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Detrital zircon ages and Nd isotope compositions of the Seridó and Lavras da Mangabeira basins (Borborema Province, NE Brazil): Evidence for exhumation and recycling associated with a major shift in sedimentary provenance

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ABSTRACT

U–Pb ages of detrital zircons and neodymium (Nd) isotope compositions from two Neoproterozoic schist belts (Seridó and Lavras da Mangabeira) in the Borborema Province (NE Brazil) indicate a significant change of sediment provenance during the deposition of sands and conglomerates and the overlying graywacke-pelite sequences. The shift in provenance defines an unconformity in the Seridó Group characterized by a metadiamictite horizon that contains pebbles and cobbles of the Paleoproterozoic to Archean basement and recycled quartzites of the underlying Equador Formation. In Lavras da Mangabeira basin the change in provenance is defined by a cryptic internal disconformity that is characterized, as in the Seridó basin, by a time gap of c. 1.0 Ga in the age of the detrital zircons. Nd compositions across these unconformities indicate that the pelites are very radiogenic ($\varepsilon Nd_{present\text{-}day} = -4$ to -11) compared with the sandy deposits ($\varepsilon Nd_{present\text{-}day} = -22$ to -31). The provenance of the metapelites at the top of the metasedimentary succession includes a prominent population of Cryogenian zircons with the youngest grains dated to between 0.64 and 0.62 Ga. These zircons were deposited in a basin developed on continental basement that preserves remnants of near-shore to terrestrial deposits with no detrital zircons younger than 1.8 Ga. This unconformity defines a useful stratigraphic horizon to correlate with other metasedimentary successions preserved in the Borborema Province. In the Seridó belt the unconformity documents the uplift of the orogenic hinterland, possibly during the continental collision, which preceded the deposition of the deep-water pelites.

1. Introduction

Zircon is a highly refractory mineral that is common in many sedimentary rocks. It can survive metamorphism and deformational processes and provide age information about the eroded sources of the rocks (Fedo et al., 2003; Gehrels, 2012). Studies of sedimentary provenance using the age spectra of detrital zircons are therefore particularly useful for investigating the origin of incomplete and fragmentary sequences, such as those exposed in deeply eroded orogenic belts. In the Borborema Province (NE Brazil), one of the first applications of zircon provenance studies defined a Neoproterozoic age for the Seridó metapelitic basin (Fig. 1; Van Schmus et al., 2003) and ended a long debate about the timing of its sedimentary infilling (Ebert, 1970; Jardim de Sá et al., 1987, 1995; Bertrand and Jardim de Sá, 1990; Caby et al., 1995; Archanjo and Legrand, 1997). This basin contains an important population of detrital zircons that formed in Cryogenian to Tonian times, which led Van Schmus et al. (2003) to conclude that the deposition of the Seridó sediments ceased just before the onset of the "Brasiliano" metamorphism and deformation. Furthermore, these findings suggest a foreland tectonic setting for the deposition of the Borborema-Nigerian "schist belts" and provide new perspectives in the search for stratigraphic correlations between northeast Brazil and West Africa (Ganade de Araújo et al., 2012; Kalsbeek et al., 2012, 2013).

Recent provenance studies have confirmed that most of the residual (meta)sedimentary sequences that are exposed between the Volta Basin and the northern margin of the Congo-São Francisco craton (Fig. 1) were deposited in the Neoproterozoic (Oliveira et al., 2006; Neves et al., 2009; Van Schmus et al., 2011; Guimarães et al.,

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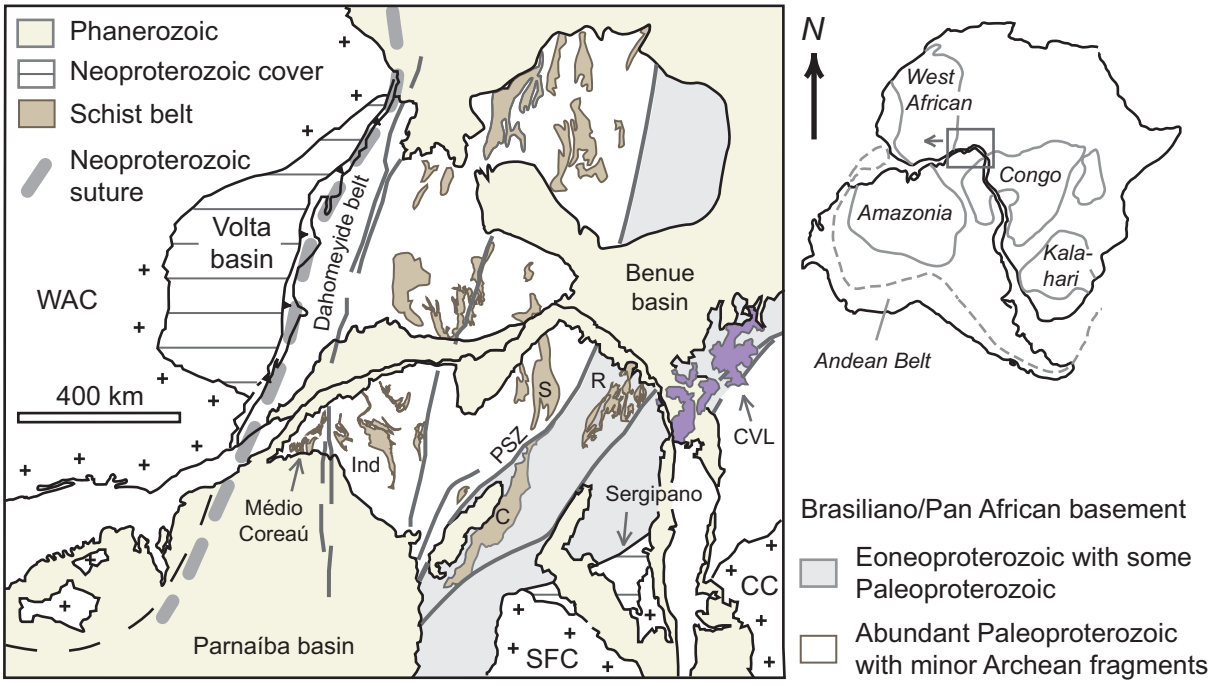

