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Restraining bends in high temperature shear zones: The "Central Cameroon Shear Zone", Central Africa

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A B S T R A C T

A detailed structural study of the Central Cameroon Shear Zone (CCSZ) segment, in the Bamoun plateau (BP) and the Tikar plain (TP) (West Cameroon), reveals a complex strain geometry of this shear zone. It shows thick mylonite bands wrapping around lenses of various country rock types, at small, medium and large scales. The mylonite foliation trends N40°E in the Tikar plain, and progressively curves into a N60°E to N70°E direction, to the NE and SW, defining a large scale S-type bend at the transition zone between two en-echelon segments, known as the Foumban and Central Cameroon Shear Zones (CCSZ). The structural, kinematic and metamorphic features of the Tikar mylonites characterize a restraining bend formed at a deep crustal level during a major dextral shear deformation. Its geometry suggests that the western extension of the CCSZ including its Brasiliano southernmost pre-drift counterpart form a left lateral stepping (en-echelon) shear zone system.

1. Introduction

Large scale shear zones usually show bends or stair-stepping geometry. Most often, these structures are associated to offsets where two en-echelon shear zones overlap (Sylvester, 1988; Woodcock and Fischer, 1986). They outline particular structures such as reverse or normal faults, resulting in the formation of nappes or troughs, due to oblique convergence (restraining offsets) or divergence (releasing offsets) of lateral moving blocks. The kinematics of these zones depends on geometrical relationships between sense of stepping and lateral displacement along the overlapping shear zones; accordingly, the corresponding structures are usually outlined by typical geomorphologic units, such as highlands or depressions that characterize local thickening or thinning of the crust. The origin and evolution of these large scale systems do not simply involve classical stress and strain models (Berthé et al., 1979; Brun and Choukroune, 1981), but also and mostly account for the existence of imposed structural boundaries due to regional mechanical heterogeneities, which generally explain the kinematics and strain variability along major shear zones (Woodcock and Fischer, 1986). The Central Cameroon Shear Zone (Fig. 1) represents a Pan-African post-collisional ductile fault (Ngako et al., 1991, 2003; Toteu et al., 2004), and a trans-continental structure marked by bends, parallel or en-echelon relays actually most documented in the NE Brazil (Corsini et al., 1996; Neves and Mariano, 1999; Neves et al., 2000). In this paper, we provide a detailed structural and kinematic study of a Pan-African deep-seated bend and discuss possible geometric links with the Brasiliano potential counterpart.

2. Regional setting

The "Central Cameroon Shear Zone" (CCSZ, Ngako et al., 1991, 2003; Fig. 1), locally designated as the "Ngaoundéré", "Foumban" or "Adamawa" faults or lineaments (Browne and Fairhead, 1983; Koch, 1953a), corresponds to the SW extension of the Central African Shear Zone (Fairhead, 1988) which is outlined by a broad mylonite belt directed N70°E, and extending from Cameroon to Sudan (Cornachia and Dars, 1983; Koch, 1953b). Most pre-drift reconstructions correlate the CCSZ with the Brasiliano ductile faults (Bertrand and Jardim de Sà, 1990; Castaing et al., 1994; Davison et al., 1995; Neves et al., 2004), mainly the Patos Shear Zone in NE Brazil as illustrated (Fig. 1a) in pre-Mesozoic reconstructions (Caby, 1989; Souza et al., 2006). Indeed, Neves and Mariano (1999) demonstrated that the Pernambuco lineament, traditionally proposed to continue into West Africa as the Sanaga or Adamawa faults, is not a trans-continental structure, its tectonic role during the Brasiliano event being secondary.

