Available online at www.sciencedirect.com

ScienceDirect

Russian Geology and Geophysics 57 (2016) 1040–1047

RUSSIAN GEOLOGY AND GEOPHYSICS

www.elsevier.com/locate/rgg

Geochemistry of rare earth elements in the modern sediments of Amur Bay (*the Japan/East Sea*)

K.I. Aksentov *, V.V. Sattarova

V.I. Il'ichev Pacific Oceanological Institute, Far Eastern Branch of the Russian Academy of Sciences, Baltiiskaya ul. 43, Vladivostok, 690041, Russia

Received 29 April 2015; accepted 28 August 2015

Abstract

The distribution of REE in the bottom sediments of Amur Bay accumulated over the last 100 years was studied, and the REE contents were evaluated. The REE contents normalized to North American Shale Composite (NASC) show a negative Ce anomaly and a predominance of LREE and MREE. The inflow and accumulation of REE in the bottom sediments are influenced mainly by natural sources, whereas their dependence on anthropogenic factors is minimal.

Keywords: rare earth elements; bottom sediments; Amur Bay; the Japan/East Sea

Introduction

Today, rare earth elements (REE) are of special geochemical interest because they show the same behavior during natural processes owing to their similar chemical properties. Isotopes of the same element show a still more similar behavior. The sources of substance preserve initial REE compositions because of their weak changes during natural processes. The distribution of REE in natural objects reflects the formation conditions of the latter; therefore, the REE composition is one of indicators of rock and ore genesis (Astakhova and Sattarova, 2012; Elderfield, 1988; Piper, 1974; Taylor and McLennan, 1985). Since lanthanides are assigned to the Fe-group elements, they can provide information about the genesis of iron oxyhydroxides. Many geologic objects have a REE composition stable in space and time, which permits it to be used as a geochemical reference. Besides the natural inflow of REE into the environment, they are supplied with commercial waste (Chiarenzelli et al., 2001; Olmez and Gordon, 1985; Olmez et al., 1991). Hence, REE can also be used as an indicator of anthropogenic pollution of a water area.

Amur Bay is the northwestern part of the Peter the Great Bay. In the west it borders a land, and in the east, the mountainous Muravyov-Amur Peninsula and Russkii, Popov, Reineke, and Rikord Islands, a specific SE striking continuation of this peninsula. The first data on the chemical composition of Amur Bay bottom sediments were obtained during the geological research into the Pacific in the early 1970s (Markov and Rassolenko, 1979). The later comprehensive geochemical investigations in 1980–1990 were dealt with anthropogenic pollution of the water area (Anikiev et al., 1993; Tkalin et al., 1996). At present, similar research continues (Aksentov and Astakhov, 2009; Kalinchuk et al., 2010; Kovekovdova and Simokon', 2004; Naumov, 2006; Shul'kin, 2004). Three types of trace-element composition of bottom sediments were recognized by mathematical statistics methods: geochemical background, geochemical anomaly, and geochemical dispersion halo (Anikiev et al., 2000). The research showed that only the southern part of Amur Bay is a geochemical background, whereas most of its area is a geochemical anomaly. The major pollutants are chalcophile elements (Zn, Pb, Cd, Cu, Ag, and Hg), and the distribution of lithophile elements is determined mainly by natural processes (Aksentov and Astakhov, 2009; Anikiev et al., 1993; Kovekovdova and Simokon', 2004; Naumov, 2006; Shul'kin, 2004). The performed investigations also demonstrated that Vladivostok is the major anthropogenic source of the Amur Bay area pollution (society's and industrial waste discharge and sheetwash). The Razdol'naya River runoff can be assigned to a natural source of pollutants. Thus, the geochemical specifics of the modern bottom sediments of Amur Bay is controlled mainly by anthropogenic pollution superposed by natural processes (first of all, sedimentation and lithody-

* Corresponding author.
E-mail address: aksentov@poi.dvo.ru (K.I. Aksentov)

1068-7971/$ - see front matter © 2016, V.S. Sobolev IGM, Siberian Branch of the RAS. Published by Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.rgg.2016.06.004

