SESSION 129, 01:30 PM
WEDNESDAY, OCTOBER 28, 1998
S20. ROLE OF PARTIAL MELTING DURING EVOLUTION OF CONVERGENT OROCORNEAL BELTS - GSA STRUCTURAL GEOLOGY TECTONICS DIVISION
MTCC 714AB

1:30 PM Silver, Paul G.
THE THERMAL AND DEFORMATIONAL PROPERTIES OF OROCORNEAL MANTLE
SILVER, Paul G., Carnegie Inst. of Washington, DTM, 5241 Broad Branch Rd. NW, Washington DC 20051, silver@dtm.uchicago.edu and KINCAID, Chris, Graduate School of Oceanography, U. Rhode Island. The recognition that mountain building can usually be attributed to the collision and deformation of tectonic plates, has revolutionized geology over the last 30 years. Although the model of a shortlived, thickened plate accreted to the edge of a continent on the margins of the plate, and the thick crustal roots usually associated with orogenies, has difficulty explaining the thermal properties of the mantle, namely the absence of a corresponding thickened and cool subcontinental mantle lithosphere (SCML). One popular explanation for the excess heat within the orocorneric mantle is delamination, where the cold lithosphere is removed and replaced by warmer asthenosphere. The delamination hypothesis can be tested using constraints on mantle deformation from seismological or heat flow data. Numerous examples exist of a transition from normal or listric delamination to delamination into the mantle, and the evidence is consistent with this transition.

1:45 PM Brown, Larry D.
DEEP SEISMIC BRIGHT SPOTS, MAGMATISM AND THE ORIGIN OF THE TIBET PLATEAU
BROWN, Larry D., and ROSS, Andrew R., Institute for the Study of the Continents, Snee Hall, Cornell University, Ithaca, NY 14853, and JORDAN, Mark, Department of Geology, University of California, Berkeley, CA 94720. A number of studies have reported the presence of high velocity, deep seismic structures that are associated with the mid- to deep-crust of the Tibetan Plateau. These features are referred to as bright spots. These high velocity structures are thought to be associated with magmatism and high temperature mantle rocks, and are interpreted to be hotspots at the base of the Tibetan Plateau. The deep seismic structures are thought to be associated with the mid- to deep-crust of the Tibetan Plateau. The deep seismic structures are thought to be associated with the mid- to deep-crust of the Tibetan Plateau.

2:00 PM Park, Stephen K.
The Influence of Fluids on Partial Melting Beneath Nanga Parbat, Pakistan
PARK, Stephen K., IGPP, 1432 Geology, University of California, Riverside, CA 92521, magnet@ucr.edu and NCF-SD Nanga Parbat Group
Rapid exhumation of the Nanga Parbat-Haramosh Massif (NPHM) in the past 3 Ma has exposed rocks from the middle crust. This leucogranite dikes, microlites, and small slabs of granite with ages as young as 1 Ma are common. Clearly, partial melting is occurring beneath Nanga Parbat. An interdisciplinary study of the NPHM yields new constraints on the extent of partial melting and the mechanisms by which melt exerts its effects on the crust. This study is based on a detailed examination of the NPHM, which includes the identification of the extent of partial melting and the mechanisms by which melt exerts its effects on the crust.
studies indicate that meteoric waters circulate to shallow crustal depths (above the b-d transition) and are then heated to a dry steam phase before returning to the surface. Most surprising is the lack of evidence for widespread magmas below the b-d transition. Prominent S wave arrivals and electrically resistive crust are arguments against widespread magmas. Average fluid contents from rock resistivity are less than 0.01% in the crust to depths of at least 40 km. Such resistivities above the 1E cut are very unusual with evidence from both seismic and magnetic data. These new results show that even from the western Aran-Ar area, alkaline basaltic magmas were emplaced contemporaneously with the onset of hydration, but were indeed present. In all, the shallow crustal heating may have been linked to the decompression of the lithospheric column during crustal thickening, which may have been driven by a change in the regional stress regime due to plate rearrangements.

3:15 PM Vanderhaeghe, Olivier CAEBEMECT TECTONICS: CRUSTAL FLOW AND INTRA-LITHOSPHERIC DECOUPLING DURING COLLISION-OF-MARGINS
VANDERHAEGHE, Olivier, Oceanography, Desert University, Halfway, Nova Scotia, B3H 4J1, Canada, olivier@deser.rock.col.ca, TESSYBER, Christian, Dept. of Geol., New York Polytechnic University, NY, USA
A major tenant of plate tectonics is that lithospheric plates are rigid and that their relative motion is localized at their boundaries. This is a useful assumption to compare relative plate motion rates at continental margins. In general, the displacement field deduced from crustal deformation is not comparable due to plate motion rates, compatibility, and the presence of an intraplate system of faults recently investigated by INDEPTH profiling (Nelson et al., 1990) with older/eroded orogenic belts such as the North American Cordillera and the Western Mexican belt, provides critical insight into the evolution of upper and mid- to lower crustal behavior at different stages of orogeny, and a possible explanation of the discrepancy between plate-scale and crustal-scale behavior. These examples indicate (1) a dominantly vertical direction of maximum shortening; (2) tectonic transport commonly oblique to plate motion; (3) an arcuate shape of the thrust front at the end of the thickened orogenic belt; (4) decoupling between a brittle upper crust affected by normal faulting and a ductile lower crust dominated by viscous flow; (5) a partially molten mid- to lower crust.

