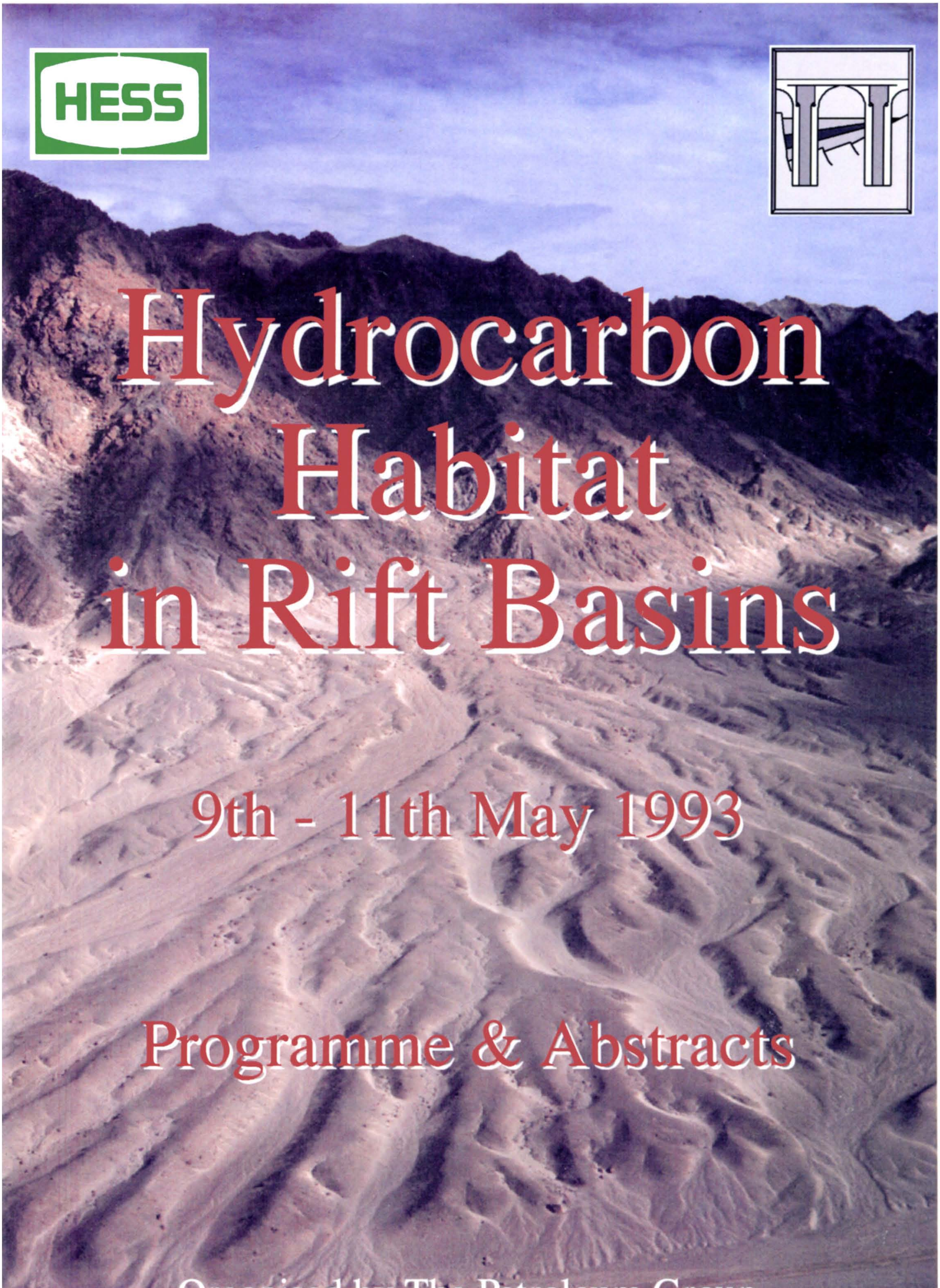

Hydrocarbon Habitat in Rift Basins

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CLIMATIC MODULATION OF SOURCE, RESERVOIR AND SEAL FACIES ALONG THE ZONAL CLIMATIC GRADIENT OF PANGEA

