Independent Technical Report on the Khatystakh and Beenchime diamond projects, north-west of the Republic of Sakha (Yakutia), the Russian Federation

Report Prepared for

Polarctic Management LLC

Report Prepared by

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ES8053
20 June 2019

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Project completion date: 20 June 2019
Date signed: 09 December 2020

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Photos on the cover page (left to right): the West wing of the Balkarsky anticline (Bulmer river); sample preparation and washing of the AGK sample, Beenchime River, 2017; a large (some carats) Ural type diamond crystal, encountered by AGK, Bechime river, 2017.

Resume

The Beenchime and Khatystakh diamond placer projects ("Projects") are early-stage exploration projects located in the north-western part of the Republic of Sakha (Yakutia), in the Oleneksky and Bulunsky ulus (districts), respectively. The work areas are located within the sparsely populated Arctic zone of Russia. This Technical Report (the "Report" or "Technical Report") was prepared by employees of the Moscow branch of SRK Exploration Services ("SRK ES") during the period from March to May 2019 and contains information that is current as at May 2019. At the time of preparation of this Technical Report, the licenses for the geological study of the Beenchime and Khatystakh sites that grant the right to conduct prospecting and assessment of mineral deposits, were owned by LLC "Arkticheskaya Gornaya Kompaniya" (Arctic Mining Company) ("AGK"). The customer of this Technical Report - Polarctic Management LLC ("Polarctic Management" or "the Customer"), was the agent to AGK and acted in its interests. The report contains technical information on the Projects available in open sources, archived literature, and made available by the AGK, including the results of the work, completed by the AGK in 2016 and 2017.

The Beenchime License area includes part of the valley of the Beenchime river, stretching for over 45 km, which, according to the results of previous workers, has potential for finding an alluvial diamond deposit. The diamond occurrences in the Beenchime licence area are of the alluvial river-bed placer deposits type. The fact that the Beenchime River alluvium contained diamond was established in the late 1950s (Gutorovich et al., 1957) and was studied during several campaigns (Kruchek, 1962, Nikolaev et al., 1980, Ostashkin et al., 1990, Manakov et al., 1994, Folisevich et al., 1999, Grakhanov, 2013). The work of the previous workers included the development of the prospecting-exploration lines of test-pits and trenches which crossed the riverbed, floodplain, and terraces, the collection of small-and large-scale samples to study the morphology of diamonds, and kimberlite indicator minerals. The best results were obtained at the Pyropovy site, which is located in the upper part of the Beenchime license area. Here, the average diamond grade in the riverbed was 0.82 ct/m^3, in the test-pits in the river floodplain along one of the exploration lines, the average diamond content was 1.24 ct/m^3. The lower part of the Beenchime River valley was characterized by the lowest diamond grades in pebbles, which averaged at 0.03 ct/m^3. In general, according to the results of the early works, the Beenchime placer was classified as non-commercial due to low grades in most of the exploration lines. According to the results of the work of OJSC "Nizhne-Lenskoe" (Grakhanov, 2013), a conclusion was made about the high mining cost of raw material at the given average productivity of the Beenchime placer.

The length of the Khatystakh license area is about 50 km, at widths from 1.2 to 3.0 km and it is located on the left bank of the Lena River. The site stretches along the left side of the Lena River and includes outcrops of Late Triassic Carnian age sediments that contain diamonds. The Carnian age sediments outcrop in the core of the anticline fold, and the diamond occurrences, associated with them, are of the placer type. The diamond potential of the Carnian age sediments was established during the works by Sibirtsev with his colleagues (1982; 1985). As a result of these works, several potential areas, including the Bulkur area, which are located within the Khatystakh license areas, were identified in downstream of the Lena River. According to the data from the surface mine workings, work by Sibirtsev and colleagues (1982, 1985) at the Bulkur site identified increased concentrations of diamonds for the length of over 12 km. In 2008-2009, OJSC Nizhne-Lenskoye continued the prospecting work and the study of the Carnian age layer (Grakhanov, 2009), which included heavy mineral concentrate sampling and low-volume sampling, bulk sampling, development of trenches, and drilling of a 5 borehole profiles across the Carnian productive horizon at borehole spacing of 10 m. The drilling intersected the diamond-productive horizon in three of the five boreholes and the average thickness was 0.5 m (verbal information from S.A. Grechanov). In addition, the productive stratum was also checked by trench sampling. It was established, according to the results of previous workers, that the productive stratum is characterized by a complex composition and facies variation, and its thickness is also very variable. Even within one outcrop or trench, the thickness ranges from 0 to 1.0 m. Due to the variability of the productive Carnian horizon and the low diamond value, OJSC Nizhne-Lenskoye did not add the Khatystakh site into its assets (verbal information from S. A. Grechanov). The nature of the Carnian horizon is highly debatable and currently, there is no unequivocal interpretation of its formation. The Carnian horizon contains the Ebelyakh ("northern") type diamonds with light isotopic composition of carbon and specific morphology, which are widely spread in Quaternary and Neogene age placer deposits in the north-west of the Siberian Platform and are not found in kimberlite bodies.

