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The discovery of late Quaternary basalt on Mount Bambouto: Implications for recent widespread volcanic activity in the southern Cameroon Line

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ABSTRACT

At the north-eastern flank of Mount Bambouto, a lateral cone, the Totap volcano, is dated at 0.480 ± 0.014 Ma, which corresponds to the most recent activity of this area. The lava is a basanite similar to the older basanites of Mount Bambouto. Two new datations of the lavas of the substratum are 11.75 ± 0.25 Ma, and 21.12 ± 0.45 Ma. A synthetic revision of the volcanic story of Mount Bambouto is proposed as follows. The first stage, ca. 21 Ma, corresponds to the building of the initial basaltic shield volcano. The second stage, from 18.5 to 15.3 Ma, is marked by the collapse of the caldera linked to the pouring out of ignimbritic rhyolites and trachytes. The third stage, from 15 to 4.5 Ma, renews with basaltic effusive activity, together with post-caldera extrusions of trachytes and phonolites. The 0.5 Ma Totap activity could be a fourth stage. In the recent Quaternary, a number of basaltic activities, similar to that of the Totap volcano, are encountered elsewhere in the Cameroon Line, from Mount Oku to Mount Cameroon. The very long-live activity at Mount Bambouto and the volcanic time-space distribution in the southern Cameroon Line are linked to the working of a hotline.

1. Introduction

Mount Bambouto is one of the great volcanoes of the Cameroon Line, with Mount Cameroon, Mount Manengouba, Mount Bamenda, and Mount Oku. It is located 150 km north-east of Mount Cameroon and constitutes an elongated shield and conical complex trending NE-SW, 50 km-long and 25 km-wide (Fig. 1). It culminates at 2740 m at the rim of a large caldera (15 × 8 km). The volcano rests above the Western Cameroon Precambrian substratum and its plateau basalt overflow dated from 52 to 38 Ma (Moundi, 2004; Fosso et al., 2005; Moundi et al., 2007). It includes various mafic to felsic products which are in a rather long time from 21 to 4.5 Ma (N'ni, 2004; Youmen et al., 2005; Marzoli et al., 2000).

According to the literature, the Mount Bambouto story is divided into three stages: (1) The pre-caldera stage corresponds to the building of the main shield volcano, between 21 and 16 Ma (N'ni, 2004). It was mainly effusive and basaltic. (2) Collapse of a large caldera initiates the second stage characterized by the extrusion of ignimbritic trachytes, between 16 and 11 Ma (Youmen et al., 2005). (3) The post-caldera and third stage consists of the pouring out of intra-caldera and adventive basaltic flows, and of extrusions of phonolitic domes, between 9 and 4.5 Ma (Marzoli et al., 2000).

New investigations led to the survey of an adventive cone, the Totap volcano, at the north-eastern slopes of Mount Bambouto, which is well preserved in shape and seems to be recent, considering the rapid erosional process in such a mountainous area (Fig. 2) (Kagou Dongmo et al., 2006). Petrographical and geochemical data have been obtained. High precision K/Ar age data have been done for the lava of the cone and of the flow, as well as for the surrounding lavas of the substratum. They indicate a young age, ca. 500 ka, compared to the Neogene ages of the last Mount Bambouto volcanic activities. This dating and the magmatological features of the Totap volcano are used to reconsider the long volcanological history of the Bambouto. Moreover, we collected all the Quaternary age data for the Cameroon Line volcanic activity. These new data allow us to discuss on the volcano-tectonic model that could be applied for the southern Cameroon Line.

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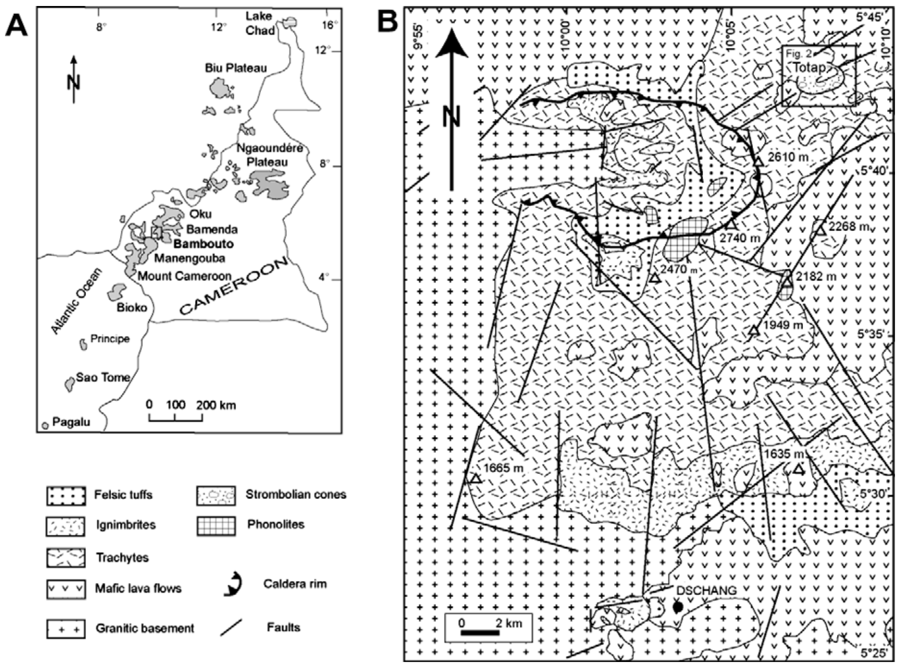

Fig. 1. (A) Location of the Mount Bambouto in the Cameroon Line; (B) Geological map. Note the site of the Totap volcano, to the north-east.

