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Plate rotation during continental collision and its relationship with the exhumation of UHP metamorphic terranes: application to the Norwegian Caledonides

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Lateral variation and asynchronous onset of collision during the convergence of continents can significantly affect the burial and exhumation of subducting material. We use 3D numerical models for continental collision to discuss how deep burial and exhumation of ultra-high pressure metamorphic rocks are enhanced by oblique convergence and resulting rotation of the colliding plates. Rotation during collision locally favours eduction, the inversion of the subduction process following ocean slab break-off, and may relate to the discontinuous distribution of ultra-high pressure (UHP) terranes along collision zones. For example the terminal (Scandian) collision of Baltica and Laurentia, which formed the Scandinavian Caledonides resulted in the exhumation of only one large high pressure/ultra-high pressure (HP/UHP) terrane, the Western Gneiss Complex (WGC), near the southern end of the collision zone. Rotation of the subducting Baltica plate during collision may provide a likely explanation for this distribution. We explore this hypothesis by comparing orthogonal and oblique collision models and conclude that an oblique collision can transport continental material up to 60km deeper, and heat material up to 300°C hotter, than an orthogonal collision. Our oblique collision model predicts that subducted continental margin material returns to the surface only in the region where collision initiated. The oblique collision model is consistent with petrological and geochonological observations from the Western Gneiss Complex and makes predictions for the general evolution of the Scandinavian Caledonides. We propose the collision between Laurentia and Baltica started at the southern end of the collisional zone, and propagated northward. This asymmetric geometry resulted in the counter clockwise rotation of Baltica and the northwards movement of Baltica's rotational pole with respect to Laurentia, consistent with paleomagnetic data from other studies. Our model has applications to others orogens with regional UHP terranes, such as the Dabie Shan and Papua New Guinea cases, where block rotation during exhumation has also been recorded.