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Seismic and structural characterization of the fluid bypass system using 3D and partial stack seismic from passive margin: inside the plumbing system.

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In recent years enormous attention has been paid to the understanding of the process and mechanism controlling the gas seepage and more generally the fluid expulsion affecting the earth system from onshore to offshore environment. This is because of their demonstrated impact to our environment, climate change and during subsea drilling operation. Several example from active and paleo system has been so far characterized and proposed using subsurface exploration, geophysical and geochemical monitoring technology approaches with the aims to explore what trigger and drive the overpressure necessary maintain the fluid/gas/material expulsion and what are the structure that act as a gateway for gaseous fluid and unconsolidated rock. In this contribution we explore a series of fluid escape structure (ranging from seepage pipes to large blowout pipes structure of km length) using 3D and partial stack seismic data from two distinctive passive margin from the north sea (Loyal field, West Shetland) and the Equatorial Brazil (Ceara' Basin). We will focuses on the characterization of the plumbing system internal architecture and, for selected example, exploring the AVO response (using partial stack) of the internal fluid/unconsolidated rock. The detailed seismic mapping and seismic attributes analysis of the conduit system helped us to recover some detail from the signal response of the chimney internal structures. We observed: (1) small to medium seeps and pipes following structural or sedimentary discontinuities (2) large pipes (probably incipient mud volcanoes) and blowup structures propagating upward irrespective of pre-existing fault by hydraulic fracturing and assisted by the buoyancy of a fluidised and mobilised mud-hydrocarbon mixture.
The reflector termination observed inside the main conduits, the distribution of stacked bright reflectors and the AVO analysis suggests an evolution of mechanisms (involving mixture of gas, fluid and probably mud) during pipe birth and development, cycling through classical fluid escape pipes evoking non-Darcy flow to Darcy flow exploiting surrounding permeable bodies (during low fluid recharge period). Limit and uncertainty of the seismic data imaging the internal structure are still controlled by illumination factor, the lateral and vertical resolution (Fresnel. Tuning thickness) and scattering/noise effect of seismic wave when they interact with the plumbing system.