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Transition from alkaline to calc-alkaline volcanism during evolution of the Paleoproterozoic Francevillian basin of eastern Gabon (Western Central Africa)

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ABSTRACT

We report new geochemical data for the volcanic and subvolcanic rocks associated with the evolution of the Francevillian basin of eastern Gabon during Paleoproterozoic times (*c.* 2.1–2 Ga). Filling of this basin has proceeded through four main sedimentary or volcano-sedimentary episodes, namely FA, FB, FC and FD. Volcanism started during the FB episode being present only in the northern part of the basin (Okondja sub-basin). This volcanism is ultramafic to trachytic in composition and displays a rather constant alkaline geochemical signature. This signature is typical of a within-plate environment, consistent with the rift-setting generally postulated for the Francevillian basin during the FB period. Following FB, the FC unit is 10–20 m-thick silicic horizon (jasper) attesting for a massive input of silica in the basin. Following FC, the FD unit is a *c.* 200–400 m-thick volcano-sedimentary sequence including felsic tuffs and epiclastic rocks. The geochemical signatures of these rocks are totally distinct from those of the FB alkaline lavas. High Th/Ta and La/Ta ratios attest for a calc-alkaline signature and slight fractionation between heavy rare-earth suggests melting at a rather low pressure. Such characteristics are comparable to those of felsic lavas associated with the Taupo zone of New Zealand, a modern ensialic back-arc basin. Following FD, the FE detrital unit is defined only in the Okondja region, probably associated with a late-stage collapse of the northern part of the basin.

It is suggested that the alkaline to calc-alkaline volcanic transition reflects the evolution of the Francevillian basin from a diverging to a converging setting, in response to the onset of converging movements in the Eburnean Belt of Central Africa.

1. Introduction

The Francevillian basin system ('Francevillian basin') of eastern Gabon (stratigraphically, the 'Francevillian Group', Gérard, 1958; Weber, 1968; Donnot and Weber, 1968–1969) is an exceptionally well preserved intracratonic domain of Paleoproterozoic age located to the eastern 'piedmont' of a folded and thrusted orogenic belt known as the Ogooué orogenic belt (Figs. 1 and 2). Recently, it has focused much attention because of the report by El Albani et al. (2010) of probable fossil forms suggesting the existence of multicellular organisms as early as *c.* 2.1 Ga.

The basin series is mainly composed of coarse- (sandstones) and fine-grained (shales and black shales) sedimentary rocks, but also includes magmatic (both plutonic and volcanic) units at different stratigraphic levels. The most largely developed is the Ngoutou subvolcanic Complex, located in the northern part of the domain (Fig. 2). This formation is composed of saturated (granite) as well as undersaturated (syenite) magmatic rocks, both showing a constant alkaline affinity (Moussavou and Edou-Minko, 2006) suggestive of an emplacement in a within-plate tectonic setting. Higher in the series, and especially in the FD unit, other magmatic rocks exist (Weber, 1968) which have not been subject to a detailed petrological study. Thus, the petrological knowledge of the Francevillian magmatism is at present incomplete.

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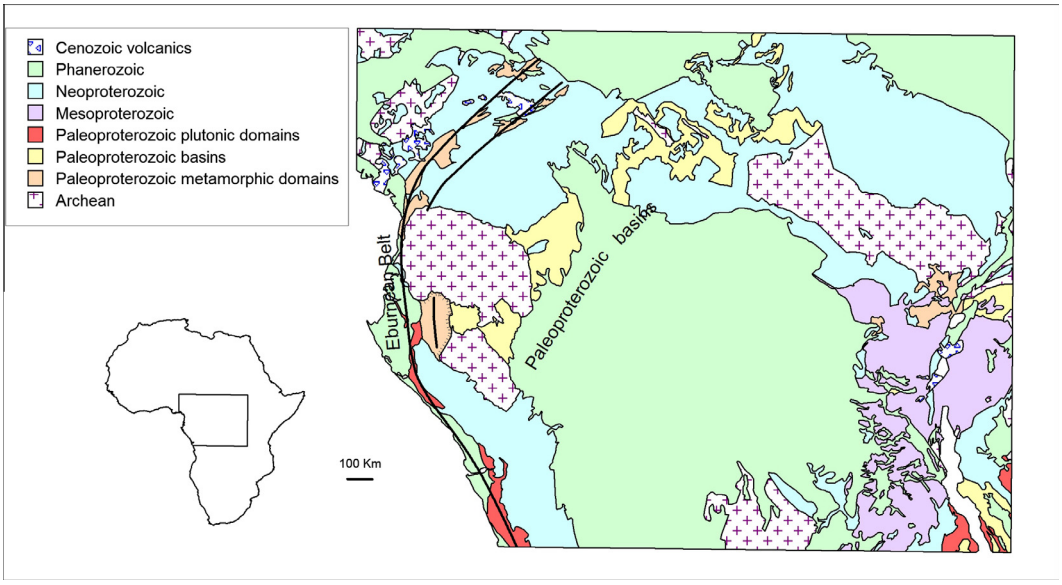