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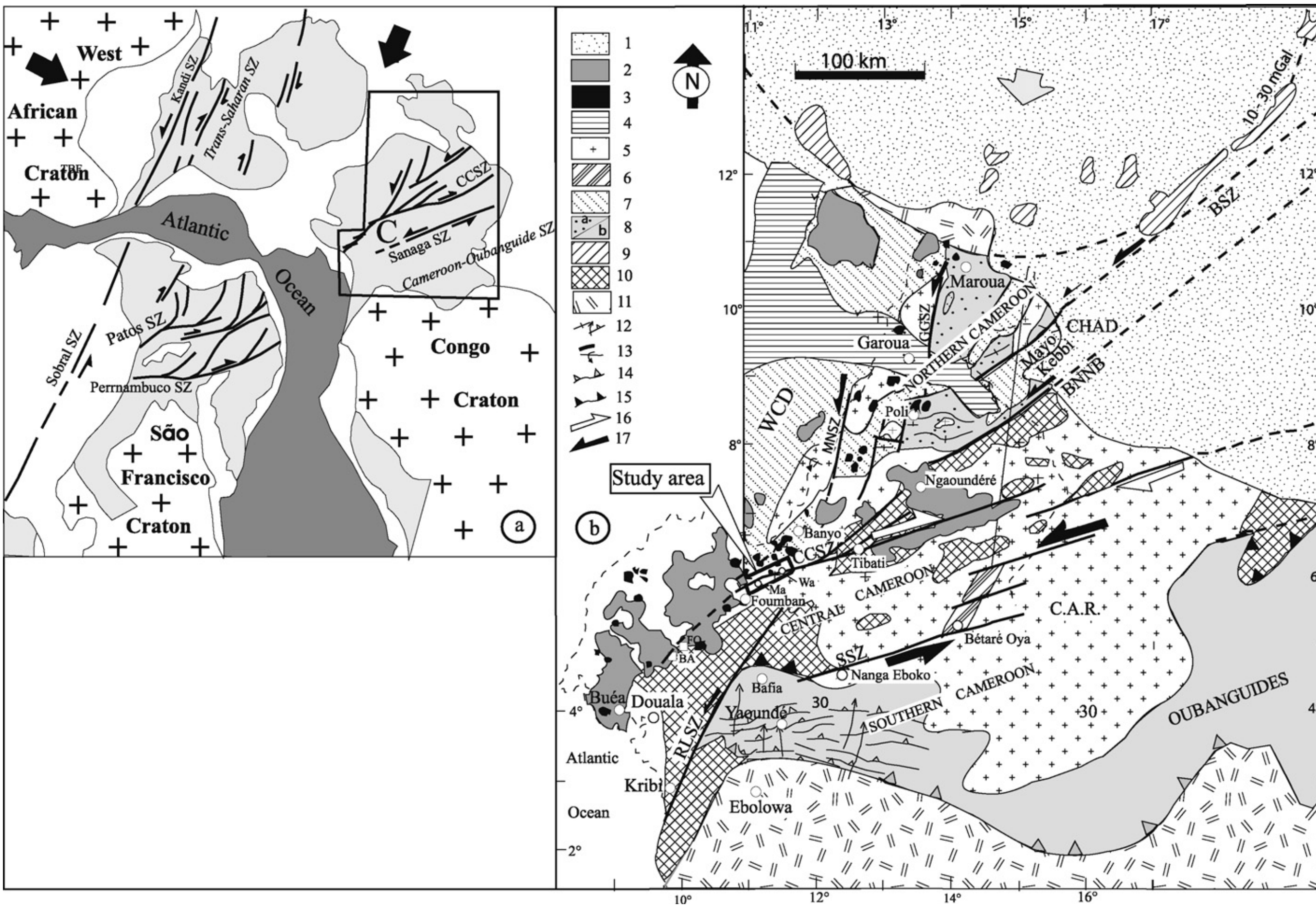

