Modern equipment for core sampling while drilling wells in the fields of Tomsk region

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Abstract. The drillers face the task to increase the volume of work on exploratory wells to the Lower Cretaceous and Jurassic basement of the fracture intervals in Tomsk region. Paleozoic basement Pz and Kv are the objects with a complex geological structure. The main purpose of each coring sampling from all types of wells is to obtain direct information about the rocks that compose the objects of interest in the fields, which is necessary for the solution of a set of problems of prospecting, exploration and production of hydrocarbons. Research tasks are to identify the features of the development of fracture intervals, the conditions of rock deposition, the type of rocks, the fracture orientation, permeability, porosity, saturation of the pore space with fluid and to forecast promising areas in the Paleozoic basement. The paper describes the work on core sampling in the Paleozoic deposits of Tomsk region. The core sampling equipment and the results obtained at the Severo-Kalinovskoye field are presented. According to the results of the analysis of the cores, the conclusions are drawn about the further stages of drilling for the assessment of the deposits of the Paleozoic basement in Tomsk region.

1. Introduction
To start operating new fields, it is necessary to carry out additional exploration of hydrocarbon reserves. Nowadays, the Paleozoic basement is unexplored in Tomsk region. The Paleozoic deposits of Western Siberia can contain significant hydrocarbon resources. However, the question of how to find and extract them efficiently is still open.

Oil exploration work in Western Siberia, including on deposits of the pre-Jurassic complex, began in the 1950s. In 1954, the first deposit was discovered in Tomsk region. Numerous oil and gas shows from the Paleozoic were obtained during drilling on the structures of the South Minusinsk intermountain area. The second stage of oil and gas exploration in the Paleozoic deposits dates back to the 70s-80s, XX century. Thus, in 1974, a powerful oil spring was obtained at the Maloichskoye field in Novosibirsk region. Later, due to purposeful drilling into pre-Jurassic formations, the deposits in Paleozoic sediments were also discovered in Tomsk and Tyumen regions.

In the pre-Jurassic complex, the total initial geological reserves of oil, which are currently state-owned, comprise to 400 million tons in Western Siberia, including 174 million tons belonging to Tomsk region [1]. However, these numbers may increase significantly, because the main problem of Paleozoic reserves is that they have not yet been truly estimated.

The oil of the pre-Jurassic complex is considered hard to recover. At the same time, it is also hard to find: the technologies have a low degree of maturity.

In Tomsk region the most extensive experience in the development of pre-Jurassic oil in Russia was accumulated, most of the Paleozoic deposits were discovered and all possible types of basement
deposits were represented. In 2014, the region received the status of a test site for the introduction of the latest technologies for prospecting, exploration and development of unconventional sources of hydrocarbon raw materials, which include the Paleozoic [2].

The expansion of prospecting and exploration objects in the basement of oil and gas basins of Western Siberia and other oil and gas provinces of the Russian Federation corresponds to the transformation stage of the paradigm of oil and gas geology, characterized by the active development of the theory of the deep origin of hydrocarbons, which allows substantiating the Paleozoic deposits as promising in terms of oil and gas deposits exploration.

2. Materials and methods

The higher the information content obtained in the process of well site construction (logging, coring, testing, etc.), the higher the reliability of the assessment of oil and gas fields. The most effective way to obtain this information is core sampling [3]. This is due to the fact that core is the main direct source and carrier of information about rocks, providing the opportunity for visual and direct study of their properties. Therefore, the improvement of the quality of coring is an important task of exploratory drilling in order to improve the quality of the used core sampling equipment.

At the moment, the drillers have a task to increase the volume of work on drilling exploratory wells to the Lower Cretaceous and Jurassic basements of the fracture intervals in Tomsk region. The Paleozoic basement Pz and Kv are the objects with a complex geological structure. However, there are many questions and unsolved problems, especially during the work with coring, what is an urgent scientific and technical problem. This is explained by insufficient knowledge of this fracture in Tomsk region, limited actual material obtained during core sampling from wells, incomplete study of the properties of reservoir fluids, the lack of prediction of the reservoir properties of the geological section of the Paleozoic basement Pz and Kv, low efficiency in the development and development of deposits. The search for modern methods of isolated core sampling has shown that the use of this core sampling equipment can increase the percentage of removal and increase the metering of coring.

