steeply dipping reverse faults reaching the crust-mantle boundary, the associated crustal root is smaller.Contraction in an orogen is associated with rock and surface uplift and gives rise to the creation of relief. For the thin-skinned style, the orogen typically has a low topographic gradient, whereas the thick-skinned contractional style is likely to cause rapid surface uplift and significant relief in the growing orogen.

91-2 Oral Butler, Robert William Hope

LOCALISATION OF DEFORMATION IN THE CONTINENTAL LITHOSPHERE; EXAMPLES FROM COLLISION BELTS

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Keywords: Continental tectonics; Himalayas; Mountain belts; rheology

The kinematic styles by which the continental lithosphere deforms during convergent tectonics are highly variable on all scales. In some large-scale cases strain is localised onto narrow zones of predominantly simple shear, involving some form of localised weakening process. This could be synkinematic and/or inherited from pre-existing features. In contrast, other deformation zones are broad. In these, strain is distributed and, on a large-scale, can be described as broadly near co-axial vertical stretching. These strains are commonly partitioned preferentially to particular places with orogens, resumably in response to original variations in the strength of continental lithosphere at long wavelengths. These different styles may reflect inherited attributes of the continental lithosphere, such as the fluid content, the presence of spaced, weak zones (e.g. inherited faults) or variations in the contrast in the homologous temperature of the deep crust and upper mantle. There are also variations between sedimentary cover and basement - largely reflecting contrasts in water content. However, all of these attributes may evolve during the development of orogens, leading to variation in localisation behaviour through time. Individual domains within orogens may show evolution in structural style while at the scale of the whole system, strain partitioning may vary temporally across an orogen. Strength variations may result from transient hydration or dehydration within critical lithospheric levels or, perhaps more commonly, evolution of the thermal structure of the deforming lithosphere. The response of different materials, especially the contrast between basement and cover will vary instantaneously and as rocks move through PT space. Long-term heating through burial and insulation will weaken deeper crustal levels, promoting bulk ductility. Consequently individual tracts of crust involved in many mountain ranges evolve through localised thrusting (narrow weak zones of predominantly simple shear) to broader belts of deformation within which earlier, localised structures are reworked. However, erosion exerts an extrinsic control on bulk strain distribution through dynamic removal of topographic loads that act against horizontal compression. Thus intrinsic explanations for strain localisation need not be sought - though they may be consequentially linked to rapid erosion. This discussion is illustrated by examples from the Alpine-Himalayan belt and ancient orogens.

91-3 Oral Law, Richard

STRAIN, DEFORMATION TEMPERATURES AND VORTICITY OF FLOW WITHIN THE GREATER HIMALAYAN SLAB, EVEREST MASSIF, TIBET AND NEPAL

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Keywords: Himalayas; Mount Everest; exhumation; strain; vorticity

Greenschist to sillimanite grade quartz-rich metasedimentary rocks exposed at the top of the Greater Himalyan Slab in the Rongbuk to North Col region of the Everest massif are characterized by Type I and II cross-girdle quartz c-axis fabrics indicating approximate plain strain conditions. Fabric opening angles progressively increase with depth beneath the overlying Lhotse detachment and indicate increasing deformation temperatures of 525-625 ± 50 °C at depths of 300-600 m beneath the detachment. Deformation temperatures of ca. 450 °C are indicated by fabric opening angles in epidote-amphibolite facies mylonites located closer to the overlying detachment. A top down-to-the north (normal) shear sense is indicated by the asymmetry of microstructures and c-axis fabrics, but the degree of asymmetry is low at distances greater than 400 m beneath the detachment, and sillimanite grains are drawn into adjacent conjugate shear bands but still appear pristine, indicating that deformation occurred at close to peak metamorphic temperatures.Mean kinematic vorticity numbers (Wm) were independently calculated by three different analytical methods. Calculated Wm values range between 0.67 - 0.98, and indicate that although a simple shear component is generally dominant, particularly in greenschist facies mylonites above the detachment, there is also a major component of pure shear in samples located at 400-600 m beneath the detachment (pure and simple shear make equal contributions at Wk=0.71). These estimated Wm values correspond to pure shear components representing 53-13% of the total recorded deformation. Wm values from the top of the Greater Himalayan Slab will be compared with vorticity estimates for samples collected from the central and lower sections of the slab on the Nepal side of the Everest massif during 2003 fieldwork.Assuming plane strain deformation, and taking into account Wm values indicated by the different vorticity methods, stretches of 10-40% parallel to the flow plane/transport direction are calculated near the top of the slab, and correspond to shortening estimates of 10-30% perpendicular to the flow plane. These data, in combination with similar estimates for vorticity of flow along the base of the slab in northern India (Grasemann et al., 1999), indicate that pure shear components of deformation may have played a significant role in extrusion and exhumation of the Greater Himalayan Slab.

