Constructing a 3D-sediment velocity cube and extracting its features in the deep water areas of the Arctic Ocean

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A 3D-sediment seismic velocity cube is constructed using seismic refraction velocity results from 118 sonobuoy stations in the deep water parts of the Canadian margin in the Arctic Ocean. Sediment compaction as well as its spatial variation are modeled and analyzed with sediment supply and tectonostratigraphic evolution. Sediment velocity and its patterns mainly depend on sediment supply, tectonic subsidence, and thermal evolution history, and they follow experimental or theoretical models very well in the deep-water environment characterized by fine-grained sediments. These models have wide-ranging applications in tectonostratigraphic interpretation and natural resource exploration.

In a large study area, such as the Canada Basin and its nearby regions in the Arctic Ocean, velocity data at 118 sonobuoy stations is too sparsely sampled for any currently available interpolation methods for interpolating a 3D velocity cube. Therefore the inverse spatial principal component analysis (isPCA) method has been developed and used in the construction of the 3D velocity cube. Patterns of velocity series are studied by modeling the slowness velocity function (which is based on compaction theory) with observed velocity series. Distinct categories of velocity models are identified based on the spatial features of modeled velocity functions in a GIS environment, such as ArcGIS, and these categories have clear spatial links with the interpreted tectonostratigraphic background of the study area.

In addition, the spatial variations describing the modeled velocity and compaction history manifest a qualitative relationship with the distance to known sediment sources such as the Mackenzie Delta, and depocenters within regions such as the Stefansson and Nautilus basins.

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