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GEOLOGY AND HEAVY MINERAL ANALYSIS OF LOOSE SAND FROM AUKZEIK AREA, THE KALEKOK ISLAND, LAMING SUB-TOWNSHIP, MON STATE

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Abstract

Heavy mineral analysis was systematically carried out mainly focus on the beach sand of the Kalekok island. It is situated about 144km south of Mawlamyine and about 35 km north of Ye township, Mon State. It lies between latitude N 15°29′00″ to 15°32′ 30″ and longitude E 97° 38′30.00″ to 97° 40′ 15.00″ in one inch Topographic Map no.95 E/10. The topographic features of the whole area are generally mountainous and the drainage pattern show medium to coarse texture, subparallel pattern. The igneous rocks are microdiorite, hornblende biotite granodiorite with microdiorite xenoliths, biotite granite and leucogranite. The probable age of the igneous rocks may be emplaced in Early Cretaceous. The study area falls in tropical monsoonal climate and the annual rain fall is 99.83". The maximum temperature is 36.2°C and the minimum temperature is 20.14°C. The wind speed lies between 6 to 25 mph and most of wind direction is SW, E and SE directions. The XRF assay results and average heavy mineral data of the research area related to the silicic igneous origin, related to high rank metamorphism and the deposition through Triassic to Miocene. Titanium, zirconium, ilmenite, monazite, magnetite, REEs and radioactive elements are commonly occurred. These minerals are very important for industrial purposes and economical point of view. This research is supporting for the genesis of heavy minerals and related rocks, to get foreign income of the country, to explore the ore mineral resources, to development of industrial zone, to get the opportunities of employment for the local people, to maintain and reduce the damage of the coastal's natural environment.

Keywords: Heavy Minerals Analysis, Drainage Pattern, REEs, Radioactive Elements

Introduction

Heavy minerals are volumetrically minor constituents in terrigenous rocks. They are characterized as heaving a specific gravity greater than 2.85. Heavy minerals are now studied as guide to source rock lithologies and dispersal patterns. They are also useful in evaluating diagenetic history as well as the pre- erosional weathering and tectonic history of the source area. The various heavy mineral species present in sediments or rock comprise the heavy minerals assemblage. Rock units in a vertical succession containing different assemblages are called heavy minerale zones. Lateral variation within a lithologic unit, the various assemblages are known as heavy mineral associations. The research area is situated about 144km south of Mawlamyine and about 35 km north of Ye township, Mon State. It lies in one inch Topographic Map no.95 E/10. The study area falls in tropical monsoonal climate alternating mostly heavy rain and dry spell. The drainage pattern is fairly poor, medium to coarse texture and displays sub parallel pattern, as shown in Fig. 2.

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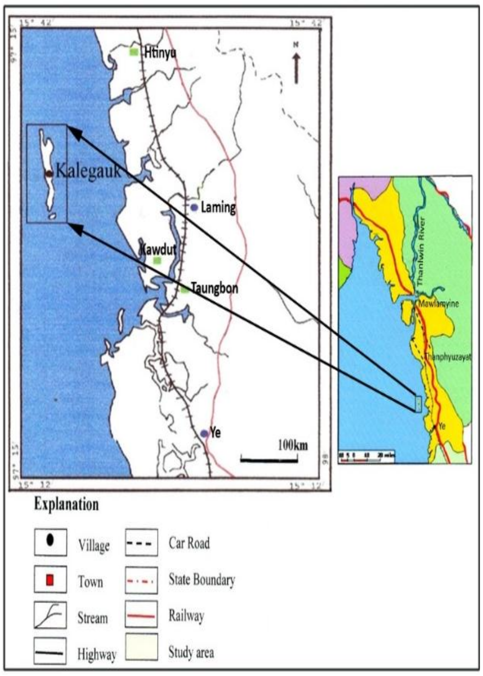

Figure 1 Location map of the research area

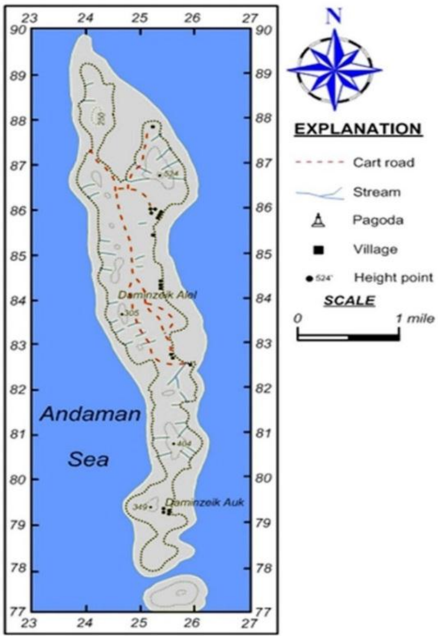

Figure 2 Drainage pattern of the research area

Purpose of Research

- The principal objectives of the research area as follows:
- To prepare a detailed geological map
- To study petrology, to understand the sampling, processing and content of heavy minerals, radioactive elements and REEs from loose sand.
- To provide detail economic exploration from underground beach sand development of industrial zone.
- To support foreign income of our country and the opportunities of the employments for local people.

