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Tectonophysical digital database of Sakhalin Island*

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Abstract. The paper summarizes the results of field tectonophysical studies of Sakhalin Island conducted by different researchers at different times. Information about the main characteristics of the stress-strained state of the upper part of the Earth's crust (principal stress axes, stress state type, Lode–Nadai coefficient, bedding planes) was obtained as a result of computations using methods of cataclastic analysis of discontinuous displacements, structural-paragenetic, kinematic, conjugate pairs of faults. The input data for the calculations were the materials of field measurements of fracturing, slickensides and structural patterns. The results obtained in the present and previous works on Sakhalin field tectonophysical research are represented in summary tables that include data on local stress states for 264 observation points. The results are incorporated to GIS, the Isoline GIS software is used for the database management system.

Keywords: fracturing, slickensides, stress-strained state of the Earth's crust, principal stress axes, Lode-Nadai coefficient

Тектонофизическая цифровая база данных территории острова Сахалин

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Резюме. База тектонофизических данных по о. Сахалин, создаваемая коллективом авторов из Института физики Земли им. О.Ю. Шмидта РАН и Института морской геологии и геофизики ДВО РАН, обобщает результаты полевых исследований деформации горных пород и геологических тел на территории острова за период с 1973 по 2023 г. Сведения об основных характеристиках напряженно-деформированного состояния верхней части земной коры (оси главных напряжений, тип напряженного состояния, коэффициент Лоде–Надаи, элементы залегания слоистости) получены в результате расчетов методами катакластического, структурно-парагенетического и кинематического анализа, а также сопряженных пар сколов. Исходными данными для расчетов служили полевые замеры параметров тектонической трещиноватости, зеркал скольжений и других структурных индикаторов деформаций. Результаты полевых тектонофизических исследований Сахалина, полученные разными исследователями в различное время, сведены в итоговые таблицы, которые включают данные о локальных стресс-состояниях для 264 точек наблюдения. Данные интегрированы с ГИС; в качестве системы управления базой данных используется программный комплекс Isoline GIS.

Ключевые слова: трещиноватость, зеркала скольжения, напряженно-деформированное состояние земной коры, оси главных напряжений, коэффициент Лоде–Надаи

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Introduction

Tectonophysics is a relatively nascent science, yet it possesses a robust methodological framework, both independently and in conjunction with techniques from other disciplines [1]. Currently, tectonophysical methods are actively employed to address problems in geodynamics, tectonics, structural geology, geomechanics, exploration and exploitation of mineral deposits. In an applied context, only these methods enable the reconstruction of the stress-strained state of the Earth's crust, for example, at mineral deposits [2, 3]. In fundamental research, these methods assist, in particular, in refining the boundaries of tectonic plates [4].

On Sakhalin Island, tectonophysical methods were actively implemented in the coal industry in the late 20th century to predict hazardous dynamic and gasodynamic phenomena (rock bursts, coal and gas blowouts). Such events occurred at the Boshnyakovo and Lopatinskoe deposits in Sakhalin mines [2]. Subsequently, the method of cataclastic analysis of discontinuous displacements [5] was utilized to reconstruct the tectonic stresses of the island, incorporating data on earthquake focal mechanisms [6]. In recent years, field tectonophysical studies have been resumed in the articles of L.A. Sim and colleagues [4, 7, 8], and continued by researchers from the

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Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences in collaboration with researchers from the Institute of Marine Geology and Geophysics of the Far Eastern Branch of the Russian Academy of Sciences (IMGG FEB RAS) [9, 10].

Field tectonophysical investigations on Sakhalin are conducted using GIS technologies. This has facilitated the creation of the Sakhalin Island Tectonophysical Database, registered with the Federal Service for Intellectual Property in 2024 [11]. This database encompasses research results from 2020-2023. The objective of the present work is to systematize tectonophysical information obtained using field tectonophysical methods on Sakhalin Island from 1973 to 2023, for its introduction into scientific circulation with open access to all interested researchers. This includes documenting features indicative of past deformation, such as fracturing patterns and the orientation of slickensides, allowing for calculation of principal stress axes and determination of the Lode-Nadai coefficient to characterize the deformation regime.

Area and materials of study

The geological structure of Sakhalin Island predominantly comprises Cretaceous-Cenozo-

ic sedimentary rocks with a minor proportion of volcanogenic formations [12, 13], with the exception of several formations in central and eastern Sakhalin. These exceptional formations consist of volcanogenic ultramafic and metamorphosed strata with a paleontologically validated age ranging from the Silurian to the Jurassic periods [14]. The relatively young age of the sedimentary rocks renders them highly susceptible to exogenic processes, manifesting as intense weathering. A significant part of the island is characterized by low-lying terrain lacking bedrock exposures.

The study area encompasses the entirety of Sakhalin Island where infrastructure facilitates access to outcrop locations. Beyond challenges related to transportation infrastructure, field investigations encounter further difficulties. During winter, snow cover precludes field work. In the summer season, luxuriant vegetation complicates both the detection of outcrops and access to them. Conducting marine traverses along the coastlines is hindered by severe weather conditions, a limited navigation and field work season, the absence of access roads, the presence of a border zone, and other factors.

Consequently, as of today, the northern part of the Schmidt Peninsula, the majority of the North Sakhalin Plain, the eastern coast of the island from Lunsky Bay to the village of Pogranichnoye, the Tym-Poronaysk Lowland and Terpeniya Peninsula, and the eastern coast of Krillion Peninsula remain poorly studied or unstudied.

Our field investigations yielded reliable data on various types of geological stress/strain indicators. Joints, without visible evidence of displacement, is the most widely represented. Less frequently observed are joints with mineralization in the form of crystals and druses, mineral crusts, as well as those lacking mineralization. Particular attention was paid to measurements of slickensides; tectonic stress reconstruction was primarily conducted based on these features, and accordingly, they constitute the foundation of the



Map of the study area with the observation points. Карта района исследования с нанесенными на нее точками наблюдения.

present work. In reconstructing stresses spatially associated with coal deposits in western Sakhalin, faults ranging from large-amplitude (displacement exceeding 1000 m) to fractures (less than 10 cm) were utilized. However, large-amplitude and medium-displacement (less than 10 m) faults, depicted on tectonic maps of areas with coal deposits, are most fully represented. These data were used for tectonophysical reconstruction, allowing for inference of the stress-strained state of the Earth's crust.

In some observation points, the replacement of certain geological stress indicators by other disjunctive features was recorded. This allowed for the identification of the relative sequence of structural formation.

Unfortunately, the scope of the present work precludes the detailed presentation of all available information. The majority of the research results have been published in our previous articles [3, 4, 7–10], with the corresponding level of detail. Full-scale and detailed results for all study areas are planned for regular posting on a dedicated page of the website of the Institute of Marine Geology and Geophysics of the Far Eastern Branch of the Russian Academy of Sciences.

As of today, the database of field tectonophysical investigations includes information for 264 observation points. An overview map, indicating these points, is presented below.

Methodology

The data utilized in this study were primarily obtained through the method of cataclastic analysis (MCA) of discontinuous displacements [5], as well as the structural-paragenetic method of analyzing minor disjunctive structures [15], O.I. Gushchenko's kinematic method [16], and M.V. Gzovsky's method of conjugate shear fractures [17]. Furthermore, L.A. Sim's method of generalizing – averaging – the stress field [18] was employed for the synthesis of field tectonophysical data. For processing field measurements of slickensides with established displacement kinematics, the method of cataclastic analysis [5] and the specifically developed STRESSgeol software [19], based on this method, were used. In addition, a modified algorithm of this method was also applied to process a series of measurements [20].

Quantitative and qualitative characteristics of the reconstructed local stress states were determined using the method of cataclastic analysis. The main characteristics include the angular orientation of the principal stress axes, as well as the magnitudes of the stresses themselves, the type of stress state, and the Lode-Nadai coefficient. The basic principles of the method of cataclastic analysis are based on the concepts of quasi-plastic deformation of the geological medium, as well as the tenets of plasticity theory under conditions of maximum dissipation of internal elastic energy for the calculated stress tensor. The STRESSgeol contains an automated algorithm for separating all data into homogeneous samples, which define the temporal phases of quasi-homogeneous deformation of the macrovolume, ensuring the maximum value of the total dissipation energy with the minimum number of identified phases. This method allows for a thorough examination of the stress-strained state of the Earth's crust.

The structural-paragenetic method of analysis of minor disjunctive structures by L.M. Rastsvetaev is based on the concept of quasi-plastic deformation of the rock mass. This concept ensures the energetic efficiency of displacements along previously formed discontinuities in the rock mass [15]. The method involves the use of the main types of geological stress indicators that describe the overall spatiotemporal series of quasi-plastic deformation of the studied area of rock. Minor disjunctive structures (tectonic fracturing) form certain template structural patterns that are interconnected by spatiotemporal characteristics and can be considered as paragenetic associations, or structural parageneses. Field data were synthesized in the form of structural diagrams and then analyzed both as individual points and

in a group manner in accordance with their place in the tectonic structure of the study area.

