HYDROGEOLOGICAL FEATURES OF THE FIELD OF KIMBERLITE PIPE UDACHNAYA

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Abstract

The hydrogeological characteristics of the deposits kimberlite pipe Udachnaya are presented, the hydrogeological characteristics of the main aquifer complexes are given. The main source of water cut of the ore bodies are identified. The hydraulic connection between the aquifer complexes is established.

Keywords

Udachnaya pipe, aquifer complexes, water cut ore body, water inflows in open-cut.

1 Introduction

The study of hydrogeological characteristics of kimberlite pipe Udachnaya is done for the purpose of study of the natural hydrogeological conditions of the deposits and their comprehensive assessment as one of the main factors, the inundation of deposit .

Unique, without analogues in the world practice, cryohydrogeological, hydrogeological and climatic conditions of the studied deposits predetermine some of the most challenging problems of protection of the underground mine from flooding.

2 Geological structure

Field of kimberlite pipe Udachnaya is located on the right bank of the river Daldyn in the central part of the basin.

The geological structure of the deposit comprises of sedimentary and igneous rocks. Enclosing sedimentary rocks are divided into:

- formation of the Archean crystalline basement, composed of granite-gneiss and quartzite-gneiss, opened with a capacity of 170 m;

- Proterozoic sediments of dolomitic composition with thickness of about 160 m;

- Paleozoic rocks, represented by carbonate-clayey sediments of the Cambrian system capacity 2000-2600 m, and the formations of the lower division of the Ordovician system with a capacity of up to 300 m [1-2].

Udachnaya pipe is a vertical column-like reservoir, which is divided into two cone-shaped ore bodies at the bottom of the existing open-pit mine. These ore bodies are called East and West. The ore body in plan has elliptical shape, dissenting overlie the host rocks and are composed mainly of kimberlite breccias, in the marginal parts of the porphyry kimberlites are marked, at least of tuff breccia.

Rocks of trap formation expressed intrusions and dikes, according to lithology is dolerite, with fine-grained structure and massive texture. Contacts trap bodies with host rocks are sharp and harsh.

The root thickness of the host rocks and ore deposits covered by quaternary sediments represented by deluvial, eluvial and proluvial formations rubbly-blocky structure. In the river valleys developed alluvial formations are developed which in the lower part are made of the sand-gravel-pebble

material, and in the upper part they are made of sand, sandy loam, silty loams and silts. The thickness of loose deposits is from 1,5 to 10 m.

Permafrost rocks of the district has a continuous distribution and lies in the Upper Cambrian aquifer complex. They are separated by the thickness of the frosty rocks without ice with a capacity of 10-60 m. Permafrost rocks is represented by carbonate-clayey sediments Morkokinskoe, Markhinskoe suite, and on watersheds – rocks of Onkhoiyuryakhskoe and Oldondinskoe suite of the Lower Ordovician. Sole of permafrost rocks in the area of the pipe lies at absolute altitudes from 100 m to 180 m. The capacity of permafrost rocks varies from 90-180 m (in river valleys) to 100-350 m at the watershed.

3 Hydrogeological characteristics of the main aquifers complexes

Subpermafrost waters are represented by four aquifer complexes: Upper Cambrian, Middle Cambrian, Lower Cambrian and Upper Proterozoic (Fig.1). In addition, within the area of flooded fields emit zones of kimberlites and traps, which are characterized by local distribution. Igneous rocks are considered as „hydraulic windows“, through which there is the connection between the flooded depths of the rocks [1-3].

