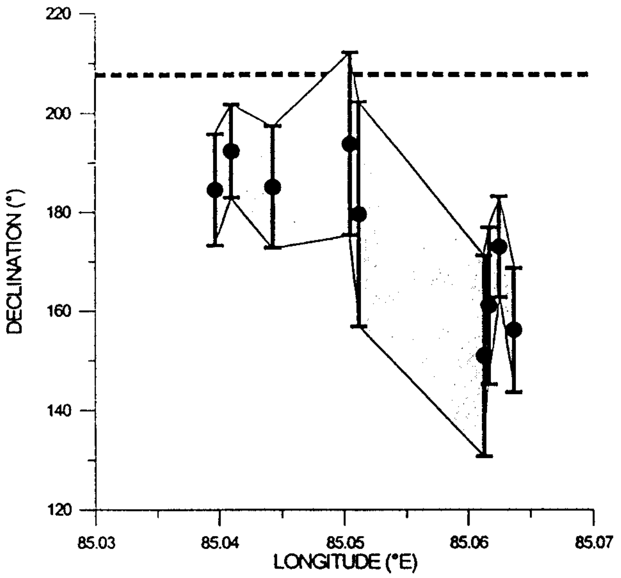

Fig. 2 Variation of the declination values of the magnetite component along a W-E profile of about 2.5 km (error bars: α_{95}-angle, black line: mean declination of the pyrrhotite component, grey strip: $2*\alpha_{95}$-angle).

about 160° to 190° (Fig. 2). The chronological order of remanence acquisition is related to cooling below the blocking temperature. The oldest remanence directions are obtained from the magnetite component most distant from the granite body, becoming younger towards the intrusion. The last record of a palaeofield is carried by the pyrrhotite component. It represents a stage in which temperatures of regional cooling were reached and the contact metamorphism has no more influence. Therefore a uniform remanence direction over the whole profile is obtained. The possibility to order the remanence acquisition relatively in time allows the reconstruction of the deformation path. Cooling rates would give an indication on velocities of rotation.

References

Appel, E., R. Müller, and R.W. Widder, 1991, Palaeomagnetic results from the Tibetan Sedimentary Series of the Manang area (north central Nepal). Geopys. J. Int., v. 104, p. 255-266.

Appel, E., A. Patzelt, and C. Chouker, 1995, Secondary palaeoremanences of Tethyan sediments from the Zanskar Range (NW Himalaya). Geophys. J. Int., v. 122, p. 227-242.

Klootwijk, C.T., P.J. Conaghan, and C.McA. Powell, 1985, The Himalayan Arc: large-scale continental subduction, oroclinal bending, and back-arc spreading. Earth planet. Sci. Lett., v. 75, p. 167-183.

Rochette, P., 1987, Metamorphic control of the magnetic mineralogy of black shales in the Swiss Alps: toward the use of magnetic isogrades. Earth Planet. Sci. Lett., v. 84, p. 446-456.

Early Miocene anatexis identified in the western syntaxis: Southern Nanga Parbat, Pakistan Himalaya

D.A. Schneider[1], M.A. Edwards[2], W.S.F. Kidd[3], P.K. Zeitler[1], C.D. Coath[4]

1: Earth & Environmental Sciences, Lehigh University, Bethlehem, PA 18015 USA, e-mail: dasd@lehigh.edu
2: Department of Geology, Wuerzburg Universtitaet, Wuerzburg, Germany
3: Earth & Atmospheric Sciences, University at Albany, Albany, NY 12222 USA
4: Earth & Space Sciences, UCLA, Los Angeles, CA 90095 USA

