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3D seismic images of tectonic, sedimentary and fluid flow processes affecting the seafloor offshore West Africa

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The seafloor along the passive margin offshore West Africa is affected by numerous processes, ranging from lithosphere scale subsidence offshore, upper crustal gravity spreading, rafting and diapirism of mobile salt and shale deposits during the Cenozoic, deeperwater sedimentation and erosion governed by factors such as salt/shale tectonics, oceanography, climate, eustasy, sediment supply and fluid expulsion due to overpressures linked with sedimentation and hydrocarbon generation. These factors interact to produce the present-day bathymetry as observed in multibeam and 3D seismic-derived subsea-scapes.

This paper will deconstruct bathymetric images derived from exploration 3D seismic volumes and relate the observed features to specific geological processes which are revealed in full 3-dimensional detail by the seismic data that is now widely available along the continental margins of the southern and central Atlantic. It will be demonstrated how the present seafloor, at the resolution afforded by the seismic images (few m in depth and 10-20 m in width) is affected by different length and time scales of geological processes, each spanning 3-4 orders of magnitude.

It is further shown that fluid expulsion can be a dominant contributor to seafloor bathymetry in some regions, particularly those affected by salt or shale tectonics, where fluid expulsion can often be linked with deeper source, reservoir and (leaking) trap configurations, stratal aquifers and seal bypass systems. Other regions may in contrast be entirely shaped by sedimentation and erosion with limited impact of slope tectonics and fluid expulsion.

Insights and understanding derived from exploration 3D seismic images can thus help interpret and ‘ground truth’ bathymetric images, even without seabed samples, leading to more confident interpretation of (paleo-) oceanographic, sedimentary and tectonic processes that affect seafloor bathymetry and associated habitats and hazards.