In 2016 and 2017, AGK employees visited the Pyropovy (the Beenchime license area) and Bulkur (Khatystakh license area) sites and conducted some reconnaissance work, which included prospecting routing, development of several trenches and test-pits, heavy mineral concentrate sampling, and low-volume sampling, and pre-concentration of samples. The study of diamonds using an XRF separator, their extraction, and sorting was carried

out in the OJSC "Almazy Anabara" recovery workshop (Molodo placer mine). As a result of these works, AGK confirmed the potential of the license areas, completed an assessment of potential resources, and prepared a works program for further studies of the placer occurrences, including the methodology, scope, and budget of the works. At the Pyropovy site, diamond grades in the AGK samples are close to or slightly higher than those of the previous prospectors'. According to the OJSC "Almazy Anabara" expert assessment, the total weight of diamonds obtained from AGK samples was 21.6 carats, at 90.2 US dollars average price per 1 carat (USD/ct) according to the international classifier (AGK data). The total weight of diamonds obtained from the two AGK trenches at the Bulkur site was 138.11 carats, the average value of diamonds according to the OJSC "Almazy Anabara" experts was 15.3 USD/ct according to the international classifier.

AGK estimated the potential diamond resources for the Beenchime license area at 1705.86 thousand carats at an average diamond content of 0.36 carats/m^3. For the Khatystakh site, the P1 category potential resources for the open cast mining method is estimated at 7690 thousand carats at an average grade of 3.66 ct/m^3 and average thickness of the productive stratum being 1.05 m, the width of the productive stratum 40 m for 50 000 m of the placer length. For the underground mining method, the resources amount to 24 450 thousand carats at an average content of 4.89 ct/m^3, the average thickness of the productive stratum being 0.5 m, the width of the productive stratum 200 m for 50 000 m of the placer length.

SRK ES was contracted for an assessment of the appropriateness of selection of the licensed areas and criteria for their diamond-containing potential, the correctness in the substantiation of predicted diamond resources , and AGK exploration program, and also evaluation of methodology of prospecting-assessment works and issuing recommendations for improvement of this methodology. If possible, the SRK ES should assess the risk of reduction of the AGK estimated potential resources.

Despite the negative assessments of the previous workers, after reviewing the available materials, SRK ES believes that the presence of placer occurrences with high diamond grades and the low exploration maturity indicate the possibility of finding commercially mineable properties within the Beenchime and Khatystakh license areas. There is no doubt that both areas represent interest from prospecting point of view, and have significant potential for commercial development, therefore, the need for their further study seems quite appropriate. For the registration of diamond resources and reserves at the State Balance of the Russian Federation, the obtaining a mining license and the commencement of mining, it is necessary to conduct prospecting-evaluation and exploration work, including core drilling, development of mine workings, engineering studies, to complete modelling of the geological setting and reserves, to study the economic aspects of Projects and make sure of their profitability.

SRK ES are of the opinion, that in general, the AGK assessment of potential resources at the Beenchime area was completed correctly by taking into account the requirements and methodological recommendations of the GKZ (State reserves committee) and the actually available material. SRK ES also agrees that in the early periods of prospecting for diamonds, the prospectors lacked the equipment, all work was done manually, and the sand concentration and diamond extraction technologies were not perfect, which could lead to some loss of the commercial component in sample processing. Probably, some material may have been lost during sample collection from the riverbed and mine workings in the summer season, when there is abundant water. Taking this into account, it can be assumed that the Beenchime placer had been undervalued due to the inaccuracies in sampling and sample concentration; however, at this stage of works, it is impossible to assess the extent of possible losses for there is no data of verification of historical mine workings.

