History of Hydrocarbon Exploration in the Black Sea Mega-Basin: From Greek Fire to Sakarya Discovery

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Abstract

The Black Sea is one of the world’s largest and gassiest anoxic basins. The numerous gas seeps documented have methane in the water column up to 13 $\mu M$ from 550-600 m depth down to the sea floor. It is a region where the spectacular mud volcanism was studied in detail both onshore and offshore, and methane hydrates were historically sampled for the first time in deep marine sediments. The Black Sea is a unique region for humankind as it was probably the place from which the biblical legend of the Great Deluge originated. In addition, it is a very important region for the history of petroleum industry and hydrocarbon exploration.

Ancient chronicles of 4th and 5th centuries AD have mentioned Greek fire as used by the Byzantine fleet against enemies. Oil for that flammable mixture originated from surface seeps in the Kerch and Taman peninsulas. Systematic offshore hydrocarbon exploration started on the Odessa Shelf in the late 1960’s, and it was crowned with the discovery of the first commercial gas field, Golitsynske (1975), in Ukrainian waters. Later, discoveries on the shelf followed in the Romanian (1980), Bulgarian (1993) and Turkish (2004) waters. After two decades of exploration, the NW Inner Shelf, Histria, Varna Bay and Akçakoca sub-basins, as well as the Peri-Kerch offshore areas, Ukraine (Subbotinske oilfield discovery, 2006) have delivered new reserves to the production portfolio in the Black Sea, but these discoveries were considered smallish compared to their global analogues.

There is still a great promise to find in the Black Sea a second North Sea petroleum province, beyond the Euxinic threshold with the advent of deepwater drilling campaigns and the discovery of the circa 3.5 TCF Domino gas field by the 5th generation Deepwater Champion drillship in the Romanian sector in 2012. All other exploration efforts made in Turkish, Bulgarian, and Russian waters (2010-2018), employing state-of-the-art drilling rigs and vessels, provided no commercial discoveries due to a particular set of the exploration risk elements which still need to be fully understood. The regional reflection seismic transects program conducted by GWL Group delivered deep long-offset 2D seismic reflection data, processed by TGS and modeled by ION Geophysical. Integrated with gas hydrate studies (Bremen’s MARUM, etc.), this superb quality modern seismic data underlined the huge exploration potential for deepwater biogenic gas accumulations within the paleo-Danube fan.
complex. Finally, in 2021, *Turkish Petroleum*, employing their own drilling fleet, have made the landmark discovery of the giant *Sakarya* gas field cluster, which gave new momentum to explore in this underexplored basin near Europe.

**Keywords:** Black Sea, exploration history, hydrocarbons, discovery.

**References**


Nolan C. Sakarya, Amasra and Çaycuma Türkiye’s 710 bcm gas discoveries in the Western Black Sea https://www.researchgate.net/publication/368353682_Sakarya_Amasra_and_Caycuma_-_Turkiye%27s_710_bcm_gas_discoveries_in_the_Western_Black_Sea, accessed 09/02/2024.
Petar Darakchiev, RND at 90 - a life devoted entirely to petroleum geology (in Bulgarian) https://mdg-magazine.bg/90-%D0%B3%D0%BE%D0%B4%D0%BD%D0%B8-%D0%B0%B8-%D0%BF%D0%B5%D1%82%D1%8A%D1%80-%D0%B4%D0%B0%D1%80%D0%B0%D0%BA%D1%87%D0%B8%D0%B5%D0%B2/, accessed 06/24/2024.


I-V centuries AD Pre-History

- 1869-1939 At the Industrial Down
  - Shiraki > Chongelek > Ompareti

- 1939-1974 Close Onshore discoveries
  - Supsa > Tyulenoovo > Samgori

- 1975-2004 First Discoveries
  - Golitsynske > Lebada > Galata

- 2004-2010 Shelfal Exploration Plateau
  - Ayazli > Sybbotinske > Kavarna East

- 2010-2021 Big Hopes – Big Failures
  - Sinop-1 > Domino-1 > Maria-1

- Since 2021 New Era of Biogenic Gas?
  - Sakarya > Amasra North > Çaycuma
The Great Deluge

A comprehensive study conducted in 1986 by geologist Willian Rann and Helmer Perman postulates that a catastrophic flood of the Black Sea inspired the biblical story of Noah’s ark, the Homeric Epic of Gilgamesh, and other myths.

1. The Great Deluge

The Great Deluge

2. According to the flood hypothesis, the Black Sea was a natural harbor at the nearest day. Deposition on its shores during the flood is a depth of the flood to 5000 BC.

3. Evidence for a breakwater outside the Black Sea region is found on the eastern shore of the Black Sea.

4. Four areas involved with the Epic of Gilgamesh were discovered at Varna, the oldest site in the Black Sea. The broad area of Gilgamesh may be translated by the Black Sea region.

5. The merging flood would eventually have covered 46,000 square miles of land at least once in a period of several thousand years, expanding the Black Sea to its present boundaries.

6. Map showing the flood scenario.

Schematic geophysical map of the north-western shelf during the Early Neolithic: (1) Palaeovalleys and large alluvial plains; (2) gently sloping plains; (3) Early Neolithic and continental landforms formed by sand; (4) palaeovalleys and continental deposits; (5) coastal valleys of the Black Sea; (6) coastal plains; (7) coastal plains; (8) coastal plains; (9) coastal plains; (10) continental slope.

