

# Soviet exchange drilling program

## Abstract

The article describes the details of a super deep drilling project developed in the USSR in the late 1960s. The program of work outlined the development of a model of the structure of the earth's crust as well as new methods for forecasting mineral deposits. In total, 10 wells with a depth of 6-9km were drilled, the deepest of which was the Kola well with a record depth of 12,262m.

**Keywords:** superdeep drilling, borehole, earth crust, mantle, kola well

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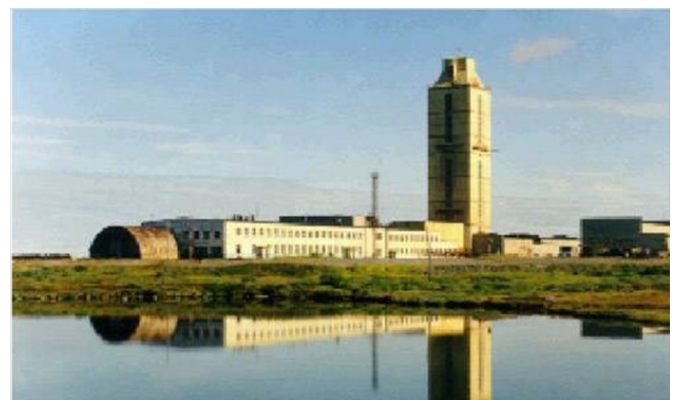
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## Introduction

At the end of the 1960s, the USSR Academy of Sciences and the Ministry of Geology of the USSR has developed a program to study the entrails of the Earth by deep drilling.<sup>1</sup> For Works was established Interdepartmental Scientific Council on the problem of "Study of the Earth's interior and ultradeep drilling", which brought together about 200 eminent scientists and experts from various ministries and departments. The first chairman of the Council was the Minister of Geology of the USSR Academy of AV Sidorenko, and since 1974 - Minister of Geology of the USSR EA Kozlovsky. Work Program for the 70 years was planned to develop a model of the Earth's crust and upper mantle, as well as new methods for forecasting mineral deposits. In the development of this problem has been developed fundamentally new technical and methodological approach to the solution of regional deep structure of the Earth's crust and upper mantle, based on a combination of deep drilling data and seismic depth sensing and other geophysical and geochemical methods. The leading organization in the implementation of the planned tasks were defined Ministry of Geology of the USSR, and for the implementation of the program attracted more than 150 scientific and industrial organizations of the Ministry, Academy of Sciences of the USSR, the academies of the Union republics, ministries and departments. According to the program for drilling have been planned in the first place and Saatli Kola ultradeep skvazhiny. 24 May 1970g, the 100th anniversary of the birth of VI in the anniversary year Lenin, C-W Kola Kola ultradeep drilling of the borehole (SG-3), - the deepest in the backbone ultra deep (deeper than 5km) wells traversed in principal ore p-tries USSR 1970-90 GG A. On the recommendation of Academician Sidorenko, SG-3 was drilled in ore Pechengsky borough, where formed Europe's largest deposit Cu-Ni ores. SG-3 is located 10 km from the SW of Polar (69° 23'46" northern latitude., 30° 36'31" E), where the earliest developed mineralized tectonic structure of early Proterozoic and Archean (Figure 1 & Figure 2).

When the design depth of 15km, by 1990 the well was to reach a depth of 13km. In contrast to the deep wells used for the extraction and exploration of oil deposits, SG-3 was originally designed to obtain scientific information on the structure of the Earth's continental crust, including the study Moho between the crust and the mantle. Drilling Kola borehole was commissioned specially organized geological expedition Kola (Kola GRE) of about 3 thousand. Man, the undisputed leader of which he was appointed member of RANS DM Huberman. To him belongs the credit for the successful implementation of

the drilling program. The preparation and organization of drilling involved 18 research institutes and more than 50 large enterprises of the USSR. All equipment and materials were of domestic origin. SG-3 was in the USSR a secret object, the world of her casual reported only in 1975, when the "Truth" published an article by the Minister of Geology AV Sidorenko. Not a single scientific publication before the collapse of the USSR and did not appear, although the well worked 16 research laboratories, which were supervised personally mingistrom geology. June 6, 1979 the well broke the record in the 9583 meters, previously owned by the well "Bert Rogers" (oil well in Oklahoma, United States), reaching 9584 meters. In the future, a record depth of penetration all increased. Sophisticated drilling conditions, high temperatures downhole that reached at the depth of 12km to 220°C, resulted in repeated accidents, breakages and loss of drilling equipment. Lost portion of the drill string cemented, vertical drilling continued with the drilling tool deviation in place of breakage, whereby the depth below the base 7km were passed five parallel shafts SG-3. In 1990 burivshiyasya parallel trunk SG-3 record depth reached 12,262 meters. The team of SG-3 is ready to achieve a depth of 14km, but the drill string is broken again, and drilling was terminated by the government's decision.