3. Results and discussion

The main purpose of each core sampling from all types of wells is to obtain direct information about the rocks that compose the objects of interest in the fields, which is necessary for the solution of a set of problems of prospecting, exploration and production of hydrocarbons. The set of problems is extensive and may include the following tasks such as: the identification of the features of the development of fracture intervals, the conditions of deposition of rocks, the type of rocks, the fracture orientation, permeability, porosity, saturation of the pore space with fluid and forecast of promising areas in the Paleozoic basement.

Drilling companies use Boart Longyear, LF-90, LF-230, LM-75, and other drilling units drill rigs for core drilling. For deep and directional core drilling projects, FORACO BF830 multipurpose drilling rigs are also used. The annual volume of core drilling significantly exceeds 100,000 m. The range of depths of work varies from several tens of meters to 2,500 m.

For core drilling, high-quality drill pipes and tools with a removable coring (double core barrel) of the best world producers are used. The use of high-quality drilling tools, regular maintenance, scheduled preventive and overhaul of drilling rigs, high qualifications and motivation of personnel allow the drilling speed to not fall below 2,000 linear meters in the project portfolio as a whole for 1 machine per month. The core recovery is traditionally not lower than 95%. For sections usually characterized by poor core recovery (less than 90%), triple core drill is used, as well as other specialized drilling technologies. In order to study the spatial strike of rocks and their fracturing, an oriented core sample is taken at the request of a customer.

The drilling rig operators of leading drilling companies independently perform inclinometric surveys in wells using magnetic and optical inclinometers of the Reflex EZ-Shot, EZ-trak and Reflex MAXIBOR II types. For additional geophysical surveys and hydrogeological surveys of wells, time-
tested specialized subcontractors are usually invited. Geological support of core drilling is also carried out with the involvement of qualified geological contractors.

**The equipment for core sampling while drilling wells in Tomsk region on the Paleozoic basement Pz and Kv.** Core sampling is a complex technological operation that requires a lot of time and money, the correct selection of the type of core sampling tool and the type of drilling bits (Figure 1).

![Diagram](image)

**Figure 1.** Systems:
- a) control internal assembly system; b) core positioning system

In order to solve the set tasks, a core sampler UK-127/80 was used, developed by VNIIBT-BI with a length of 6.0 m and 8.0 m using an isolated technology with the use of disposable fiberglass and steel core receivers and drilling bits produced by Russian factories both UDOL and BURSERVICE.

**Basic information and technical data of the coring device UK-127/80 [4]**

1. The coring device UK-127/80 (hereinafter referred to as the device) of one-two-section design is intended for core sampling in rocks of all categories when drilling wells with a rotary method or bottomhole motors using cutting drill bits reinforced with diamond-hard alloy plates, synthetic or natural diamonds. The coring device includes a sealed filled disposable coring pipe for filling it with cuttings along the annular space.
2. The device is produced in a single-section version UK-127 / 80.000, which is the base for the assembly of devices consisting of two or more sections. Technical characteristics are shown in Table 1.

| Table 1. Core technical characteristics |
|------------------------------------------|
| 1. Diameter of the lower and upper stabilizers, mm | 137.0 ± 2 |
| 2. Nominal body diameter, mm | 130 ± 3 |
| 3. Nominal core diameter, mm | 80 |
| 4. Maximum length of the sampled core, m | 6.0+ 8.0 or (12.0+18.0) |
| 5. Temperature range up to | 200°C |

| Table 2. System of core sampling and standard size of drilling bits for coring. |
|------------------------------------------|
| Type of system of core sampling | Diameter of applied drilling bits, mm |
|------------------------------------------|
| UK-127/80 | 142.9, 152.4, 155.6 |
| + | + | + |
The reliability of the results is confirmed by actual core sampling from well No. 609 of the West Luginetskoye field and wells No. 37 and No. 91 of the Severo-Kalinovoye field. The results of the work of UK-127/80 device in the fields are presented in Table 3.

