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Sedimentary facies as control of the shallow gas seismic signatures: Ría de Vigo (NW Spain)

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The Ría de Vigo, in the north-west Iberian Peninsula, is one of four, large, submarine, incised valleys that run in an east-west direction, subject to seasonal upwelling. Geophysical data have revealed characteristic acoustic turbidity in the Holocene fill-sediments, indicating shallow gas accumulation in the Ría de Vigo as well as water column acoustic targets and pockmarks on the seafloor representing gas escape from the sediment. Direct analysis of the gas showed CH_4 to be a major component leading to the conclusion that the Ría de Vigo is a net source of CH_4 to the hydrosphere and atmosphere (Garcia-Gil, 2003).

Interpretation of recent high resolution seismic records has allowed mapping of three new shallow gas fields at the innest part of the Ría de Vigo. There are two fields in the Rande strait area (1.53 $km^2$and 0.26 km^2) and other in San Simón Bay (3.58 km^2). San Simón Bay gas field is the shallowest in Ría de Vigo where gas accumulates almost at the present seabed (ranging from 0 to 2.1 ms TWT). Gas fronts in Rande strait are placed between 0 and 5.3 ms TWT.

Detailed interpretation and mapping of the different seismic signatures of gas fronts and escapes have been performed. There are noticeable spatial variations in the seismic signatures of the gas fronts (ranging from net-sharp to diffuse) as well as in the gas escape seismic targets.

As the gas accumulates almost at the present sea floor in San Simón Bay, is it possible to analyze the relationship between different seismic features and the superficial facies distribution (Vilas et al, 1990). Have been found that gas accumulations only occur when the overlaying facies is muddy - mud/sand ratio $>$1- with less than 30% gravel content. Detail analysis of gas front seismic signatures show the following results: a)

net-sharp gas front appear when overlying muddy facies have less than 1% of gravels and the mud/sand ratio is higher than 9 ('F' facies) or between 9 to 1 ('Fa' facies); b) diffuse gas fronts occur when the overlaying muddy facies have higher coarser fraction coinciding with facies 'F(g)' - mud/sand ratio higher than 9 and 1% to 5% gravels-, facies 'Fa(g)' with 9 to 1 mud/sand ratio and 1% to 5% gravels-, and/or facies 'Fg' -mud/sand ratio $>$1and 5% to 30%gravels-.

Gas fields from Rande strait are deeper than in San Simón. In this area the gas fronts and present sea floor facies seems not to be in agreement with the results from San Simón Bay. Then the relationship between facies and seismic features have been analyzed by using vibrocore data (1.5 m length-compacted) tied to seismic profiles, in order to check vertical changes of facies. OM and carbonate content logs from the vibrocore allowed more precise determination of the gas front, located to 90 cm depth. Sedimentological analysis reveals that seal facies (F) at the seafloor changes to facies F(g) in depth (90 cm). The facies F (g) also controlled the occurrence of diffuse gas fronts in San Simón Bay gas field. Therefore, it can be concluded that seal sedimentary facies control the seismic signature of gas accumulations. The facies also control the seeps distribution. These last targets are located on sandy seafloor.

The biogeochemical cycling of CH_4 and the air-sea flux of CH_4 in this environment remain understudied. A previous estimate of CH_4 emission from the Ría de Vigo based on the density of acoustic plumes and pockmarks and assuming a constant gas composition concluded that $\sim$150-4500 t/yr were emitted annually (Garcia-Gil, 2003). This estimate did not take into account the new gas fields and neither the contribution of dissolved methane exchange via diffusion between the sediment-water and air-sea interfaces and is therefore probably an underestimate of the total flux. At present, studies on biogeochemical cycling of methane in the Ría de Vigo, combining acoustic survey data with field measurements of dissolved CH_4 concentrations and the δ^{13}C-CH_4 isotopic signature in sediments and the overlying water column are being carry out.

Garcia-Gil, S (2003). A natural laboratory for shallow gas: The Rías Baixas (NW Spain). Geo-Mar Lett 23: 215-229.

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