FILTERING ACQUISITION ARTIFACTS AT MULTIPLE SCALES FROM A SEISMIC-DERIVED SEAFLOOR MAP WITH FACTORIAL KRIGING

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ABSTRACT: Accurate seafloor maps are critical in offshore petroleum projects. Almost all modeling workflows depend on it including pore pressure modeling and reservoir geomechanics. These studies generally involve sums of properties along the vertical, consequently noise or acquisition artifacts at the seafloor map tend to propagate and even amplify in the subsequent models taking seafloor as input. Seafloor maps are acquired by means of sensing technology and other procedures, which expectedly introduce noise and artifacts. Moving window filters are easy to use, fast to compute and are data-dependent, however they are unable to discern noise, artifacts and signal, either in spatial or frequency domains. Convolution-based algorithms are effective spatial filters but they are data-independent. Spectral analysis filters can pose problems with irregular data or when noise, artifacts and geological information overlap in the frequency domain. Factorial kriging (FK) is a data-dependent spatial filter based on the principle that structurally complex information is a sum of independent information components that yields an estimate decomposed into factors, each corresponding to a variogram nested structure. Hence, this method can be used to separate acquisition artifacts from an already noise-free seafloor information based on their different spatial structures modeled by data-adherent variograms. This work investigates a FK application to filtering artifacts in seismic data as, differently from random noise, are spatially correlated information components mixed with seafloor information. Initially, the bathymetric trend was removed in order to make the case stationary and a high-resolution variogram map was computed in the frequency domain via Fast Fourier Transform (FFT), which enabled a full 2D approach to variogram modeling. The approach consisted of fitting theoretical variogram surfaces to the experimental variogram map allowing the identification and modeling of nine nested variograms. Search strategies were envisaged in order to select a small number of informative samples to reduce kriging runtime and, at the same time, cover the necessary variability. A workflow is demonstrated on a large seismic-derived seafloor 2D map, detailing each step with emphasis on the sensitive variogram modeling step, followed by search strategy definition, choice of the geology-bearing factors and trend addition for seafloor restoration. The results revealed delicate seafloor features that were previously unseen in the original map, obfuscated by prominent artifacts.

KEYWORDS: Factorial Kriging; Artifact Filtering; Seismic.