Seismic Imaging of Fluid Migration in Petroleum Basins

Serie, Christophe [1]; Huuse, Mads [1] (1) SEAES, University of Manchester, Manchester, United Kingdom.

Advances in 3D seismic quality and visualization tools bring new insights into the shallow manifestations of fluid flow systems. Fluid flow systems are known from (paleo-) seafloor features such as pockmarks, mud volcanoes, carbonate mounds, seeps, and seismically detectable subsurface fluid flow pathways.

Fluid flow pathways are mainly characterized by stratigraphic carriers and seal bypass systems. Seal bypass systems are by definition seismically resolvable geological features embedded within sealing sequences that promote cross-stratal fluid migration and allow fluids to bypass the pore network.

Published work proposes a subdivision of seal bypass systems according to a threefold, object-based classification scheme, in which seal bypass systems are divided into fault bypass, intrusive bypass, and pipe bypass systems. While the first two categories are documented by numerous studies, only a handful of studies have so far addressed the latter category.

This study proposes a review of enigmatic pipe bypass systems from both seismic data and potential outcrop analogues. Seismic responses of pipe bypass systems are usually characterized by velocity pull-up, velocity push-down, vertical dim zone/blanking, vertical high amplitude/bright zone, polarity shift, and discontinuous reflections, with size ranging from tens to hundreds meters in diameter, and hundreds to a thousand meters in height. Potential outcrops analogues are smaller in size, with dimensions ranging from meters to tens of meters. Recent studies of outcrops have documented the morphology and the spatial distribution of pipes, and describe processes of formation.

Integration of seismic interpretations with potential outcrop analogues could help to identify the internal structure and composition of seal bypass systems, as such seismic anomalies could either be associated to one or a combination of conditions such as highly fracture zones (either cemented or filled with gas and gas hydrates) sediment remobilization, diagenetic processes, or simply seismic artefacts and misleading features associated with lower seismic resolution. A better understanding of those features will help characterizing pipe bypass systems, and in turn be used to track, and possibly quantify, the expulsion and migration of hydrocarbons in petroliferous basins through time.