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Mathematical modeling of shear and converted waves in deep seismics offshore

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Marine deep seismic surveys using ocean bottom seismometers with multi-component wave field recording enable to register dynamically expressed shear and converted waves on vertical and horizontal components in addition to high-amplitude compressional waves. Since S-waves do not propagate from a source in a water layer, researchers currently do not have a single point of view on where the first P-S conversion takes place. A mathematical finite-difference modeling with Tesseral 2D software (Tesseral Technologies Inc.) was performed for a number of models of the Earth's crust and upper mantle offshore. Properties of the main waves, which may be formed in a process of a typical deep marine seismic survey, were studied. Analysis of synthetic seismic records and calculated traveltime curves for the generalized models of continental, transitional, and oceanic types of Earth's crust and upper mantle offshore allows to make conclusions as follows: (1) converted waves of sufficient amplitude are formed both on downgoing and upgoing rays on all the major model interfaces (sea floor, sedimentary cover bottom, and crustal bottom). The most high-amplitude are PS-wave undergone a single act of conversion; (2) seismic record of horizontal components is dominated by shear and converted PS-waves. The most high-amplitude are shear and converted waves reflected from the sedimentary cover bottom and crustal bottom and refracted PS-waves moving along the surface of consolidated crust with velocity of P waves; (3) seismic record of vertical component, in addition to primary events of P-waves, comprises high-amplitude field of multiple waves associated not only with the sea floor, but with the sedimentary cover bottom. Converted waves from crustal interfaces are less dynamically pronounced in vertical component because of their near-horizontal polarization and/or low amplitude of converted SP-waves.