SRK ES are of the opinion that the thickness of the productive stratum at the Khatystakh area and as a consequence - the potential resources for the open cast mining method in the author's option are overestimated by 2-3 times. SRK ES recommends AGK to refrain from the estimation of potential resources for the underground mining method for the issue of extracting the resources using the underground mining method has not yet been resolved in principle.

SRK ES are of the opinion that, the AGK work program for the Beenchime site has been prepared by taking into account a good knowledge of placer geology and work experience in northern conditions and will allow studying the license area with sufficient detail to identify a deposit class property, conduct its exploration and calculate the resources and reserves. However, at the prospecting-assessment stage, the Khatystakh project represents a technically challenging task, taking into account the different degree of competence of the Carnian horizon diamond-bearing tuffaceous rocks, the small and variable thickness of the horizon, which would cause significant dilution of sand during mining and increase the cost of production of works, and the presence of fault tectonics and other factors that would lead to higher operating costs.
In addition, in accordance with the requirements of the Russian mining legislation, the AGK work program envisages to conduct a complex of works for the assessment of the entire territory of licenses already at the first stage of

works, followed by infilling of the exploration grid in the potential areas. SRK ES believes that, in the interests of investors in the generation of profit as soon as possible and the minimization of investment risks associated with non-confirmation of the potential resources should be taken into account when planning the stages of work. SRK ES is of the opinion that in the case of possible marginal economic parameters of the Projects, the priority will be a detailed study of the potential areas already identified at the first stage of works, and recommendations for their commissioning in case of profitability.

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1 Introduction and technical assignment

The Beenchime and Khatystakh diamond placer projects ("Projects" or "Areas") are early-stage exploration projects located in the north-western part of the Republic of Sakha (Yakutia), in the Oleneksky and Bulunsky ulus (districts), respectively. The work areas are located within the sparsely populated Arctic zone of Russia. The Beenchime area is located within Beenchime River valley, a left tributary of the Olenek River, 370 km north-east of the Olenek village, the administrative centre of Oleneksky ulus. The Khatystakh area is located on the left bank of the Lena River, 60 km west of Tiksi village, the administrative centre of Bulunsky ulus. The Licenses for Beenchime and Khatystakh areas allow the performance of exploration and evaluation of mineral resources. The licences are owned by LLC "Arkticheskaya Gornaya Kompaniya ("AGK" or the “Company”). Polarctic Management LLC ("Polarctic Management" or the "Client ") is an agent to AGK and acts in its interests.

Following the successful field reconnaissance work 2016-2017, AGK prepared exploration programs for both Areas (the "Exploration Programs") aimed at assessment of the diamond mineral resources in C1+C2 categories and potential resources in P1+P2 categories. In February 2019, Polarctic Management approached SRK Exploration Services Ltd (“SRK ES”) with a request to review the exploration potential of both Projects and the possibility of implementing the Exploration Programs, based on the experience of SRK ES in supporting such projects.

In preparing this Technical Report, SRK ES followed the recommendations of the National Instrument 43-101 of the Canadian Securities Administrators. This Technical Report does not contain a statement on mineral resources and ore reserves and considers only the exploration potential of the sites. SRK ES is aware that this Technical Report will be used by Polarctic Management to raise investments in these Projects.

This Technical Report is a result of a desktop study, and SRK ES staff did not visit the Areas during the preparation of the Report. The Technical Report summarizes the technical information available on the Beenchime and Khatystakh Projects and demonstrates that the Projects are early stage exploration projects, as determined by the Toronto Stock Exchange. For registration of diamond mineral resources at the State Balance of the Russian Federation, the Projects require expenditures related to exploration, including (but not limited to) core drilling, trenching, metallurgical studies, modelling of the geology and diamond mineral resources. The Technical Report was originally prepared in Russian and translated into English following the request of Polarctic Management.

