Preliminary Rb-Sr and Sm-Nd isotope geochemistry on Ediacaran and Early Cambrian sediments from the Ossa-Morena Zone (Portugal)


(1) Departamento de Geociências, Centro de Geofísica de Évora, Universidade de Évora, Apt.94, 7001-554 Évora, Portugal
(2) Departamento de Geociências, Universidade de Aveiro, 3810-193 Aveiro, Portugal
(3) Staatliche Naturhistorische Sammlungen Dresden, Museum Mineralogie und Geologie, Konigsbrucker Landstraße 159, D-01109 Dresden, Germany

E-mail (s): mpereira@uevora.pt, jmedina@geo.ua.pt,

SUMARY

This work presents preliminary Rb-Sr and Sm-Nd isotope geochemistry results from samples of detrital rocks from the Ossa-Morena Zone Ediacaran-Early Cambrian basins. The analysed samples present low $^{147}\text{Sm}/^{144}\text{Nd}$ values (0.105-0.119) and negative $\varepsilon_{\text{Nd}}(T)$ values (-3.9 to -12.4), which suggest a typical upper continental crust provenance. These results of Ediacaran-Early Cambrian Ossa-Morena Zone rocks are close to those obtained for the Saxo-Thuringian Zone (Germany) correlatives.

Key-words: Rb-Sr; Sm-Nd, Ediacaran-Early Cambrian, TIMS, Gondwana

Introduction

Isotope geochemistry has been used to identify the different isotopic reservoirs in the crust and the mantle and to characterize the sources of igneous and sedimentary rocks [1]. In this radiogenic isotope study we used two different systems: Rb-Sr, and Sm-Nd, to characterize detrital sedimentary rocks. Sr reflects fairly close the original bulk composition of rocks, although Rb is more mobile. Sr and Rb are strongly fractionated from one another between crust and the mantle leading to the accelerated Sr isotope evolution of continental crust relative to the mantle.

Sm and Nd isotopes are not significantly fractionated within continental crust by sedimentary processes and thus preserve the characteristics of their source (e.g., [2]). The Rb-Sr and Sm-Nd isotopic characterization has been applied to test correlations between old sediments from basins separated in nowadays by several kilometers due to post-Variscan tectonics [3].

Geological setting and sample selection

In the northern domains of the Ossa-Morena Zone (OMZ) close to the Central-Iberian Zone (CIZ)
boundary (Northeast Alentejo, Portugal) outcrops the Serie Negra Cadomian succession [4-5], which is composed by Ediacaran metapelites, metagreywackes, black metacherts and metabasalts (Mosteiros Formation). Early Cambrian calcalkaline volcanic-sedimentary and detritic-carbonate complexes unconformably overlie the Serie Negra. They represent a sequence of reworked felsic tuffs, andesites, ryholodacites and rhyolites (Nave de Grou-Azeiteiros volcanic-sedimentary complex) that passes to the top to arkosic sandstones and pelites and then to limestones (Assumar detritic-carbonate complex) [6-7].

The selected sample from Ediacaran was taken from a Serie Negra outcrop at North of Alter do Chão (CTO-200). The Early Cambrian rocks were sampled from the felsic-dominated volcanic-sedimentary complex of Nave de Grou-Azeiteiros at North of Ouguela (OGL-1) and the detritic-carbonate complex of Assumar in the same cross-section where was taken the Serie Negra sample (CTO-2).

[6], have studied the geochemistry of such rocks recently. There are no main differences in major elements between these detrital rocks, but there is an increasing tendency for the Al2O3/SiO2 values from CTO-2 to OGL-1: La n/Ybn= 16.8). The chondrite-normalized REE distribution patterns are similar with nearly flat patterns characteristic of a slightly positive Eu-anomaly.

Analytical procedures

Three samples (CTO-2, OGL-1 and CTO-200) were selected for the study of Sr and Nd isotopes. The samples were dissolved with HF/HNO3 solution in Teflon Parr acid digestion bombs at 180°C of temperature. After evaporation of the final solution, the samples were distillate two times, and the water was loaded on a Ta outer side filament, with HCl (2,5N), in a Ta-Re-Ta triple arrangement with Re as the ionizing central filament. Both elements were determined using a Multi-Collector Thermal Ionisation Mass Spectrometer (TIMS) VG Sector 54, with 7 Faraday cups. Data were acquired at multidynamic mode with peak measurements at 1-2V to 88Sr and 0.8-1.5V to 144Nd. The measurements of Sr were corrected for possible interference by 87Rb and were normalized to 86Sr/88Sr=0.1194. The measurements of Nd were corrected for interference by 142Ce and 144Sm and normalized to 146Nd/144Nd=0.7219. During this study, the NBS-987 standard gave an average value for 87Sr/86Sr=0.710263±10 (N=8; conf. lim.=95%) and 143Nd/144Nd=0.512114±2 (N=27; conf. lim.=95%) to JNd-1 standard (143Nd/144Nd data are normalized to La Jolla standard). The error on εNd calculations is ±0.3.

Rb-Sr and Sm-Nd results

Rb-Sr and Sm-Nd results are reported in Table 1.

Table 1: Rb-Sr and Sm-Nd analytical data together with εNd (T) for three clastic sedimentary rocks from OMZ.

