Shale gas – geological challenge for Poland

Shale gas – great geological discovery of last decades has or may have unusual impact in on some countries' economies around the world.

Shale gas occurs in fine-grained laminated clayey rocks enriched in organic matter that are formed of compacted silt and clay. In geological terms shale formations result from settling of sedimentary particles and then compaction of silt and clay and other particles during diagenetic maturation of sediments. They are important rocks not only because they make up to about 60% of the earth's sedimentary crust. It is caused by overburden and thus complex interaction between temperature, pressure and deposited organic matter they are prone to expel mature gas and oil. In effect, shales appear also as a primary source for most of the conventional hydrocarbon deposits. Moreover, these clastic formations have recently gained additional utilitarian value because of discoveries of unconventional hydrocarbon accumulations of gas and oil in them around the world. As a result, oil and gas operators throughout the world are exploring for shale plays.

Certainly much new gas and oil production from shales may come from Europe. However, hydrocarbons-bearing shales are irregularly distributed across Europe. Therefore, frontier exploration for shale hydrocarbons on different scales is taking place across the European sedimentary basins from west (Spain) to east (Lithuania) and further south (Bulgaria and Romania) as well as up north of the continent (Norway) (European sector of Svalbard and even Novaya Zemlya). Although gas and oil shales can be targeted in most countries of Europe, Eastern Europe countries like Poland, Ukraine, Lithuania, Hungary, Romania and Bulgaria boast promising shale gas resources (see World Oil, July 2013, p. 97–98).

The idea of shale gas exploration in Poland has been brought to Poland and then successfully recommended to the world investors by Dr. Jan Krasoń (Geoexplorers International, Inc., Denver, USA) in 2006 (pers. inf., August 2013). This interest has realized by shale gas prospection and exploration licenses soon after (2007) by Prof. Mariusz-Orion Jędrysek, the Ex-Chief National Geologist of Poland. Recent shale gas discoveries in Poland have ascertain that interest in exploration of gas from shales will keep increasing. Most developments in gas from shales are concentrated in the Pomeranian region.

However, exploration of gas shale in Poland bears a range of challenges. Except of obvious technology challenges (e.g. complexity of hydro-frac reservoirs modeling), technological development (horizontal drilling plus fracturing and geosteering capabilities), water management and finally public dialog required to drill through high-TOC sweet spots there are many unknown geological and geophysical data. Selected problems are presented in this special issue of the Polish Geological Review.

Timing of extensive future shale gas development in Poland seems largely dependent on some uncertainties that have impeded shale gas investments. To avoid further exits of hydrocarbons operators hence the Polish government is working on new regulations to ease shale investments. The new regulations are designed to allow operators rights to produce and function on the gas market. However lately the European Parliament introduced rigorous environmental directive with respect to gas shale exploration. Implementation of these environmental regulations certainly will limit future investment profitability. This political question is raised by the present Chief National Geologist **Piotr Woźniak** in his call on the need for a debate on the shale gas in Europe addressed to the National Geological Surveys of Europe, politicians and to wider audience. On the other hand we need improved public communication. A close dialog of government and local authorities with oil companies operating in the areas explored would accelerate the rate of acceptance of these new geoscience technologies and appears as effective way to achieving the goal (**Przybycin & Sidorczuk**).

Apart from the above requests, shale gas development encompass' of geoscience challenges including geology of the gas formations, geophysics, petrophysics and other data. This issue of the Polish Geological Review is concentrated on selected recent results on the geology of shale gas in Poland.

Shale operators are discovering, and geologists know, that no two shale plays are alike because of sedimentary variability in different depositional basins. **Karcz et al.** present a regional overview of selected Central and Eastern European sedimentary basins of different stratigraphic ranges which hold the unconventional potential for shale gas and shale oil exploration that have attracted spectacular interest in the last few years. Among them the Polish Ordovician-Silurian Basin appear as having a high hydrocarbon potential (J. Krasoń, pers. inf., August 2013).

The most typical feature of the Polish Ordovician-Silurian Basin deposits are characteristic fossils – graptolites. **Podhalańska** stresses that these fossils are not only an excellent tool for biostratigraphic dating and regional correlations of shale formations but also provide an equally important instrument, in addition to elevated TOC values or increased gamma ray radiation on well log. That allows identification of potential source rocks for hydrocarbons, including shale gas.

Case study of **Porębski et al.** of pericratonic Silurian shale succession in the Lublin Basin has shown the value of integrating facies analysis of sedimentary record and well-log characteristics to interpret lithology and characteristics of these heterogenic target shales. There is a number of contentious issues that need to be resolved before this emerging shale gas play will enter a stage of successful development. They should be solved to predict reservoir quality and thus to reduce exploration risk and identify new hydrocarbon prospect.

The Polish Geological Institute – National Research Institute in its Assessment Report from 2012 strongly decreased earlier geological assessments of shale gas resources because of inadequate geological data. While the EIA increased its global estimate of shale resources by 10%, the agency reduced its estimate of Polands' resources from 187 Tcf to 148 Tcf, as a result of removing from analysis formations whose total organic content (TOC) is less than 2% (see World Oil, July 2013, p. 97–98). Shale gas resources estimates are highly uncertain however become more accu-

rate when are extensively tested with production wells. To determine the minimum data needed to make more conclusive decisions by the operators **Kiersnowski and Dyrka** propose a new approach to geological assessments with respect to shale gas resources for the Polish Ordovician--Silurian Basin. In order to prepare by the PGI-NRI more realistic assessment of shale gas resources in 2014, they plan to introduce new geological input data including results of exploration wells and make a segmentation of the whole basin area into five smaller regional assessment units.

Exploration for gas shale leads to a likely environmental impact on the surrounding area. This activity requires a comprehensive look on environmental issues arising from the used technology, i.e. horizontal drilling and multistage hydro--fracturing. Water is essential to energy resource development. **Woźnicka** concludes that because of deeply buried shale formations in Poland which are covered by thick complex of overburden with rocks insulated in nature causes no possible migration of pollutants from horizontal drillings. This point contributes to the European debate related to integrated groundwater management and environmental threat.

This issue of the Polish Geological Review is dedicated to the participants of the international conference organized by EuroGeoSurveys with collaboration of Polish Geological Institute in Warsaw (Poland) in Warsaw in 12–13 November 2013. The conference "Shale Gas as a Bridge Energy Carrier – from Fossil Fuels to Green Energy" is devoted to discover chances of unconventional gas resources to bring a new form of energy sources. This conference is a first step towards achieving more environmentally friendly energy resource management and presents better understanding of the need to onboard EU countries and the Parliament with fossil and new green energy.

The editors of the Polish Geological Review hope this issue will attract users who are interested in the shale gas subject. Articles about shale-specific advances in geology and groundwater protection should provide additional information and also – attract wider audience.

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