91-4 Oral Mugnier, Jean-Louis

CONTROLS OF EPISODIC THRUST SHEET MOTION IN THE HIMALAYAS (WESTERN NEPAL)

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Keywords: continental compression; thin-skinned; erosion; Himalaya

The kinematics and rates of displacement along single faults of the Outer Belt and through the whole thrust belt of the Himalayas of Western Nepal have been estimated by structural field work, balanced cross-sections, fluviatile terrace deposit studies and geodesy. 15 +/- 2mm/yr shortening perpendicular to the trend of the Western Nepal Himalayas is deduced from GPS geodetic studies, compatible with elastic strain accumulation. This surface shortening would be induced by 19 mm/yr slip rate at depth on the basal detachment beneath the Great Himalayas whereas the detachment is locked beneath the Lesser Himalayas. In this outer zone, most of the displacement presumably occurs during major seismic events, and the 2.5-5 m thrust movements observed locally for imbricate fans that branch off the major thrusts of the Sub-Himalayas could reflect surficial rupture during these events. During the Holocene, the Main Frontal Thrust (MFT) is active, but portions of the piggy-back thrusts of the Outer Belt also show episodes of activity that vary from a few meters to several tens of meters displacement. The ratio of MFT shortening versus total Himalayan shortening varies laterally from 1 to less than 0.5, and out-of-sequence thrusting occurs behind the MFT, in the Sub-Himalayas and possibly in the Lesser Himalayas. The total shortening rate through the Himalayas of Western Nepal since the Miocene is 19 mm/yr with uncertainties that are respectively 2, 6 and 5 mm/yr for present-day, Holocene and long term shortening rates. This pattern of episodic out-of-sequence reactivation fits in with the evolution of a brittle thrust wedge affected by surficial mass transport and/or fluid pressure variation due to fault-valve behaviour. The influence of climatic variation (mainly glacial cycle is also discussed.

91-5 Poster Ebert, Hans Dirk

STRAIN PARTITIONING IN DEEP CRUSTAL THRUST SHEETS OF A PRECAMBRIAN COLLISIONAL SUTURE ZONE IN SE-BRAZIL

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Keywords: strain partitioning; ductile thrusting; collision tectonics; deep crust; Brasilia Belt

