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- **D**eep hydrocarbon sphere as a possible source for the formation of oil deposits

ABSTRACT

• . The issue of hydrocarbon sources to form the deposits of oil fields remains relevant, despite the long history of its study. Scientific advanced technics in this case are the results of a study of unique ultra-deep wells. Of greatest interests are SG-3 Kola unique is the deepest in the world 12262 meters and SG-1 Saatli 8268 meters. Kola super-well has been drilled on the ancient Baltic shield and opposite Saatli, has been drilled on the young Kura rift structure. Thus there is a unique opportunity to trace hydrocarbon saturation of ultra depth in the time interval from the ancient Archean rocks to the present day. Hydrocarbon in SG1Saatly and the SG-3 Kola are in different forms: free, dissolved, adsorbed, occluded. In the Kola segment of the Baltic Shield abundantly distributed C₁-C₇ alkanes, and bitumen. The content of the gases in the microcracks of rocks to 55.8 liter / ton, bitumen up to 110 grams / ton. In closed rock pores and vacuoles methane content is in the range 0.04 -120.1 cm³ / kg. In the Saatli well, the composition of gases presented to C₅, inclusive, and hydrocarbon gas saturation is up to 5.7 cm³ / kg. In its composition, rocks gases unique ultradeep wells resemble the composition of oil and gas fields. Hydrocarbons of different forms and component exist along the whole section of Kola and Saatli. Thus, the combined section of diverse genetic groups of rocks and various types of geological structures Kola (shield) and Saatli (geosyncline) showed that in ultradepth in the temporary crustal section from the Archean 3 billion years and till today there are hydrocarbon gases. Thus ultradepth saturated hydrocarbons. Hydrocarbons virtually exists from the early Archean geological history and up to modern times the Earth and can be a source of oil and gas fields.

introduction

- ▶ **The issue** of hydrocarbon sources to form the deposits of oil fields remains relevant, despite the long history of its study. **Scientific advanced technics** in this case are the results of a study of unique ultra-deep wells.

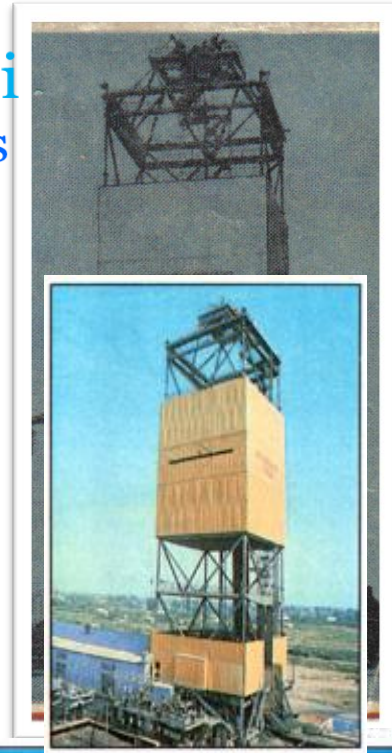


introduction

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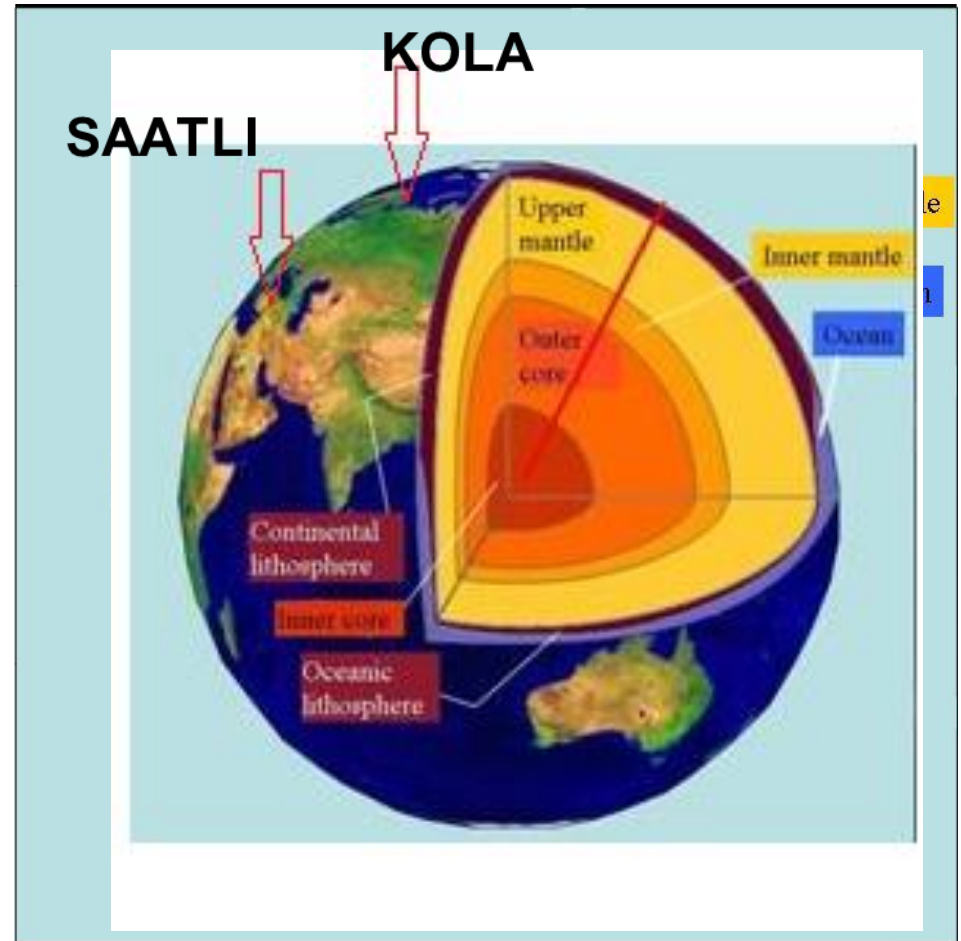
SG-1 Saatli
8268 meters

