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Phlogopite compositions as an indicator of both the geodynamic context of granitoids and the metallogeny aspect in Memve'ele Archean area, northwestern Congo craton

Sylvestre M. Ntomba [a, b, *], François Ndong Bidzang [a, c], José Eric Messi Ottou [a], François Jeannot Goussi Ngalamo [a], Dieudonné Bisso [a], Christelle Rufine Magnekou Takamte [a], Joseph Mvondo Ondoa [a]

[a] DST Faculté des Sciences, Université de Yaoundé I, B.P 812, Yaoundé, Cameroon
[b] Centre de Recherches Géologiques et Minières, B.P 333, Garoua, Cameroon
[c] LTM, Laboratoire de Traitement des Minerais, B.P 4110, Yaoundé, Nkolbisson, Cameroon

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ABSTRACT

A barium bearing phlogopite (celsian) has been found for the first time within the charnockitic and tonalitic suites that compose Archean mineral belt in Cameroon. Electron microprobe analyses of these phlogopites are reported and contain moderate contents of BaO (0.42–1.26 wt. %) and up to 5.95 wt. % TiO_2. Micas are Mg-rich and their compositions indicate phlogopites rich-meroxenes. Phlogopites from Memve'ele are characterized by a nearly horizontal trend of increasing total aluminium (2.494–2.931 a.p.f.u.) and relatively constant Fe/(Fe + Mg) suggesting contributions of aluminous supracrustal material to the magmas by anatexis or assimilation. Compositions of the barium titanium bearing phlogopite vary systematically according to rock types. It seems that the substitution scheme include $Ba + Al + {}^{VI}(Mg, Fe)^{2+} + 2\,{}^{IV}Si = K + Si + {}^{VI}Ti + 2{}^{IV}Al$ was dominant in the Memve'ele area thus, this scheme has made easy incorporation of Ba into phlogopite structure. The binary diagram of aluminium vs. titanium shows that phlogopites from the Memve'ele area have been formed by the same metasomatic mechanism as phlogopites from Canary Island xenoliths and Mezitler andesites but Ba enrichment of phlogopites from the Memve'ele area implies an early Ba-metasomatism contrary to those from Mezitler. The estimated temperature of the studied phlogopites indicated mainly two groups: (1) temperature range from 662 to 688 °C (average 676 °C) for phlogopite grains with High $Mg^{\#}$ in the trondhjemite sample and (2) temperatures with interval limits from 757 to 800 °C (average 777.07 °C) for remnant phlogopites; reflecting primary and late crystallization respectively from slightly to highly oxidized magma (−17.30 to −13.87 Kbars). The geothermal gradient with average temperatures are 35.57–53.360 °C/Km and 30.95–46.42 °C/Km corresponding to 14.56–21.84 Km and 14.56–30.58 Km depth of below crust respectively. The crystallizing melt is enriched in Ba emanated from sea water at medium and high temperatures, low and high fugacity and high water fugacity generated Ba-bearing phlogopite grains both in trondhjemite samples ($S_{13}W_6$) and remaining granitoids during partial melting of the mantle. The phlogopite grains with low $Mg^{\#}$ in $S_{13}W_6$ sample have more Ba than all remain phlogopites. The presence of high Ba contents in these phlogopite grains can be explained by (1) the admixture of residual and new Ba rich melts or (2) the presence of both low Mg and Mn contents in the octahedral site that generate a large interlayer site which accommodate more Ba or (3) both mechanisms are displayed to crystallize these phlogopite grains. Thus Ba rich phlogopites occur in the fresh granitoids depending only on early magmatic processes or hydrothermal alteration at high temperature. Contents of titanium are only controlled by temperature during phlogopite crystallizations. Moreover, igneous phlogopites are used as

* Corresponding author. Département des Sciences de la Terre, Faculté des Sciences, Université de Yaoundé I, B.P. 812, Yaoundé, Cameroon.
E-mail addresses: sylmanto.gary@gmail.com, sylvestre.martial@yahoo.fr (S.M. Ntomba).

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metallogenic indicator. The study is useful to the exploration efforts for barium ore and shows that the Ba-rich parent granitoids can produce Ba-rich soils which can be potential economic interest for Cameroon.

