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TERRESTRIAL AND EXTRATERRESTRIAL DRILLINGS IN THE 21ST CENTURY. RESEARCH CHALLENGES AND THE WAY TO SATISFY THEM BY MEANS OF A NEW RESEARCH INFRASTRUCTURE AT AGH UST

Abstract: Knowing the impact of technical solutions on the drilling process is a very important element in the process of the exploration of new fossil fuel deposits. Drilling equipment used during drilling operations is highly liable to all conditions which prevail in the well bore. The study of the impact of drilling fluid flow with various rheological properties on the strength and work of drill stem components will allow to search for the best solutions. The article describes the design and construction of two boreholes, fill up with 9 5/8" (244.5 mm) and 24" (609.6 mm) casings. The designed boreholes will be a joint part of the drilling laboratory in the S-1 building at AGH-UST in Krakow. Research The research described above can be done in openholes and implemented at the beginning of the design process for drilling works in new deposits. In addition, it will provide an opportunity for all engineers to get to know the behavior of components operating in an open hole.

Keywords: drillings, space drilling, lunar regolith research, drilling tests, data acquisition and processing, real time condition

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1. INTRODUCTION

The control of the drilling process based on real-time data leads to an increase in the demand for researchers related to the impact of real data on the entire process, in particular their correct implementation during drilling. Knowledge, correct selection, and analysis of data in real time, facilitates correct drilling operations. At the same time, it is possible to improve the drilling parameters in order to increase the economics of the drilling project. Therefore, research showing the interdependence of individual drilling technology parameters and their impact on the design task is a very important factor. The limitation of parameters resulting from the strength of the drill string components, as well as the components of the drilling device, do not allow to fully use the power transmitted to the bottom of the well. On the other hand, the power delivered to the bottom of the borehole is burdened with the sum of pressure losses inside the scrubbing unit, starting from the high pressure pipeline and the pressure inside the drill string. Pressure losses at the bottom of the borehole account for approximately 55–60% of all losses in the entire drilling process [3]. That is why it is so important to be able to analyze the obtained data in real time. A correlation with archived data will allow the search for optimal solutions In terms of the technology of production and the creation of drilling tools, as well as the technology itself of drilling boreholes. The development of exploration for crude oil and natural gas as well as other mineral resources confronts engineering and technical staff with a number of issues in the field of technical and technological aspects of drilling wells [1]. Knowledge of the impact on the drilling process and the correct correlation of technical and technological parameters in laboratory conditions will allow effective and multi-dimensional prediction of input data that can be successfully implemented in real conditions.

2. REQUIREMENTS FOR THE S-1 BOREHOLES

Justifying the decision on the execution of a geological works project for the implementation of experimental boreholes in the S-1 building, first and foremost it is necessary first and foremost to mention the need to educate future graduates of the Oil and Gas Drilling Department. In the present state, the facilities available for practical education purposes are both small and significantly limited. They mainly result from the lack of large-scale technical and technological solutions. One such solution will be the design of the holes in the S-1 building. They will allow the performance of many real-time tests in the borehole. Experimental boreholes will be used during practical classes on MA and engineering courses. The second aspect that argues for the need to implement the designed boreholes is for industry to be able to perform specialized tests in boreholes under laboratory conditions.

3. CONSTRUCTION ANALYSIS OF THE DESIGNED S-1 BOREHOLES

Figure 1 shows a horizontal cross section through the laboratory in which the boreholes are planned for execution.

