orientations as the ductile fabric, are also common. Late strain is often indicated by narrow (metres) zones where hydrothermal flux has developed thick biotite accumulations. Spectacular asymmetric folding (cm-wavelength) of the biotite layers indicates east side up and over west. Th-Pb ion microprobe [UCLA's Cameca IMS1270] analyses of monazites separated from deformed and undeformed portions of the granite give ages ranging from 2-8 and 12 Ma, respectively (Schneider et al., this issue).

Overall, the granite gneiss belt defines a N-S trending, W-vergent, reverse sense shear zone ~5 km in width. We term this the Diamir Shear Zone. The E over W displacement sense of the Diamir Shear Zone is consistent with the development of the Gashit fold, and with the upper limb that includes the overturned cover/MMT layers (again note that here on the NPHM SW flank the massif is again "bulging out" in cross-sectional view). The Diamir shear zone forms the mechanical continuation of the main Raikhot Fault: at Raikhot Bridge, where last seen, the structure is marked by a NW-vergent reverse fault with NPHM in the hanging wall (Madin, 1986; Madin et al., 1989). The Raikhot Fault is much narrower (<<5 km) however, and represents more focused strain.

We interpret the emplacement of the Jalhari granite to be at least partly syn-kinematic with exhumation of NPHM, intruded in discrete episodes between 2 and 12 Ma.

Eastern margin of Diamir Shear Zone and Mazeno Pass section

The geology between the Diamir Shear Zone and the central portions of massif is well exposed in the Diamir and Airl Gah valleys. The zone boundary is marked by brittle deformation within layers/lenses of retrograde (highly chloritised) metapelite. These then pass to more typical basement gneisses (e.g. showing metre-scale layering due to differing Fe-weathering & biotite content). From here to Rupal Valley, structures are more complex. Across Mazeno Pass, the 1.4 Ma pluton (Schneider et al., this volume) shows evidence of some normal motion associated with its emplacement. (top to NW on steep, NW-dipping fabric). Principal gneissic fabric here is N-NE trending. In places this is cut by quartz-pegmatites, and by leucogranite dykes that stem from the Mazeno Pass pluton. Some of the leucogranite dykes cross-cut the quartz-pegmatites, and in both cases, wall rock margins show normal sense of opening, but this may not be significant if (e.g.) the granite remained super-solidus during much of the strain.

Conclusion

In conjunction with our observations of Central and SE NPHM (Edwards et al., this issue), we conclude that the uplift of the NPHM massif is accommodated upon two conjugate shear zones that define a pop-up structure. The RCSZ (on the eastern flank) is the "retro" structure while the Raikhot Diamir system (on the western flank) is the "pro" or "dominant" structure. The overturning (bulging out) of the massif is occurring on both flanks, however this occurs outwith the main shear zone on the eastern flank (away from the centre of the massif); this is consistent with an overall more-diffuse focus of strain in the retro shear zone. We have recognised original "high Himalayan" features in the areas outwith of central NPHM, including (1) the original MMT, and (2) evidence for Early Miocene plutonism that is ubiquitous to the main Himalaya and hitherto unrecognised in the NW Himalaya.

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New map of southern Nanga Parbat

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A new structural and lithologic map (as part of the Nanga Parbat Continental Dynamics Project) has been made for the southern Nanga Parbat area in the Pakistan Himalaya. About 90% of the mapped area was hitherto unreported in recent geological literature, the remaining 10% being covered by preliminary or work.

The portions of the massif where mapping was conducted include: (Clockwise from Mazeno Pass) Diamir, Bunar, Biji and Jalhari Gah area (in the SW), the Astor Gorge and Dichil Gah - including the the two tributaries that intersect the Eastern margin, Rama, Bulan and Ghurikot Gah areas (including the two northern tributaries of Ghurikot Gah), The Lower Rupal Valley (Tarshing Area) and northern Rattu valley, Chichi valley (to the foot of the pass to the Kishanganga) and central and Upper Rupal areas (to the foot of Toshe Gali and up to and over Mazeno Gali).

Three major findings include (1) a major new shear zone, the Rupal-Chichi Shear Zone , (2) the Diamir-Rupal Shear Zone - a significant continuation of the Raikot system for >60 km to the SW, and (3) that the original MMT on the east side has not been signifacantly modified or displaced, only rotated to vertical (for all three see Edwards et al., and Schneider et al., this issue).

