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Exhumation of UHP rocks: deciphering the petrologic and geochronologic evidence in Himalayan examples

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The discovery of coesite in Himalayan rocks, although spectacular in itself, has faded into insignificance with the subsequent realisation of the rate of subduction and exhumation of continental crust in this most spectacular of all present-day orogens. The combined petrological, isotopic and fission track results for both the NW Himalayan eclogite localities (Kaghan, N Pakistan, and Tso Morari, Ladakh, NW India) orogen suggest an average subduction and exhumation rate of several tens of mm per year. That subduction rates are high is no great surprise but the subduction of continental crust (all the eclogites appear as minor mafic bodies in units dominated by granitic basement and metasedimentary cover rocks) at such rates is certainly of great significance. The critical point to be made is that the initial exhumation rate of these units, from depths of ca. 100km to about 30km, is at rates the same as those of subduction. This is almost certainly a reflection of the buoyancy of average continental crust compared to the mantle (over 10% difference in density). However, in places the degree of reaction at these UHP conditions is evidently very low - older structures and minerals are completely preserved or are only modified by minor overgrowths - and thus it is likely that the buoyance affect was even greater than that predicted assuming equilibrium assemblages in the crust at these depths. The short duration of the UHP event is also reflected in the fine grained nature of the UHP rocks (driven by competing nucleation and growth factors) and by the presence of well preserved overgrowth features in garnet that are suitable for deducing the temperature-time history by diffusion modelling. The exhumation rate from 30 km depth to the surface in the Himalaya is relatively fast, as reflected in fission track ages already indicating that the rocks were at 10-15km depth only 5-8 Ma later than their maximum burial position. In other UHP terranes, the rate of this subsequent exhumation stage and the nature

of subsequent metamorphic events may have considerably modified the information record of the host rocks to the UHP bodies. For example, a rock that didn't react at UHP conditions but then later recrystallised at the amphibolite-facies stage when exhumation slowed, would not be able to show UHP relics because it never obtained the UHP mineralogy despite having 'experienced' the conditions. This is a critical point when understanding UHP terranes. It is not necessary for all the rocks to transform - the short timescale for deep subduction actually hinders reaction and if the only response in minor coronitic reactions then this information could easily be wiped out by subsequent events.