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KARST DEVELOPMENT IN CAMBRIAN LIMESTONES

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Russian gas pipeline system is one of the largest in the world. In 2012, the length of the main pipelines is more than 175 thousand kilometers. According to official statistics of «Gazprom» 42 % of all accidents of gas pipelines are connected with direct or indirect influence of natural factors.One of the biggest problem occurs with pipeline, which is called «The Power of Siberia». The length of the dangerous part is 160 kilometers. This section starts from Chayandinskoye deposit. The route of this pipeline is located on the territory of Lensky Ulus of the Sakha Republic (Yakutia). There are difficult climate conditions, for example, the temperature in winter can change from −25 °C to −62 °C, shift from winter to spring is usually sharp with big difference between night and day temperatures. Moreover, this place has territory, which is rich in karst. From year to year, there are developing new sinkholes. Development of karst is connected with fractured rocks. Ground water circulates through it; consequently, there occurs dissolution and removal of soluble minerals. Therefore, this place is located in the most difficult conditions, which are seriously complicated by karst [3].

To start solving this problem, firstly, it is necessary to predict the deformations of the pipelines using a forecasting of the area. However, often it is not possible to know when sinkhole will open, so secondly, monitoring of bending pipeline is necessary to operatively fix an accident. Efficient solution can be found if we can use the modern methods of monitoring and protection of pipelines.

The first method is represented by pipeline's protection with bored piles. The invention relates to the construction and operation of pipelines and can be used to prevent accidents in pipelines caused by karst failures. The problem is solved due to the fact that in the known method of protection of pipelines from emergency situations caused by karst dolines, which reveal the pipeline (Figure 1). On both sides, bored piles 1 are performed, placed under the pipeline 2 metal lodgement 3. Metal lodgement is connected with bored piles, covered pipeline the ground, bored piles are performed so that the pile heads were above the earth's surface, as met-al lodgement use the half pipe of larger diameter than the diameter of the pipeline. Metal lodgement is connected with bored piles with a steel rope 5, which is bypass pipe, and the ends of the rope are fixed on the tip piles 4 using a tension clutch regulating the tension of the rope. In addition, at the ends of the cord before compression couplings there are sensors - 8. This prototype is shown in Figure 1 [1].

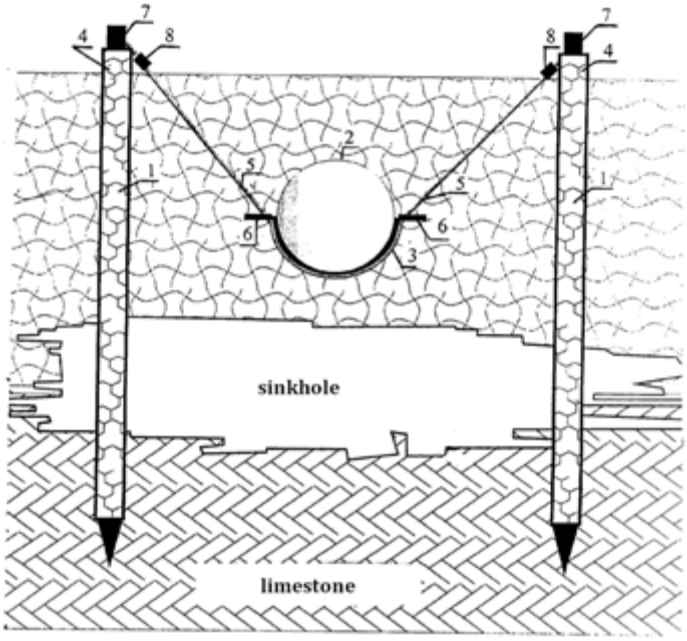

Fig. 1. Protection with bored piles:1 – device comprises bored piles, 2 – pipeline, 3 –metal lodgment,4 –top of piles, 5 – steel cable, 6 – loop,7 – clamping sleeves, 8 – sensors

The disadvantage of this method, taken as a prototype, is the high complexity of the installation design, due to the fact that the metal beam is connected with bored piles by welding. One more disadvantage is the large metal structure and the absence of visual control over the design during the operation. The benefit of this way is that due to this invention pipeline is independent on any movements, which can be in the soil.

It is important to know that today a lot of companies use different sensors to determine karst problems, for example sensors, which are based on Barkhausen effect. This method represents one of the most reliable and efficient way to determine deformations. The Barkhausen effect is an indirect evidence of the existence of magnetic domains within ferromagnetic materials. When domains grow, under an applied magnetic field, the movement of the domain walls occurs by discontinuous and abrupt Barkhausen jumps. The jumps in magnetization of a ferromagnetic material can induce a voltage in a winding coil of wire which, in turn, can produce Barkhausen noise [2]. For excitation and detection of magnetic Barkhausen noise overhead sensors are used (Fig. 2). Transverse field dipole magnet of sensors generates varying magnetic field in the area which is close to a pipe. This magnetic field creates jumps of magnetization, consequently, in the receiving coil of sensor there is noise signal which is registered by a device. The level of magnetic noise depends on the properties and state of the crystal lattice and mechanical tension.

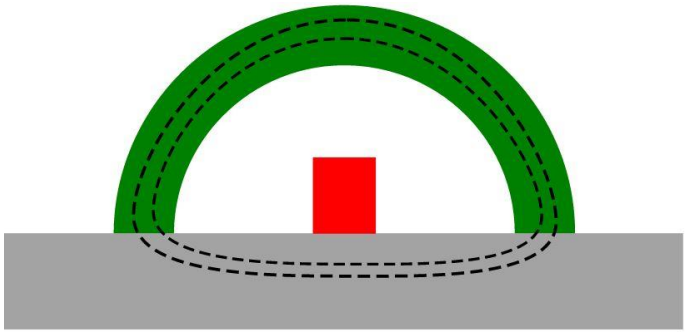

Fig. 2. A set-up for non-destructive testing of ferromagnetic materials: arc – magnetising yoke, square – inductive sensor, rectangle – sample of pipeline under test

In most types of steel under tension the intensity of the Barkhausen noise is increased, under compression-decreased. Control of the pipe deformation is based on this property. Moreover, this kind of sensors may be used in hard conditions. In particularly, the working temperature starts from −70 °C to +70 °C. It is very important for Chayandinskoye area. The disadvantage of this method that, it is not possible to use the sensor with the type of pipelines which were made from non-metal materials [4].

Thus, there are methods to detect sinkholes, as well as ways to predict and monitor the growth of cavities and protect pipelines from their negative impact. However, in spite of this karst is still the number one problem for specific regions. Unfortunately, an optimal solution that satisfies all the needs of humanity has not been found yet. Karst problem is a serious challenge for safe transportation of oil and gas that is why regular researches devoted to karst are continuing all over the world. The influence of natural factors on the stability of pipelines in karst areas has a huge impact on the development of petroleum industry, as well as it helps to attract investment to this knowledge-intensive field. In conclusion, analyzing all methods, which were mentioned here, it can be said that sensors based on Barkhausen effect is the best way of monitoring pipelines deformations. Indeed, the method provides optimal temperature range.

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APPLICATION OF TIME-DOMAIN ELECTROMAGNETIC SOUNDING FOR DRAINAGE BRINE LANDFILL MONITORING

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Nowadays major diamond deposit mining in West-Yakutia province is mainly complicated due to underground mining of lower horizons of kimberlite pipes and brine (chloride and calcite) flooding of workings [1]. For more than two decades most drainage waters have been removed into cryolite subsurface using two most effective methods, such as