**Figure 1** Kola ultradeep borehole (SG-3).

In 1991 the company received the status of "Kola ultradeep" Research and Production Center. In 1995-2007 GG SPC operated in the status of the Kola deep geolaboratory, on the basis of which more than 20 countries carried out research on the UNESCO international projects and the International Geological Union. In the following years, due to financial difficulties it had resolved the issue of the

final closure of the Kola deep geolaboratory, although projects for further work by experts developed country could bring huge profits at relatively low cost: at the close of the budget of the NPC was 3mln. Rub. in year. In 2008, SG-3 was suspended, the equipment partially dismantled and partly looted for scrap metal itself rig and production facilities were in ruins. SG-3 is still the deepest vertical borehole world in crystalline rocks, but the length of it surpassed drilled at an acute angle to the surface of the earth in 2008, an oil well Maersk Oil BD-04A, the length of which 12,290 meters (located in the oil basin Al Shaheen, Qatar), as well as the well field Odoptu-sea Sakhalin-1 project length of 12 345m drilled in 2011, also at an acute angle to the surface of the earth. Penetration to a depth of 12 km in the monolithic rocks and its overcoming in conditions of modern cost is comparable with the performance of a large space program. USSR project cost 400mln. Rub. Given the fact that the state, by performing this prestigious project, virtually no thought to the cost, project performance vertical drilling in solid rock to a depth of 14-15km at present require enormous effort and cost several billion. dollars. It can be stated that the closure of the well - a very rash decision. It is unclear why the country abandoned the idea of the creation on its base an important laboratory for the study of geological processes in the earth's crust. Cost Recovery SG-3 - about a hundred million rubles. At this point, you can restore the scientific significance of the SG-3, and in particular, to open research and production center for training specialists in deep drilling. In the well a work trunk diameter of 20cm and a depth of 4km, more trunk diameter 10cm extends to a depth of 8km.



**Figure 2** Kola ultradeep borehole (SG-3).

Lifting equipment has been preserved, but the wireline equipment can be run in the usual logging lift. This will allow at any time to begin the study of the deep layers of the lithosphere, to build three-dimensional geophysical model of the Earth's crust shifts, to predict earthquakes, catastrophic shifts of geological units, solve dozens of other important scientific problems.<sup>2</sup> Interest in this unique object showing dozens of research centers in Russia and abroad. Perhaps Kola ultradeep borehole has not yet said its last word. SG-3 has fulfilled all its tasks, and in the technical and scientific terms. On the surface of 4024m was raised core, including dvenadsatkilometrovy depth holds more than 400 thousand. Km log 25 geophysical methods. As an academician EA notes Kozłowski,<sup>3</sup> the main task of drilling SG-3 was to study the deep structure and ore potential of the ancient continental crust, namely: getting deep geological section; a comprehensive study of the material composition of rocks and the

nature of their change with depth; finding features of endogenous geological processes in the deeper parts of the crust and the connection with ore-forming processes; clarification of the geological nature of the deep geophysical boundaries and geophysical parameters of the geological strata. During the study a number of important information about the Earth's interior. The results were largely unexpected and not yet sufficiently appreciated by the scientific community.

First of all, it sets a high permeability to fluids deep zones of the Earth's crust. Previously it was believed that the depth of rock solidity increases, decreases the porosity, fracture, and overall permeability. However, the density of cracks and porosity of the rocks at great depth, contrary to predictions, maintained, and in some areas increased. Under the high pressure in these areas fractured circulate superheated water and fluid flows. In the 60-70-ies of the last century, there were major projects of disposal of liquid radioactive waste by pumping them into deeper layers of the earth's crust. Results of drilling SG-3 was forced humanity to abandon the implementation of such projects - hydrothermal flows would spread the radioactivity in the whole surrounding area thousands of kilometers and hundreds of years have poisoned the deep waters of the largest European countries. As a result, penetration of the Kola borehole were first obtained by the direct data about the composition and physical state of rocks at great depths. As a result, it has been refuted design ideas about the structure of the Earth's crust in the area in the Pechenga structure. Project section SG-3, created by seismic data, he predicted that at a depth of 4 km from the well will volcanosedimentary sawmills Pechengsky structure and enters the granite-gneiss Archean foundation. Drilled three-kilometer layer granite-gneiss and relatively low power at this site basalt layer, the well was immerse in rock mantle.

