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Using SP precursor waves to detect upper mantle discontinuities

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We investigate the usability of converted phases, such as SP and PS, and their precursors, which reflect off the underside of upper mantle seismic discontinuities. In contrast to PP and SS waves, converted phases do not reflect midway between source and receiver but about three quarters for SP and one quarter for PS on the great circle path and therefore might lead to a better data coverage, especially of oceanic regions where usually few receivers can be deployed. As the SP and PS phase arrive at about the same traveltime and with similar slowness values, the standard array seismological processing methods do not provide useable results. One feature, which makes it possible to distinguish between the two phases, is their polarization. In theory, the SP wave is a vertically polarized wave with P and SV contributions, the PS wave is mostly polarized into the SV direction. Therefore, to entirely decouple the three components, a rotation into the LQT system is needed, which takes into account not only the backazimuth but also the incidence angle of the wave. We developed such a polarization filter to separate SP and PS waves and their precursors. Here we show that the polarization filter successfully makes a separation of the SP and PS phase possible. We show examples of precursors to SP and also explain the problems with interfering phases. Only very few distance ranges can be used to avoid interference of other waves, even using vespagrams. We are able to detect several SP precursors of the underside of the 410 and 660 km discontinuity and use those to map the presence and topography of mantle discontinuities.