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Pulses of earthquake activity in the mantle wedge track the route of slab fluid ascent

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Earthquakes typically record the brittle failure of part of the Earth at a point in space and time. These almost invariably occur within the crust or where the upper surface of subducting lithosphere interacts with the overriding mantle. However, there are also reports of rare, enigmatic earthquakes beneath rifts, above mantle plumes or very deep in the mantle. Here we report another type of mantle earthquake and present three locations where earthquake clusters occur in the mantle wedge overlying active subduction zones. These earthquake clusters define broadly circular to ellipsoidal columns that are 50 km or greater in diameter from depths between ~150 km and the surface. We interpret these rare pulses of earthquakes as evidence of near vertical transport of fluids (and associated flux-melts) from the subducted lithosphere through the mantle wedge. Detailed temporal analysis shows that most of these earthquakes occur over two-year periods, with the majority of events occurring in discrete month-long flurries of activity. As the time and location of each earthquake is recorded, pulses of seismic activity may provide information about the rate of magma ascent from the dehydrated subducted slab to sub-arc/backarc crust. This work indicates that fluids are not transported through the mantle wedge by diapirism, but through sub-vertical pathways facilitated by fracture networks and dykes on monthly to yearly time scales. These rare features move us toward solving what has until now represented a missing component of the subduction factory.