O.I. Gushchenko's kinematic method [16] is applied in processing field data on both the position of rupture planes and the orientation of slickensides. The method is based on the postulate of dislocation analysis, from which it follows that, with a known orientation of the principal stress axes, the direction of the displacement vector on the plane of an arbitrarily oriented fracture lies within the angle defined by the extreme values of the Lode–Nadai coefficient. The inverse problem of reconstructing the orientations of tectonic stresses that caused these displacements is solved based on the orientations of the displacement vectors on the ensemble of slickensides.

In M.V. Gzovsky's method of conjugate shear fractures, pairs of shear fractures – isochronous fractures that formed in a homogeneous stress field are selected. The conjugacy of shear fractures in two directions is determined by their merging, mutual intersection, or opposite directions of displacement [17]. The line of intersection of these fractures coincides with the axis of intermediate principal stress, and the bisectors of adjacent angles coincide with the directions of the principal stress axes.

Research results

From 2016 to 2023, a team of researchers conducted several short-term and long-term expeditions, including those for industrial purposes. Most of the results from these field investigations have been published [3, 4, 7–10]. Data systematization resulted in a summary of parameters characterizing the stress-strained state of the Earth's crust (calculated from field measurements) (see Tables 1 and 2 in the Appendix). Table 1 presents: the coordinates of observation points 1–212; the orientations of the principal stress axes (σ_1 , minimum (extension), σ_2 , intermediate, and σ_3 , maximum (compression)), reconstructed using cataclastic analysis (MCA) based on structural-kinematic data from slickensides and joints; the type (environment) of the stress state; the Lode–Nadai coefficient (μ_{σ}); bedding planes; and the number of measurements at each point (total and those used for calculation in the STRESSgeol). Table 2 (from data in [4]) presents the available information on the principal stress axes. Data from [2, 3] reconstructing the principal stress axes using M.V. Gzovsky's method of conjugate shear fractures are also included.

Alongside other geological and geophysical data [21], the results presented in this study are integrated within a unified digital geoinformation system (GIS). Isoline GIS, provided by the developers for educational and research purposes, serves as our database management system. While primarily oriented towards the oil and gas and mining sectors [22], it provides a functional interface for working with the digital tectonophysical database. Simultaneous visualization and interpretation of diverse geological and geophysical information enables research at a new level. Furthermore, unlike results from past studies [2], this digital information is accessible to all interested researchers.

Investigations conducted from 2016 to 2023 revealed differences in the geodynamic setting between the eastern and western coasts of the Schmidt Peninsula. Horizontal shear regimes (shear type of deformation) predominate throughout this area. The western coast is characterized by a NW-trending orientation of the axis of maximum compression and its subhorizontal attitude. The eastern coast is characterized by horizontal extension regimes, typically localized in the axial parts of anticlinal structures. Directions of maximum compression are highly variable in this region. The parameters defining the stress-strained state of the Schmidt Peninsula differ significantly from those of the remainder of Sakhalin Island during the neotectonic period.

The central Sakhalin region exhibits a dominant subvertical orientation of the axis of maximum compression and a subhorizontal, most often submeridionally oriented axis of minimum compression (extension). Horizontal extension, as a type of stress state, is characteristic of the entire central Sakhalin region. Horizontal compression and shear regimes are significantly more widespread in the western part of central Sakhalin. The number of horizontal extension regimes increases in the eastern and axial parts, approaching the Sea of Okhotsk.

Disruptive faults in the coal deposits of the western coast of Sakhalin Island are characterized by two, and less frequently three or four, density maxima on stereographic projections. Because most of the studied deposits are characterized by normal faults, fault elements whose bedding form each pair of maxima can be considered as conjugate.

A general pattern identified across all deposits is the nearly horizontal position of the extension axis, which is oriented sub-meridionally. A northerly to north-northeasterly trend of this axis is characteristic of the Lopatinskoe, Lesogorsk, Duysky, and Mgachi deposits, as well as a significant portion of the Uglegorsk and Boshnyakovo deposits; this abruptly changes to a sublatitudinal trend in the southern Uglegorsk and Boshnyakovo deposits. The compression axis is oriented predominantly sub-latitudinally, with minor deviations in the southern and northern directions, and dip angles 30–70°.

Based on data from local stress states (LSS), the regional field of southern Sakhalin was reconstructed using the method of finding the "general", or averaged, field of tectonic stresses [18]. Two LSS were reconstructed in five homogeneously-axed volumes, and three LSS in one homogeneously-axed volume; the averaged stress field was determined using 36 local compression and extension axes. Their localization on a stereogram allowed determination of the compression and extension cones and the regional stress field with the following characteristics (defining the principal stress axes and allowing calculation of the Lode-Nadai coefficient, though those specifics were not measured in this case): $\sigma_1 - 350^\circ$ $\angle 10^{\circ}; \sigma_2 - 112^{\circ} \angle 66^{\circ}; \sigma_3 - 260^{\circ} \angle 20^{\circ}; \tau_{max} - (-32^{\circ})^{\circ}$ $\angle 83^{\circ}$); $\tau_{\rm max} - 125^{\circ} \angle 68^{\circ}$.

Conclusion

This study provides a synthesis of key results from field tectonophysical investigations conducted during different years by various research groups at different times. The information on 264 observation points is presented in tabular format, containing crucial parameters of the stress-strained state of the Earth's crust in Sakhalin. In contrast to the outcomes of previous studies and analogous works in other regions, our database is fully integrated with a GIS and managed using the Isoline GIS software suite.

Thus, unique regional tectonophysical information has been combined, generalized, and systematized, making it possible to leverage this information for both fundamental and purely applied purposes, such as evaluating the stability of wellbores, quarry walls, slopes, and other engineering challenges. This enables a qualitatively new level of field tectonophysical investigations in conjunction with other geological and geophysical data. The database, which documents the orientation of slickensides and the distribution of fracturing, allowing the inference of principal stress axes and calculation of the Lode-Nadai coefficient, is continually updated with new results from field observations and will be made publicly available on a dedicated page of the website of the Institute of Marine Geology and Geophysics of the Far Eastern Branch of the Russian Academy of Sciences.

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APPENDIX / IIPUJIOЖЕНИЕ

Таблица 1. Параметры палеонапряженного состояния территории о. Сахалин (по данным полевых исследований авторов и опубликованных источников за период с 1973 по 2023 г.) Table 1. Parameters of the paleo-stress state in the area of the Sakhalin region (according to field research data of the authors and to published works during 1973–2023)

No.	Observa-	Observation po	int coordinates	0		6	5	d		Stress state type	μ	Bedding	Measu	rements
	1ulod uoli	Z	Щ	Dip Az	V	Dip Az	N	Dip Az	N			plancs	N total	N used
-	21108	46°23.321'	143°20.470'	83	24	338	30	205	50	Hor.Ext.	0.1		13	12
2	21109	46°25.637'	143°19.826'	277	30	164	34	38	42	Hor.Ext.	0.02	Ι	8	9
ŝ	21110	46°25.079'	143°19.956'	214	12	308	19	95	67	Hor.Ext.	-0.12	I	6	5
4	21111	46°17.852'	143°34.045'	114	12	205	П	297	78	Hor.Ext.	0.02	I	10	10
5	21112	46°17.836°	143°34.106'	277	30	185	б	90	09	Hor.Ext.	0.02	I	12	12
9	21113	46°17.127'	143°33.961'	121	18	30	4	288	72	Hor.Ext.	0.35	Ι	12	6
٢	22133	46°49.218'	143°25.845'	239	12	148	L	28	76	Hor.Ext.	0.04	259∠60	10	6
×	22134	46°44.459'	143°25.277'	165	19	73	9	326	71	Hor.Ext.	0.06		13	11
6	22135	46°52.702'	143°08.525'	112	34	202	-	293	56	Hor.Ext.	0.01	240∠30	11	6
10	22136	46°52.372'	143°09.315'	176	4	354	86	86	0	Hor.Sh.	-0.07	I	13	10
11	22152	46°43.158'	143°30.508'	90	0	360	12	180	78	Hor.Ext.	-0.01	335∠20	٢	7
12	22153	46°43.342'	143°30.426'	342	25	251	4	153	65	Hor.Ext.	0.02	290∠25	10	9
13	22154	46°43.569'	143°30.097'	78	12	280	LL	169	5	Hor.Sh	-0.05	80∠30	10	10
14	22155	46°44.309'	143°29.747'	139	11	232	16	16	71	Hor.Ext.	0.32	90∠70	6	6
15	22156	46°44.281'	143°26.445'	342	0	252	13	72	77	Hor.Ext.	0.01	I	10	10
16	22159	46°59.111'	143°04.332'	90	9	183	24	347	65	Hor.Ext.	-0.46	70∠15	11	10
17	22160	46°30.045'	143°29.843'	84	0	354	12	174	78	Hor.Ext.	0.6	I	11	8
18	22161	46°31.653'	143°30.340°	103	18	235	65	٢	18	Hor.Sh	0.01	Ι	13	12
19	22162	46°32.122'	143°31.907'	283	18	191	4	90	72	Hor.Ext.	-0.05	I	13	11
20	22163	46°33.154'	143°31.851'	9	17	103	21	240	62	Hor.Ext.	0.27	I	10	9
21	22165	46°35.162°	143°30.798'	180	18	83	22	306	61	Hor.Ext.	0.13	I	10	10
22	22167	46°18.640'	143°22.765'	264	12	5	42	162	45	Hor.Ext.+Sh.	-0.33	I	8	7

