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Environmental impacts of heavy metals, rare earth elements and natural radionuclides in marine sediment from Ras Tanura, Saudi Arabia along the Arabian Gulf

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HIGHLIGHTS

- Ras Tanura city is one of the most important cities in Saudi Arabia.
- The concentration of natural radionuclides, heavy metals and rare earth elements were measured.
- The specific activities of 238U, 226Ra, 232Th, 40 K and 137Cs (Bq/kg) were measured.
- Heavy metals and rare earth elements were measured using ICPE-9820 Plasma Atomic Emission Spectrometer.

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ABSTRACT

Ras Tanura city is one of the most important cities in Saudi Arabia because of the presence of the largest and oldest oil refinery in the Middle East which was began operations in September 1945. Also its contains gas plant and two ports. The concentration of natural radionuclides, heavy metals and rare earth elements were measured in marine sediment samples collected from Ras Tanura. The specific activities of ^{238}U, ^{226}Ra, ^{232}Th, ^{40}K and ^{137}Cs (Bq/kg) were measured using A hyper-pure Germanium detector (HPGe), and ranged from (20.4 ± 4.0–55.1 ± 9.9), (6.71 ± 0.7–46.1 ± 4.5), (3.51 ± 0.5–18.2 ± 1.5), (105 ± 4.4–492 ± 13) and from (0.33 ± 0.04–2.10 ± 0.4) for ^{238}U, ^{226}Ra, ^{232}Th, ^{40}K and ^{137}Cs respectively. Heavy metals and rare earth elements were measured using ICPE-9820 Plasma Atomic Emission Spectrometer. Also the frequency distributions for all radioactive variables in sediment samples were analyzed. Finally the radiological hazards due to natural radionuclides in marine sediment were calculated to the public and it's diagramed by Surfer program in maps. Comparing with the international recommended values, its values found to be within the international level.

1. Introduction

Heavy metals pollution of the aquatic environment has become a worldwide problem. Metals like arsenic, cadmium, chromium, mercury, nickel, and lead are often considered indicators of anthropogenic influence in marine environment and are themselves of potential risk to the natural environment (Khan et al., 2017). A number of researchers have demonstrated that the evaluation of metal distribution in marine sediment is important due to high pollution with heavy metals (Cuculić et al., 2009; Ali and Soltan, 1996). Hence, to assess and track the abundance of these heavy metals in coastal ecosystem is an important task

Rare earth elements have very similar chemical properties and tend to be present in nature as groups rather than alone, which makes them very useful as tracers in geochemical studies (El-Taher, 2007). Rare earth elements are used as important tools in delineating the geochemical environment during the formation of authigenic and diagenetic minerals (Khan et al., 2012). Traditionally, the lanthanide elements have been separated into two groups: the light rare earth elements (LREEs) lanthanum through europium (Z = 57 through 63) and the heavy rare earth elements (HREEs) gadolinium through lutetium (Z = 64 through71) (El-Taher, 2010a, 2010b, 2010c, 2010d).

Natural Radioactivity is common in rocks, soil, beach sand, sediment, and even in our building materials and homes. Its arises mainly from the primordial radionuclides, such as ^{40}K and the radionuclides from ^{238}U and ^{232}Th series and their decay products, which are present at trace levels in all ground formations (Tzortzis et al., 2004). The background radiation from these radionuclides can be high if the