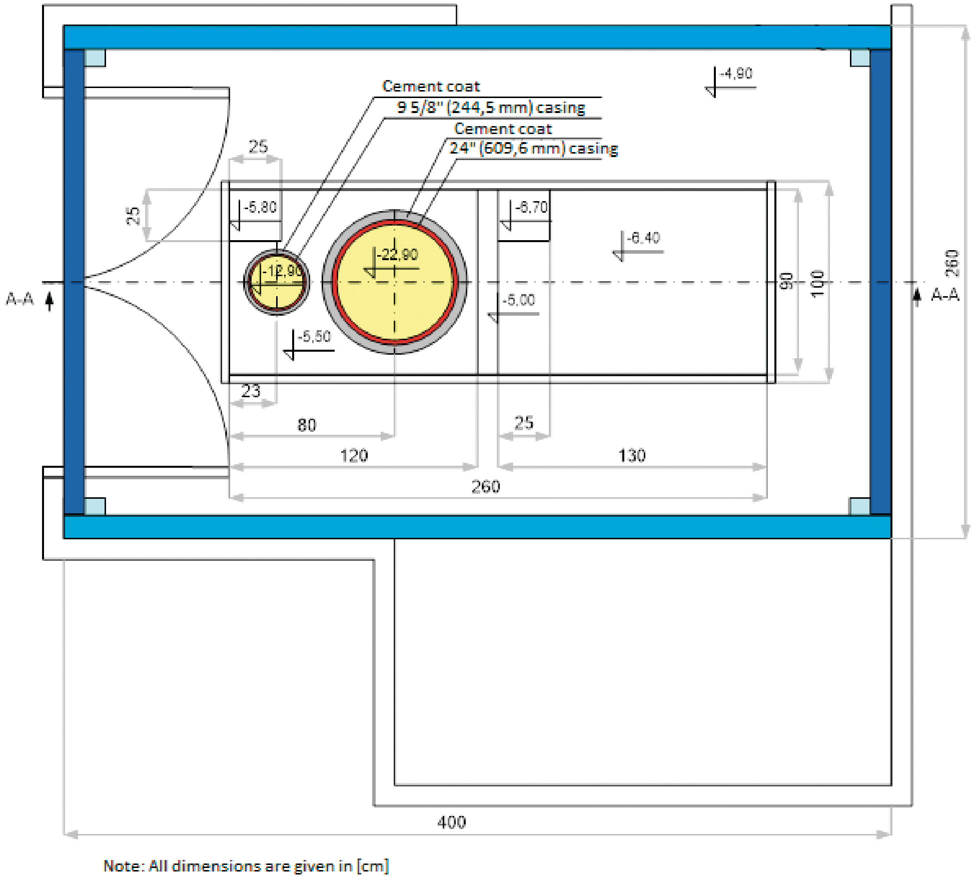

Fig. 1. Horizontal cross section through laboratory in S-1 building, drilling field segment

In order to drill boreholes, it was necessary to develop crussial drilling works related to the preparation and drilling of boreholes. The projects have been developed in accordance with the existing legal provisions [2]. The experimental openings will be made for scientific research purposes as part of the didactic infrastructure of the Oil and Gas Drilling Department in the designed AGH S-1 building. The openings will have a depth of 11.0 m and 21 m from the ground level, respectively (9.0 m and 19.0 m from the level of the basement floor in the S-1 building). Hole No. 1, with a depth of 11 m from the ground level, will be cased with a K-55 steel grade 9 5/8" (244.5 mm) diameter casing, with a wall thickness of 8.94 mm, and cemented to the top. Borehole No. 2, cemented 21 m below ground level, will be cased with a B 24" (609.6 mm) casing, with a wall thickness of 12.7 mm, and cemented to the top. The boreholes were drilled from the ground level before the construction works of the designed S-1 building, which is an extension of the existing A4 building, in the area of the AGH University of Science and Technology in Krakow. Below we would like to show the PGTO (geological and technical projects), concerning the drilling technology of the planned experimental boreholes for research purposes (Figs. 2 and 3).

