Porosity Formation Beneath Subaerial Unconformities in the Lisburne Field, Prudhoe Bay, Alaska

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Five major regional unconformities are present within the Lisburne Group carbonates at Prudhoe Bay. All show erosional truncation but differ in origin, sediment response, length of exposure, and diagenesis. Economically significant porosity is associated with three of the five unconformities; the pre-upper Permian unconformity (PUPU), the lower Cretaceous unconformity (LCU), and the mid-Mississippian unconformity (MMU).

Both the LCU and PUPU are high-angle, erosional surfaces formed during long periods of regional exposure associated with major tectonic events. Neither surface preserves signs of early porosity development. The lack of relief along both of these surfaces within the Prudhoe Bay region suggests that transgression after exposure removed any early porosity that may have been present. Karstic breccias lacking porosity are present below the PUPU in outcrop 150 miles (300 km) away. Petrographic and geochemical data indicate porosity is late, formed during burial and expulsion of fluids from overlying thick marine shales. Local tectonics and paleogeographical setting are likely to have been important in focusing fluid flow into the Lisburne carbonates in the Prudhoe Bay structure.

The other three unconformities are more likely to be of eustatic origin. These differ greatly in sediment response, length of exposure, and amount of preserved porosity. While signs of subaerial exposure are present along all unconformities, only the MMU shows significant porosity in peritidal dolomites immediately beneath the unconformity surface. Intercrystalline porosity in the dolomites is related to widespread peritidal facies and does not show clear evidence of diagenetic processes related to the unconformity. Thus, porosity development beneath unconformities of eustatic origin is most closely related to the distribution of facies tracts at the close of major depositional sequences. In summary, near-surface diagenetic processes have not been important in creating porosity at unconformity surfaces in the Lisburne carbonates at Prudhoe Bay. However, significant burial dissolution and dolomitization has occurred along unconformities of tectonic origin. Predicting porosity associated with these surfaces relies on understanding the structural evolution of the Prudhoe Bay region.

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Biographical Sketch

Jeremy Jameson has spent much of his career studying mid-Paleozoic carbonates, first in Scotland, then in Alaska, and most recently in the CIS. Jeremy has fourteen years experience with Exxon in various aspects of carbonate petroleum geology. He is currently working for Timan Pechora Company (which is partially owned by Exxon Ventures CIS) on the description and assessment of oil fields in the CIS. Before that, he spent eight years at Exxon Production Research Co. and Exxon USA working various aspects of the Lisburne Field appraisal, equity determination and development planning. He received a B.A. degree from Indiana University in 1973 and a Ph.D. from the University of Edinburgh, Scotland in 1980.