Major and trace elements composition of basalts from ultramafic and volcanic seafloor. Southwest Indian Ridge (61 to 67°E)

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Our study area is located on the ultra-slow Southwest Indian Ridge, east of the Melville Fracture Zone, between 61 and 67°E. This part of the SWIR has a very low magmatic supply, and the axial lithosphere is thick. The melt distribution is very heterogeneous with volcanic areas and areas of ultramafic seafloor where plate separation is accomodated by large offset normal faults [1]. The ultramafic rocks are locally overlain by a thin veneer of basalt. Basalts samples have been dredged on these two types of seafloor during the EDUL (1997) and SMS (2010) cruises. We use the major and trace elements composition of these basalts to discuss the magmatic plumbing system of this very low melt supply ridge.

Most basalts from ultramafic seafloor areas have higher Na_2O and TiO_2 contents at a given MgO, and higher Zr/Y and Sr than those from volcanic seafloor. These differences could be explained [2] by a lower degree of partial melting of the mantle source for ultramafic seafloor basalts. However, the lower CaO content of most ultramafic seafloor basalts suggests larger amounts of early fractionation of clinopyroxene [3] from the melts feeding ultramafic areas. This early clinopyroxene fractionation could also partly explain the Na_2O and TiO_2 trends, but not the Zr/Y trend. Our data therefore suggest that both the melting regime and the magma plumbing system producing the two groups of basalts are different. $(La/Sm)_n$ ratio and REE spectra point to a similar source for the two groups of basalts, possibly a refertilized depleted mantle [4]. One dredge in volcanic seafloor stands out with a depleted LREE spectrum, low $(La/Sm)_n$ and very high MgO content. This dredge could be interpreted as resulting from very low degree of melting of a non-refertilized residual mantle domain.

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Early Solar System ^{87}Rb-^{87}Sr Chronology

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The long-lived ^{87}Rb-^{87}Sr system provides a useful chronometer for early Solar System events. Due to differences in the volatility of Rb and Sr, ^{87}Sr/^{86}Sr ratios record information about condensation and volatile depletion in the early Solar System. Thus, high-precision analysis of Rb-Sr systematics in Solar System materials such as calcium-aluminum inclusions (CAIs), meteorites and lunar rocks provide insight into processes that shaped the early Solar System, including the formation of Earth's Moon.

Recent studies have argued for a late formation of the Moon based on Sm-Nd and U-Pb systematics [e.g., 1-2], but have avoided use of Rb-Sr chronometry due to possible disturbance of the Rb-Sr system. However, a chronology may be constructed based on relative variations in initial ^{87}Sr/^{86}Sr in Solar System materials, rather than absolute ages derived by the Rb-Sr isochron method. For Rb-poor samples such as Moore Co. plagioclase, Angra dos Reis, Juvinas and the lunar anorthosite 60025, corrections for radiogenic ingrowth are small, and variations in resulting initial ^{87}Sr/^{86}Sr may be interpreted to reflect differences in the timing of separation from an evolving solar nebula [e.g., 3-5]. Based on a compilation of literature Rb-Sr data measured in various laboratories over the course of decades, Halliday and Porcelli [6] computed a young Sr model age for lunar formation of 90±20 Myr after the formation of CAIs. However, from the fact that 60025 has an initial ^{87}Sr/^{86}Sr between the basaltic achondrite best initial and Angra dos Reis [3-4], it appears that 60025 must be essentially as old as these meteorites, requiring a very old age for the Moon (<30 Myr after CAIs).

In order to determine an internally-consistent Sr model age of lunar formation, we undertake precise Sr isotopic measurements in a comprehensive suite of early Solar System materials in a single laboratory. We also develop a Sr double spike method to distinguish any non-radiogenic isotopic anomalies [e.g., 7,8] and thus further refine our chronology.

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