Methods of Study

Field investigation

Before conducting the field works, literature collection and studies of previous works have been performed. Based on the available data and information, the field programme was planned. Field works including systematic sampling, measurement of the geological structures and geological mapping have been carried out by using tape and compass traverse method and GPS. After the ground checking, detail geological mapping was carried out and to make regional geological survey, see Fig. 3. The heavy minerals bearing beach sand are collected by making 2″Ǿ pile analyzed and to collect geochemical sampling for the petrochemical analysis. At each station, sand sample weighting 250g were collected.

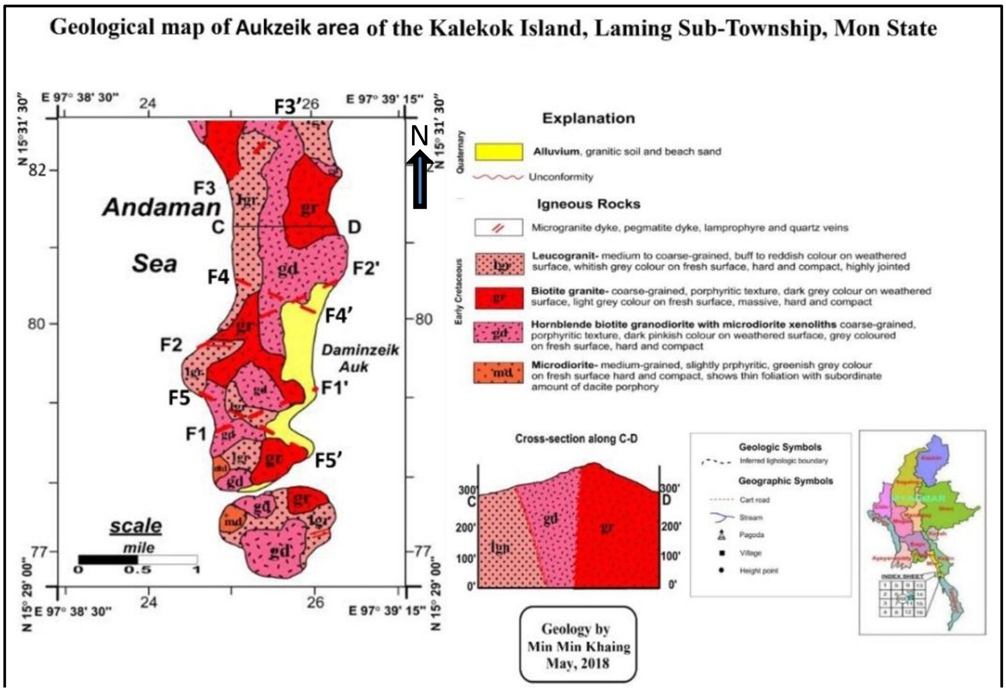

Figure 3 Geological Map of the Research Area

Distribution of rock units and field description

The study area is mainly composed of igneous rocks of microdiorite, hornblende biotite granodiorite with microdiorite xenoliths, biotite granite locally porphyritic and foliated texture, leucogranite. Igneous rocks are well exposed in the southern part of the Kalekok island and lamprophyre, pegmatite, microgranite, aplite dykes and quartz veins are intruded into it. Good exposures are found as boulder, as domes and as small bodies at the coastlines in the study area. Igneous rocks are highly weathered and are developed as different types, shapes and sizes of the igneous landforms. Microdiorite are commonly occurred at the southern part of the Kalekok island. Hornblende biotite granodiorite with microdirite xenoliths are mostly occurs at outboard portion of the island and the southern part of Aukzeik area. Biotite granite locally with porphyritic and foliated texture are mostly occurred as large domes and batholiths and they are sometimes gradationally contacted with hornblende biotite granodiorite with microdiorite xenoliths especially occurred at the eastern part of Aukzeik beach. Biotite granite is sharply contact with hornblende biotite granodiorite with microdiorite xenoliths and leucogranite mainly encounter at the Aukzeik pagoda hill and western part of Warsho hill. Leucogranite are mainly exposed at southern part of the study area and good exposure are found at the beach of Cavendish island and Aukzeik area. It is generally hard, compact and highly jointed. They intruded hornblende biotite granodiorite with microdiorite xenoliths and biotite granite. Lamprophyre dykes are intruding hornblende biotite granodiorite with microdiorite xenoliths, biotite granite and leucogranite. Lamprophyre dykes are mainly intruded into leucogranite as dyke swams at Cavendish island and Aukzeik area. Pegmatite dykes intruded hornblende biotite granodiorite with microdiorite xenoliths and biotite granite. Pegmatite dykes and veins are mainly occured at Warsho hill. Aplite dykes mainly intruded into hornblende biotite ganodiorite with microdiorite xenoliths and biotite granite. They are mainly found at southern part of Aukzeik area. Microgranite (biotite microgranite) dykes are mainly intruded into hornblende biotite granodiorite with microdiorite xenoliths and biotite granite, especially occurred at Aukzeik area. Quartz veins are intruding in all the granitoid rocks and they are widely distributed.

Geological Structures

There are five minor normal fault in the research area. F_1-F_1', F_2-F_2' and F_3-F_3' are trending NE-SW. F_4-F_4' and F_5-F_5' are trending NW-SE.

Figure 4 Loose sand samples location map of the research area

Laboratory investigation

The laboratory investigation of the representative samples include the following; thin section study of different rock units exposed in the research area and modal analysis were analyzed by means of polarizing microscope. Quantitative and qualitative elements analyses of various rock types and unknown minerals have been carried out using XRF and XRD analyses. The collected the loose sand samples are dried and weighted. Grain size differentiation by sieving and after sieving, the samples are weighted. Magnetic fraction by hand magnet and weighted. Heavy minerals are removed from more abundant light minerals by gravity separation by using a high density heavy liquid of Bromoform, Acetylene tetrabromite, Methlene iodide.

Previous Works

Brown and others (1951), Hutchison (1973) (1978), Bender (1983), Nyan Thin (1984) and Khin Zaw (1990) studied the regional geological study of the neighbouring area. Min Min Khaing (2013) studied petrological and petrochemical analysis on granitic rocks of the Kalekok Island and its environs.

The research area is part of the Shan-Tanintharyi Block and the northern continuation of Thanintharyi Ranges. The area can be regarded as a southern continuation of SE-Asia Tin-Tungsten Belt. It lays the Western Granite Province of SE-Asia and also within the Central Granitoid Belt of Myanmar, as shown in Fig.4

