New $^{207}\text{Pb}/^{206}\text{Pb}$-Zr minimum evaporation, metamorphic $^{87}\text{Rb}/^{86}\text{Sr}$-WR-Bt ages and tectonic imprints in the Archean So’o Group (Ntem Complex/Congo Craton, SW Cameroon)

S. OWONA, J. M. ONDOA, M. TCHOMIROWA, L. RATSCHBACHER, F. M. TCHOUA AND G. E. EKODECK

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ABSTRACT

New ages were obtained from charnockites and tonalites collected in the So’o Group in the Ntem Complex. The rocks were analyzed for their petrography, tectonics and $^{207}\text{Pb}/^{206}\text{Pb}$ zircon minimum ages of their zircons as well as metamorphic $^{87}\text{Rb}/^{86}\text{Sr}$ isochron ages. The charnockites yielded zircon ages with a mean value of 2739±18 Ma interpreted as their intrusion age. This age is in agreement with previously published zircon Archean ages of charnockites and TTG from the NC. The So’o Group has been subjected to the D$_1$ N-S compression emplacing the S$_1$ sub-vertical foliation and L$_1$ lineation, followed by a D$_2$ E-W compression. The D$_2$ induced subgrain reduction, area reduction feldspar and quartz dynamic recrystallization, N-S large-scale F$_2$ folds and an “Archean nappe” on a large-scale. The charnockites and tonalites metamorphic $^{87}\text{Rb}/^{86}\text{Sr}$ ages were significantly younger than the Archean $^{207}\text{Pb}/^{206}\text{Pb}$ zircon ages, showing that they were overprinted by later processes. Metamorphic $^{87}\text{Rb}/^{86}\text{Sr}$ isochron ages of charnockites and tonalites differ. The older age of 1969±170 Ma, which corresponds to the Eburnean orogeny (2400~1800 Ma) was obtained in charnockites located near the Nyong Complex emplaced during the Congo-Sào Francisco craton collision. The younger $^{87}\text{Rb}/^{86}\text{Sr}$ isochron age of 1129±13 Ma, determined in tonalites located close to the border of the Yaounde Group represents the Kibarian/Greevalian orogeny. Both $^{87}\text{Rb}/^{86}\text{Sr}$ isochron ages are assigned to the Eburnean and Kibarian/Greevalian cooling ages respectively.