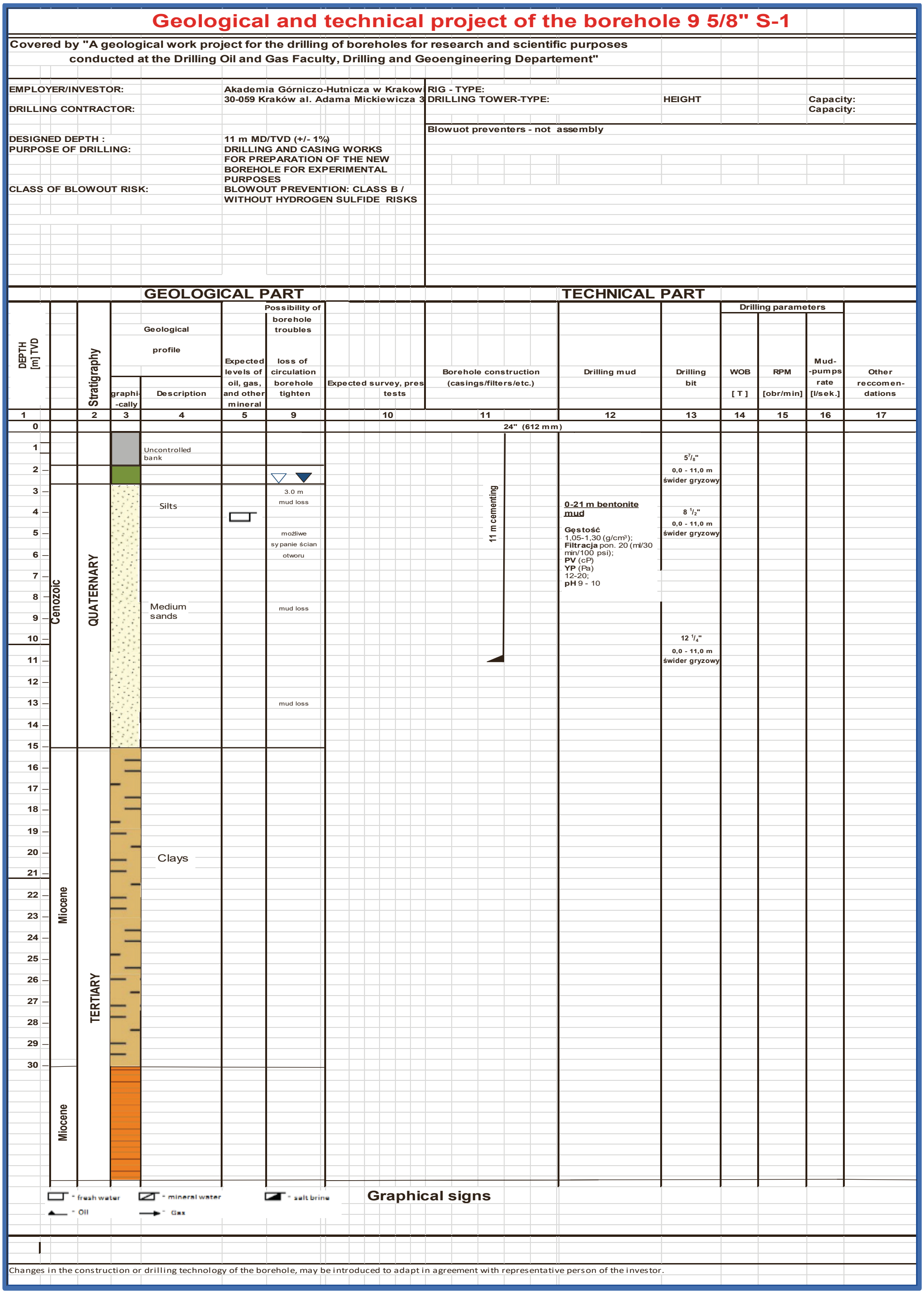

Fig. 2. Geological and technical project of 9 5/8" (0.2445 m) cased borehole

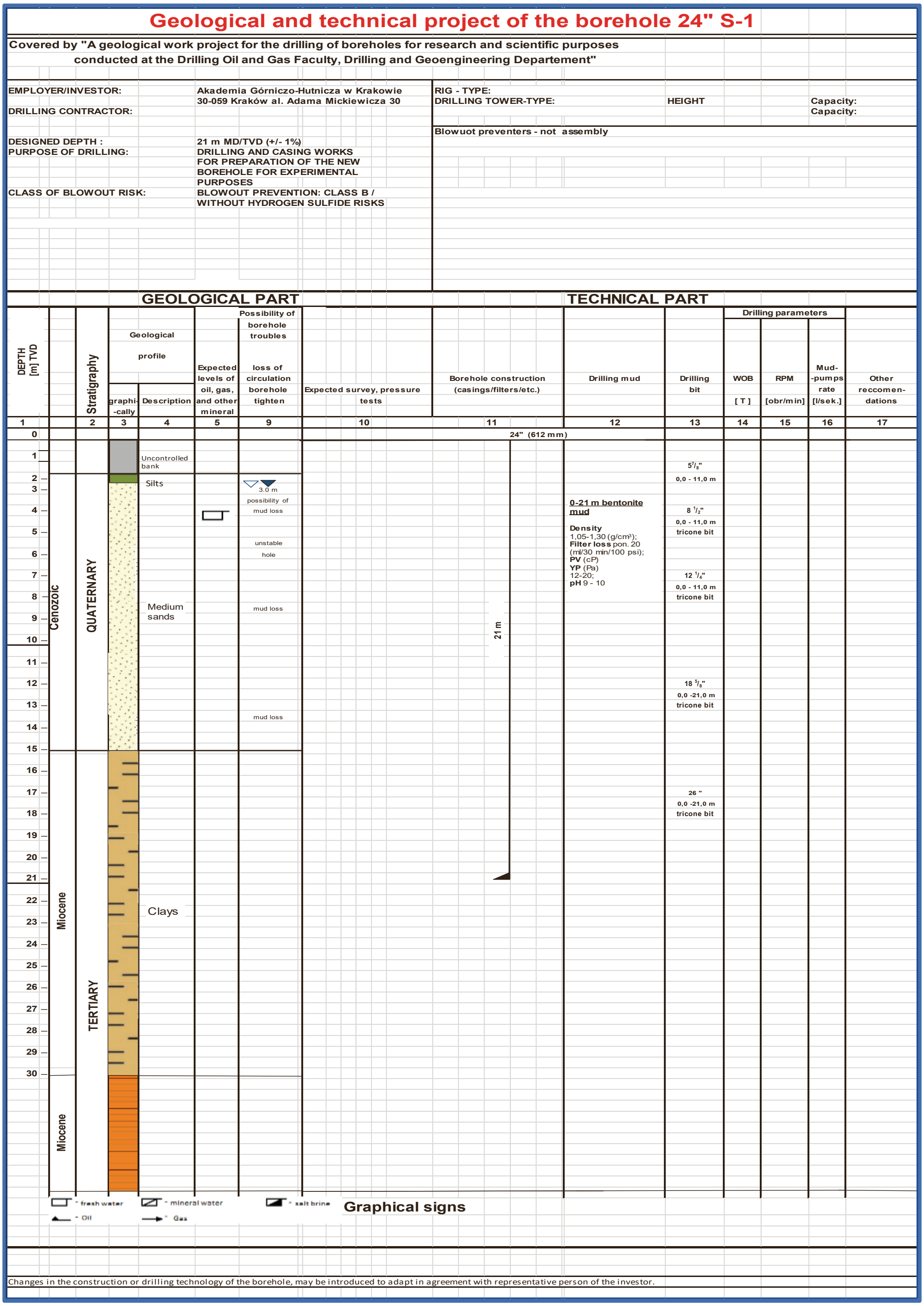

Fig. 3. Geological and technical project of 24" (0.6096 m) cased borehole

4. THE FUTURE OF THE S-1 BOREHOLES

The designed experimental open holes will be use for practical learning of engineering problems during drilling, technology parameters for the subsequent stages of the borehole. These include drilling, piping, installation of blowout preventers, tripin and tripout the drill string, twisting of individual components included in the drill string, failure recognition and drilling complications and the search for possible solutions under time pressure. Casings installed in the laboratory were prepared for placement in an analog ofa lunar regolithknown as AGK-2010, which was developed and patented at the AGH University of Science and Technology. AGK-2010 has been used in many projects i.e. an ultralight drilling rig for planetary exploration with the cooperation of the European Space Agency. It provides the opportunity to conduct a range of studies directly connected with tough type of drilling in extraterrestrial conditions and to observe the behavior of drilling tools during drilling works performed in this way. In space, drilling time is not an important factor, while the minimization of mass and power consumption has the highest priority [4]. Drilling boreholes in terrestrial conditions known as deep drilling can reach up to a few kilometers in depth, whilst deep drilling in extraterrestrial conditions is seldom over a dozen meters. Furthermore, setting up, developing, and research in laboratory conditions are so important nowadays that we should focus more on the preservation of drilling system components before working in extraterrestrial conditions. An important factor that positively evaluates the desirability of designing and performing