MASSIVE GAS DEPOSITS (CLATHRATES) IN THE GULF OF MEXICO

Allen Lowrie[1] and Michael Max[2]

ABSTRACT

Geophysical reconnaissance of ocean basins, including the Gulf of Mexico, reveal extensive distribution of bottom simulating reflectors (BSR), generally regarded as evidence of massive gas hydrates (clathrates). These BSR reflections represent pronounced velocity changes associated with the base of the clathrate stability zone (CSZ). Thickness of the CSZ depends on the local pressure-depth and geothermal gradient. The BSR mimic the seafloor morphology.

Preliminary estimates by U.S.G.S. geologists indicate that there may be as much hydrocarbon in the deep and adjacent margins, in the form of clathrates, as have been found so far on the continents, including coal. In the Gulf of Mexico, there could be from 200 to 2000 Tcf of gas. As the global economy goes through a transition to gas-based from oil-based, these clathrates and related gas deposits may provide the main non-nuclear energy resources for the planet.

Clathrates are compound crystalline substances formed from natural gas (mainly methane) and water, which are stable at the moderate to high pressures commonly found in oceans below about 400 m water depth (pressure increases at an atmosphere per ≈10 m depth). Clathrates occur in a surface-parallel zone of thermodynamic equilibrium (Clathrate Stability Zone, CSZ) in which heat input from the warmer earth below and heat transfer into cold bottom water are in equilibrium and pressure-temperature fields in which clathrate is stable are maintained.

Clathrates can form and accumulate in any ocean sediment having suitable gases and appropriate thermodynamic conditions, de Boer, *et al.*, 1985. Optimum conditions for formation of clathrates are found in thickly sedimented areas of the deep oceans where large quantities of gas can be produced petrogenetically in the lower part of the sediment column. Regions of high heat flow can produce more gas than comparable areas of low heat flow. A thickly sedimented area that has a high rate of sedimentation and considerable buried organic carbon debris has a high gas-producing potential. Such an area is characteristic of passive continental margins as along the Gulf of Mexico.

The bottom-simulating reflector (BSR), commonly imaged on seismic reflection profiles, is an acoustic impedance marker associated with the base of the clathrate blanket. Where free gas occurs beneath the clathrate layer, a strong negative impedance contrast occurs because of the pronounced velocity and density change. The BSR is usually sub-parallel to the sea floor.

[1] 230 F.Z. Goss Road, Picayune, Mississippi 39466-9707
[2] SACLANT ASW Research Centre, Viale San Bartolemeo 400, 1-19026 La Spezia, Italy