KEY WORDS: Archean, Eburnean, Kibarian/Greevalian, Ntem complex, Cameroon

1. INTRODUCTION

The Ntem Complex (NC) is the Cameroon part of the NW Congo Craton (CC, Fig. 1; Chaptetier de Ribles and Aubagne, 1956; Maurizot et al., 1986; Trompette, 1994; Feybesse et al., 1998). It consists of charnockite, monzogranite, syenogranite, tonalite, trondhjemite, granodiorite (TTG), syenite and band iron formation (BIF), greenstone-belt type, migmatite and granulitic gneiss. The TTG are differentiated into charnockitic, granodioritic, and tonalitic suites (Fig. 2; Nédélec et al., 1990; Nsifa and Riou, 1990; Tchameni, 1997; Shang, 2001) that intruded according to concordant U/Pb zircon dating between 3.3 and 2.7 Ga (Caen-Vachette, 1988; Toteu et al., 1994b; Tchameni et al., 2000; Tchameni et al., 2001; Shang et al., 2004a, b, 2010). In the studied So’o Group, rocks are constituted of charnockite, monzogranite, syenogranite, TTG, syenite and BIF. Their geochemistry has been widely described. It suggests subduction as the main tectonic model (Nédélec et al., 1990; Tchameni et al., 2000; Tchameni et al., 2001; Shang et al., 2001b; 2004a, b, Shang et al., 2006). As the NC and the whole NW Congo craton, the So’o Group was also subjected to two main phases of metamorphism including the gneissification episode (e.g. Haute Noya and Mitizic-Oyem gneiss in the Mont de Cristal Complex in Gabon (Caen-Vachette et al., 1988) as well as Ebolowa gneiss in the NC (Lasserre and Soba, 1976a recalculated in Caen-Vachette et al., 1988)) and the charnockitization (Caen-Vachette et al., 1988; Toteu et al., 1994b; Tchameni, 1997). Despite their stability, these rocks were affected by ductile and brittle deformations (D$_3$). The D$_1$ deformation was described as a non-rotational, showed hypersolidus textures and S$_1$ foliation (Nsifa et al., 1993; Feybesse et al., 1998). The D$_2$ deformation known as a coaxial tectonics is underlined by the S$_2$ foliation F$_2$ folds and C$_2$ sinistral shear planes (Owona, 2008; Owona et al., 2011b). The sub-vertical S$_2$ foliation was observed in the relict greenstones belts and TTG series while sinistral C$_2$ shear planes trend N-S to N45E - N50E was associated with a partial melting of the TTG and greenstone belts country rocks (Tchameni, 1997; Feybesse et al., 1998; Shang, 2001; Shang et al., 2004a, b; Owona, 2008; Owona et al., 2011b). D$_3$D$_4$ showed transparent tectonics in the NC (Tchameni et al., 2001), represented by several C$_3$ mylonitic and shear corridors (Shang et al., 2004a). While the petrography, geochemistry of charnockites and TTG main rock types have been characterized (Tchameni, 1997; Shang, 2001; Shang et al., 2004a, b; Owona, 2008), the mineralogy and associated pressure-temperature-deformation-age (P-T-d-t) conditions are still poorly described. The present study aims at highlighting the 1/50.000 geological map of the So’o Group (the available ones have scales ranging from 1:1.000.000 to 1:500.000), new discussions on its petrography, tectonic imprints and geochronology in a regional geodynamic context.
2. Methods
Lithological types were surveyed, studied in outcrops, hand sample and in thin sections. The major structural elements as the foliations, lineations, axial planes, fold axes, shear planes and faults were indentified. The \( S_n \) foliations include as possible the \( S_0 \) bedding, lithological and metamorphic \( S_n \) layering. The \( L_n \) lineations include the stretching and mineral types. The \( F_n \) folds studied are cartographic. The faults were measured through their strikes, dips and associated slickensides. The pole of the \( S_n \) foliation, the \( L_n \) lineations, the \( S_{n+1} \) axial planes and \( A_{n+1} \) fold axes as reference directions were plotted in an equal area of the lower hemisphere in the SPHESISTAT stereographic projection. (See the Stesky R.M., Sperhistat User's Manual, Pangaea Scientific, Brockville, Ontario, Canada). Planar structures are in the Dip/Dip-direction e.g. 45/273 and linear structures in the Dip-direction/Dip e.g. 273/45 forms. For fault slip analysis, we calculated the orientation of principal stress axes and the reduced stress tensors (e.g., Angelier, 1984) with the computer Turbo Pascal program packages of Sperner et al. (1993) and Sperner and Ratschbacher (1994). (See Appendix B for details in Ratschbacher et al. (2003)).

