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Baseline

Sedimentary heavy metal(loid) contamination in the Veracruz shelf, Gulf of Mexico: A baseline survey from a rapidly developing tropical coast

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ABSTRACT

This study examines sediment texture, geochemistry and sediment accumulation in cores from four sites in the Veracruz shelf area of the Gulf of Mexico, to assess the inputs of heavy metal(loid)s (and their potential biological impacts) in this carbonate-dominated shelf system, and to examine the rate of sedimentation near to the mouths of the La Antigua and Jamapa Rivers. The use of different pollution indices showed enrichment with Pb in all cores studied, although based on sediment quality guidelines As was the only element that has potential to occasionally cause damage to the benthic organisms present in the area. Heavy metal(loid) and sediment input from terrestrial and coastal sources is limited compared to more proximal, near-shore areas. The sediment core data presented however give a baseline dataset for heavy metal(loid) concentrations in the Veracruz shelf, against which future anthropogenic inputs can be assessed.

1. Paper text

Many highly biodiverse tropical and sub-tropical near-shore/shelf environments and ecosystems are under increasing threat from the rapid development of adjacent coastlines. Enhanced sediment supply from dredging and coastal run-off (from urbanized areas and deforested river catchments), coupled with increased inorganic and organic contaminant loadings from industry and agriculture, may severely impact these ecosystems. Indeed, a number of studies have noted a range of degradative effects around Australian, Chinese, Asian and African tropical and sub-tropical coasts due to sediment and contaminant input (e.g. Ayyamperumal et al., 2006; Mckinley et al., 2011; Song et al., 2014, and Salem et al., 2014). Along the Mexican coast, several authors have noted increases in terrestrially-derived materials, and contaminant loading, in coastal and estuarine sediments (Rosales-Hoz et al., 2003, Ruiz et al., 2004, Muños et al., 2012, Celis-Hernández et al., 2013, Botello et al., 2015, Ruiz et al., 2016), particularly due to enhanced river catchment erosion and urban and industrial inputs. It is unclear however to what extent this increased sediment and contaminant loading has impacted more distal, carbonate-rich offshore areas. Here, we report results from a baseline survey of marine sediments from the Veracruz shelf area of the Gulf of Mexico, to

a) Assess the inputs of heavy metal(loid)s, and their potential biological impacts, in this carbonate-dominated shelf system.
b) Examine the rate of sedimentation near the mouths of the La Antigua and Jamapa rivers on the Veracruz shelf.

The Veracruz coast in the southwest Gulf of Mexico, from 18° 30.08′ to 19° 57.77′ north latitude and from 94° 53.26′ to 96° 29.59′ west

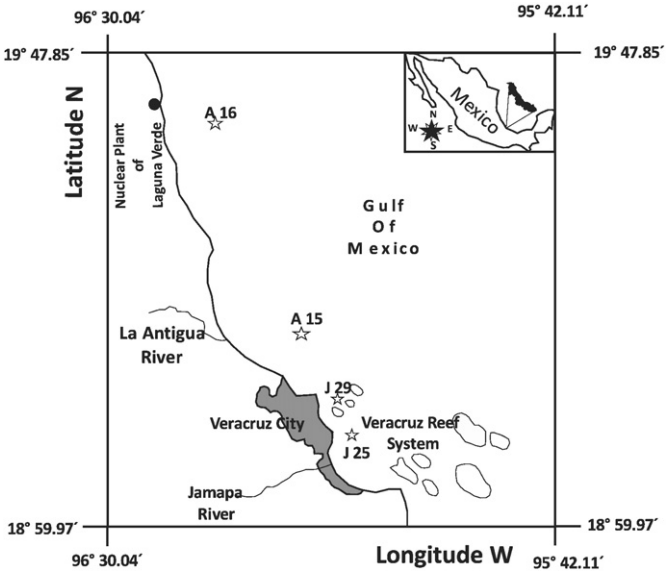

Fig. 1. Study area and sampling locations.

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longitude, receives freshwater and terrestrial sediments from the La Antigua and Jamapa rivers (Fig. 1). The combined population of both river catchments is 1,656,285 (INEGI, 2012a, 2012b) which represents 70.9% of the total state population. The main potential sources of anthropogenic heavy metals in the area are from agriculture, cattle production and local urban and industrial activities, particularly around Veracruz City, which contains 43.5% of all state infrastructure, is the most important industrial and manufacturing center in this region of Mexico, and contains one of the major Mexican ports on the Gulf of Mexico. The lithology of the La Antigua and Jamapa basins consists of varied sedimentary, intrusive and igneous rocks (INEGI, 1984).

Four sediment cores (Fig. 1) were collected using a box corer and subsampled with a PVC pipe (10 cm inner diameter) aboard the O/V Justo Sierra in August 2008. Samples labeled as J25 and J29 were collected 6.5 and 11.8 km from the mouth of the Jamapa River at water depths of 21.3 and 25.5 m; cores marked as A15 and A16 were collected 13.6 and 40 km from the La Antigua River mouth at water depths of 43.1 and 50 m. Core A16 was taken closer to the Laguna Verde nuclear plant. Every core was extruded and subsampled at 1 cm intervals. All analyses, except grain size, were applied to ground samples stored in polyethylene bags. All concentrations are expressed with reference to dry weight.

