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Analogue sandbox experiments, anisotropy of magnetic susceptibility (AMS) and paleomagnetism

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In this contribution we present results from AMS measurements on samples from analogue models simulating fold-thrust belts. The models are made of 99 % well sorted beach sand, consisting of quartz and feldspar and 1 % magnetite, by volume. The sand is contained within a model space with initial size of 30 cm width, 60 cm length and 2 cm height. Four models with identical setup were deformed by bulk shortening (compression) ranging from 8 % to 33 %. In each model, three different tectonic domains were studied, representing the state of deformation, analogous to the compression experienced by a mountain belt. The hinterland, closest to the "pushing" side of the model (backstop) accommodate the largest deformation where thrust wedges develop. The foreland, being farthest away from the backstop, remains weakly affected by the compression. A transition zone separates these two end-member domains, where deformation is apparent by layer-parallel shortening and thickening, but thrusting is absent (deformation is accommodated by penetrative strain). With progressive shortening (compression), more of the model is deformed and the hinterland gradually expands.

The analyzed AMS closely reflects the deformation in the models, and can be quantitatively used to study the development of model deformation. The initial undeformed fabric is oblate (depositional) and uniform throughout the model, where the k3 axes tightly group as a pole to the bedding/foliation plane. During shortening, the original magnetic fabric becomes gradually overprinted, with a reduction in the degree of anisotropy in the transition zone and development of a triaxial susceptibility ellipsoid. Principal susceptibility axes become more scattered. The degree of anisotropy increases in the hinterland, and the fabric consist of a mix of prolate and oblate susceptibility ellipsoids. The k1 axes obtain a grouping that is parallel to the backstop (i.e. parallel to the strike of the "orogenic wedge"). AMS analysis shows that the shortened layers accommodate certain amount of penetrative strain before they are folded and thrusted. Once folded, the layers do not suffer any further tectonic penetrative strain with further bulk shortening of the model, and the deformation front propagates towards the foreland where it incorporates and deforms additional materials. This occurs because initial tectonic compaction of the model material reaches a limit and the mode of deformation changes from penetrative strain to folding/thrusting; a good analogue for penetrative strain in natural compressional settings.

A wide variety of models can be envisioned for future applications, where it is possible to simulate and test AMS and paleomagnetism in tectonic regimes of compression, extension and strike-slip. Rock and sediment deformation will also affect the paleomagnetic signature, with important consequences for how paleomagnetism is interpreted in different tectonic regimes. By studying the combined AMS and magnetic remanence in analogue sandbox model we may thus gain a better understanding for how remanence and the paleomagnetic signature of rocks develop in tectonic settings, including cases of block rotation and deformation-related overprinting of the paleomagnetic remanence.