2. The Totap volcano

The Totap volcano (10°07′50″E, 5°43′15″N) is a SW-NE elongated strombolian cone (2100 × 1700 m) covering 2.7 km^2, at the north-eastern upper slopes of Mount Bambouto.

Its crater, 750 × 350 m-large with a depth of 100 m, is opened to the north-east along the downhill slope. A short lava flow crops out below the cone and extends to 500 m at the north-eastern opening (Fig. 2a). The volcanic rocks of the Totap substratum consist of a hawaiite flow to the south-west, of a mugearite flow to the north-east, and of various trachyte flows to the north-west and the south-east. The hawaiite unit overlays the trachytes and the trachytes overlay the mugearite which covers the granitic substratum 2 km further to the east (Fig. 2b). The Totap volcano lavas and the surrounding lavas have been investigated for their mineral compositions by electron probe microanalyzer at the University of Orléans (France) (Table 1), and for their chemical compositions by ICP-AES and ICP-MS at the CRPG-CNRS of Nancy (France) (Table 2).

3. Composition of the Totap lavas

The Totap volcanic products include the lava flow and the pyroclastic material of the cone, all having the same basaltic composition. Texture is hyalo-microlitic and porphyritic with 13–20 vol% of olivine and pyroxene phenocrysts. The paragenesis, in the order of crystallization is as follows:

(1) microcrysts of spinel and chromian spinel included in olivine and showing two compositional ranges, one Al-rich (80.4 < spinel + hercynite% < 84.8; 4.7 < chromite + Mg–chromite% < 8.2) and the second Cr-rich (39.2 < spinel + hercynite% < 56.6; 24.3 < chromite + Mg–chromite% < 32.4) (Table 1a); (2) phenocrysts (Fo_{88-85}) and microcrysts (Fo_{83-77}) of olivine (Table 1b; Fig. 3); (3) microphenocrysts and microcrysts of Ti–magnetite (24 < ulvospinel% < 47) (Table 1a); (4) phenocrysts and microcrysts of clinopyroxene ranging from aluminium-rich fassaite to diopside-augite (3.9 < Al_2O_3 wt% < 10.5; 37.3 < XMg% < 50.4; 2.3 < XFe^{2+} + Mn% < 16.4; 44.0 < XCa% < 53) (Table 1c, Fig. 3); (5) microliths of plagioclase (An_{61-50}) (Table 1d); and (6) rare microcrysts of leucite (Table 1e). Interstitial glass has a nepheline to sodic plagioclase composition. In addition, some xenocrysts of pyroxene are present and show a Fe-rich diopside composition (25.1 < XMg% < 36.4; 15.2 < XFe^{2+}+Mn% < 28.0; 46.5 < XCa% < 50.0) (Table 1c; Fig. 3).

The fassaitic character of some phenocrysts of pyroxene is a common feature of pyroxenes from alkaline lavas. It has been pointed out in the Quaternary alkaline basalts of the Noun Plain, East of Mount Bambouto (Wandji et al., 2000). On the basis of their Al^{IV}, Al^{VI}, and Ti contents, the pyroxenes show large variations ranging from typical high-pressure megacristic pyroxene of alkaline lavas to common low-pressure phenocrysts (Fig. 4). There is a continuous compositional trend between the two pyroxene types. The various pyroxenes originated from a polybaric crystallization, which occurred from 8 to 1 kbar, according to the geobarometer of Nimis and Ulmer (1998). The pyroxene xenocrysts, Al-poor but Fe- and Na-rich (up to 1.4 wt% Na_2O), could not have been derived from late crystallization of the basanitic magma. They have been sampled from a previously evolved magma.

The Totap lavas are basanite, according to their silica and alkaline contents (Table 2), and to their normative composition (6.3 < nepheline wt% < 10.7; 24.2 < olivine wt% < 24.8). According to the sodic–potassic discrimination of Middlemost (1975), these lavas belong to a sodic series as well as most of the lavas of Mount Bambouto (Fig. 5). They are characterized by a moderate rare earth element fractionation (16.9 < La_N/Yb_N < 17.4) and by an OIB-like trace element normalized pattern similar to those of Mount Bambouto basaltic lavas (Fig. 6).

4. Composition of the surrounding lavas

The south-western hawaiite lava is hyalo-microlitic and fairly porphyritic with phenocrysts of olivine, pyroxene, amphibole, and plagioclase. The mineral composition includes microcrysts of apatite, Ti–magnetite (37 < ulvospinel% < 57) (Table 1a) and ilmenite, phenocrysts and microcrysts of olivine (Fo_{85-75} and Fo_{76-67}, respectively) (Table 1b; Fig. 3), of fassaitic diopside