Understanding In-situ Stresses in Permafrost and Gas Hydrates and Their Application to Well Design and Drilling Hazards in the Mackenzie Delta, NWT

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The recent increase in exploration interest in the Mackenzie Delta region of the Northwest Territories has generated some important questions regarding the in-situ stress regime in permafrost and gas hydrate reservoirs. The orientation and magnitudes of the principal in-situ stresses as a function of depth are used for designing safe and efficient drilling and completion strategies in this setting.

In-situ stresses can be used to: 1. avoid borehole instability; 2. estimate the fracture gradient; 3. design a cuttings re-injection process; 4. design or avoid a hydraulic fracture when stimulating a gas hydrate zone; 5. assess the risk of vertical fracture growth above a gas hydrate interval that is experiencing high gas dissociation pressures; 6. understand overpressures; 7. assess the integrity of the permafrost and its role as a seal; and 8. design stable well completions to prevent collapse during production-related thaw subsidence or freeze-back.

This presentation will first review the current state of knowledge regarding in-situ stress in permafrost and gas hydrates for a selected area of the Mackenzie Delta (stress orientations, leak-off tests and laboratory measurements of K_o). The key factors that can affect the stress regime at a given location will then be reviewed (thermal history, glacial loading, thermokarst and other factors). Model-based predictions of the profile of vertical and horizontal stresses will be illustrated for a range of plausible assumptions.