Particle size distribution within sediment samples was determined using a Coulter Model LS-230 laser diffraction analyzer, following dispersion with sodium hexametaphosphate. For other analyses, sediment samples were dried at 55 °C for 48 h and ground to a fine flour consistency in an 8000 SPEX MIL. Organic carbon content was determined by oxidation with $K_2Cr_2O_7$ (Gaudette et al., 1974). Carbonates were determined by titration (after Hesse, 1971), in which excess HCl that did not react with the carbonate was reverse titrated with sodium hydroxide. Glass beads were prepared from the samples in a 1:1 ratio of $LiBO_2$ and LiB_4O_7 (ultrapure grade), and major elements determined using a Siemens SRS 3000 XRF spectrometer. The accuracy of this method was evaluated using the AGV-1 standard, and was 100 ± 2% for all of the oxides,

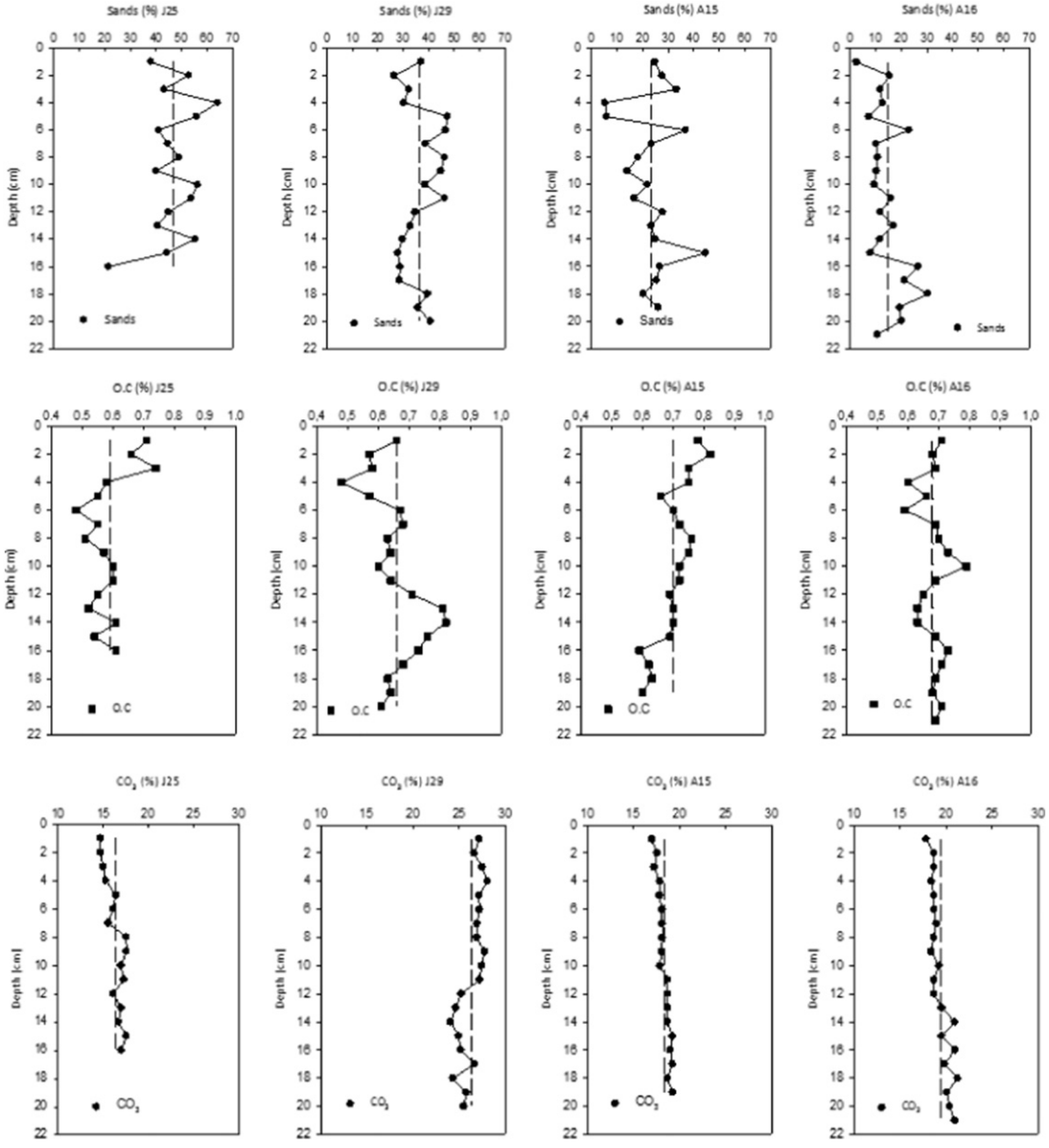

Fig. 2. Variation in sand, organic carbon and carbonate content (%) in core profiles. Vertical dashed lines show average values over entire core depth.