3:30 PM Jamieson, R. A. PARTIAL MELTING IN CONVERGING ORYGENS: THERMAL CONSTRAINTS AND MECHANICAL CONSEQUENCES
JAMIESON, R.A., Dept. of Earth Sciences, Dalhousie University, Halifax, N.S., Canada, B3H 3J5, becker@ds.dal.ca; BEAUMONT, C., Dept. of Oceanography, Dalhousie University, Halifax, N.S., Canada, B3J 4H1; ELLIS, S., Geologisches Institut, Universitat Bern, Bern, Switzerland
Migmatites in convergent orogens typically form relatively late in the metamorphic history at temperatures above 700°C and pressures of 5-10 kbar. These migmatites are commonly deformed by strike-slip faulting and contain complex structural styles, and leucosomes may show a variety of cross-cutting relationships with respect to host-rock fabrics. Because the presence of partial melt should significantly decrease the ductile rheology during convergent tectonics, it is likely to influence the style of subsequent deformation within the orogen. Coupled thermal–mechanical models of convergent orogens offer some insights into heat sources and sinks, timescales of heating and cooling, exhaustion mechanisms, and feedbacks between thermal and mechanical processes. Simple models involving advection of sub- orogenic mantle beneath the ‘standard’ crust, with heat production concentrated in the upper 20 km, produce model orogens that are too complex. Under a partially deformed convergent boundary, topographically material is mantled by a fast conduction of heat from the upper orogenic crust into the upper mantle, and the orogen’s current geometry is maintained by a relatively thin sub- orogenic mantle. Temperature high enough for partial melting within the orogenic crust is by tectonically thickening the heat–producing layer at crustal levels, can be done through incorporation of a large accretionary wedge, and can increase the temperature at the base of the sub- orogenic mantle. Temperatures high enough for partial melting appear to result from substantial amounts of continent collisions. Moreover, one finds that even moderate heating of the lower orogenic crust leads to some decoupling and propagation of the orogen into its footwall. As the model orogenic crust weakens, exhaustion of lower crust on the rear side of the orogen may be focused by lateral stress contrasts. Where a very weak lower crustal layer is caught between two strong converging blocks, deformation is broadly distributed, crustal thickening is limited, and exhaustion is localized against the bounding stronger blocks. In this case the style of deformation in the upper crust is not strongly dependent on the polarity of underthrusting.

4:00 PM Bailey, R. C. THRESHOLDS FOR GRAVITATIONALLY INDUCED THRUSTING BY ELEVATED TOPOGRAPHY OVER A DUCTILE CRUST
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Overthickened crust over a region of enhanced ductility (produced by local heating or partial melting) cannot support sustained earthquake activity, because if the elastic thickness of the upper crust is small enough. Geodynamic analysis shows that for a given geometry of crustal thickening, the important diagnostic parameter is the ratio of excess elevation to elastic thickness. Above some critical value of this ratio, which depends on the geometry of the overthickened, hydrostatic upbend by the overpressured underlying ductile crust is sufficient to force thrust faulting at the lateral boundaries of the ductile zone. Values as low as a quarter for the ratio are quite possible even without sediments or sediments, which are high gradients. The lower thresholds are achieved only if the lateral boundary value is a ductile thrust, which occurs over the length of the elastic ductile crust. This type of geologically induced thrusting can only occur at a lateral contrast in the ductility of the lower crust. So that the lateral boundary has to be more ductile than the upper crust and escape to deformate by lateral flow in the lower crust as modeled by Bird and others, thus releasing the upper crust stresses which would otherwise initiate thrusting. Thrusting, once initiated, will accelerate with a grain to an elevation which is in isostatic equilibrium with the island and exceed the gradient to deformate by lateral flow in the lower crust. An increase in the elevation will release compression, which will continue. If the excess elevation exceeds a yet larger threshold, thrusting is not rate limited by orogen failure but by the rate of sedimentation at the foot of the orogen. Consequently, there will be a propagating overthickening of the crust as the upper crust raft with external and thinning.

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Photo of Scarborough Bluffs, Ontario by Peter Mvkusz