casurements	d used	9	5	7	10	10	10		13	8	13 8 7	13 8 9	13 8 7 8 8	13 8 7 8 8 8 8	13 8 8 8 10	13 9 7 8 8 8 10 8 8	13 8 10 8 8 8 13 8 13 8 13	13 8 8 8 8 8 8 8 10 8 9 13	13 8 7 9 7 8 8 8 9 7 8 13 8 10 8 10 8 10 12 12 13 13 13 14 14 14 15 16 16 17 17 17 18 18 19 19 19 19 19 19 19 19 19 19 19 19 19	13 8 8 9 7 8 8 8 10 10 10 10	13 8 8 8 8 8 8 10 10 10	13 8 8 8 8 10 10 10 10 10 10 10 10 10 10 10 10 10	13 8 7 9 8 8 10 7 8 10 10 10 10 10 10 10 10 10 10 10 10 10 1	13 8 10 10 10 10 10 10 10 10 10 10 10 10 10	13 8 8 8 10 10 10 10 8 8 10 10 10 8 8 10 10 10 8 8 10 10 10 8 8 10 10 10 10 10 10 10 10 10 10 10 10 10	13 8 13 8 13 8 10 10 8 8 13 8 10 8 10 8
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Stress state type		Vert.Sh.	Hor.Ext.	Hor.Sh.	Hor.Ext.	Hor.Ext.	Hor.Sh	$\mathbf{U} \circ \mathbf{c} \mathbf{E}_{\mathbf{v}, \mathbf{t}}$	HOI.EXL.	Hor.Ext.+Sh.	Hor.Ext.+Sh. Hor.Ext.+Sh. Hor.Ext.	HOLEXL+Sh. HOLEXL+Sh. HOLEXL	HOR.EXt.+Sh. HOR.EXt. HOR.EXt. HOR.EXt. HOR.EXt.	HOLEXL+Sh. HOLEXL+Sh. HOLEXL HOLEXL HOLEXL	HOLEXL+Sh. HOLEXL+Sh. HOLEXL HOLEXL HOLEXL HOLEXL	HOR.EXt.+Sh. HOR.EXt.+Sh. HOR.EXt. HOR.EXt. HOR.EXt. HOR.EXt. HOR.EXt.	Hor.Ext.+Sh. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Comp. Hor.Ext. Hor.Sh.	HOLEXL+Sh. HOLEXL+Sh. HOLEXL HOLEXL HOLEXL HOLEXL HOLEXL HOLEXL HOLEXL	HOR.EXt.+Sh. HOR.EXt.+Sh. HOR.EXt. HOR.EXt. HOR.EXt. HOR.EXt. HOR.EXt. HOR.Sh. HOR.Sh. HOR.Sh.	HOR.EXL+Sh. HOR.EXL+Sh. HOR.EXL HOR.EXL HOR.EXL HOR.EXL HOR.Sh. HOR.Sh. HOR.Sh. HOR.Sh. HOR.Sh.	Hor.Ext.+Sh. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Sh. Hor.Sh. Hor.Sh. Hor.Ext. Hor.Ext. Hor.Ext.	Hor.Ext.+Sh. Hor.Ext.+Sh. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Comp. Hor.Ext. Hor.Sh. Hor.Sh. Hor.Ext. Hor.Ext. Hor.Ext.	Hor.Ext.+Sh. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Sh. Hor.Sh. Hor.Sh. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext.	Hor.Ext.+Sh. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext.	Hor.Ext.+Sh. Hor.Ext.+Sh. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Comp. Hor.Ext. Hor.Ext. Hor.Sh. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext.	Hor.Ext.+Sh. Hor.Ext.+Sh. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext. Hor.Ext.
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int coordinates	Ш	143°22.397'	143°24.257'	143°24.257'	143°24.012'	143°24.552'	143°25.029'	143°25.346'		143°25.476'	143°25.476' 143°25.439'	143°25.476' 143°25.439' 143°25.309'	143°25.476' 143°25.439' 143°25.309' 141°55.250'	143°25.476' 143°25.439' 143°25.309' 141°55.309' 141°55.315'	143°25.476' 143°25.439' 143°25.309' 141°55.250' 141°55.315' 141°54.939'	143°25.476' 143°25.439' 143°25.309' 141°55.250' 141°55.315' 141°55.315' 143°08.220'	143°25.476' 143°25.439' 143°25.309' 141°55.250' 141°55.315' 141°54.939' 143°08.306' 143°08.306'	143°25.476' 143°25.439' 141°55.309' 141°55.315' 141°55.315' 141°55.315' 141°54.939' 141°54.939' 142°44.130' 142°44.130'	143°25.476' 143°25.439' 141°55.250' 141°55.250' 141°55.315' 141°55.315' 143°08.220' 143°08.220' 143°08.306' 142°44.130' 142°49.002'	143°25.476' 143°25.439' 141°55.250' 141°55.250' 141°55.315' 141°54.939' 143°08.220' 143°08.206' 143°08.306' 142°44.130' 142°45.948'	143°25.476' 143°25.439' 141°55.250' 141°55.315' 141°54.939' 141°54.939' 143°08.200' 143°08.306' 142°44.130' 142°44.130' 142°44.002' 142°43.3337'	143°25.476' 143°25.439' 141°55.309' 141°55.315' 141°55.315' 141°54.939' 141°54.939' 141°54.939' 142°44.130' 142°44.130' 142°44.130' 142°44.130' 142°44.130' 143°33.337' 143°33.337'	143°25.476' 143°25.439' 141°55.250' 141°55.250' 141°55.315' 141°55.315' 143°08.220' 143°08.306' 143°08.306' 142°44.130' 142°44.130' 142°45.948' 142°45.948' 142°45.948' 142°45.33.337' 143°33.289'	143°25.476' 143°25.439' 141°55.250' 141°55.250' 141°55.315' 141°54.939' 143°08.206' 143°08.306' 143°08.306' 142°44.130' 142°44.130' 142°45.948' 142°45.948' 143°33.337' 143°33.217' 143°33.211'	143°25.476' 143°25.439' 141°55.250' 141°55.315' 141°55.315' 141°54.939' 143°08.306' 143°08.306' 142°44.130' 142°44.130' 142°44.130' 143°33.337' 143°33.337' 143°33.317' 143°33.311' 143°33.217' 143°33.217' 143°33.217'	143°25.476' 143°25.439' 141°55.250' 141°55.250' 141°55.250' 141°55.315' 141°55.315' 141°55.315' 142°48.306' 143°08.306' 142°49.002' 142°49.002' 142°49.002' 142°45.948' 142°45.948' 143°33.337' 143°33.289' 143°33.289' 143°33.289' 143°33.289' 143°33.289' 143°11.403'
Observation po	z	46°19.306'	46°03.941'	46°03.941'	46°05.421'	46°08.736'	46°09.966'	46°11.048°		46°11.714'	46°11.714' 46°12.124'	46°11.714' 46°12.124' 46°12.722'	46°11.714' 46°12.124' 46°12.722' 46°06.984'	46°11.714' 46°12.124' 46°12.722' 46°06.984' 46°06.993'	46°11.714' 46°12.124' 46°12.722' 46°06.984' 46°06.993' 46°02.751'	46°11.714' 46°12.124' 46°12.722' 46°06.984' 46°06.993' 46°02.751' 46°38.473'	46°11.714' 46°12.124' 46°12.722' 46°06.984' 46°06.993' 46°02.751' 46°38.473' 46°37.199'	46°11.714' 46°12.124' 46°12.722' 46°06.984' 46°06.993' 46°02.751' 46°37.199' 46°43.905'	46°11.714' 46°12.124' 46°12.722' 46°06.984' 46°06.993' 46°06.993' 46°02.751' 46°38.473' 46°37.199' 46°51.346'	46°11.714' 46°12.124' 46°12.722' 46°06.984' 46°06.993' 46°06.993' 46°02.751' 46°33.473' 46°37.199' 46°37.199' 46°37.199' 46°37.199' 46°43.905' 46°40.629'	46°11.714' 46°12.124' 46°12.722' 46°06.984' 46°06.993' 46°06.993' 46°037.199' 46°37.199' 46°37.199' 46°37.199' 46°37.199' 46°37.199' 46°37.199' 46°37.199' 46°37.199' 46°37.199'	46°11.714' 46°12.124' 46°12.722' 46°06.984' 46°06.984' 46°06.938.473' 46°02.751' 46°38.473' 46°33.473' 46°37.199' 46°43.905' 46°51.346' 46°51.346' 46°51.346' 46°51.372'	46°11.714' 46°12.124' 46°12.722' 46°06.984' 46°06.984' 46°02.751' 46°38.473' 46°33.473' 46°37.199' 46°37.199' 46°43.905' 46°40.629' 46°27.626' 46°27.215'	46°11.714' 46°12.124' 46°12.722' 46°06.984' 46°06.984' 46°03.473' 46°37.199' 46°37.199' 46°37.199' 46°37.199' 46°37.199' 46°27.372' 46°27.626' 46°27.372' 46°26.351'	46°11.714' 46°12.124' 46°12.722' 46°06.984' 46°06.984' 46°06.938.473' 46°02.751' 46°38.473' 46°37.199' 46°43.905' 46°43.905' 46°43.905' 46°27.372' 46°27.215' 46°27.215' 46°47.125'	46°11.714' 46°12.124' 46°12.722' 46°06.984' 46°06.984' 46°06.993' 46°02.751' 46°03.473' 46°33.473' 46°23.199' 46°43.905' 46°43.905' 46°51.346' 46°51.346' 46°27.215' 46°27.215' 46°27.125' 46°47.125'
Observa-	tion point	22168	22185 A	22185 B	22186	22189	22190	22191		22192	22192 22193	22192 22193 22194	22192 22193 22194 22195	22192 22193 22194 22195 22196	22192 22193 22194 22195 22195 22197	22192 22193 22194 22195 22196 22197 22197	22192 22193 22194 22195 22195 22197 22206 22207	22192 22193 22194 22195 22197 22197 22206 22206 22207 23209	22192 22193 22194 22195 22197 22197 22206 22206 22207 23209 23210	22192 22193 22194 22195 22196 22197 22197 22206 22207 22207 23210 23210	22192 22193 22194 22195 22197 22197 222197 22206 22207 23209 23210 23210 23211	22192 22193 22194 22195 22197 22197 22206 22207 22206 22207 23210 23210 23213 23213	22192 22194 22194 22195 22196 22197 22206 22207 22207 22207 23210 23210 23213 23213 23214	22192 22193 22194 22195 22196 22197 22206 22207 22209 23210 23210 23213 23213 23213 23213 23213	22192 22194 22194 22195 22197 22197 22206 22207 22207 23210 23210 23211 23213 23213 23215 23215 23216 A	22192 22193 22194 22195 22196 22197 22206 22207 22206 22207 23210 23210 23211 23213 23214 23216 23215 23216 23216 23216 23216
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No.	Observa-	Observation po	int coordinates	Ь	_	6		6		Stress state type	щ	Bedding	Measu	rements
	tion point	Z	ш	Dip Az	N	Dip Az	N	Dip Az	N			planes	N total	N used
48	23219 A	46°35.937'	143°03.449'	99	40	325	13	220	47	Vert.Sh.	0.56	I	11	7
49	23219 B	46°35.937'	143°03.449'	18	0	108	0	270	06	Hor.Ext.	0.14	I	11	4
50	23220 A	46°36.521'	143°19.384'	264	12	161	46	5	42	Hor.Ext.+Sh.	0.02	I	16	9
51	23220 B	46°36.521'	143°19.384'	24	0	114	0	270	06	Hor.Ext.	0.13	I	16	10
52	23221	46°41.937'	143°28.174'	341	15	247	14	115	69	Hor.Ext.	0.51	I	10	10
53	23222 A	46°39.869°	143°29.928'	249	28	344	6	90	60	Hor.Ext.	-0.05	I	8	б
54	23222 B	46°39.869°	143°29.928'	146	36	237	1	328	54	Vert.Sh.	-0.41	I	8	5
55	23223	46°40.926'	143°29.763'	264	12	359	25	150	62	Hor.Ext.	0.35	I	10	7
56	23224	46°41.290°	143°29.841'	42	0	132	0	270	06	Hor.Ext.	-0.04	I	7	7
57	23225	46°41.815°	143°28.462'	323	21	213	41	73	41	Hor.Ext.+Sh.	-0.36	I	8	8
58	23226	46°48.437'	143°25.712'	211	30	318	27	81	48	Hor.Ext.	0.03	$210{ eq}60$	11	6
59	23227	46°48.655°	143°26.544'	108	11	206	33	2	54	Hor.Ext.	0.17	260∠40	10	10
60	23228	46°36.778'	142°58.918'	257	23	129	55	358	25	Hor.Sh	0.03	I	10	10
61	23229	46°37.091'	142°56.477'	252	11	156	28	7	60	Hor.Ext.	-0.04	260∠40	12	12
62	23230	46°36.591'	142°59.978'	288	47	142	38	38	18	Hor.Comp.+Sh.	0.47	I	8	7
63	23231	46°37.507°	142°52.332'	114	9	205	11	356	78	Hor.Ext.	0.13	I	10	10
64	23232	46°37.411'	142°52.006°	90	36	360	0	270	54	Vert.Sh.	-0.05	I	٢	9
65	23233	46°37.361'	142°51.462'	115	12	213	34	8	53	Hor.Ext.	-0.39	I	٢	7
99	20060	50°05.563°	143°44.308'	167	27	99	21	304	54	Hor.Ext.	0.04	329∠10	8	8
67	20061	50°05.644'	143°44.541'	146	26	54	4	317	64	Hor.Ext.	0.42	$334 \angle 10$	6	6
68	20062	50°05.724°	143°44.634'	131	27	232	19	353	55	Hor.Ext.	-0.01	284∠12	٢	7
69	20066	50°08.174'	143°51.883'	349	21	246	29	110	52	Hor.Ext.	-0.01	214∠50	8	8
70	20068	50°03.654'	143°41.660'	202	10	72	74	294	12	Hor.Sh	0.01	$204 \angle 10$	٢	5
71	20072	46°28.449'	141°49.797'	180	12	280	41	LL	47	Hor.Ext.+Sh.	0.11	64∠30	9	5
72	20073	46°35.385°	141°48.781'	258	12	348	2	90	78	Hor.Ext.	-0.05	Ι	10	10

