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THE BLACK SEA – AN ENERGY CROSSROADS AND/OR AN UNCONVENTIONAL ENERGY AND RESOURCE CENTER IN EUROPE

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Abstract: The notion "energy center" is deeply misunderstood in our country. Modern Bulgarian politicians intentionally wave the energy map where, instead of energy sources, we can only see oil and gas pipelines crisscrossing the Black Sea and Bulgaria. These pipelines start from the real energy center to the end consumer. Under the conditions of shortage of energy resources in Bulgaria it is absurd to insist the Bulgaria could become an energy center on the Balkans. So, instead of an energy center, Bulgaria is rather an energy crossroads due to its favorable geographic location. Bulgaria was the center providing raw materials for the nuclear energy until the 1980s. The uranium, produced in Bulgaria, made the Bulgarian and other countries' nuclear blocks independent. Nowadays, the attempts to revive the production of uranium meet the overwhelming resistance of environmental organizations and nuclear monopolies controlling the world markets of nuclear fuel. The traditional sources of energy such as oil, natural gas and coal satisfy as much as 1 to 5% of the needs of our energy sector. Our scarce deposits of traditional energy sources make Bulgaria entirely dependent on the world markets of energy sources. Currently the raw material and energy market for Bulgaria and the EU is monopolized by Russia and the Arabic countries due to their geographic location. The irregular geographic distribution of the raw materials for the energy industry such as oil and gas on the world geographic map creates the problem with their transportation to the end consumer. Nowadays hydrocarbons are transported by tankers or via pipelines. Pipelines are preferred due to a number of reasons. Their advantages make them very attractive and are expressed in the following:

- They shorten considerably the distance to the end consumer;
- The transport charges for the transit of the products are avoided;
- The risks to the environment during this means of transportation are reduced.

Keywords: DOMS, H_2S, gashygrates, pipelines, natural geobiotechnological reactor, non-traditional resources, agrobiotechnologies, nanotechnologies.

1. Introduction

Russia and the countries from the Caspian region, the Middle East, the North Sea and Middle Asia are seen as the natural centers of energy resources for Europe. Since these centers of energy resources are available the economic advantage of their use is determined mainly by the methods of their transportation to the end consumers. Two competitive projects, the South Stream and Nabucco (fig. 1), are suggested taking into account the unstable economic environment in those countries and with a view to avoiding a new gas crisis as the one we saw in January 2009. It became clear after the implementation of the Blue Stream project (fig. 1) along the Black Sea bottom and connecting the Russian Station of Djubga with the Turkish port of Samsun that the underwater pipelines are an economically advantageous and environmentally safe transport corridor. The length of the underwater route is 396 km and its maximum depth is 2150 m. The project comprises two pipelines with diameter of 610 mm and the amount of the natural gas reaching Turkey is expected to reach in 2010 16 billion m^3 a year (Aybulatov, 2005).

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2. Materials and methods

The Nabucco and South Stream projects are expensive facilities starting from different energy centers. The Nabucco project will break the Russian gas monopoly and will protect the EU from energy extortion. This, of course, affects directly Russian interests because the republics in Central Asia have been selling their natural gas very cheaply through the gas transport network of Gazprom. The Nabucco project will allow them to export natural gas independently at market prices. While the pipelines of South Stream (fig. 2, 3) will be laid along the Black Sea bottom, the route of Nabucco will pass through politically unstable countries with religious intolerance.

Fig. 1. Plan of the pipelines.

Irrespective of the positive and negative aspects of the two projects they will provide Bulgaria and the other European countries with choice and energy stability. That became clear also at the summit on Natural Gas for Europe – Security and Partnership, held in Sofia on 24th and 25th April 2009 at the initiative of President Parvanov and dedicated to energy stability. The conclusive declaration adopted at the business forum welcomed the implementation of all gas projects in the wide Black Sea and Caspian regions and in South Eastern Europe.