However, in reality Pechengsky rock structure ranged up to 6842 m depth and only then replaced Archean granite-gneiss. A basalt layer was not detected at all - until the record depth penetrated through the drill Archean granitoid rock. It was found that densified at Granitoids seismological research geophysicists were perceived as more dense as compared with standard granites basalts, or even more dense rock mantle. These misconceptions about the deep structure of the Kola Peninsula, and were the basis for the design of the well section. Thus, instead of on the intended depth semikilometrovy "surface Conrad" (roof basalt layer) was identified subhorizontal "crustal waveguide", a kind of the decompression zone, in which there were large displacement subhorizontal cortex blocks; similar decompression zones have been installed in other parts of the SG-3. Moving tectonic blocks in these areas provided scaly-thrust structure of the entire Lapland-Pechenga supply. As a result, a comprehensive study of the core rocks SG-3 made a number of new discoveries in the field of geology and paleontology. It was found that the deep crustal rocks were formed with the active participation of biological processes. Isotopic Carbon analysis revealed two sources of origin: the first has a mantle origin, the second - biogenic, wherein biogenic carbon prevails in Proterozoic metasedimentary rocks. In the past also found micro-organisms, whose age-. More than 2 billion years old. Thus, it confirmed the idea VI Vernadsky's presence in the world of the Precambrian biosphere. New data obtained in the evaluation of the actual temperatures at great depths. It was assumed that the granite-gneiss foundation Baltic shield temperature with depth increases slightly (approximately 8-10°C for 1km). The actual temperature in the SG-3 at a depth of 10 km reached 180°C, and at a depth of about 12 km - 212°C, instead of the expected 120°C. Perhaps this is due to increased tectonic activity in the deep horizons of the crust. Besides, the results of the downhole gammakarotazha and other geophysical

investigations the vertical zonation in the distribution of concentrations of uranium, thorium and potassium. It-essential contribution to the development of an overall thermal model of the formation of the crust. The first to demonstrate the existence at depth in granite-gneiss foundation arrays underground saline water. The largest of highly water inflows are installed in areas of tectonic faults with increased permeability. The circulation of groundwater areas recorded at great depths (6,5-11,5km or more), there was a relatively low-temperature hydrothermal deposition mineralization (copper, lead, zinc, nickel). This is evidenced by the fundamental possibility of the appearance at these depths large clusters, low- and high ore that is of fundamental importance for the development of the doctrine of mineral resources and the search for ore deposits at great depths. Furthermore, at a depth of granite-gneiss were detected in significant concentrations of hydrocarbon gases, including methane. This is another argument in favor of non-organic origin of hydrocarbons. Implementation of a complex of diverse geophysical research enables professionals to SG-3, relying on a network of drilled ultra deep (deeper than 7km) wells in other regions of the USSR, to track changes of geophysical parameters in three-dimensional space, to build a three-dimensional spatial model of the stress state of the earth's crust, to predict changes in these states, making it possible to forecast the Earth's crust earthquakes and catastrophic shifts for many thousands of kilometers from the SG-3. Industrialized world, are located in seismically hazardous state areas, and above all - Japan, allocate tens of billions of dollars on research related to the study of earthquakes and warning of volcanic eruptions, catastrophic movements of tectonic plates and other natural disasters related to the easing of tension in the bowels of our planet.

Continued research on the SG-3, short-sighted stopped at the end of the last century, much closer to humanity to address human security issues, living in tectonically stressed regions of the world. At the same time it could be solved as dozens of problems related to tracking changes in patterns of geophysical parameters in the strata of the hydrosphere and lithosphere of the planet - including the ability to detect movements of submarines and other underwater objects in Earth's oceans. Total for deep drilling program in the Soviet Union, in addition to the SG-3, was drilled as well Ural Sverdlovsk

region (depth of 6.3km), Saatli well in Azerbaijan (depth of 8.3km), Yong-Yakhinskaya well under Urengoy (depth of 8, 25km), Timan-Pechorskaya well (depth of 7km), Tiomenskaia well (depth of 7.9km), Shevchenko well Z. Ukraine (depth of 7.5km). Thus, drilled ultradeep wells in our country can be counted on the fingers of both hands. Throughout the world, these wells also a little - only 8 (4 in the US and one in Kazakhstan, Sweden and Germany should be noted that the current 2018 - . Turning against ultradeep drilling Again in skirmishers -. Our state Director Rosgeologiya Roman S.. Panov said in an interview with the weekly "Arguments of the week", that drafted four drill ultra-deep wells up to 7km, the first of which will be drilled in the North Caucasus in order to test the hypothesis that large deposits of hydrocarbons at depth. It is generally recognized that the sinking of the SG-3 - the flagship ultra-deep drilling project, a new period began studying the Earth's crust. Deep drilling on the continent and in the oceans grows into a new branch of science and technology, which combines the latest achievements of scientific and technological progress in general and geological disciplines in particular. There is no doubt that the achievement of deep horizons of the Earth will open for geologists, new patterns of development that will fundamentally differently represent features of the deep structure of the crust of our planet and the prospects for its ore content.

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## Conflict of interest

The author declares that there is no conflict of interest.

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