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^{40}Ar–^{39}Ar ages from the Sabongari and Nana igneous complexes within the central part of the Cameroon Line (Central Africa)

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ABSTRACT

The Sabongari and Nana volcano–plutonic complexes are two of about sixty complexes that outcrop along the Cameroon Line. In both complexes, granites and rhyolites are the prevalent rock types among plutonic and volcanic rocks, respectively. The Nana complex has never been dated, while data ranging from 77 to 49 Ma have been reported for the Sabongari intrusive rocks. These ages appeared inconsistent with field relationships, the oldest ones 77 and 74 Ma being obtained on microgranites that form a WSW–ENE alignment of small plugs within the main granite. We performed ^{40}Ar–^{39}Ar laser step–heating analyses on a plutonic and a volcanic rock for each complex. The age obtained on Sabongari granite, 57.70 ± 0.44 Ma, is about 1 Ma older than the age obtained on a related trachyte, and consistent with field relationships. Rocks from the Nana complex are younger than those from Sabongari, ranging from 52 to 49 Ma. This is the second paper with ^{40}Ar–^{39}Ar data on the Cameroon Line anorogenic complexes after that on the Hossere Nigo complex, sited at about 240 km to the NE of the study area. Both results challenge earlier K–Ar and Rb–Sr model ages along the Cameroon Line. More ^{40}Ar–^{39}Ar data on a large number of complexes are necessary to better understand their spatial relationships over time.

1. Introduction

The Cameroon Line (CL) is one of the major Tertiary tectono–-magmatic features in Africa. It extends from the Pagalu Island in the Atlantic Ocean to the Kapsiki plateau on the continent, forming a ca 1600 km linear alignment of magmatic edifices. Along the continental part (Fig. 1a), more than sixty small volcano–plutonic complexes co-exist with volcanic massifs. The available geochronological data along this CL are more abundant on volcanic (see Mbowou et al., 2012 for compilation) than on plutonic complexes (Njome and de Wit, 2014). Furthermore, data are mainly based on K–Ar and Rb–Sr analyses, using methods that require assumptions about the initial isotopic ratios of analyzed minerals in order to calculate ages. For example, the only ^{40}Ar–^{39}Ar age published on a CL pluton (65.0 ± 0.8 Ma) disagrees with the K–Ar data of the same sample (69–82 Ma) (Kamden et al., 2002).

Here we present new ^{40}Ar–^{39}Ar ages of plutonic and associated volcanic rocks from two complexes in the Tikar plain, called Sabongari (or Mba Namboué) and Nana. Both are characterized by near surface emplacement levels (presence of miarolitic cavities in the rocks). The Sabongari granites have been previously dated (Rb/Sr and K/Ar) by Lasserre (1978) and Cantagrel et al. (1978), between 77 and 49 Ma. However, these data are inconsistent with field relationships (see Fig. 2), and show a quite long interval of time across a few kilometers wide pluton. The Nana complex has not been dated previously. Volcanic rocks associated to the plutonites in the Tikar plain are dated, enabling us to test their relative emplacement history.

2. Geological setting

Seven alkaline magmatic complexes along the CL (Fourougain, Nana, Bitou, Sabongari, Mbafé, Pamsa, Pandé) are located in the Tikar plain (Fig. 1b). The Sabongari, Nana and Pandé complexes form a SW–NE alignment of isolated massifs. Petrological data have been recently obtained from these complexes, except on Fourougain and Bitou (Njonfang et al., 2013 and references therein). This new data show that

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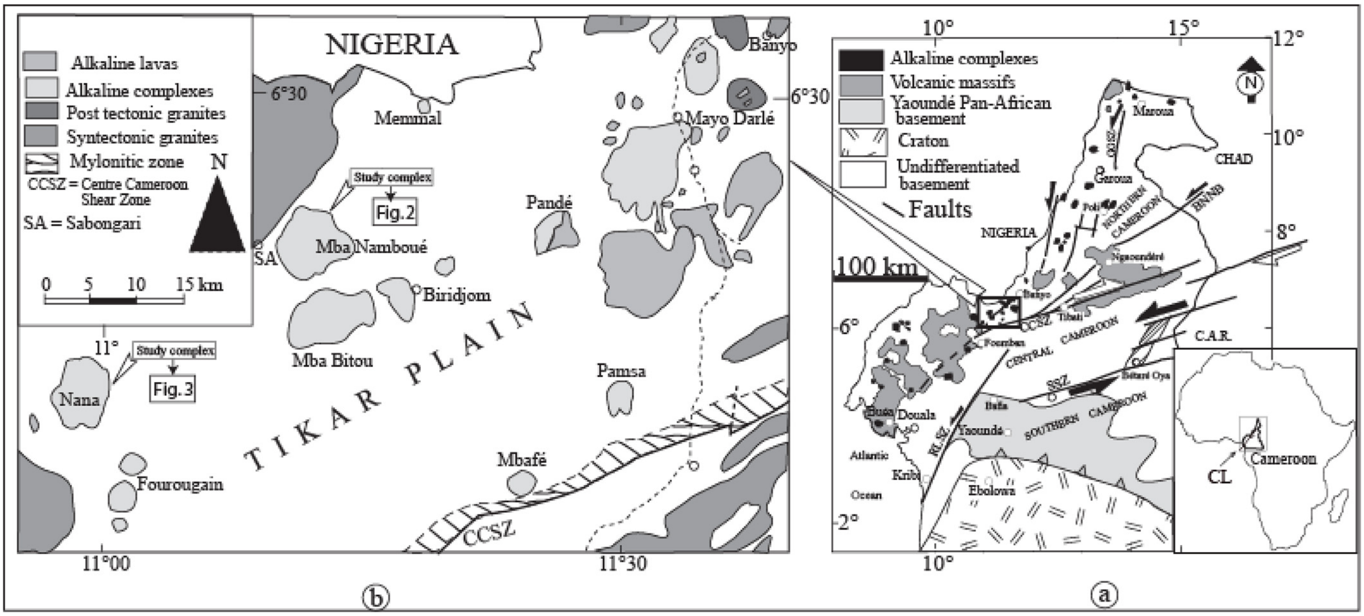