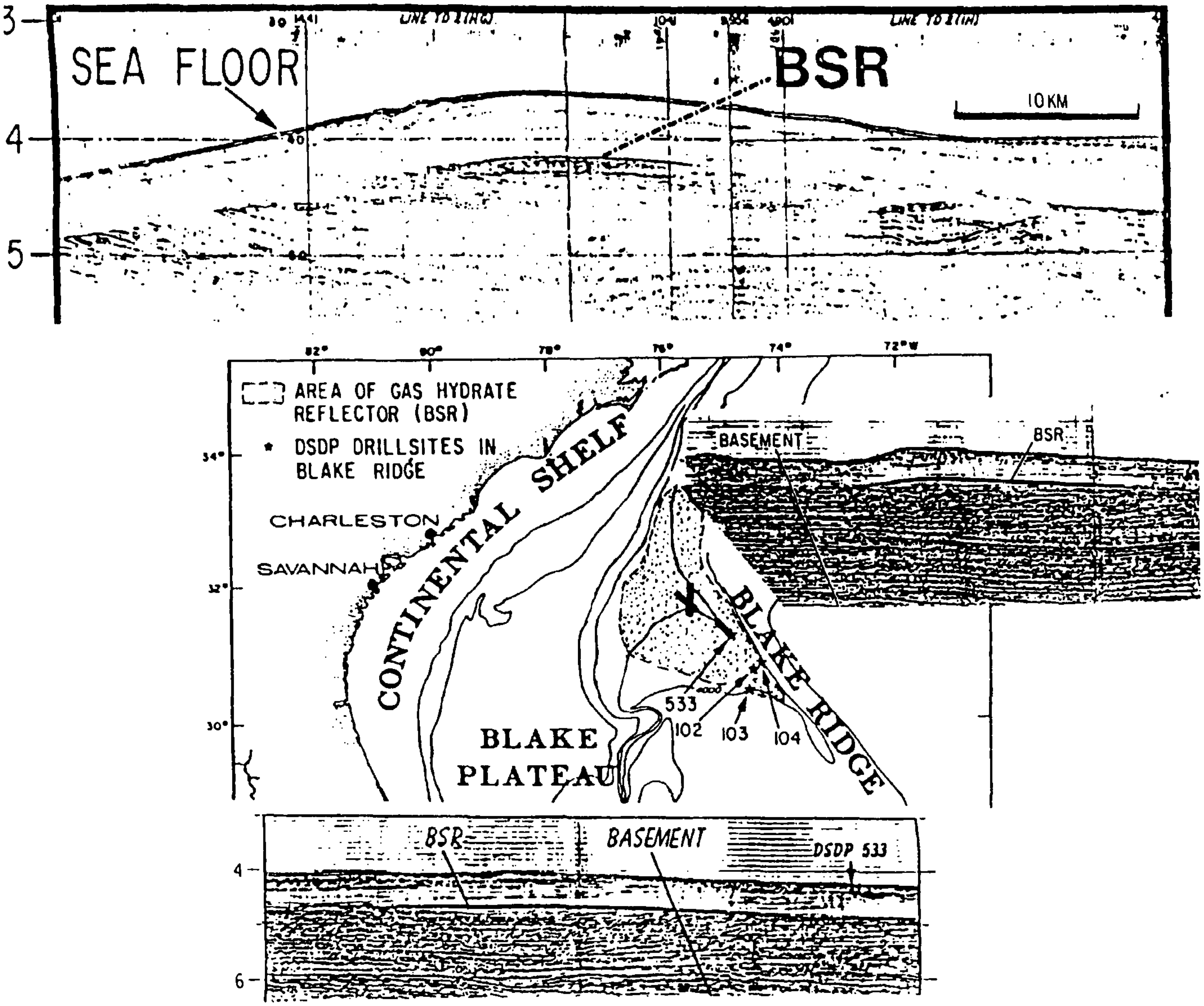

Figure 1. Composite figure after Dillon and Paull (1983) showing location and orientation of seismic sections and the position of trapped gas beneath the BSR in relation to seafloor and BSR culminations off the U. S. southeast coast. Sedimentary structure appears to pass up into zone toward sea bottom, possibly indicating that the present bottom here is an erosional surface; 10 scale for all sections. Note that the lower part of the CSZ is more transparent, indicating more massive and saturated clathrate.
A. N-S section showing single gas concentration.
B. NW-SE section ground-truthed by DSDP drilling at hole 533. Base of clathrate not penetrated.

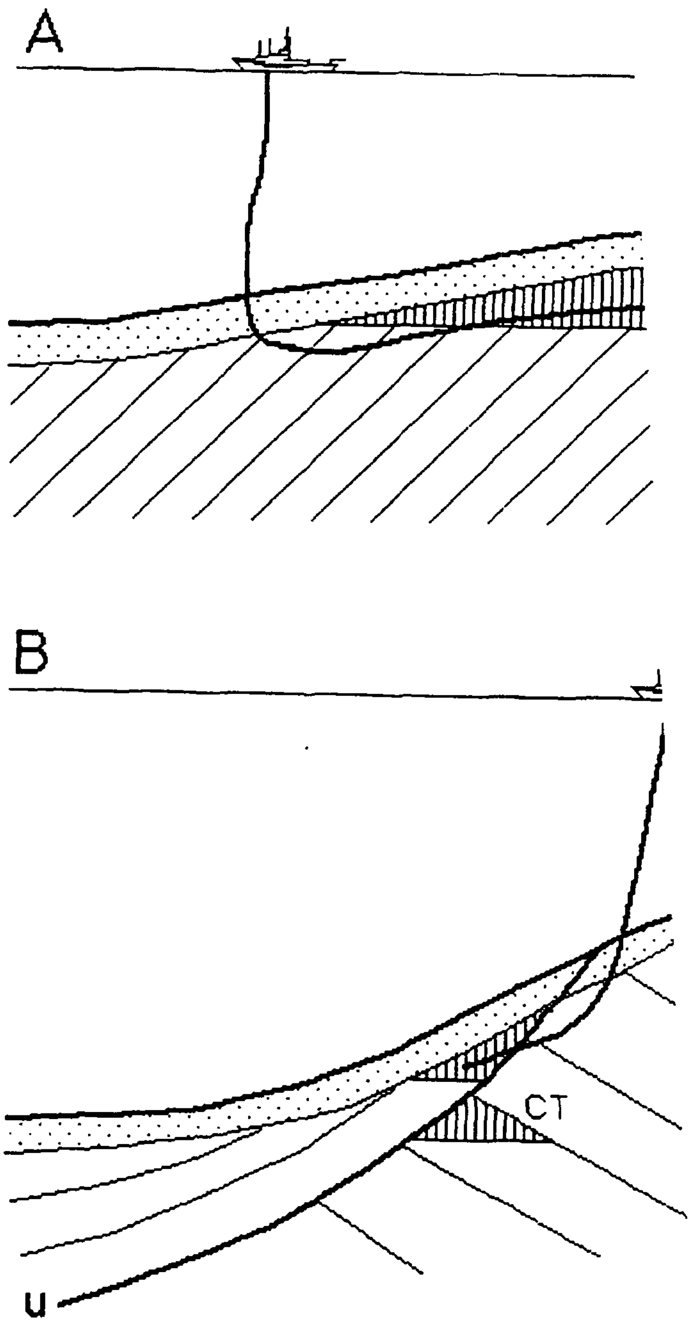

Figure 2. Clathrate traps and drilling strategies diagram; no scale. Drill hole shown by heavy line emanating from drill ships. A. Clathrate culmination trap with steep penetration of CSZ to the side of gas pocket and largely lateral penetration of the gas reservoir. B. Compound clathrate-geological traps. Hole number near drilling ships refer to the two general cases in Figure 2. Classical geological trap, CT, for comparison; in this case by unconformity/impermeable strata. Major unconformity, U, in continental slope.