SG-3 Kola
12262 meters



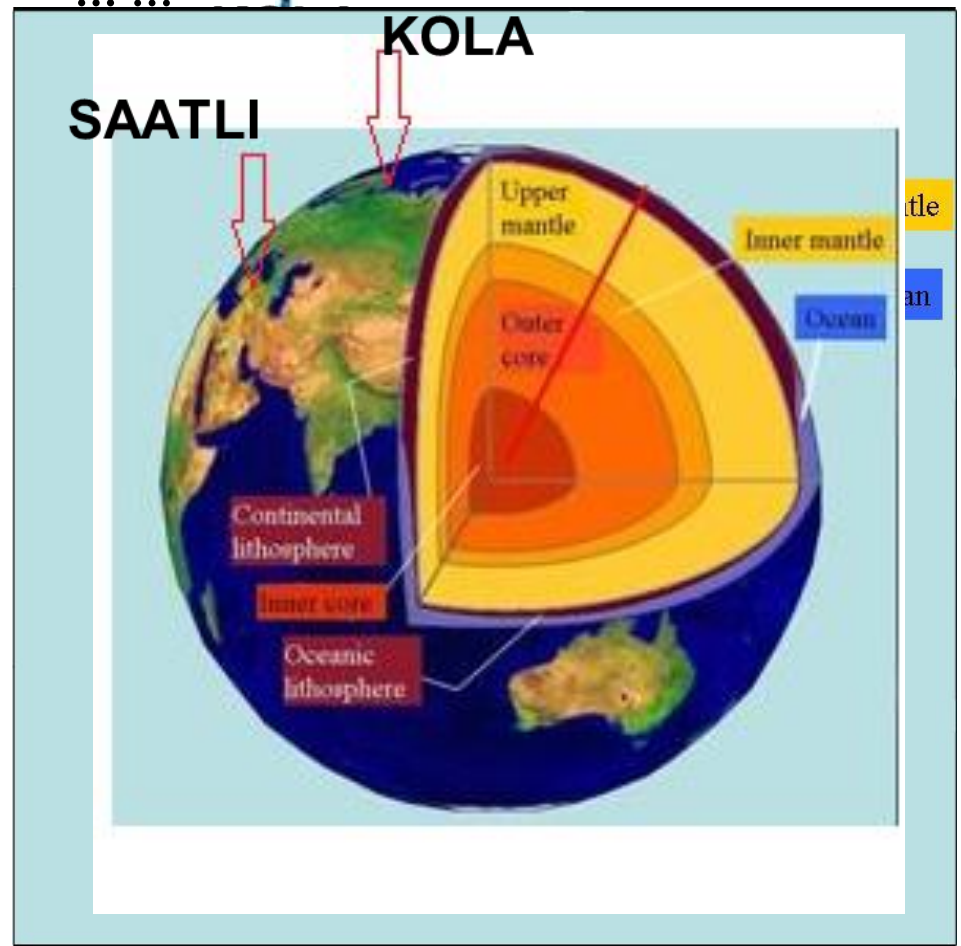
location of **KOLA** and **Saatli** ultradrill on **Earth**

- . **Kola** super-deep wells in Russia in the Murmansk region, near the town of Zapolyarny, is laid to study the geological structure and metallogeny of continental crust ; deepest in the world (12,262 m)



location of KOLA and Saatly ultradrill on Earth

Saatly ultradeep well SG-1, in Azerbaijan, near the town of Saatly; one of the deepest in the world (8324 m) is laid on high gravity maximum, presumed roof "basalt" layer; for the construction of geophysical model of the Earth's crust within the intermontane depressions ; definition features of endogenous processes in the deep layers of the earth's crust



location of **KOLA** and **Saatly** on Earth



KOLA Drilled (1970- 92) with coring all over the wellbore, in

the **West part of Baltic Shield**

Saatly Drilled (1977- 82) with coring all over the wellbore, 10 km south of gravity maximum

Saatly –

Kyurdamir ultradrill

Location of **KOLA** and **Saatli** on Earth

geology SG3 **KOLA**

Kola super-well has been drilled on the ancient Baltic shield and opposite **Saatli**, has been drilled on the young Kura rift structure. Thus there is a unique opportunity to trace hydrocarbon saturation of ultra depth in the time interval from the ancient Archean rocks to the Present day.

SAATLI

KOLA

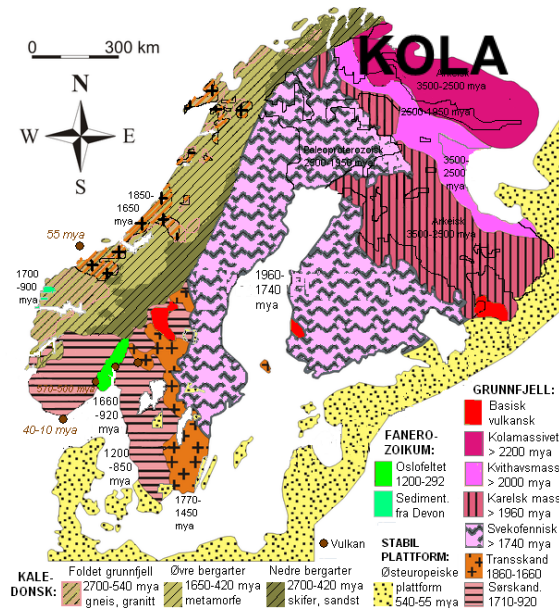


Kola Geology

- Baltic shield geological provinces

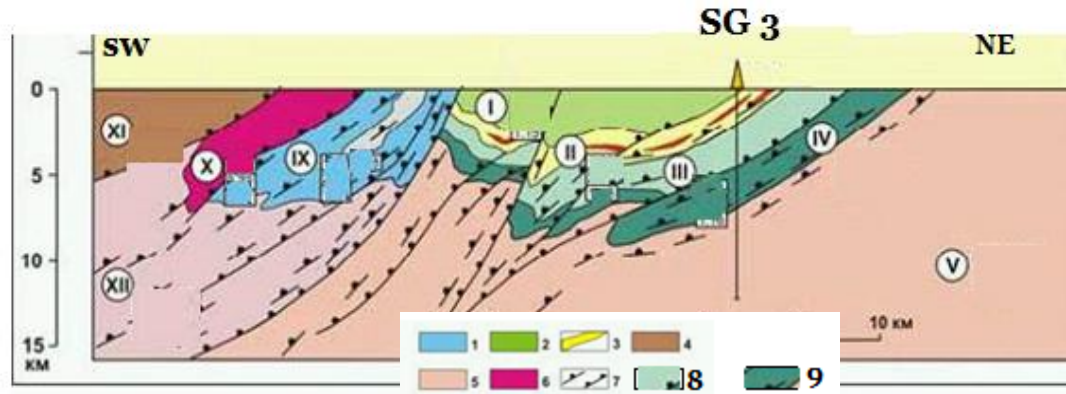
Baltic shield geological provinces

- **BALTIC SHIELD - a projection of the Precambrian basement in the north-west of the East European Platform.**



Baltic Shield consists of the most ancient known to humanity terrestrial rocks.

