special electronic, magnetic, optical and catalytic properties that makes them indispensable in many high tech products, in the clean technology sector and in various defense applications (Angerer, 2009; Bailey Grasso, 2012; BGS, Rare Earth Elements profile, 2011; Bruno, 2012)

1.1 Geology of the Study Area

Shillong plateau singularly represents a Precambrian cratonic block of North East India. The plateau lies between the Himalayan belt in the North and Indo-Myanmar mobile belt in the East. The plateau is tectonically detached from the Indian peninsula by the Garo-Rajmahal tectonic graben (Eremenco *et al.*, 1969). This vibrant plateau is seismically very active due to continued north northeastward counterclockwise movement of the Indian plate producing severe compression tectonics (Harijan *et al.*, 2003; Ramesh *et al.*, 2005). The study is carried out in the Tyrsad and Weiloi area of East Khasi Hills, Meghalaya of North-East, India.

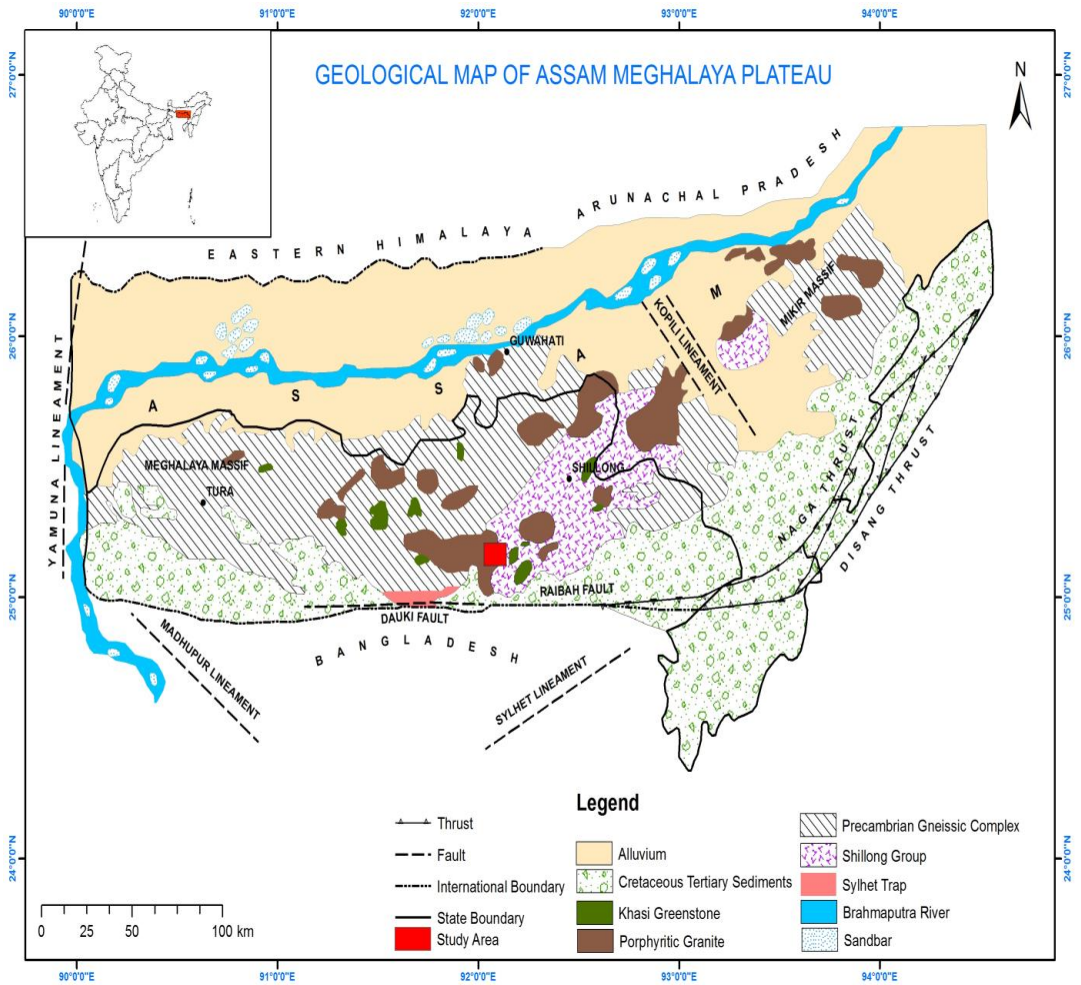

Fig.1. Location map of the study area showing the Geology of the Shillong Plateau (modified after S.K.Mazum, 1976 & R.K.Verma, 1991)