Fig. 1. Simplified regional geological map of Central Africa (from Milesi et al., 2004) showing the major lithostratigraphic domains with discrimination between the sedimentary, plutonic and metamorphic domains within the Eburnean orogeny.

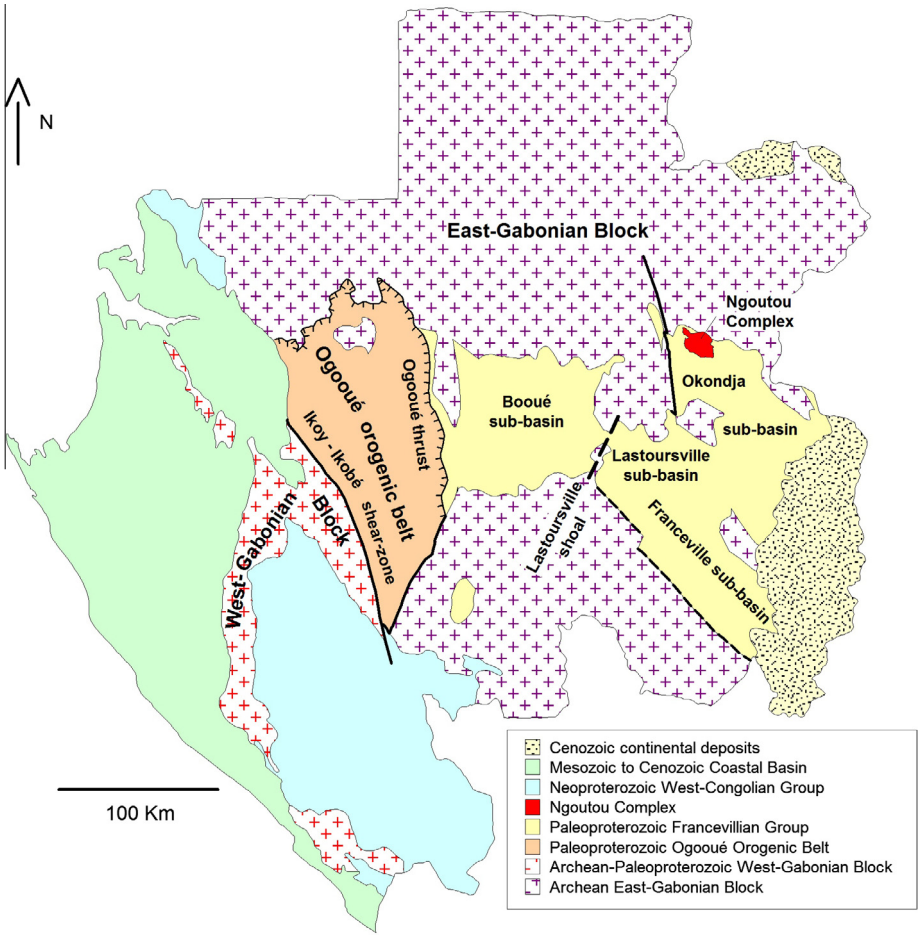

Fig. 2. Simplified geological map of the Gabonese Republic (from Thiéblemont et al., 2009) showing the major lithostructural domains including the Paleoproterozoic Ogooué Belt and the Francevillian basin.

Considering the spatial relationship between the Francevillian basin and Ogooué orogenic belt (Fig. 2), the basin system should be better defined as a foreland basin (Feybesse et al., 1998) than as a strictly anorogenic domain. Indeed, the Francevillian series of the western part of the basin system, *i.e.* the Booué basin (Fig. 2), show significant deformation (Prian et al., 1990; Feybesse

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