General Geology

Regional Geologic Setting

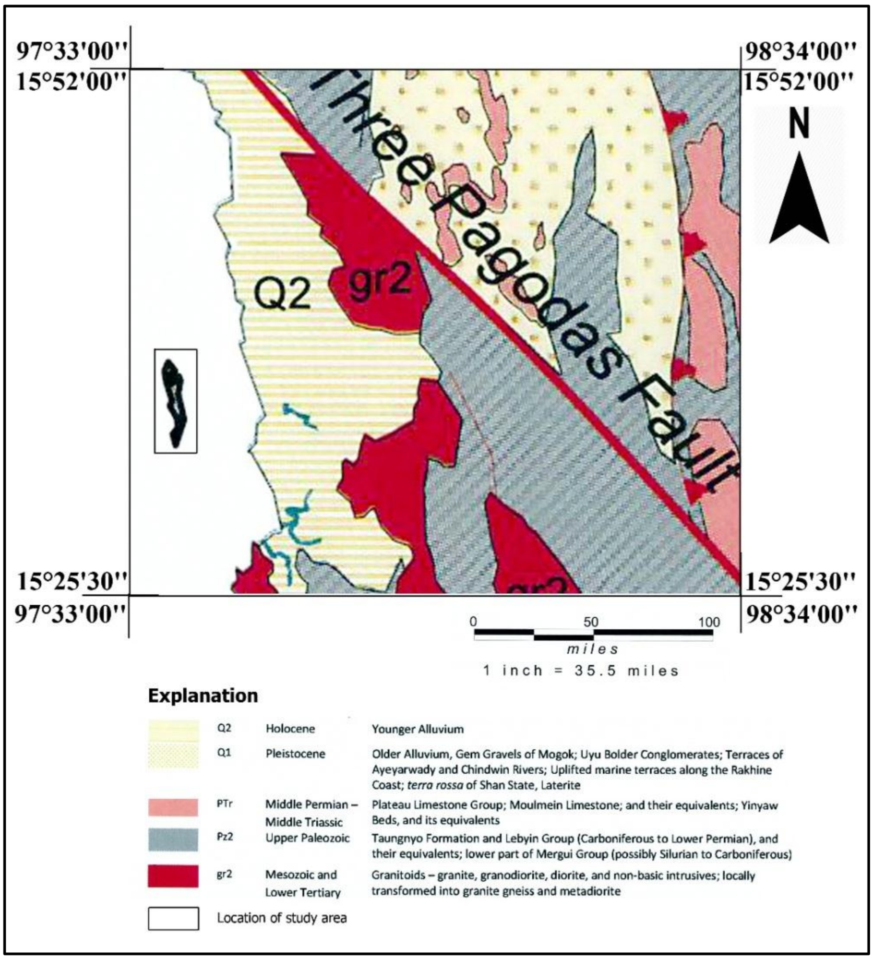

Figure 5 Regional Geological Map (After 1 million scale Geological Map of Burma, 2014

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Minerals Description

Most of the heavy minerals of the research area are anisotropic minerals but spinel and garnet are isotropic. Opaque grains are ilmenite and hematite, these minerals are very similar physical characteristics but different streak and crystal form. Ilmenite is also known as manaccanite, primary titanium ore and mostly connected with igneous deposits. Ilmenite is reddish brown colour and commonly altered to leucoxene. Quartz, apatite, amphibole monazite, tourmaline, epidote, rutile, zircon and sphene are also observed, See Fig. 5, Fig. 6. According to the mineral distribution map of the study area, Chromite, Leucoxene and Zircon are mostly distributed at the northern part and Geothite, Ilmenite and Sphene are distributed in southern part of the research area.