Single zircons from samples of charnockites were analyzed in the Isotopenlabor of the Technische Universität Bergakademie Freiberg in Germany. The analytical technique is an evaporation technique developed by Kober (1987), detailed in Tichomirowa et al. (2001). In this method, a single zircon grain of 125 – 250 µm size mounted on rhenium filaments was "cleaned" for 10 minutes by heating at 1450 °C. This should remove common Lead from cracks and discordant parts of the zircon. Then the zircon grain was evaporated and the Pb transferred to the second filament during a single cycle at 1600 °C. Pb was then ionized at temperatures between 1190 – 1220 °C and, the \( ^{207}\text{Pb} \), \( ^{206}\text{Pb} \) and \( ^{204}\text{Pb} \) isotopes were analysed in a FINNIGAN MAT 262 using dynamic SEM ion counter. Ion beam intensities were measured in 10 blocks of 9
scans. The $^{206}\text{Pb}/^{207}\text{Pb}$ ratios were corrected for (1) common lead derived from the $^{208}\text{Pb}/^{206}\text{Pb}$ ratios, following the two-stage Pb isotope evolution model of Stacey and Kramers (1975) and (2) fractionation and mass-bias of 0.0036 per amu involving of the spectrometer, determined through repeated analyses of zircon standards. The values obtained 1064.9 +/- 2.1 Ma (n=13) were checked by repeated analysis of the zircon standards 91500 and 380.3 +/- 1.9 Ma for the standard S-2-87 (accepted age 381.5 +/- 4.0 Ma) Wenham Monzonite (Geological Survey of United States, Wiedenbeck, 1995). After evaluation of outliers and the corrections mentioned above, a mean ratio of $^{207}\text{Pb}/^{206}\text{Pb}_{\text{corr}}$ was gained from a single zircon measurement (Table 1). Apparent zircon ages were produced by iteration of the two system equations of the decay chains $^{238}\text{U}/^{205}\text{Pb}$ and $^{235}\text{U}/^{207}\text{Pb}$; the error on the single zircon age was calculated as 2 standard errors of the mean (2σ mean), using the mean ratio of $^{207}\text{Pb}/^{206}\text{Pb}_{\text{corr}}$ and the error of the measured ratios (calculation program Isotopengeochemisches Labor der Technische Universität Bergakademie Freiberg/Sachsen). For the age estimation, it is important to obtain reproducible ages by analysis of several zircons from the same sample, because the calculated $^{207}\text{Pb}/^{206}\text{Pb}$ ages are model ages with no information about concordance or the degree of discordance. Given that these ages resulted from high-temperature evaporation with no significant changes in the $^{207}\text{Pb}/^{206}\text{Pb}$ ratios, the data points are concordant or nearly so. In addition, we suggest on a statistical basis that when 5 – 7 zircon ages from one sample fall within a similar range, this should be considered as dating a zircon magmatic crystallization event. The single zircon isotopic data was evaluated by the weighted mean ages; corresponding error from a zircon population has been plotted in a single variable diagram. A weighted mean age calculated (Ludwig, 2001) from this population was determined by this method, and by definition, corresponds to minimum ages. This method has been successfully applied in magmatic, metamorphic and sedimentary terrains and checked with U/Pb ages (Tichomirowa et al., 2001). Analytical results are given in Table 1 and Figure 3a.

For Sr isotope analyses, about 50 mg of whole-rock sample powder was spiked with mixed $^{86}\text{Sr}/^{87}\text{Sr}$ tracers prior to dissolution in HF+HNO$_3$ acid at 120°C, under high pressure in polytetrafluoro-ethylene (PTFE) reaction bombs. Element separation (Rb, Sr) was performed in quartz columns containing a 4ml resin bed of AG 50W-X8, 100–200 mesh, conditioned and equilibrated with 2.5N HCl. For mass spectrometric analyses, Sr and Rb was loaded with phosphoric acid and measured on a single Ta filament. All analyses were performed using a FINNIGAN MAT 262 thermal ionisation mass spectrometer (TIMS) equipped with 8 Faraday cups in a static collection mode. $^{87}\text{Sr}/^{86}\text{Sr}$ ratios were normalized to $^{86}\text{Sr}/^{86}\text{Sr} = 0.1194$ derived for the year 2007. Within the same period, the NBS 987 Sr standard yielded $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of 0.71029. Total procedural blanks (chemistry and loading), were <200pg for Sr and Rb. Least-square regression of Rb/Sr isotopic data with assessment of fit using square regression of Rb/Sr isotopic data with assessment of fit using mean square of weighted deviates (MSWD), were calculated using ISOPLOTO program of Ludwig (2001). All regression errors are quoted at 2σ. Biotite and muscovite samples were separated by their magnetic properties. Analytical results are given in Table 2 and Figure 3b, c.

