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Klyazma 2: Ice cover characteristics by DAS

Dmitriy A. Presnov[1] , Valentin V. Gravirov[1] , Ruslan A. Zhostkov[1] , Ilya V. Fokin[1] , Nikita V. Shamaev[1] , Andrey S. Shurup[1] , Ivan S. Ponomarev[2,3] , Edgard A. Fomiryakov[2] , **Konstantin V. Kislov[4] ,** Egor P. Spiridonov[2] , Sergei V. Pyanzov[5] , Igor V. Frolov[5] , Danil R. Kharasov[2]

[1] O.Yu. Schmidt Institute of Physics of the Earth, Russian Academy of Sciences
[2] T8, LLC, Russia
[3] Lomonosov Moscow State University, Moscow, Russia
[4] Institute of Earthquake Prediction Theory and Mathematical Geophysics, Russian Academy of Sciences
[5] Saranskkabel-Optika, Ltd

kvkislov@yandex.ru

The study of ice cover is an urgent task of both practical and scientific significance. Long-term and detailed monitoring of the ice cover is carried out using seismic methods. These methods make it possible to determine ice thickness, density, and Young's modulus by analyzing the dispersion curves of flexural waves. In addition, displacements, deformations, and ice hummocking are tracked. Distributed acoustic sensing (DAS) enables these investigations with unprecedented spatial resolution without risking expensive interrogator [1]. In February 2024, the first stage of an experiment to determine ice cover characteristics using DAS was conducted on the Klyazma Reservoir. Recently, in February 2026, the second stage of the study was completed.

The experiment was conducted to address the following objectives:

1. Comparison of interrogators. Interrogators manufactured by T8 LLC and PetroFibre LLC were used.

2. Comparison of cables. Two types of cables, each containing 4 fibers, differ in the material of their outer sheath. Differences in material properties are expected to affect the transfer function differently.

3. Comparison of cable deployment. Two methods were used: freezing the cable into the surface of the ice cover and laying the cable on the reservoir bottom between ice holes.

4. Comparison of active impulse signal sources. Impacts by hammer strikes and explosions of firecrackers were used.

5. Determining the feasibility of recording flexural waves with a horizontal fiber. If a flexural wave propagates along the cable, fiber stretching occurs at its crest and compression in its trough [3]. Seismic signals were generated both along the cable axis and at different angles.

6. Determining the Feasibility of Event Location. In the future it is planned to classify events (crack development, hummocking, etc.).

7. Comparison of ice characteristics obtained from DAS data and data from standard seismic sensors [4]. As reference instruments, we deployed 8 three-component geophones in a linear array with 5-meter spacing.

The report describes the methodology of this stage of the experiment, the differences from previously conducted work, the tasks being addressed, the peculiarities of conducting this type of experiment, the problems encountered, and the ways to solve them.

References

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