



Heavy metal assessment in surface sediments off Coromandel Coast of India: Implication on marine pollution

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ABSTRACT

The present study investigates the distribution of heavy metals (Fe, Cd, Co, Cr, Cu, Ni, Zn and Pb) in the surface sediments along the Coromandel Coast of Bay of Bengal as an indicator of marine pollution. Pollution indices such as Contamination factor (CF), Enrichment factor (EF) and Geo-accumulation index (I) were performed to assess the spatial distribution and pollution status of the study area. The heavy metal concentration in the study area is closely associated with grain size and organic matter. Both geoaccumulation index and metal contamination factor indicate that the sediments are free from contamination with regards to the metals Cr and Ni, followed by uncontamination to moderate contamination of Co, Cu and Zn. However, sediments are found to be extremely polluted with respect to Cd and Pb. Factor analysis reveals that the accumulation of these heavy metals in the shelf sediments are due to anthropogenic inputs from the adjacent land area.

1. Introduction

Heavy metals are the most serious pollutants in the natural environment due to their toxicity, persistence and potential to bioaccumulate and it can be a serious risk to ecosystems (Ghaderi et al., 2012; Haruna et al., 2011; Tam and Wong, 2000). Heavy metals in marine sediments originate from both geogenic (physical and chemical weathering of parent rocks) and anthropogenic sources (Callender, 2005). With the rapid industrialization, urbanization and associated activities like agriculture, disposal of domestic and mining waste constitute the major anthropogenic inputs. These unusual activities affect the natural environment and ecosystem i.e. water, sediment and particularly organisms (Vidović et al., 2014). Several studies have established that the sediments in the coastal regions are highly contaminated by heavy metals; hence, the assessment of heavy metals distribution in surface sediments helps to understand the pollution in marine environment (Jayaprakash et al., 2007; Pekey, 2006; Buccolieri et al., 2006; Bellucci et al., 2002). Sediment parameters (mineralogy, texture), metal features, pH, organic matter and oxidation-reduction potential are important parameters controlling the accretion and the availability of heavy metals in the sediment (Hokanson, 1980; Wright and Mason, 1999; Tam and Wong, 2000; Buccolieri et al., 2006; El Nemr et al., 2012; Bastami et al., 2012). Metals such as Ni, Cd, Cr, Zn and their relationship with anthropogenic activities are used in understanding pollution status in marine systems (Burton et al., 2004; Munuz et al., 2004). The distribution of heavy metals and pollution in the nearshore

and shelf sediments of Bay of Bengal has been investigated in various regional studies. (Durgaprasada Rao and Poornachandra Rao, 1973; Rao 1978; Sarin et al., 1979; Sathynarayana et al., 1985; Rao and Murty, 1990; Rao and Sarma, 1993; Mohanachandran, 1988; Mohanachandran and Subramanian, 1990; Subramanian and Mohanachandran, 1990; Achyuthan et al., 2002; Jonathan and Ram Mohan, 2003; Selvaraj and Ram Mohan, 2003; Selvaraj et al., 2003; Selvaraj et al., 2004; Jonathan et al., 2004; Jayaprakash et al., 2007; Muthu Raj and Jayaprakash, 2008; Stephen-Pichaimani et al., 2008; Jayaraju et al., 2009; Alagarsamy and Zhang, 2010; Sundararajan and Natesan, 2010; Solai et al., 2013; Jayaprakash et al., 2014; Kasilingam, 2014; Kasilingam et al., 2016; Magesh et al., 2017; Gopal et al., 2016; Krishnakumar et al., 2017). These studies demonstrate a significant spatial difference in the trace metal composition of shelf sediments. In the Vishakhapatnam shelf, the trace metals are more abundant in clay sediments of inner shelf than the outer shelf clays, which indicates that the rates of detrital supply control the heavy metal distribution (Durgaprasada Rao and Poornachandra Rao, 1973), while in other areas viz. off Mahabalipuram to Periyakuppam, off ennore, the northern part of Point Calimere, off Tuticorin, East Coast Sediments, off Pondicherry, off Palk Strait, near the shore of Tamiraparani estuary, off Chennai, the distribution of heavy metals are mainly influenced by the industrial, agricultural activities and urban development (Selvaraj et al., 2004; Muthu Raj and Jayaprakash, 2008; Stephen-Pichaimani et al., 2008; Jayaraju et al., 2009; Alagarsamy and Zhang, 2010; Solai et al., 2013; Kasilingam et al., 2016; Magesh et al., 2017; Gopal et al.,