### Table 1: Pb isotopic data from single grain zircon evaporation for Pb/Pb-Zr ages

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<tr>
<th>Sample</th>
<th>Zircon morphology</th>
<th>Grain</th>
<th>Mass scan</th>
<th>$^{206}\text{Pb}^{207}\text{Pb}$ b</th>
<th>2σ error</th>
<th>$^{206}\text{Pb}^{207}\text{Pb}$ b</th>
<th>2σ error</th>
<th>$^{206}\text{Pb}^{207}\text{Pb}$ b</th>
<th>2σ error</th>
<th>$^{206}\text{Pb}^{207}\text{Pb}$ b</th>
<th>2σ error</th>
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<td>Ow417</td>
<td>Long-prismatic, idiomatic, yellow to pink</td>
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<td>0.001210</td>
<td>0.000016</td>
<td>0.187970</td>
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<th>Sample</th>
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<td>0.001104</td>
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### Table 2: Rb and Sr isotopic data for Rb/Sr isochron ages

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<th>Samples</th>
<th>Rb [ppm]</th>
<th>Sr [ppm]</th>
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<th>$^{87}\text{Rb}/^{86}\text{Sr}$</th>
<th>WR-Bt-</th>
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<td>Ow417 (Chamokite)</td>
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<tr>
<td>WR</td>
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<td>571.0</td>
<td>0.71361</td>
<td>0.285</td>
<td>1969±1</td>
<td>0.7105±0.13</td>
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<td>3.66942</td>
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<td>70 Ma</td>
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<td>Bt-4</td>
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<td>2.35768</td>
<td>57.800</td>
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<tr>
<td>WR</td>
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<td>22.5</td>
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3. RESULTS

a. Petrography

The So'o Group (Fig. 2a) consists of tonalites, charnockites, gneisses and norites (Fig. 2; Nédélec et al., 1990; Tchameni, 1997; Tchameni et al. 2001; Owona, 2008). Only the charnockites (Ow417, GPS 11°27'11'' N and 3°14'22'' E) and tonalites (Ow402 GPS, 11°22'16'' N and 3°09'43''E) were analyzed in this study. Charnockites are pink and isotropic in outcrop while feldspar and quartz could be identified in hand specimen. In thin section, they contain quartz (35-30%), plagioclase (25-30%), hypersthene (20-25%), microcline (5-10%), green amphibole (5%) and biotite (2%). Hypersthene (0.5-1 mm) forms subhedral grains with quartz, biotite and opaque inclusions. The quartz (<0.2 mm) presents undulose and patchy extinction. It shows recrystallized rims including micrometric sub grains forming subgrain rotation (SGR) fabrics (Photo 1a) and inclusions in blasts and subhedral (0.5-1 mm) grains. Plagioclase (An10-15) is represented by subhedral poikiloblasts (1-2 mm). It is altered to epidote. Microcline consists of anhedral blasts (1 mm). It is saussuritized to epidote from its cracks and rims to the core. Feldspars define SGR grains where old magmatic cores are continuously replaced by new grains. Amphibole (0.2-0.5 mm) includes euhedral grains in the matrix. Biotite (0.2 mm) is kinked and surrounds hornblende. Apatite and zircon are inclusions in biotite, pyroxene and plagioclase. Epidote and sericite derived from the transformation of feldspar and calcite, and from amphibole. In general, charnockites are made of two mineral associations including magmatic and blast minerals. Magmatic minerals are represented by Pl+Hyp+Qtz+Bt±Op±Zr±Ap. Blasts are recrystallized Pl+Amp+Bt+Qtz. Ultimate retrogression is represented by Ep±Ca±Ser.

Tonalites are pale-green and isotropic in outcrops and hand sample in which feldspar and quartz are recognizable. Under the microscope, they are constituted of plagioclase (60-65%), quartz (15-20%), plagioclase (5-10%), diopside (5%), biotite (2%) and epidote. Plagioclase (An13-38) is represented by subhedral grains (0.5-1.5 mm) containing zircon and opaque as inclusions. It shows a less pronounced SGR microtexture. Quartz is represented by subhedral and
polycrystalline grains (0.2-1 mm), forming the sub grain area reduction (SGAR) recrystallized fabric with undulose and patchy extinction (Photo 1b). Phlogopite (0.2-0.5 mm) comprises opaque inclusions. Diopside (0.2-1 mm) is represented by subhedral grains transformed into amphibole. Apatite and zircon (0.2-0.5 mm) are euhedral and are present in the matrix. In general, the tonalites define magmatic (Pl+Di+Qtz+Bt±Op±Zr±Ap) and recrystallized (Pl+Amp+Bt+Qtz±Op) fabrics. The ultimate retrogression is represented by Ep±Ca±Ser.

