Structural and Thermal Constraints on the Tectonic Evolution of the North-Western Margin of the Nanga Parbat-Haramosh Massif (Pakistan)

TALK

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In the Haramosh region of northern Pakistan, the Kohistan island arc is separated from the Indian crust of the Nanga Parbat-Haramosh massif (NPHM) by a 2.5 km-wide, steeply inclined ductile shear zone containing intercalated lithologies derived from both terranes. A combined structural, geochemical and geochronological study across this zone has helped to constrain the thermal and tectonic evolution of the region.

The youngest stage of magmatism within the eastern part of the Kohistan batholith is characterised by biotite granite sheets (Confluence granites) emplaced at 50-30 Ma and younger muscovite granite sheets (Parri granites) at ~26 Ma. These are geochemically distinct, with the Confluence granites comprising a range of granitic compositions with high Sr and Ba abundances and the Parri granites forming granite sheets enriched in Rb. Undeformed granites in both suites have $(^{87}Sr/^{86}Sr)_i$ in the range 0.7045-0.7054 and $\varepsilon_{Nd}(T)$ of +0.1 to +2.7, suggesting that both groups may be derived from juvenile arc sources.

The Kohistan granite sheets can be traced into the shear zone at Sassi, where they are generally intensely deformed and mylonitised, although locally the sheets cross-cut shear fabrics and intrude intercalations of Indian crust material. Whilst none of the sheets appear to have intruded far into the NPHM, these relationships indicate that the Kohistan granite sheets postdate the initial collision of the northern Kohistan terrane with the Indian continent. The isotopic evidence from the undeformed granite sheets suggests that significant underthrusting of northern Kohistan by the Indian continental crust may not have occurred until after 26 Ma. Within the shear zone, deformed granite sheets show a marked increase in $(^{87}Sr/^{86}Sr)_i$ (0.7075-0.7784), with decreased $\varepsilon_{Nd}(T)$ (-13 to -26). These trends are thought to be due to a combination of sub-solidus fluid infiltration and assimilation of crustal material, with fluids or material derived from the adjacent, isotopically evolved NPHM crust.

Structual data were collected from a 24 km-long section along the western margin of the NPHM. The main shear fabrics within the belt are at greenschist grade and rework the earlier amphibolite-grade metamorphic assemblages. Kinematic indicators demonstrate an east-side up

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movement sense, with a strong component of dextral-slip. Since the foliation dips moderately to steeply west, the shear zone has a normal fault geometry, characterised by a north-westerly motion of the Kohistan arc relative to the NPHM.

The timing of movements within the shear zone have been constrained using mica geochronology on deformed lithologies within the zone. Rb-Sr muscovite-WR ages lie in the range 12-28 Ma, and reflect variable post-metamorphic cooling through the 500°C closure temperature. Rb-Sr biotite-WR and biotite-feldspar ages are 11 and 24 Ma, and have locally been reset to 6 Ma, probably during the retrograde shearing within the zone. Interestingly, leucogranites and their metamorphic country-rocks within the adjacent part of the NPHM have Rb-Sr ages of 2.8-7.7 Ma (muscovite) and 1.4-3.4 Ma (biotite), related to recent uplift and leucogranite intrusion within this part of the NPHM. The absence of such young mica ages within the shear zone bordering the Kohistan arc indicates that in the Haramosh area, the major, recent uplift of the NPHM was not accommodated along the western margin of the NPHM, as occurred further south. The disparity in mica ages between the shear zone and the NPHM, and the lack of any consistent age variation within the NPHM, may indicate a relatively passive uplift of this part of the massif.