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Identification, mapping, and analysis of possible evidences of active petroleum systems in the Colorado Basin, offshore Argentina, South America

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The analysis of a dense 2D seismic reflection dataset and 12 exploration wells data, allowed us to reconstruct the geological evolution of the Colorado Basin, offshore Argentina. We identified and mapped the major syn- and post-rift seismic sequences, and their boundaries such as unconformities and regional seismic markers, present on the continental shelf and slope (water depths from 50 to 1800 m) of the Colorado Basin. Seismic-to-well log correlations, as well as integration with biostratigraphic data provided a chrono-stratigraphic framework for the interpreted horizons. The construction of isochronal (twt) maps provided a 3D spatial visualisation of the stratigraphic relationship among the sequences. The maps show a change in configuration from the break-up unconformity (130 Ma) to the present-day seafloor. The break-up unconformity displays a central EW-elongated graben which prevails on the overlying sequences up to the Miocene. The EW Colorado basin turns NW-SE towards the East, going perpendicular to the present-day continental margin (oriented NE-SW). The strong obliquity of the basin orientation related to the direction corresponding to the opening of the South Atlantic (NE-SW) suggests a structural control from the pre-rift basement on the rift and post-rift sequences. Starting from the break-up unconformity, the history of basin filling is illustrated up to the flat seafloor. The basin sag phase is represented by the sequences deposited between the break-up unconformity and the Colorado discontinuity (Aptian to Campanian). The Campanian to Eocene successions are more or less parallel- layered suggesting sequence aggradation.

The distribution of liquid/gas hydrocarbon-leakage features (i.e. gas chimneys, mud volcanoes, and seabed pockmarks) should allow the definition of potential migration pathways. In this sense, a systematic mapping of these paleo- and present-day features observed in the seismic profiles has been performed and their distribution was analysed in relation to structural and stratigraphic elements present within the syn-rift and post-rift successions. The main observed features consist of seismic vertical pipes where the seismic signal is strongly disturbed. The diameter of mapped seismic pipes ranges from 100 m up to 2000 m. Preliminary classification of these features shows two families of seismic pipes: (1) the first and principal family is mostly concentrated in the centre and innermost part of the basin and seems to be mainly controlled by the stratigraphy, ending in the Elvira Fm (Eocene). Many of these features are linked to the presence of volcanics, as demonstrated by some wells; (2) the second family is located on the oceanward outer part of the basin, reaching the seafloor and resulting in pockmark depressions or seabed mounds. These features represent possible candidates for gas chimneis. Other kinds of gas escape structures as seismic wipe-out zones and hydraulic brecciation are also tentatively observed. The present-day bathymetry from 3D seismic reflection data indicates the presence of seabed pockmarks and submarine channels on the slope of the basin. The circular to near-circular seafloor depressions initially identified on the 2D seismic-reflection profiles correspond to circular-to-elongate pockmarks mapped on the high-resolution bathymetry. Most of the pockmarks present a diameter from 200 m to 900 m and vertical length between 20 m to 100 m, and occur close to submarine channels, which range from 1000 m to 5000 m in width and from 100 m to 500 m in depth.

A highly-dense vertically-faulted interval has been identified within the Colorado (Campanian) and Pedro Luro (Paleocene) Formations in the slope region of the basin. These faults correspond to polygonal fault systems that could breach Paleocene/Eocene sealing sequences, allowing fluids to flow vertically or sub-vertically across the

seal. Numerical modelling of hydrocarbon generation and migration, calibrated to the observations on the seismic data, should allow better insights on the potential of Permian, Jurassic and Early Cretaceous source rocks, as well as the characterisation of possibly active petroleum systems in the basin.