b. Structure
The D₁, D₂, and D₃₋₄ deformation phases affected the NC as well as ductile and brittle episodes (Champetier de Ribes and Aubagne 1956; Maurizot et al. 1986; Tchameni, 1997; Tchameni et al. 2001; Shang 2001; Shang et al. 2004b). D₁ is represented by the S₁ foliation, L₁ lineation and F₁ folds. The S₁ foliation in outcrops is sub-vertical, displayed by the greywackes, BIF, sillimanite-bearing paragneisses and amphibolite layers (Shang et al. 2006). The S₁ foliation is oriented from NNW-SSE to E-W on both sides of the Adzap fault (Fig. 3a). It defines two average values, 62/067 and 42/302, suggesting a regional and large-scale folding. Greywackes, BIF, sillimanite-bearing paragneisses and amphibolite S₂ layers are folded in F₁ folds. The L₁ stretching lineation is oriented SE-NW to W-E (Fig. 3b). L₁ trajectories are locally reoriented W-E in the western side of Adzap fault. It is parallel to secant A₂ fold axis with 353/36 average value. D₂ is represented by meso- and large-scale F₂ folds inferred from S₁ foliation trajectories. These F₂ folds are tight to open sub-N-S synclines suggesting a regional E-W compression. The regional folding is oriented ca 60/085 (Fig. 3a). During D₂, NC rock types recorded dynamic recrystallization (Kurse et al., 2001; Stipp et al., 2002; Passchier and Trouw, 2005) as the bulging (BLG), subgrain rotation (SGR) and subgrain area reduction (SGAR) are similar to Adzap charnockites and Avebe tonalites (Photo 1a, b). The D₃₋₄ is represented by faults defining important valleys and guiding hydrographical patterns (Owona, 2008). Brittle deformation is represented by normal dip-slip faults oriented NNE-SSW, NNW-SSE, WNW-ESE and ENE-WSW generated by a sub- vertical shortening according to the overall principal stress tensor σ₁ and σ₃ accompanied by a sub-E-W extension (Fig. 3b).

c. Geochronology
Table 1, 2, Fig. 4
The single sample dated for the ²⁰⁷Pb/²⁰⁶Pb zircon is Ow417 from Adzap charnockite (Table 1). The selected zircons were long-prismatic with slightly rounded terminations, without core, and with colour ranging from yellow to pink. Six grains without core yielded reproducible Archean ²⁰⁷Pb/²⁰⁶Pb ages between 2762±6.9 Ma and 2722±15.1 Ma, with a weighted mean 2737±5.6 and an isochron mean with total correction of 2739±18 Ma (Fig. 4a). ⁸⁷Rb/⁸⁶Sr isopes were obtained from the whole-rock and biotite separates (Table 2). The analyzed samples were Ow417 from Adzap charnockite and Ow402 from Avebe tonalite. In Ow417, the best fit correlation was determined, combining WR, Bt-3 and Bt-4. They yielded at 1969±170 Ma, MSWD = 2.3, with an initial ⁸⁷Sr/⁸⁶Sr ratio of 0.71 ± 0.13 (Fig. 4b). In Ow402, the best fit correlation was determined, associated with WR, Bt-1-1, Bt-2 and Bt-1-3 and yielded at 1129±13 Ma, MSWD = 0.68, with an initial ⁸⁷Sr/⁸⁶Sr ratio of 0.70227 ± 0.00028 for the Avebe tonalite (Fig. 4c).
4. DISCUSSION

Petrographic studies of tonalite and charnockite provided evidence of the coexistence of magmatic and metamorphic minerals in the So'o Group and NC. The first ones were residual clasts, representing a preserved magmatic flow in minerals while the second were blasts related to Eburnean tectonothermal events known in NyC border (Feybesse et al., 1998; Penayé, 2004; Owona, 2008), Kibarian/Greenvillian or Panafrican close to the CAFB (Nzenti et al., 1988; Mvondo Ondoa et al., 2009; Owona, 2008; Owona et al., 2011b). Clasts such as feldspars, pyroxene, opake, apatite and zircon that form the S1 foliation represent the Archean event E1. The MT-MP blasts as amphiboles occurred during the peak of the amphibolitic Eburnean event dominated by the orthotaxity of pyroxene to amphibole. The LT-LP blasts as biotite, SGR feldspar and SGR-SGAR quartz (Kurse et al., 2001; Stipp et al., 2002; Passchier and Trouw, 2005; Owona, 2008) can be related to the Eburnean cooling phase or the Kibarian/Panafrican events. The saussuritization, sanmelonisation, sericitization and chloritization of minerals can be related to NC uplift and erosion.