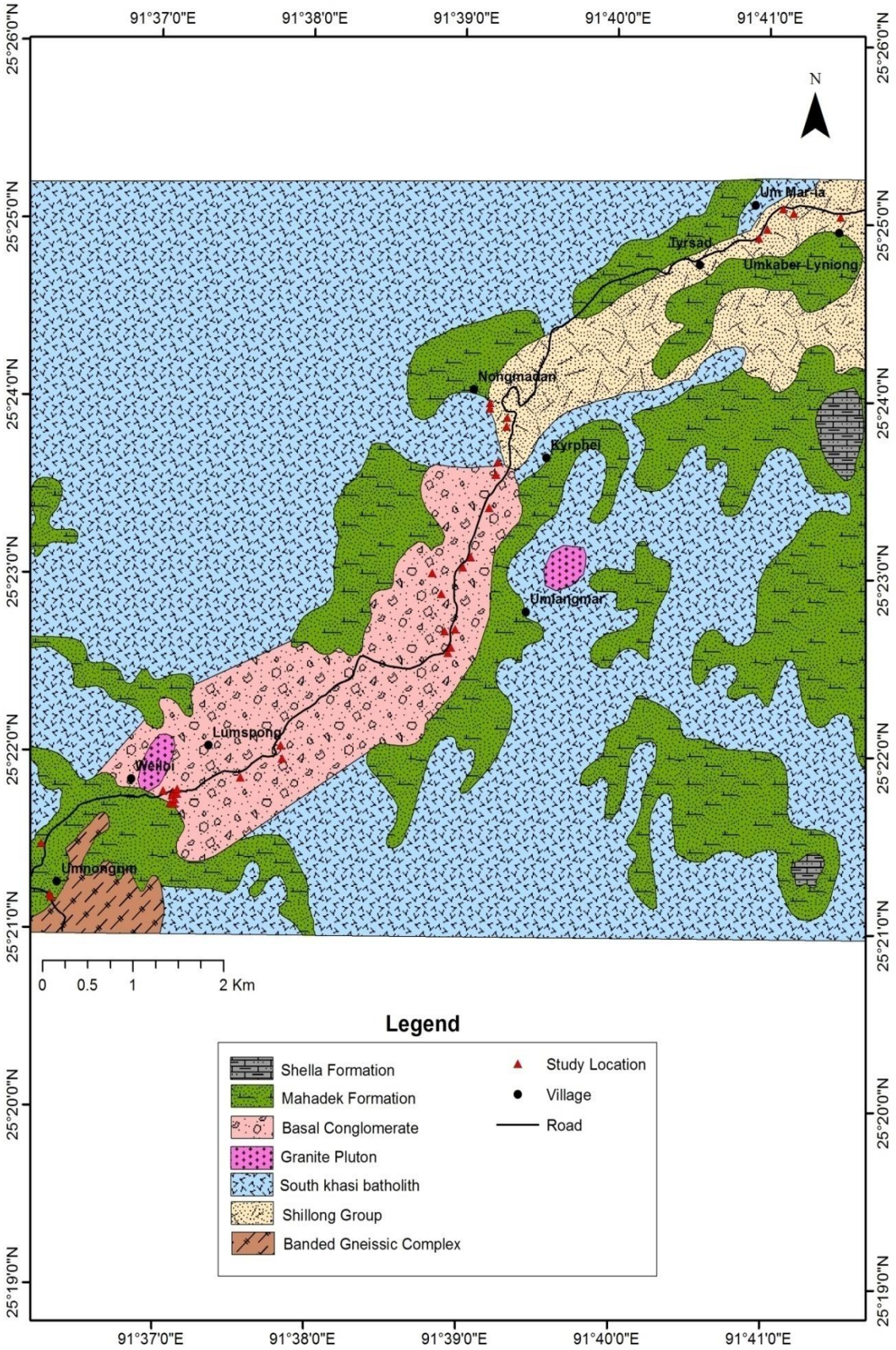

Fig.2. Geological Map of the Study area along with the sampling sites (Modified after Geological Survey of India, 2012)

Table 1. Generalised Geological Succession of the Study Area

Group	Formation	Age	Lithology
Top Soil/Alluvium	Unclassified	Quaternay	Sand, silt and clay
Unconformity (?)			
Khasi Group	Mahadek	Upper Cretaceous	Arkosic sandstone (often Glauconitic and Uraniferous)
	Basal Conglomerate	Mid-Cretaceous (?)	Conglomerates
Unconformity			
Granite Plutons	Unclassified	Neo-Proterozoic-Lower Palaeozoic	Porphyritic coarse granite , pegmatite, aplite/quartz vein etc.
Shillong Group	Upper Shillong	Mid-Proterozoic (?)	Mainly quartzites intercalated with phyllites, conglomerate
	Lower Shillong	Early Proterozoic (?)	Mainly schists with Calc Silicate rocks, carbonaceous phyllite and thin quartzite layers, conglomerate
Unconformity			
Basement Gneissic Complex	Unclassified	Archean (?) Proterozoic	Mainly quartzofeldspathic gneiss with enclaves of granites, amphibolites, schists etc

1.1.1 Materials and Methods

The topographic sheet number 78 O/11, with a mapping on 1:50,000 scale is used for detailed disposition of the conglomerate rocks. 100 conglomerates samples are collected and 8 selected samples are studied for its trace elemental composition through EDS technique.

It is a chemical microanalysis technique used in conjunction with scanning electron microscopy (SEM).The EDS technique detects x-ray emitted from sample during bombardment by an electron beam to characterize the elemental composition of the analyzed volume. The x-ray energy is characteristic of the element from which it was emitted.

The system is comprised of three basic components (Bob Hafner, EDS)

- an X-ray Detector which detects and converts X-ray into electronic signals;
- a Pulse Processor which measures the electronic signals to determine the energy of each X-ray detected; and
- A Multiple Channel Analyzer which displays and interprets the X-ray data.

Eight samples of Tyrsad-Weiloi conglomerates are selected for (EDS) elemental analysis.The samples collected are air dried in the laboratory and processed. The selected samples are kept in the oven for 24hours at 60 degree Celsius to remove its moisture content and the dried sample is carried out for EDS experiment to determine its trace element composition.

