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Interferometric imaging of metastable olivine wedge and implications for deep focus earthquakes

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Transformational faulting of metastable olivine has been the leading hypothesis for deep focus earthquake initiation, thanks to the pioneering experiments by Harry Green and others. However, the existence and exact geometry of the metastable olivine wedge (MOW) within slabs are still debated among seismologists, partly because the waveform signatures of a low-velocity MOW can be complicated by the shallow structures (e.g., continental and oceanic crusts, mantle wedge). Here we apply coda wave interferometry to pairs of deep focus earthquakes to estimate the Green's functions between the event pairs. This new approach thus removes effects of shallow structures, as if one of the deep events is turned into a deep seismometers, or more precisely, strainmeter. Preliminary results for the subducted slab beneath the Japan Sea show signs of MOW, but probably with substantially smaller dimensions than previously thought. The smaller dimensions are actually more consistent with the b value of 0.5 for intermediate-magnitude deep focus earthquakes in warm slabs. We suggest that shear melting is necessary for large deep focus earthquakes to rupture beyond the metastable olivine wedge. Dynamic simulations involving both transformational faulting and shear melting start to reproduce rupture behaviors consistent with seismic observations.