1.1 The Scope of Work

The Scope of Work (“SoW”) was prepared by Polarctic Management and includes the following:

- assessment of the suitability of criteria used in the selection of the areas for their diamond content, based on the results of the historical work and from the experience of SRK ES;
- • the correctness of the substantiation of the predicted diamond resources;
- the correctness of estimates of the budgets of the Exploration Programs for the successful completion of the exploration programs, preparation of the mineral resource estimate (“MRE”) report in accordance with GKZ requirements, and for passing the State expert appraisal and registration of the reserves and resources in the State balance of the Russian Federation;
- assessment of the methodology of exploration and recommendations for its improvement, if necessary;
- assessment of the risk of reduction in the potential resources based on the available information and SRK ES’ experience in the diamond exploration;
- AGK's compliance with the terms and conditions of the license agreements.

1.2 Basis for the Technical Report

During the preparation of this Technical Report, the SRK ES works program included a review of the data provided by the Client and data collected by SRK ES from open sources. This Technical Report is prepared by SRK ES Moscow during the period from March to May 2019. The basis for the Technical Report is geological reports from the State Geological archive of the Russian Federation

("Rosgeolfond") which were obtained by SRK ES itself or provided by the Client. SRK ES has not performed any verification of the data from historical reports as well as data received from AGK and Polarctic Management and accepts these information as true at face value. The following sources of information were used in the preparation of this Technical Report:

- reports on diamond exploration, conducted by previous workers in different years on the Beenchime and Khatystakh license areas;
- AGK materials on diamond reconnaissance work, conducted by the Company in 2016 and 2017, including descriptions and coordinates of sampling points, photos of sampling and sample preparation procedures;
- AGK Exploration Programs aimed at studying the licences' potential and assessing the diamond mineral resources and potential resources in the Areas;
- sorting of diamonds, collected by AGK at the Beenchime and Khatystakh Areas during the reconnaissance works in 2016 and 2017, conducted by OJSC "Almazy Anabara" specialists;
- scientific publications devoted to the diamond exploration within the Yakitian kimberlite province;
- verbal discussions between SRK ES, AGK and Polarctic Management specialists;
- other information from open sources.

1.3 SRK professional reputation and specialist qualifications

The SRK Group of Companies (the "SRK Group") employs over 1400 professional employees, offering services in a wide range of engineering disciplines related to mineral resources, reserves and mining. The independence of the SRK Group is ensured by the fact that it holds no equity in any project and is wholly owned by its staff. These facts allow SRK to provide its clients with conflict-free and objective recommendations. SRK Group an established and proven track record in providing independent evaluations of Mineral Resources and Ore Reserves, assessment and audit of projects, Technical Reports and Independent Feasibility Study reports of projects in accordance with bank standards in the interests of junior and large mining companies and financial institutions worldwide. Working with a large number of international mining and exploration companies, the SRK Group has established itself as a company providing sought after consulting services to the global mining industry.

This Technical Report was prepared by SRK ES Chief Geologist Mikhail Tsypukov, FIMMM, Senior Geologist Grigory Kislyuchenko, and Geologist Alexander Frolov, under the supervision of James Gilbertson PGeo. By virtue of their education, membership in a recognized professional association, and relevant work experience, M. Tsypukov and J. Gilbertson are independent Competent Persons, as this term is defined by NI 43-101.

John Paul Hunt, Pr. Sci. Nat., FGSSA, SRK ES Senior Geologist - reviewer of the Report, in accordance with SRK ES internal procedures.

1.4 Field visit

While preparing this Technical Report, SRK ES did not visit the license areas. The report summarizes technical information available on the Beenchime and Khatystah projects as of May 2019, including the AGK exploration in 2016 and 2017.

1.5 Disclaimer

The opinion of SRK ES expressed herein is based on the information collected by SRK ES during the preparation of this Technical Report and SRK ES experience. The information reflects the technical and economic conditions at the time of preparation of this Technical Report

SRK ES is not an insider, associate, or affiliate of Polarctic Management or AGK, and neither SRK ES nor any SRK ES affiliate has acted as an advisor to Polarctic Management or AGK, their subsidiaries, or affiliates in connection with this project. The results of the technical review by SRK ES are not dependent on any prior agreements concerning the conclusions to be reached, nor are there any undisclosed understandings concerning any future business dealings.

