Fe-Mn crusts from the Central Atlantic

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ABSTRACT

The exploration of seamounts south of the Azores during the EMEPC/Açores/G3/2007 campaign allowed for the collection of 30 Fe-Mn crusts from the Atlantis, Great Meteor, Small Hyeres, Irving and Plato seamounts, as well as from the East Azores Fracture Zone. These were the first samples of Fe-Mn crusts studied from these seamounts. The Fe-Mn crusts were analyzed using multiple analytical methods.

The crusts are fairly homogeneous, showing typical textures for this type of occurrences. The Fe/Mn ratio, patterns and concentrations in rare earth elements, and the great homogeneity of the crusts lead to the conclusion that they have a hydrogenetic origin, precipitating directly from seawater. Although the content in Fe and Mn of the crusts is consistent with data available for the Atlantic, the mean concentration of Co is comparable to the average values for the Pacific. Cu and Ni show lower values than the ones known for the Pacific.

Introduction

The Task Group for the Extension of the Continental Shelf (EMEPC) is the organization responsible for the Extension of the Portuguese Continental Shelf proposal to be submitted under article 76 of the United Nations Convention on the Law of the Sea (UNCLOS). EMEPC submitted the Portuguese proposal in May 2009 and has been since that time collecting and preparing more data to be ready for the analysis of its proposal by the Commission on the Limits of the Continental Shelf (CLCS).

The samples analyzed in this work were collected in the 2007 EMEPC/Açores/G3/2007 Cruise held by the EMEPC aboard the R/V *Kommandor Jack*. The Cruise objectives focused on geological sampling by dredge of the Atlantis, Plato, Hyeres, Irving and Great Meteor Seamounts, located south of the Azores Plateau in the Mid-Atlantic Ridge off-axis domain (Fig. 1). Dredging recovered 40 samples of ferromanganese crusts, the first to be collected on this seamount group, which expands the few occurrences known in the central and NE Atlantic.

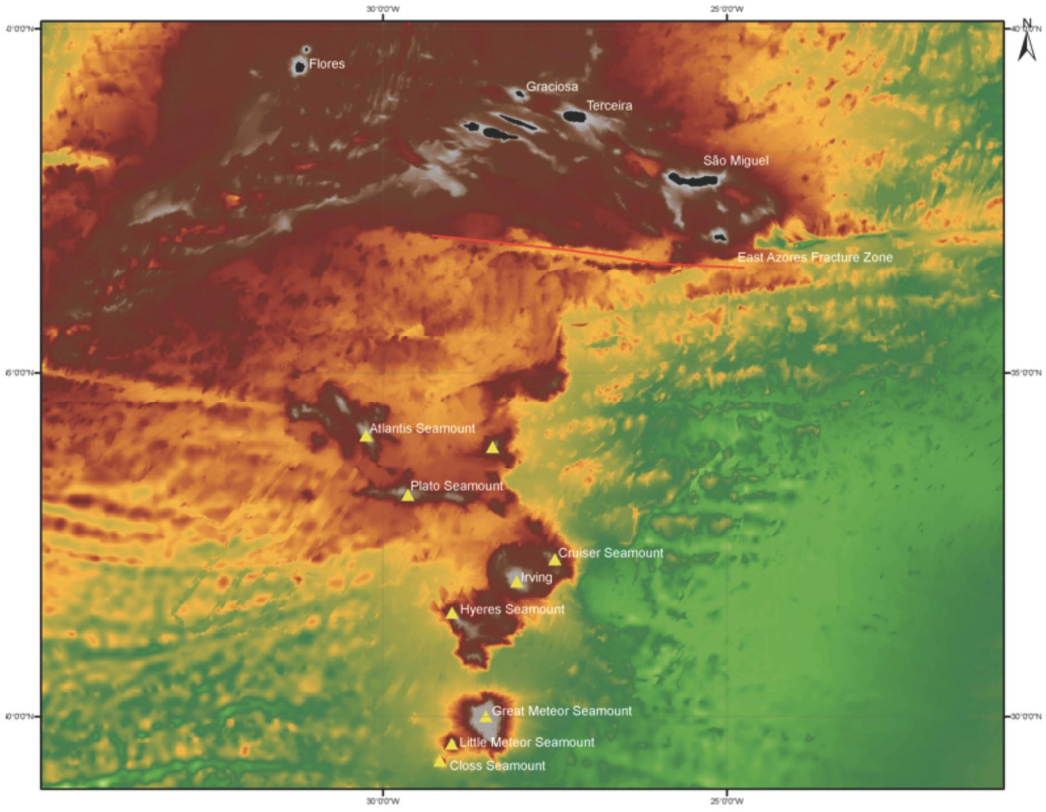

Figure 1 – Map showing the location of the South Azores Seamount Chain. Azores Islands in black.

