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Poisson's ratio and porosity in deep seismic zone under Izu-Bonin, Japan

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Deep earthquakes can provide the deep information of the Earth directly, but their focal mechanism is not clear yet. We have collected the arrival time data generated by the deep earthquakes with depth greater than 400 km under Izu-Bonin in Japan and have used them to study the velocity anomaly in deep seismic zone. In our previous studies, a forward-modeling method to the travel times of P-wave is used to determine the compressional velocity anomaly under the Japan Sea and the adjacent region of northeastern China, respectively, in which a lower anomaly shows the possible exist of metastable olivine wedge (MOW) in the Pacific slab deeper than 400 km. However, the disadvantage of the forward-modeling method is that the final result might obtain a local minimum rather than a global one. Another problem in our previous studies is that only P-wave velocity was considered, according to which we hardly discuss whether the water exists. To issue these problems, in this study, we used the Singular Value Decomposition (SVD) to solve an equation in which P- and S-wave velocity anomalies are unknown parameters and the double differences of travel times for deep event-pairs are observation data. As we know, the trade-off between the event location and the velocity anomaly is very strong. To remove the effect of event mislocation, a modified double-difference relocation method is used to relocate all deep earthquakes. The relocation of events and the inversion of velocity anomalies are processed iteratively until the velocity anomaly is stable. The Poisson's ratio and the porosity in the region around the deep earthquakes are then calculated according to the P- and S-wave velocity anomalies. Our new results show that the average P-wave velocity anomaly is lower 6%, however the S-wave anomaly is higher 2% than the iasp91 model. The corresponding Poisson's ratio and porosity anomaly are -24% and -4%, respectively, which suggest that the possibility of water in the deep seismic zone is very few and the porosity might be richer. All results indicate that the MOW might exist in the Pacific slab under the Izu-Bonin region and the deep earthquakes might be induced by the phase change of metastable olivine. To verify the mechanism of deep earthquakes, we will further invert their moment tensors by their waveforms, and then decompose the isotropic component associated with the volume change. If the isotropic component relative to the deviate one is large enough, we could infer with more confidences that the generation of deep earthquake is related to the metastable olivine wedge indeed.