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Letter

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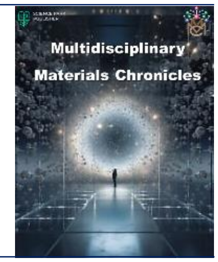

Multidisciplinary Materials Chronicles

Mineralogical implications of black sands in the coastal area of Mediterranean Sea, Egypt

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Abstract

The current area contains heavy metals connected with black sand throughout a long stretch of the Mediterranean Sea coastline. These formations have large reserves of various precious minerals. The current study aims to determine of mineralogical aspects of black sand along of Mediterranean Sea. The Mediterranean Sea Coast research region is comprised of detrital sediments deposited by the White Nile, Blue Nile, and Atbara rivers. Egyptian black sands contain commercial minerals, including garnet, zircon, and monazite. Monazite and certain zircons are radioactive minerals. Nonetheless, monazite content in Egyptian beach sands is far lower than that of zircon.

Keywords: Black sand, Mineralization, Mediterranean Sea, Egypt

1. Introduction

The research area is located on the Mediterranean Sea shoreline. It lies about 8 km east of the Rosetta distributary mouth, northwest of Burullus Lake, between longitudes 30˚ 25' 48" - 30˚ 33' 00" E and latitudes 31˚ 26' 42" - 31˚ 27' 18" N (Figure 1 A&B). The part measures 10 km² long, parallel to the beach, and 1 km broad, nearly perpendicular. The research zone east of Rosetta has a rectangular coastal plain measuring around 10 km². It is 10 kilometres long parallel to the beach and 1 km broad perpendicular to the shore. This area was sampled with 306 specimens to a depth of one meter at the junction of a 200mx200m grid pattern that was nearly parallel and perpendicular to the coastline. Field samples were gathered throughout the summer of 2012. Africa has vast deposits along its eastern coast, notably in South Africa and Sierra Leone. Richards Bay's Holocene high dunes have large mineral concentrations. They often reach a height of roughly 20 meters and contain 10 to 14 percent heavy minerals. Ilmenite, rutile, and zircon make up around 5.9 weight percent of all dune sands [1]. Placer deposits are made up of radioactive-resistant minerals that are widely distributed over the world. The radioactive minerals in the placer deposits supplied a source of uranium, thorium, and rare earth elements such as monazite, radioactive zircon, thorite, uranothorite, and xenotime, which are routinely removed during the production of more widely utilized minerals.

The mineralogy of Egyptian black sands, which has been used by researchers to precisely identify various coastal habitats, is important for the commercial minerals industry, notably in the nuclear, metallurgical, and engineering sectors [2]. The Egyptian black sands' economic minerals are mostly opaque, accounting for around 86 percent of total economic minerals characterized these opaque particles as iron oxides, whereas identified them as magnetite, ilmenite, and haematite [3-5]. The size of grains is crucial in the concentration and separation of commercially useful heavy minerals utilizing wet gravity, electrostatic, and magnetic techniques during black sand extraction [6-9]. The size of mineral particles is essential in metallurgy, chemical processes, and the manufacture of paints, pigments, and abrasives. Egyptian black sand is radioactive and magnetically sensitive.

The beach placer deposits along the Egyptian Mediterranean coast have an enhanced natural radiation environment due to the occurrence of radiogenic heavy minerals such as monazite, radioactive zircon, thorite, and uranothorite, which include radioactive elements in their chemical makeup [7]. Uranium, thorium, and radioactive potassium are the most common radionuclides found in Egyptian Mediterranean beach sediments [10-13]. Researchers looked at the natural radioactivity of thorium, uranium, and radioactive potassium in Egyptian black sands. The field radioactivity was attributed to the thorium tenor, which disguised the impact of uranium and the radioactive potassium isotopes. The major objectives of this study are to investigate and analyze the mineralogy of economically relevant beach minerals, as well as the radioactive concentrations of placer deposits in the sands of East Rosetta Beach, namely the southern coastal plain region. Such research creates the framework for the development of mineral concentrates that meet the needs of both domestic and international markets.

