Stratigraphy, sedimentology and reservoir characteristics of glaciogenic reservoirs using high-resolution quantitative mineralogical and textural analysis of drill cuttings

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Deeply incised and buried glacial valleys and their infill are prominent geomorphologic and sedimentary features of glaciated regions such as those ones occupied by the Pleistocene ice sheets in North America, North Europe and Russia. Very similar features formed during the earlier glaciations such as those ones during the Upper Ordovician and Carboniferous, which characterise Palaeozoic terrains in North Africa and Middle East.

In both cases, these glacial valleys represent very important geological features which often contain abundant natural resources such as ground-water, mineral resources and hydrocarbons. Unravelling their stratigraphic infill, sedimentology and reservoir characteristics is therefore vital to drive an effective exploration and sustainable development of these resources.

Understanding the geology of glacial valleys however, is often a challenging task as the nature of the sedimentary systems genetically associated with glaciers and continental ice-sheets development is typically very variable and complex. Generally, this results in large uncertainties on reservoir stratigraphy, facies types and distribution and internal 3D architecture. These uncertainties can be even larger when dealing with few and sparse well data with little core material available.

In this paper, we present the results of a high-resolution mineralogical and textural analysis performed on ditch cuttings derived from two different wells located in Ontario, Canada and NW Germany, Europe. Both wells were drilled in the middle of deeply buried Pleistocene glacial valleys. In both cases these tunnel valleys represent important ground-water reservoirs and at the same a relevant analogue for Palaeozoic hydrocarbon reservoirs.

The cutting materials were analysed using the QEMSCAN® automated mineralogical analysis system. This system uses a combination of XRD and SEM techniques to identify the mineralogical composition of the sediment together with texture on undisturbed cutting samples. Grain-size was then compared with the reconstructed density and porosity logs and used to identify potential reservoir flow units.

The combination of mineralogical and textural composition and the derived vertical distribution of lithotypes provided an invaluable tool to define stratigraphical units, sediment provenance, the nature of sediment and, finally, attempt a sequence stratigraphical reconstruction of the glacial valley infill.

This study demonstrates the value of the QEMSCAN® analytical approach as a tool to unravel the stratigraphy, sedimentological and property distribution of heterogeneous sedimentary sequences such as glacial valley infills. It also highlights how cuttings, in absence of cores, if

properly analysed, can represent important source of information to assist the characterisation of the modelling of subsurface reservoirs.