Morari dome (eastern Ladakh, NW Himalaya). European Journal of Mineralogy, 9, 1073-1083.
Spencer, D.A. (1993) Tectonics of the Higher- and Tethyan Himalaya, Pakistan: Implications of an early collisional, high pressure (eclogite facies) metamorphism to the Himalayan belt. Ph.D. ETH-Zürich, pp 953.
Waters, D.J., Martin, H.N. (1993): Geobarometry in phengite-bearing eclogites. Terra Nova, 5 (abstracts), 410-411.

Shortening in the southern Lhasa block during India-Asia collision

Y. Pan and W.S.F. Kidd

Dept of Earth Sciences, University at Albany, Albany NY 12222, USA, e-mail: wkidd@atmos.albany.edu

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 Linzizong 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 Doilung 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 Linzizong volcanics are well-folded and are locally vertical in the section; it is 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 Linzizong 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 Linzizong 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 Linzizong 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

Chang Chenfa, Chen Nansheng, M.P. Coward, Deng Wangming, J.F. Dewey, A. Gansser, N.B.W. Harris, Jin Chengwei, W.S.F. Kidd, M.R. Leeder, Li Huan, Lin Jinlu, Liu Chengjie, Mei Houjun, P. Molnar, Pan Yun, Pan Yusheng, J.A. Pearce, R.M. Shackleton, A.B. Smith, Sun Yiyin, M. Ward, D.R. Watts, Xu Juntao, Xu Ronghua, Yin Jixiang, Zhang Yuquan, 1986. Preliminary conclusions of the Royal Society and Academia Sinica 1985 Geotraverse of Tibet. *Nature*, 323, 501-507.
Copeland, P., T.M. Harrison, W.S.F. Kidd, Xu Ronghua, and Zhang Yuquan, 1987. Rapid early Miocene acceleration of uplift in the Gangdise belt, Xizang (southern Tibet) and its bearing on accommodation mechanisms of the India-Asia collision. *Earth and Planetary Sci. Lett.*, **86**, 240-252.
Copeland, P., T.M. Harrison, Y. Pan, W.S.F. Kidd, M. Roden, and Y. Zhang, 1995. Thermal evolution of the Gangdese batholith, southern Tibet: a history of episodic unroofing. *Tectonics*, **14**, 223-236.
Coulon, C., H. Maluski, C. Bollinger and S. Wang, 1986. Mesozoic and Cenozoic volcanic rocks from central and southern Tibet: $^{40}Ar/^{39}Ar$ dating, petrological characteristics and geodynamical significance. Earth Planet. Sci. Lett., **79**, 281-302.
Coward, M.P., W.S.F. Kidd, Pan Yun, R.M. Shackleton and Zhang Hu, 1988. The structure of the 1985 Tibet Geotraverse, Lhasa to Golmud. *Phil. Trans. Roy. Soc. London.* **A, 327**, 307-336.
England, P. and M. Searle, 1986. The Cretaceous-Tertiary deformation of the Lhasa Block and its implications for crustal thickening in Tibet. Tectonics, 5, 1-14.
Murphy, M.A., A. Yin, T.M. Harrison, S.B. Durr, Z. Chen, F.J. Ryerson, W.S.F. Kidd, X. Wang, and X. Zhou, 1997. Did the Indo-Asian collision alone create the Tibetan Plateau?, *Geology*, **25**, 719-722.
Pan, Y., 1993. Unroofing and structural evolution of the southern Lhasa Terrane, Tibetan Plateau: implications for the continental collision between India and Asia. Unpublished PhD. dissertation, University at Albany, SUNY, 330 pgs.

Pan, Y., W.S.F. Kidd, T. M. Harrison, and P. Copeland, 1991. $^{40}Ar/^{39}Ar$ thermochronology of Linzizhong volcanics and timing of deformation in Takena Formation, southern Tibet. *EOS, Trans. Amer. Geophys. Union*, 72, 288.

Pan, Y., P. Copeland, M.K. Roden, W.S.F. Kidd, and T.M. Harrison, 1993. Thermal and unroofing history of the Lhasa area, southern Tibet: evidence from apatite fission track thermochronology. *Nucl. Tracks*, 21, 543-554.

Yin, A.,. T M. Harrison, F.J. Ryerson, W. Chen, W.S.F. Kidd, and P Copeland, 1994. Tertiary structural evolution of the Gangdese thrust system, southeastern Tibet. *J. Geophys. Res.*, 99, 18,175-18,201.

