Porcupine Basin: Cold Water Corals, Mud Mounds, Sedimentology, Stratigraphy and Tectonic setting

CARBONATE MUD MOUNDS AND COLD WATER CORALS IN THE PORCUPINE SEABIGHT AND ROCKALL BANK: ARE THEY METHANE RELATED?

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The TTR programme has taken in 1997 a multi-vessel profile, with R/V *Belgica* and R/V *Pelagia* carrying out surveys for preparing the operations of R/V Prof. *Logachev*, respectively in Porcupine Basin and on Rockall Bank. One of the main tasks of the TTR7 programme was the study of seabed carbonate mud mounds in the Porcupine Seabight and on the Rockall Bank and the analysis of their possible relation to hydrocarbon seeps through the seafloor. To tackle this problem, a wide set of methods has been applied, including single-channel seismic profiling, which on board of R/V *Prof. Logachev* has been carried simultaneously with swath surveying of the seafloor with the OKEAN long-range sidescan sonar, and seafloor characterization with the O.R.E.TECH deep-towed medium-to-short-range sidescan sonar equipped with a 5-kHz subbottom profiler. Underwater video-filming and photography and bottom sampling with a large-diameter gravity corer, boxcorer, kastencorer, dredges, and TV-controlled grab-sampler has been carried out along five profiles in Porcupine Basin.

The following sub-sample analyses have been carried out: free gas (by the head-space method), interstitial water, micropalaeontological studies and different sedimentological and geochemical analyses. Furthermore, Eh and pH values have been measured on board on sedimentary cores, and abundant benthic taxa were collected and defined.

The preliminary interpretation of the geophysical field data and the first sedimentological and geochemical analyses can be summarized as follows. Seismic, sidescan sonar and subbottom profiler data suggest that some local acoustic anomalies might be connected with gas flux or shallow gas accumulations. The shallow core examinations on deck however did not show any visible evidence for the presence of gas or any geochemical clues. These observations were confirmed by measurements in fresh sediments. The values obtained are typical of normal basinal sediments. The continuous TV records and discrete photographic pictures taken along lines running over carbonate mounds revealed neither gas seeps through the seafloor, nor associated phenomena. According to the conclusions drawn by the biological team, none of more than 100 epibathyal species defined from carbonate mounds belongs to chemosynthetic communities. In other words, they cannot be looked upon as being related to methane seeps or enhanced bacterial activity.

These results, together with low methane concentration in sediments (from chromatography data) and low EOM content, can not suggest the existence of detectable hydrocarbon fluxes through the carbonate mounds in the shallow sediments along the investigated profiles. The mineralogical composition of carbonate components (carbonate inclusions, fragments of shells and corals, etc.), as

well as isotope values of $\delta^{13}C$ and $\delta^{14}C$ for coral fragments collected from different parts of the sequence recovered attest that the stable hydrocarbon flux has been absent on the samples sites during the whole Holocene and part of the Pleistocene, at least over 70 ka.

Thus, the question of the nature and origin of the carbonate mud mounds of Porcupine Basin remains open. Surface evidence suggests that - at present and in the recent geological past - the distribution and the patterns of active growth of cold water corals inhabiting these mounds are closely controlled by climatic variations and bottom currents. On the other hand, the numerous buried ring reefs ("Magellan mounds") mapped by R/V *Belgica* argue for a past fluid flow event, and some acoustic anomalies can be interpreted in terms of local gas accumulations or fluxes. What probably eludes our efforts might be patterns in space (focused versus diffusive fluxes) and/or time (transient versus steady-state flows). An indirect evidence for this could be some observations of abnormal increases in the concentration of methane in the uppermost parts of several cores. Together with the observation of possible gas plumes on the subbottom profiler records, this might suggest charging of the sediment with methane-saturated water from nearby venting sites.

Only drilling the base of the mounds will probably bring the clue towards their origin.

THE GEOLOGICAL DEVELOPMENT OF THE PORCUPINE BASIN

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The Porcupine Basin is a north-south trending basin lying west of Ireland. It is approximately 230km long and is 100km at its widest, narrowing northwards to 65km. Water depth increases southwards from 300m in the north to over 1500m in the south where the basin opens out into the Porcupine Abyssal Plain.

The Porcupine Basin is underlain by thinned continental crust, 9-10km thick. It has a roughly symmetrical profile and contains up to 10km of Mesozoic and Cenozoic strata. A Devonian to Carboniferous succession of non-marine to marginal marine clastics represent the deposits of an early east-west sag basin. Later, Permo-Triassic extension produced a number of small rift basins in which red-bed continental clastics were deposited. Post-rift marine and non-marine shales and sandstones were followed by onset warp and rift clastics of Late Jurassic to Early Cretaceous age. Cretaceous and Tertiary thermal subsidence then took place, with associated basin fill. The subsidence was interrupted in Aptian-Albian times by the development of rift related deltaics and also during the Early Tertiary when a major regression resulted in sandstone deposition in deltaic and submarine fan environments.

Present day features in the Basin include numerous high relief, deep water carbonate build-ups and the development of a deeply incising, low sinuosity channel system draining from the continental shelf south-west of Ireland into the deeper Porcupine Abyssal Plain.