Table 2. Location of the conglomerate samples of Tyrsad and Weiloi area

Sl.no.	Location	Samples
1	Um Ma-ria	2
2	Kyrphei	1
3	Umlangmar	1
4	Umnongrim	4
	Total	8 samples

2. Results and Discussions

The conglomerates samples selected for elemental analysis are collected from the following sampling sites: Um Ma-ria, Kyrphei, Umlangmar, Umnongrim. The conglomerate deposits in each location have different variations from clast supported conglomerates to matrix supported conglomerates with varying thickness, of different shape and size.

Table 3. Trace elements of E.D.S. spectra for Tyrsad-Weiloi area conglomerates

Sl.no	**Location**	**Trace Elements**	**RREs**
1	Um Ma-ria	Ti,Cu,Zn,Br,Dy,Hg	Dy
2	Um Ma-ria	Ge,Sr,Zr,Dy,Lu,Nb	Dy,Lu
3	Kyrphei	Sr,Dy,Hg	Dy
4	Umlangmar	Cu,Sr,Hg	
5	Umnongrim	Sr,Zr,Ti,Dy,Ce,Pr,Sm,Eu	Dy, Ce,Pr,Sm,Eu
6	Umnongrim	Sc,Br,Hg,Cu,Sb,Th,U,Tc,Dy	Dy
7	Umnongrim	Br,Sr,Dy,Sb,Th,U, W	Dy
8	Umnongrim	Br,Dy,W,Ti,Cu,U	Dy
	Total	23	6 RREs

2.1 Um Ma-ria conglomerates

The first major exposure starts near Tyrsad in Um Mar-ia area, the conglomerates outcrop here has a significant exposure and sources from Geological Survey of India, suggested that they would propose in the near future to protect the area; before it diminishes as quarrying is a daily activity here and clasts of the conglomerate are used for building houses and for other construction activities. The following figures and graphs shows the EDS spectra obtained for two samples of Um Ma-ria conglomerates.

Sample 1: Um Ma-ria conglomerates

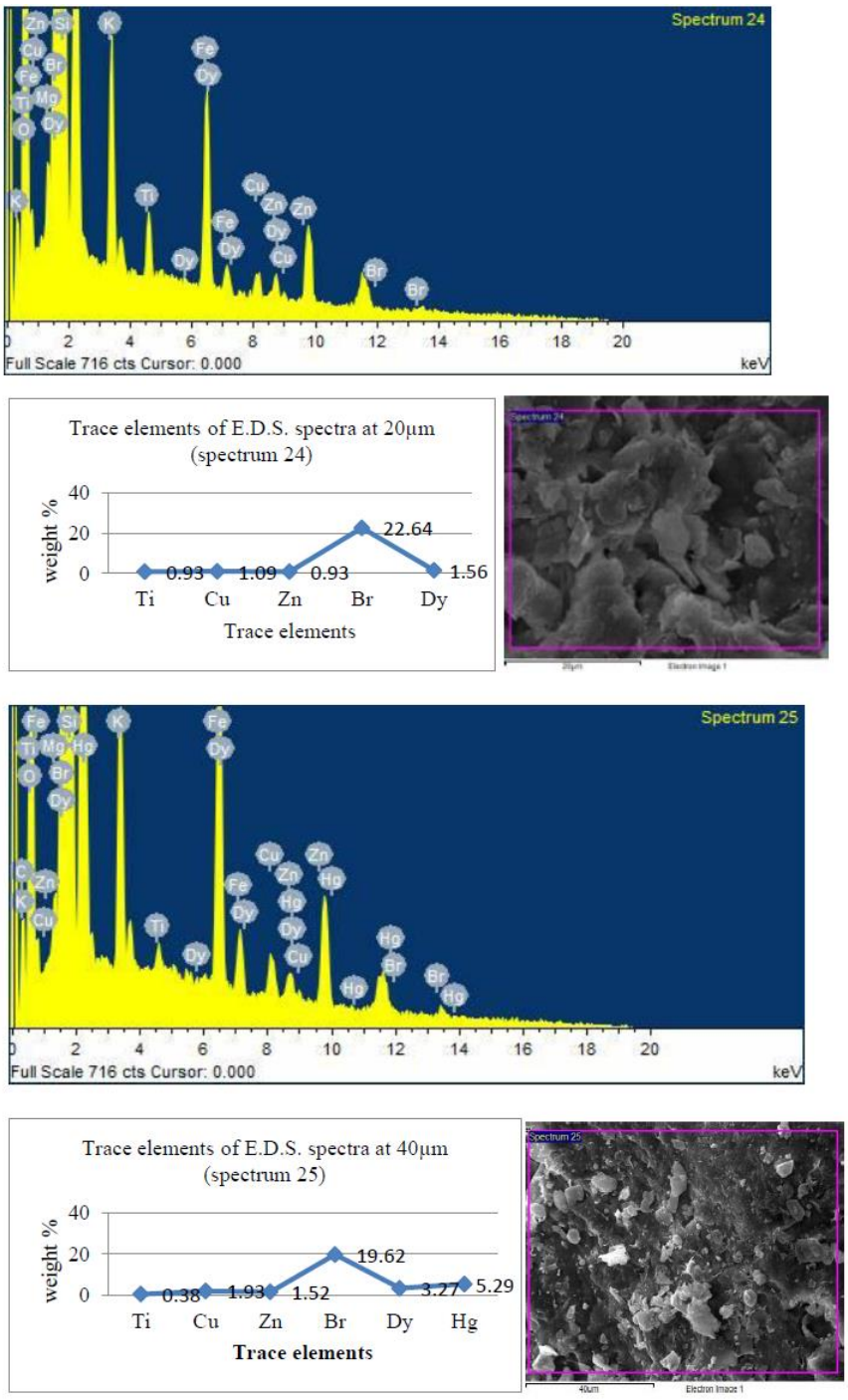

Fig.3. (a) EDS spectra and graphs of (UmMa-ria conglomerate smple 1) elements determined at 20µm and 40µm

The above EDS spectra and graph shows the elements obtained at 10µm and 5µm for sample 1 of Um Ma-ria conglomerates.Eight major elements and six trace elements Ti,Cu,Zn.Br,Dy and Hg are obtained.

