Spectrum of Gas Migration Phenomena Across Multi-Layered Sealing Sequences

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ABSTRACT

We describe a spectrum of seismic high-amplitude anomalies from the Great South and Canterbury Basins (New Zealand) that have a number of characteristics that make them distinct from previously described hydrocarbon-related amplitude anomalies. We propose a new classification scheme that is based on the specific vertical stacking of the anomalies, and thereby reflects their genetic inter-relationships. We demonstrate by combining AVO and other attribute analyses that the anomalies are the product of gas migration across thick sequences of low permeability sediments and identify specific units where migration is focused through discontinuities (e.g. faults), and storage units where the gas spreads laterally. Based on our observations we argue that fluid flow phenomena in which Darcy flow must have occurred can be hosted within low permeability layers that would normally be regarded as high quality sealing sequences. The documentation of a wide range of gas-related anomalies developed in a relatively uniform lithostratigraphy and in similar basinal contexts allows us to infer a migration sequence based on the morpho-structural and geophysical characteristics of the anomalies. We suggest that the shape of the composite anomalies is directly controlled by gas flux and by probably quite subtle variations in physical properties of the host sediments. The distribution of the anomalies is generally correlated with maximum burial regions of the most prospective source rock intervals and in trend with the gas maturation window. This spatial coincidence supports the hypothesis that thermogenic gas from hydrocarbon maturation is the source of the gas generating the anomalies.