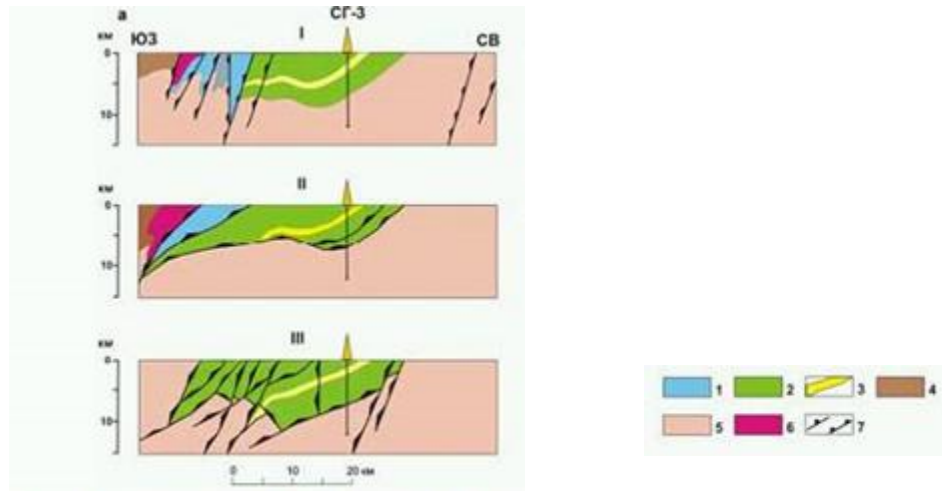
The Baltic Shield is the oldest pre baikal structure, which is composed mainly of metamorphic rocks of the Archean and Early Proterozoic age and the individual intrusive massifs of Karelian, Baikal, Caledonian Hercynian tectonic-maamatic cvcles.



- **Schematic section of the volumetric integral geodynamic model of the Pechenga ore district through the well SG-3 (Kazansky et al., 1994)**
- I - XII - Formalized tectonic blocks. 1 - South Pechenga series: metavolcanites and metaandesites, 2-3 - North Pechenga series: 2 - metavolcanic and metasedimentary rocks, 3 - productive strata, 4 - metavolcanic and meta-sedimentary rocks of the tundra series, 5 - gneisses, migmatites and amphibolites of the Kola series, 6 - rheomorphic granites, 7 – faults, 8 - metabasalts of the Kolosjoki, suite, 9 - Schistose metabasalts and trachybasalts of the kuetsarvi suite; schistose metandeesites and andesite - basalts of the Akhmalahiti suite; schistose metasedimentary rocks of the suites of the Kolosjoki, Kuetsarvi, Akhmalahiti .

The shield is made of old, strongly altered rocks: Archean gneisses, schists, intrusive rocks aged up to 3.5 billion years or more. The lower layer of the Archean continental crust (30-40 km depth), which is a **protocrust**.

Upper part (7 km) - Proterozoic strata with layers of volcanic (diabase) and sedimentary rocks (sandstone, dolomite). Below 7 km - Archean strata with repeated batches of rocks (mainly gneisses and amphibolites).



- **Alternative models of the deep structure of the Pechenga structure in the projection to the section through the Kola superdeep well (Kazansky et al., 1994).**
- I - graben-syncline model (Lanev and Rusanov, 1984), II - the model of the collisional suture zone (Berthelsen, Marker, 1986), III - the model of the explosive apparatus of the central type (Petrov, 1988). 1 - South Pechenga series: metavolcanites and metaandesites, 2-3 - North Pechenga series: 2 - metavolcanic and metasedimentary rocks, 3 - productive strata, 4 - metavolcanic and meta-sedimentary rocks of the tundra series, 5 - gneisses, migmatites and amphibolites of the Kola series, 6 - rheomorphic granites, 7 - faults.

Kola HC existence and distribution

At the Kola ultradeep well influxes hydrocarbon gases exists throughout the section: methane, heavy hydrocarbons.

The largest influxes gas observed in zones of tectonic disturbances having enhanced permeability. Such hydrocarbon circulation areas with groundwater observed at great depths (6.5-9.5 km or more).

At depths, 7 km there are methane in large concentrations. Also from numerous fractures was gushing water - superheated to 200 degrees containing complex hydrocarbon molecules.

Also, at a depth of 10-12 km were fractured and porous rock saturated with highly mineralized water and the presence of high concentrations of methane gas.

In 1995, in the well at a depth of 12,262 m.-slaughtering- was an explosion of methane contained in the cavity of granitic rocks. Isotopes of carbon gases determines the Archean strata as the mantle, Proterozoic - biogenic. These gases enter in crystalline rocks at great depths

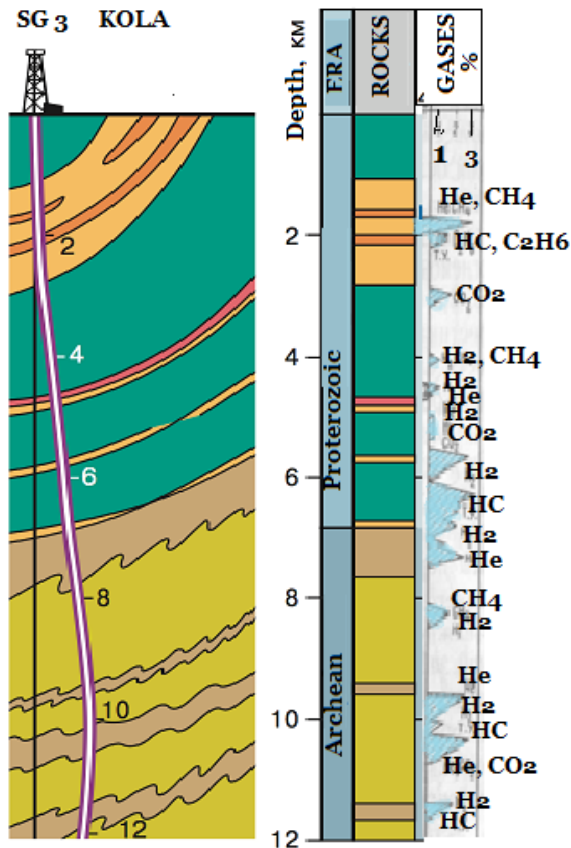
- Oil was discovered during the drilling of the Kola super-deep well at a depth of many kilometers! The Kola has INDUSTRY oil-saturated reservoir OF PRECAMBRIAN igneous rocks DEPTH 7-8 km.

geochemistry SG3

CONTENT of HYDROCARBONS in KOLA SUPERDEEP WELL. Thru interval of CUT were notice HC: both in rocks and faults zones

Materials of the: V.S. Popov, A.A. Kremenetskii, (1999); NPO "Nedra" from A.I. Krivtsov and others, 1993.

