



## Baseline

## Status of trace metals in surface seawater of the Gulf of Aqaba, Saudi Arabia



Ahmed A. Al-Taani<sup>a,\*</sup>, Awni Batayneh<sup>b</sup>, Yousef Nazzal<sup>b</sup>, Habes Ghrefat<sup>b</sup>, Eslam Elawadi<sup>b</sup>, Haider Zaman<sup>c</sup>

<sup>a</sup> Department of Earth and Environmental Sciences, Faculty of Science, Yarmouk University, Irbid 21163, Jordan

<sup>b</sup> Department of Geology and Geophysics, King Saud University, PO Box 2455, Riyadh 11451, Saudi Arabia

<sup>c</sup> Department of Geology, Taibah University, PO Box 30002, Madinah 41477, Saudi Arabia

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## ABSTRACT

The Gulf of Aqaba (GoA) is of significant ecological value with unique ecosystems that host one of the most diverse coral communities in the world. However, these marine environments and biodiversity have been threatened by growing human activities. We investigated the levels and distributions of trace metals in surface seawater across the eastern coast of the Saudi GoA. Zn, Cu, Fe, B and Se in addition to total dissolved solids and seawater temperature exhibited decreasing trends northwards. While Mn, Cd, As and Pb showed higher average levels in the northern GoA. Metal input in waters is dependent on the adjacent geologic materials. The spatial variability of metals in water is also related to wave action, prevailing wind direction, and atmospheric dry deposition from adjacent arid lands. Also, water discharged from thermal desalination plants, mineral dust from fertilizer and cement factories are potential contributors of metals to seawater water, particularly, in the northern GoA.

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The GoA is a semi-enclosed basin located at the northern extension of the Red Sea (Fig. 1). It contains unique ecosystems and biodiversity and is habitat for one of the most diverse coral communities in the world. Only 27 km of its 180 km eastern coastline lies in Jordan, while the remaining portion, largely undeveloped, belongs to Saudi Arabia.

The Gulf is of significant strategic and economic value to all gulf-bordering states, particularly to Jordan, where it provides Jordan with its only marine outlet. Lack of significant wave activity along with the low rate of water circulation and renewal, among others, render the Gulf particularly susceptible to pollution. Thus, the impact of intense and widespread human activities from the neighboring countries, poses a potential threat to the Saudi GoA coast. Evidence of human impact has been documented (Batayneh et al., 2012; Al-Trabulsy et al., 2013; Batayneh et al., 2013a,b).

The growing concern over the potential contamination of aquatic ecosystems along the Saudi GoA has gained momentum in recent years and became a priority issue. Among other contaminants, heavy metals in seawater have received particular attention as a way of assessing the early impact of human activities on the marine environment. This is also of critical importance for