2 Using the opinions of other experts

AGK provided to SRK ES' disposal all available data, including copies of reports, descriptions, and photo documentation on its own field studies, descriptions of sampling points, results of work, and publications by AGK specialists related to diamond-bearing magmatic and sedimentary formations. A list of reports and publications received by SRK ES for review is included to Chapter 13 of this Report. SRK ES takes into account the professional opinions and assessments of the authors of such reports and publications, and assumes that the geological descriptions, sampling volumes and other information contained in these publications are accurate, and the described studies had been conducted and results were obtained in reality.

Given the early-stage nature of the projects, the fact of random sampling and the presence of several opinions and author's assessments of the resource potential of the Areas, made during different study campaigns, SRK ES cannot confirm that the sampling, conducted during different campaigns, was representative and thus reflects the real potential of the Areas, and the conclusions of the authors of the reports are conclusive, unambiguous and correct.

3 The position and description of the Projects

The Licenses YAKU 05120 KP (Beenchime area) and YAKU 05120 KP (Khatystakh area) are located in the Far North of the Russian Federation, beyond the Arctic Circle, in the north-western part of the Republic of Sakha (Yakutia) (Fig. 3-1). The Beenchime area is located in the middle reach of the Beenchime River, a left tributary of the Olenek River. The Khatystakh area is located on the left bank of the lower reach of the Lena River. The northern (upper) part of the Beenchime license area (Pyropovy site) was previously a part of the Alrosa YAKU02878KP license (Sektelyakhskaya license), which had been issued for geological prospection for diamonds and was effective in the period 2010-2015. According to AGK, ALROSA company did not conduct any work on the Beenchime territory and focused its prospecting work in the Kuoyka and Sektalyakh river basins. The Khatystakh license area was previously part of the YAKU02580KP license of OJSC "Nizhne-Lenskoye" (Bulkurskaya license), which was in effect in the period 2007-2009 for prospecting for diamonds. The information on the Beenchime and Khatystakh Areas is presented in Table 3-1, Table 3-2 and Table 3-3.