Sample 2: Um Ma-ria conglomerates

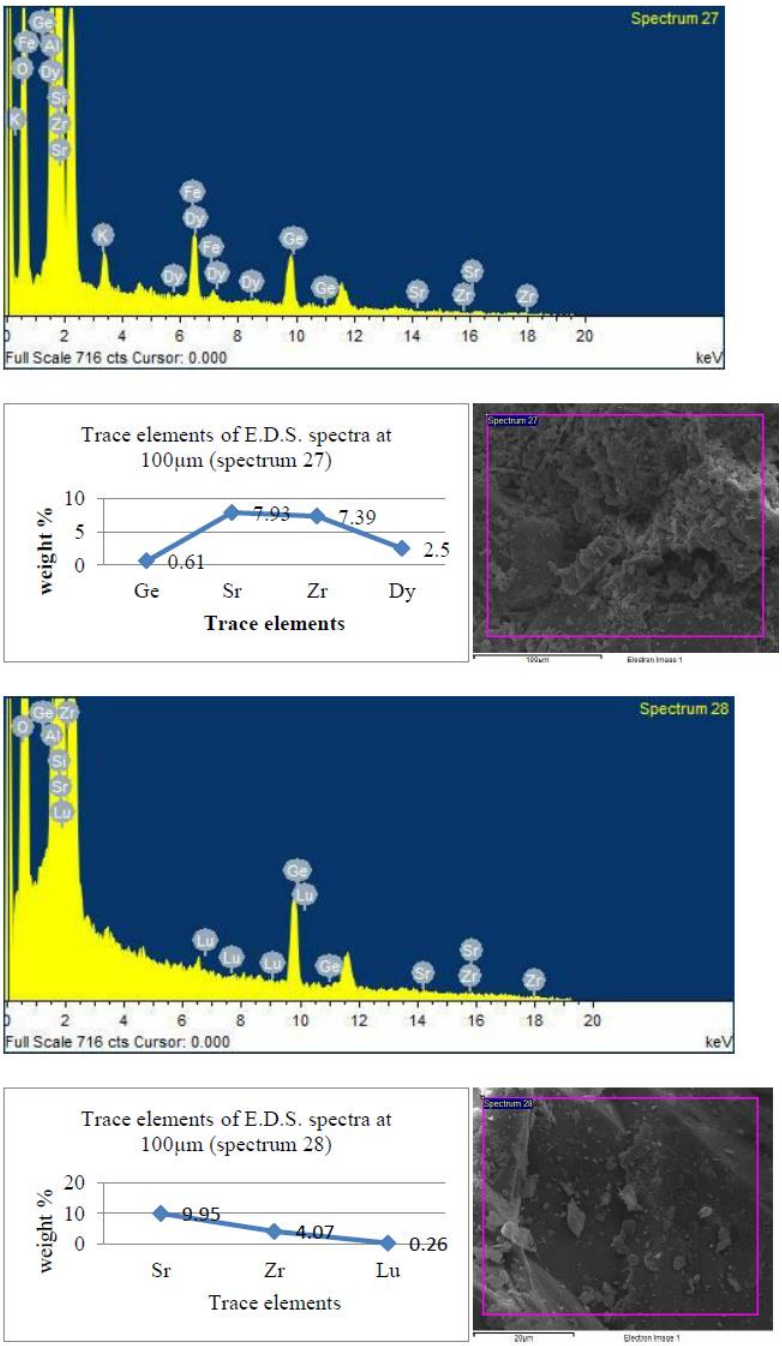

Fig.3. (b) EDS spectra and graphs of (Um-Maria conglomerate smple 2) elements determined at 20µm and 40µm

The above EDS spectra and graph shows the elements obtained at 10µm and 5µm for sample 2 of Um Ma-ria conglomerates.Eight major elements and six trace elements Ge,Sr,Zr,Dy,Lu, and Nb are obtained.

The result for Um Ma-ria conglomerates showed the concentration of the following 9 major elements 9 Major (C, O, Na, Mg, Al, Si, K, Ti and Fe) and 11 trace elements (Ge, Sr,Dy, Br, Zn, Zr, Nb, Lu, U, Hg, and Cu). Traces of rare earth elements (R.E.E.s), Dysprosium (Dy) is obtained from conglomerates samples of Um Ma-ria area.

3. Kyrphei Conglomerates

Kyrphei conglomerates is about sixty per cent clast supported conglomerate outcrop, where the clasts are dominated of quartzitic clasts.The thickness of the conglomerates deposit is about 2 meters thick .The following shows the result obtained E.D.S spectra of Kyrphei conglomerates.

