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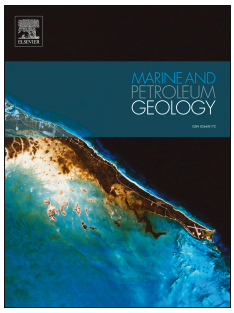

Seismic and structural characterization of fluid escape pipes using 3D and partial stack seismic from the Loyal Field: A multiphase and repeated intrusive mechanism

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Seismic and structural characterization of fluid escape pipes using 3D and partial stack seismic from the Loyal field: a multiphase and repeated intrusive mechanism.

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Abstract

The potential for fluid leakage from sub-surface reservoirs has important implications for CO_2 storage, hydrocarbon reservoirs and water resources. Understanding the genesis, morphology, fluid flow mechanisms and extent of fluid escape from reservoirs allows for better risking of geological resources and storage potential. Here we describe in detail the structures of fluid escape pipes from the Loyal field, observed from a 3D full and partial stack seismic dataset. The seismic imagery suggests that the fluid escape pipes are rooted at least in the main Paleocene reservoir and by-pass the reservoir seal to cross the post Lista Formation overburden up to the intra-Neogene units. The pipes extend for a few hundred meters to a few kilometres and show a varying shape structures from blow-out structures to incipient mud volcanoes. The structural relation of the pipes termination suggest they were active between the formation of Neogene faults and fractures and the erosive event related to the Intra-Neogene unconformity. A detailed analysis of the seismic characteristics observed both from main baseline and partial stack data allows a division of the pipes into two families: (1) seeps and pipes following structural discontinuities (2) pipes unrelated to the pre-existing structural features. The pipes internal seismic response, the reflector termination of the main conduits and the distribution of stacked bright reflectors suggests an upward migration mechanism (during pipe birth and development), requiring a cyclic switching from non-Darcy hydrofracturing (during overpressure) to Darcy flow lateral migration (during low-pressure stage). The improved understanding of the seal by pass