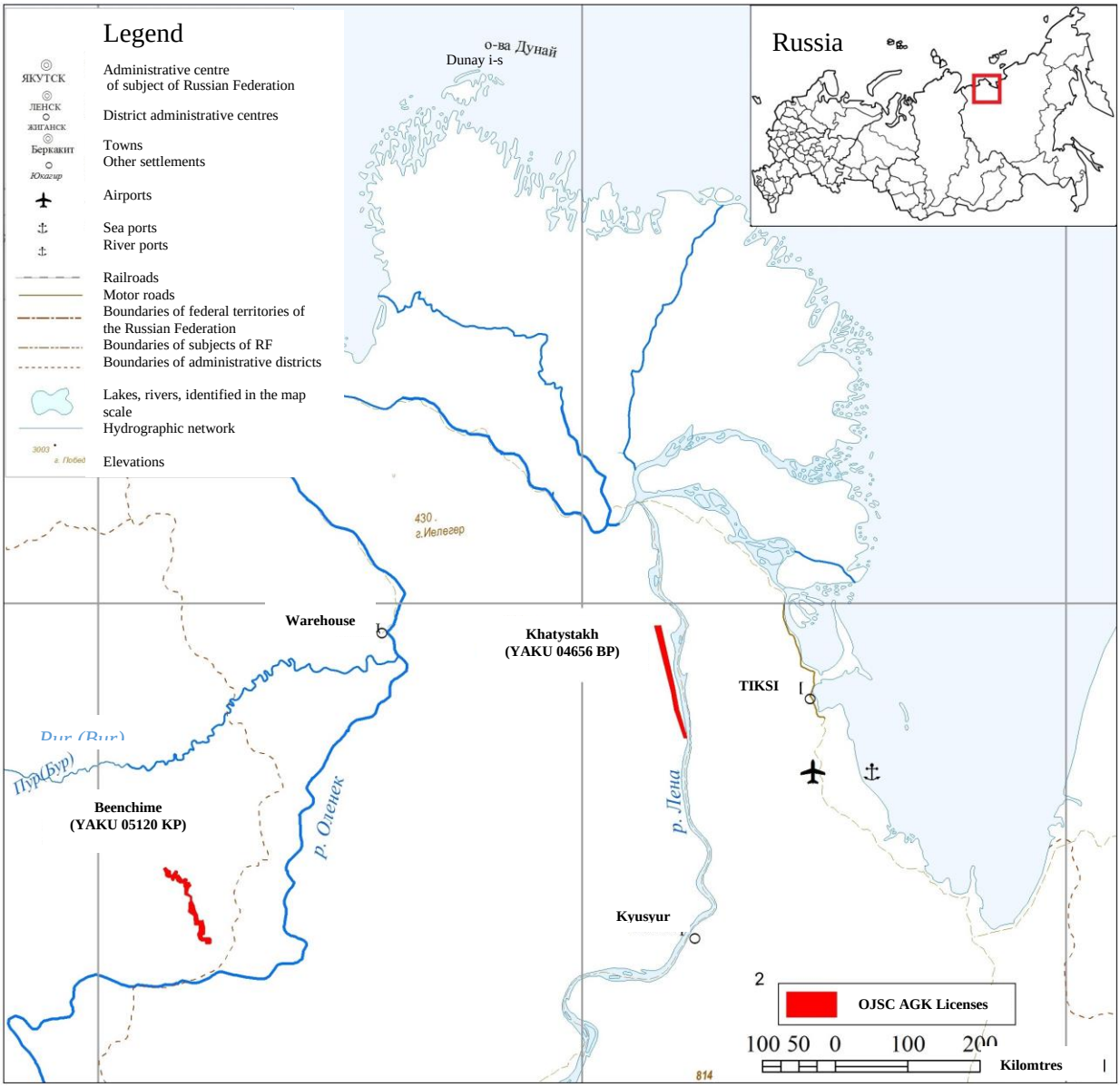

Fig. 3-1 AGK Licenses location plan

Table 3-1: Information on AGK license areas

License area	License Agreement number	Area covered, km2	Main mineral resource	Date of registration of the agreement	Date of expiration of the Agreement
Beenchime	YAKU 05120 KP	93.5	Diamonds, sands for diamonds	08.11.2016	30.11.2021
Khatystakh	YAKU 04656 BP	96.3	Diamonds	25.05.2016	31.05.2021

Table 3-2 The corner coordinates of Beenchime area

Corner points	Northern Latitude			East longitude				Corner points	Northern Latitude			East longitude		
	degr.	min.	sec.	degr.	min.	sec.			degr.	min.	sec.	degr.	min.	sec.
1	70	56	12.89	120	49	45.69		32	70	40	15.46	121	22	48.91
2	70	57	12.76	120	48	08.59		33	70	39	54.70	121	23	46.21

3	70	57	32.36	120	50	03.94		34	70	38	56.01	121	23	39.49
4	70	56	47.70	120	51	52.81		35	70	38	48.78	121	19	51.08
5	70	56	35.07	120	53	45.90		36	70	39	23.91	121	19	30.63
6	70	55	47.12	120	53	33.68		37	70	39	24.66	121	16	37.45
7	70	55	34.22	120	54	55.84		38	70	40	01.74	121	14	30.95
8	70	56	41.16	120	57	13.15		39	70	41	11.74	121	13	44.92
9	70	56	27.89	120	59	02.35		40	70	41	48.18	121	14	46.34
10	70	55	37.10	120	58	19.43		41	70	43	27.11	121	15	06.24
11	70	55	36.28	120	59	57.61		42	70	43	26.90	121	11	29.23
12	70	54	31.06	121	2	12.94		43	70	44	28.35	121	11	10.34
13	70	54	50.06	121	4	25.61		44	70	45	41.41	121	11	20.88
14	70	54	34.15	121	6	09.01		45	70	46	40.90	121	6	48.50
15	70	53	44.60	121	5	21.89		46	70	47	42.34	121	7	26.37
16	70	53	57.19	121	7	25.53		47	70	48	59.02	121	7	21.07
17	70	53	08.95	121	8	46.86		48	70	49	19.79	121	8	34.17
18	70	52	31.38	121	6	59.10		49	70	50	17.08	121	8	22.66
19	70	51	13.57	121	6	14.72		50	70	51	00.24	121	4	01.87
20	70	50	28.19	121	9	11.40		51	70	52	31.08	121	4	27.57
21	70	49	21.16	121	9	38.66		52	70	52	54.17	121	3	10.49
22	70	48	09.21	121	11	20.85		53	70	53	49.20	121	3	39.66
23	70	47	08.56	121	11	56.91		54	70	53	38.57	121	0	47.88
24	70	45	55.98	121	13	40.74		55	70	54	15.30	120	58	16.26
25	70	44	24.53	121	14	19.32		56	70	54	49.75	120	58	03.13
26	70	44	30.88	121	17	46.45		57	70	54	55.88	120	56	51.37
27	70	43	07.15	121	18	44.96		58	70	54	13.10	120	55	54.31
28	70	41	58.70	121	18	56.41		59	70	54	30.33	120	54	24.12
29	70	41	10.76	121	18	41.43		60	70	55	03.78	120	54	34.04
30	70	40	56.54	121	16	52.44		61	70	55	07.21	120	51	19.48
31	70	40	17.88	121	17	16.85		62	70	55	25.86	120	50	06.30