Геофизика. Геотектоника и геодинамика

Observa- Observation point cc	Observation point cc	int cc	ordinates	0		6	.6	0	-6	Stress state type	n,	Bedding	Measu	rements
tion point N E Dip Z	N E Dip Z	E Dip Z	Dip Az	N		Dip Az	N	Dip Az	7			planes	N total	N used
20074 46°36.318' 141°51.125' 126 6	46°36.318' 141°51.125' 126 6	141°51.125' 126 6	126 6	9		33	28	226	61	Hor.Ext.	-0.13	Ι	6	4
21075 48°21.340° 142°38.755° 108 6	48°21.340° 142°38.755° 108 6	142°38.755' 108 6	108 6	9		9	65	201	24	Hor.Sh	-0.03	0L∠97	14	13
21076 48°21.861' 142°39.490' 258 6	48°21.861' 142°39.490' 258 6	142°39.490° 258 6	258 6	9		167	10	17	78	Hor.Ext.	0.03	109∠70	12	6
21077 48°35.008° 142°41.559° 276 0	48°35.008' 142°41.559' 276 0	142°41.559' 276 0	276 0	0		9	18	186	72	Hor.Ext.	0.11	89∠75	9	4
21078 48°34.602' 142°43.104' 216 6	48°34.602' 142°43.104' 216 6	142°43.104' 216 6	216 6	9		316	60	122	29	Hor.Sh	0.08	0 <i>L</i> ∠ <i>9</i> ∠70	12	10
21079 48°38.185° 142°45.962° 245 18	48°38.185' 142°45.962' 245 18	142°45.962' 245 18	245 18	18	\sim	153	5	46	71	Hor.Ext.	0.16	Ι	11	8
21080 48°38.089° 142°45.920° 110 2′	48°38.089° 142°45.920° 110 2	142°45.920' 110 2.	110 2.	3	ŝ	16	٢	270	99	Hor.Ext.	0.08	Ι	12	12
21081 48°20.857' 142°39.987' 102 12	48°20.857' 142°39.987' 102 12	142°39.987' 102 12	102 12	1	0	196	16	337	70	Hor.Ext.	-0.37	Ι	×	٢
21083 49°14.159' 142°05.091' 288 1	49°14.159' 142°05.091' 288 1	142°05.091' 288 1	288 1	1	_	21	15	162	71	Hor.Ext.	0.13	Ι	10	8
21084 49°14.211' 142°05.106' 251 1'	49°14.211' 142°05.106' 251 1'	142°05.106° 251 1′	251 17	Ļ,	2	136	54	351	30	Hor.Sh	0.14	Ι	10	5
21086 49°38.715' 142°09.828' 78 0	49°38.715° 142°09.828° 78 0	142°09.828' 78 0	78 0	0	_	168	50	348	40	Hor.Ext.+Sh.	-0.3	71∠80	10	8
21087 49°38.802° 142°09.305° 203 5	49°38.802' 142°09.305' 203 5	142°09.305' 203 5	203 5	Ś		112	16	311	74	Hor.Ext.	-0.45	I	8	7
21088 49°29.997' 142°08.493' 318 5	49°29.997' 142°08.493' 318 5	142°08.493' 318 5	318 5	5		226	26	59	64	Hor.Ext.	0.01	Ι	6	9
21089 49°26.968° 142°08.192° 205 1	49°26.968' 142°08.192' 205 1	142°08.192' 205 1	205 1	Ē	9	301	18	76	65	Hor.Ext.	0.29	Ι	11	6
21091 49°16.268° 142°04.580° 188 8	49°16.268' 142°04.580' 188 8	142°04.580° 188 8	188 8	~	\sim	287	46	91	42	Hor.Ext.+Sh.	-0.1	I	8	9
21092 49°10.866° 142°04.018° 258 1	49°10.866° 142°04.018° 258 1	142°04.018' 258 1	258 1	1	5	167	ю	62	78	Hor.Ext.	0.1	224∠15	10	10
21093 50°47.927' 142°09.546' 69.4 28	50°47.927' 142°09.546' 69.4 28	142°09.546° 69.4 28	69.4 28	28	4.	335	8	231	60	Hor.Ext.	0.03	I	8	8
21094 50°47.597' 142°08.744' 356 [∠]	50°47.597' 142°08.744' 356 ²	142°08.744' 356 [∠]	356 4	7	–	264	24	95	99	Hor.Ext.	0.23	Ι	8	8
21095 50°49.300' 142°05.214' 83.1 29	50°49.300' 142°05.214' 83.1 29	142°05.214' 83.1 29	83.1 29	29	8.	345.8	12.5	235.7	57.2	Hor.Ext.	0.38	Ι	13	10
21096 50°49.370° 142°05.416° 348 2	50°49.370° 142°05.416° 348 2	142°05.416° 348 2	348 2	0	×	127	56	247	19	Hor.Sh	-0.09	I	6	5
21097 50°50.872' 142°06.647' 306 6	50°50.872' 142°06.647' 306 6	142°06.647' 306 6	306 6	9		48	63	214	26	Hor.Sh	0.18	I	15	10
21098 50°53.579° 142°07.202° 77 18	50°53.579' 142°07.202' 77 18	142°07.202' 77 18	77 18	18	~	169	4	270	72	Hor.Ext.	-0.39	265∠80	12	9
21099 51°06.044° 142°15.267° 294	51°06.044° 142°15.267° 294	142°15.267° 294	294	-	0	24	41	204	49	Hor.Ext.+Sh.	-0.24	Ι	6	6
21100 51°14.853' 143°15.854' 306	51°14.853' 143°15.854' 306	143°15.854' 306	306	-	9	216	4	94	83	Hor.Ext.	-0.05	250∠45	10	7
21101 51°15.078' 143°15.927' 252 6	51°15.078' 143°15.927' 252 6	143°15.927' 252 (252 (•	,	157	42	348	48	Hor.Ext.+Sh.	0.28	Ι	10	8

