Mesozoic source rocks of the Arctic: understanding their occurrence

Jan Golonka
AGH University of Science and Technology; Faculty of Geology, Geophysics and Environmental Protection, Mickiewicza 30, 30-059 Krakow, Poland, e-mail: jan_golonka@yahoo.com; jgolonka@agh.edu.pl

Understanding the critical processes controlling the accumulation and preservation of organic matter to eventually form source rocks and how these processes vary depending on the specific paleogeographic, tectonic, and climatic setting is the starting point for source rock prediction. Prediction of source rocks includes two steps:

1. Construction of palaeogeographic map (with palaeoenvironment and palaeolithofacies) and identification of palaeobasins
2. Evaluation of palaeobasins and obtaining the Source Rocks Prediction Value (SRPV).

The Mesozoic palaeogeographic maps were constructed using a plate tectonic model, based on **PLATES** and PALEOMAP and GPLATES programs, which describes the relative motions between plates and terranes. It takes tectonic features in the form of digitised data files, assembles those features in accordance with user specified rotation criteria. The generalised facies and palaeoenvironment database information were posted on base maps. For example the reef data (see Kiessling *et al*. 1999) were rotated together with plate's polygons. The calculated palaeolatitudes and palaeolongitudes were used to generate computer maps. Information from several general and regional palaeogeographic papers were filtered and utilized.

The presented palaeogeographic maps of the Arctic region (Golonka, 2011) distinguish 17 palaeoenvironments: active mountains, inactive highlands, non-depositional medium-low areas, terrestrial undifferentiated, fluvial, fluvio-lacustrine, lacustrine, eolian, marginal marine, paralic, intertidal, deltaic, shallow-marine, deep basin with sedimentation, ocean basin without sedimentation, slope and area covered by gravity deposits.

Evaluation of organic richness in a specific palaeogeographic, climatic and tectonic setting is control by three major processes (Golonka *et al*. 2009). These three processes are biologic productivity, background sedimentation rates with non-dilution of organic richness by clastic sedimentation, and preservation of organic matter. The amount and richness of organic matter buried in marine sediments then depends on the balance between production and destruction, where the latter includes consumption, decomposition, and dilution. The overall efficiency of each of these processes, including their sub-processes, was assigned a value between 1 and 5 (5 being most effective) as judged by at least five experts and the results combined into an average value. The three values, one for each of the major processes, were multiplied together to produce a Source Rock Prediction Value (SRPV, range 1-125). The SRPV gives a semi-quantitative assessment of the efficiency of accumulation and preservation of organic matter within a depocenter. It does not actually indicate whether the organic facies will be rich enough to be a good source rock. However, the processes described above and evaluated to determine SRPV also control source rock richness, and source rock richness can be measured. By calibrating SRPV with known, measured values of source rock richness (SPI), the *presence and richness* of potential source rocks can be predicted. The source potential index (SPI) is a measure of cumulative petroleum potential (Demaison & Huizinga, 1991). It is defined as the maximum quantity of hydrocarbons (in metric tons) that can be generated within a column of source rock under 1 m^2 of surface area, Fig. 2. This index combines thickness and richness into a single parameter, which does not distinguish between gas or oil or depend on maturity or source rock type.

The Late Jurassic-Early Cretaceous supersequences (Golonka & Kiessling, 2002) were selected as a test case for the SRPV study because they encompass long periods of transgression and regression. Marine source rocks of this age are globally distributed in a variety of geographic settings and have contributed more oil and gas reserves (25% of the world's discovered hydrocarbons) than any other source rock interval (Klemme & Ulmishek, 1991, Klemme, 1994). The modeling of the Source Rocks Prediction Value has placed the Barents-Greenland paleobasin) among the basins, which contain the richest Late Jurassic-Early Cretaceous source rocks in the world (Golonka *et al*. 2009).

Referemces:

Demaison, G. J. & Huizinga, B. J., 1991. Genetic Classification of Petroleum Systems. *American Association of Petroleum Geologists Bulletin*, 75: 1626-1643.

Golonka J., 2011. Phanerozoic palaeoenvironment and palaeolithofacies maps of the Arctic region. In: Spencer, A. M., Embry, A. F., Gautier, D. L., Stoupakova, A. V. & Sørensen, K. (eds) *Arctic Petroleum Geology. Geological Society, London, Memoirs*, 35, 79–129.

Golonka, J., & Kiessling, W., 2002. Phanerozoic time scale and definition of time slices, In: Kiessling, W., Flügel, E. & Golonka, J., (Eds.), *Phanerozoic Reef Patterns*. *SEPM Special Publication*, 72: 11-20.

Golonka, J., Krobicki, M., Waśkowska, A., Matyasik, I., Pauken, R. Bocharova, N.J. Edrich, M., & Wildharber, J., 2009. Source Rock Prediction Value: world provinces during Late Jurassic-earliest Cretaceous times and position of West Carpathians in SRPV prediction. *Annales Societatis Geologorum Poloniae*, 79: 175-185.

Kiessling, W., Flügel, E., & Golonka, J., 1999. Paleo Reef Maps: Evaluation of a comprehensive database on Phanerozoic reefs: *Association of Petroleum Geologists Bulletin*, 83: 1552-1587.

Klemme, H. D., 1994. Petroleum Systems of the World Involving Upper Jurassic.

Source Rocks. In: Magoon L. B. & Dow, W. G. (Eds.), *The Petroleum System - From Source To Trap*. *American Association of Petroleum Geologists Memoir*, 60, 51-72.

Klemme, H. D. & Ulmishek, G. F., 1991. Effective petroleum source rocks of the world: stratigraphic distribution and controlling depositional factors. *American Association of Petroleum Geologists Bulletin*, 75, 12, 1809-1851.