Table 3-3 Corner points of the Khatystakh Project

Corner points	Northern Latitude			East longitude		
	degr.	min.	sec.	degr.	min.	sec.
1	71	54	45.86	126	53	41.94
2	71	54	47.99	126	58	11.75
3	71	40	33.76	127	08	26.30
4	71	35	13.95	127	11	41.83
5	71	28	39.25	127	17	51.09
6	71	28	30.03	127	15	49.34
7	71	35	15.30	127	08	27.87
8	71	39	30.84	127	06	09.44

3.1 Terms and conditions of the License Agreement

The License agreements for the Beenchime and Khatystakh Areas allow the subsoil user to carry out the geological study of the subsoil, prospecting and assessment of mineral deposits, but do not give its license owner the preferential right for obtaining a mining license (the Law of the RF "On subsoil"). The Areas were issued to AGK on the declarative principle, since they do not contain tested P1-2 category potential resources, in accordance with the order N 583 of the Ministry of Natural Resources of the Russian Federation dated 10.11.2016.

Licenses of this type do not allow the subsoil user to conduct capital mining operations and commercial development of deposits. The License agreements were issued for a period of 5 years and may be extended at the initiative of the subsoil user, if necessary, until the completion of prospecting-assessment works (Article 10 of the Law of the Russian Federation "On Subsoil").

In accordance with the Russian legislation, the subsoil user independently determines the types and scopes of work for this type of licenses (the "Technical assignment" or "TA") and includes geological study of the Areas in the Works Program ("Works Program"); The Works Program is subject to approval by the State Committee of the Republic of Sakha (Yakutia) on Geology and Subsoil use (hereinafter "Goskomgeologia"). According to AGK, the Work Programs for the licensed Areas were approved by the Goskomgeologia of the Republic of Sakha (Yakutia) prior to commencement of the field work.

According to the information, contained on the websites of the Federal Agency for Subsoil Use "Rosnedra" ("Rosnedra") and Russian Geological Archives (Rosgeolfond), which is part of Rosnedra, as well as the information received from Polarctic Management, the Beenchime and Khatystakh licenses are valid as of the date of preparation of this Technical Report, there are no fines or complaints, and no lawsuits have been established that may potentially affect the Projects.

3.2 Permits and authorization

Geological studies of the subsoil without conducting capital mining operations and industrial development of deposits do not require additional permits and authorization.

4 Access, climate, local resources, infrastructure, physical-geographical conditions

4.1 Access

There are no settlements or communication lines at or near the Beenchime and Khatystakh Areas The nearest settlements to the Beenchime Project– the Siktyakh and Kyusyur villages, are located on the Lena River, 160 km south-east and 220 km east of the license area, respectively. Tiksi urban-type settlement, the administrative centre of Bulunsky Ulus, is located in 290 km north-east of the license (described below).