No.	Observa-	Observation pc	int coordinates	Ь		р ₂		6	~	Stress state type	щ	Bedding	Measu	rements
	tion point	z	ш	Dip Az	N	Dip Az	N	Dip Az	N			planes	N total	N used
98	21102	51°15.576'	143°11.999°	180	09	312	21	50	20	Hor.Comp.	-0.41	I	8	5
66	21103	51°13.150°	143°09.459'	282	0	192	31	12	59	Hor.Ext.	0.07	Ι	12	11
100	21104	51°25.073°	142°46.674'	142	42	7	38	256	24	Hor.Ext.+Sh.	-0.05	I	10	7
101	21106	50°28.733'	142°39.080'	62	63	193	18	290	19	Hor.Comp.	0.05	I	10	7
102	21107	50°28.692°	142°39.084'	229	27	48	63	138	0	Hor.Sh	-0.13	I	8	8
103	21114	50°02.152'	143°35.603'	185	11	06	24	298	63	Hor.Ext.	-0.07	I	11	10
104	21115	50°02.067'	143°32.357'	120	9	214	32	21	57	Hor.Ext.	-0.24	239∠40	13	12
105	21116	50°01.909'	143°30.383'	216	9	306	5	75	82	Hor.Ext.	0.12	I	6	6
106	21117	50°01.245°	143°28.148'	199	15	293	14	65	69	Hor.Ext.	0.3	229∠60	10	10
107	21118	50°01.336°	143°27.169'	289	71	158	13	65	14	Hor.Comp.	-0.48	I	10	6
108	21119	50°00.951'	143°25.257'	47	11	138	4	246	78	Hor.Ext.	-0.06	I	10	10
109	21120	49°57.087°	143°21.995'	161	15	264	40	55	46	Hor.Ext.+Sh.	0.28	I	11	7
110	21121	49°57.153°	143°23.389'	206	16	299	13	99	69	Hor.Ext.	0.05	I	11	8
111	21122	49°57.249°	143°22.181'	282	12	192	2	90	78	Hor.Ext.	-0.08	I	6	8
112	21123	50°01.715'	143°21.344'	162	25	71	4	333	65	Hor.Ext.	0.04	I	6	7
113	21124	50°01.715'	143°21.344'	270	12	7	29	160	58	Hor.Ext.	0.33	I	8	8
114	21125	48°57.868°	142°58.690°	36	9	300	44	132	46	Hor.Ext.+Sh.	-0.13	220∠20	11	6
115	21126	48°58.014°	142°58.714'	110	23	19	2	284	67	Hor.Ext.	0.27	I	6	7
116	22129	47°52.498°	142°29.129'	99	9	334	16	175	73	Hor.Ext.	0.32	I	14	11
117	22130	47°07.371'	142°03.787'	276	18	173	36	28	49	Hor.Ext.+Sh.	-0.16	I	٢	5
118	22131	47°10.191'	142°05.535°	6	6	260	65	102	24	Hor.Sh	-0.05	15∠30	٢	7
119	22137	46°25.564°	141°52.433'	48	0	138	45	318	46	Hor.Ext.+Sh.	-0.27	90∠15	14	10
120	22138	46°26.270°	141°52.603'	336	0	246	72	99	18	Hor.Sh	0.1	98∠15	13	13
121	22139	46°26.161'	141°56.009°	174	23	268	8	14	65	Hor.Ext.	0.2	240∠85	11	11
122	22140	47°02.456°	142°33.479'	09	6	329	5	199	82	Hor.Ext.	-0.01	Ι	15	11

No.	Observa-	Observation po	int coordinates	Ь		وَ		р		Stress state type	ň	Bedding	Measu	rements
	tion point	Z	Ш	Dip Az	N	Dip Az	N	Dip Az	N			planes	N total	N used
123	22140-2	47°01.825'	142°27.015'	200	31	98	19	341	53	Hor.Ext.	0.21	I	14	7
124	22141	47°01.872'	142°30.020'	4	4	270	42	66	48	Hor.Ext.+Sh.	0.19	$300{\angle}10$	13	6
125	22142	47°02.019'	142°30.645'	338	10	237	48	LL	40	Hor.Ext.+Sh.	-0.08	75∠20	9	5
126	22144	49°34.865'	142°11.18'	152	11	46	54	249	34	Hor.Sh	0.18	$219 \angle 80$	12	7
127	22145	49°09.477'	142°09.486'	270	72	121	16	29	6	Hor.Comp.	-0.12	I	12	10
128	22146	49°40.071'	142°17.286°	338	21	62	26	215	56	Hor.Ext.	-0.34	I	14	12
129	22147	49°42.623'	142°09.451'	195	11	46	78	286	9	Hor.Sh	-0.13	I	15	14
130	22148	49°31.386'	142°09.158'	283	18	15	8	127	71	Hor.Ext.	-0.52	I	13	11
131	22149	49°31.026'	142°08.947'	283	18	191	4	90	72	Hor.Ext.	0.14	I	6	6
132	22150	49°20.126'	142°04.568°	11	5	260	LL	102	12	Hor.Sh	-0.36	I	8	9
133	22157	47°00.187'	142°15.088°	31	30	296	8	192	58	Hor.Ext.	0.01	$215 \angle 10$	11	11
134	22158	46°57.909'	142°12.941'	120	9	210	2	320	84	Hor.Ext.	0.16	110∠50	7	7
135	22170	49°42.631'	142°39.657'	09	9	156	47	324	42	Hor.Ext.+Sh.	-0.49	340∠25	12	7
136	22171	49°41.584'	142°35.139'	157	5	249	27	56	63	Hor.Ext.	0.35	290∠60	8	8
137	22172	49°49.256'	142°24.513'	284	29	150	51	28	23	Hor.Sh	-0.17	250∠70	12	12
138	22173	50°01.859'	142°11.819°	360	9	91	12	244	ΤŢ	Hor.Ext.	0.1	70∠75	13	12
139	22174	50°01.209'	142°08.554°	11	5	109	60	279	30	Hor.Sh	-0.11	I	10	6
140	22175	50°02.437'	142°10.063'	47	11	309	34	152	53	Hor.Ext.	0.1	I	10	10
141	22176	50°02.822'	142°10.643'	285	65	102	25	192	1	Hor.Comp.	0.01	I	12	12
142	22177	50°03.076°	142°10.297'	186	17	92	13	327	69	Hor.Ext.	0	I	11	10
143	22178	49°51.517'	142°22.917'	187	42	285	6	25	47	Vert.Sh.	0.11	I	8	8
144	22179	50°15.851'	142°29.559'	355	11	87	7	207	77	Hor.Ext.	-0.02	80∠85	12	11
145	22182	50°23.681'	142°21.155'	310	51	70	22	174	30	Hor.Comp.	0.02	255∠75	8	8
146	22183	49°56.017'	143°12.834'	360	9	262	53	94	36	Hor.Ext.+Sh.	0.01	I	11	11
147	22184	49°56.036'	143°12.817'	68	34	309	36	187	36	Hor.Ext.+Sh.	-0.03	-	6	8

