BORSA SIMP 2018 PER UN SOGGIORNO DI STUDIO ALL'ESTERO: RELAZIONE SULL'ATTIVITÀ SVOLTA

Sr-Nd ISOTOPIC CHARACTERIZATION OF MAGMATIC PRODUCTS FROM CENOZOIC SOUTHALPINE MAGMATIC PROVINCE (NORTH-EAST ITALY) AND FROM EASTERN EQUATORIAL PACIFIC OCEAN (EEP-ODP LEG 203)

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INTRODUCTION AND AIMS OF THE PROJECTS

The radiogenic isotope Sr-Nd systematics is considered a powerful tool for understanding fundamental Earth processes as well as the Earth's evolution. $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ ratios, which show variations by radioactive decay of long half life isotopes of ^{87}Rb and ^{147}Sm, respectively, are routinely used in geochemistry as petrogenetic tracers, yielding information on time-integrated elemental fractionation through processes of melting, crystallization, metasomatism, and contamination (Davidson *et al.*, 2007). In particular, the Sr-Nd ratios of mantle-derived rocks, like basalts and basanites, give us direct information about the nature and the evolution of the upper mantle.

This scholarship allowed the isotopic characterization in terms of $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ ratios of basic-ultrabasic magmatic products for two unrelated scientific projects: *i*) two basanites and one basalt are part of a sample suite collected in the Cenozoic Southalpine magmatism (North-East Italy) for a petrological, geochemical, and geochronological study to understanding the apparently unusual occurrence of anorogenic magmatism in collisional settings; *ii*) six basalts are from the drilling site 1243 in the Eastern Equatorial Pacific collected during the Ocean Drilling Program (ODP) Leg 203 project. Site 1243 in oceanic crust was created by fast seafloor spreading, providing the opportunity to examine crustal genesis, evolution and crust/mantle interaction for a seafloor-spreading end-member, responsible for generating the majority of the oceanic lithosphere.

THE CENOZOIC SOUTHALPINE MAGMATIC PROVINCE (NE ITALY)

The Cenozoic Southalpine magmatic province (NE Italy), known in literature as Veneto Volcanic Province (VVP; *e.g.*, De Vecchi & Sedea, 1995) is one of the widest magmatic districts of the Adria microplate, the northern continental promontory of the African plate (Beccaluva *et al.*, 2007). From late Paleocene to early Miocene relatively undifferentiated lavas, from nephelinites to tholeiites, erupted (Beccaluva *et al.*, 2007). The magma generation appears to have been triggered by decompression melting for mantle upwellings through slab window(s) after the European slab break-off occurred ~ 35 Ma (Macera *et al.*, 2008). However, considering new tomographic images evidencing a continuous subvertical slab beneath the Central Alps (*e.g.*, Hua *et al.*, 2017) a new geodynamic model was proposed invoking a poloidal mantle flow, which arised from the tip of the subducted slab and induced the breakdown of carbonates in slab-derived materials, providing carbonatitic melts, which could be responsible for the metasomatism of the VVP mantle sources (Brombin *et al.*, 2019). According Macera *et al.* (2003) and Beccaluva *et al.* (2007) the VVP magmatic products have similar Sr-Nd-Pb isotopic signatures pointing to a common sub-lithospheric mantle reservoir from western Europe to the Mediterranean area called European Asthenospheric Reservoir (EAR; *e.g.*, Hoernle *et al.*, 1995). Deviations and compositional variations from the mantle reservoir composition may be the result of mixing of EAR-derived melts with heterogeneous lithospheric mantle sources originated from earlier silicate/carbonate melts or metasomatic fluids, which could be related to subduction processes (Pfänder *et al.*, 2018).

This scholarship allowed the Sr-Nd isotopic analyses for two basanites and a basalt from two VVP

districts: Lessini Mts. and Marosticano. Mantle xenoliths hosted in alkali basalts from Lessini Mts. record a Na-alkaline silicatic metasomatic signature (*e.g.*, Beccaluva *et al.*, 2001; Gasperini *et al.*, 2006), whereas mantle xenoliths from Marosticano are the only ones recording a carbonatitic/CO_2-rich silicatic metasomatism (Brombin *et al.*, 2018). The new isotopic data collected during this project, integrated with incompatible element distributions, represent a fundamental tool to better constrain the nature of the metasomatic agents affecting the lithospheric mantle sources and to confirm if they are related to the subduction process of the European-Adria geodynamic framework.

