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Extreme source heterogeneity and complex contamination patterns along the Cameroon Volcanic Line: New geochemical data from the Bamoun plateau

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ABSTRACT

We investigated mafic and felsic volcanic rocks from the Bamoun plateau, a magmatic province located north of Mount Cameroon, in the continental part of the Cameroon Volcanic Line (CVL). Basalts and dacites were probably emplaced more than 40 Ma ago, while basanites represent very young volcanic eruptions. Among the basalts, some of them have suffered crustal contamination during their uprise through the continental crust, and their primary trace element and isotopic compositions have been slightly modified. The formation of the dacites was also accompanied by some crustal contamination. Non-contaminated rocks show that the oldest magmas are transitional basalts formed by relatively high degrees of partial melting of a moderately enriched mantle source, probably containing pyroxenites. Recent basanites were produced by very low partial melting degrees of an enriched mantle source with HIMU composition, but different from the source of the nearby Mount Cameroon lavas. The mantle beneath the CVL is thus very heterogeneous, and the tendency towards more alkaline mafic-ultramafic compositions in the youngest volcanic manifestations along the CVL seems to be a general feature of all CVL.

1. Introduction and geological setting

The Cameroon Volcanic Line (CVL) is one of the major recent magmatic provinces in Africa (Fitton and Dunlop, 1985). It extends over up to 1500 km from northeast to southwest, with the peculiarity of being partly on the Africa continental crust, and partly on the Atlantic oceanic crust (Fig. 1). The magmatic activity of the CVL also covers a large period of time. Several plutonic massifs as well as some volcanic rocks were emplaced more than 50 Ma ago (Moundi et al., 1996; Okomo Atouba et al., 2016), while the last volcanic activity is the year-2000 eruption of Mount Cameroon. The origin of this large magmatic province is still highly debated. It has been argued that the alignment of the volcanic massifs is the ancient track of the Saint-Helena mantle plume, but no age progression has been evidenced along the CVL. Several alternative models have been proposed, suggesting a formation of the CVL from several mantle plumes (Ngako et al., 2006), or the melting of the uppermost mantle previously impregnated by the Saint-Helena hot spot (Halliday et al., 1988; Lee et al., 1994; Rankenburg et al., 2005). More recently, geophysical

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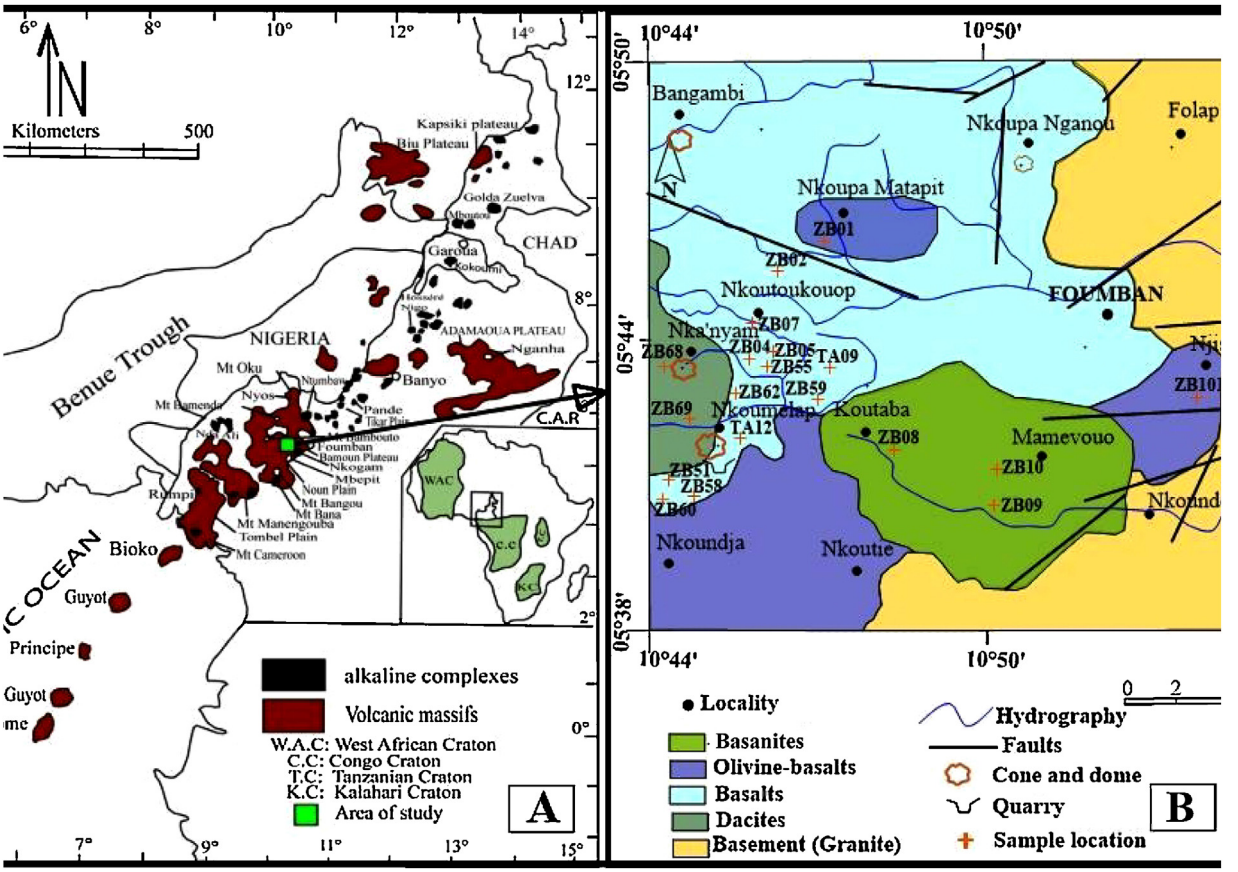