10 /	11 10	11 10 16 10	11 10 16 10 6 4	11 10 16 10 6 4 15 10	11 10 16 10 6 4 15 10 11 10	11 10 16 10 6 4 4 11 10 12 10 12 10	11 10 16 10 6 4 15 10 11 10 12 10 12 10	11 10 16 10 6 4 15 10 11 10 12 10 8 8	11 10 16 10 6 4 6 4 11 10 11 10 12 10 8 8 13 6	11 10 16 10 6 4 11 10 11 10 11 10 12 10 13 8 6 4 7 4 6 4	11 10 16 10 6 4 6 11 11 10 11 10 11 10 11 10 12 11 13 8 7 4 6 6 7 5	11 10 16 10 6 4 15 10 11 10 12 10 13 6 13 6 14 11 13 6 14 11 14 11	11 16 16 16 6 4 15 10 11 10 12 10 13 8 8 8 13 6 14 4 15 10 16 11 17 4 18 8 19 6 11 10 13 6 14 11 15 5 16 11 17 5 18 3 19 11 11 5 11 5 11 11 11 11 13 11 14 11 15 5 16 11 17 11 18 11 19 11 11 11 11 11 12 11 <	11 10 16 10 6 4 15 10 11 10 12 11 13 8 8 8 13 6 13 6 13 6 13 7 7 7 8 11 13 8 13 7 13 7 14 11 11 10 13 10 14 11 15 11 16 11 17 11 18 11 19 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11	11 16 16 16 17 18 11	11 16 16 16 16 16 17 11 11 10 11 11 11 10 11 10 11 10 11 10 11 10 11 10 11 5 12 11 13 6 10 10 10 10	11 16 16 16 17 18 11 12 13 14 15 16 17 18 19	11 16 16 16 17 18 11 12 13 14 15 16 16 16 17 18 19 10 10 11 12 13 14 15 16 17 18 19 10	11 16 16 16 17 18 11 12 13 14 15 16 17 18 19	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
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	0.06	0.06 0.1 0.1 0.18	0.06 0.1 0.18 0.18 0.22	0.06 0.1 0.18 0.18 0.22 -0.05	0.06 0.1 0.18 0.18 0.22 -0.05	0.06 0.1 0.18 0.18 0.22 -0.05 -0.08	0.06 0.1 0.18 0.18 0.22 -0.05 -0.08 -0.08 -0.22	0.06 0.1 0.18 0.18 0.22 -0.05 -0.08 -0.08 -0.03 -0.03	0.06 0.18 0.18 0.18 0.22 -0.05 -0.08 -0.03 -0.03 -0.03 0.41	0.06 0.18 0.18 0.22 -0.56 -0.08 -0.08 -0.03 -0.03 0.41 0.14	0.06 0.18 0.18 0.22 -0.05 -0.08 -0.03 -0.03 0.14 0.14	0.06 0.18 0.18 0.22 -0.05 -0.08 -0.03 -0.03 0.14 0.14 0.14 0.35	0.06 0.18 0.18 0.22 -0.56 -0.08 -0.03 -0.03 0.41 0.14 0.14 0.14 0.14 0.21 0.21 0.29	0.06 0.18 0.18 0.22 -0.05 -0.08 -0.03 -0.03 0.14 0.14 0.14 0.14 0.35 0.35 0.35	0.06 0.18 0.18 0.22 -0.05 -0.03 -0.03 -0.03 0.14 0.14 0.14 0.29 0.35 0.35 0.35 0.35 0.21 0.29 0.29 0.29 0.20	0.06 0.18 0.18 0.22 -0.05 -0.08 -0.03 -0.03 0.41 0.41 0.41 0.14 0.14 0.14 0.29 0.29 -0.39 0.29 0.15 0.15	0.06 0.18 0.18 0.22 -0.56 -0.08 -0.03 -0.03 0.14 0.14 0.14 0.14 0.14 0.29 0.35 0.35 0.35 0.35 0.29 0.12 0.12 0.12	0.06 0.18 0.18 0.22 -0.56 -0.08 -0.03 -0.03 0.14 0.14 0.14 0.14 0.14 0.29 0.35 0.35 0.35 0.29 0.12 0.12 0.15 0.15 -0.24	0.06 0.18 0.18 0.22 -0.05 -0.03 -0.03 0.41 0.41 0.41 0.41 0.41 0.14 0.14 0.14	0.06 0.18 0.18 0.22 -0.05 -0.05 -0.03 0.41 0.41 0.41 0.14 0.14 0.14 0.29 0.29 0.29 0.15 0.29 0.15 0.15 0.15 0.29 0.15 0.29 0.15 0.29 0.29 0.29 0.29 0.29 0.29 0.29 0.29	0.06 0.18 0.18 0.22 0.22 -0.05 -0.03 0.14 0.14 0.14 0.14 0.14 0.29 0.35 0.35 0.29 0.12 0.12 0.12 0.29 0.12 0.29 0.20 0.15 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.22	0.06 0.18 0.18 0.22 -0.056 -0.03 -0.03 0.14 0.14 0.14 0.14 0.14 0.14 0.29 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15	0.06 0.18 0.18 0.22 -0.05 -0.05 -0.03 0.14 0.14 0.14 0.14 0.14 0.15 0.29 -0.39 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
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142°31.240° 97 142°31.273° 97 142°31.273° 97 142°31.301° 97 142°31.301° 97 142°31.301° 97 142°31.305° 97 142°33.447°	02 142°31.011' 04 142°31.011' 05 142°31.093' 07 142°31.093' 08 142°31.016' 09 142°31.106' 142°31.106' 142°31.106' 142°31.106' 142°31.106' 142°31.106' 142°31.123' 142°31.123' 142°31.123' 142°31.126' 142°31.230' 142°31.250' 196' 142°31.250' 142°31.230' 142°31.250' 142°31.230' 142°31.250' 142°31.230' 142°31.273' 142°31.200' 142°31.273' 142°31.301' 142°31.301' 142°31.301' 142°31.301' 142°31.301' 142°31.301' 142°31.301' 142°31.301' 142°31.301' 1142°31.303' 142°31.301' 1142°33.476' 142°33.476'	02 142°31.011' 54' 142°31.093' 54' 142°31.093' 56' 142°31.106' 56' 142°31.106' 56' 142°31.106' 56' 142°31.106' 56' 142°31.106' 56' 142°31.123' 56' 142°31.123' 56' 142°31.123' 99' 142°31.236' 57' 142°31.240' 56' 142°31.240' 57' 142°31.236' 57' 142°31.236' 56' 142°31.236' 57' 142°31.236' 56' 142°31.236' 56' 142°31.236' 57' 142°31.236' 57' 142°31.301' 57' 142°31.301' 57' 142°33.476' 57' 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ţ ć	J4 VJ.1V4	54°04.954'	54°04.954' 54°04.894' 54°04.894'	54°04.887' 54°04.887' 54°04.887'	54°04.954' 54°04.954' 54°04.887' 54°04.879'	54°04.954' 54°04.954' n 54°04.894' g 54°04.879' n 54°04.879' c 54°04.879'	54°04.954' n 54°04.954' n 54°04.894' g 54°04.879' n 54°04.879' k 54°04.879' n 54°04.876' n 54°04.876'	0 0.4 0.4 0.4 0 54°04.954' m 54°04.887' g 54°04.887' m 54°04.879' k 54°04.879' m 54°04.876' m 54°04.876' k 54°04.876' k 54°04.876' k 54°04.856'	 54°04.954' 54°04.954' g 54°04.887' m 54°04.879' k 54°04.876' m 54°04.856' k 54°04.856' k 54°04.856' 	 54°04.954' 54°04.954' 54°04.879' 54°04.879' 54°04.876' 54°04.856' 54°04.856' 54°04.787' 54°04.787' 54°04.787' 	 9 74 °04.954' 9 54 °04.954' 9 54 °04.887' m 54 °04.879' m 54 °04.876' in 54 °04.856' ik 54 °04.856' ik 54 °04.787' 9 54 °04.718' 0 54 °04.718' 	 24°04.054' 54°04.954' 54°04.887' 54°04.879' 54°04.876' 54°04.856' 54°04.856' 54°04.787' 54°04.787' 54°04.787' 54°04.718' 54°04.718' 54°04.718' 	 9 54°04.954' 9 54°04.954' 9 54°04.887' m 54°04.879' k 54°04.876' m 54°04.856' k 54°04.856' 9 54°04.787' 9 54°04.787' 9 54°04.788' 8 54°04.699' 	24°04.054' 9 54°04.954' 1 54°04.887' 1 54°04.887' 1 54°04.876' 1 54°04.876' 54°04.856' 54°04.856' 1 54°04.856' 1 54°04.718' 24°04.718' 54°04.718' 1 54°04.699' 8 54°04.695' 8 54°04.695'	 9 9 54°04.954' 9 54°04.887' in 54°04.879' in 54°04.876' 54°04.856' 54°04.856' 9 54°04.787' 9 54°04.699' 8 54°04.695' 2 54°04.666' 	24°04.054' 9 54°04.954' m 54°04.887' m 54°04.887' m 54°04.879' h 54°04.876' h 54°04.876' h 54°04.876' h 54°04.876' h 54°04.876' h 54°04.876' h 54°04.866' h 54°04.690' 1 54°04.690' 2 54°04.690' 8 54°04.690' 3 54°04.695' 3 54°04.695'	 24°04.954' 54°04.887' 54°04.887' 54°04.879' 54°04.856' 54°04.856' 54°04.856' 54°04.787' 54°04.699' 54°04.699' 54°04.695' 54°04.672' 54°04.672' 54°04.672' 54°04.655' 54°04.655' 54°04.655' 	9 54°04.954' 9 54°04.954' 1 54°04.856' 1 54°04.879' 1 54°04.876' 1 54°04.856' 1 54°04.856' 1 54°04.856' 1 54°04.856' 1 54°04.856' 1 54°04.699' 8 54°04.695' 8 54°04.695' 3 54°04.655' 3 54°04.655' 54°04.655' 54°04.655' 5 54°04.505'	7 9 54°04.954' 9 54°04.887' 1 54°04.887' 1 54°04.879' 1 54°04.876' 1 54°04.856' 3 54°04.856' 9 54°04.856' 3 54°04.856' 9 54°04.856' 9 54°04.856' 9 54°04.699' 1 54°04.699' 1 54°04.699' 2 54°04.695' 8 54°04.695' 3 54°04.695' 3 54°04.695' 3 54°04.695' 3 54°04.695' 3 54°04.695' 5 54°04.605' 3 54°04.605' 5 54°04.605' 5 54°04.605'	0 54°04.954' m 54°04.954' m 54°04.887' m 54°04.887' m 54°04.887' k 54°04.879' k 54°04.856' k 54°04.856' k 54°04.856' k 54°04.718' 54°04.718' 54°04.695' 54°04.695' 54°04.695' 54°04.695' 54°04.695' 54°04.695' 54°04.695' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°04.605' 54°02.955'	54°04.954' 54°04.954' 54°04.954' 54°04.887' 54°04.879' 54°04.856' 54°04.856' 54°04.856' 54°04.856' 54°04.699' 54°04.699' 54°04.666' 54°04.666' 54°04.605' 54°02.955' 54°02.931'	9 54°04.954' m 54°04.954' m 54°04.887' m 54°04.887' m 54°04.887' k 54°04.879' m 54°04.879' fk 54°04.876' k 54°04.876' k 54°04.876' k 54°04.696' k 54°04.699' 54°04.699' 54°04.695' 8 54°04.695' 54°04.605' 54°04.605' 8 54°04.605' 54°04.605' 54°04.605' 7 54°04.605' 8 54°04.605' 9 54°04.605' 1 54°04.505' 54°04.505' 54°04.505' 54°04.505' 54°02.955' 1 54°02.955' 54°02.927' 54°02.927'	9 54°04.954' 9 54°04.954' 1 54°04.887' 1 54°04.887' 1 54°04.876' 1 54°04.856' 1 54°04.856' 1 54°04.856' 1 54°04.695' 2 54°04.695' 3 54°04.695' 3 54°04.695' 3 54°04.695' 4 54°04.605' 5 54°04.605' 3 54°04.605' 3 54°04.605' 3 54°04.605' 3 54°04.605' 4 54°04.605' 5 54°04.605' 5 54°04.605' 6 54°04.605' 7 54°04.605' 7 54°04.605' 8 54°04.605' 7 54°02.905' 8 54°02.905' 1 54°02.905' 1 54°02.905' 2 54°02.905' 5 54°02.905' 6 54°02.905'
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No.	Observa-	Observation po	int coordinates	6		6	2	ď		Stress state type	ň.	Bedding	Measu	rements
	tion point	Z	ш	Dip Az	N	Dip Az	V	Dip Az	N			planes	N total	N used
173	20294	54°02.359'	142°34.245'	109	71	228	10	321	0	Hor.Comp.	0.18	230∠23	17	11
174	20295	54°02.224'	142°34.286'	233	11	27	78	142	0	Hor.Sh	-0.05	233∠33	٢	9
175	20784	54°02.009°	142°34.399'	307	11	216	7	115	0	Hor.Ext.	-0.21	238∠35	12	10
176	20297	54°01.988'	142°34.417'	262	42	49	43	156	0	Hor.Comp.+Sh.	-0.12	216∠26	12	٢
177	20785	54°01.935'	142°34.455'	338	57	209	22	109	0	Hor.Comp.	0.14	233∠38	12	11
178	20789	54°00.980°	142°35.641'	90	36	270	54	0	0	Hor.Comp.+Sh.	0.38	I	5	4
179	20791	54°00.211'	142°36.772'	270	48	74	41	171	0	Hor.Comp.+Sh.	0.17	198∠30	5	4
180	20816m	54°01.818'	142°58.375'	300	9	34	32	201	57	Hor.Ext.	-0.46	I	6	6
181	20816b	54°01.818'	142°58.375'	141	16	273	67	46	17	Hor.Sh,	0.2	I	18	11
182	20819 и 20820	54°01.450'	142°57.457'	264	12	66	78	173	4	Hor.Sh,	-0.15	68∠48	11	8
183	20821	54°01.328'	142°57.270'	108	9	15	27	209	63	Hor.Ext.	-0.03	13∠40	11	8
184	20822	54°01.217'	142°57.155'	206	LL	310	ю	41	13	Hor.Comp.	0.12	228∠60	12	8
185	20823 и 20824	54°01.170°	142°57.023°	209	22	103	35	325	47	Hor.Ext.	-0.25	128∠45	L	Ś
186	20326	54°01.058'	142°56.815'	189	6	92	36	290	52	Hor.Ext.+Sh.	0.25	I	14	10
187	20327	54°01.015'	142°56.746'	218	42	18	47	119	10	Hor.Comp.+Sh.	0.25	313∠25	6	5
188	20328	54°00.955'	142°56.551'	138	37	С	43	248	25	Hor.Comp.+Sh.	0.11	218∠37	13	9
189	20330	54°00.541'	142°56.117'	233	11	54	62	323	0	Hor.Sh	-0.1	58∠61	12	10
190	20331	54°00.514'	142°56.136'	246	9	153	б	346	60	Hor.Ext.	-0.18	28∠75	16	15
191	20826	54°00.505°	142°56.089'	240	35	46	54	146	7	Hor.Sh	0.05	203∠55	24	13
192	20827	54°00.485'	142°56.048'	0	0	270	90	06	0	Hor.Sh	0.18	63∠35	10	5
193	20830	54°00.427'	142°55.879'	270	72	53	15	145	11	Hor.Comp.	0.45	38∠35	6	4
194	20831	54°00.364'	142°55.745'	233	11	140	14	0	72	Hor.Ext.	-0.07	118/24	13	11
195	20832	54°00.140'	142°55.535'	262	42	49	43	156	17	Hor.Comp.+Sh.	0.11	178/25	14	12
196	20835	53°59.897'	142°55.006'	279	48	76	40	176	12	Hor.Comp.+Sh.	-0.32	243∠52	16	14