Sample 1: Kyrphei conglomerates

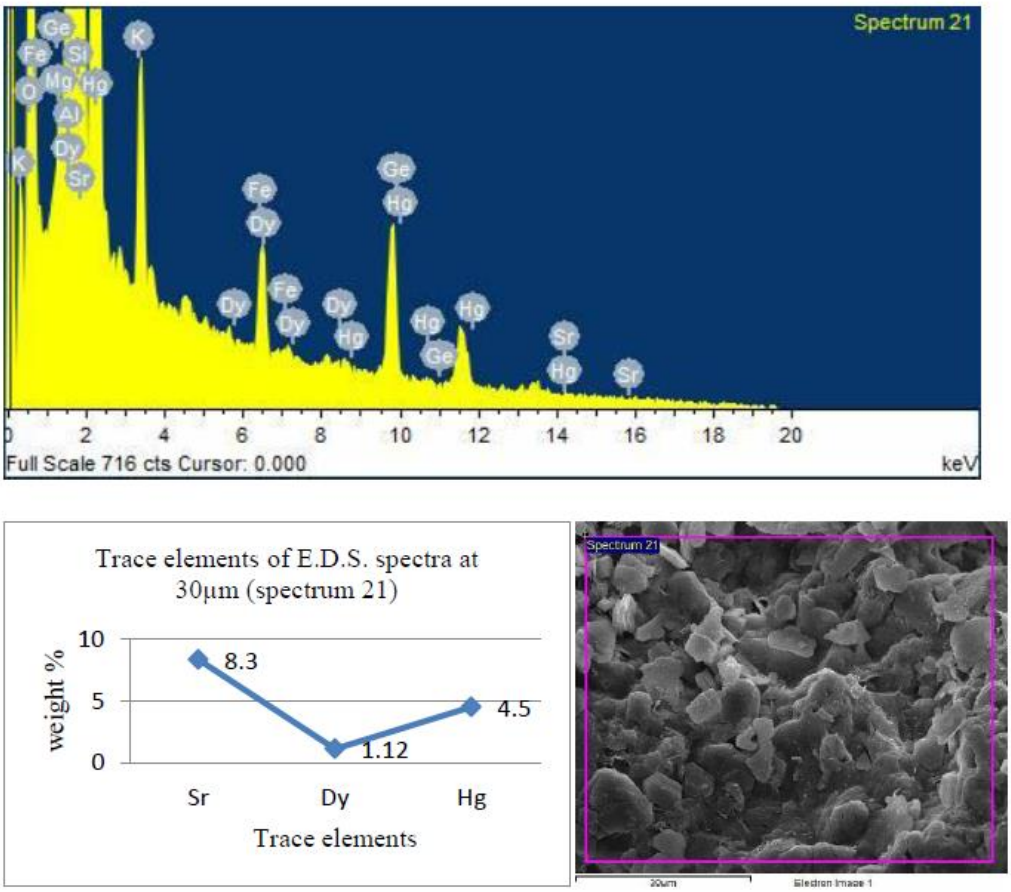

Fig. 4. EDS spectra and graphs of (Kyrphei conglomerate smple 1) elements determined at 30µm

The above EDS spectra and graph shows the elements obtained at 30µm for sample 1 of Kyrphei conglomerates.six major elements (O,Mg,Al,Si and Fe) and three trace elements Sr,Dy and Hg are obtained.

4. Umlangmar conglomerates

The conglomerates of Umlangmar area are clast supported conglomerates with quartzitic clasts. The thickness of the conglomerates is about 3 meters. The following results shows the EDS spectra and the elements determine.