The Burgas - Alexandroupolis pipeline (fig. 1) is currently a controversial project taking into account, first of all, the environmental safety of the Bosphorus and the Dardanelles straits. Tankers carrying about 130 million tons of oil pass through them annually thus threatening the safety of navigation in those straits and in the Black Sea. The Bulgarian community is concerned about the environmental safety of the terminal in the Burgas Bay that is surrounded by attractive holiday resorts and balneo-therapeutic health resorts. The environmental frenzy that has seized the municipalities around the Bay will hardly allow the government to consider the issue correctly and take the best decision. The absence of a reasonable and competent evaluation of the environmental safety of the terminal and the land route to the Bulgarian-Greek border will cost this country much. It is strange in this case that the press and the electronic media emphasize the opinion of various environmentalists while the evaluations made by competent experts are ignored. It should not be forgotten that when 10 years ago the Russian government suggested the Blue Stream pipeline to be laid along the sea bottom from Novorosiysk to Varna the Bulgarian government discarded quite lightheartedly in the name of environmental safety and energy independence of Bulgaria from Russia! Paradoxical, yet a fact!

We can often hear even today apocalyptic prophesies of the near end of oil and gas era and appeals to industrial societies to quit the use of oil and natural gas and to start using alternative energy sources and raw materials.

However it should be pointed out that world deposits of oil and natural gas are constantly growing and in 2007 for example the new discovered deposits exceeded their extraction. There are 807,172 drill facilities producing oil and natural gas from these deposits and about 4,000 million tons of oil and 2,800 billion m^3 of natural gas were extracted only in 2006. At this rate of production humanity will have oil and natural gas for 45 and 62 years respectively. The geographical distribution of this wealth is a different issue. For example, the own retrievable deposits of oil will be sufficient for Iraq for the next 247 years, for Kuwait – for 143 year, etc. (Radler, 2003; Gojik et al., 2007). The situation with the geographical distribution of natural gas is analogical. The irregular (for some – unjust) geographical distribution of natural resources as oil and gas puts most countries of the world, as well as Bulgaria, in a very unfavorable situation.

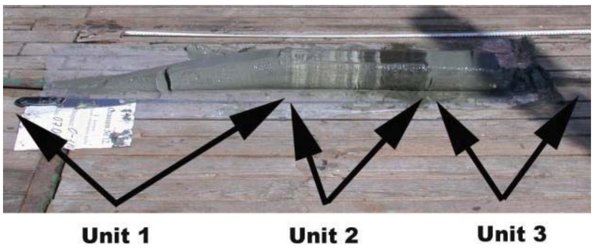

Fig. 2. Geological studies of the route of South Stream performed with R/V Akademik (June 2009) in the Bulgarian economic area.

The only outcome is the search for unconventional (alternative) sources of energy, moreover that the prices of these resources will continue to grow in the foreseeable future. The search for unconventional alternative (to oil and natural gas) resources and the prospects for their use will bring reassurance for the future of humanity.

contaminating the air of our towns and villages will be closed down over the next few years if they do not begin to use natural gas and that will doom

