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Origin and evolution of phyllosilicate deformation bands in the poorly lithified sandstones of the Rio do Peixe Basin, NE Brazil

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In this work we describe the genetic processes and the microstructural evolution of phylossilicate deformation bands developed in poorly lithified, high porosity sandstones of the Rio do Peixe Basin, Northeast Brazil. The studied deformation bands occur in damage zones of NE-SW and NW-SE transtensional faults that exhibit well developed anastomosed clusters, with a thickness varying from tens of centimeters to $\sim$ 1 meter. The Host rocks are arkosic to lithic arkosic coarse sandstones to fine conglomerate and with less than 1% of clay content in the matrix. Based on (i) field observations, (ii) clay amount in deformation band cores and (iii) clay mineral arrangements in deformation bands cores, we identified two types of phyllosilicate deformation bands: (1) clay smearing deformation bands and (2) phyllosilicate deformation bands formed by clay authigenesis. The former occur only in fault zones that cut across clay-rich layers and are characterized by 45-50% of clay content. Single element chemical analysis indicates that the composition of clay minerals in clay smearing deformation bands is similar to that of clay-rich layers in the host rocks. The dominant deformation mechanism is particulate flow, which produces preferential alignments of grains and clay minerals. Only subordinate cataclasis occurs. Based on microstructural fabrics, three evolutionary stages can be identified for phyllosilicate deformation bands formed by clay authigenesis. The first one is characterized by preferentially cataclasis and weathering of feldspars. Clay concentration is relatively low, reaching 15-20%, with preferential concentration where crushed feldspar abundance is higher. The second stage is characterized by clay migration within deformation bands, to form continuous films with more than 20-25% of clay concentration. In the last stage clay mineral fabric re-organization occurs, forming well a developed S-C foliation. Clay concentration exceeds 35%. Single element chemical analysis indicates that the only external element present in phyllosilicate deformation bands formed by clay authigenesis is iron oxide. This feature suggests formation at very shallow depth, in the vadose zone where fluid flow preferentially occurs by capillarity in deformation band cores. Petrophysical analysis shows that both types of phyllosilicate deformation bands have high sealing potential. Clay smearing deformation bands reduce rock permeability by three orders of magnitude whereas phyllosilicate deformation bands formed by authigenesis causes permeability reduction of about two orders of magnitude with respect to the corresponding host rock.