Ice scour in the geological record and its applicability to offshore oil and gas development

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Interaction between the keels of floating ice masses and seabed or lakebed sediments results in the formation of linear or curved scours in the substrate. A typical iceberg scour is 1.4 m deep and 45 m wide, and a typical scour formed by sea ice pressure ridge keels is 0.5 m deep and 26 m wide. Scour length in both cases may range from several hundreds of metres to several tens of kilometres.

Examinations of relict Pleistocene scours exposed above water level, and of modern, small scale tidal flat scours developed in clays and silts provide subsurface information which cannot be easily obtained from submerged features. Sediments are displaced by the penetrating, moving keel. In the general case material in front of the keel is pushed forward into a surcharge and is displaced laterally to either side forming linear piles, or berms, of typically disaggregated sediment which form the outer berm margins. Sediments beneath the keel are displaced downward, and sediment at the free surfaces on either side of the keel respond to this compression by upwarping to form the inner berms of typically cohesive material with prominent fractures. Localized faults with large displacements (3.5 m) may develop beneath the scour trough and berms.

Small scale modelling of the scour process has been undertaken in sand and silt at 1 gravity, and in clay at 100 gravities. Among the most important findings of these physical models are: that sub-scour deformations are not negligible, that the attack angle of the keel's leading edge makes a significant difference to the sub-scour deformations, and that soil density and type are major controllers of seabed response to scouring.

The combination of field observations and small scale modelling has allowed the development of more accurate conceptual models of the scour process. These models will lead to codes of practice for burying submarine pipelines in sediments affected by scour, because well defined zones of scour-related perturbations may be delineated. This could lead to savings of millions of dollars in development regions such as the Canadian east coast and Beaufort Sea.