Fig. 1. A. General map of the Cameroon Volcanic Line (CVL), showing the location of the Bamoun plateau. B. Geological map of the studied area showing the location of the samples analyzed in this study.

data as well as numerical modelling have been used to bring more constraints on the structure and evolution of this part of Africa, and the model of mantle melting due to edge-driven convection along the Congo craton has been put forward to explain the linear structure of the CVL as well as its extension on the oceanic plate (Adams et al., 2015; De Plaen et al., 2014; Fourel et al., 2013; Milelli et al., 2012; Reusch et al., 2010, 2011). Even in the framework of these models, there are still many unanswered questions about the composition of the sources of the magmatism, as well as about their location in the mantle beneath the CVL.

We investigated volcanic rocks from the southwestern part of the Bamoun plateau, located in the central part of the continental CVL (Fig. 1). The studied volcanic rocks were emplaced on Pan-African gneisses, granites and gabbros, and both mafic and felsic rocks are present on the field; old basalts appear in deep valleys as part of lava flows, often highly weathered. They are in some places covered by ignimbrite deposits from the Mbam massif nearby. On the opposite, basanites are very fresh volcanic rocks, and form columnar lava flows sitting on top of older volcanic products and appear as the youngest volcanic event in the area. The same field relationships were already described and confirmed by K–Ar dating (Moundi et al., 2007, Okomo Atouba et al., 2016).

Major and trace elements analyses, as well as Sr, Nd, and Pb isotopic measurements were performed on these samples in order to assess the importance of the interactions between the mantle magmas and the crustal rocks, and to discuss the nature and composition of the mantle source of this volcanism, especially in an area where magmatic activity has been present for more than 50 Ma (Moundi et al., 1996; Okomo Atouba et al., 2016), allowing us to discuss the melting process evolution through time. In their previous studies, Moundi et al. (1996, 2007) focused on the oldest volcanic rocks of the area, and did not provide any Pb isotopic data, while the basanites were poorly studied by Okomo Atouba et al. (2016).

2. Analytical techniques

Major and trace elements were obtained by ICP–AES and ICP–MS at IUEM (European Institute for Marine Studies, "Pôle de spectrométrie ocean", Brest, France). Sr and Nd isotopic measurements were performed on a Thermo Scientific Triton at the IUEM in Brest (France), while Pb isotope compositions were obtained using the Thermo Neptune MC–ICP–MS of IFREMER-Brest. The detailed analytical procedures and the analytical results are available as supplementary material.