Dehydration-driven stress transfer as a mechanism for lower Wadati-Benioff earthquakes

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Although extensively documented, intermediate-depth earthquakes (40-400 km) within subducting oceanic slabs remain enigmatic. Here we reconcile more than a decade of apparently contradictory experimental studies on the possible link between these earthquakes and serpentine dehydration. We show that for realistic compositions, antigorite dehydration triggers dynamic embrittlement of sintered olivine-antigorite aggregates deformed at confining pressure and temperature conditions representative of intermediate-depth seismicity (1 to 3.5 GPa, 500 to 800°C). At 1.1 GPa pressure, dehydration of antigorite in volume proportion as low as 5% triggers dynamic shear failure of the olivine load-bearing network. For higher contents, deformation remains silent and distributed. At 3.5 GPa pressure, acoustic emissions are observed for mixtures with up to 50% antigorite. In both cases, dehydration of antigorite proportion as low as 5% is sufficient to trigger analogs of lower Wadati-Benioff earthquakes in the laboratory. Intermediate-depth seismicity could therefore ultimately be seen as an indicator for the degree of hydration in subducting lithospheric mantle.

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