3. Strategy // About Gazprom / Public Joint-Stock Company PJSC Gazprom [Electronic resource] // URL: http://www.gazprom.ru/about/strategy/ (date of the application: 01.02.2017).
4. Construction of the Amur GPP // Joint Stock Company "Research and Design Institute for Gas Processing" [Electronic resource] // URL: http://www.nipigas.ru/about/amur/ (date of the application: 01.02.2017).
5. "Ukhta-Torzhok" and "Ukhta-Torzhok-2" // Development of the northern corridor of the UGSS of Russia / Projects of PJSC Gazprom / Public Joint-Stock Company PJSC Gazprom [Electronic resource] // URL: http://www.gazprom.ru/about/production/projects/pipelines/active/ukhta-torzhok2/ (date of the application: 01.02.2017).

DETERMINATION OF WELLBORE STABILITY IN ROCK MASSIF

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Wellbore stability during drilling process should be estimated accurately and wellbore trajectory should be designed such that drilling process is mostly safe according to the collapse of borehole walls. For example, until the target drilling depth is reached a well penetrates rocks with different mechanic properties and stresses' spectra due to the difference in geological properties and chemical composition. It leads to the possible solution by which unstable rocks are penetrated with zero vertical angle so as not to allow excess tangential stresses to be formed near the wellbore. It diminishes the risk of collapsing (Figure 1).

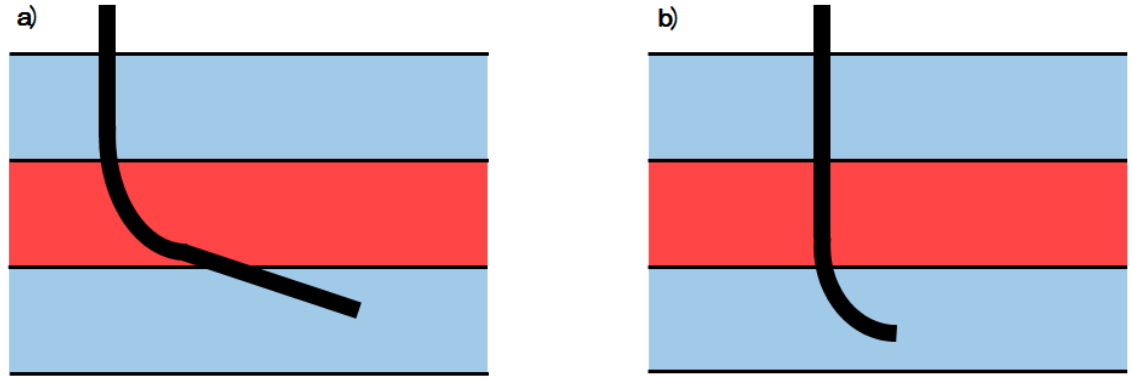

Fig. 1 Relationship between KOP and formation stability: a) build-up section is designed within the unstable formation (KOP is at the top); b) build-up section is located below the unstable formation (KOP is at the bottom)

Moreover, rocks may be characterized by critical build-up rate. That is why drilling well trajectory should be designed such that build-up section is not in the formation with undesired properties for this option, as shown in Fig. 1a, or build-up rate must be as low as possible.

If these requirements are not followed, it causes well's collapsing which may lead to following aftermaths:

Choosing of untrue and unsafe trajectory for well drilling can lead to inability of using less expensive water-based drilling mud and another more expensive drilling fluid has to be used instead, such as polymer drilling mud that allows hardening action on wells. Not only it is more expensive but more dangerous for the environment and it is harder to utilize it;

Collapsing causes reduction in rate of penetration due to the excess quantity of drilling cuttings in the wellbore, poor circulation of mud. It all makes drilling of particular well more expensive;

Unsafe drilling can cause the local increase in well diameter that will inevitably require higher volume of cement slurry for well cementing;

The critical case is that when further drilling operations' performing is not possible and it will be obligatory to install additional casing string so as to isolate the problematic interval. It will raise the price of well drilling and can even lead to inability to lower the tubing string of necessary diameter due to decreased casing internal diameter.

The basic aim is to investigate how geological conditions influence the wellbore stability so as to optimize the drilling process, reduce possible risks and choose the safest and most economically viable drilling method and most suitable well trajectory.