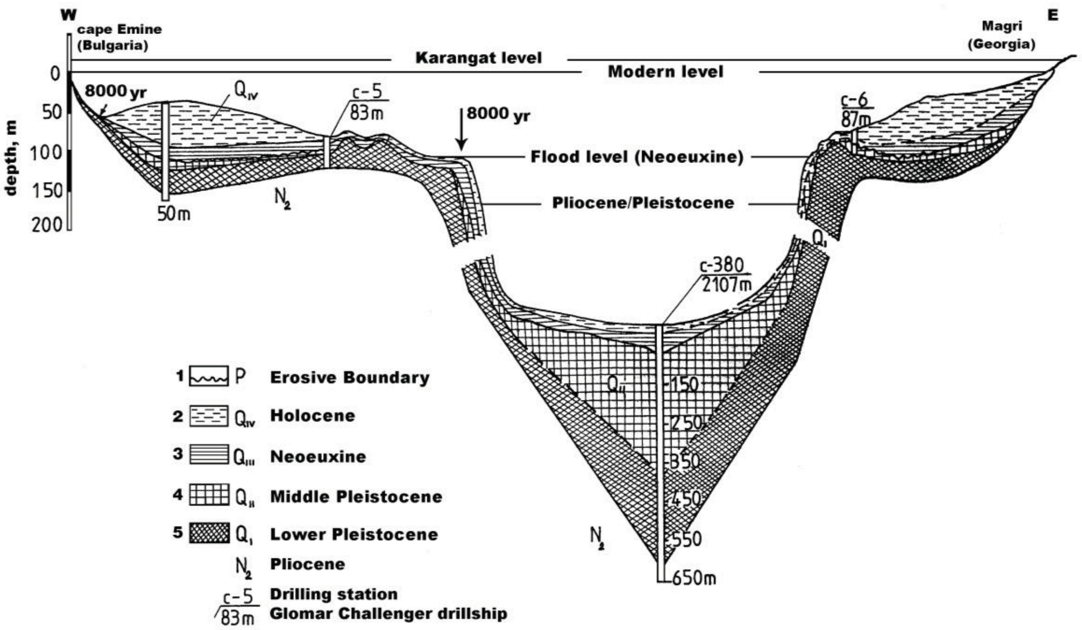

Fig. 3. Schematic geological cross section along the route of South Stream.

The situation of the problem with the use of unconventional sources of energy is unenviable due to two main reasons:

- First, the fierce resistance of gigantic petrol and nuclear monopolies controlling the world market of energy;
- Second, the coalescence of energy monopolies with the ruling political class.

The unstable condition of our energy sector is the result of numerous factors, the topmost being the lack of own energy resources.

The construction of Nuclear Power Plant “Belene”, the restarting of blocks 3 and 4 of Nuclear Power Plant “Kozlodui” and the restoration of the production of uranium will encounter lots of obstacles in the face of the EU and of the environmental organizations. The heated discussion on the fate of Nuclear Power Plant “Belene” until the ultimate rejection of its construction is extremely detrimental to our country. What is more, in the next 10 years Nuclear Power Plant “Kozlodui” (blocks 5 and 6) will exhaust their resources. It is interesting to hear the evaluation of European experts who believe that nuclear energy will have no alternative in the next 50 years; what is more, its safety continues to grow. The existing thermal power plants our energy security. The political emotions should give way to real expert evaluations otherwise we risk the future of our children and grandchildren.

Making Bulgaria an energy crossroads is a temporary solution of the problems with energy resources.

New results were obtained over the past 20 years in the sphere of unconventional resources of energy in the Black Sea and the sophisticated technologies that made possible the development of several pilot projects.

The topmost is the project for research and production of methane gas from the gas hydrate deposits on the bottom of the Black Sea.

In 2006-2007 countries like Canada, Norway, the USA and Japan started the industrial production of a pioneering and unconventional source of methane gas considered to be inexhaustible in practice – methane hydrates or gas hydrates containing, according to some estimates, 113.10^{17} m^3 of methane and $53.55x10^{17}$ m^3 methane gas below the gas cap. Gas hydrates occur on the bottom of Arctic regions and in marine sediments covering 93 – 95% of the bottom of the World Ocean (Glumov et al., 2005; Shnyukov and Ziborov, 2005).

Gashydrates and the gashydrates below the gas cap in the Black Sea represent an important potential source of energy that could resolve many of the problems of the Bulgarian and the European energy industry (fig. 4) (Vassilev, 2006).

in question. It is quite possible that Bulgarian researchers who have been working on Black Sea gas hydrates for more than 20 years will have the same fate as their Ukrainian colleagues. Black sediments containing gas hydrate crystals are