**Table 3. Results of the work of UK-127/80 device**

| № of well | Area, deposit          | Layer designation | Coring interval, m | Drilling progress, m | Core recovery m% |
|-----------|------------------------|-------------------|--------------------|----------------------|-----------------|
| 37        | Severo-Kalinovoye      | Pz and KV         | 3080-3180          | 46,5                 | 43              | 92,5            |
| 91        | Severo-Kalinovoye      | Pz and KV         | 3051-3081,9        | 29,4                 | 20,95           | 71,3            |
| 609       | West Luginetskoye     | Pz and KV         | 2748-3060          | 173,8                | 127             | 73              |
| Total:    |                        |                   |                    |                      | 249,7           | 190,95          | 77              |

The high level of the reliability of the assessment of oil and gas fields depends on the level of the information content of the core. Therefore, the improvement of the quality of the core is an important task for exploration drilling, as well as for sidetracking. In addition to the informative one, the problem of the improvement of the quality of the core also has an economic aspect, which consists in the fact that the low quality of the core requires drilling additional wells with its sampling.

That is why, when core sampling with a small diameter, UDOL developed U-109/67 system of core sampling, the development of which in the field of engineering and technology of coring, due to their high efficiency, gained fame and recognition. In the context of their scientific and technical level, the applied systems of core sampling and the isolated core sampling technology are superior to national and international analogues and can significantly increase the information content of the core material, due to the increase in core recovery up to 90-100%. It is necessary to note that the operational characteristics of the existing core barrels of UKS-U-109/67 series of various sizes and the ease of maintenance and high reliability do not require special adaptation of the drilling crew when using them. Moreover, during the work, the technique and technology of coring is constantly being improved.

**Equipment for core sampling during sidetracking**

There are many different systems and types of coring tools for core sampling during sidetracking (Table 4).

**Table 4. Core sampling devices used for sidetracking coring**

| Type of technical means | Casing diameter, mm |
|-------------------------|----------------------|
|                         | 139,7                | 146                  | 168                  | 178                  |
| UKSU-109/67             | +                    | +                    | -                    | -                    |
| Diameters of drilling bits, mm |
|                         | 120,6/67             | 122/67               | 142,9/80             | 154/80               |
|                         | 123/67               | 152,4/80             | 156/80               |
|                         | 126/67               |

The use of an internal core pipe located in the steel body of the core device has two functions: it improves the quality of the core material, the material of which is physically supported during the extraction of the core and the internal core pipe serves as a protection system for the core raised to the surface. The material for the production of internal core pipes can be PVC, ABS polymer plastic, aluminum, steel, fiberglass and other composite materials. In practice, the most commonly used are steel and fiberglass pipes. Internal core pipes are inserted inside a traditional coring machine and held in place by a coring tool assembly and frictional force.
4. Conclusion
In practice, disposable internal core-receiving fiberglass receivers are used, produced by kompozitmash, Perm. The use of a disposable internal core pipe allows increasing the safety of the core by performing all operations with the core after extraction from the well without removing the core from the pipe. Internal coring pipes usually have a sectional design with a long section reaching 6-12 m. During core sampling, a two-section device is used and should be used. Fiberglass pipes can be used for temperatures between 80-100°C. Fiberglass pipes can be used up to temperatures of 120°C and 180°C using a special high temperature resin. However, in the process of coring, especially during sampling in the weathering crust and the Paleozoic, core plugging often occurs, both in the assembly and inside the core-receiving soil dump. There are a lot of reasons leading to the destruction of the core, locking during drilling and lifting of the tool.

In order to avoid the rise of the system of core sampling, after the incoming core is locked, Kompozitmash plant in Perm has developed an anti-locking telescopic system with one lock during the selection process for this type of device. This system makes it possible, after a lock has occurred, to fix core receiver and ensure that they can be triggered at the required moment and will allow the continuation of core sampling when a lock occurs in the core receiver. In this case, the diameter of the sampled core corresponds to the diameter, as indicated in the certificate of the drilling bit.

The paper describes the work on core sampling in the Paleozoic deposits of Tomsk region. The results are presented at the Severo-Kalinovskoye field. Nowadays the core is being studied in the laboratory. According to the results of the core analysis, the analysis will be carried out and a strategy for further core sampling in the Paleozoic deposits of Tomsk region will be developed.

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