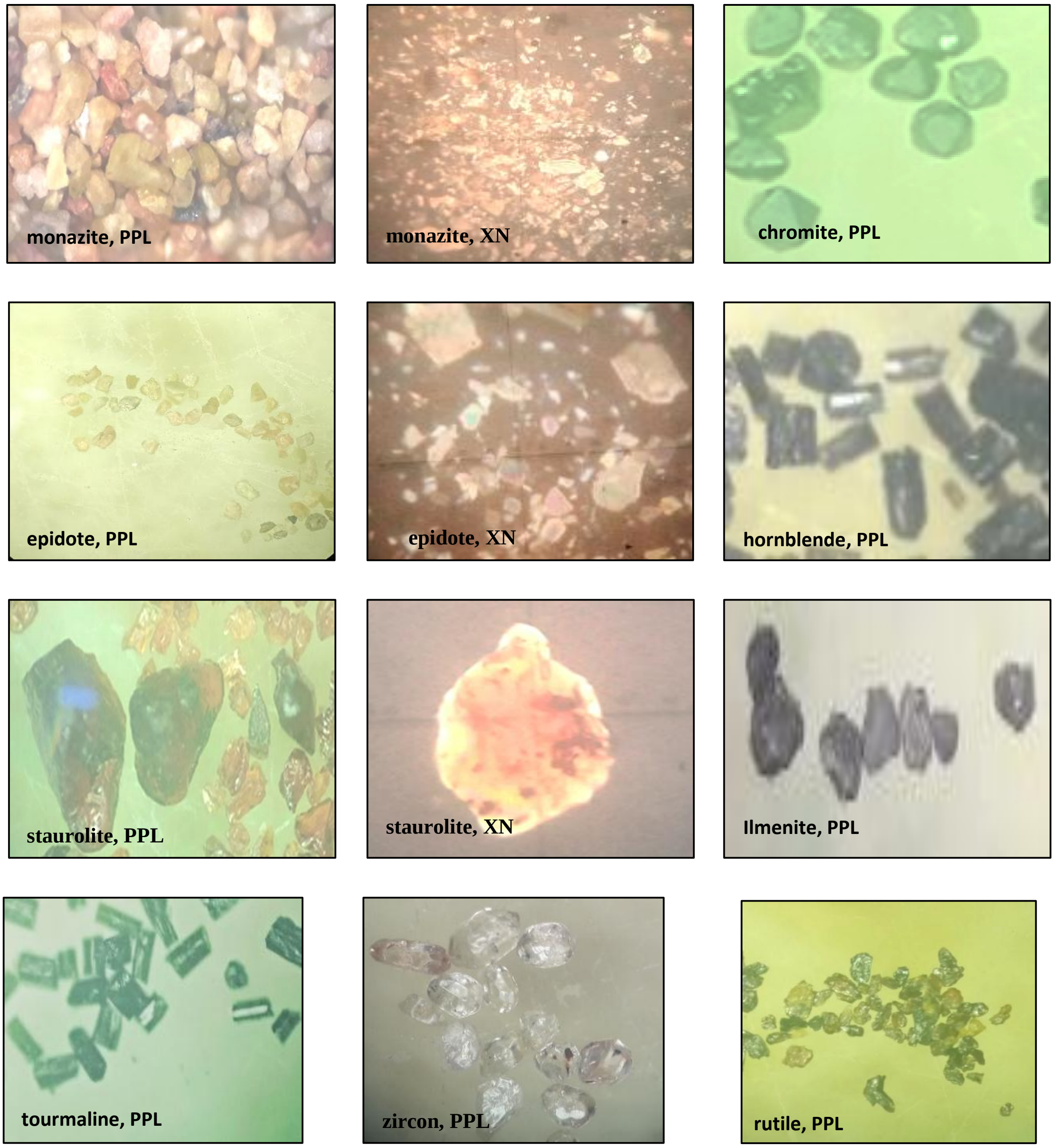

Figure 6 Microscopic study of heavy minerals

Results and Finding

At the beach of the research area, heavy minerals bearing sand are commonly occurred as layer by layer about 2cm to 6cm thick. Generally, the surface ground radiation is (100) CPM to (1000) CPM are widely distributed on beach sand flats. In some place, locally surface ground radiation is mostly occurred as (20) CPM to (100) CPM and strong radiation (300) CPM to (1000) CPM are found, Table. 1, Table. 2, Table. 3, Table. 4. REE minerals of Y, La, Ce, Pr, Nd and Th are observed. Y is up to 0.088 ppm, La is up to 0.235 ppm, Ce is up to 4.7 ppm, Pr is up to 0.206 ppm, Nd is up to 0.167 ppm and Th is up to 0.113 ppm respectively.

Table 1 List of heavy mineral analysis data from Aukzeik area (2015-16)

Sample No	mm 1 Aukzeik-S	mm 2 Aukzeik-S	mm 3 Aukzeik	mm 4 Aukzeik-N	mm 5 Aukzeik-N
Magnetic fraction %	0.88	Trace	0.10	10.13	73.02
Light Mineral %	88.70	92.04	93.80	3.35	18.62
Quartz	65.30	56.05	55.30	2.50	-
Feldspar	22.40	35.99	26.50	0.84	-
Mica	1.00	-	12.00	0.01	-
Heavy Mineral (%)					
Zircon	3.40	2.30	1.90	3.63	1.08
Monazite	0.50	1.45	0.10	0.13	0.18
Ilmenite	3.60	1.27	2.70	79.87	4.53
Tourmaline	2.10	1.86	0.70	0.62	0.05
Garnet	0.06	0.43	0.10	0.99	0.09