South Azores Seamount Chain Fe-Mn Crusts

The studied area includes several groups of seamounts that occur in the vicinity of the Mid-Atlantic Ridge, between the Oceanographer and Atlantis fracture zones (29ºN 34ºN and 27ºW to 31ºW), as well as some Fe-Mn crusts recovered in a dredge haul on the East

Azores Fracture Zone (EAFZ). Crusts form by precipitation of metal oxides from seawater onto the substrate surfaces, forming a pavement. The recovered rock types are carbonate rocks (s.l.), sedimentary and volcanic breccias, as well as generally altered basaltic rocks. Considering the depth range of dredging operations and the nature of the recovered materials, the seamounts show a fairly constant geological cross section, ranging from massive basalts near the base, followed by a wide zone dominated by volcanic rocks and/or breccias.

Chemical analyses of 21 samples showed that the Fe-Mn crusts from the different seamounts are fairly homogeneous and somewhat different from the ones recovered from the EAFZ.

The Fe-Mn crusts show high concentrations of many critical metals essential for the production of 'high tech', 'green tech' and 'emerging tech' devices as well as engineered systems and energy applications which have been in great demand in the last few years and have experienced a reduced supply (Hein et al., 2013). Values of cobalt (to 6380 ppm), gallium (to 42 ppm), molybdenum (to 519 ppm), tungsten (to 99 ppm), vanadium (to 1113 ppm), zirconium (to 651 ppm) and rare earth elements (cerium up to 2100 ppm), among others are comparable to crusts found in many places of the global ocean. In Figure 2 the mean concentrations of some metals of these crusts are compared to the means known for crusts from different oceans.

EAFZ crusts are set apart from the south Azores seamounts crusts, since they are chemically different mainly in the relative contents of Fe and Mn as well as in the percentages of Co and Cu.

The Fe/Mn ratios (0.63 to 1.4), the total REE contents, the lack of todorokite, and the homogeneity of all the studied crusts lead us to conclude that they have a hydrogenetic origin, even though the EAFZ crusts show some chemical differences to the crusts collected in the South Azores Seamount Chain. Fe and Mn contents of the crusts are consistent with the available data for Atlantic crusts and Ni and Cu are lower than the known values for the Pacific and consistent with the Atlantic values. The mean concentration of Co in our samples is comparable to the highest mean values described for

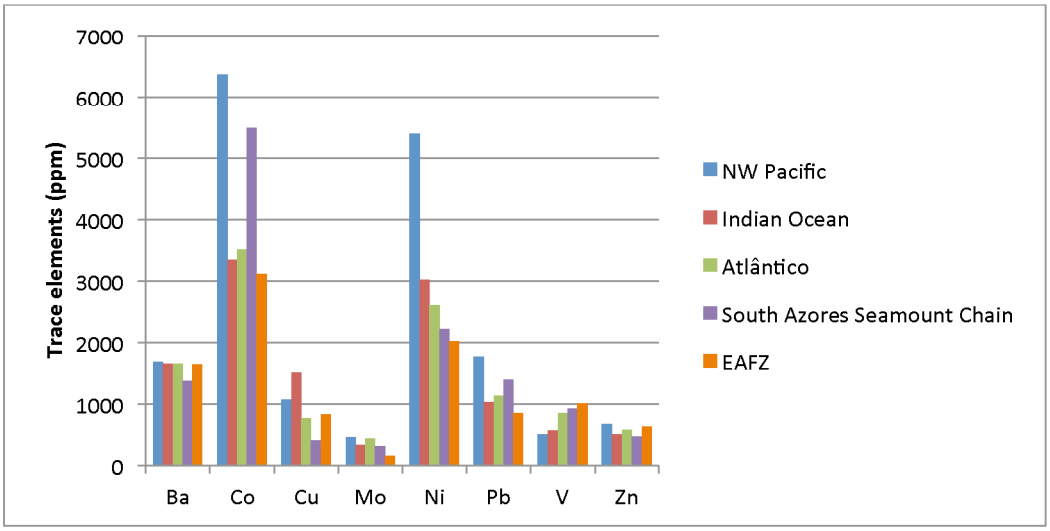

Figure 2 Mean concentrations of some metals in the South Azores Seamount Chain, EAFZ crusts, and the known values for the global oceans.

the Pacific ocean. This may result from the location of these seamounts. Most of the known samples in the Atlantic Ocean are not as centrally located in the Atlantic Ocean as the ones in this study and thereby show a continental-margin type composition as defined by Muiños et al. (2013).

Keywords: Fe-Mn crusts, central Atlantic, south Azores seamount chain.

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