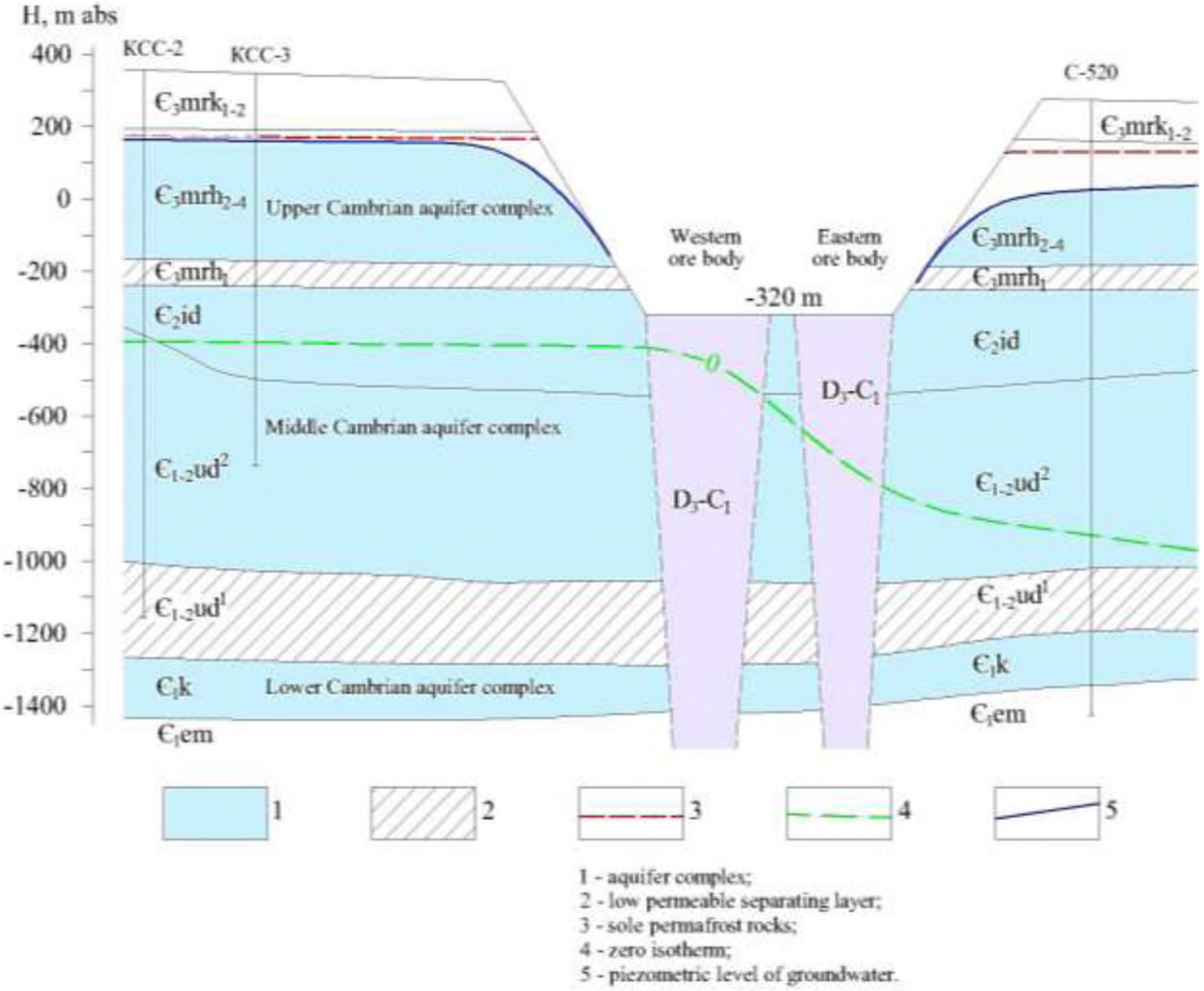

Fig.1: Cryohydrogeological schematic section through the Udachnaya pipe

Upper Cambrian aquifer complex has a widespread development in the field area, and it is confined to the strata-collectors in the deposits of the Markhinskoe and Morkokinskoe suites, represented by thin irregular intercalation of marls, clayey limestones, dolomites. The capacity of the complex water

enclosing rocks is an average of 370 m, the total effective capacity of the reservoir reaches 52 m., the capacity of water-saturated collectors generally is from 0,2 to 2,2 m, only a few of them reach 8 m.

A distinguishing feature of Upper Cambrian aquifer complex is the low water abundance and very low filtration parameters: the permeability varies from 0,03 to 0,0003 m^2/day, open porosity rocks do not exceed 7-14 %. Groundwater of Upper Cambrian aquifer complex has low pressure over the roof (20-54 m), the natural piezometric level were established at depths from +169 to + 207,5 m abs. Currently, Upper Cambrian aquifer complex revealed and draine by the open-cut mine Udachnu.