Fig. 1. Location of the study area. Inset: Cameroon in Central Africa; CL: Cameroon Line a) Location of the Tikar Plain along the CL. Note the distribution of alkaline complexes; b) Location of the study sites (Figs. 2 and 3) across the Tikar Plain. Mba Namboué is the local name of the Sabongari complex.

the complexes are made up mainly of felsic alkaline plutonic rocks (granites and/or syenites) with minor volcanic felsic rocks (rhyolites and/or trachytes) (Njonfang, 1998; Njonfang and Moreau, 2000). The Sabongari and Nana complexes include also minor basaltic and intermediate rocks.

3. Petrography

Rocks nomenclature used here (TAS, Total Alkali–Silica) follows Le Bas et al. (1986). Chemical analyses of whole–rock and minerals microchemistry (feldspars, pyroxenes, amphiboles, biotites) of dated samples are summarized in Tables 1–5. Analytical methods can be found in Njonfang et al. (2013).

3.1. The Sabongari complex

The plutono-volcanic complex of Sabongari is located between 6°20′38" and 6°23′39" Lat. N and 11°10′16" and 11°13′44" Long. E (Fig. 2). It is emplaced in Pan-African basement constituted of abundant biotite–garnet gneisses and few amphibolites. In the first survey, Koch (1953) mapped the complex as mainly comprising peralkaline granites in which riebeckite and aegirine constitute the mafic phases. But volcanic rocks are also associated with the plutons (Njonfang et al., 2013). In all, the plutonic rocks include granites, syenites, microdiorite and monzodiorites and the volcanic rocks comprise basalts, trachytes and rhyolites. Field relationships show that the volcanic rocks post-date the plutonic ones (Njonfang et al., 2013). A more detailed description of this complex is given in Njonfang et al. (2013).

Here only a short description of major rock–types is presented. Granites are the most abundant rock-type of the complex, and the amphibole–pyroxene bearing ones, including the dated sample (89SA), are predominant. Small plugs and/or dykes of biotite–, amphibole–-biotite and pyroxene–bearing granites are isolated and a series of microgranite outcrops trends WSW–ENE. Syenites are of amphibole–pyroxene and amphibole–biotite bearing types. Monzodiorites and diorite are less abundant.

Rhyolites are the dominant volcanic rocks, followed by trachytes and basalts. The rhyolites displays vitreous and microlitic porphyric textures. Trachytes (including a dated sample; 63SA) differ from rhyolites by the absence of phenocrysts of quartz and the presence in the groundmass of small amount of pyroxene, amphibole and biotite. Two types of basanite dykes are distinguished texturally and structurally: olivine–clinopyroxene basanite with a microlitic porphyric texture and olivine basanite with a microlitic microporphyric texture and a flow structure. As in rhyolites and trachytes, xenoliths of alkali feldspar granite are present (Njonfang et al., 2013).

3.2. The Nana complex

The Nana complex is located between 6°10′ and 6°16′ Lat.N and 10°57′ and 11°02′ Long.E. (Fig. 3). The complex is emplaced in Pan-African basement comprising orthogneisses and few amphibolites, coarse–grained granites and gneisses. Peronne (1969) described this complex as a granitic massif composed mainly of alkaline biotite granite passing to peralkaline type. The ongoing petrological and geochemical studies show that few gabbros and diorites are associated with the predominant granites. The plutonites are cut or partially covered with volcanic equivalents. These include rhyolites, basalts, basaltic trachyandesites and trachyandesites.

The alkaline granites have granular to microgranular textures. Granular granites are medium-to fine-grained. The mineral composition defines two main types of granites: biotite granites and biotite-amphibole granites. Gabbros and diorites have microgranular textures. The dated microdiorite sample (NA223) occurs as small dykes (2–3 m thick) that crosscut biotite granite (Fig. 3). It is made up of plagioclase (40%; $An_{48-36}Ab_{63-53}$) + amphiboles (25%; X_{Mg} = 0.63–0.68) + clinopyroxene (15%; $Wo_{37.9–38.5}En_{37.7–40.6}Fs_{21.1–24.3}$) + biotite (10%; X_{Mg} = 0.52–0.56) + quartz (3%) + alkali feldspar (2%) + oxides (2%; magnetite and ilmenite) + sphene (2%) and apatite (1%) (Tables 1–4). Plagioclase phenocrysts are often zoned; microcrystals are often moulded by acicular crystals of pyroxene in the groundmass. Developed flakes of biotite are usually associated to phenocrysts of amphiboles whereas small ones are rather associated with oxides and groundmass plagioclase. Interstitial crystals of orthoclase ($Or_{85}Ab_{14}An_1$) occur occasionally. The whole–rock chemistry of the diorite indicates that it is sodic–potassic (Na_2O/K_2O: 1.28).

The rhyolites make up almost 85% of volcanic rocks of the complex; followed by basalts (10%) and less abundant basaltic trachyandesites and trachyandesites (5%). These lavas mainly occur as domes and dykes at the eastern border of the granitic intrusions or intrude the basement