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Himalayan coesite eclogites: ages and characteristics of prograde, peak and exhumation features and geotectonic implications

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Ultrahigh-pressure, coesite-bearing eclogites of the Himalaya occur in Indian Plate basement and cover units that were subducted to depths of 100km or more during consumption of Tethys and subsequent collision with the Asian margin. Both in Pakistan (Upper Kaghan Valley [1]) and India (Tso Morari, Ladakh [2]) the coesite eclogites are not slices of subducted, eclogitised oceanic crust but represent former dykes and sills in rocks of the continental crust emplaced during a Permo-Triassic rifting of the Indian margin [3, 4, 5]. The petrology and geochronology of these eclogites has been investigated by several workers in recent years but a recent work [6], in contrast to all previous studies, proposes exhumation of the Tso Morari eclogite by diapiric ascent through the overlying mantle wedge. This new model is based on a pressure-temperature path derived for the eclogite comprising a very low temperature (ca. 400°C, 2.6 GPa) for the peak pressure stage (just below the coesite field) followed by significant heating (to ca. 700°C at 1.8 GPa) during initial exhumation. Other studies on essentially the same rocks also note a significant heating episode but this occurs at much lower pressures and postdates the major part of the exhumation history. Why two different interpretations?

The most suitable eclogites for detailed study of a *P-T*-path must show disequilibrium and partially preserve a number of different reaction stages. For this reason special care has to be taken when choosing mineral compositions for different *P-T* stages. A magnesite and dolomite-bearing eclogite investigated with thermodynamic modelling considering also its trace and major element zoning patterns linked to sequential changes in inclusions [2] allows a check of the conclusions of [6]. Strong growth zoning of garnet makes it difficult to choose the appropriate composition for a particular *P-T* stage. The strong zoning in Ca and Mg can be explained with the help of forward thermodynamic modelling considering changing bulk composition due to fractionation. Critical is the location of coesite inclusions not in the core as required by [6] but in an outer mantle. In addition, different omphacite generations (in the matrix and as inclusions in garnet) with different jadeite content, must also be separated and the interpretation of phases as inclusions rather than as later reaction products along cracks leads to further problems in *P-T* determination. Further, interpretation of inclusion phases as pseudomorphs after lawsonite has important implications for the expected *P-T*-path. Finally, multi-equilibria pseudosection modelling to deduce PT fields must use realistic fractionation steps to correctly account for the effect of garnet zoning on effective bulk composition. Once all these problems are carefully avoided the *P-T*-path for diapiric exhumation through the mantle disappears and a deep, fast subduction and fast exhumation history including a marked heating at around 10 kbar emerges: a path directly comparable, also in its timing, to that of the coesite-eclogite of the Kaghan Valley, Pakistan.

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