Apparent Temperature Gradient across the Lesser Himalayan Sequence: Raman Spectroscopy on Carbonaceous Material in the Eastern Bhutan Himalaya

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One of the important features of the Himalayan tectonics is the inverted apparent metamorphic field gradient across the Lesser Himalayan Sequence (LHS) and the Greater Himalayan Sequence (GHS). Several conceptual models have been put forward since the recognition of this phenomenon, but field testing of numerical and analytical models is constrained by the ability to precisely determine the peak metamorphic temperature in the LHS. Raman spectroscopy on carbonaceous material (RSCM) provides a means of determining peak metamorphic temperatures in rocks lacking metamorphic assemblages permitting standard thermobarometry. Here we present RSCM data on 16 slates samples collected along a transect across the LHS of eastern Bhutan.

RSCM data yield peak temperatures ranging from ~340 °C at the bottom of the sequence to ~ 510 °C at the top of it. The Shumar thrust, which may be equivalent to the Ramgarh thrust in the central and western Himalaya, separates this apparent temperature gradient in two parts. In the footwall, characterised by dominantly Paleozoic rocks (McQuarrie and others, 2008), the temperatures are nearly constant at ~350 °C. In the hanging wall, which is composed of Paleoproterozoic rocks (McQuarrie and others, 2008), temperatures progressively rise from ~450 °C to ~510 °C from the base (Shumar thrust) to the top (Main Central thrust). In the footwall there is therefore no apparent temperature gradient over a structural distance of ~12 km, whereas in the hanging wall there is an inverted apparent temperature gradient of 7-11 °C/km over a structural distance of ~8 km. Across the Shumar thrust there is thus a temperature jump on the order of 50 or 100 °C depending on the interpretation of the temperature in the highest sample in the footwall. Furthermore, we observe a temperature jump on the order of 140 °C between the highest sample in the LHS to the GHS where the temperatures were determined by standard thermobarometry (Daniel and others, 2003).

Finally, our data are consistent with equivalent data reported in central and western Himalaya (Beyssac and others, 2004; Célérier and others, 2009). However, the estimated thermal gradients are significantly different. We note that there are significant jumps in temperature across the first-order structures, and, therefore, only data between them should be taken into account to construct apparent temperature gradients.

We conclude that temperature distribution in the LHS of eastern Bhutan is compatible with the predictions of geodynamic models of Himalaya applying concepts of channel flow hypothesis (Jamieson and others, 2004) modified by discrete faulting.

References

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