Since drilling starts from the pad for the field being developed it is recommended to use the existing pads for drilling new wells but not installation of new pads for new wells. It will severely reduce capital costs for operating company. So the particular problem now is how to choose the most appropriate pad for drilling depending on the safety drilling (Fig. 2).

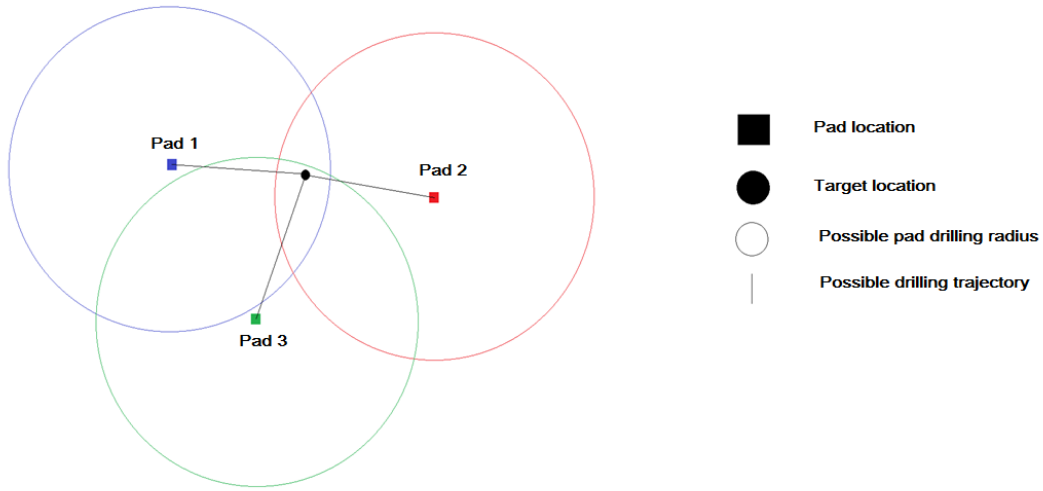

Fig.2 Possible trajectories of drilling the development well

While calculating of the wellbore stability it was gained that drilling from the pad 1 with "S-shape" trajectory is the most optimal way due to the unstable rocks right above the target reservoir. Drilling from the pad 3 the most advisable drilling trajectory is "Build and Hold" as it is the simplest possible type here when there are no any possible crucial drilling problems. The pad 2 allows drilling down to the target point if the well is vertical at the upper portion ("Deep Kock Off"). More stable rocks at the lower portion allow high build up rate (Figure 3). When the economic viability was estimated it was proved that here the trajectory "Deep Kock Off" is the most viable while being safe for drilling.

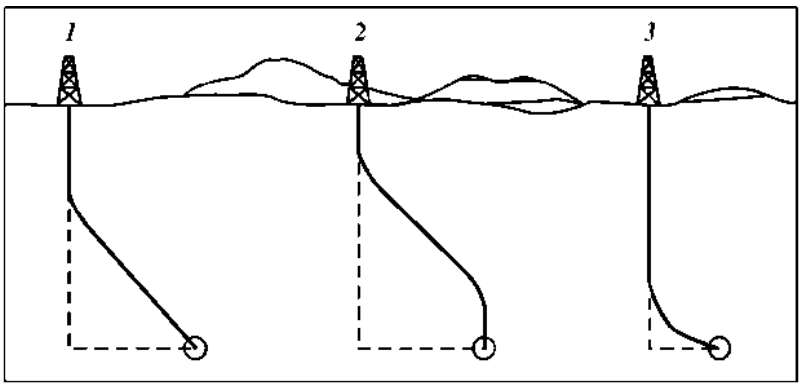

Fig.3 Types of drilling trajectories: 1 - Build and Hold, 2 - S-shape, 3- Deep Kick Off

References

1. Zoteev, O.V. Geomechanics: Training manual / O.V. Zoteev. – Ekaterinburg: UGGU, IGD URO RAN, 2003. – 252 p.
2. Zoback D., Mark Reservoir Geomechanics/ interdisciplinary book/ Mark D. Zoback. – Cambridge: Cambridge University Press, 2010. – 461 p.