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Largely continental rift basins formed in a broad belt from Greenland and Spitzbergen to the Gulf of Mexico and northwest Africa during the initial stages of the breakup of Pangea. There was a clear latitudinally zonal pattern with dramatic gradients during the Late Triassic and Early Jurassic with a narrow (>10°) equatorial humid zone and a broad high-latitude humid temperature zone. This is in agreement with new paleomagnetic data from the Newark basin of Eastern North America and the predictions of recent GCM studies of Pangea by Kutzbach and others.

The overall zonal pattern resulted in a distinct array of types of largely lacustrine rift fill along the humid to arid gradient. I recognise four lacustrine sequences types. These are: 1) the Richmond-type characteristic of the humid equatorial zone, 2) the Newark-type characteristic of the transitional region between the humid equatorial zone and the arid zone, 3) the Fundy-type characteristic of the broad arid zone, and 4) the Cap Stewart-type characteristic of the humid temperate zone. Richmond-type basins have very well developed organic-rich rocks produced in perennial lakes that lasted many tens of thousands of years. These organic shales are interbedded with many types of sandstone providing a wide array of reservoir and seal combinations in proximity to the source rocks. Newark-type basins have rich but thin organic rich shales intimately interbedded with volumetrically much more abundant organic poor mudstones arranged in a clear hierarchical cyclical pattern. The organic rich units were produced by perennial lakes that lasted less than 10,000 years while the organic-poor mudstones were produced in playas. Sandstones in Newark-type sequences tend to be limited to the margins of the basin which along with the laterally continuous but vertically limited source rocks provide fewer reservoir and seal combinations. Fundy-type sequences tend to have no or few organic-rich shales and have little source potential. However, they do tend to have excellent reservoir potential in aeolian sands as well as excellent potential seals in red shales and evaporites. The Cap Stewart-type of lacustrine sequence is poorly documented, but tends to have organic-rich mudstones dominated by terrestrial plant matter and coals, intimately interbedded with sandstones. This type of basin might again offer a wide variety of trap and seal combinations, but would tend to be gas-prone, at least in the known examples. Both Fundy-type and the Cap Stewart-type of basin are important in the North Sea area.

During the Late Triassic and Early Jurassic North America (and most likely the rest of Pangea) drifted north at fast rates during the Carnian and Early Norian at much slower rates during the rest of the Norian and early Hettangian and at faster rates again during the rest of the Early Jurassic. The overall northward drift produced a dramatic change in the geographic areas in each climate zone. In eastern and western North America, this resulted in apparent increasing aridity as these areas passed from the humid equatorial zone into the arid zone. In northern Europe and Greenland the same drift northward can be seen as an overall trend to more humid conditions as those areas pass into the humid temperature zone.

As a consequence of the northward drift of Pangea, the lacustrine sequence-type changes dramatically through the basin section within individual basins. Thus the Richmond and Taylorsville basins, which start out at the equator in the Early Carnian, show a transition from Richmond-type lacustrine sequences at their base to Newark-type sequences in their Late Carnian-Early Norian strata. Likewise, the East Greenland rifts show a change from Fundy-type lacustrine sequences in the Carnian-Middle Norian to the Cap Stewart-type in the Rhaetian-Hettangian.

Superimposed on these dramatic changes caused by the northward drift of Pangea are more subtle changes caused by the tectonic growth of the rifts and global climate changes, as well as constant fluctuations caused by Milankovitch-type climatic cycles.

Similar types of lacustrine sequences can be recognised through the Mesozoic and early Cenozoic along similar climatic gradients. Modern analogs might include lakes Tanganyika and Malawi for Richmond-type sequences. Lake Turkana for Newark-type sequences and perhaps lakes in the Afar region of Ethiopia for Fundy-type sequences. Because, the temperature zones of the world presently tend to have cool or cold winters, there may be no modern analogs for Cap Stewart-type basins.