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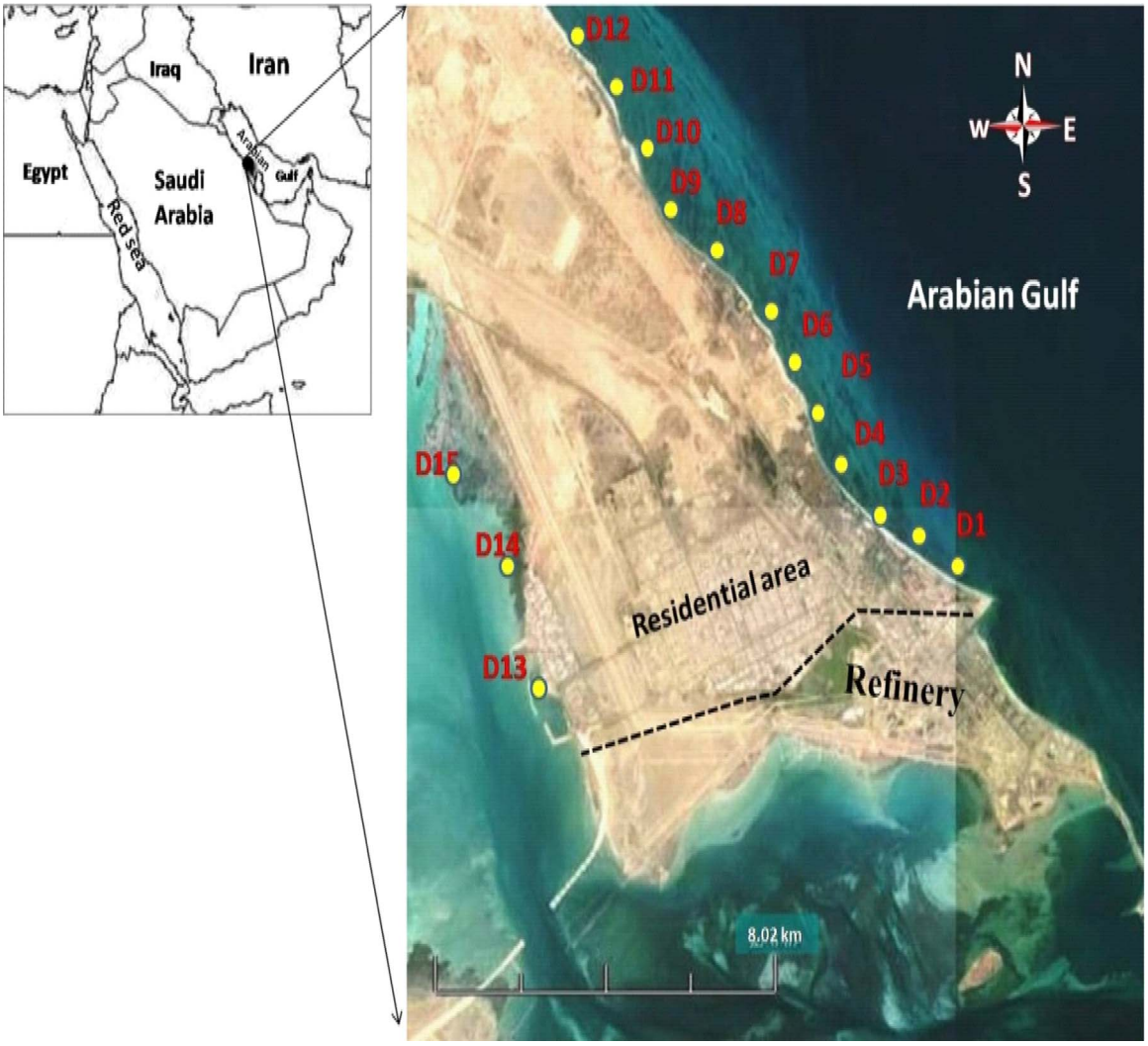

Fig. 1. Location map for the sediment samples.

environment is polluted either from man-made or natural activities (Chandrasekaran et al., 2014). The essential reservoirs for natural and anthropogenic radionuclide retention are marine sediments because of their diverse composition.

The sediment movement and accumulation provide a strong signal about the sediment origin and future abnormality in the radionuclide concentrations, hence, it is the basic indicator of radiological contamination in the environment (Suresh et al., 2011). Radionuclides have been released to the marine environment from a multiplicity of sources, both planned and accidental. The physical processes of water movement and mixing, marine chemistry, marine sediments, accumulation and redistribution of radionuclides by marine organisms, all affect the fate of radionuclides transport. Long-term exposure to uranium and radium through inhalation has several health effects such as chronic lung diseases, acute leucopoenia, anemia, and necrosis of the mouth. Radium causes bone, cranial, and nasal tumors. Thorium exposure can cause lung, pancreas, hepatic, bone, and kidney cancers and leukemia (El-Taher and Madkour, 2014).

Therefore, the knowledge of the concentrations and distributions of heavy metals, rare earth elements and natural radionuclide in the marine sediments along the Arabian Gulf coast and aquatic environmental locations are of great interest since it provides useful information in monitoring of environmental contamination and associated human health by natural radioactivity.

2. The importance of the study

Due to the fact of that the last 30 years, the Gulf marine environment have been subjected to several threats, especially from the 3 Gulf war events which exerted great stress on the marine environment and exposed its resources to damage. Despite the availability of scientific data on the contamination of the environment with metals and hydrocarbons, very limited information exists on the exposure of the Gulf to radioactive material. This is particularly important, especially with the increase in the number of nuclear power activated vessels visiting the Gulf, the possibility of release or leakage of radioactive compounds from nearby nuclear facilities, the drilling activities taking place for oil and gas exploration and exploitation, the increase in land-based sources leading to the discharge of surface water from major cities, and the disposal of cooling and waste water from Industrial cities in addition to the competition between Gulf states to own nuclear facilities in the near future for peaceful use and power generation. Radionuclides have been released to the marine environment from a multiplicity of sources, both planned and accidental. There have been a growing number of known sources of anthropogenic radionuclides in the marine environment. The physical processes of water movement and mixing, marine chemistry, marine sediments, accumulation and redistribution of radionuclides by marine organisms, all affect the fate of radionuclides transport.