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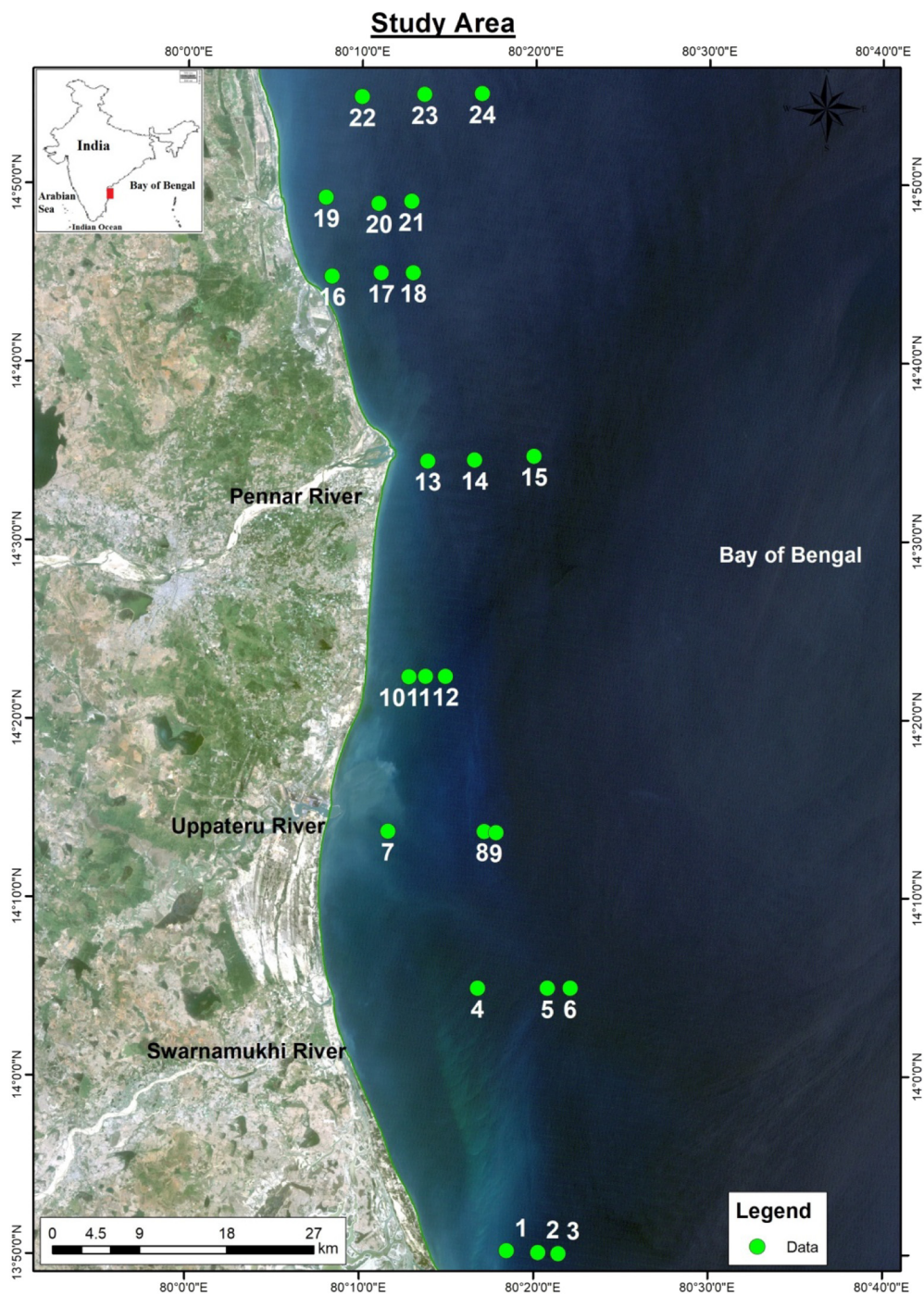


Fig. 1. Study area and sampling locations.

2016). Jayaraju et al. (2008) investigated the benthic foraminiferal response to pollution from Nellore coast. Sundara Raja Reddy et al. (2009, 2016) has reported foraminifera as bio indicators of pollution from estuaries of Pennar River and Nellore coast. Jayaraju et al. (2011) studied the response of foraminifera to iron tailing in marine setting from Uppateru river estuary. Most of these studies are carried out in the estuaries and near shore regions; therefore, present work is focused on geochemistry and heavy metal pollution in shelf sediments.

1.1. Geological setting

The Bay of Bengal, the world's largest, semi-enclosed, roughly triangular, tropical Bay is situated in the northeastern part of the Indian

Ocean (La Fond, 1966). The present area is situated in the Coromandal Coast of Bay of Bengal and covers a stretch of about 180 km (Fig. 1). The annual mean temperature of the present area is about 29 °C and experiences tropical to humid climate condition. The major sediment inputs in the shelf region are from Ganges, Brahmaputra, Mahanadi, Godavari, Krishna and Pennar rivers and minor inputs from Uppateru and Swarnamukhi rivers (Anbuselvan and Senthil Nathan, 2017). The factors which control sediment distribution along the Coromandal coast are wave actions, currents, and geomorphological features. Residual weathering of Archean rocks resulted in the formation of low-level laterite cappings and sand mixed secondary laterites, which are some of the important geomorphological features found in the coastal region. The Precambrian basement rock is overlain by Pleistocene and recent

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