experimental boreholes in the S-1 building is the fact that it will be possible to simulate various conditions during laboratory projects directly resulting from the technical and technological solutions used in the drilling process. The most important factor in the design and implementation of boreholes in the S-1 building are industrial research of technical solutions and drilling technology that can be performed in real conditions (with appropriate computer-scale rescaling of the drilling process). After installing the blowout preventers on the 9 5/8" casing column and equipping the testing laboratory with computer stations simulating the inflow of reservoir fluids into the well, we will be able to conduct courses in the prevention and liquidation of reservoir fluid eruption.

The broad application and developed possibilities offered by the designed boreholes will be a part of the expanding program of the Department of Drilling and Geoengineering as a response to the industry's demand for the described processes without the need to assemble a drilling device. The tests that can be performed in the designed boreholes will result from needs that are directly related to the development of drilling technology and technology for new boreholes.

The following research will be a part of both the practical education of drilling technology and gaining the knowledge of drilling equipment as well as the market needs described earlier:

- exchange of preventer rubbers dedicated to education of laboratory participants,
- emergency closure of blowout preventers in the case of the inflow of deposit medium into the borehole,
- removing gas kick from the borehole in the desired direction by controlling the gate valves on the choke manifold,
- pressure tests,
- setting up the safety valves of mud pumps,
- selection of a drilling tool for the type of drilled rocks–drill test, selection of nozzles etc., laboratory of rock mechanics,