The Guaxupé Syntaxis is a regional thrust wedge from the southern Brasilia-belt that record the collision of the São Paulo Block to east onto the Sanfrancisco Paleocontinent during the neoproterozoic amalgamation of Western Gondwana. Paragneisses, quarzites, orthogneisses, migmatites and granulites exhibit a widespread subhorizontal foliation and frontal stretching lineations with low dip to the SW. Strain analysis, using Fry and Rf/phi methods, underwent in 120 samples of gneisses and quartzites help understanding how local deformation accommodated large scale thick-skinned tectonics. The analyses of the strain ratio for distinct minerals in each sample indicates that the quartz exerted strong rheologic importance for shear zone development, better accomodating the regional strains in relation to feldspars, that does not show substantial strain variation among samples with low and high deformation. Quartz is always more strongly orientated, stretched/flattened (as ribbons) and recrystallised than the feldspar porphyroclasts, hornblende and biotite. Deformation fabrics reveal a heterogeneous general non-coaxial flow with an alternation between slivers, where either coaxial, or non-coaxial deformations predominate. Horizons of oblate strain ellipsoids and quasi-coaxial deformation are dominant and they comprise granoblastic, blastomylonitic and symmetric, flattening type fabrics (S and SL tectonites) with low strain ratios and low kinematic vorticity numbers (Wn < 0.25). The vertical flattening of rock slices in outcrop scale, which would theoretically promote crustal thinning, is explained by the increasing weight of the thickening crust and was regionally compensated by crustal overstacking. These horizons often preserve high-grade metamorphic assemblages and they represent lenses of deep crustal material which were protected from hydration during cooling and exhumation to higher levels. Interleaving those packages exist narrow slivers of predominantly non-coaxial deformation, high shear strains, higher strain ratios and asymmetric fabrics (Wn between 0.25 and 0.75). They record strong dynamic recrystallisation, retrograde metamorphism and represent gliding surfaces which have concentrated differential motion during A-type subduction along which the former and much thicker sheets have been displaced and thrusted to higher crustal levels.

91-6 Poster Dehler, Nolan Maia

OROGENIC-PARALLEL TANGENTIAL SHEARING IN CONVERGENT OROGENS: TRANSIENT STRAIN ACCOMMODATING PARALLEL FLOW DURING TRANSPRESSION AND EXTRUSION IN THE PARAÍBA DO SUL BELT, SOUTHEASTERN BRAZIL

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Keywords: extrusion; transient flow; extension-parallel folding

In this abstract we discuss the structure in two regional cross-sections situated on the southern limb of the structural divergence in the Paraíba belt southeastern Brazil. Structural data collected along the cross-sections in the deep levels of a hot and partially molten transpressional orogen, suggest that tangential motion parallel to the orogenic trend was coeval with extension-parallel folding. Overprint relationships also suggest a protracted history of transversal shortening strain. The stability situation in which flat-lying decollements are active and coeval with extension-parallel folding requires relatively low values of accumulated orthogonal shortening. The situation tends to change with advancing convergence and the diminishing of the area at a determined structural level in the orogenic pile. Increasing shortening deformation may rotate the fold limbs and create axial plane foliation.The overall effect is to increase axial surface anisotropy at an orientation that transcurrent/transpressive motion in subvertical flow planes is facilitated. This may lead to a fundamental geometric change in the style of orogen-parallel motion in oblique convergent orogens. Flat-lying transcurrences have the tendency, by extension-parallel folding, to be replaced by subvertical transpressive shear belts in the structural evolution. Hence, changes in geometry lead to changes in the kinematics of accommodation of orogen-parallel motion: at an earlier stage, rotation axis of ductile deformation were subhorizontal and at high-angle to the orogenic margin; at a later stage, with increasing shortening, steeply dipping transpressive flow planes having subvertical rotation axis.Active transcurrent motion on flat-lying shear zones during convergence requires a mechanism to prevent changes in area at a specific level of the orogen. We believe that magma generation (anatexis) and emplacement may promote the required prerequisite. Magma may generate strain softening facilitating orogen-parallel shearing, and dilatational stresses, facilitating both orogenic-parallel motion and vertical ductile stretching. This would lead to transient strain regimes and also to a complex vertical strain partitioning in order to maintain space compatibilities in the crustal column. This dynamic process may promote the required boundary conditions for the emplacement of subhorizontal bodies of magma in convergent environments during the exhumation of hot and partially molten terranes.

91-7 Poster Emmanuel, Njonfang

UNUSUAL DELTA-TYPE PORPHYROCLAST GEOMETRY IN SUPERPOSED SHEAR ZONE/ EXAMPLE FROM THE CENTRAL CAMEROON SHEAR ZONE (CENTRAL AFRICA)

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