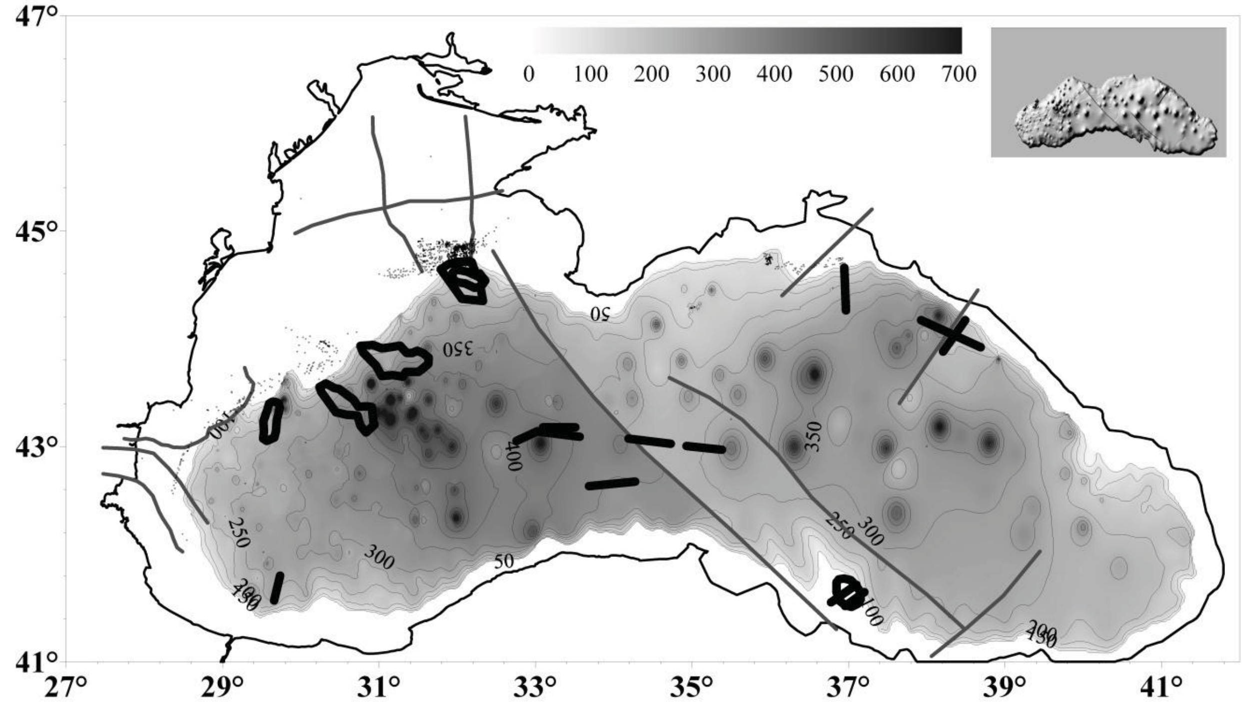

Fig. 4. Thickness (in meters) in the gashydrates stability area in the Black Sea (the "optimistic" model) (Vassilev, 2006) and the registered BSR (Bottom Simulating Reflector) (black lines and polygons).

The reserves of methane gas in the form of gashydrates is estimated at 25 – 50 trillion m^3 by Bulgarian and Russian experts, while the reserves of conventional carbonhydrates are about 1450,8 tons of conditional fuel (Shnyukov and Ziborov, 2005; Vassilev, 2006). A number of international companies are interested in the Black Sea deposits of gas hydrates. For example the American Venco International LLC won a competition in 2007 announced by the Ukrainian government for research and development of gas hydrates in an area of 13 000 km^2 at depths from 300 to 2000 m (Shnyukov and Ziborov, 2005). The other conditions, according to Ukrainian scientists are too unfavorable and humiliating without taking into account their contribution to the studies of gas hydrates. What is even more insulting is the fact that in case of industrial production the Ukrainian consumers will have to buy energy resources from their own deposits, though as privileged customers, at market prices. And it is very unlikely that Ukrainian scientists and geology researches will ever be permitted to work in the licensed company found in front of the Bulgarian coast, in the area of the continental slope and the abyssal bottom at depths from 700 m to the maximum sea depths and at about 500 m under the sea floor. It is known at 1 m^3 of gas hydrate yields about 160 m^3 of methane and the problem with the production of methane gas from the gashydrates is purely technological. Nearly half of the Bulgarian economic zone, with area of 33 800 km^2, is a promising field with deposits of gashydrates and gashydrates below the gas cap (fig. 5).

I hope that the Bulgarian government will allow the Bulgarian contribution to the study of gas hydrates to have the fate of Ukrainian scientists.

Let's consider another project developed by Bulgarian scientists for more than 25 years.

