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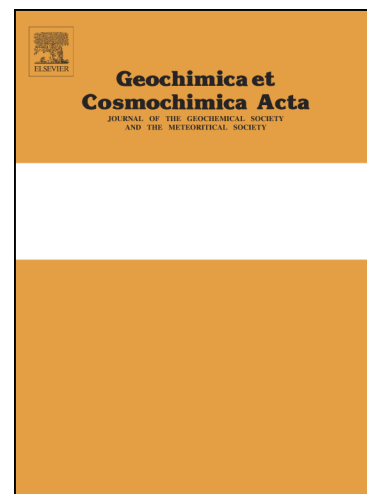
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# Low Cerium Among the Dissolved Rare Earth Elements in the Central North Pacific Ocean

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## Abstract

Seawater samples were collected at the Vertex IV site at 28°N, 155°W in the central North Pacific Ocean. The very old deep waters show low concentrations of dissolved Ce, and the lowest values worldwide of dissolved Ce relative to the other REE, as defined by either the Ce/Nd ratio or the Ce anomaly Ce/Ce\*. The very old deep waters in the central North Pacific show the highest concentrations of dissolved strictly trivalent REE, i.e. except for Ce. Within the thermocline region there exist very close linear relations of the REE series with the nutrients PO<sub>4</sub> and NO<sub>3</sub>, but curvature versus nutrient SiO<sub>4</sub>. This and the general about twofold enrichment of deep Pacific versus deep Atlantic of REE and PO<sub>4</sub>, NO<sub>3</sub>, would support the notion that ocean biogeochemical cycling of the REE is coupled with the ocean cycling of organic matter. Multiple regressions of Nd, representing the LREE, and Er, representing the HREE, versus both phosphate and silicate are significant. Nevertheless there is room for the hypothesis of invoking additional net deep water scavenging of mostly the LREE (i.e. Nd) but also the HREE (i.e. Er). There is a trend of increasing REE abundance with increasing atomic number, when the dissolved seawater data at Vertex IV site is normalized versus PAAS reference. This trend is consistent with stabilization in seawater due to stronger inorganic complexation with carbonate ion with increasing atomic number from La to Lu. There are indications for a positive Gd anomaly at Vertex IV site and also in other datasets of dissolved REE in other oceans. Interoceanic comparison between the North Pacific and the Northwest Atlantic shows for the deep Pacific an up to 2.5-fold relative enrichment for the strictly trivalent REE, that is parallel with enrichment of phosphate and nitrate, suggesting REE-cycling along with the ocean cycle of organic matter. The Pacific/Atlantic concentration ratio does not increase with increasing atomic number along the REE series. The deep Pacific shows an up to 3-fold relative Ce depletion versus the deep Atlantic. The deep North Pacific is enriched with Eu relative to the deep Northeast Atlantic, likely due to more emissions of Eu-enriched hydrothermal fluids in the Pacific basin.

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## 1. INTRODUCTION

The Rare Earth Elements (REE) are an unique series of 15 chemical elements ranging from atomic number 57 element <sup>57</sup>La and the 14 elements that follow, up to <sup>71</sup>Lu. In seawater all REE exist in the REE<sup>3+</sup> ion state with identical electron configurations of the outermost 5s and 5p electron shells (2 and 6 electrons respectively) causing very similar

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