Sample 1: Umlangmar conglomerates

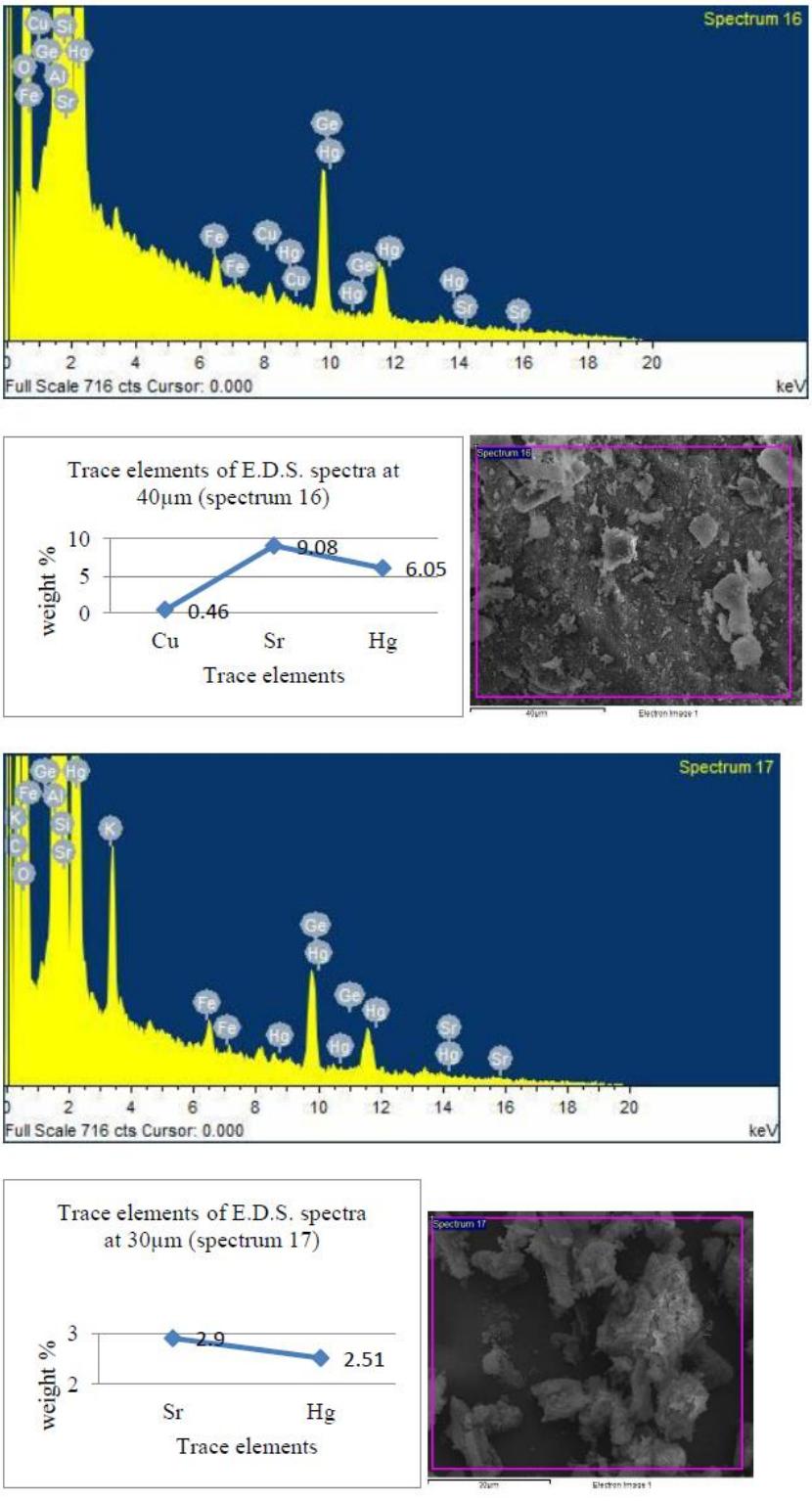

Fig. 5. EDS spectra and graphs of (Umlangmar conglomerate smple 1) elements determined at 40µm and 30µm

The above EDS spectra and graph shows the elements obtained at 40µm and 30µm for Umlangmar conglomerates sample: six major elements (C, O, Al, Si, K, Fe) and three trace elements Cu, Srand Hg are obtained.

5. Umnongrim Conglomerates

The conglomerate in Umnongrim sampling site is a matrix supported conglomerate intruded within the Mahadek sandstone. The results show the EDS spectrum obtain for 9 major elements C, O, Na, Si, K, Ca, Fe, Mg, Al and 21 trace elements Br, Sr, Dy, Ge, Th, U, Sb, W, Hf, Sr, Zr, Mn, Ce, Pr, Sm, Eu, Nb, Cu, Hg, Sc and Tc of which 5 rare earth elements Dy, Ce, Pr, Sm and Eu are obtained. The following figures show the EDS spectra and graph of trace elements obtained for the four conglomerate samples of Umnongrim area.

Sample 1: Umnongrim Conglomerate

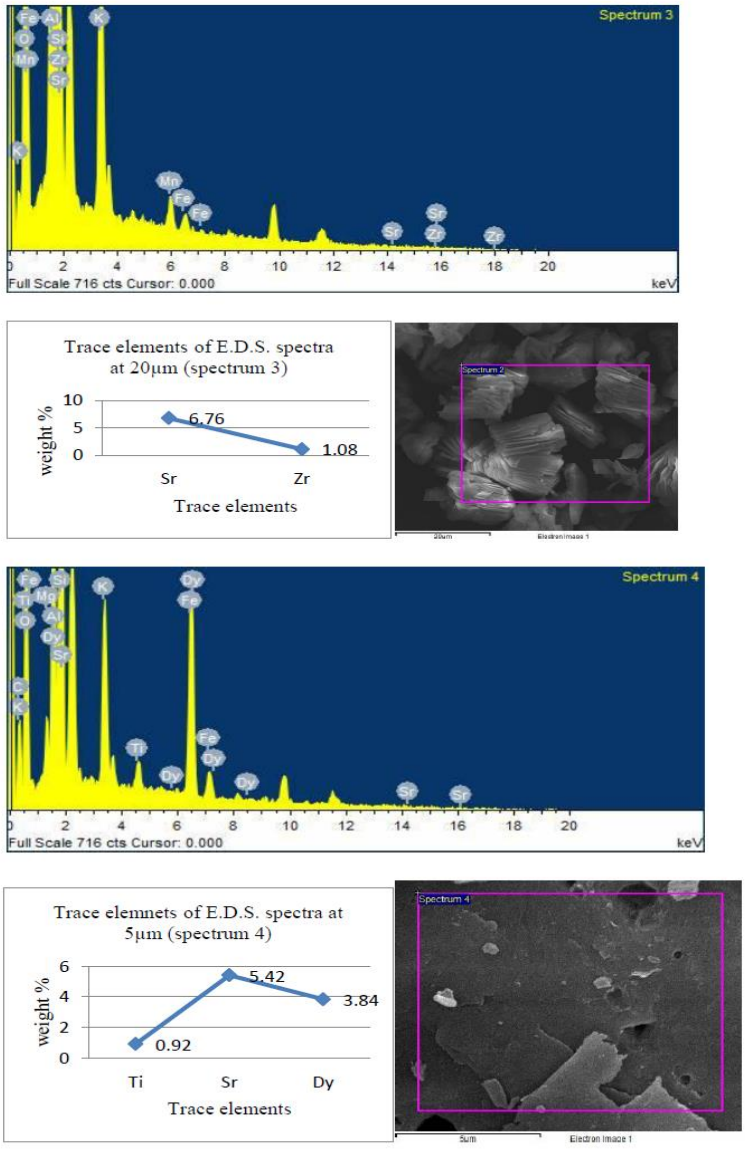

Fig.6. (a) EDS spectra and graphs of (Umnongrim conglomerate smple 1) elements determined at 10µm and 5µm

The above EDS spectra and graph shows the elements obtained at 10µm and 5µm for sample 1 of Umnongrim conglomerates. Eight major elements and eight trace elements Sr, Zr, Ti, Dy, Ce, Pr, Sm and Eu are obtained.

