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Flow of partially molten lower crust in the CAOB (Central Asian Orogenic Belt) and the Chinese Altai driven by indentation, oroclinal buckling and regional-scale detachment folding - insights from analogue models employing the 2D-3D photogrammetry methods.

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Dynamics of orogenic systems is controlled primarily by the indentation velocity (deformation), heat transfer and rheology of the lithospheric layers. During indentation, significant advective heat redistribution in these accretionary systems takes place within the partially molten weak domains by the Couette flow, Poiseuille flow or Rayleigh-Taylor instability evolution. The most advanced techniques for investigation and prediction of material transfer pathways in the accretionary systems are methods of numerical and analogue modeling.

In our study, we employ the PIV (Particle Image Velocimetry) to trace material transfer within complex analogue models of oroclinal bending and crustal scale detachment folding above a weak anatectic layer. We developed two models that represent the late Paleozoic oroclinal buckling of the Mongol-Okhotsk accretionary system and detachment folding associated with building of the Chandman dome (Mongolia) or the Chinese Altai mountain range. We applied the PIV method and derived dynamical parameters based on the velocity field, such as divergence, velocity components, flow azimuth, strain-rate or vorticity. Results reveal dynamic feedbacks between the ductile flow and topography evolution as well as deformation of ductile lithosphere layers.

Application of divergence theorem to oroclinal buckling models served well for correlation between topography development and mass transport. The oroclinal buckling models displayed development of curvilinear domains that are represented by pop-up and pop-down belts as products of oroclinal amplification. While uplift zones are marked by negative anomalies in field of divergence, positive divergence anomalies correspond to wide and only slightly deformed plateaus with horizontal material transport. Azimuth of velocity field then correspond with regional trends of flow in the horizontal plane which is induced by movement of indenter and locally varied by movement of orocline hinges. Rapid rotation of specific curved and linear segments of belt structures are clearly indicated by the vorticity of the deformation field.

In crustal scale detachment folding experiments, the divergence is used as a
quantifficator for redistribution rate of the molten material alongside the mantle-crust interface as well as for redistribution of melt into the core zones of amplifying folds. Negative anomalies of divergence field represent zones of melt inflow parallel with the fold limbs and accumulation zones beneath hinges of detachment folds. These anomalies are balanced with positive values of divergence field that are situated below the folds in the source layer of partially molten material. Time evolution of divergence is related with amount of melt measured from the side-view photographs of the progressively evolving models. Both parameters, divergence and melt volume, are compared with strain-rate fields and show polyphase dynamics of fold development. This is marked by three following major stages: 1) initial slow amplification of the multilayer and coalescence of melt below the hinge zones, 2) rapid amplification and melt vertical redistribution along the axial zones of the folds, 3) vertical extrusion of the weak hinge domain along steep limbs during further horizontal compression of the locked-up folds.

Our results show distinct advantages and potential the of photogrammetric methods for post-processing of geodynamic and tectonic analogue models.