California State University-Fresno

Environmental Sciences Seminar Series
Presents:

Stopping Plate Tectonics: The Subduction, Metamorphism and Exhumation of Continental Crust

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Abstract

Prior to 1984, it was not imagined that continental crust could be buried to the depths attending ultrahigh-pressure (UHP) metamorphism (>2.5 GPa and 500°C). And although it is now generally accepted that parts of the continents can be subducted to such extreme depths, the mechanisms by which these rocks return to the surface remain dimly perceived.

The two paradigms most commonly invoked for the exhumation of UHP rocks involve large-scale extension: either the rocks are exhumed as a coherent entity in the footwall of a single extensional structure, or they are exhumed as crustal slivers bounded by an extensional fault above and a contractional fault below. Determining which of these is responsible for the exhumation of a given UHP terrane has fundamental implications for our understanding of orogenic processes in the deep levels of mountain belts.
Continental rocks of the Scandinavian Caledonides were subjected to UHP metamorphism during the Late Silurian/Early Devonian collision between the Baltica (Scandinavia) and Laurentia (including Greenland) continental plates. Previous tectonic models have assumed that the UHP rocks in Norway formed the leading edge of the Baltica slab; were subducted intact to extreme depths of 135 km or more, and exhumed in the footwall of a large-scale extensional detachment fault (Nordfjord-Sogn Detachment).

In the Nordfjord area of western Norway, UHP (>2.7 GPa) and HP (2.2-2.7 GPa) eclogites occur above and below (HP only) a major extensional detachment. The boundary zone between the UHP and HP eclogites is transitional over a 20 km distance and not coincident with the extensional detachment, and hence is likely the result of kinetics (e.g., variations in times and pressures of equilibration) or deformation predating motion along the detachment. Furthermore, the HP eclogites below the detachment diminish in abundance toward the foreland, with no recognized metamorphic or structural break. We interpret these features to indicate that the UHP and HP area of western Norway was subducted and exhumed as part of a coherent crustal (and possibly lithospheric) section and that the major extensional detachment is a later, intracrustal feature that was not responsible for significant exhumation.

Slab failure is a necessary finale of continental collision, with implied elastic rebound of the remaining lithosphere. This may provide a mechanism for exhuming a coherent (U)HP crustal section--the uncertainties now concern the strength of the mantle wedge above the UHP rocks, and whether rebound rates are consistent with actual geochronology.