Deepsea organogenic mineral sediments (DOMS) on the sea floor are referred to the unconventional resources and their use is determined by the following factors:

- The availability of industrial reserves

- The availability of modern technical facilities for studies, extraction, transportation and floatation
- Economic efficiency
- Positive geo-ecological efficiency

The mining and geological conditions in the Black Sea that could be rated as extreme, are determined by:

- The complex (risky) meteorological and hydrodynamic conditions, especially during the autumn-winter period (periodic phenomena), possible earthquakes and resulting tsunami, effusion of natural gas, activation of mud volcanoes, etc.
- The considerable depths of the underwater deposits, located at depths from 500 to 2245 m under the conditions of H_2S contamination, complex relief, underwater landslides and turbid streams.
- Influence of the aggressive marine and hydrogen sulfide environment on the technological equipment and other unknown phenomena related to the specific gas and geochemical characteristics of the basin.

The utilization of the deep sea sediments on the oceanic floor has no analogue in the world practice and the initial stage of their production will consume huge investments and considerable risk and is innovative in its nature.

The studies of the origin, composition, properties and application of the deep sea organogenic mineral sediments (DOMS) helped to establish that this mineral – biolithic substance has very precious properties for the economy and the agriculture. The reserves of DSOMS in the Black Sea are estimated at $3{,}2x10^{11}$ m^3 (Shnyukov and Ziborov 2005); the amount of DSOMS is about 8 billion m^3 in the Bulgarian economic zone according to the estimates where the average thickness of the working layer is > 1 m (Dimitrov, 2010).

3. Results and Discussions

The studies of DOMS as a complex resource have indicated broad perspectives for their application in the sphere of agrobiotechnologies, nanotechnologies, construction sector, medicine and other

Fig. 5. Description of core (core: MD04-2782, depth 1009 m) on board of the French R/V Marion Dufresne. Setting methane gas from gas hydrates on fire (Dimitrov, 2010).

spheres. Under the conditions of chronic energy crisis and shortage of quality food products we have to pay special attention to unconventional raw materials and resources of energy. An important factor for the organic farming in Bulgaria is the use of the practically inexhaustible reserves of natural ecological fertilizers found in the Bulgarian economic zone in the Black Sea.

Our achievements in the studies of DOMS and the developed know-how are threatened with becoming property of the companies that search for oil and gas in the Black Sea area of Bulgaria. Our research work dedicated to DSOMS is financed by the Scientific Research Fund (Project DO-02-35) which allows us to introduce the product quickly as a complex raw material in different economic spheres (Dimitrov et al., 2007).

The Black Sea is a powerful **natural geobiotechnological reactor**, capable of producing various natural resources. The Black Sea is the biggest generator of H_2S in the world and is a global source for the production of hydrogen and sulphur (fig. 6).

According to the available data the overall amount of H_2S in the basin is 40 – 50 billion tons and it grows annually by 10^7 - 10^8 tons. The composition of hydrogen sulfide changes from 0.3 mg/l to 10-12 mg/l in the near-bottom water layer. Its content in bottom sediments varies from 100 to 240 mg/l. As an illustration we can compare hydrogen sulfide with a highly calorific source such as methane. The burning of 1 m^3 of methane releases 8500 Kcal of heat, while the burning of 1 m^3 of hydrogen sulfide releases 5535 Kcal of heat (Dimitrov and Dimitrov, 1999).

The analysis of the possibilities to use the hydrogen sulfide gas as a source of energy showed that the energy losses are immense and that the technology is not environmentally safe.

The adoption of new, renewable sources of energy and the production of hydrogen and the accompanying products from the hydrogen sulfide extracted from the marine water and the sediments provides the hydrogen energy sector with a new perspective.

The non-governmental organization of Energetika was set up in 1989 in Sevastopol with the aim of utilization of the Black Sea hydrogen sulfide deposits. The first developments were dedicated to the plasma and electrolytic decomposition of H_2S and to the use of ion exchange resins and polymers for the production of H_2 and S. The plasma technology has a number of advantages because it yields H_2 and S while the electrolysis yields S and H_2O. Besides, the plasma technology is five times less energy than the electrolytic technology and is environmentally safe. Some time later the extraction of H_2S was stopped.