Fig. 1. (a) Pan-African shear zone network in a pre-Mesozoic reconstruction (after caby 1989, modified). SZ = Shear Zone; C = Cameroon area. (b) Pan-African structural map of Cameroon and location of the study area (modified from Toteu et al., 2001). 1: Quaternary sediments; 2: Cameroon Line volcanism; 3: Cameroon Line plutonism; 4: Mesozoic sediments (Benue Trough); 5: Late syntectonic subalkaline granitoids; 6: Lom syntectonic basin (meta-sediments, conglomerates, volcanic ashes and lavas); 7: Western Cameroon Domain (WCD; early syntectonic basic to intermediate calc-alkaline intrusions, 660–600 Ma); 8a: Poli Group (active margin Neoproterozoic supracrustal and juvenile intrusions) 8b: Yaoundé Group (intracratonic deposits); 9: Massenya-Ounianga gravity highs (10–30 mGal); 10: Adamawa-Yadé and Nyong Paleoproterozoic remnants; 11: Craton and inferred craton; 12: S_2 foliation and L_2 lineation trends; 13: F_2 upright and overturned antiforms; 14: *Syn*-D_2 main frontal thrust zone; 15: *Syn*-D_1 thrust zone (separates the LP to MP zone in the North from the HP zone in the South); 16: *Syn*-D_3 sense of shear movement; 17: *Syn*-D_2 sense of shear movement. Large grey arrow represents *syn*-D_{1-3} regional main stress direction. Thick lines = shear zones (SZ): BSZ = Balché SZ; BNMB = Buffle Noir – Mayo Baléo SZ; CCSZ = Central Cameroon SZ; GGSZ = Godé – Gormaya SZ; MNSZ = Mayo Nolti SZ; RLSZ = Rocher du Loup SZ; SSZ = Sanaga SZ. In the study area: Ma = Magba; Wa = Wakaa. Small squares: Ba = Bandja complex; Fo = Fomopéa complex.

The CCSZ displays a complex structural evolution including Pan-African (Ngako et al., 1991, 2003; Toteu et al., 2001), Cretaceous (Ngangom, 1983) and Tertiary tectonic events (Moreau et al., 1987), successively. Indeed, it represents a deep crustal structure (Njonfang et al., 1998) originally interpreted as a transform fault and correlated to the direction of the Pan-African convergent movements in central Africa (Toteu et al., 1991). Most recent studies consider this shear zone as post-collisional (Ngako et al., 2003; Njonfang et al., 2006; Toteu et al., 2004) although still poorly integrated in a global tectonic model. Its evolution may be correlated to the Bandja sinistral shear zones of north-central Cameroon and associated synkinematic intrusions dated at ca 604–580 Ma (U–Pb and Pb–Pb ages by Nguiessi Tchankam et al., 1997; Toteu et al., 1994). However, the relationship between the Bandja magmatic complex (Nguiessi Tchankam et al., 1997) and the CCSZ is still unclear.

The Cretaceous and Tertiary reactivations have been linked to the evolution of the Santonian transform fault inherited from the opening of the South Atlantic Ocean (Sibuet and Mascle, 1978; Sykes, 1978). But, more recently, Ngako et al. (2006) suggested that Post Pan-African reactivations in central-north Africa originated from a lasting tectonic process involving complex interaction between hotpots and Precambrian faults during the northward migration of the African plate between Ordovician and Tertiary.

3. Geology of the study area

The study area is represented by a N40°E directed band, of about 24 km width Pan-African granitoids, trending northeastwards from the Bamoun plateau (mean altitude = 1200 m) to the Tikar plain (mean altitude = 700 m) (Figs. 1b and 2). Its southwestern extension is partly masked by Tertiary to Recent volcanic outflows and pyroclastic deposits.

The morphology of the study area is marked by (i) a series of hills aligned and elongated SW–NE, that are parallel to the well known Cameroon Line (e.g. Moreau et al., 1987); (ii) and two secondary mountains ranges trending SW–NE up to Magba and N70°E from Bandam to Nyakong (Fig. 2). The hills are more or less covered by drift boulders of various sizes at their summits and on their flanks; flagstones are mostly observed in the valleys and along the river beds. Rocks are mostly porphyritic to medium-grained granites and orthogneisses more or less mylonitized (Figs. 3–6).