Shortening in the southern Lhasa block during India-Asia collision

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Recently, it has been suggested that shortening deformation in the Lhasa block during the India Asia collision, starting ~45Ma ago, has been minimal (Murphy et al, 1997). Our mapping in the area between Lhasa and Yangbajian in the southern Lhasa block shows that here, to the contrary, there is significant shortening of the Paleocene-Eocene Linzizzong volcanics. Horizontal shortening due to folding and south-directed thrusts in these volcanics amounts to 20+-5%, from a detailed 35km-long section along the Doliung Qu valley through the well-known locality at Maqu, where the unconformity that these volcanics cover is spectacularly exposed, above significantly more strongly folded strata of the late Cretaceous Takena Formation. It is important to emphasise that the Linzizzong volcanics are well-folded and are locally vertical in the section; it simply not true that they are all (nearly) flat-lying as seen at the Maqu unconformity locality. In some reports, it has been suggested that the underlying Takena Formation contains volcanics; we are of the opinion based on our detailed observations that this is also not the case, and that Linzizzong volcanics have been included in the Takena solely because they are significantly dipping.

Age constraints on the time of shortening come from the youngest dated volcanics, about 50Ma (Pan, 1993, Coulon et al, 1986), and the time of opening of the Yangbajian graben and related normal faults that truncate the folds in the Linzizzong volcanics, suggested to be about 11Ma (Harrison et al, 1995). Medial Miocene volcanics near Majiang, dated as 14-15Ma (Pan, 1993, Coulon et al, 1986), are also tilted, but the amount and extent of significant shortening in these rocks is not yet clearly defined. It is perhaps possible that a significant part of the shortening in the southern Lhasa block occurred between 15-11Ma ago; other evidence, of significant and rapid Early Miocene unroofing of the southern Lhasa block associated with the Gangdese Thrust (Copeland et al, 1995; Yin et al, 1994; Pan et al, 1993; Copeland et al, 1987) suggests that the shortening may have been, at least in part, early Miocene (27-15Ma), but not older than this.

As first suggested by England and Searle (1986), limited collisional shortening in the southern Lhasa block, within the area of the Andean-type Gangdese batholith and related Linzizzong volcanics, is consistent with the idea that this would have been the location of already thickened crust from subduction-related processes. However, the dating of exhumation of the southern Lhasa block shows that the simple model of thickening spreading north from the Indus-Zangbo suture cannot be correct since collision must have begun here by 40Ma.

What is still unresolved in most places is how much shortening of India-Asia collisional age occurs in upper crustal strata north of this well-dated section near Lhasa. The occurrence of the 40-50% shortening in the 100km long section through the Eocene strata of the Fenghuoshan in northern Tibet (Chang et al, 1986; Coward et al, 1988), perhaps suggests that the minimal shortening reported by Murphy et al. (1997) may be an anomaly, rather than representative of the Tibetan Plateau.

References


An overview of the paleo-Proterozoic
granitic magmatism in the Kumaun Lesser
Himalaya and the coeval event in the
northern margin of the peninsular shield
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Pre-Himalayan granites represent plutonic episodes
concurrent with the Indian craton in the Himalayan
orogenic belt. The Amritpur Granite Series (AGS) is
one such pre Himalayan Proterozoic granite exposed in
the juxtaposition of the Siwaliks along the Main
Boundary Thrust (MBT) in the Kumaun Lesser
Himalaya.

Field, petrographic and geochemical studies of AGS
suggests that the AGS is a composite body with three
distinct phases i.e. Porphyritic Amritpur Granite (PAG),
Equigranular Amritpur Granite (EGAG) and Amritpur
Porphyry (AP). The AGS shows an intrusive
relationship with the Bhimaltal- Bhowali Formation
(Rawat & Prabha, 1994) and has a thrusted contact with
the Siwaliks. Geochemical studies on the AGS indicate
that all the three phases are cogenetic and owe their
origin to different degrees of melting of source rock. The
AGS is an S-type granite characterized by peraluminous
composition, presence of normative corundum and
A/CNK value (> 1.0). The low Na/K, fractionated REE
pattern and LREE/ HREE ratios (9-14) indicate a pelitic
source (Prabha, 1996). The deviation from parental
composition resulting in a non-linear trend on inter-
element plots are controlled by the subsequent fractional
crystallization of the parental granitic melt.

The AGS has yielded 1880±40 Ma age
(Varadarajan, 1978; Trivedi & Pande, 1993).
Geochemically, they show the syn-collisional regime.
Similar geochemistry and syn-collisional regime has
been observed in the Bundelkhand granitoids exposed to
the south of the AGS in the Bundelkhand massif in the
peninsular shield. The Bundelkhand Granitoid Complex
is known to contain a very few relics of older crust. The
relics of these rocks are also supposed to be present in
the Lesser Himalayan belt, indicating a much wider
extent of the Bundelkhand craton. The Paleoproterozoic
tectonomagmatic evolution of the AGS is similar to the
tectonomagmatic history of the Bundelkhand pluton, the
northern extension of the Indian shield. The
Bundelkhand massif have yielded 2550 Ma (Crawford,
1970), 2402-2246 Ma (Sarkar et al., 1984) ages. Thus
the gneisses and the granitoids in this region represent
Archaean and post-Archaean components respectively.

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Post-thrusting exhumation of the footwall:
Evidence from textural and fluid inclusion
study along the Jakhri shear zone in the
Himachal Himalayan, India
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The Jakhri Shear (Thrust) marks the northern
boundary of the Rampur-Larji window in the Satluj
valley. It has an important consequence on the tectonic-
stratigraphic evolution of the Lesser and Higher
Himalayan zone in the Himachal Himalaya. It represents
an intracrustal thrust with marked post-
thrusting extension in the hanging wall and exhumation of
the footwall. A marked decrease in the effect of thrusting on
the degree of mylonitization and recrystallization has been observed in the quartz mylonite away from
the Jakhri Shear. This has been verified by rock texture,
which suggests decreasing intensity of directional shear
fabric.

The fluid inclusion trails are syngentic to the
thrusting as well as post-thrusting extension
phenomenon. Away from the shear Zone, bulk density of
CO₂-H₂O inclusion increases and NaCl-H₂O inclusion
decreases; however, the density of CO₂ in CO₂-H₂O
inclusion and Wt.% of NaCl in NaCl-H₂O inclusion
increases. This change also suggests the decreasing effect
of the thrusting away from the Jakhri Shear. The fluid
inclusion studies on the quartz mylonite in the thrust-
affected zone suggest peak metamorphic condition in the
lower Green Schist facies during thrusting. The chlorite
is the only metamorphic mineral present in the footwall
also represents the similar PT condition during
thrusting. The isochores of CO₂-H₂O inclusion suggests
-14-15 Km depth of tectonic burial during thrusting.
The isochores of the NaCl-H₂O inclusions in the thrust
zone suggests an isothermal exhumation of the footwall
from a depth of 7-8 Km. These quantitative data
suggest that the Jakhri Shear in the Satluj valley, which
otherwise was considered a local phenomenon, is an
important intracrustal tectonic boundary affecting the
tectonic disposition and evolution of Lesser and Higher
Himalayan zone in the Himachal Himalaya.
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