Epidote	0.30	Trace	0.40	-	0.07
Xenotime	-	-	-	0.01	0.33
Rutile	0.43	0.65	0.10	1.27	0.34
Diopside	-	-	-	-	-
Cassiterite	0.03	-	0.10	-	0.20
Anatase	-	-	-	-	-
Uraninite	-	-	-	-	-
Sphene					0.31
Hematite					0.11
Amphibole					0.08
Andalusite					0.05
Geothite & Limonite					0.53
Leucoxine					0.41

Table 2 List of heavy mineral analysis data from Aukzeik area (2018)

Heavy Minerals	MK-1	MK-2	MK-3	MK-4	MK-5	MK_6
Magnetic fraction Wt%	33.25	34.63	48.42	47.39	50.92	55.24
Light fraction Wt %	7.25	23.18	14.23	12.42	7.56	3.16
Heavy fraction Wt %	59.5	42.19	37.35	40.19	41.51	41.6
Ilmenite	12.81	6.86	3.67	2.97	3.72	2.43
Epidote	1.51	3.86	3.46	2.77	4.15	0.79
Garnet	2.99	0.45	1.28	0.35	0.22	0.2
Leucoxene	3.22	2.71	1.5	2.16	4.45	1.63
Amphibole	8.54	1.81	3.85	0.21	2.56	0.01
Geothite	2.45	1.58	1.22	0.94	2.08	1.17
Staurolite	14.62	5.68	12.12	19.54	11.51	7.94
Kyanite	2.12	1.72	1.14	1.05	0.45	0.34
Tourmaline	0.9	4.82	0.36	0.71	1.36	0.72
Rutile	4.88	4.43	2.03	5.09	2.46	8.03
Zircon	5.46	4.87	4.02	2.61	5.64	15.99
Anatase	0.01	0.07	0.11	0	0	0.09
Sphene	0	2.34	0.81	1.09	1.64	0.99
Monazite	0	0.99	0.3	0	0.65	0.25
Sillimanite	0	0.01	0.64	0.4	0.49	0.01
Chromite	0.01	0.01	0.84	0.19	0.08	0.75
Rock clasts	0	0	0	0.11	0.05	0.28
Spinel	0	0	0	0	0	0.01
Xenotime	0	0	0	0	0	0