Sample 2: Umnongrim conglomerate

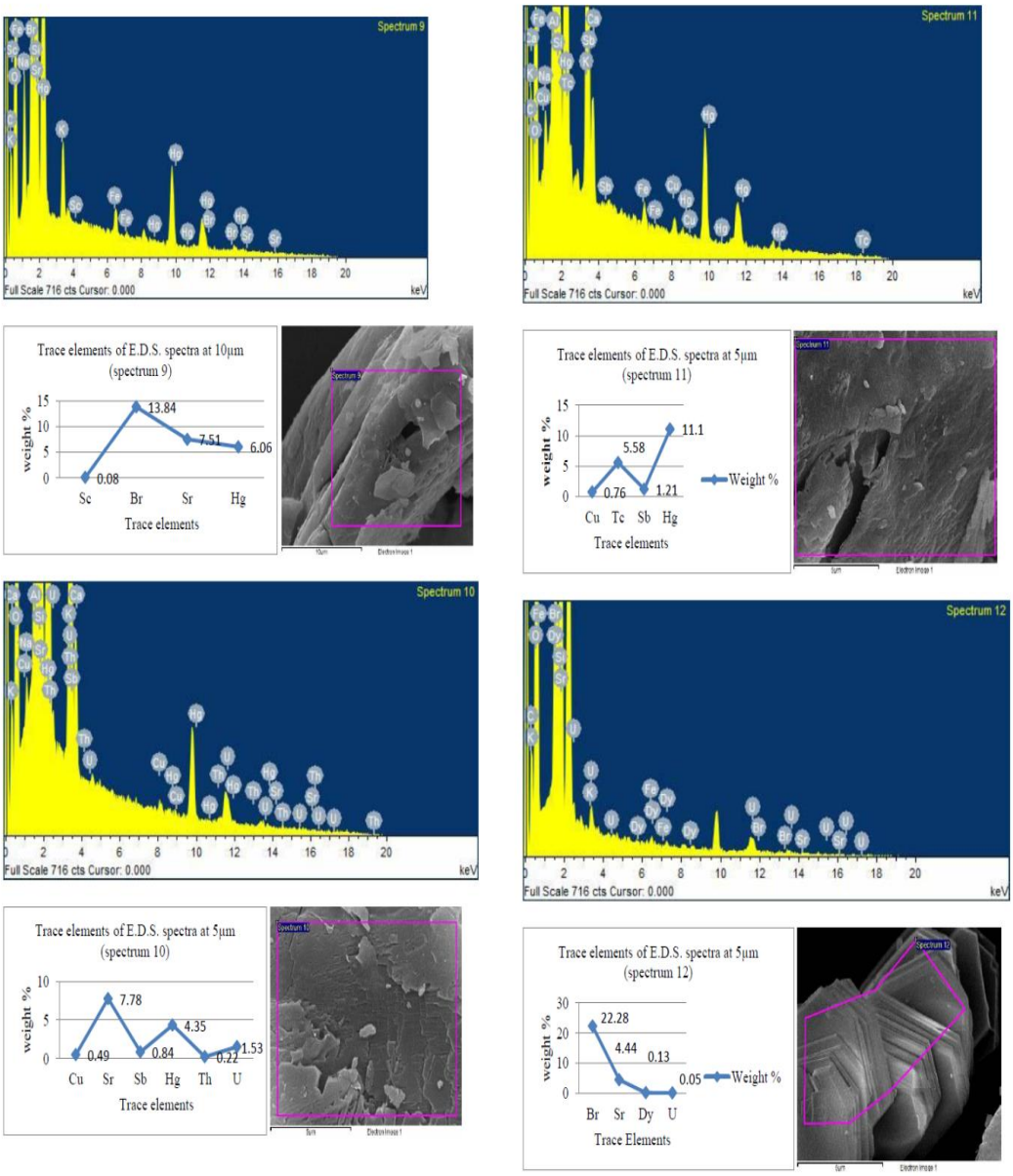

Fig.6. (b) EDS spectra and graphs of (Umnongrim conglomerate smple 2) elements determined at 10µm and 5µm

The above EDS spectra and graph shows the elements obtained at 10µm and 5µm for sample 2 of Umnongrim conglomerates. Eight major elements and ten trace elements Sc, Br, Sr, Hg, Cu, Sb, Th, U, Tc and Dy are obtained.

