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Formation, detachment and exhumation of ultra-high-pressure rocks during continental subduction: Implications for 'extension' in convergent orogens

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In many Phanerozoic collisional orogens, ultra-high-pressure (UHP) rocks are inferred to have been formed and exhumed during the early stages of continental subduction. We use thermal-mechanical, upper-mantle-scale models to investigate how detachment and exhumation of UHP material in the subduction channel are affected by the competition between down-channel shear traction and up-channel buoyancy forces. The model results can be interpreted in terms of a lubrication theory of channel flow in which the exhumation number, E, expresses the relative contributions of Poiseuille (up-channel) and Couette (down-channel) components. The value of E depends on the pressure gradient (dominated by density contrasts), channel thickness, effective viscosity, and subduction velocity, and varies with both time and distance down the channel. Although buoyancy is the main driving force for exhumation, viscous strain weakening plays a critical role in the models by first reducing the downward Couette drag and then promoting upward Poiseuille flow of low-viscosity UHP material. In natural systems, other weakening mechanisms may also play a role. During the later stages of exhumation, the models predict the formation of a prominent low-angle extensional shear zone at high structural levels during doming, consistent with observations from many natural examples. The models also predict *PTt* paths and timing

constraints which are consistent with natural examples. Neither surface erosion nor slab break-off are required for UHP exhumation.