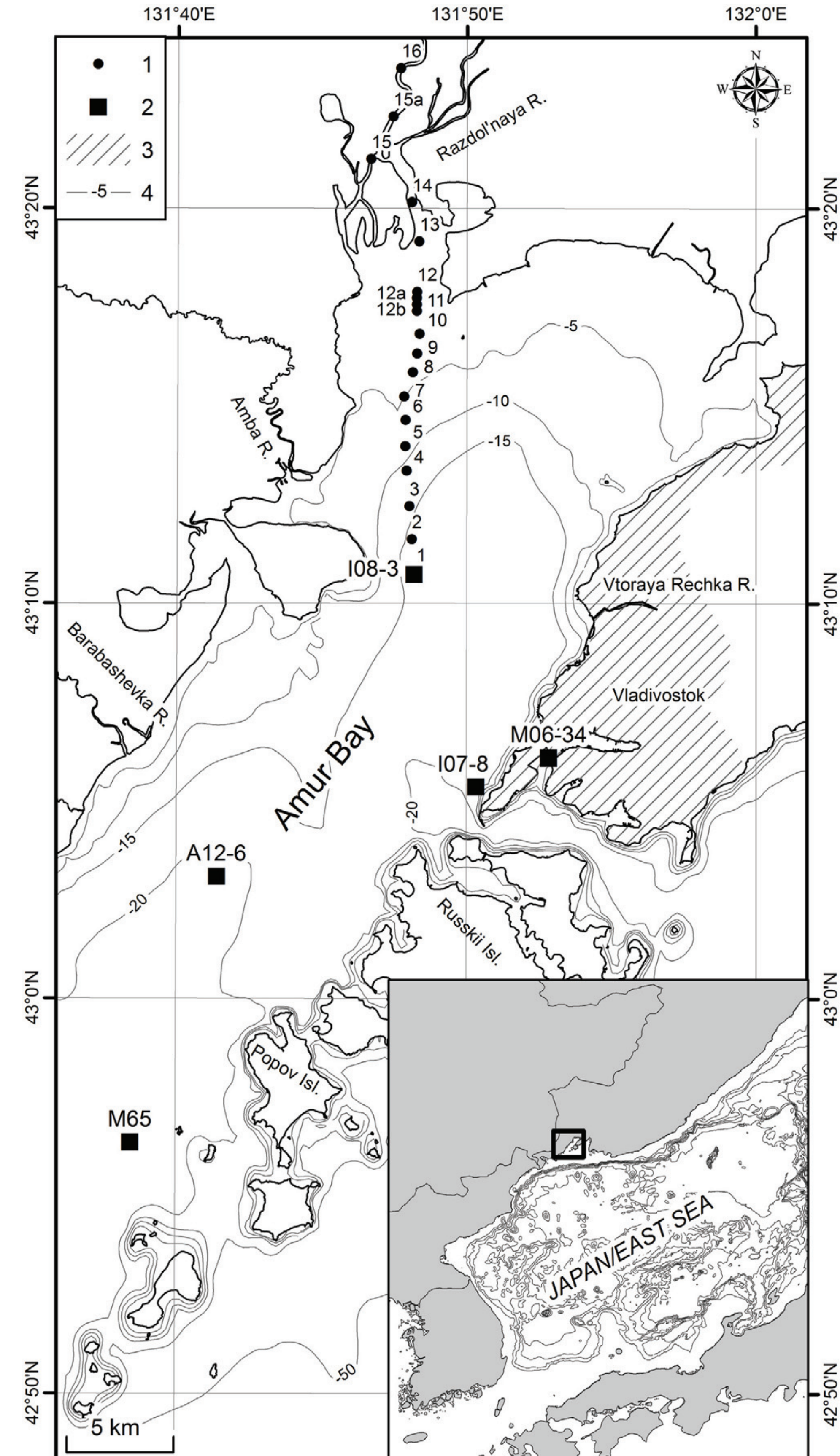

Fig. 1. Schematic map of bottom sediment sampling. *1*, surface layer samples (Gramm-Osipov, 2005); *2*, bottom sediment cores sampled by the authors; *3*, Vladivostok area; *4*, isobaths. Inset shows the location of the study area.