ANOMAL CONTENT of GASES in SG 3 KOLA



•At the Kola SUPERdeep well - As can be seen from the cut hydrocarbon content (CH₄ HC) reaches 3%.



1 - Reservoir deposits of igneous rocks of medium and acidic composition, 2 - reservoir deposits of igneous rocks of basic composition, 3 - basalts, 4 - sedimentary rocks, 5 - crystalline schists, 6 - granites and gneisses, 0 - gases


geochemistry SG3 **KOLA**

CONTENT of HYDROCARBONS in **KOLA** SUPERDEEP WEEL. Thru interval of CUT

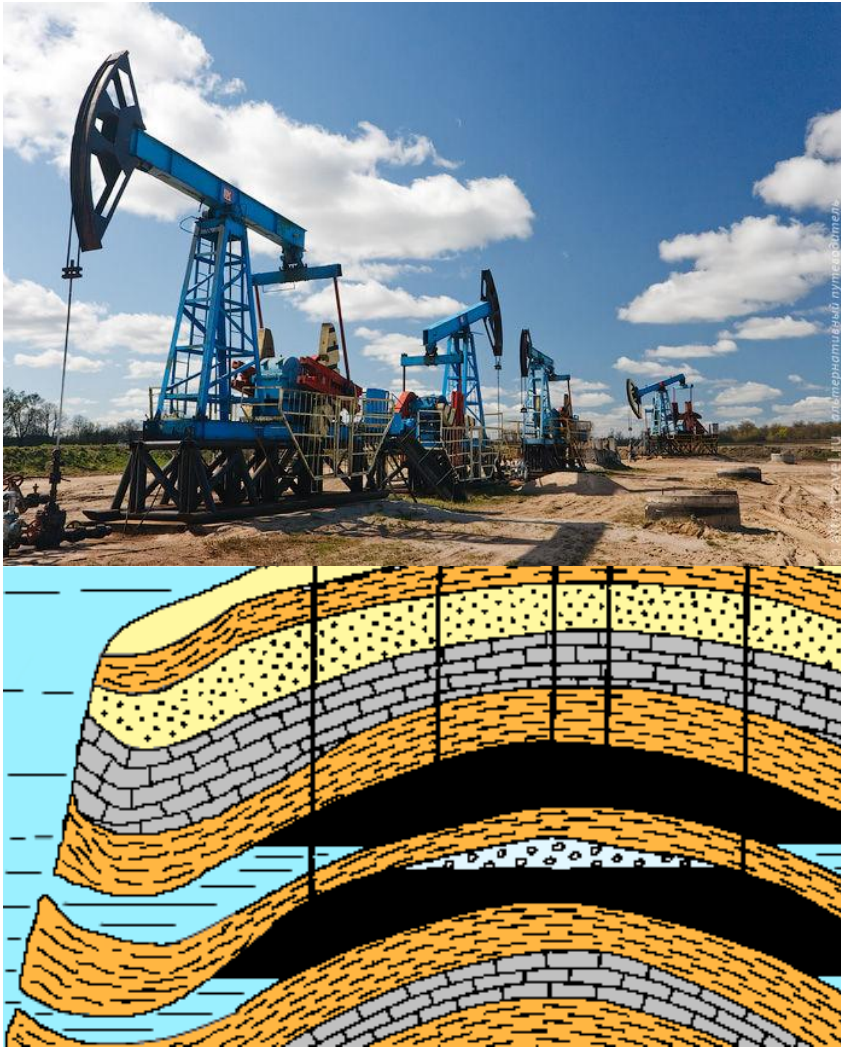
were notice HC: both in rocks and faults zones

TYPE of CUT	HYDROCARBONS
<p>Upper part (7 km) - Proterozoic strata with layers of volcanic (diabase) and sedimentary rocks (sandstone, dolomite).</p> <p>SEDIMENTARY-VOLCANOGENOUS</p> <p>KOLA</p>	<p>CH₄ –to 3%</p> <p>HHC to 2%</p>
<p>VOLCANOGENOUS-metamorphic</p> <p>Below 7 km - Archean strata with repeated batches of rocks (mainly gneisses and amphibolites).</p>	<p>CH₄ –to 1,4%</p> <p>HHC to 2,8%</p>

Around the Kola borehole, there naphthenic and aromatic hydrocarbons in igneous and metamorphic rocks, there is a C1-C6 alkanes up to 55.75 liters / ton, black bitumen (90-100 grams / ton, where more than 32% paraffins C27-C31). On the Baltic Shield, oil shows flows of hydrocarbon condensate gas has in large plutons of nepheline syenite, profuse discharge of gases in the Khibiny Pluton, bitumen in microcracks of the pluton

	CH_4	C_2H_6 ^{rocks}	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{16}
Explore drills	9.37-49.2	0.37-1.40	0.016-0.23	0.001-0.021	tr	tr
Gases of faults l/t (from-to)	0.99-54.02	0.02-1.44	0.01-0.24	0.0-0.05	-	-
Gas-liquid inclusions l/t (from-to)	6.75-27.33	0.45-1.27	0.32-0.85	0.00-0.008	-	-
Gases of micro- faults l/t (from-to)	1.74-5.32	0.07-0.36	0.00-0.01	-	-	-

Baltic syncline' oil fields



- In the Baltic syncline found nine oil fields located east of Kaliningrad.
-
- During drilling, "Kumzha-9" on the Pechora River in Arkhangelsk region at a depth of 7 km zone of abnormally high reservoir pressure has hit strong flow of gas and oil wells was inflamed

geochemistry SG3

HC degassation (flows $60-80 \text{ cm}^3/\text{m}^2/\text{year}$) of Granite Rocks of Old Baltic Shield (Hibin alkaline massive) show, that



- **Hydrocarbons- fields can to be formed for short geological time ~1- 3 million years**

Location of KOLA and Saatly on Earth

geology SG1 Saatly

Saatly, has been drilled on the young Kura rift structure and opposite Kola super-well has been drilled on the ancient Baltic shield. Thus there is a unique opportunity to trace hydrocarbon saturation of ultra depth in the time interval from the ancient Archean rocks to the present day.