THE EASTERN EQUATORIAL PACIFIC OCEAN

The location of Site 1243 in the Eastern Equatorial Pacific (EEP; near Galapagos) provides a rare window into the petrology, geochemistry, and paleomagnetic history of fast-spreading 10- to 12-Ma Pacific basement material. One of the purpose of ODP Leg 203 was to drill an uncased hole (Hole 1243B) through the sedimentary section in order to core >80 m of oceanic crust (Schultz *et al.*, 2006). The rocks recovered were largely from pillow basalts and comprised both aphyric and sparsely plagioclase and olivine phyric basalts (Moberly *et al.*, 2006). On the basis of phenocrysts content, vesicularity, and degree of alteration eight lithologic units were identified, of which seven were igneous and one was sedimentary. All igneous units are tholeiitic with the exception of one lithologic unit (Unit 4), which consists of an exceptional alkali-rich "tholeiites" (basalts) (Moberly *et al.*, 2006). According to the trace element patterns the tholeiitic units likely derived from a single N-MORB type mantle source, whereas the Unit 4 has a distinctive geochemically enriched signature, typical of E-MORB type mantle source (Moberly *et al.*, 2006). Such enrichment in trace elements can be related to *i*) the low partial-melting degree of a depleted MORB type mantle source, similar to the one from which the tholeiitic basalt originated or *ii*) the partial melting of a distinctive (enriched) mantle source such as the Galapagos mantle plume (Moberly *et al.*, 2006). In order to resolve this dilemma, new Sr-Nd isotopic analyses were performed for six basalts, of which two were from Unit 4 and four from the other tholeiitic units. The obtained isotopic results will be compared with the isotopic domains of the Galapagos plume.

ANALYTICAL METHOD

The Sr and Nd isotopes of the selected samples were analyzed by Thermal Ionization Mass Spectrometry (TIMS), with a new generation Triton+ mass spectrometer at "Geosciences Environment" of Toulouse (GET) at Université Toulouse III Observatoire Midi-Pyrénées, Toulouse (France) under the supervision of Dr. Mathieu Benoit and Professor Michel Gregoire. The analyses at the GET were performed using a TRITON+ Thermo-scientific mass spectrometer. Sr and Nd isotopic compositions were determined after whole rock dissolution in a clean lab. For each sample 100 mg of whole rock powder was weighed in a teflon beaker and dissolved with $HF + HNO_3 + HClO_4$ acids. After dissolution, samples were dried and then dissolved in Acqua Regia (a mixture of HNO_3 and $HClO_4$). Aliquots of these solutions were taken, diluted and directly processed through SB-ICPMS in order to get precise Rb/Sr and Sm/Nd ratios. The remaining solutions were dried and Nd/Sr was extracted from the matrix using a combination of Sr-Spec and Thru-Spec resins.

EXPECTED RESULTS

The interpretation of the results are still a work in progress. For the basic-ultrabasic magmatic products from the VVP, the new isotopic geochemical data will contribute to *i*) enrich the isotopic dataset of the Cenozoic Southalpine magmatic province, *ii*) enlarge the knowledge of spatial heterogeneity within the mantle of this domain, and *iii*) identify the nature of the metasomatic agents of the mantle sources, which could be related to the subducting process of this area.

The new isotopic geochemical data from the basalts from the EEP will allow to *i*) complete the geochemical picture of the various units recorded from the hole, *ii*) extend the limited inventory of baseline data

about this understudied, yet common, lithospheric setting, and *iii*) investigate the origin of the combination of normal and enriched basalts (*i.e.*, if the E-MORB basalts are a record of the Galapagos mantle plume, or if they erupted close in space and time with N-MORB as consequence of spreading rate and mantle thermal regime).

The results are going to be published on at least two papers for international journals with high impact factor.

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