The map originally appeared in Edwards (1998).

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The "Marginal Areas" (e.g., Namche Barwa, Nanga Parbat, Tian Shan). Can they tell us anything truly significant about the collision?

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For the purposes of this discussion, regions that are not in the principal regions of the India Asia collision (i.e., Tibet and the Himalaya) are termed the "Marginal Areas". Under the term Marginal Areas are included (e.g.) Namche Barwa, Nanga Parbat, Tian Shan, all of which are being reported on elsewhere in the workshop.

Although the Marginal Areas have much to offer regarding tectonic interest in general, in particular because of the relatively recent nature of much of the tectonic activity, it is by no means clear if the recent accumulation of deformation in any of these areas is a predictable product of the India-Asia collision. Does the present information, and/or will further information significantly enlighten us as to the timing, thermal and mechanical evolution of the converging crust?

There are presently very active tectonics at Nanga Parbat at the western end ("syntaxis") of the Himalayan chain (e.g., 1.4 Ma age of Mazeno Pass leucogranite pluton at Nanga Parbat - Schneider et al., 1999), and also at Namche Bharwa at the eastern end of the Himalayan chain (where cooling ages are also notably young, e.g., Burg, 1998). For Nanga Parbat, there is evidence to suggest that significant exhumation has been only within the last 10 Ma. ~10 Ma is also identified by some as an approximate date for the attainment of a gravitationally unstable thickness of the crust beneath Tibet. Are events at Nanga Parbat related to elevation increase in Tibet?

It has been proposed that there is a significant and predictable partitioning of strain, with arc-parallel extension accumulating at the in the "syntaxial regions" of the straining arc (Seeber & Pecher., 1998). It has been subsequently suggested that fossil Nanga Parbat-type features will be found in ancient collisional belts, and various types of modelling have been presented in which displacement or weakening is concentrated at the tips of the arc (e.g., Koons et al., submitted). On the other hand, it is known that a wide range of features can be generated by modelling using geologically reasonable input.

In the Tian Shan, there is some evidence for significant Late Oligocene exhumation (Hendrix et al., 1994). Modern exhumation rates in the Tian Shan are also high however, and these cannot have continued for the last ~25 m.y. How can these periods of deformation be a predictable or obvious result of the ongoing convergence of India & Asia?

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The Pre -Tertiary metamorphic history of the Nanga Parbat Haramosh Massif, Pakistan Himalaya

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It is often assumed that within active orogenic zones, such as the Himalaya, metamorphic and tectonic fabrics exposed at the surface today relate to the most recent phase of orogenesis. However, for collision-related orogenesis this assumption is only valid for metasedimentary lithologies deposited immediately prior to the most recent event, e.g. sediments deposited on the continental margin of the now-closed ocean basin. The basement rocks on which these sediments were deposited, are almost inevitably polymetamorphic, and tight chronological controls on their thermal and deformation histories are required to avoid erroneous tectonic interpretations. The Nanga Parbat Haramosh

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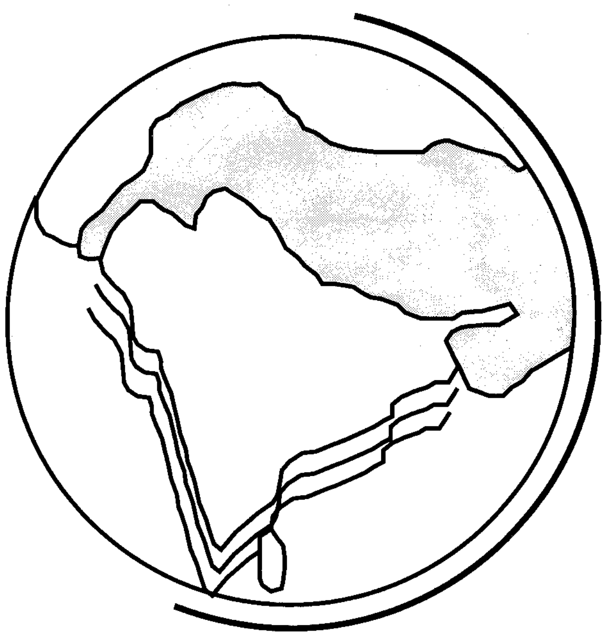

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