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Wide-spread pockmarked surface: evidence for a Paleogene massive fluid escape event in the Orange Basin, South Africa

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Pockmarks, mud volcanoes and diapirs, gas chimneys, pipe structures, and other seismic anomalies are widely accepted as evidence for fluid and gas migration and leakage processes. A fundamental understanding of the temporal and spatial controls on present-day and paleo fluid seepage is essential when reconstructing the thermal and burial history of sedimentary basins, especially with respect to the numerical reconstruction of hydrocarbon generation, migration, sequestration and leakage. Such seafloor leakage expressions and seismic anomalies have been shown to exist along the West African continental margin. Evidence of fluid leakage processes, such as mud diapirs and seismic chimneys, have previously been identified in some areas of the Orange Basin, South Africa, and were characterized on 2D seismic surveys. Here we present the integration of these published results with our ongoing investigation focusing also on 3D seismic reflection data, which provides new insights and a basin-wide view into the timing and dynamics of fluid migration and seepage on the Orange Basin.

The interpretation of 3D seismic data in the NW of the Orange Basin has led to the identification of a pockmark-covered horizon within Paleogene slope sediments. The pockmarks have average sizes from 200 to 350 m. Their density increases upslope to the point, that they form interconnected structures similar to those described by Pilcher & Argent (2007) in the Congo basin. The pockmarked surface, which has been mapped by integrating the 3D dataset with industrial 2D seismic grids, extends for an area of approximately 2800 km^2 , mainly in Exploration block 2 to the north of the basin. Its dimensions and location, in junction to the fact that it is confined to a wide-spread continuous seismic horizon, make it an ideal time marker for a massive fluid leakage event. It occurs within slope sediments above a well constrained Cretaceous/Cenozoic unconformity and below a Miocene erosional surface.

Several possible triggering factors for this event are currently being investigated: (1) Cenozoic uplift, erosion, and/or Paleogene sea-level fluctuations, (2) Initiation and shifting of ocean currents during early Cenozoic, (3) potentially increased paleo-heatflow due to Paleocene/Eocene and Eocene/Oligocene volcanism along the Southwest African coast, which could have led to the generation and subsequent seepage of thermogenic hydrocarbons along existing migration pathways.

Pilcher, R. and Argent, J., 2007. Mega-pockmarks and linear pockmark trains on the West African continental margin. Marine Geology 244, 15-32