Sediments are critical to assessing heavy metals because they serve as intermediate and/or long-term integrators of metal inputs. According to the horizontal distribution of metals, the chemical composition of surface sediments is a good indicator of local contamination [14].

2. Materials and methods

The coastal plain region was sampled with 306 specimens to one-meter depth at the intersections of a 200m-by-200m grid pattern that was almost parallel and perpendicular to the beach. Field samples were collected throughout the summer of 2012. The upper meter sampling process is based on the sand's moisture content, which helps to keep it in the sample container. As a result, water has hydrated the dry crust formed by solar evaporation. Each sample was collected by submerging the sampler vertically in saturated sediments until the whole sample container was immersed, then carefully extracting and putting it in a sample bag. The process was repeated several times until the upper meter was sampled. Mineralizations were investigated using scanning electron microscopy. Environmental scanning electron microscopy (ESEM) is a unique system that can examine encapsulated biological and industrial materials using an electron beam in a high-pressure water vapor atmosphere.

3. Result and discussion

3.1. Mineralogy of the Economic Minerals

3.1.1. Garnet

Garnet is identified by its pale pink, pale red, or pinkish-brown color. It appears as fine eu-hedral to sub-hedral dodecahedral crystals in amounts of up to 7% in severely changed rocks. According to EDX examination, it has an almandine composition of predominantly Fe up to (28.87%), O up to (26.86%), Si up to (22.21%), Ca up to (8.21%), Al up to (6.87%), Mg up to (4.35), with amounts of Mn, Ti, and k up to (2.63%) (Figure 2a).

3.1.2. Monazite

Monazite is distinguished by its resinous luster. It appears as rounded, egg-shaped, or spherical colorless, greenish-yellow, and infrequently brown crystals with up to 5% heavy mineral content. EDX examination reveals that monazite possesses P content up to (15.97%), O (21.89%), Ce (21.10%), La (11.12%), Nd (9.35%), and Th (7.38%), as well as Ca up to 1.68% and Fe up to (1.97%) as showing in (Figure 2b).

3.1.3. Zircon

Zircon crystals are eu-hedral and sub-hedral, with a black halo surrounding them. It is normally colorless, pink, purple, orange, or yellow, with a rare exception of blue or grey. In general, zircon accounts for a variable percentage of the major heavy mineral concentration, ranging from 1% to 13%. According to EDX examination, it has Zr content up to 48.59%, with a significant amount of O, Mg, Al, and Fe up to 41.41% (Figure 2c).

The researched mafic minerals include sphene, pyroxene, and amphibole minerals. Sphene (titanite) appears as fine an-hedral, and infrequently as eu-hedral wedges of light to dark brown color. It is distinguished by conchoidal fractures. Sphene has a significant amount of Fe (39.28%), but less Si (12.70%), Al (6.77%), and Mg (4.40%) (Figure 2d).