No.	Observa-	Observation po	oint coordinates	в		<u>م</u>		6		Stress state type	n,	Bedding	Measu	Irements
	tion point	Z	Щ	Dip Az	N	Dip Az	N	Dip Az	~			planes	N total	N used
197	20337	53°59.891'	142°55.004'	41	11	297	51	139	37	Hor.Ext.+Sh.	0.08	59∠57	6	8
198	20341	53°59.542'	142°54.595'	64	23	164	22	292	57	Hor.Ext.	-0.27	I	10	6
199	20342	53°59.475'	142°54.515'	249	28	137	36	8	41	Hor.Ext.+Sh.	-0.12	100∠26	10	9
200	20838	53°59.424'	142°54.467'	60	0	330	50	150	40	Hor.Ext.+Sh.	-0.04	48∠75	8	5
201	20842	53°59.281'	142°54.385'	246	9	343	49	151	40	Hor.Ext.+Sh.	0.1	38∠70	9	9
202	20843	53°59.250'	142°54.362'	38	42	131	б	225	48	Vert.Sh.	-0.42	62∠60	11	7
203	20841	53°59.108'	142°54.257°	99	9	157	10	307	78	Hor.Ext.	-0.07	218/52	11	6
204	20345	53°59.095'	142°54.268'	108	9	215	71	16	19	Hor.Sh.	0.12	70∠75	10	7
205	20846	53°58.354'	142°53.879'	257	18	134	60	355	23	Hor.Sh.	0.14	208∠55	12	8
206	20847	53°58.141'	142°53.810'	206	49	73	31	327	24	Hor.Comp.	-0.27	I	L	5
207	20809k	53°58.104'	142°53.797'	51	22	171	51	307	30	Hor.Sh.	0.43	33∠45	11	7
208	20809g	53°58.104'	142°53.797'	270	24	104	65	358	8	Hor.Sh.	-0.13	53∠33	L	9
209	20809b	53°58.104'	142°53.797'	47	11	202	78	316	5	Hor.Sh.	0.45	28∠42	5	4
210	20807	53°57.629°	142°53.617'	157	5	66	9	290	82	Hor.Ext.	0.06	I	14	11
211	20806	53°57.606°	142°53.601'	123	24	18	31	244	49	Hor.Ext.	0.29	249∠76	12	7
212	20805	53°57.575°	142°53.596°	52	17	166	53	312	32	Hor.Sh.	-0.31	258∠50	11	7
Notes. mum c (Hor.E (Hor.E compr compr in the ? <i>Ilpume</i> Meжyr данны данны со сдви пользо	The table shc ompressive s xt., horizonts ession with s siTRESSgeol vanua. B rac of a rac of a septearia centue b cove trom, Vert.Sl bahhbix для bahhbix для	wes the number a stresses) reconstr al extension; Hoi hear; Vert.Sh., v(software, Dash (5лице приведен) – максимальных к скольжения и тании со сдвигс h. – сдвиг в верл расчета в прогр	und coordinates o ructed using the c r.Ext.+Sh., horizo ertical shear); the denotes that no d bi Homep и koopJ x сжимающих i трещинах; тип om, Hor.Sh. – rop тикальной плос oamme STRESSg	f the obse cataclastic ontal exte of Lode–N ata availa ata availa (обстанс изонтали кости); к eol. Про-	rvation pc c method nsion wit adai coef uble. эчек набл эка) нап эный сдв оэффици depk – да	ints; the c [5] accorc h shear; H ficient μ_{σ} ; нодения; ряженног иг, Hor.Cc ент Лоде- ент Лоде-	rrientatio ling to stu lor.Sh., h betting p ориенти ориенти ото состоя ото. – го -Надаи р	n of the pr uctural au orizontal lane dip; pobku oce при помс Huns (Hor pursohran	incipal st nd kinem shear; Ht the total iй главнн лци ката Ext. – гс ьное сж: гты зален	ress axes (σ_1 , minin atic data on the sli or.Comp., horizont number of measur χ_{X} напряжений (σ $\chi_{Ластического меризонтальное расатие, Ног.Comp.+fзания слоистости;$	num (exturest extension extension extension extension all comprements at ements at ements [5] илода [5] ггода [5] ггода [5] ггода extension office к	ension); σ_2 , int and joints; ty ession; Hor.Co the point and Maльных (рас по структурн , Hor.Ext.+Sh 130нтальное с оличество зал	ermediat pe of the mp.+Sh. used for тяжение ю-кинем с. – гориз жатие в меров в т	e; $σ_3$, maxi- stress state , horizontal calculation), $σ_2$ – προ- атическим онтальное сочетании гочке и ис-