4. General conclusions

Current studies indicate that the processing of marine water and sediments for the production of H_2 and S may be performed on the spot (*in situ*). The

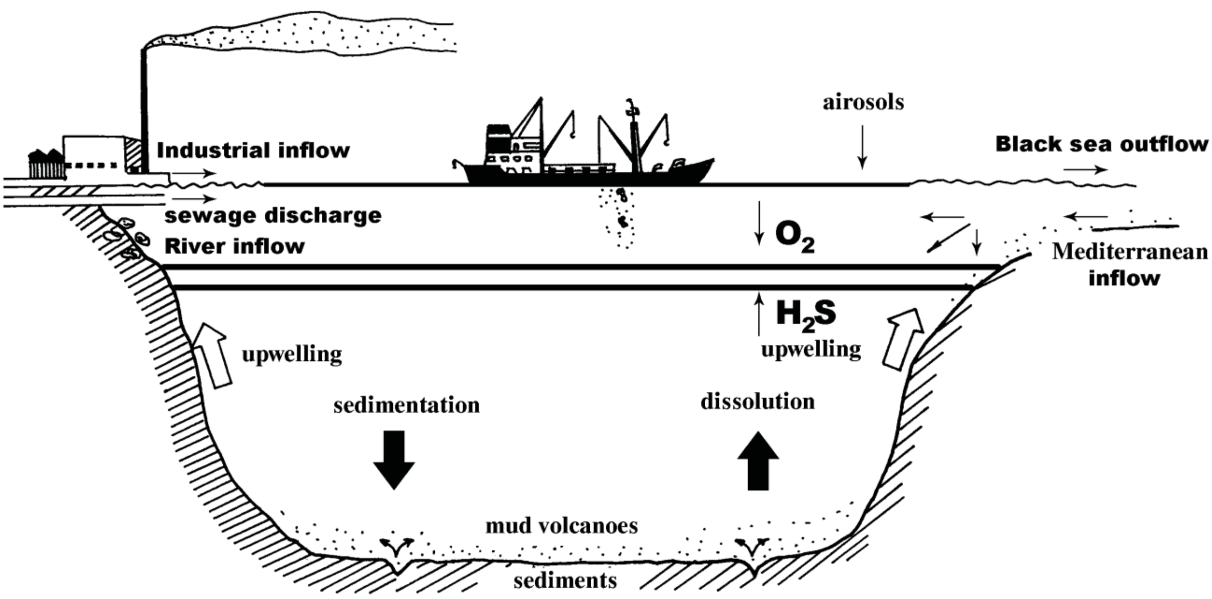

Fig. 6. The Black Sea is – A Natural Geobiotechnological Reactor.

facilities and unmanned devices equipped with a polymer strip, the so called polymer module, are submerged in the hydrogen sulfide area to the maximum depth of the Black Sea several times to perform selective absorption of the two forms of hydrogen sulfide. After completing its mission the underwater apparatus appears on the sea surface and is collected by the floating plant. The polymer module (sorbent) is dismantled and passed through a plasma regenerator where the sorbed forms of H_2S are released into a solution and the recovered polymer module is submerged again. The dissolved H_2S is flushed through a hermetically closed plasma chamber where the H_2 and S are dissociated.

The suggested technology for production of hydrogen sulfide and regeneration of H_2 и S includes a floating plant, unmanned devices each of which with a) a polymer module and b) an operation module.

The unlimited reserves of H_2S in the Black Sea are an important challenge to the modern technologies for production of a new type of energy resources as H_2 and the accompanying products (S). The reserves of H_2S are estimated between 2.88 and 4.18 billion tons or 169 – 245 million tons of H_2 and 2.7 – 3.9 billion tons of S (Dimitrov et al., 1999).

New/unconventional sources of natural gas are the natural gas torches. The preliminary estimates of gas release show that about 150 billion m^3 of methane gas are released from the bottom on an annual basis. The natural gas released fro the bottom passes through the water and ends up in the atmosphere contaminating it and destroying the ozone layer. Apart from being a sign for search of oil and gas, gas torches can also be considered an independent low-debit source of energy.

The studies of the scale of gas release will lead to the development of new solutions and technical facilities for catching and transportation of the natural gas.

Apart from production of gas, gas springs can also be used for the establishment of geodynamic polygons for early notification of earthquakes in seismic regions such as the seismic area of Kaliarka and Shabla where earthquake centers are located in the sea.

Undoubtedly, the suggested energy corridors will contribute to the energy security of the Balkans. We should not forget however the immense potential of the unconventional resources of the Black Sea whose studies and utilization will secure the future of the energy sector of Europe.

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