Evidence for typical Himalayan Early to Middle Miocene anatexis has remained elusive in the Nanga Parbat massif in the western Himalaya of Pakistan; previous work has identified only young plutonism: 10 Ma in the north to ~1 Ma in the south (e.g., Schneider et al., 1997; Zeitler et al., 1993). New U-Th-Pb data from the Southern Chichi granite, a large leucogranite in southern Nanga Parbat, reveal that crustal melting occurred during the Early Miocene. This indicates that the main belt(s) of Miocene granite that are documented for the main Himalaya (Harrison et al., 1997) continues all the way to the syntaxes. The newly discovered and dated pluton is a largely undeformed, fine-grained leucogranite of several 10's sq km; it intrudes strained marbles and metapelites of the Indian metasedimentary cover sequence adjacent to the Rupal shear, a major shear zone at Nanga Parbat (Edwards et al., 1996). Th-Pb ion microprobe results of monazites from the Chichi granite yield ages between 22 and 16 Ma, with the majority of analyses lying at 19-18 Ma. U-Pb ion microprobe zircon analyses yield ages which fall along a chord with a concordant lower intercept age of 19 Ma. The zircons also contain an ~1860 Ma inherited component showing that the protolith was probably the underlying Proterozoic Indian basement, which is exposed to the north. The older Miocene ages are consistent with typical High Himalayan melting (24-20 Ma). These data indicate that the Early Miocene anatexis that is ubiquitous in central portions of the Himalayan orogen, unreported anywhere in the NW Himalaya, also occurred in the western Himalayan syntaxis, and demonstrates that Nanga Parbat has a protracted melting history. Also dated was a small, little-deformed structurally discordant granite dike within the outer Rupal shear. It yielded monazite ages between 22-9 Ma, where the young ages correlate with high-U concentrations. ^{40}Ar/^{39}Ar biotite ages from adjacent gneisses indicate cooling by 10 Ma, requiring significant displacement on this portion of the Rupal shear to be older than ~10 Ma and possibly as old as ~20 Ma. The extent of this granite dike is unknown but is older then previously reported leucogranite dikes from the northwest margin of the Rupal shear (Schneider et al.,1997). We think it possible that displacement has not occurred concurrently across the entire Rupal shear, but has migrated into the massif as deformation progressed. This is consistent with a general 'inboard' younging of plutonism that we have previously reported for the massif (Schneider et al., 1997). Consistent with our dike crystallization ages and nearby biotite cooling ages, we infer that most of the displacement along the southeast margin of the Rupal shear ceased by 9 Ma and along the northwest margin by 2-3 Ma.

References

Edwards MA, Kidd W, Seeber L, Pêcher A, Le Fort L, Riaz M, Khan MA (1996), An upwardly mobile indentor? The Nanga Parbat-Haramosh Massif viewed as a crustal-scale pop-up structure. EOS Trans 236: 692.

Harrison TM, Lovera OM, Grove M, (1997) New insights into the origin of two contrasting Himalaya granite belts. Geology 25: 899-902.

Schneider D, Zeitler P, Edwards M, Kidd W (1997), Geochronological constraints on the geometry and timing of anatexis and exhumation at Nanga Parbat: A progress report. EOS Trans 237: 312.

Zeitler PK, Chamberlain CP, Smith H (1993), Synchronous anatexis, metamorphism, and rapid denudation at Nanga Parbat, Pakistan Himalaya. Geology 21: 347-350.

Geochronologic summary and lithotectonic architecture of the Nanga Parbat-Haramosh Massif, NW Himalaya

D.A. Schneider[1], M.A. Edwards[2], W.S.F. Kidd[3], P.K. Zeitler[1]

1: Earth & Environmental Sciences, Lehigh University, Bethlehem, PA 18015 USA, e-mail: dasd@lehigh.edu
2: Department of Geology, Wuerzburg Universtitaet, Wuerzburg, Germany
3: Earth & Atmospheric Sciences, University at Albany, Albany, NY 12222 USA

