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CORRESPONDENCE AND NOTES

More evidence of pre-Himalayan orogenesis in Northern Pakistan

SIRS – The distinction of pre-Himalayan from Himalayan deformation and metamorphic features is obviously an important preliminary stage in any study of Himalayan tectonism. There is an increasingly large body of evidence relating to pre-Himalayan tectonic events in northern India and Pakistan. While agreeing with the findings of Baig, Lawrence & Snee (1988) in the Tanakki village area near Abbottabad in the Hazara district of northern Pakistan, we dispute their implied assertion that this is the only area in the Himalayas in which there is 'clear evidence' of pre-Himalayan deformation.

For example; Pognante & Lombardo (1989) describe a pre-Himalayan metamorphism and fabric forming event in southeast Zanskar in north India; and there is pre-Himalayan metamorphism in many parts of the Indian plate in northern Pakistan. One such area is around Besham in the Swat district, approximately 100 kw NNW of the Tanakki village area, where the northernmost exposed portion of the Indo–Pakistani plate is separated from the overlying Kohistan Arc sequence by a major suture, the Main Mantle Thrust (MMT), (Tahirkheli, 1979; Bard *et al.*, 1980).

Around Besham, a crystalline basement of gneisses, coarse-grained schists and granites, the Besham Group, is overlain unconformably by a fine-grained dominantly pelitic sedimentary sequence, the Karora Group, (Coward *et al.*, 1982, 1986; Fletcher, Leake & Haslam 1986; Treloar *et al.*, 1988), allowing two different deformation events to be recognized. The Karora Group has a polymict basal conglomerate in a psammitic pelite matrix, which is overlain by a sequence beginning with graphitic pelite, followed by psammitic pelite, calc pelite and lastly marbles. The conglomerate occurs in two linear N–S striking outcrops on either side of the main N–S antiformal axis passing through Besham.

After shearing to produce the main fabric, thrust imbrication during the Himalayan deformation has repeated the basement-cover sequence twice. The undeformed cover/basement contact marked by the conglomerate is only present in the first cover slice. This ductile SE to S directed shear is footwall deformation conseqùent to overthrusting of the Kohistan Arc southwards over the Indian plate following Eocene collision of the Indian plate and Asian plate (with its attached Kohistan Arc).

The Besham Group consists of biotitic gneisses and schists, granitic gneisses, metapsammites, blue-quartz pegmatites, weakly deformed hornblende-granodiorite, mylonites and phyllonites. The older gneissic textures and fabrics, with a quartz, feldspar, biotite, garnet and hornblendic-amphibole mineralogy, are overprinted by Himalayan shear fabrics. The intensity of the Himalayan shear varies from pervasive mylonites and phyllonites to areas of anastomosing discrete brittle-ductile shear zones (where the earlier gneissic fabrics are largely unaffected) with a few narrow bands of mylonite. The deformation is most intense in the north immediately below the MMT where there are large thicknesses of quartzo-feldspathic mylonites and blastomylonites (Lawrence & Ghauri, 1983), and decreases further south. The grade of metamorphism also decreases southwards, from garnet grade in the mylonites beneath the MMT to biotite and chlorite grade a few kilometres further south. The metamorphism is not pervasive, however, as the anhydrous gneissic assemblages have resisted change in areas of low strain.

These rocks are intruded by largely undeformed late-orogenic Himalayan granitoids, mostly fine- or medium-grained tourmaline-rich granites. The intrusions are in the form of sheets intruded parallel to the Himalayan fabric, and some small cross-cutting stocks. One of these granites, practically undeformed and fine-grained, cuts the blastomylonites just below the MMT. It must have been intruded late during the Himalayan deformation, (Treloar *et al.*, 1988).

The Karora Group metasediments on the other hand show no gneissic textures or fabrics. They are dominantly folded and crenulated phyllites and phyllitic schists metamorphosed at greenschist to amphibolite facies conditions. Metamorphic mineral growth occurred in hydrous conditions during the SE to S directed shearing that produced the main fabric, and prior to the thrust imbrication.

The basal conglomerate of the cover contains clasts of biotitic gneisses, granitic gneisses, metapsammites, blue slate, plus undeformed blue-quartz pegmatites and hornblende granodiorite. The blue slates are not found outcropping in the area but are very similar in appearance to the Hazara Slates found further south. All the lithologies of the older basement gneisses of the Besham Group occur in the conglomerate. The gneisses of the basement were formed during pre-Himalayan tectonism prior to deposition of the Karora Group which is certainly pre-Himalayan in age. The Karora Group may be of Palaeozoic age.

There are a number of other areas in north Pakistan where a pre-Himalayan deformation can be recognized. In the Hazara District between the Besham and Tanakki areas, the Mansehra granite intrudes metasediments of the Tanawal Formation as massive sheet-like bodies. This coarse-grained two mica granite was dated using Rb–Sr whole rock isotope data by Le Fort, Debon & Sonet (1980), giving a Cambrian age of 516 ± 16 Ma implying that the Tanawal Formation metaquartzites and micaceous metapsammites are probably of Precambrian age. Evidence of pre-Himalayan metamorphism is locally seen near Mansehra where, in the contact aureole of the Mansehra granite, chiastolite and cordierite clearly overprint an older slaty cleavage, (Treloar & Williams, unpublished data).

To the south-west of Besham in the Swat District, Manglaur Crystalline Schists are intruded by the Swat granite which is identical in appearance to the Mansehra granite. These non-calcareous quartzo-feldspathic garnet-mica schists and schistose gneisses show evidence of a previous metamorphism in the form of relict garnet porphyroblasts, and as schist and gneiss xenoliths in undeformed Swat granite, (Kazmi *et al.*, 1984). This deformation must have pre-dated granite intrusion, and is

therefore either late Precambrian or earliest Cambrian in age.

Pre-Himalayan fabrics and associated metamorphic assemblages are characteristic of large parts of the Nanga Parbat syntaxis. Ages of about 1800 Ma have been derived from the syntaxis for the Shengus gneisses (Zartmann in Chamberlain, Jan & Zeitler, 1988), which may date the main metamorphism of the garnet-kyanite bearing sequence. In addition, amphibolite dykes, cut by Himalayan shears clearly post-date the strong regional fabric within the syntaxis. Their relationship, which implies a pre-Himalayan age for the fabric, is clearly seen both in the Indus gorge where it cuts across the syntaxis (Butler, Knipe, Barnicoat & Treloar, unpublished data) and in the Fairy Meadow area south of Raikot (Butler & Prior, 1988).

Thus we can see the effects of pre-Himalayan deformation in five areas in northwest Pakistan. These are the low-grade Hazara slates of the Tanakki village area, chiastolite in aureoles of the Mansehra granite overprinting a slaty cleavage in the Tanawal Formation, the schists and schistose gneisses of the Manglaur Crystalline Schists, the gneisses of the Besham Group, and the gneisses of the Nanga Parbat syntaxis. It is not certain whether the pre-Himalayan deformation is of the same age in each area. Although there is evidence of a 1800 Ma deformation in the Nanga Parbat gneisses, deformation in the Besham and Hazara areas could be of this or later age, possibly as part of the Proterozoic Pan-African event which affected large areas of Gondwanaland. The Mansehra and Swat granites are part of a series of similar intrusions found all along the Himalayan chain which were intruded around 500 Ma ago. They may possibly be late orogenic. To conclude, there is plenty of direct evidence of pre-Himalayan tectonism in northern Pakistan, although not all of it is necessarily part of what Baig, Lawrence & Snee term the 'Hazara orogeny'.

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