Marine Pollution Bulletin 135 (2018) 880–888

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Temporal metal concentration in coastal sediment at the north region of Persian Gulf

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ARTICLE INFO

Keywords:
Persian Gulf
Sediment core
Pollution assessment
Geochemistry

ABSTRACT

The purpose of this article is to study, result of metal concentration in two-sediment cores from Persian Gulf. Age of sediment is determined by C^{14} isotope method and bulk concentration is determined by ICP. This research output shows that, age of BandareAbbas core back to 9660 and Bushehr core to 15,600 years ago. Also,concentration in BandareAbbas and Bushehr cores respectively change as, As (1.08–11.76 Vs 5.2–13.09), Ba (15.03–129.5 Vs 73.9–120.4), Cd (0.09–0.46 Vs 0.09–0.18), Li (5.66–58.5 Vs 15.3–33.4), Mo (0.3–0.75 Vs 0.3–0.8), Mg (7928.4–15,503.9 Vs 13,102.8–17,227.8), Mn (110.6–566.4 Vs 279.3–429.1), Na (8905.47–27,993.3 Vs 9357.7–27,541.4), Ni (13.3–110.3 Vs 37.1–88.4), Pb (0.5–42.5 Vs 2.5–13.6), Sr (407.5–1773.2 Vs 440.3–1596.9), Zn (13.05–71.2Vs22.4–50.5), Fe (0.46–4.07 Vs 1.7–3.18), Ca (9.25–23.3 Vs 13.8–19.2) and Al (0.62–8.15 Vs 2.48–4.65). Moreover different pollution index investigation represent that except Ca, the rest of the metal elements do not show pollution.

1. Introduction

Signs of the environmental condition on the planet can be identified from ice cores, ocean sediments, corals, insects, fossils and trees (Andrade et al., 2017; Mil-Homens et al., 2017; Scholz et al., 2017; Nejman et al., 2018). Ocean Sediments as one of the most promising method, providing the ability to reconstruct the environmental conditions (for example rate of sedimentation or climate) for millions of years ago (Wick et al., 2003; Karbassi and Amirnezhad, 2004; Leng and Marshall, 2004; Dean et al., 2015; Mays et al., 2017). Study of long-term marine sediment bulk concentration, can help us to identify changes in concentration caused by environmental parameters (salinity, water depth, pH, Eh) or paleoclimate indices (temperature, precipitation) (Chappaz et al., 2014; Delile et al., 2015; Knabb et al., 2016; Mariet et al., 2016). Sediments are the privileged environment that records the changes in marine environment systematically and permanently. So they are known as an important source of metallic pollution and can play crucial role in environmental assessment and paleo- toxicity (Ikem et al., 2003; Sarasiab et al., 2014; Moore et al., 2015). It is assumed that bulk concentration lower than standard/background concentration expresses the innocuous conditions. Recent research on surface sediments in the Persian Gulf shows that concentrations of some metallic elements, such as nickel, lead, calcium or cadmium are more than global sediments, in order to address the question of whether this increase in concentration is part of historical lactogenic concentration, pollution history in this area could be analyzed. Literature reviews show that despite Persian Gulf importance, field data especially in the northern region of Persian Gulf are limited (John et al., 1990; De Mora et al., 2004; Pourang et al., 2005). Moreover, study of sediment bulk concentration in Persian Gulf is restricted to surficial sediment (Karbassi et al., 2005; Bastami et al., 2015; Vaezi et al., 2015; Delshab et al., 2017; El-Taher et al., 2018; Sharifinia et al., 2018) and no report is available for deep core marginal sediment. Several articles emphasize the necessity of analyzing the deep sedimentary cores in the Persian Gulf. The present research focus on C^{14} vertical distribution to define sedimentation rate, analyzing bulk sediment concentration back to Holocene and assessing the level of pollution and its temporal character in two deep sediment core at the north region of Persian Gulf.

2. Material and methods

2.1. Study area

In this research, two sediment cores in Busher (Lat 36° 37′, Long 28° 93′) and BandareAbbas (Lat 56° 18′, Long 27° 19′) shore at north region

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https://doi.org/10.1016/j.marpolbul.2018.08.017
Received 3 May 2018; Received in revised form 17 July 2018; Accepted 7 August 2018