The Nanga Parbat-Haramosh massif (NPHM), most notable for its extremely young metamorphic and igneous ages, represents the most northerly exposure of Indian craton. Reworking of the Indian craton in the last 10 m.y. has been of a large enough scale to apparently fully overprint the Himalayan signature. Previously reported leucogranite crystallization ages for NPHM are markedly younger from those reported elsewhere in the Himalaya. Undeformed leucogranites within the massif show a southward younging of accessory mineral U-(Th)-Pb ages: a 10 Ma pluton in the north, 7 to 5 Ma dikes along the Indus and Astor Valleys, and ~2 to 1 Ma dikes, stringers and larger plutons in the south near the main summit (Zeitler and Chamberlain, 1991; Zeitler et al., 1993; Schneider et al., 1997). To the SE and SW of the summit, leucogranites again increase in age: in the SE, a dike which cross cuts the Rupal shear yields monazite ages from 17-9 Ma as well as the Early Miocene Southern Chichi pluton (Schneider et al., this vol.); to the SW, the much larger, and deformed, Jalhari granite yields monazite ages from 8-2 Ma, and in a separate sample 13 Ma. Thermochronologic results from basement micas are very young and indicate a similar southward-younging pattern, also with a marked age increase to the SE and SW, yielding typical Himalayan cooling ages in those areas.

In the central portions of the massif are found the highest grade rocks and youngest ages. Zeitler et al. (1993) obtained a ~1 Ma zircon U-Pb age for the Tato pluton. Subsequently, for the Mazeno Pass pluton, the opposite (southern) side of the Nanga Parbat summit ridge from the Tato pluton, we (Schneider et al., 1997) obtained strikingly coincident zircon and monazite U-Th-Pb ages of 1.4 Ma. That the 1.4 Ma age is obtained on both zircons and monazites for a larger body of granite illustrates the degree of very young melting.

A number of the granites cross-cut large crustal scale shear zones, hence post-dating the displacement on, and constraining the timing of, the shear zones. Along the NW margin, a small, undeformed tourmaline-bearing granitic dike which cross-cuts the high strain fabric of the MMT yields an age of 7 Ma, requiring that deformation along the MMT ceased by at least that time. This is in agreement with the conclusions of Pêcher and Le Fort (in press) which suggest that ductile deformation ended around 7-6 Ma on the Nanga Parbat-Karakorum suture to the north. Deformation in the north was due to doming and the entire northern section of the massif behaved as a single crustal block (Pêcher and Le Fort, in press).

Along the Rupal shear zone, south of the Nanga Parbat summit, the 2-1 Ma Rupal dikes also provide key timing constraints on structures and fabrics of the Rupal valley; the oldest crystallization age gives the minimum age of deformation. In this case the oldest dike dated in this study gives an age of 2.3 Ma. Thus, cessation of ductile deformation had to occur before 2.3 Ma. Furthermore, dike emplacement was coeval with cooling where the dike ages are similar to the Ar/Ar biotite cooling ages in the valley. This suggests the dikes were emplaced into shallow crustal levels, the melt having possibly migrated along the Rupal shear and into fractures accompanying the general uplift and erosional unroofing. The ages and structural orientation of the Rupal dikes compare well with those of the dikes and stringers on the north side of the summit which give ages between 3 and 1 Ma (Zeitler et al., 1993). These were emplaced, and somewhat deformed, into the Raikot-Lichar shear zone. Furthermore, monazites from two deformed granites along the WNW margin of the massif (at Jalipur and Diamir) yield ages as young as 5-3 Ma. This implies that deformation in southern Nanga Parbat (south of Indus-Astor confluence) has ceased much more recently (4-3 Ma) than the north (Haramosh; 7 Ma), and the southern NPHM, like the north, may have behaved as a single crustal block, bounded to the south by the Rupal and Diamir shear zones.

Crystallization ages on the SE margin of the Rupal valley are significantly older. Both the geochronology of a thin leucogranite dike (mentioned above) which cross-cuts the fabric of the SE Rupal shear in Chichi valley and the thermochronology of the shear zone rocks constrain the age of that portion of the Rupal shear zone

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