Demultiple strategies in the submarine slope of Taiwan accretionary wedge

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Reducing multiple contaminations in reflection seismic data remains one of the greatest challenges in seismic processing and its effectiveness is highly dependent on geologic settings. We undertook two-dimensional reflection seismic data crossing the upper and lower accretionary wedge slopes off SW Taiwan to test the efficiency of various multiple-attenuation scenarios. The area has resulted from an incipient arc-continent collision between the northern rifted margin of the South China Sea and the Luzon volcanic arcs. The wedge extends from shallow water to deep water bathymetries, hence promoting both short-period and long-period multiples within the seismic records. The multichannel seismic data were achieved under 468 hydrophones, 4-ms sampling rate, 12.5-m channel spacing, 50-m shot spacing and 15-second recording length. Preprocessing flow includes swell noise removal, direct wave mute, and missing channel and shot restoration. A subset of demultiple methods based on the periodicity nature and the spatial move-out behavior of multiples were explored to attenuate multiples energy under different geologic environments. The first step relies on the simultaneous subtraction of surface-related multiples, which combined wave-equation multiple attenuation (WEMA) and surface-related multiple elimination (SRME). WEMA is a shot domain multiple attenuations based on a combination of numerical wave extrapolation through the water layer and the water bottom reflectivity. This method was capable to partially suppress the water layer multiples. SRME was applied to attenuate the residual multiple energy at near-offset. This method assumes surface-related multiples can be kinematically predicted by convolution of prestack seismic traces at possible surface multiple reflection locations. Some primary reflections seem to be better retained after the combined subtraction process than using WEMA or SRME filtering independently. The second step lies on parabolic Radon transform to attenuate far-offset multiples by subtracting the noise energy in \(tau-p\) on input gathers that have been corrected for normal move-out and inverse transform the remaining primary energy back to CMP-offset domain. Predictive deconvolution in the \(x-t\) domain was performed to attenuate low-frequency reverberations in the upper wedge slope. A double-gap deconvolution operator was extended to predict reverberations with correct relative amplitudes, followed by time-variant bandpass filtering to reduce much of residual multiple energy. In general, WEMA and predictive deconvolution were more effective in attenuating the
multiples energy at the upper wedge slope where the water depths are shallower; whereas SRME and parabolic Radon were capable of reducing the energy of multiples at the lower wedge slope. Nevertheless, multiples energy could not be fully eliminated due to several factors. The dependency of some demultiple methods (e.g. parabolic Radon, WEMA, SRME) on velocity function may perturb the forward multiple predictions before subtraction as primary velocities might not be present due to the highly tilted strata in the thrust belts domain. Furthermore, parabolic Radon may not perform well in shallow water and area with slowly increasing velocities with depth (e.g. the upper wedge slope). Since the reflection seismic dataset spans various tectonic environments and water depth, results suggest there was no single demultiple method capable to suppress multiples in all environments.