Geophysical Research Abstracts
Vol. 19, EGU2017-12356, 2017
EGU General Assembly 2017

Structural and microstructural evolution of fault zones in Cretaceous poorly lithified sandstones of the Rio do Peixe basin, Paraiba, NE Brazil

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In this contribution we describe the structural architecture and microstructural features of fault zones developed in Cretaceous, poorly lithified sandstones of the Rio do Peixe basin, NE Brazil. The Rio do Peixe basin is an E-W-trending, intracontinental half-graben basin developed along the Precambrian Patos shear zone where it is abutted by the Porto Alegre shear zone. The basin formed during rifting between South America and Africa plates and was reactivated and inverted in a strike-slip setting during the Cenozoic. Sediments filling the basin consist of an heterolithic sequence of alternating sandstones, conglomerates, siltstone and clay-rich layers. These lithologies are generally poorly lithified far from the major fault zones. Deformational structures in the basin mostly consist of deformation band-dominated fault zones. Extensional and strike-slip fault zones, clusters of deformation bands, and single deformation bands are commonly well developed in the proximity of the basin-boundary fault systems. All deformation structures are generally in positive relief with respect to the host rocks. Extensional fault zones locally have growth strata in their hangingwall blocks and have displacement generally <10 m. In map view, they are organized in anastomosed segments with high connectivity. They strike E-W to NE-SW, and typically consist of wide fault cores (< 1 m in width) surrounded by up to few-meter wide damage zones. Fault cores are characterized by distributed deformation without pervasive strain localization in narrow shear bands, in which bedding is transposed into foliation imparted by grain preferred orientation. Microstructural observations show negligible cataclasis and dominant non-destructive particulate flow, suggesting that extensional fault zones developed in soft-sediment conditions in a water-saturated environment. Strike-slip fault zones commonly overprint the extensional ones and have displacement values typically lower than about 2 m. They are arranged in conjugate system consisting of NNW-SSE- and WNW-ESE-trending fault zones with left-lateral and right-lateral kinematics, respectively. Compared to extensional fault zones, strike-slip fault zones have narrow fault cores (few cm thick) and up to 2-3 m-thick damage zones. Microstructural observations indicate that cataclasis with pervasive grain size reduction is the dominant deformation mechanisms within the fault core, thus suggesting that late-stage strike-slip faulting occurred when sandstones were partially lithified by diagenetic processes. Alternatively, the change in deformation mechanisms may indicate faulting at greater depth. Structural and microstructural data suggest that fault zones in the Rio do Peixe basin developed in a progression from “ductile” (sensu Rutter, 1986) to more “brittle” deformation during changes from extensional to strike-slip kinematic fields. Such rheological and stress configuration evolution is expected to impact the petrophysical and permeability structure of fault zones in the study area.