KOLA

SAATLI



Saatly Geology

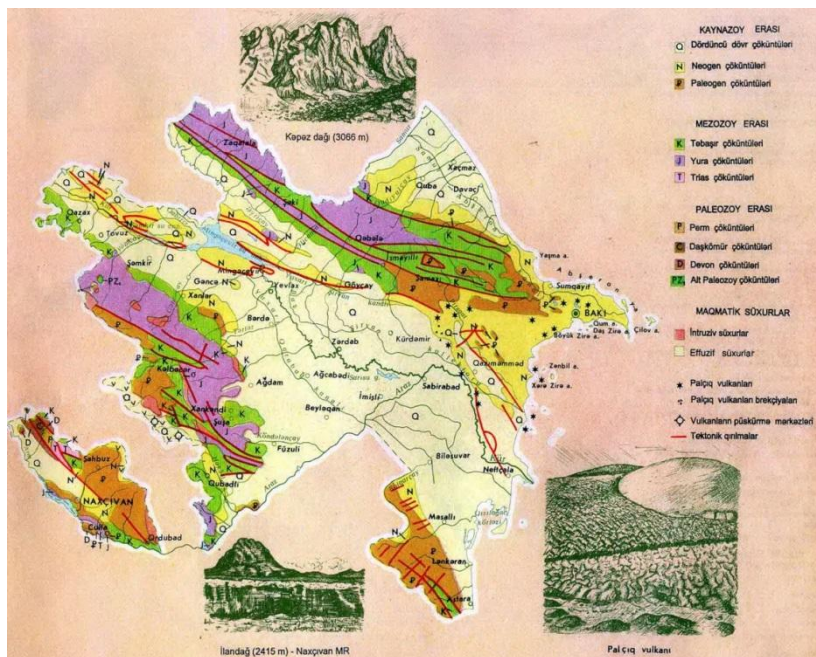
Geological map of Azerbaijan

- Kura rift geological provinces

Kura rift geological provinces

- KURA rift- projection of the Mesozoic vulcanite between Great-Small Caucasus

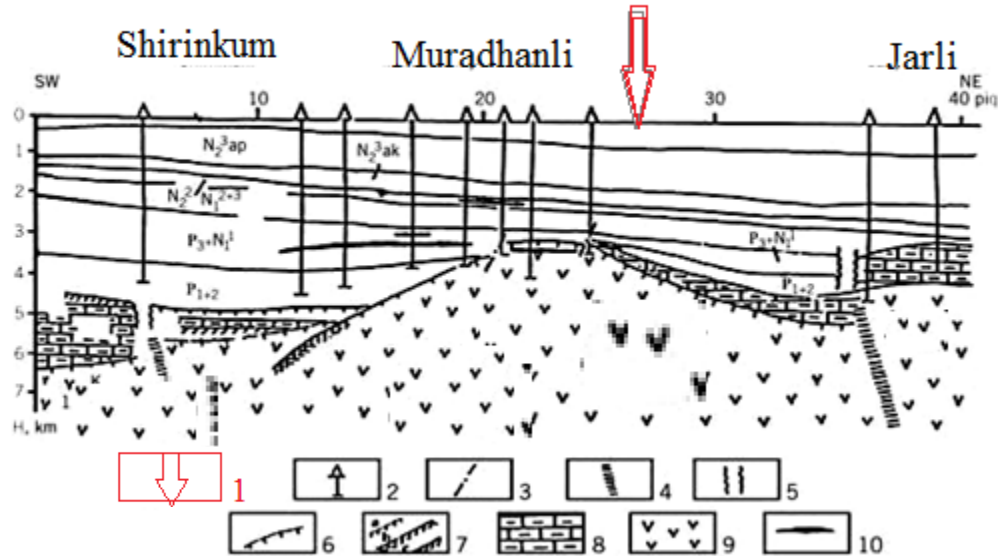
In Kura rift basement structure it **composed** powerful (up to 8 km) molasses sequence Oligocene-Quaternary age, overlying Mesozoic-Paleogene complex. Pre-alpine substrate is immersed in a stepwise depression south-easterly direction, having a block structure. Kura depression for up to orogenic stage is a median massif.



According to the super-deep borehole Saatly sedimentary rocks are of Mesozoic and up to date from late Cretaceous until middle Miocene times (Shikalibeily et al. 1998; Ali-Zade et al. 1999). On the section Saatly super-well recognized several volcanic complexes, the two most important of which are widespread: lower-middle Jurassic volcano-sedimentary series of at least 4784 m, with basalts, andesite, dolerites, diorites and late Jurassic early Cretaceous carbonates with basalts sills (Ali-Zade et al. 1999). Volcanic rocks are in the main being basalts and andesite-basalts.



SG 1, SAATLI



Kura rift formed over a long period. Formation of the Kura rift covers the period of geological time from Upper Jurassic to Upper Cretaceous.

However, modern configuration was finally formed in Quaternary period - Oligocene. In the Kura basin comprises several sub-basins of different origin, with up to 15 km of sediment separated by areas with less sediment (Brunet et al. 2003).

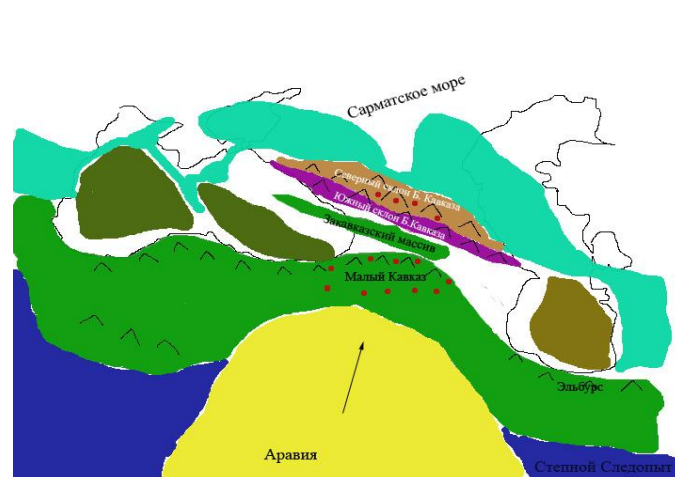
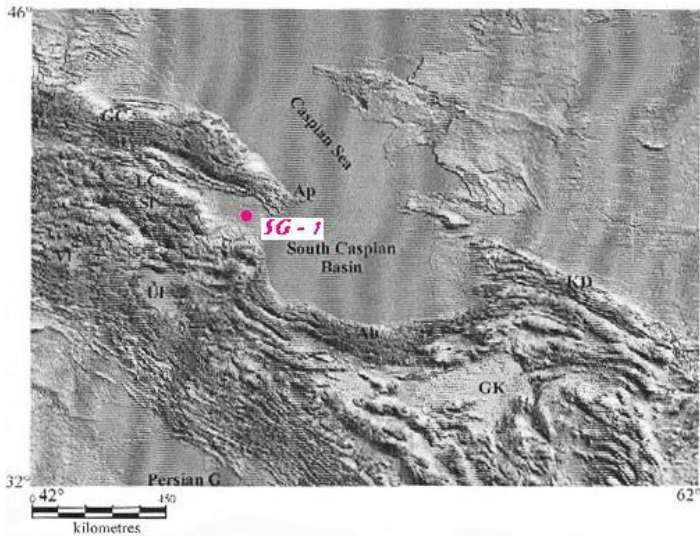
The depth of the mantle, located at 20 kilometers under the Kura rift.