Table 3 Comparison of heavy mineral analysis datas from Aukzeik area (2015– 2016–2018)

Heavy Minerals	2015-16	2018
Ilmenite	1.27-79.84	2.97-12.81
Epidote	Trace-0.40	0.79-4.15
Garnet	0.06-0.99	0.20-2.99
Leucoxene	0-0.41	1.5-4.45
Amphibole	0-0.08	0.01-8.54
Geothite	0-0.53	0.94-2.45
Staurolite	-	5.68-19.54
Kyanite	-	0.34-2.12
Tourmaline	0.05-2.1	0.36-4.82
Rutile	0.1-1.27	2.03-8.03
Zircon	0.08-3.63	2.61-15.99
Anatase	-	0-0.11
Sphene	0-0.31	0-2.34
Monazite	0.1-1.45	0-0.99
Sillimanite	-	0-0.64
Chromite	-	0.01-0.84
Rock clasts	-	0-0.28
Spinel	-	0-0.01
Xenotime	0.01-0.33	-
Cassiterite	0.03-0.1	-
Hematite	0-0.8	-
Andalusite	0-0.05	-

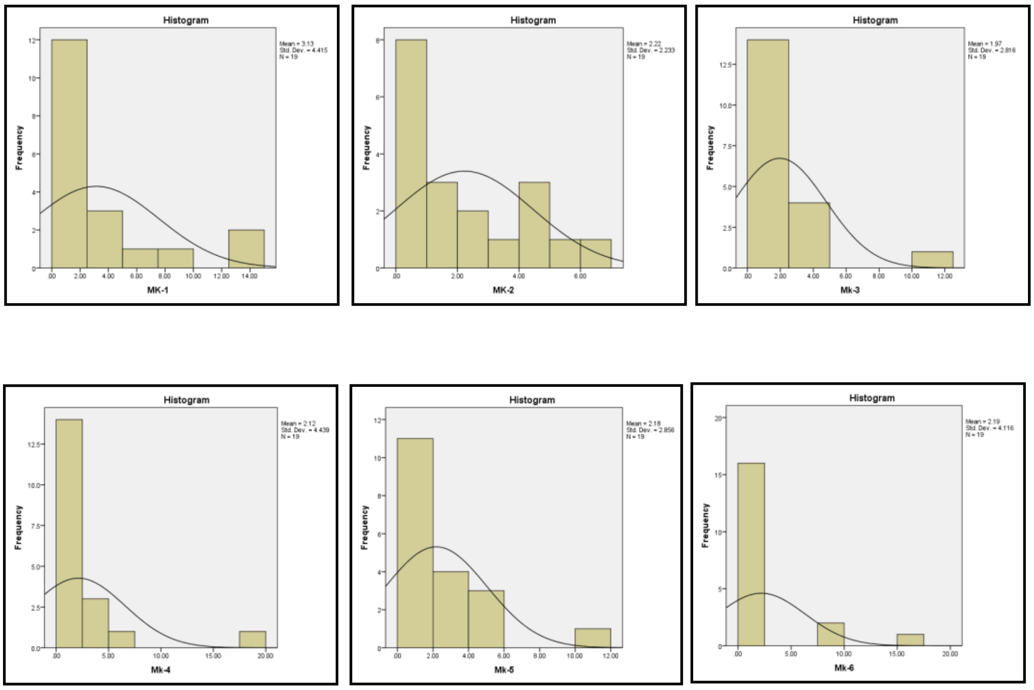

Figure 7 Histogram of heavy minerals from the research area. Data used in Table. 4.

