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Using an Adaptive and Data Driven Signal Decomposition Technique to Delineate Structural Geology in Post-Stack Seismic Data

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ABSTRACT

Seismic attribute calculations have been traditionally used for measuring specific traits in seismic data for further interpretation. (Chopra and Marfurt, 2007) These calculations tend to have a fixed operator from one sample to the other during the computation. This can be very limiting given the varied nature of the seismic signal and aspects such as seismic attenuation. We have looked at how we can calculate signal decomposition features for typical fluvial system detection in an adaptive fashion to overcome these challenges. To enhance the spectral decomposition workflow, we have investigated the use of an adaptive filter size driven by the seismic data to guide in the selection of the best operators for each frequency content extraction. We do this in a multitier system and stack the results per frequency extracted to gain a better balancing between the extracted content. Our approach starts by first studying the relation between operator sizes and frequency detection (Gonzalez and Woods, 2002). We identified that for a given operator size, there can be a discrepancy between the analyzed frequency and the content representation in the frequency domain. We also identified that for each frequency, there are several operator sizes that give a good match to represent the frequency content. By stacking the results of the calculations from each operator, we get a more complete representation of the content present in a single frequency and ultimately reducing noise. We also explore the possibility of selecting the desired frequencies from a data driven perspective using the same technique. The focus in this study has been on fluvial systems (channels), fault networks, salt bodies, and mass transport deposits. The data sets used to test the results are from Norway North Sea, the US Gulf of Mexico, Australia, and New Zealand. Our results show that the adaptive approach of data-driven tuning of spectral decomposition calculations towards optimal operator sizes and multitier stacking of frequency content enhances the balancing of the content, improves the blended imaging quality, and ultimately results in improved delineation of structural geological features. This is especially highlighted in our comparison study of the more traditional methods.