1. Introduction

Barium-titanium rich phlogopites previously observed in magmatic and contact metamorphic rocks worldwide including alkaline and peralkaline magmatic suites and marbles (Thompson, 1977; Wendlandt, 1977; Mansker et al., 1979; Solie and Su, 1987; Bol et al., 1989; Tracy, 1991; Bigi et al., 1993; Mitchell and Platt, 1984; Shaw and Penczak, 1996; Yavuz et al., 2002). The Archean Ntem complex corresponds to the northwestern limit of the Congo craton in the southern part of Cameroon. The study area is located in the Ntem complex, not far from the boundary between it and the Nyong Complex (Fig. 1a; Pouclet et al., 2007; Owona et al., 2011; Boniface et al., 2012). The Ntem complex was formerly known as Ntem unit (Tchameni et al., 2001; Shang et al., 2004a,b) and is exposed in the Memve'ele region (Fig. 1b; Champetier de Ribes and Reyre, 1959). Several mineralogical studies on Archean granitoids from the Ntem complex published but, none of these evidence the presence of barium-titanium bearing phlogopite in the rock formations (Nedelec, 1989; Toteu et al., 1994; Tchameni et al., 2000; Shang et al., 2004a,b and 2007; Pouclet et al., 2007). Otherwise, none of these works have been reported from Memve'ele granitoids precisely. Igneous phlogopites cover a wide range of crystallization conditions and reacts very sensitively to changes in the physico-chemical conditions such as oxygen and water fugacities,

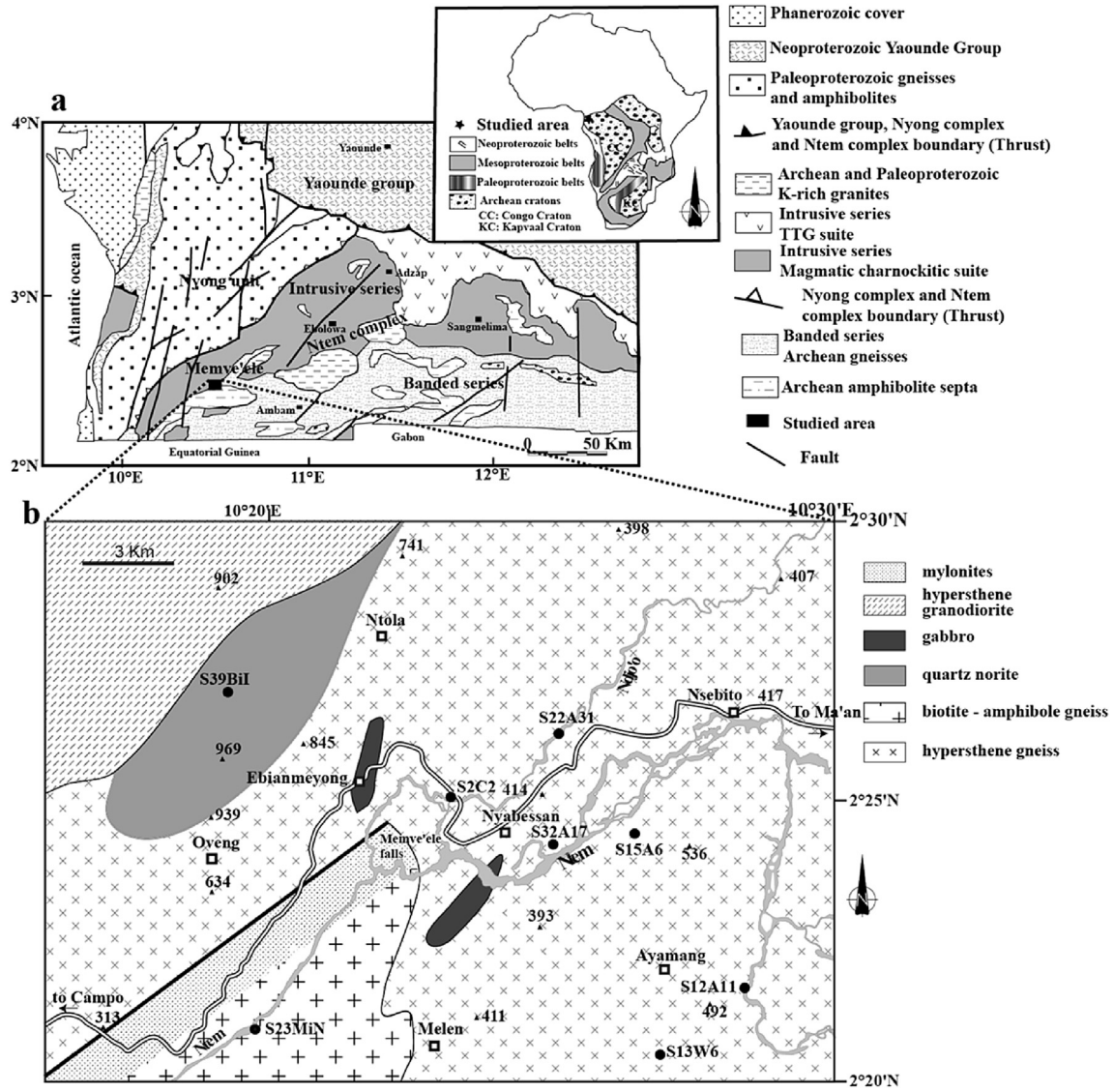

Fig. 1. a-Simplified geological map of the Ntem Complex Southern Cameroon (modified after Pouclet et al., 2007); b- Simplified geological map of the study area (modified from Champetier de Ribes and Reyre, 1959) showing visited sites.