Kinematics of Oblique Continental Collision inferred from the fold geometry, Gangpur Terrane, Eastern India

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Outcrop-scale asymmetric folds are frequently used as reliable kinematic indicators [1] whereas large scale folds are seldom used. The Gangpur Terrane (GT) in the eastern Indian Precambrian complex describes a southward-verging regional-scale overturned fold that gently plunges and closes towards east. Taking the Gangpur fold (GF) as an example it is shown that geometry of the regional scale folds can be used to decipher the kinematics of continent-continent collision. Partial melting of the subducted sediments atop the Singhbhum Plate (SP) created a melt-weakened ductile wedge at the top of the downgoing slab [2]. This ductile wedge, being hot, and thus weak and buoyant, began extruding updip as a ductile nappe as stronger cratonic lithosphere of SP began impinging the ductile wedge at crustal depths [3]. The nappe was caught between the converging plates as SP began colliding with the North Indian Plate (NIP) in the west. Using this initial point of collision as the pinning point, the upper plate (NIP) rotated clockwise towards the lower plate [4]. This would have resulted in a channel that began closing eastwards progressively with the clockwise rotation of the upper plate (NIP). The ductile nappe acted as a weak zone between the stronger cratonic lithospheres of the colliding continents. The ductile nappe extruded laterally towards east as the oblique continental collision closed off the channel in the west. Fluid dynamics models indicate that the weaker material experiences Poiseuille flow in a closing channel. A comparison with the easterly closure of the GF reveals that very similar Poiseuille flow might indeed have taken place whereby velocity of flow at the central part of the channel is higher as compared to the sides of the channel. The easterly closure of GF, thus, can be construed as a consequence of the eastward extrusion of GT through a closing channel. The broad easterly plunge of the GF can be thought of as the natural gradient of flow as weaker ductile material would flow towards the unconfined end in a closing channel. It is concluded that SP-NIP collision was accommodated by up-dip extrusion of the GT as a ductile nappe from the mid-crustal depth and strike parallel extrusion towards the unconfined end of the channel. With continued shortening the regional scale fold tightened considerably acquiring isoclinal limbs and overthrusted its foreland towards south. Second order asymmetric folds at the interior of the orogen indicate dextral transpression between colliding continents.

References

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