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Internal solitary wave shoaling in the Dongsha region of South China Sea

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Internal solitary wave shoaling is the product of the interaction of internal solitary waves (ISWs) with the seafloor. There will be a series of changes in the waveform of the internal solitary wave when water depth decreases, and it affects the flow near the seafloor. These processes are captured by the seismic oceanography(SO) method. We analyze and summarize water-column reflections characteristics in the Dongsha region of South China Sea(SCS). The interior of the ocean is dominated by high/low frequency internal waves, internal solitary waves and high-mode internal waves. The seismic oceanography profiles record 45 internal solitary waves in the study area, and the depression waves are widely distributed in both deep and shallow water area. During their shoaling process in the Dongsha region, the depression waves gradually come into the transition stage under influence of the topography, and finally convert its polarity to elevation waves in the shallow water area. In addition, the energy dissipation during the internal solitary wave shoaling process, has an important impact on the shaping of the upper continental slope in the northern South China Sea.

It is proposed that the computational fluid dynamic (CFD) modelling is combined with seismic forward modelling to study seawater seismic facies. Modelling experiments are focused on internal solitary waves shoaling as well as the formation and evolution of seismic facies over sand dunes. Shoaling internal solitary waves propagating westward in the northeastern South China Sea of depression, transition and elevation types are simulated. The temperature, velocity field and seismic reflection events in forward modelling sections are compared with observed SO data. The shape of isothermal curve is analyzed to study the speed of ISWs and the effect of seafloor fiction. Different Iribarren numbers are discussed to study the diverse types of ISW breaking, including surging and plunging breaking.

The depression and elevation internal solitary waves bring about the southeast and northwest direction wave-induced currents respectively. On the one hand these near-bed wave-induced currents resuspend sediment particles into water columns to generate nepheloid layers, and on the other hand they contribute to the bed load, which maintains the very large sand dunes formation and migration. Seawater seismic facies over sand dunes are analyzed, including the coupling of seismic events and morphology, the high frequency oscillating seismic events in both edges of ISWs, and hair reflection configuration seismic events over sand dunes on slope. Modelling results show that the coupling of sand dunes and seismic events may be related to unidirection flow over sand dunes. The high frequency oscillating seismic events in both edges of ISWs are related to ISWs propagating over sand dunes. While the shape of the oscillating seismic events is similar to undulation of sand dunes in the beginning, they are reshaped by ISWs and move toward the same direction of ISW propagation.

This study may reveal the relationship among multi-scale movements of seawater, bottom topography and sedimentary processes, which can deepen the understanding of the seafloor interface process.