1 – SG 1, SAATLI, 2 – deep boreholes, 3 – faults revealed by the data from: 4 – gravimetric and magnetic prospecting, 5 – zones of complex seismic recording, 6 – location of magmatic rocks roof determined by magnetic field modeling, 7 – conventional seismic horizons: (a) Mz roof, (b) volcanogenic rocks roof, (c)

Mz carbonaceous rocks roof, 8 – carbonaceous-terrigenous rocks, 9- magnetized magmatic rocks (in the figure the magnetization J is given in $\text{mA/m}=12,56 \cdot 10^{-6} \text{ SI}$, 10 – oil-bearing layers

Fig. Middle Kura depression geological-geophysical cross - section (Source: Gadirov & Eppelbaum 2012)

- According Dynamic model Kura rift is location in the area Transcaucasian micro continent that was a part of the Tethys Ocean until Oligocene times (Khain et al. 1991).



SAATLY geochemistry SG1

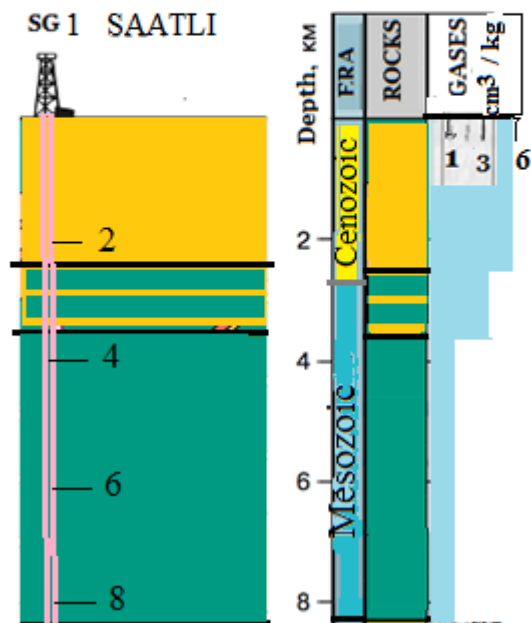
CONTENT of HYDROCARBONS in SAATLY SUPERDEEP WEL. Thru interval of CUT were notice HC: both in rocks and faults zones

- In SAATLY super deep well, hydrocarbon gases of various forms, content and structure of the homologous series were revealed throughout the section prior to bottom hole of 8267 meters methane, heavy hydrocarbon.
- Was found that in super big depths within the geosynclinals belts there are inflows of gases in zones of tectonic disturbances with increased fracturing and permeability .
- Also, were found contents of hydrocarbon compounds and bitumen in super big depths .
- The specific content of HC gases varied between 0.8 and 25 cm³/kg in the rocks of the sedimentary stratum, and between 0.3 and 6.0 cm³/kg in the volcanogenic section. The HC gas composition in sedimentary as well as volcanogenic rocks covers the whole HC spectrum (up to C₆ inclusive) with saturated, unsaturated, normal and isometric forms. The gas composition in sedimentary rocks is identical to the one in volcanogenic rocks and these two gas varieties differ only by their saturation.
- With depth, the total content of hydrocarbon gases decreases: methane, HHC, isomers of C₄ + C₅. Simultaneously, the content of unsaturated hydrocarbons increases.
- These gases enter in magmatic and sedimentary rocks from great depths.
- Oil seeps have been recorded: (2707-m depth), three horizon (0-3.5, 3.5-5.0, 8.5-9.5 km) oil and gas reserves.

geochemistry SG3

CONTENT of HYDROCARBONS in SAATLI SUPERDEEP WEL. Thru interval of CUT were notice HC [whole HC spectrum (up to C_6 inclusive)] : both in rocks and faults zones
Materials of the: Ak. A. Alizade and others, 2000; Galant, 1987, 2010.

CONTENT of GASES in SG 1 SAATLI



1 - basalts, 2 - sedimentary rocks, 0 - gases

geochemistry SG1

**CONTENT of HYDROCARBONS in SAATLY SUPERDEEP WEEL. Thru interval of CUT
were notice HC: both in rocks and faults zones**

TYPE of CUT	SUM of HYDROCARBONS Cm3 /Kg
SEDIMENTARY	0,75-24,62
SEDIMENTARY- VOLCANOGENOUS	0,41-5,31
VOLCANOGENOUS	0,27-5,52



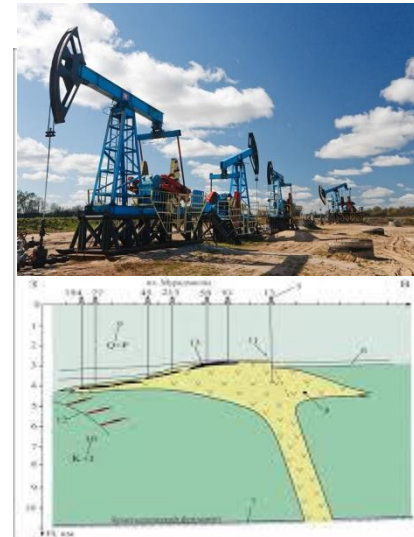
It should be observed existence of HC gases around SG 1 also

Component mg/gr of rocks Rocks Range of fluids from-to average	$H_2+CO+CH_4$	H_2O+CO_2
Basalt $H_2O>CO>H_2>CO_2>CH_4$.	<u>0.71-60.96</u> 8,7	<u>1.6-74.68</u> 22.902
Andesit-basalt $H_2O>CO>CO_2>H_2>CH_4$	<u>0.34-52.4</u> 13,788	<u>2.68-76.86</u> 26.801
Tuff $H_2O>CO>H_2>CO_2>CH_4$	<u>1.2-39.75</u> 16.206	<u>4.12-36.47</u> 19.079

Kura basin' oil field

Kura rift known for its oil fields:

In the Kura basin, near Kurdamir uplift and Adjara-Trialeti zone of the Lesser Caucasus, in formations of volcanic genesis of Mesozoic deposits, discovered commercial accumulations of oil (Muradkhanli, Samgori, Patardzeuli, Teletskoe).



geochemistry SG1

**HC degassation (flows $1700 \text{ cm}^3/\text{m}^2/\text{year}$)
of Young Alpine geosyncline's (Barum granite massive) show
that**

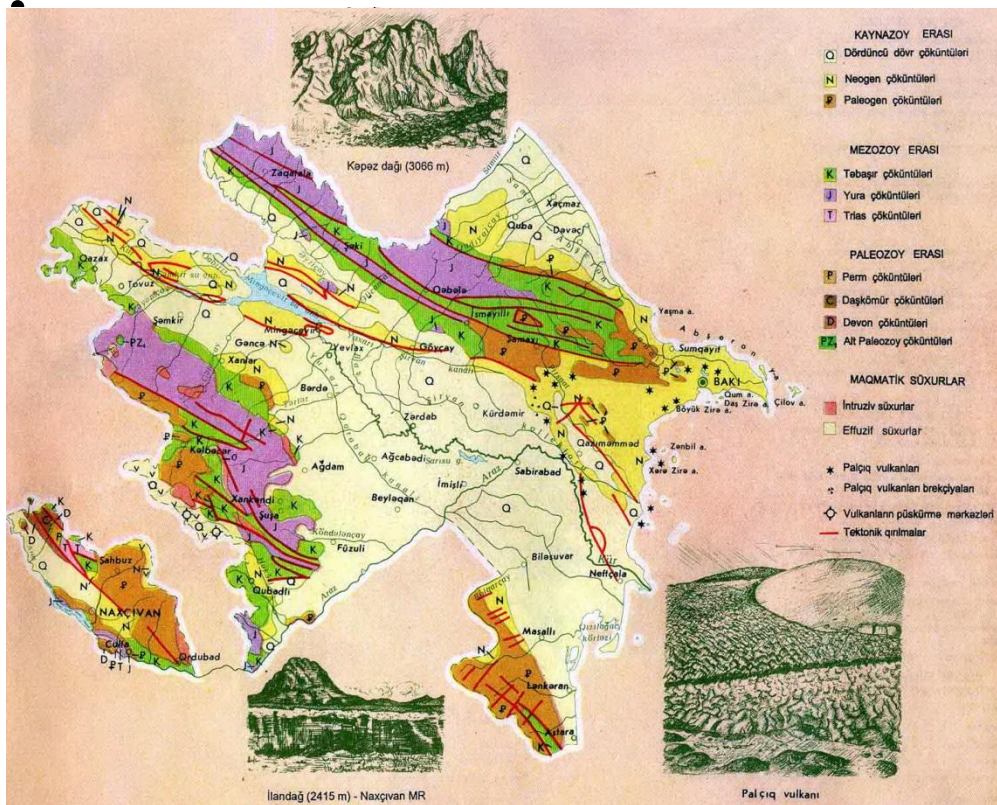


- **Hydrocarbons- fields can to be formed for short geological time ~1- 3 million years**

Conclusion

SaatlyKOLA EEGeology

- SO . On the Baltic Shield practically have a the primary rock, which are the foundation of the Earth as a planet! And on the Kura rift there are modern rock!



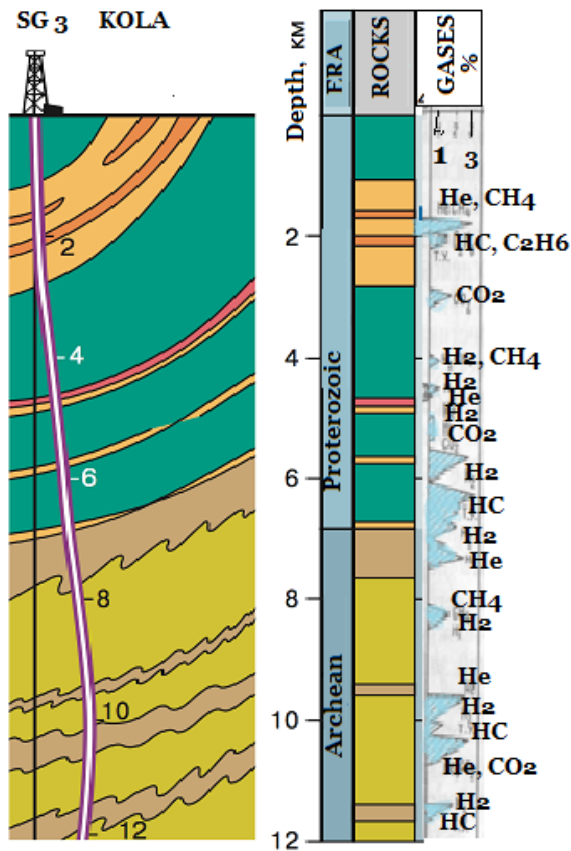
Conclusion

- Hydrocarbon in SG1Saatly and the SG-3 Kola are in different forms: free, dissolved, adsorbed, occluded. In the Kola segment of the Baltic Shield and Kura Rift abundantly distributed C₁-C₇ alkanes, and bitumen. These gases influx into crystalline rocks at great depths. In its composition, rocks gases unique ultradeep wells resemble the composition of oil and gas fields.
- 1) The presence of oil in the well itself and 2) the presence of oil in the surrounding rocks, and 3) in the structure indicates the existence of deep hydrocarbon sphere and which is likely a source for generating of hydrocarbon accumulations!