Post-thrusting exhumation of the footwall: Evidence from textural and fluid inclusion study along the Jakhri shear zone in the Himachal Himalayan, India

Anand K. Pandey[1], H.K.Sachan[2] & N.S.Virdi[2]

1: Geology Institute, ETH - Zentrum, 8092-Zurich, Switzerland
2: Wadia Institute of Himalayan Geology, Dehra Dun 248001, India

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 syngenetic to the thrusting as well as post-thrusting extension phenomenon. Away from the shear Zone, bulk density of CO_2-H_2O inclusion increases and NaCl-H_2O inclusion decreases; however, the density of CO_2 in CO_2-H_2O inclusion and Wt.% of NaCl in NaCl-H_2O 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 CO_2-H_2O inclusion suggests ~14-15 Km. depth of tectonic burial during thrusting. The isochores of the NaCl-H_2O 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.

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

Prabha Pandey[1] & R. S. Rawat[2]

1: National Geophysical Research Institute, Hyderabad, 500007, India,
e-mail: postmast@csngri.ren.nic in
2: Wadia Institute of Himalayan Geology, Dehra Dun, 248001, India, e-mail: wihg@giasdl01.vsnl.net.in

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 (EAG) and Amritpur Porphyry (AP). The AGS shows an intrusive relationship with the Bhimtal- 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$\pm$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 relicts of older crust. The relicts 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.

Terra Nostra, n. 2, 1999

14th
Himalaya-Karakoram-Tibet
Workshop

Abstract Volume

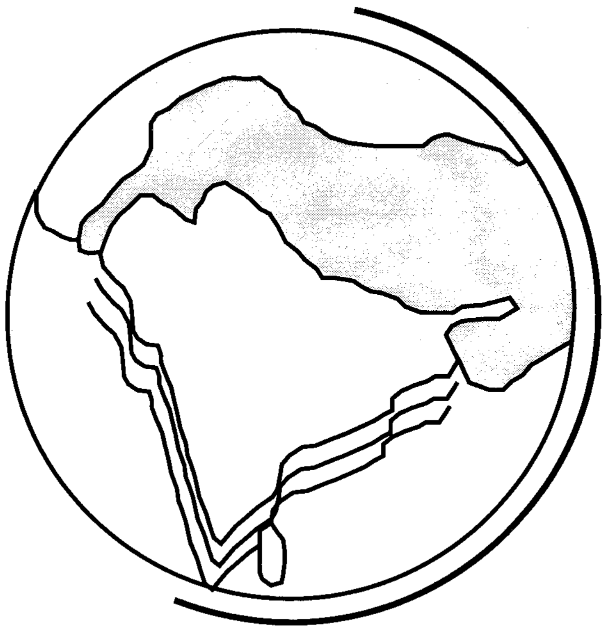
Editors:
Edward Sobel, Erwin Appel, Manfred Strecker,
Lothar Ratschbacher, and Peter Blisniuk

Kloster Ettal, Germany
March 24-26, 1999

TERRA NOSTRA

Schriften der Alfred-Wegener-Stiftung 99 / 2

14th
Himalaya-Karakoram-Tibet
Workshop



Kloster Ettal, Germany
March 24-26, 1999

Organized by the Universities of Potsdam, Tübingen and Würzburg

Universität Potsdam
(Germany)

Eberhard-Karls-Universität
Tübingen (Germany)

Bayerische Julius-Maximilian-Universität
Würzburg (Germany)

Impressum

Terra Nostra, 99/2: 14th Himalaya-Karakoram-Tibet Workshop, Kloster Ettal Germany

Herausgeber:
Alfred-Wegener-Striftung, Weyerstr. 34-40, 50676 Köln
Telefon: 49-(0)221-921 54190, Telefax: 49-(0)221-921 8254

Schriftleitung:
H. Ristedt, Institut für Paläontologie
Nussallee 8, 53115 Bonn
Telefon: 49-(0)228-732935, Telefax: 49-(0)228-733509
e-mail: pal-inst@uni-bonn.de

Verantwortlich:
Edward Sobel
Manfred Strecker
Peter Blisniuk
Institut für Geowissenschaften
Universität Potsdam
Postfach 601553
D-14415 Potsdam, Germany
Telefon: 49-(0)331-977-2047
Fax: 49-(0)331-977-2087
email: ed, strecker, peter@geo.uni-potsdam.de

Erwin Appel
Institut für Geologie und Paläontologie
Abteilung Geophysik
Universität Tübingen
Sigwartstrasse 10
D-72076 Tübingen, Germany
Tel: 49-(0)7071-2974132
Fax: 49-(0)7071-295727
email: erwin.appel@uni-tuebingen.de

Lothar Ratschbacher
Institut für Geologie
Universität Wuerzburg,
Pleicherwall 1
D-97070 Wuerzburg, Germany
Tel: 49-(0)931-312580
Fax: 49-(0)931-57705
email: lothar@geologie.uni-wuerzburg.de

Redaktion und Layout:
Edward Sobel

Druck:
Audiovisuelles Zentrum der Universität Potsdam
Am Neuen Palais 10
14469 Potsdam

ISSN 0946-8978

Selbstverlag der Alfred-Wegener-Stiftung, Köln, (1999)
Printed in Germany