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Radiocaesium dispersion and fixation in the lagoon systems of "Ria de Aveiro", Portugal

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Abstract

Radiocaesium (^{137}Cs) dispersion and Cs^+ fixation were studied in the sediments collected from the lagoon systems of "Ria de Aveiro". The Cs^+ sorption was tested for the fine mica grains and for the <2 μm clay fractions extracted from silty clays. The Cs^+ exchange is found strongly onto mica-rich fractions than smectite-rich fractions. The distribution coefficient increases if the silty material is constituted by rich-mica clay fractions or if the non-clay minerals are removed from the silty-clay material. The samples studied behave as multisite ion exchange, where Cs^+ engages in ion-exchange reactions with hydrated cations on planar sites on expansible layer silicates. Higher concentrations of the ^{137}Cs were found associated with mica-rich silty clays. The ^{137}Cs ranges from 3.2 to 3.9 Bq kg^{-1} in the <38 μm fractions and from 2.9 to 3.3 Bq kg^{-1} in the <64 μm fractions.

Keywords: Radiocaesium; Distribution coefficient; Silty-clay sediments; Lagoon systems of "Ria de Aveiro"; Portugal

1. Introduction

Large concentrations of ^{137}Cs were released to environment around the world in the last 50 years. The ^{137}Cs with half-lives of 30.2 years found out in sediments is connected to the worldwide fallout, resulting from atmosphere nuclear tests and the Chernobyl accident (Ukraine). Also, it is an important constituent of radioactive wastes held in storage by several nuclear potentially countries.

The migration of the ^{137}Cs to the biosphere and its subsequent bioavailability depends on the mechanisms of clay minerals adsorption (Higgo, 1987) and organic matter (Staunton et al., 2002). The interface of river–ocean, via estuaries or lagoon systems, acts as sinks for natural and anthropogenic radionuclides.

Weathering effects on the structure of mica-type clay mineral is a sensitive consequence of the relative ^{137}Cs concentrations in highly selective fashion to "frayed edge" sites (Jackson, 1963). The ^{137}Cs may also be viewed as a potential radioisotope to data very recent sedimentation rates and ages of contaminated core (Siegel et al., 1994). The aim of this study is focused on the ^{137}Cs dispersion, Cs^+ ion-exchange reaction and estimation of the sedimentation rates in the living ecosystem of "Ria de Aveiro" based on the dispersion of ^{137}Cs.

2. Materials and methods

The so called "Ria de Aveiro" is a barrier type lagoon located in the central north-western littoral of

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Portugal (Fig. 1). The lagoon covers an area of approximately 50 km^2 developed from the Atlantic Ocean to the estuary of the river Vouga. The genesis of lagoon is assumed to have taken place on top of a favourable geological structure, started less than 1000 years ago when a littoral sandy spit grew southwards, and isolated the estuary of river Vouga from the Atlantic Ocean (Delgado et al., 1992). The lagoon extends parallel to the coast, forming several tidal channels. The lagoonar environment is of the transition type, where both fluvial and marine effects may be observed. The silting up of the lagoon to the east caused the continuous diminishing of the wet areas due to the transport of terigeneous sediments from the drainage basin of the river Vouga and the effluents. Silty clays and sands occur at the upper level of lagoon.

Samples studied were collected from 2 sites located in western part of lagoon and from 4 sites located to the eastern part of lagoon, where the interface rivers–lagoon is more evident (Fig. 1). Sediments were sampled in channels and interfluves down to depths from 10 to 30 cm. The mineralogy of selected samples was determined by X-ray diffraction (XRD) analysis using a Philips X'Pert machine equipped with a Cu$k\alpha$ anticathode. The samples were run in the range 2–50° 2θ and ana-

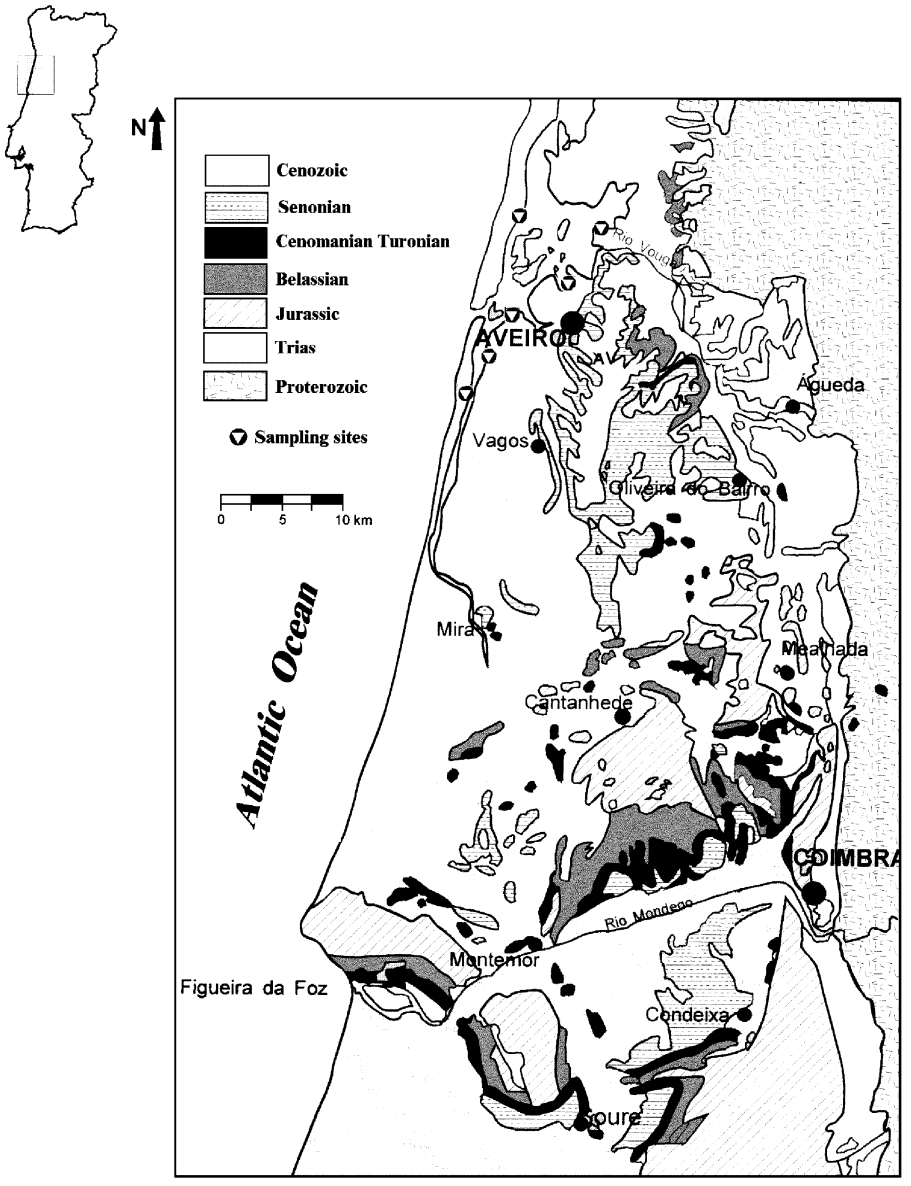

Fig. 1. Geological map of the Aveiro region and localization of samples studied.