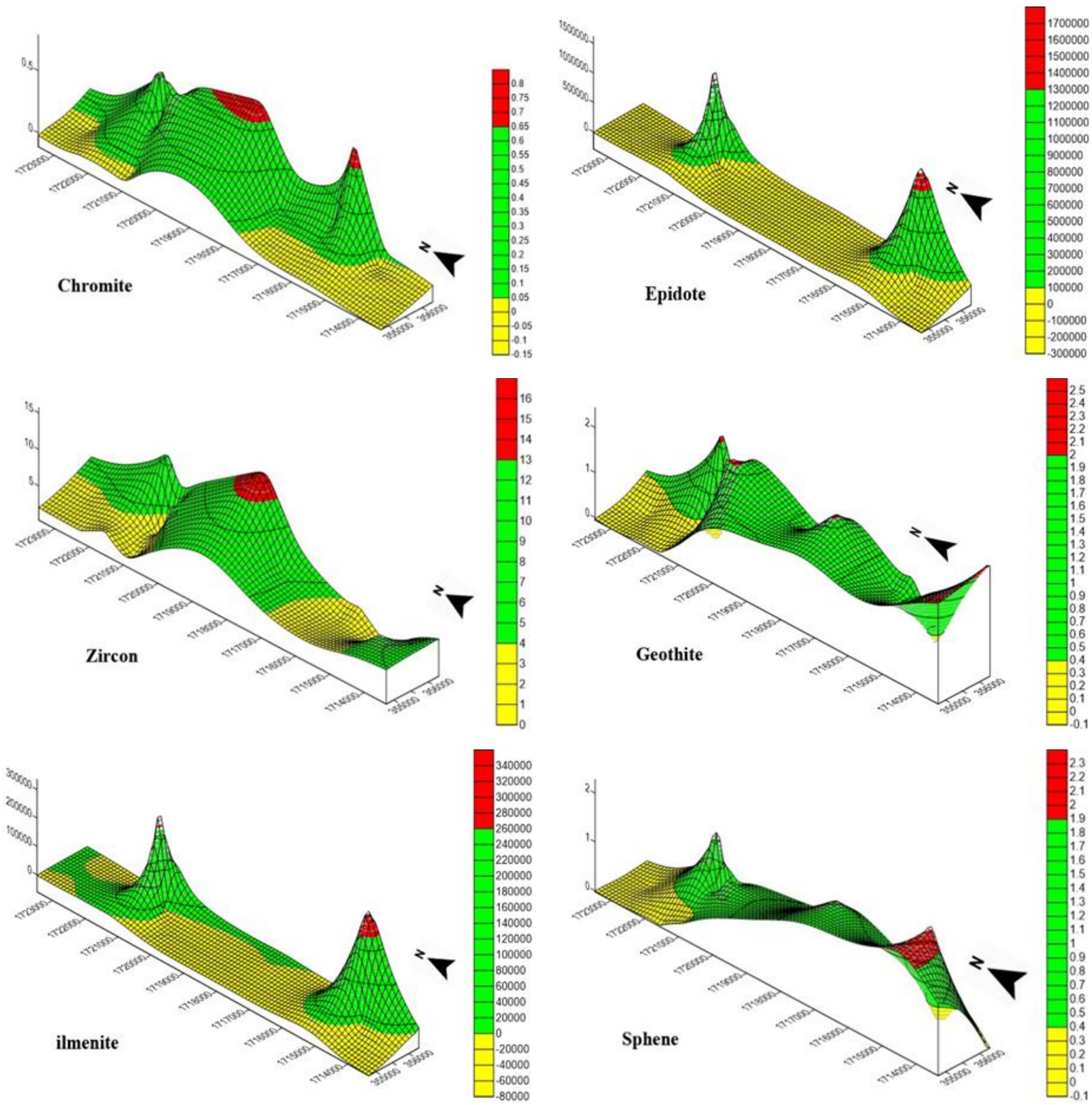

Figure 8 Minerals distribution map of the research area

Discussion and Conclusion

The research area is mainly composed of igneous rocks (Early Cretaceous) and they are intruded by lamprophyre, pegmatite, microgranite, aplite and quartz vein. Heavy mineral assemblages in marine deposits are strongly influenced by major rivers, on adjacent land masses, with drainage basins of different lithologic make up. The origin of many heavy mineral species are limited to rather specific rock types. In the research area, rutile, tourmaline and zircon are commonly occurred. According to detrital heavy mineral suites characteristic of source rock types (modified from Pettijohn, 1970) this fact indicated that it is reworked sediments. Andalusite, epidote, garnet, hornblende are found, so it is related to high rank metamorphism. Also apatite, amphibole, monazite, sphene, tourmaline and zircon are occurred it is the origin of silicic igneous origin. Some mineral species (e.g zircon and rutile) are minor constituents in source rock. Other more abundant mineral species (e.g hornblende) are relatively unstable and most are destroyed during weathering in source area.