<table>
<thead>
<tr>
<th>Sample</th>
<th>CTO-2</th>
<th>OGL-1</th>
<th>CTO-200</th>
</tr>
</thead>
<tbody>
<tr>
<td>87Rb/86Sr</td>
<td>3.419</td>
<td>11.651</td>
<td>0.789</td>
</tr>
<tr>
<td>87Sr/86Sr</td>
<td>0.731820</td>
<td>0.776305</td>
<td>0.714828</td>
</tr>
<tr>
<td>143Nd/144Nd</td>
<td>0.119</td>
<td>0.118</td>
<td>0.105</td>
</tr>
<tr>
<td>142Sm/144Nd</td>
<td>0.512163</td>
<td>0.511859</td>
<td>0.511662</td>
</tr>
<tr>
<td>εNd (0)</td>
<td>-9.3</td>
<td>-15.2</td>
<td>-19.0</td>
</tr>
<tr>
<td>εNd (540)</td>
<td>-3.9</td>
<td>-9.7</td>
<td>-19.0</td>
</tr>
<tr>
<td>εNd (560)</td>
<td>-12.4</td>
<td>-9.2</td>
<td>-15.0</td>
</tr>
</tbody>
</table>

The 87Sr/86Sr values obtained from the three clastic sedimentary rocks range from 0.714828 (CTO-200), to 0.731820 (CTO-2) and 0.776305 (OGL-1). The 2σ error range from 0.000035 to 0.000042. The obtained 143Nd/144Nd values show an increasing tendency from 0.511662 (CTO-200), to 0.511859 (OGL-1) and 0.512163 (CTO-2). The 2σ error range from 0.000012 to 0.000018. This trend is followed by the 142Sm/144Nd values, which range from 0.105 (CTO-200), to 0.118 (OGL-1) and 0.119 (CTO-2). The three samples display negative εNd values:

For 560 Ma –Ediacaran deposition age – CTO-200, metagreywacke, εNd(560) = -19.0 and εNd(550) = -12.4; For 540 Ma –Lower Cambrian deposition age – OGL-1, reworked felsic tuff/pelite, εNd(560) = -15.2 and εNd(550) = -9.2. And for 540 Ma –Lower Cambrian deposition age – CTO-2, arkose, εNd(560) = -9.3 and εNd(550) = -3.9.
Discussion

These three samples present low $^{147}\text{Sm}/^{144}\text{Nd}$ values (0.105-0.119), which suggest a typical upper continental crust provenance. The obtained results fit well with the Sr and Nd compositional ranges of Precambrian upper continental crust ($^{87}\text{Sr}/^{86}\text{Sr}=0.71463-0.78662$ and $^{143}\text{Nd}/^{144}\text{Nd}=0.511843-0.512261$) and detrital rocks ($^{87}\text{Sr}/^{86}\text{Sr}=0.711440-0.78919$ and $^{143}\text{Nd}/^{144}\text{Nd}=0.511816-0.512259$) from Southern Britain (e.g.,[2, Table 6.6, pp.235-236]).

The obtained $^{87}\text{Sr}/^{86}\text{Sr}$ and $^{143}\text{Nd}/^{144}\text{Nd}$ values are in agreement with previous studies made by for detrital and volcanic Ediacaran-Early Cambrian rocks of the Ossa-Morena and Central-Iberian zones:
- [8] on Early Cambrian OMZ arkoses ($^{87}\text{Sr}/^{86}\text{Sr}=0.754677$ and $^{143}\text{Nd}/^{144}\text{Nd}=0.512149$) and Ediacaran CIZ greywackes and pelites ($^{87}\text{Sr}/^{86}\text{Sr}=0.735193$; $^{143}\text{Nd}/^{144}\text{Nd}=0.512131-0.512172$);
- [9] on Ediacaran OMZ metapelites ($^{87}\text{Sr}/^{86}\text{Sr}=0.742721-0.745356$; $^{143}\text{Nd}/^{144}\text{Nd}=0.511976-0.512008$) and Ediacaran-Early Cambrian CIZ metapelites and metagreywackes ($^{87}\text{Sr}/^{86}\text{Sr}=0.736217-0.812759$; $^{143}\text{Nd}/^{144}\text{Nd}=0.512171-0.512288$);
- [10] on Ediacaran-Early Cambrian CIZ pelites ($^{87}\text{Sr}/^{86}\text{Sr}=0.72747-0.77767$; $^{143}\text{Nd}/^{144}\text{Nd}=0.511971-0.512272$);
- [11] on Early Cambrian OMZ pelites ($^{143}\text{Nd}/^{144}\text{Nd}=0.512055-0.512129$) and Early Cambrian OMZ andesites ($^{143}\text{Nd}/^{144}\text{Nd}=0.512555-0.512745$); and Ediacaran-Early Cambrian CIZ andesitic basalts ($^{87}\text{Sr}/^{86}\text{Sr}=0.721888$; $^{143}\text{Nd}/^{144}\text{Nd}=0.511993$) and Ediacaran-Early Cambrian CIZ dacitic volcaniclastic rocks ($^{87}\text{Sr}/^{86}\text{Sr}=0.712356-0.716902$; $^{143}\text{Nd}/^{144}\text{Nd}=0.512361-0.512310$).
- [12] on Neoproterozoic CIZ metasedimentary rocks (pelites) ($^{87}\text{Sr}/^{86}\text{Sr}=0.73495-0.79150$; $^{143}\text{Nd}/^{144}\text{Nd}=0.51213-0.512272$) and Neoproterozoic-Cambrian CIZ andesitic rocks (pelites) ($^{87}\text{Sr}/^{86}\text{Sr}=0.73495-0.79150$; $^{143}\text{Nd}/^{144}\text{Nd}=0.51213-0.512272$) with European and North African Cadomian correlatives.

References