



AUTHOR Peter P. Johnson and James D. Craig

AFFILIATION U.S. Minerals Management Service

ADDRESS 949 E. 36th, Room 101, Anchorage, Alaska
99508-4302

TELEPHONE (907) 261-4000

TITLE: An Overview of the Shallow Geology and Environmental Conditions
Affecting Petroleum Activities on the Beaufort Shelf, Northern Alaska

ABSTRACT

The Arctic environment is unique in both the number and severity of geologic and environmental factors which affect offshore development. In addition to the potential conditions of sediment instability, near-surface faults, and shallow gas, operations on the Beaufort shelf must also contend with cold-temperature-related factors such as sea-ice movement, seabed ice scouring, subsea permafrost, and the generally hostile climate.

Seismic data indicate that shallow gas occurs across large parts of the Beaufort shelf and is often associated with the permafrost layer and near-surface faults. Free gas has been encountered in geotechnical boreholes and may pose a hazard to these shallow drilling operations. Faults near or at the seafloor have been identified throughout the Beaufort shelf, although the highest concentration is in the eastern Beaufort associated with actively growing anticlines. Seafloor sags and small fault scarps indicate that many of these faults were recently active. Seismic activity with shallow-focus earthquakes to a magnitude of 5.3 has been detected in this area. Large, near-seafloor faults have also been identified in seismic data along the shelf-slope break, where they bound large-scale slump features tens of kilometers long.

Ice scouring is particularly prevalent in mid-shelf water depths (18 to 30 m) where shearing between the relatively stationary landfast ice and the highly mobile arctic pack ice forms deep-keeled pressure ridges which scour the bottom. In this zone, virtually 100% of the seafloor is covered by gouges and the sediment is reworked to depths of 5 m. Well-bonded permafrost is widespread on the inner Beaufort shelf below a few to tens of meters of unfrozen to partially frozen sediments. Seismic refraction data indicate that this layer may occur out to mid-shelf water depths as well. In addition to creating variable and potentially unstable foundation conditions, the permafrost layer may trap gas migrating upward to shallow subbottom depths.

Geologic assessment of the processes and character of the Beaufort shelf is hampered by the relatively low density of high-resolution seismic data and borehole data. However, the existing data base indicates that the shallow geology may vary greatly within small geographic areas. Therefore, the U.S. Minerals Management Service requires that detailed site-specific surveys by both geophysical and geotechnical techniques are carried out and thoroughly evaluated prior to the installation of offshore facilities on the Beaufort shelf.

