Tectonostratigraphic Evolution, Paleogeography and Hydrocarbon Plays of the Nuussuaq Basin: An Outcrop Analog to the Huge Frontier Petroleum Basins Offshore West Greenland

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Abstract

The Cretaceous-Paleogene Nuussuaq Basin in central West Greenland represents a unique outcrop analog for the huge frontier basins offshore West Greenland. Widespread oil seeps demonstrate the presence of a working petroleum system and the Nuussuaq Basin not only serves as an analogue for the offshore areas, but also has its own hydrocarbon potential. The basin fill is divided into five tectono-stratigraphic phases representing: 1) Pre-Rift, 2) Albian - Early Cenomanian Early Rift, 3) Early Cenomanian - Early Campanian Subsidence, 4) Early Campanian - Early Paleocene Late Rift, 5) Early Paleocene - Late Eocene Break-Up and Drift. The rocks of the Pre-Rift Phase consists of deeply weathered Archean gneisses and Proterozoic metasediments. The Albian - Early Cenomanian Early Rift Phase is defined by N-S directed extensional faults. Alluvial fan, fan-delta and lacustrine sediments were deposited in grabens and half grabens, onlapping weathered basement highs. Biomarker studies of oil seeps suggest the presence of an Albian lacustrine Type I-III source rock. The sediments of the Early Cenomanian - Early Campanian Subsidence Phase overlie a regional marine drowning surface and consist of sandy shelf-delta deposits and basinal marine mudstones. A Cenomanian-Turonian marine Type II source rock is proven by biomarker studies of oil seeps. The Early Campanian - Early Paleocene Late Rift Phase was characterized by a change in stress regime, formation of NW-SE directed extensional faults

associated with a major change in palaeogeography and transformation of the basin into a turbidite basin. Major uplift of the basin occurred just prior to continental break-up during the latest Cretaceous - Early Paleocene resulting in deep canyon incision. Oil seeps and well data indicate the presence of a Paleocene Type II-III source rock. Following break-up, a thick succession of volcanic extrusives of the Drift Phase was deposited. During the Late Paleocene - Early Eocene transpressional movements and counter-clockwise rotation of Greenland caused compressional structures to develop. Based on outcrops and well data, three main plays are established. 1) Albian - Early Cenomanian Early Rift Play (SR: Albian mudstones; Reservoir: Albian - Early Cenomanian fluvio-deltaic sandstones, Seal: Cenomanian-Turonian shales), 2) Early Cenomanian - Early Campanian Subsidence Play (SR: Cenomanian-Turonian shales, Reservoir: Early Cenomanian - Santonian shelf-deltaic sandstones, Seal: Campanian shales), 3) Late Cretaceous - Early Paleocene Late Rift Play (SR: Cenomanian-Turonian and Paleocene shales, Reservoir: Late Cretaceous - Early Paleocene turbidite channel and incised canyon sandstones; Seal: Paleocene shales). The most important traps appear to be associated with fault-bounded 3-way closures and compressional structures.