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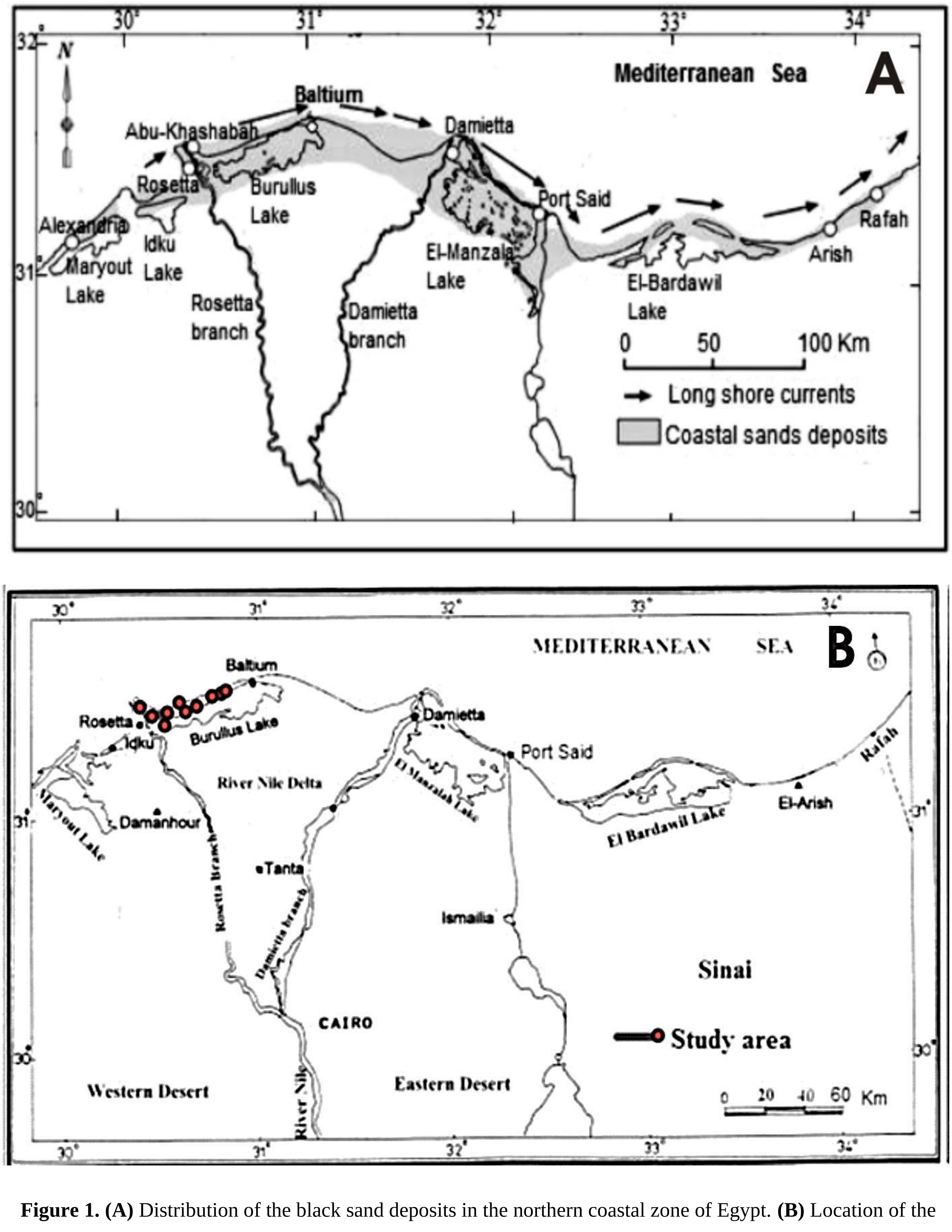

Figure 1. (A) Distribution of the black sand deposits in the northern coastal zone of Egypt. **(B)** Location of the study area in the Nile Delta coastal plain.