Yanko-Hombach et al. 2017

Petko Stoyanov Dimitrov, 2003

Petko Dimitrov & Dimitar Dimitrov, 2004

GREAT DELUGE
Output of oil in the northern part of the Black Sea region was begun more than a thousand years ago that is confirmed by Byzantine emperor Constantine VII Porphyrogenitus (905 – 959). In his treatise De administrando imperio he described 14 mineral oil springs on the outskirts of Tamatarkha (later Tmutarakan).

The sources of oil known to the Byzantines lie entirely within the so-called North Caucasus oilfield, covering the regions from the eastern Crimea, north-western, eastern and south-eastern Caucasus, western Transcaucasia, western Turkmenia and the Caspian coastal zone of northern Iran.
NATURAL OIL SEEPAGE, KERCH PENINSULA

- Kerch Peninsula, 2004
- Lake Tobechik
- Mud volcano at the shore
- Priozerne field abandoned well, 2004

Surface oil seeps
The numerous gas seep documented have methane in the water column up to 13 µM from 550-600 m depth down to the sea floor. To compare, economically viable methane concentrations in Lake Kivu are at 17 µM.

Just in the Black Sea methane hydrates were historically sampled for the first time in deep marine sediments (Yefremova A.G., Zhizhchenko B.P. 1974).

Multiple BSRs, Popescu et al., 2007

The northwestern continental slope, BS-05-26

Bialas & Haeckel, 2022

Yuri Makogon

He was born in Ukraine and started his career at the Shebelinka gas producing facility. He discovered that hydrates of natural gas can accumulate as deposits in nature.

Sozansky, 2002
SUPSA DISCOVERY, 1939

- Omparety-Supsa field, 1939
- Tari et al., 2018
- Sachsenhofer et al., 2021
- Well Shromisubani-101
TYULENOVO DISCOVERY, 1951

- G. Georgiev, 2012
- Oleksandr Paliy
- Petr Darakchiev
- Monument to discovery of the field

- S. Bottomley, G. Pritchard, 1998
- J. Mayer et al., 2018
GOLITSYNSKY DISCOVERY, 1975

- M-3 Structural map, 2014

- Yevpatoria O&G Exp. Act on the III-rd interval successful testing in Golitsynska-7 well, March 4, 1975

- Drilling crew and geologists on Golitsyno-4 platform

- Volodymyr Vovk

- Petro Godovanets

- Sivash jack-up rig
The first seismic line were acquired in 1969. The acquisition, processing and interpretation of the seismic lines was performed by IPGH (now Prospectiuni s.a.) The first well - 1 Ovidiu was drilled in 1976. The East Lebada was drilled by Petromar company, a subsidiary of Petrom by Grlora drilling platform in 1979 – 1981. On May 20, 1987 was registered the first oil production from Black Sea.

- Structural map at the Albian top (Ionescu G. et al, 2002)
- Geological cross-section along the Histria sub-basin, Cranganu et al., 2009
AYAZLI DISCOVERY, 2004

- Akcakoca-1 well, 1976
- Ayazli depth structure, 2021
- Trillion Energy, 2023
SUBBOTINSKE DISCOVERY, 2006

Kerch Peninsula

Area of interest

Maikop Series

Black Sea

Dovzhok Ye. et al., 1996

Ihor Popadyuk

Sergiy Stovba

Migration model, 2006

Natural oil sicks detected within South Kerch offshore according to interpretation of ERS SAR images for 1992-2003

Quaternary / Holocene

Pliocene

Upper Miocene

Lower Miocene

Upper Oligocene

Early-Mid Oligocene

Eocene + Palocene

Cretaceous undiff.

Jurassic-Trassic acoustic basement

Geological cross-section # 2 - 1 - 403 - 3

ROCK VARIETIES
DOMINO DISCOVERY, 2012

- Pre-drill play concept, Tari & Simmons, 2018
- Nolan, 2023
- Sterling Resources, 2013
- Zamir Bega
- Gabriel Ionescu
- Deepwater Champion
- INCDM, 2015
- Domino drillbit
Spaceborn gravity field anomalies depicting proto-Danube deepwater fan controlling the Sakaya gas cluster
DEEPWATER WELLS, 2013

NEW EXPLORATION STAGE IN THE BLACK SEA

- Romania
- Ukraine
- Russia
- Bulgaria
- Georgia
- Turkey

- Eugenia - 1
- Ioana - 1
- Domino - 1
- Kaliakra East - 1
- Istranca - 1
- Yassihoyuk-1
- DSDP-380
- DSDP-381
- DSDP-379
- Subbotina - 403
- Sinop - 1
- Kastamonu - 1
- Sürmene - 1
- HPX - 1

100 km
NEW DEEPWATER WELLS
THE FLEET

- Ocean Endeavor
- Tavrida
- Petro Godovanets
- Leiv Eriksson
- Sivash
- GSP Prometeu
- Petro Godovanets
- Development Driller 2
- Ukraina
- Scarabeo 9
- Yavuz
- Fatih
- Petromar V
THE NAMES FOR GEOSTRUCTURES

Petro Sagaydachnyi
Grygori Potiomkin
Mikhaylo Lomonosov
Peter Simon Pallas
German Abikh
Fedor Ushakov
Pavel Nakhimov

Crigore Cobaleseu
Boris Golitsyn
Nikolai Andrussov
Ivan Mushkef
Volodymyr Luchitsky
Otto Schmidt
Ivan Gubkin
Volodymyr Selsky

Andrei Arkhangelsky
Vladimir Obruchev
Mikhail Telyaev
Nikolai Shatsky
Grigory Gamburgtsev
Mikhail Polshkov
Serafim Subbotin
Eugeniy Fedorov
Eugeniy Dvoryanin