The So'o Group like the whole NC, is dominated by the sub-vertical S1 foliation suggesting that their emplacement was related to a sub-horizontal compression D1 (Fig. 3a). The large-scale F2 folds inferred the S1 foliation folding and stereographic analyses support a sub-E-W compression with a sub-N-S transport of the “Archean nappe” as stated by the L1, stretching lineation and A2 fold axis oriented 355±30 (Fig. 2c; Owona, 2008; Owona et al., 2011b). This Group was subjected to a brittle D3 deformation represented by normal dip-slip faults oriented NNESSW, NNW-SSE, WNW-ESE and ENE-WSW under an overall crustal thinning as shown by the vertical σ1 and horizontal σ3 paleostress tensors (Fig. 2d; Owona, 2008; Owona et al., 2011b).

The 207Pb/206Pb zircon age obtained from six grains without core for the Adzap charnockite in the So'o Group yielded reproducible Archean 207Pb/206Pb ages between 2762±6.9 Ma and 2722±15.1 Ma also as the 207Pb/206Pb ages between 2717±9 Ma and 2724±3 Ma (Shang et al., 2010) with an isopleth weighted and corrected mean age of 2739±18 Ma (Fig. 4a). This age is closer and slight older than 2722±2 Ma, interpreted as the minimum estimate of the crystallization age of the Sangmelima high-K granites (Shang et al., 2010). Despite the very limited number, the single age obtained can be interpreted as the minimum estimate of the crystallization age of the Adzap charnockite in the So'o Group; younger than 3016±10 Ma to 2960±10 Ma for Sangmelima charnockite and 2896±7 Ma for Ebolowa charnockite in the NC and interpreted as charnockite protholith emplacement ages (Toteu et al., 1994b; Tchameni, 1997; Tchameni et al., 2000; Tchameni et al., 2001; Shang et al., 2001, 2004b, 2010; Owona, 2008). That youngest Archean age of Adzap charnockite in the So'o Group confirms demonstrated Pb losses in the Sangmelima Group extendable in the whole NC (Shang et al., 2004a; 2010), which suffered minor reactivation during the Eburnean as well as the Panafrican tectono thermal events is represented by the orthotaxity of pyroxene and various dynamic mineral recrystallization stages (Owona, 2008; Owona et al., 2011a).

The 87Rb/86Sr-WR-Bt age from Adzap charnockite dated at 1969±170 Ma within error limits (Fig. 4b) confirms Paleoproterozoic ages previously obtained from the Sangmelima charnockite (87Rb/86Sr-WR-Bt, 2299±22 Ma to 1997±19 Ma, Shang et al., 2004a), and the Ebolowa syenite (87Rb/86Sr-WR-Bt, 2349±1 Ma to 2321±1 Ma, Tchameni et al., 2001) in NC as well as the Makoukou and Kinguele pegmatites from the Mont de cristal complex in Gabon (87Rb/86Sr-WR-Bt, 2284±39 Ma to 1930±39 Ma, Caen Vachette et al., 1988). It represents the cooling period of the Eburnean (2400-1800 Ma) tectono thermal event that slightly affected the NC (Feybesse et al., 1998; Shang et al., 2004a; Owona, 2008). The 87Rb/86Sr-WR-Bt age in the Avebe tonalite recorded for the first time in the NC that yielded at 1129±13 Ma can be assigned to the Kibarian/Greenvillian tectono thermal event (Fig. 4c). Considering the good MSWD value of that new age, it can be interpreted as the Kibarian/Greenvillian orogeny cooling period in the NC. The Kibarian/Greenvillian intermediate between the Eburnean and Panafrican tectono thermal events has certainly contributed to the NC reactivations and above Pb loses too. This orogeny already mentioned in the SW Cameroon (Feybesse et al., 1987), needs to be confirmed by further occurrences.
as in Sierra Leone (West Africa) dated at ca. 1349 Ma (207Rb/206Sr, Rollinson and Cliff, 1982 in Caen-Vachette et al., 1988; Bertrand et al., 1987).