– the intensity of rinsing the bottom of the borehole by rationally using the hydraulic power in the drill bit and secure a sufficient (possibly maximum – dependent on the characteristics of the drilling pump) flow velocity of the mud in the annular space,
– practical tasks to calculate the displacement of the drill string,
– fulfill of the annular or casing space,
– analyzing the flow of drilling mud in both the annular space and in the drill string, depending on the BHA used,
– optimization of drilling fluid parameters,
– centralization of casing column, preparing atrip into the hole,
– procedures for casings,
– the impact of aggressive environmental conditions (organic acids, salts) on drilling equipment used in the hole,
– use offishing tools,
– completion of documentation on the drilling process and work performed during drilling,
– drilling research with use of lunar regolith blocks putted into the hole,
– testing of drilling tools, autonomous drilling process in different conditions use of variety rock samples,
– coring drilling process, sample and data acquisition.

5. CONCLUSIONS

The designed boreholes will develop the scientific potential of the Drilling and Geoengineering Department. The laboratory and its planned boreholes will be equipped with computer equipment that will simulate real conditions. The growing demand for research to improve the drilling process confirms our efforts to develop a laboratory unit to do just that. The varied laboratory tests that can be performed will allow us to increase of the didactic potential ofclasses in the Department. Furthermore, the industry needs units that will be able to carry out varied drilling tests in simulated laboratory conditions and thus it is economically justified. For all of these reasons, the designed drilling wells will find applications in many areas, both scientific and industrial.

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