Estimating focal depths of the equatorial Mid-Atlantic Ridge earthquakes

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Focal depths of oceanic earthquake are needed for investigations of the seismogenic zone of oceanic transform faults (OTF) and rift valleys of the Mid-Atlantic Ridge (MAR). Methodologies for centroid depth determinations have been presented in the literature using P-waveform modeling of events of magnitude above M 4.0-6.0. Hypocenter have also been analyzed using surface wave with data of teleseismic stations. Here, we present depth estimations of Mw>5.4 events that occurred on normal faults located 4-5ºN on the MAR. The focal depths were computed from the arrival time differences between the water surface reflection of the P phase (wpP) and the first arriving phase (P). For that purpose, we used high-quality wpP phases recorded by 19 stations of the global seismographic network IRIS, situated at distances 20º - 90º, and with azimuthal gaps 130-170º and 230-290º. These stations presented suitable signal-to-noise ratio to pick P and wpP phases. The phases were identified using Seismic Analysis Code after removing instrument response from WWSSN short-period instruments. The ray parameters were calculated from the IASP91 global velocity using the TauP software, and used to estimate the incidence angles in the local 1D crustal velocity model profile (CRUST1.0), sampled at Lat 4.5ºN, Lon 32.65ºW. For comparison, we analyzed the focal depths for the same earthquakes using the surface waveform modeling in ISOLA software with regional stations on the two sides of the Atlantic at epicentral distances 1,200 until 2,200 km. We used the low-frequency range of 0.01-0.03 Hz, featuring a very good signal-to-noise ratio. Synthetic waveforms were calculated in the same frequency range. In this study, we observed wpP-P differences of ~5.3-5.9 seconds, which were modelled with a hypocenter depth of 5.1±0.1 km. The seabed or sediment reflection phase (bpP) was weakly identified in the seismograms, possibly due to the rough topography affecting the seabed impedance contrast compared with the oceanic water surface. The surface waveform inversion in ISOLA presented a depth of 5 km, close to the depth estimated by the wpP-P time delay. Overall, our results are encouraging as suggesting that source depths could be estimated more widely for moderate earthquakes along the MARs using both surface waveforms and travel time differences of wpP and P phases.