5. CONCLUSION

The petrography of the charnockites and tonalities from the So'o Group in the NC has revealed their clast and blast minerals constitution. The 207Pb/206Pb evaporation zircon age obtained in Adzap charnockites from the So'o Group yielded 2739±18 Ma confirms its Archean age and Pb losses during the NC Eburnean, Kibarian/Greenvalvian and Panafriarian reactivation, in agreement with previously published results. The Eburnean orogeny is represented by the orusalitization of pyroxene, the foldspar and quartz blasts dynamic recrystallizations. This orogeny yielded with 87Rb/86Sr-WR-Bt method at 1969±170 Ma in Adzap charnockites, interpreted as the Eburnean cooling age. The 87Rb/86Sr-WR-Bt has yielded at 11294±13 Ma in Avebe tonalites, new in the So'o Group and NC, interpreted as the Kibarian/Greenvalvian cooling time. The So'o Group involved in D1, N-S compression emplacing the subvertical S1 foliation and L1 lineation. It experienced a D2 E-W compression during the second E2 tectonothermal event inducing SGR, SGAR feldspar and quartz, N-S large-scale F2 folds and an “Archean nappe”. The So'o Group and NC were affected at least by the brittle tectonic stage under an overall vertical shortening and sub-E-W horizontal extension. The final exhumation and erosion stage induced the damouritization, sericitation of feldspar and the chloritization of biotite in the NC.

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6. Table captions

Table 1: Pb isotopic data from single grain zircon evaporation for Pb/Pb ages
Table 2: Rb and Sr isotopic data for Rb/Sr isochron ages

7. Figure captions

Fig. 1: (a) Geological sketch of the west-central Africa and South America connexion with cratonic masses and the Pan-African province of the Pan-Gondwana belt in a Pangea reconstruction modified from Castaing et al. (1994) and Ngako et al. (2003). CMR: Cameroon; CAR: Central African Republic; EG: Equatorial Guinea; CAFB: Central African Fold Belt; CCSZ: Central Cameroon Shear Zone; SF: Sanaga Fault. Blooded outline roughly marks the political boundary of Cameroon. (b) Southern Cameroon geological map (Modified after Champetier de Ribes et Aubagne, 1956; Nгnotué et al., 2000; Ngako et al., 2003; Penayé et al., 2004; Nzenti et al., 2006; Toute et al., 2006b; Thakounté et al., 2007); NC: Ntem complex; NyC: Nyong Complex; SG: Sanaga Group; YG: Yaounde Group; DG: Dja Group; YoG: Yokadouma Group; SOG: Sembe-Ouesso Group. The location of study area (Fig. 2) is shown.

Fig. 2: The So'o Group sketch of lithology and faults showing the crustal shortening.

Fig. 3: The So'o Group (Ntem Complex) thematic sketches. (a) The sketch of foliation and its regional folding. (b) The sketch of lineation displaying its main SSE-NNW strike. NyC: Nyong Complex; OC: Oubanguide Complex. Poles of foliations Sn and axial planes An, are plotted in equal area lower hemisphere that displays great circle of large scale folds Fn (Owona, 2008).

Fig. 4: The So'o Group new ages (Owona, 2008): (a) The 207Pb/206Pb zircons age and (b, c) 87Rb/86Sr isochron ages. a) sample Ow417 (Adzap charnockite) and c) sample Ow402 (Avebe tonalite).

8. Photo caption

Photo 1: The charnockites and tonalites granoblastic texture in XZ sections. Note the SGR quartz in Adzap charnockite (Ow417) with undulose extinction and SGR type-1 to -2 SGR feldspars. b) The complete recrystallization of old quartz1 in SGAR quartz2 grains in Avebe tonalite Ow402 (Owona, 2008).

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