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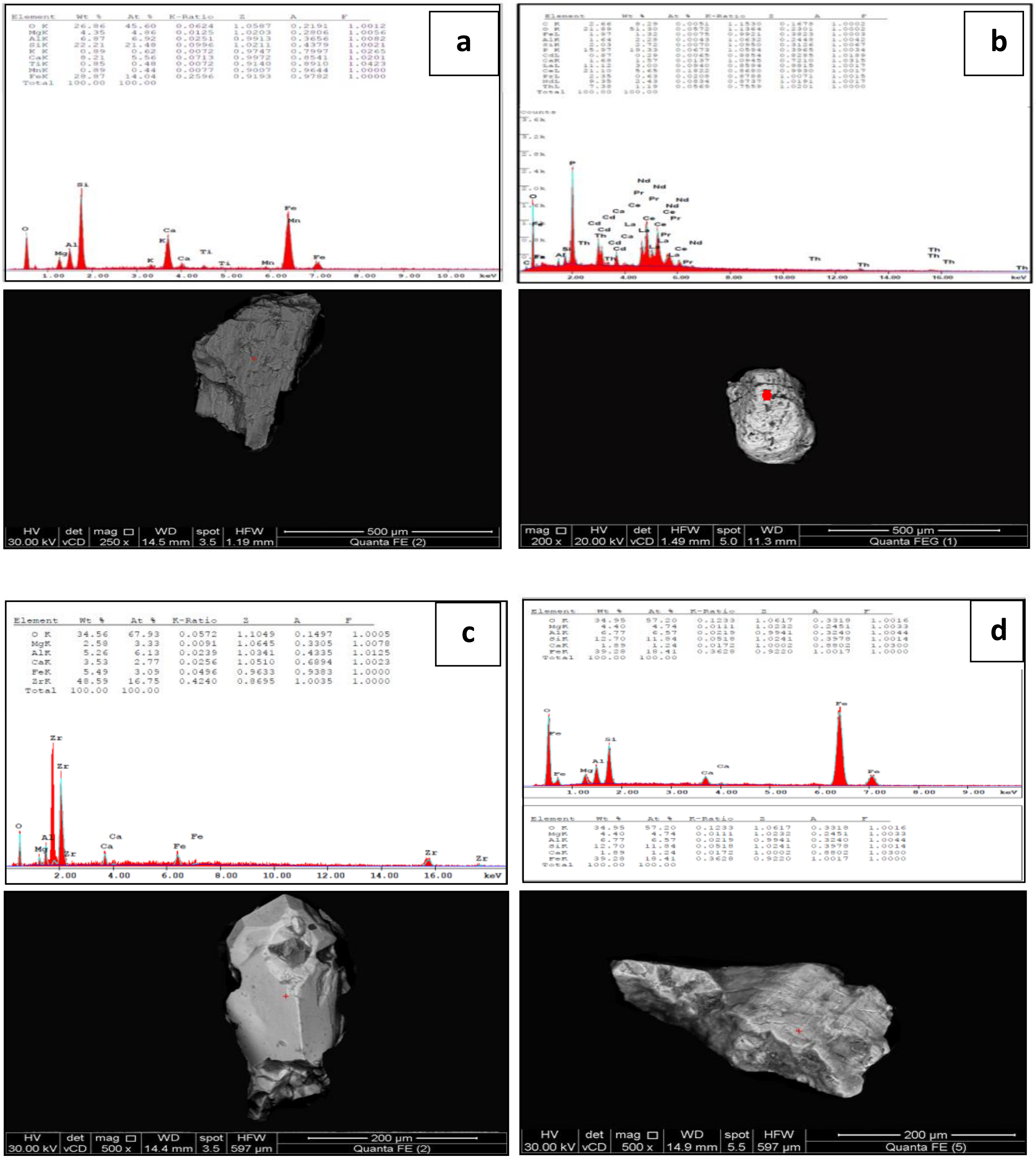

Figure 2. (a) EDX and BSE image of garnet, **(b)** EDX and BSE image of monazite, **(c)** EDX and BSE image of zircon, and **(d)** EDX and BSE image of sphene.

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4. Conclusion

The Egyptian black sand deposits are considered a source of strategic and commercial heavy minerals such as garnet, zircon, and monazite. Monazite and certain zircons are radioactive minerals. Monazite contains far greater amounts of thorium (Th) and uranium (U) than zircon. Nonetheless, monazite concentrations in Egyptian beach sands are far lower than in zircons. Egyptian black sands are recognized as raw materials for the atomic energy and engineering industries because they include radioactive transporting minerals, which may pose a radioactive risk, emphasizing their rising environmental relevance.

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