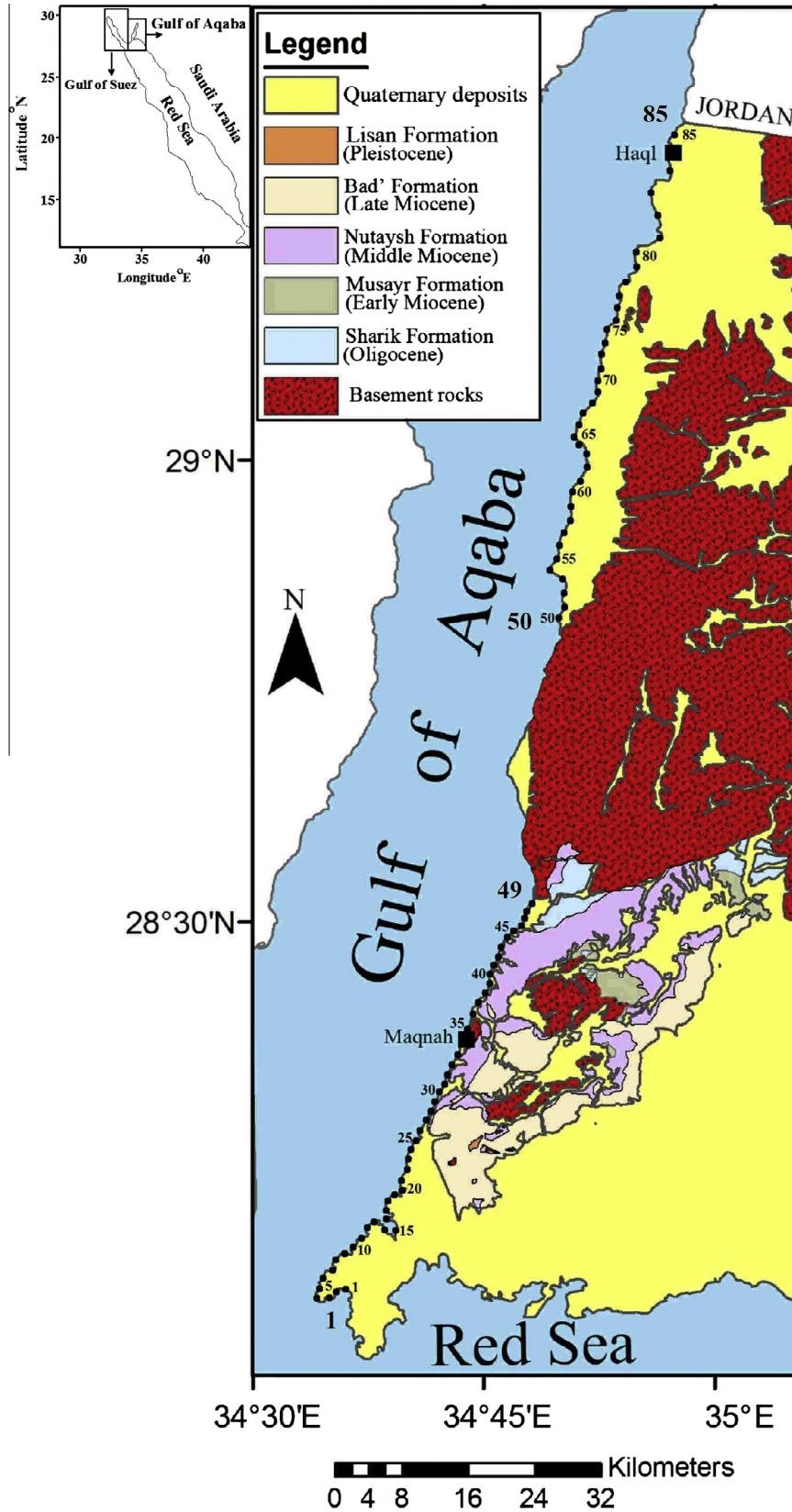
protecting aquatic ecosystems and determines the proper conditions for various uses.

The prevailing sub-tropical arid conditions of high temperatures and rare rainfall along with limited freshwater input, made the GoA of unique aquatic ecosystems. The surface water of the GoA is oligotrophic with a shallow but stable thermocline for most of the year, except during the winter, when winds drive convective mixing of deep (higher-nutrients) and surface waters. Because of a low rate of water exchange between the GoA and the Red Sea, the average residence time of water in the Gulf is relatively long about one year (Klinker et al., 1976; Paldor and Anati, 1979; Hulings, 1979). The tidal waves generated at the Strait of Tiran in the southern GoA are carried by the inflow waters from the Red Sea and propagate northwestward into the GoA (Manasrah et al., 2004), which play a role in metals distribution. Surface runoff is limited to intermittent flash floods occurring in winter, which is discharged into the Red Sea or percolated to groundwater aquifers. Groundwater is the primary source of drinking and irrigation water in the region, though evidence of salinization has been reported (Al-Taani et al., 2013; Batayneh et al., 2013a,b).

The geologic outcrops in the study area include (in ascending order): the Proterozoic metamorphic basement which is unconformably overlain by Sharik Formation of conglomerate and sandstone (Fig. 1). These rocks are also unconformably overlain by sandstone, conglomerate, limestone and gypsum of Musayer Formation (Early Miocene). Nutaysh Formation (Middle Miocene) of

\* Corresponding author. Tel.: +962 779610469; fax: +962 7211117.

E-mail address: [taaniun@hotmail.com](mailto:taaniun@hotmail.com) (A.A. Al-Taani).



**Fig. 1.** Geologic outcrop location and sampling sites. The sampling sites are numbered as shown in the figure, beginning the sampling at the lower end of the GoA, and ending at the Jordan-Saudi Arabia border.

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