ess axes for observation points No. 213–264 (according to [2–4, 7, 8])	зных напряжений для точек наблюдения 213–264 (по данным [2-4, 7, 8])
of principal stress axes	овке осей главных наг
ormation on orientation or	Сведения об ориентир
Table 2. Ini	Таблица 2.

No.	Observation	Coordinates or location e	of observation point	α		σ2		ີ d	
	point	Z	Е	Dip Az	7	Dip Az	V	Dip Az	V
213	1	47°01.450°	142°48.217'	9	20	106	25	243	56
214	2a	46°39.483'	141°50.950°	202	20	356	67	110	6
215	2b	Nevelsk, northern subur of marine t	b and southern part terrace	356	67	202	20	108	10
216	3	46°44.667°	142°07.017'	162	30	21	55	264	18
217	4	46°51.133'	142°59.500'	34	10	130	32	288	54
218	5	Lyutoga River, near the brid Ogon?	dge up of the village of ki	18	10	271	68	112	20
219	6a	$46^{\circ}46.800'$	142°28.433'	176	36	65	28	306	40
220	6b	Center of the quarry near the lovskoe, ol	s settlement of Petropav- d field	65	30	176	32	302	43
221	7	The entrance to the Petr	opavlovskiy quarry	330	50	196	30	90	20
222	8	46°37.033'	142°58.133'	132	23	343	65	227	10
223	6	Mt. Yun	ona	208	10	345	75	118	10
224	10	Town of Korsako	v, rocky wall	314	30	176	52	58	30
225	11	$48^{\circ}00.167$	142°31.250°	210	5	116	50	304	40
226	12a	47°06.220°	142°36.910'	320	40	228	2	134	50
227	12b	The left bank of the Susuya Sanatorny	river to the south of the village	159	35	35	38	274	30
228	13	$46^{\circ}40.973$	143°27.212'	82	10	218	74	348	10
229	14a	46°38.278°	143°30.705'	347	30	182	56	80	5
230	14b	Cape Ptichiy by the	Sea of Okhotsk	322	20	64	26	195	55
231	14c	Cape Ptichiy by the	Sea of Okhotsk	20	20	150	09	280	20
232	15	46°39.353'	143°28.685'	152	10	246	18	34	68
233	16	46°46.743°	142°28.975°	188	5	293	64	76	24
234	17a	The left bank of the river Tsu the highway Yuzhno-Sa	unai under the bridge on Ikhalinsk–Kholmsk	16	15	116	26	254	56

No.	Observation	Coordinates or locatio	n of observation point	Ø			52	0	
	point	Z	ш	Dip Az	V	Dip Az	V	Dip Az	7
235	18	47°22.585'	141°59.883'	152	30	20	50	255	26
236	19	The shore of the Tatar Str. into th	ait, Simakovo village, cut le road	318	10	54	21	204	61
237	20	47°03.502'	142°07.025'	52	15	322	0	237	70
238	21a	Yuzhno-Sokolovsky	/ quarry, young field	256	70	40	18	132	12
239	21b	Yuzhno-Sokolovsk	ky quarry, old field	42	18	260	70	130	12
240	22	Yuzhno-Sokolovsky qua	rry, foot wall of the fault	268	70	130	12	36	10
241	23	Ilyinsky village, the left b	oank of the Jasminka river	319	30	104	53	216	18
242	24	Ilyinsky village, right ba	unk of the Jasminka river	206	25	94	40	320	40
243	25	47°57.230°	142°20.988'	306	ю	216	74	38	14
244	26	Northern outskirts of t	he village of Vzmorye	234	60	26	16	122	10
245	27	46°43.600'	142°26.917'	145	10	297	76	53	5
246	28a	46°53.133'	142°20.988'	155	20	359	56	250	10
247	28b	Izvestkovy qu	arry, old field	92	42	194	14	300	45
248	29	Izvestkovy qua	rry, eastern wall	144	47	3	35	256	20
249	Due deposit			195	5	100	09	295	60
250	Lopatinskoe	deposit (Dolinskaya mine)		215	5	315	25	120	30
251	Mgachi depo	sit (west wing)		215	5	125	60	305	30
252	Mgachi depo	sit (east wing)		0	5	270	09	90	35
253	Boshnyakovc	o deposit (west wing)		240	20	45	70	150	10
254	Boshnyakovc	o deposit (east wing)		5	5	275	09	100	25
255	Boshnyakovc	deposit (southern centrocli	inal)	270	5	175	70	5	20
256	Boshnyakovc	deposit (northern centrocli	inal)	25	10	290	5	150	80
257	Lesogorsk de	posit (Telnovskaya mine)		335	10	65	20	225	70
258	Lesogorsk de	posit (Upper Telnovskaya 1	(1	20	5	280	25	110	25
259	Lesogorsk de	posit (Upper Telnovskaya 2	2)	225	5	315	15	130	70
260	Uglegorsk de	posit (Sergeevsky site)		180	30	20	40	280	5

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No.	Observation	Coordinates or location	of observation point		3	α		ີ່ຢ	
	point	Z	ш	Dip Az	7	Dip Az	7	DipAz	7
261	Uglegorsk dej	posit (Uglegorsk 6 mine)		150	5	240	40	50	55
262	Uglegorsk dej	posit (Uglegorsk 4-1 mine)		320	20	220	30	75	50
263	Uglegorsk dej	posit (Uglegorsk 4-2 mine)		220	50	40	40	130	0
264	Uglegorsk dej	posit (Udarnovskaya mine)		240	50	25	30	125	20
Note. ' Примі Abou l	The orientation ечание. Ориент t the Authors	of the principal stress axes: с ировка осей главных напр	σ_1 , minimum (extension); σ_2 , i яжений: σ_1 – минимальных (intermediaté (растяжени	e; σ_3 , maximum (e), σ_2 – npomese;	compressive stre: уточных и σ ₃ – л	sses. Лаксимальных	сжимающих не	пряжений. Об авторах
Kamer Senior Geolog p.kame	nev, Pavel A. († Researcher, Labo ry and Geophysic mev@imgg.ru	attps://orcid.org/0000-0002-993 oratory of geochemistry and russ of the Far Eastern Branch c	4-5855), Cand. Sci. (Engineer egional geology, Institute of Mt of RAS, Yuzhno-Sakhalinsk, Ru	ing), Кам arine ниче issia, геолс Южн	енев Павел Ален сских наук, старг огии, Институт м эо-Сахалинск, Ро	ксандрович (http: ший научный сот юрской геологии ссия, p.kamenev(@	s://orcid.org/0000 рудник лаборати и геофизики Да. jimgg.ru	-0002-9934-5855 эрии геохимии льневосточного	, кандидат тех- 1 региональной отделения РАН,
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Sim, L Lead H Schmic Russia,	ydia A. (https://or Researcher, Labo It Institute of Ph. , sim@ifz.ru	cid.org/0000-0003-0267-2241) ratory of fundamental and a ysics of the Earth of the Russi), Doctor of Geology and Mineral pplied problems of tectonophy ian Academy of Sciences, Moss	logy, Сим sics, рало cow, клад	г Лидия Андрееі тических наук, вс ных проблем текі , Россия, sim@if2.	вна (https://orcid.(эдущий научный (гонофизики, Инст .ru	ərg/0000-0003-02 сотрудник лабор: ситут физики Зел	67-2241), доктој атории фундамен али им. О.Ю. Ш	о геолого-мине- гальных и при- идта РАН, Мо-
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