Middle Cambrian aquifer complex is the main source of irrigation of the field. It is confined to carbonate deposits interbedded limestone and dolomite strata ($Є_2$id) and carbonate sediments of the upper bundles of the suite Udachninskoe ($Є_{1-2}ud_2$). The total capacity of water enclosing rocks in the field area is about 1000 m. The natural hydraulic gradient groundwater levels were installed at elevations from +108 to +180 abs. m, with the pressure above the roof about 400 m. In the context of Middle Cambrian aquifer complex conditionally allocated two aquifers.

The first aquifer ($Є_2$id) distributed in carbonate deposits that are confined to the reservoirs of limestone and dolomite strata. The capacity of the aquifer is not maintained and ranges from 10 to 480 m.

The average total capacity of the reservoir is 250 m, the capacity of individual permeable seams varies from 0,1 to 8-10 m. The aquifer is characterized by unrestrained proliferation of reservoirs in plan and section, as well as significant heterogeneity of filtration parameters. The coefficient of water transmissibility capability varies from 0,02 to 87 m^2/day, coefficient of piezoconductivity from $0,1\times10^3$ to 1×10^5 m^2/day.

The second aquifer is highlighted in reef cavernous-fractured limestones and dolomites of the upper part of the Udachninskoe suites with a total capacity of 450-500 m. The Maximum water-resistant capacity of a pack, separating the first and second horizons is about 300 m. The total effective capacity of the reservoir is changed from the first meters to 12-15 m. The transmissivity of aquifer varies from 0,024 up to 0,59 m^2/day.

In general the Middle Cambrian aquifer complex is the most modability and has a wide range of hydrodynamic parameters, in the context of Middle Cambrian aquifer complex the most watery is the first aquifer. The hydrodynamic regime of the Middle Cambrian aquifer complex is formed under the influence of the discharge brines via underground water-bearing zone, thickness of rocks and ore bodies in the quarry faces.

The Lower Cambrian aquifer complex opened below the depths of 1350-1450 m and is confined mainly to the cavernous fractured reservoirs in the dolomites, lower unit suite of Udachninskoe ($Є_{1-2}ud^1$) and silicified porous-cavernous dolomites Kumakhskoe suite ($Є_1$km). The total effective capacity of the reservoir reaches 90 m.

The Upper Proterozoic aquifer complex is exposed in the field area in the depth interval 1810-1832,5 m and is confined to the carbonate-clayey silicified sediments Starorechenskoe suite (Vst). In general, rocks of the suite can be considered as waterproof.

Flooded zones of kimberlites. In vertical section of ore bodies there are two flooded zones. The first (upper) zone, environmental fracture of kimberlites, now completely opened up and drained the open-cut mine. The second flooded zone, located at depths from 350 to 1300 m (0 to -1080 m abs.), opened by the open-cut mine. There is a natural increase in water inflows coming from cryohydrogeological linear structures called Doldynskoe flexural.

In the Eastern ore body the roofing part of the second flooded area is confined mainly to the fractured porphyry kimberlites. Below the flooding kimberlite bodies are associated with explosive neotectonic dislocations with localized structural nature of the distribution. Water transmissibility kimberlites

roofing of the area was 30 m^2/day, coefficient piezoconductivity 10^5 m^2/ day, i.e. the parameters have the same values as the Middle Cambrian aquifer complex in the axial part of Doldynskoe flexure.

In the Western ore body in the second zone of the greater part of the pipe is characterized by low abundance of water and low values of hydrodynamic parameters (water transmissibility ~ 0,01 to 0,2 m^2/day). However, a local fracture zone are come across, where water abundance is high (specific capacity 0,74 m^3/h/m). Piezometric level of this flooded zone has a single surface with piezometric level of the Middle Cambrian aquifer complex, and also the similar chemical composition and salinity of brines.

4 Conclusions

Analysis of the hydrogeological conditions of the area of the open-cut mine pipe Udachnaya gives us the oppotunity to come to the following conclusions:

1. Middle Cambrian aquifer complex is the main source of water trouble of the ore bodies, characterized by the greatest abundance of water: water transmissibility to 87 m^2/day, piezoconductivity to 1×10^5 m^2/day.

2. Admission to the underground brines in the open-cut mine workings comes from the middle Cambrian aquifer system and lower Cambrian aquifer system primarily through the zone of crushing of ore-controlling faults, fractured kimberlites and near contact zones of the ore bodies.

3. The Eastern ore body is the most water cut than the Western ore body, also it is confined to the area of Doldynskoe flexure characterized by elevated filtration properties of water enclosing rocks.

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