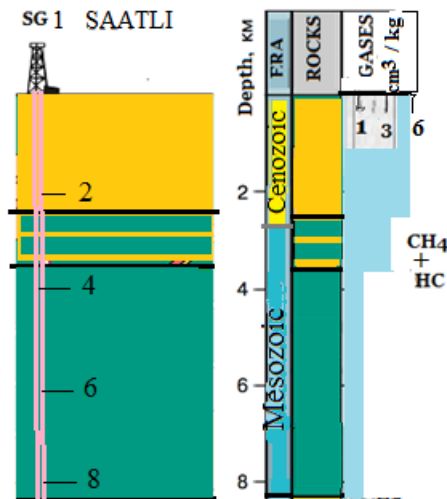
General conclusion

PROFILE KOLA + SAATLI

ANOMAL CONTENT of GASES in SG 3 KOLA

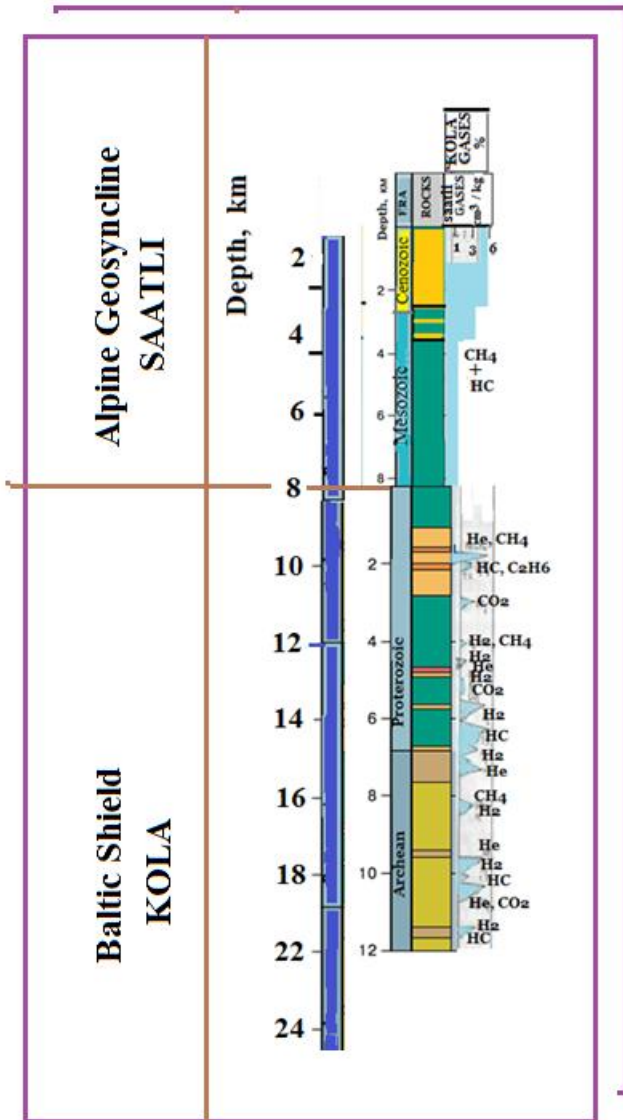


CONTENT of GASES in SG 1 SAATLI



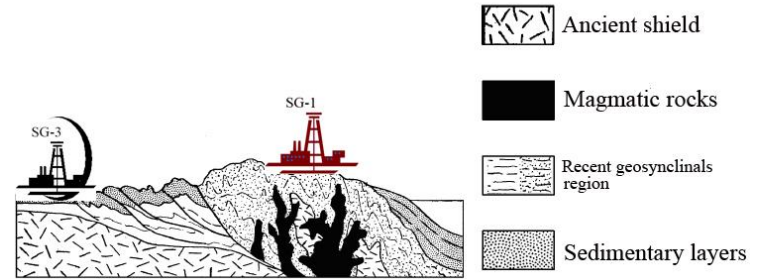
General conclusion

UNIT PROFILE KOLA + SAATLI



- 1 - Reservoir deposits of igneous rocks of medium and acidic composition,
- 2 - reservoir deposits of igneous rocks of basic composition, 3 - basalts, 4 - sedimentary rocks, 5 - crystalline schists, 6 - granites and gneisses, 0 - gases

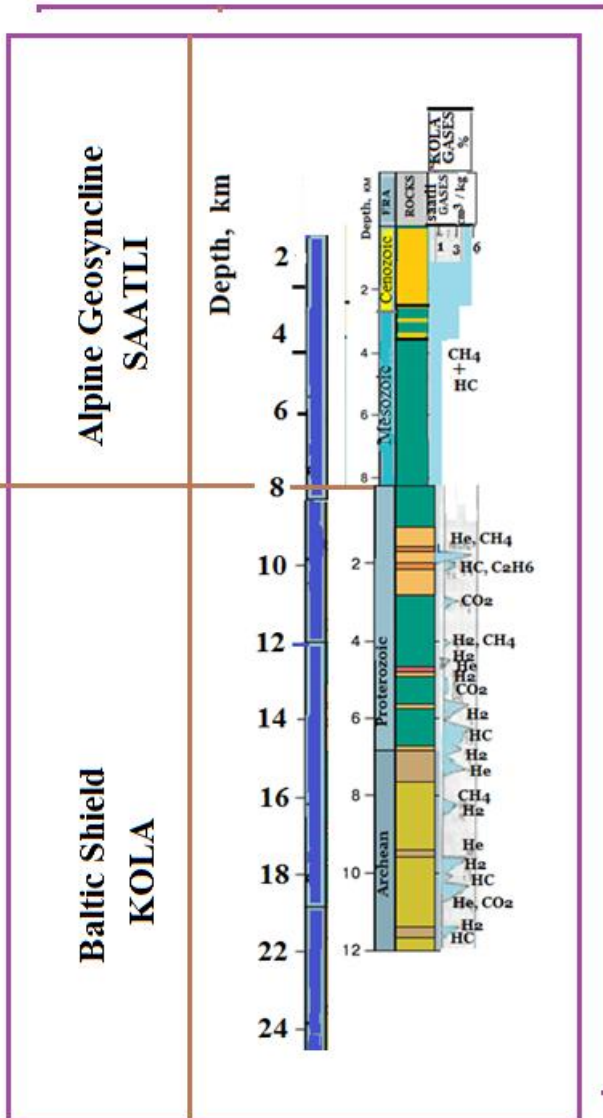
General conclusion



- Thus, the combined section of diverse genetic groups of rocks and various types of geological structures Kola (shield) and Saatli (geosyncline) showed that, in Space ultradepth more than 22 км in the temporary crustal section from the Archean 3 billion years to update, and passed all tectonic magmatic cycles till today there are actively dynamically circulating zones hydrocarbons . Thus ultradepth saturated hydrocarbons. **Thus the sphere of hydrocarbons formed, already with primary crustal rocks, the first stage of the Earth's geological history, and exists to the present day, intensive degassing through Tectonic Magmatic cycles participating in geological processes. Ultradeep hydrocarbon sphere can be a source of forming oil fields !!!**

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Thoughts after General conclusion



- I.e. impression
 - that against the background
 - of increasing the age of the Earth
 - and the aging of rocks,
 - the flows of **hydrocarbons** are always
 - as intense and always young,
 - that is,
 - from antiquity until now
 - they are constantly - intensely young.
 - The scale of their flow is high
 - and can form hydrocarbon deposits.

Gratitude

thank you for your attention