Sample 3: Umnongrim conglomerate

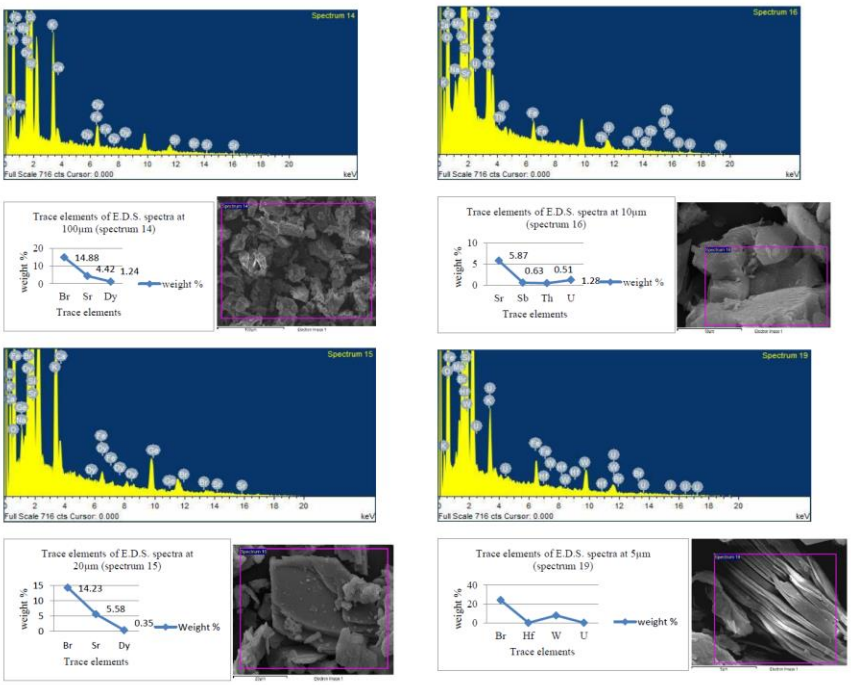

Fig. 6. (c) EDS spectra and graphs of (Umnongrim conglomerate sample3) elements determined at 100µm, 20µm,10µm and 5µm

The above EDS spectra and graph shows the elements obtained at 100µm, 20µm,10µm and 5µm for sample 3 of Umnongrim conglomerate.Eight major elements and eight trace elements Br, Sr, Dy, Sb, Th, U and W are obtained.

Sample 4: Umnongrim conglomerate

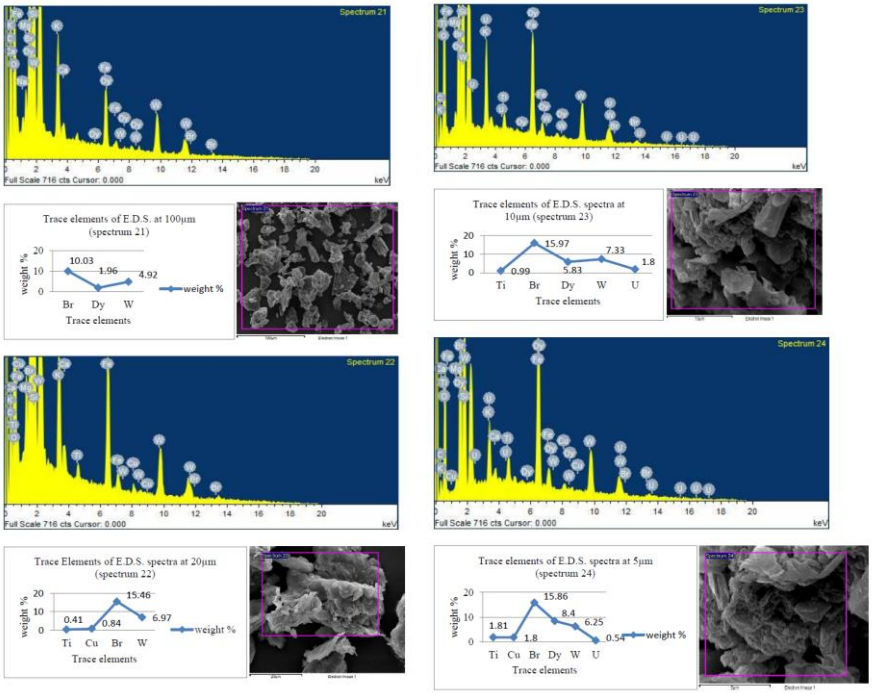

Fig. 6. (d) EDS spectra and graphs of (Umnongrim conglomerate smple 4) elements determined at 100µm, 20µm,10µm and 5µm

The above EDS spectra and graph shows the elements obtained at 100µm, 20µm,10µm and 5µm for sample 4 of Umnongrim conglomerates. Eight major elements and six trace elements Br, Dy, W, Ti, Cu and U are obtained.

6. Conclusions

The analysis of conglomerates using the EDS shows 9 major elements - C, O, Na, Si, K, Ca, Fe, Mg, Al and 24 trace elements- Br, Sr, Dy, Ge, Th, U, Sb, W, Hf, Sr, Zr, Mn, Ce, Pr, Sm, Eu, Nb, Cu, Hg, Sc, Br, Zn, Lu and Tc. Presence of traces of RREs like dysprosium, cerium, praseodymium, samarium, europium and lutetium has been determined. The following table shows the overall trace elements determine through EDS technique.

Out of the total 8 samples analysed, 7 samples shows traces of REEs which comprised of three light rare earth elements i.e Ce, Pr and Sm and three heavy rare earth elements i.e Eu, Dy and Lu and may occur in mineral phase as xenotime or monazite. Bastnaesite, monazite and xenotime are the economically significant minerals known to contain essential or significant REEs. The study is a preliminary work carried out and is the first reporting so far for REEs presence in the conglomerates of Tyrsad-Weiloi area .Further research need to be conducted to locate areas of REEs enrichment in the area.

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