Effects of exhumation in the hydrocarbon exploration of the Snøhvit Field, Hammerfest Basin, Norwegian Barents Sea.

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The Barents Sea is well known for its unusual basin evolution and complex uplift history which have resulted in the discovery of abundant gas and little oil. Several recent oil and gas discoveries in the southwestern Barents Sea are now triggering an increased interest in this huge, largely unexplored petroleum province. The complexities of the Hammerfest Basin necessitate the use of all available geological and geophysical information when undertaking regional interpretations, play fairway assessments and prospect definition. In order to study the petroleum system, it is also important to investigate exhumation effect on the rock properties and hydrocarbon prospectivity. This study focuses on estimation of Cenozoic exhumation in the Snøhvit field that comprises three discoveries; Snøhvit, Albatross and Askeladd (Fig. 1).

An integrated approach, using well log data and published compaction curves (Mondol *et al.*, 2007, Mondol 2009), has been utilized to estimate Cenozoic exhumation. This estimation is based on transition zone between mechanical and chemical compactions. Bottom hole temperature has been used to infer the transition zone temperature. On the basis of transition zone, the estimation for exhumation is investigated. A suite of well logs from 15 exploration wells from the Snøhvit area, has been taken into account. The transition zone from mechanical to chemical compaction marked on the basis of grain framework stiffening due to the onset of quartz cementation as long as the surface area is available for precipitation of quartz and temperature is higher than 70ºC.

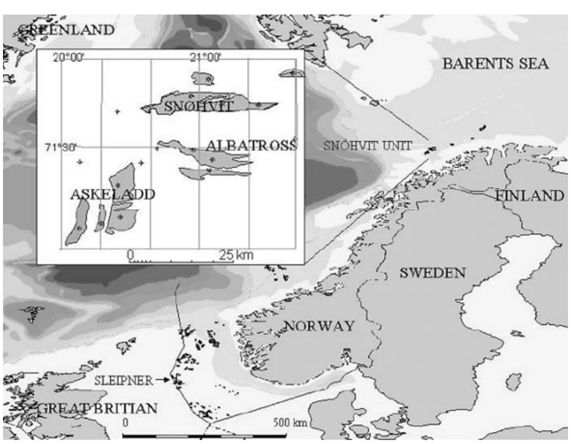

Fig. 1.: The map showing the location of Snøhvit area (after Maldal & Tappel, 2004).

Compaction of sediments occurs due to effective vertical stress at a shallow depth (mechanical compaction) and dissolution of unstable minerals and precipitation of new and more stable minerals at a higher temperature corresponds to greater burial depth (chemical compaction). Due to the combine effect of mechanical and chemical compaction, the rock properties such as velocity, density and porosity alter continuously with increasing burial depth (Mondol *et al.*, 2007).

Our analyses show that the present day transition zone temperature in the study area does not match with the actual temperature reflecting the Hammerfest Basin as an exhumed basin. The compaction trends, particularly, velocity versus depth found in the studied wells have been used to investigate the transition from mechanical to chemical compaction. When sonic velocity versus depth trends have been compared with published compaction curves, there was found a mismatch on the basis of which exhumation was calculated. The calculated exhumation estimates differs for Snøhvit, Albatross and Askeladd discoveries depending upon the structural configuration (Fig. 2). The exhumation for Snøhvit discovery is from 300 to 800 m increasing from west to east whereas, in the Albatross discovery it increases in opposite direction ranging from 700 to 1000 m. In the Askeladd discovery it ranges from 300 to 1000 m and decreasing from south to north. This exhumation estimation is in accordance with the published literature (Ohm *et al.*, 2008, Henriksen, 2011).

It is clear from our investigation that a complex burial history of the Hammerfest Basin involving uplift, erosion and renewed burial during Cenozoic time has influenced the distribution of oil and gas in the reservoirs and the position of fluid contacts.

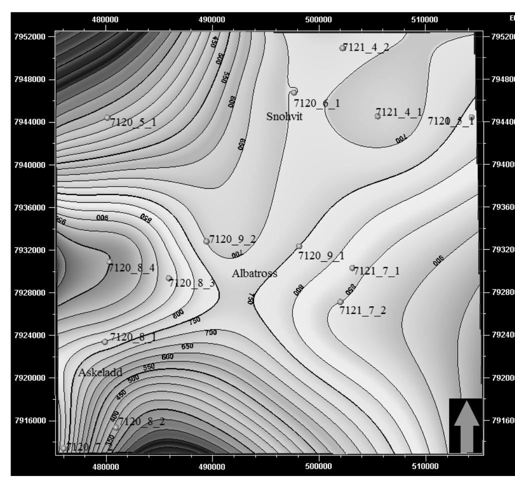

Fig. 2.: Contour map (Butt, 2012) showing exhumation based on the experimental curve (Mondol, 2009) kaolinite-silt (50:50) in the Snøhvit development.

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