



# Monitoring of selected trace elements in sediments of heavily industrialized areas in Calcasieu Parish, Louisiana, United States by inductively coupled plasma-optical emission spectroscopy (ICP-OES)

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## ABSTRACT

Located in Southwest Louisiana Calcasieu Parish is the home of several recent multibillion-dollar industrial projects creating a need for environmental monitoring projects. The monitoring of certain metals in the environment is important due to the toxic nature of these elements and the region's history of Superfund sites. Sediment samples were collected from seven locations around Calcasieu parish, and the concentrations of Al, Cr, Cu, Fe, Mg, Mn, Ni, Pb, and Zn were determined by ICP-OES. The locations were selected due to their proximity to industrialized locations. None of the sampled sediments exceeded the Louisiana Department of Environmental Quality regulations. All sampled locations had higher concentrations when compared to a non-industrialized location from the area. These differences may have been caused by anthropogenic factors.

## 1. Introduction

Harmful trace metals can accumulate in sediments over time as they settle to the bottom from natural and anthropogenic processes. Once these toxic metals are in the environment they can bioaccumulate in biota and humans and have detrimental effects [1,2]. These metals can come from a variety of natural and anthropogenic sources including industrial effluent [2]. All elements are part of the natural geochemical cycles, and thus are present to some extent in the environment. In the past, some significant contamination has occurred in the Calcasieu Parish, including the accumulation of mercury in Bayou d'Inde [3,4]. Currently, some of the largest scale industrial expansions in the world are taking place in the area. With recent construction and new petrochemical facilities, it is important to make sure the environment stays healthy and does not pose a health risk to the surrounding communities. It is also important to continue monitoring these areas over time because some toxins can slowly accumulate.

ICP-OES can be used to determine the concentrations of many different elements and is a primary technology for environmental contaminants involving trace elemental monitoring, and has been successfully used in the past to screen sediments and other media for trace elements [3–10]. ICP-OES is used routinely by state and federal environmental agencies as well as academic institutions. ICP-OES is routinely used in multi-elemental analysis and for this reason is much faster and more cost-effective than single elemental techniques such as

atomic absorption.

Given that toxic metals are a source of water quality deterioration and affect humans and wildlife, the goal of this project was to determine the concentrations of selected trace elements in sediments in Calcasieu Parish. Sediments were collected from locations that may pose risk of contamination from industrial effluent and other activities. This was a preliminary study of the sites of concern. This study can serve as an initial data set to determine if additional environmental monitoring may be needed in the future.

## 2. Materials and methods

### 2.1. Sample collection

Samples were collected with polyvinyl chloride (PVC) pipes at the sites depicted in Figs. 1–4, site locations are described in Table 1. Sediment samples were collected via inserting a PVC pipe with a diameter of 1.89 cm into surface water areas. The pipe was pushed 10 cm into the ground and pulled back out with the sample core in the pipe. The sediment cores were then extruded by pushing out the core with a polypropylene rod. The sediments from depths of 1–5 cm were discarded, and the cores from depths of 5–10 cm were saved for analysis. The samples were placed in Ziploc bags for storage and transportation. Each bag was labeled according to its collection location.

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Fig. 1. Sample collection sites A & B [10].

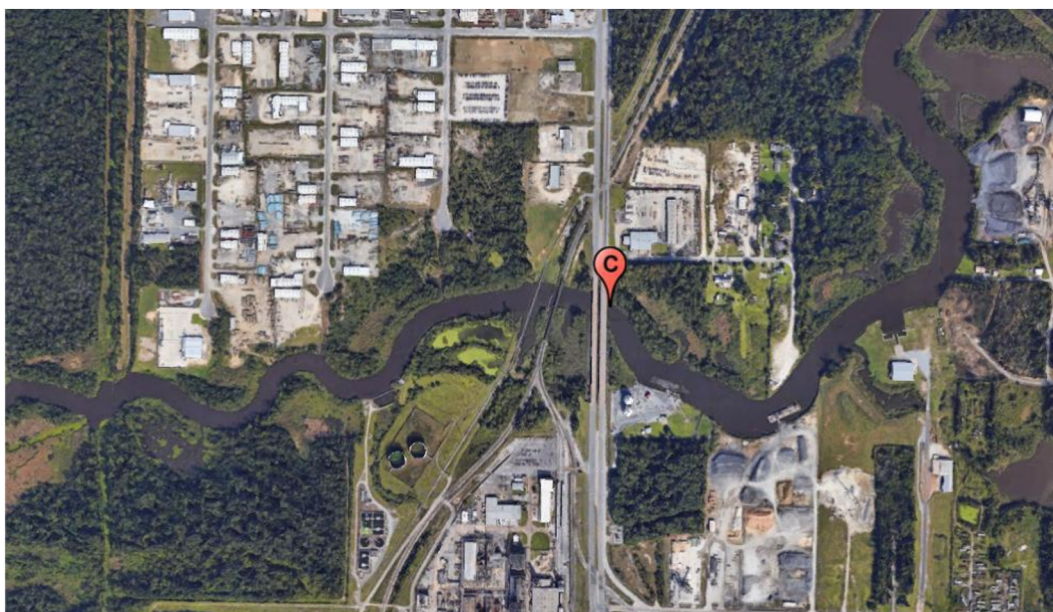


Fig. 2. Sample collection site C [10].

## 2.2. Sample preparation

Each sample was placed on a labeled watch glass and heated in an oven at 105 °C for 48 h. The watch glasses were then removed from the oven and cooled to room temperature in a desiccator. The dried sediments were then ground with a mortar and pestle to pass a 250 µm sieve. The samples were then stored in new Ziploc bags until microwave digestion could be carried out. For the microwave digestion portion of the analysis three 0.500 g aliquots of each sample were placed into 55 mL PFA microwave digestion vessels. Additionally, five replicates of approximately 0.500 g of AgroMAT CP-1 certified reference material (CRM) were additionally analyzed along with laboratory procedure blanks (LPBs). Sample digestion was done by first using 10 mL of ultrapure (70%) nitric acid to each vessel, and the vessels were loaded into a microwave oven (MARSXpress, CEM Corporation, Mathews, North Carolina), utilizing EPA Method 3052 for the digestion program, the samples were then allowed to cool to room temperature before removing them. After cooling, the samples were filtered with filter paper with a 0.45 µm pore size and diluted to a volume of 50 mL with

distilled water. Aliquots of each digested sample were then pipetted into labeled polypropylene 15 mL centrifuge tubes.

## 2.3. Instrumentation

Concentrations of the selected elements were determined by ICP-OES (Agilent 725 ICP-OES, Agilent Technologies, Santa Clara, California). The instrument utilized an autosampler for speed, ease, and repeatability of analysis. The sample introduction system consisted of a peristaltic pump, nebulizer, and spray chamber. The instrument measured the emission intensities using radial viewing mode. The optical system consisted of an Echelle polychromator, and a VistaChip II. VistaChip II is a custom charge coupled device detector that can detect wavelengths from 167 to 785 nm. The elements determined and their corresponding wavelengths are listed in Table 2.

## 2.4. Quality control/quality assurance

Calibration curves were generated for each element listed in

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