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Implications of channel flow analogue models for extrusion of the Higher Himalayan Shear Zone with special reference to the out-of-sequence thrusting

Soumyajit Mukherjee, Hemin A. Koyi, Christopher J. Talbot

Abstract

The Higher Himalayan Shear Zone (HHSZ) contains a ductile top-to-N/NE shear zone—the South Tibetan detachment system-lower ($STDS_L$) and an out-of-sequence thrust (OOST) as well as a top-to-N/NE normal shear at its northern boundary and ubiquitously distributed compressional top-to-S/SW shear throughout the shear zone. The OOST that was active between 22 Ma and the Holocene, varies in thickness from 50 m to 6 km and in throw from 1.4 to 20 km. Channel flow analogue models of this structural geology were performed in this work. A Newtonian viscous polymer (PDMS) was pushed through a horizontal channel leading to an inclined channel with parallel and upward-diverging boundaries analogous to the HHSZ and allowed to extrude to the free surface. A top-to-N/NE shear zone equivalent to the $STDS_U$ developed spontaneously. This also indirectly connotes an independent flow confined to the southern part of the HHSZ gave rise to the $STDS_L$. The PDMS originally inside the horizontal channel extruded at a faster rate through the upper part of the inclined channel. The lower boundary of this faster PDMS defined the OOST. The model OOST originated at the corner and reached the vent at positions similar to the natural prototype some time after the channel flow began. The genesis of the OOST seems to be unrelated to any rheologic contrast or climatic effects. Profound variations in the flow parameters along the HHSZ and the extrusive force probably resulted in variations in the timing, location, thickness and slip parameters of the OOST. Variation in pressure gradient within the model horizontal channel, however, could not be matched with the natural prototype. Channel flow alone presumably did not result in southward propagation of deformation in the Himalaya.