Folded Slickensides: Flexural Slip Vs. Early Stratum Parallel Failure in Low Temperature Deformation of Sedimentary Sequences

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Deformed sedimentary sequences in fold-and-thrust belts are often decorated with slickensides parallel to bedding. While a layered anisotropy helps in generation of bedding parallel slickensides during flexural slip folding or in flexural slip duplexes [1], flexural slip kinematics is consistent only with opposite sense of slip on adjoining fold limbs. In the western part of Nallamalai fold belt (NFB), south India, arenaceous to argillaceous sequences have profuse bedding parallel slickensides with consistent top-to-west sense of slip. Such slickensides are folded by regional D1 deformation. Unidirectional slip and slickenfibres even over fold hinges are inconsistent with flexural slip mechanism. The combined role of pre-metamorphic water saturation in pelites, dehydration reaction during low-grade metamorphism and enhanced anisotropy in mediating layer parallel failure is examined. Pre-metamorphic mineral composition changes (Eqs. (1) & (2), [2], [3]) in the western NFB are indicated by the presence of mixed-layer muscovite (illite)-chlorite with their (001) planes parallel to bedding laminae.

$$\text{Smectite} + K^{+} + Al^{3+} \rightarrow \text{Illite} + Na^{+} + Ca^{+} + Si^{4+} + Fe^{2+} + Mg^{2+} + H_2O \quad (1)$$

$$\text{Smectite} + nH_2O + Fe^{2+} + Mg^{2+} + Al^{3+} \rightarrow \text{Chlorite} + H_4SiO_4 + Ca^{2+} + 6H^{+} \quad (2)$$

Low-grade metamorphic changes enhance illite crystallinity index (IC), as well as release of water from crystal lattice leading to increasing P_{H2O}. Experimental results and analysis of faults in sedimentary terrain [4] suggest that anisotropy parallel brittle failure in rocks occur when $\sigma 1$ (maximum compression axis) is at a low angle with anisotropy (~25º). In western NFB bedding parallel slip as indicated by slickensides call for early (possibly pre-metamorphic) bedding parallel brittle failure, driven by high P_{H2O} under sub-horizontal E-W maximum compression. This was followed by more distributed ductile deformation regime under low-grade metamorphism (T ~200-300º C), when the layered sequence with slickensides got folded and cleaved under slow strain rate and low differential stress.

Keywords: Low-grade metamorphism; Nallamalai fold belt; slickensides.

References

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