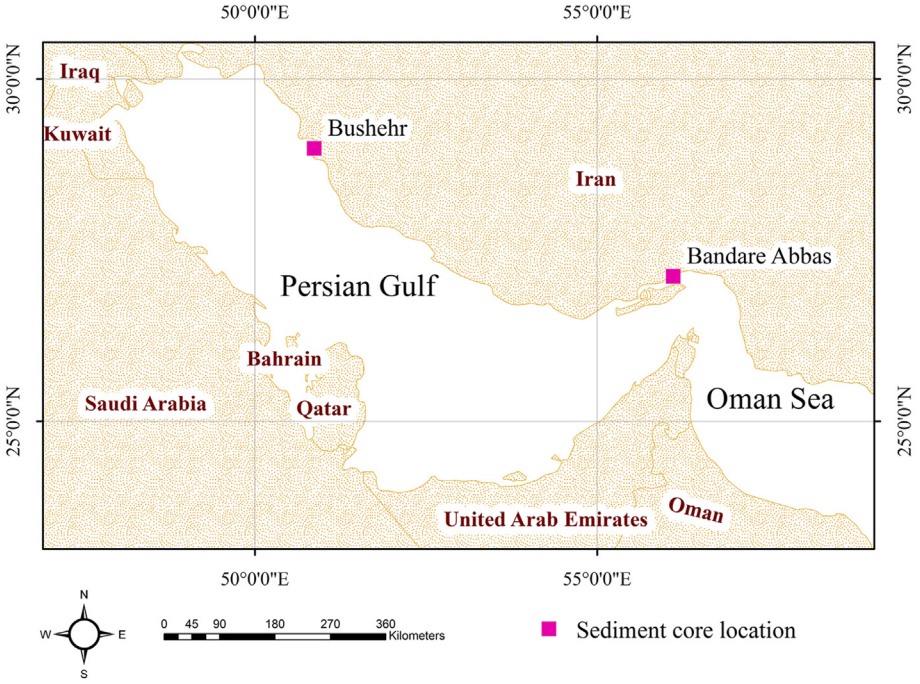

Fig. 1. Study area in the Iran map.

of Persian Gulf are investigated (Fig. 1). The average depth of the sea on the coasts of BandareAbbas is approximately 30 m and on the coast of Bushehr is approximately 20 m (Kämpf and Sadrinasab, 2005). Also, annual rainfall in the BandareAbbas and Bushehr synoptic station are 174 and 271 mm per year. Annual evaporation in this area is app $1.8 myr^{-1}$. And this region nominated as hypersaline Gulf with salinity of 37–39 (John et al., 1990). The ecological importance of this area is due to the existence of mangroves forest in BandareAbbas and coral reef in Bushehr shore. Recent environmental threats in this area include the development of industry (nuclear power plant), oil transportation and agriculture (Agah et al., 2009).

2.2. Sampling and experimental method

For coring, a research barge equipped with a rotary drilling machine has been used. To maintain the sediment tissue and keep the cores intact hydraulic pressure method equipped with inside polythene tube has been used. Metal concentrations were measured in the sediments mineralization phase. To do this, sediment sample treating using agate mortar and pestle have been done and HF, $HNO_3$and $HCLO_4$ in bulk digestion phase has been used. Experiments were carried out using the ICP-Mass (Perkin Elmer elan 9000) device in Iranian Geological Survey and mineral exploration. The accuracy and precision of measurements were verified using certified reference material and analyzing parallel samples.

Grain size test, up to 63 μm performed by sieve shaker and less than 63 μm performed by laser grain size test (Analysette 22 compact) in Iranian Geological Survey and mineral exploration. C^{14} Isotope experiment exclusively done at Poznań Radiocarbon Laboratory.

3. Results and discussion

To characterized bulk sediment core, grain size test was used. This test result shows that upper part of both core comprise of gravelly mud and the middle part are mud (Fig. 2). Also bottom layer is often composed of slightly gravelly mud in Bushehr and slightly gravelly sandy mud in BandareAbbas core.

According to the results of the carbon-14 isotope experiments, the age of BandareAbbas core back to 9660 years ago and Bushehr core back to 15,600 years ago. Also, the average sedimentation rate in Bushehr was 1.04 mm and in BandareAbbas core was 0.66 mm per year. Maximum sedimentation rate in BandareAbbas core was 1.2 mm/year in 6885 years ago, and its minimum was 0.11 mm/year in 2525 years ago and Bushehr maximum sedimentation rate was 1.64 mm/year at 7105 years ago and its minimum reach to 0.2 mm/year in 2840 years ago (Fig. 3). Also, the upper layers of both sedimentary cores show a lower sedimentation rate than the lower layers.

Fig. 4 shows the profile distribution of metal bulk concentration in two sediment cores. Since at the time of the investigation back to Holocene there was not any significant human activity, it could be inferred that changes in average concentrations of elements are mainly due to paleo-climatic conditions (precipitation, temperature or evaporation), Persian Gulf interior paleo-biological activity or long term degradation at the northern Persian Gulf basins. The average concentration of all investigated metals except Na and Ca is lower than that of earth's crust. The concentration of Ca and Na in both core, is higher than the concentration of the earth's crust (Ca = 2.2% and Na = 9600 mg/kg) (Turekian and Wedepohl, 1961), which can be a sign of intense paleo-biological and evaporation rates in the Persian Gulf. Fe and Al show similar profile distribution pattern as indicator of detritus matters. The maximum values of these elements are simultaneously seen at a depth