Fig. 1. Geological setting of West Africa and NE Brazil in West Godwana (right), highlighting the distribution of Nigerian and Borborema "schist belts" (Ind, Independência; S, Seridó; C, Cachoeirinha; R, Rio Capibaribe) and major shear zones (PSZ, Patos shear zone). WAC, West African craton, SFC, São Francisco craton, CC, Congo craton. Adapted from Van Schmus et al. (2008) and Ganade de Araújo et al. (2012).

2012; Ganade de Araújo et al., 2012; Kalsbeek et al., 2013; Caxito et al., 2014). However, a close inspection of the zircon age spectra of these units reveals clear differences in their respective provenance patterns. Zircons exclusively from Paleoproterozoic and Archean sources were documented in quartzites of the Benin plain (Kalsbeek et al., 2013) and on its Brazilian counterpart, the São Joaquim Formation of the Médio Coreaú Domain (Ganade de Araújo et al., 2012). Clastic sequences (metasandstones and mica-schists) containing detrital zircons from Mesoproterozoic and Early Neoproterozoic (Tonian) sources, but with no record of younger Cryogenian or Ediacaran zircons, were found in the basal strata of the Volta Basin (Bombouaka Group, Kalsbeek et al., 2013), in the Independência Unit of the Ceará Central (Ganade de Araújo et al., 2012), in the Macururé quartzites of the Sergipano belt (Oliveira et al., 2006), in the Canabravinha Formation at the northwest margin of the São Francisco craton and in the Yaoundé Group at the margin of the Congo craton (not shown in Fig. 1; Kalsbeek et al., 2013; Caxito et al., 2014). Metasedimentary sequences with abundant Cryogenian zircons are present in phyllites of the Cachoeirinha Group (Van Schmus et al., 2011), in mica schists of the Rio Capibaribe domain (Neves et al., 2009) and in phyllites of the Frei Paulo Formation in the Sergipano belt (Oliveira et al., 2006). The peculiar provenance patterns suggest that the deposition of these Neoproterozoic sequences recorded major unconformities in the sedimentary cycle that most likely resulted from a complex evolution of basins in an active margin setting. For instance, a cryptic unconformity has been proposed in the Volta Basin between epicontinental nearshore sand deposits (Bombouaka Group) that contain no zircons younger than c. 900 Ma and the marine flysch-type sediments (Oti Group) that contain abundant Cryogenian zircons (Kalsbeek et al., 2008; Carney et al., 2010). Tectonic processes may also juxtapose metasedimentary sequences with distinct provenances (e.g. Ganade de Araújo et al., 2012; Caxito et al., 2014), which highlights the importance of good stratigraphic control of the samples to test regional correlations.

Our study combines detrital zircon provenance data and whole-rock Sm–Nd crustal residence times (T_{DM} model ages) to explore the significance of an erosional unconformity that was described in the Seridó Group (Caby et al., 1995) but that has not been investigated in previous provenance studies. In Seridó and Lavras da Mangabeira basins, the unconformity is characterized by an abrupt change in sediment provenance and shows evidence of recycling of the basal strata by the overlying deposits. We investigate the unconformity by determining the trends of the detrital zircon ages and the Nd isotope compositions of key sections in which the transition between the strata can be monitored almost continuously.

2. Geological setting

The Seridó and Lavras da Mangabeira basins are dominated by siliciclastic sediments and are displaced apart by the Patos shear zone (Fig. 2). The geological framework of the Seridó belt and the Assaré block, which includes the Lavras da Mangabeira and Caipu pelites, was summarized by Caby et al. (1995).

The Seridó belt comprises pre-Brasiliano basement that consists of variably migmatized gneisses of Paleoproterozoic age with minor remnants of supracrustal units, which are referred as the Caicó Complex. Small Archean fragments included by the dominant Paleoproterozoic basement have been documented in a few places (Van Schmus et al., 2008). The Seridó Group, which lies upon the Caicó Complex, is a thick metasedimentary unit that is composed of the lower Jucurutu Formation and the overlying Equador and Seridó. The Jucurutu Formation consists of calc-silicate gneiss, marble and minor mica schist with subordinate quartzite lenses. In the central Seridó belt the Jucurutu Formation is located beneath metapelites of the Seridó Formation, but to the west along the contact with the basement, it is covered by quartzites of the Equador Formation. The Nd composition of the Jucurutu Formation ranges in εNd_0 (present-day) values from −10.0 to −14.5, and the detrital