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Viscous dissipations in simple shear zones- analytical models and a Himalayan example

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An analytical model is presented for shear heating (viscous dissipation) due to simple shear in inclined ductile Newtonian viscous simple shear zones. Considering the presence of an extrusive pressure gradient and a downdip flow due to a component of gravity, the models show that the viscous dissipation is (i) inversely proportional to the thermal conductivity. (ii) When both the boundaries are sheared and a resultant pressure gradient acts, a cubic profile of shear heating across the shear zone is produced. (iii) For a horizontal shear zone with no pressure gradient, and also in inclined shear zones where there is no effective pressure gradient, shear heating is inversely proportional to the viscosity, and is proportional to the square of the total slip rates at the boundaries. (iv) For a purely Poiseuille type flow, no shear heating is produced. (v) Where the boundaries are sheared and the effective pressure gradient is zero, the shear heating profile is parabolic. (vi) In all the cases the shear heating is maximum at the center of the shear zone, and is zero at the boundaries. This remains the same for any type of velocity profiles as described by Mukherjee (Geol Mag, in press). Taking known parameters from the Higher Himalayan Shear Zone along the entire Himalayan chain, it is estimated that the shear heating at the middle of the shear zone could have reached as high as 1200 0C during $\sim$ mid-Miocene Period when crustal channel flow mechanism of extrusion was active in the terrain.