Table 4 XRF analysis data of heavy minerals from loose sand of Aukzeik area

	mk 1	mk 1a	mk 2	mk 2a	mk 2b	mk 3	mk 3b	mk 3c	mk 3d	mk 4	mk 4a	mk 4b	mk 4c	mk 4d	mk 5	mk 5a	mk 5c	mk 6	mk 6c
Ti	1.3	5.29	0.2	0.2	0.35	0.33	8.334	10.51	2.07	8.358	7.874	8.355	4.199	2.98	14	14.1	2.909	0.3	0
V	-	0.02	-	-	-	-	0.035	0.043	-	0.039	0.04	0.036	0.018	-	0.04	0.03	-	-	-
Cr	0.1	0.38	-	0	-	0.015	0.731	1.12	0.123	0.875	0.763	0.855	0.37	0.194	0.59	0.7	0.141	-	-
Mm	0.1	0.35	0.1	0	0.06	0.028	0.562	0.708	0.167	0.582	0.533	0.575	0.292	0.205	1.21	1.2	0.231	0	0
Fe	2.8	10.3	2.2	2.4	2.95	0.014	13.59	16.64	5.896	14.36	13.54	14.01	8.23	7.402	17.2	17.1	3.871	0.8	3
Co	0	-	0	-	0	0.005	0.011	0.011	0.0061	-	0.0112	-	0.006	0.002	-	0.01	0.002	0	0
Zn	-	0.02	0	-	0.01	-	0.03	0.034	0.0408	0.034	0.0272	0.027	0.0175	0.016	0.03	0.03	0.017	-	-
Se	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-
Rb	0	-	0	0	0.02	0.005	-	-	0.005	-	-	-	-	-	-	-	-	0	0
Sr	-	0.02	0	0	0.05	-	0.018	0.012	0.0092	0.01	0.0123	0.011	0.0112	0.014	-	-	-	0	-
Y	0	0.05	-	-	-	-	0.088	0.136	0.0175	0.115	0.102	0.108	0.0488	0.022	0.07	0.09	0.0167	-	-
r	0.8	1.19	0	0.1	0.03	0.138	2.824	4.884	0.4194	4.377	3.723	3.886	1.544	0.408	6	7.09	1.237	0.1	0
Nb	0	0.02	-	-	-	-	0.02	0.021	0.0062	0.015	0.164	0.016	0.0096	0.01	0.03	0.03	0.0083	-	-
Ba	-	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-
La	-	0.08	-	-	-	-	0.169	0.235	-	0.186	0.19	0.196	-	-	-	0.11	-	-	-
Ce	-	0.15	-	-	-	-	0.293	0.47	-	0.398	0.369	0.379	0.157	0.074	0.17	0.2	-	-	-
Pr	-	-	-	-	-	-	-	0.206	-	-	-	-	-	-	-	-	-	-	-
Nd	-	-	-	-	-	-	0.138	-	-	0.16	0.167	0.166	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	0.067	0.1	-	0.1	0.082	0.083	-	-	0.13	0.18	0.021	-	-
W	0.1	-	0.1	-	0.04	0.114	-	-	0.049	-	-	-	-	-	-	-	-	0.1	0
Th	-	0.03	-	-	-	-	0.067	0.113	-	0.102	0.0879	0.096	0.04	-	0.06	0.08	-	-	-

During the time, when a sedimentary sequence is being deposited the character of the source area will be likely change. Such changes may be reflected in the succession of heavy mineral zones. According to heavy mineral zone (modified from Pettijohn 1974, based on data from Anderson 1948); the heavy mineral zone of rutile, zircon, tourmaline, garnet minerals fall in Triassic zone, rutile, zircon, tourmaline, garnet and epidote minerals fall in Upper Cretaceous zone, rutile, zircon, tourmaline, garnet, epidote and amphibole minerals fall in Miocene zone. The trend most cited is an upward increase in the complexity of the assemblages. Minerals present in the younger beds but absent in the older ones are commonly less stable species. According to the heavy mineral zones, the heavy mineral situation involves the deposition through Triassic to Miocene, especially fall in Cretaceous. The XRF assay results, average heavy minerals data, the heavy minerals relation of histogram and mineral distribution map of the research area, in Fig. 7, Fig. 8, ilmenite mineral commonly occurred in the southern part and suggest that related to the silicic igneous origin. Ilmenite is a major ore of titanium, a minor ore of iron, so used as a metal need make a variety of high- performance alloys, used to manufacture of titanium dioxide, pigment, whiting and polishing abrasive. The occurrences of heavy minerals and REEs are important for military and industrial purposes.

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