The Khatystakh Project is in the Arctic zone of Russian Federation. The nearest settlements from the Khatystakh area – Tiksi urban-type settlement and the Kyusyur village are located 60 km to the east and 100 km to the south, respectively. Tiksi urban-type village with a population of 4,537 people (2018) - the administrative centre of Bulunsky ulus, is located on the Laptev Sea shore, in the Tiksi and Neyolov bays, east of the mouth of the Lena River. The village has an airport, designed for landing and taking-off of all types of airplanes, and a seaport. Kyusyur village, with a population of some 1,345 people (2010), is located on the right bank of the Lena River.

4.2 Local resources and infrastructure

The Beenchime Project is located in the territory of Oleneksky ulus. Oleneksky ulus covers an area of 317,900 km^2 and is scarcely populated – 4 settlements of the ulus include 4,072 people (2018). No labour resources and infrastructure are available in the work areas. The local population of the ulus is engaged in reindeer breeding, fishing and hunting. The closest waterway to the Beenchime area is the Olenek river, which is navigable for sea ships to Taymylyr village. It is possible to use small auto-boats - water jets or motorboats to transport small cargo batches along the Olenek river tributaries, including the Beenchime river.

The Khatystakh Project is located in the territory of Bulunskiy ulus. Bulunsky ulus covers some 235,100 km2 area and is sparsely populated - 10 settlements with about 8,339 people (2018). The Khatystakh area is located on the left bank of the Lena River, at a distance of several hundred meters to 3 km from the riverbed. During the navigation period (end of May - end of October), freight and personnel can be transported to the site along the Lena River.

Helicopters are the most commonly used type of transport in the Arctic. As an option, light aircraft such as AN-2 can be used, which can land on river bars with dense soil. Deer transport is also used. In winter, it is possible to use winter roads for the delivery of goods and personnel.

4.3 Climate

The region is characterized by a sharply continental climate with long winters and short cool summers, wide range of annual and daily temperature fluctuations. The duration of the period with negative temperatures is 9 months, from September to May. The lowest temperatures are observed in December-January and reach -40-50°. Above-zero temperatures are observed from mid-June to mid-September, the average temperature of the summer period is +8 - +10°. Frosts are frequent in the summer. In winter, strong winds are often observed, up to 20 meters/second (“m/s”).

The warmest month is July when the air temperature can reach +25° and above. Snow cover forms in the third week of September and melts in the second half of June. Its thickness builds up (up to 0.5 – 1.5 m) slowly, reaching a maximum by April. The ice thickness on rivers and lakes in winter is 1.0-2.0 m (the average thickness is 0.8 m). Usually, the melting of snow begins in early June and the snow cover is lost within 10-15 days. The annual amount of precipitation does not exceed 250-300 mm, most of the precipitation falls in the summer.

Permafrost is developed in region. Thawing of the soil in summer occurs to a depth of 0.6-1.5 m (averaging in 0.8 m) and depends on the slope exposure, the lithological composition of the rocks that compose the slopes, the vegetation cover and the water content of the soil. The deepest thawing of soils is observed on the slopes that are exposed to the south, in places where there is no vegetation cover. The thickness of permafrost rocks reaches 400 m.

4.4 Physical-geographical conditions

4.4.1 The Beenchime area

The Beenchime license area is located within a hilly trappean plateau on the north-eastern edge of the Central Siberian Highlands. The absolute elevations of the valleys are 45-50 m above mean sea level (AMSL). The highest elevation is the Trappovaya bald peak (334 m AMSL), the elevation difference is 250-280 m.

The exposure of the area is from poor to satisfactory. The bedrock outcrops are developed on the sides of the Beenchime River. Watershed spaces are often covered with boulder placers - the debris flows. Thermakarst origin lakes can be found in watersheds, while crescent lakes occur in the Beenchime river valley.

The vegetation of the area is represented by sparse woodlands and the tundra zone vegetation with thickets of Dahurian larch, dwarf birches, and alder, with tussock bogs and moss cover. March elder can be found in the valleys.

The fauna of the work area is typical of polar conditions. Fishing is developed around the Lena River and its tributaries, where a large number of valuable wild-capture fish are caught, including sturgeon, Siberian white salmon, omul, European cisco, muksun, danube salmon and broad whitefish.

Fig. 4-1 The Beenchime River (photo by Dmitry Yakovlev, Institute of Geochemistry SB RAS)

4.4.2 The Khatystakh area

The Khatystakh area is located on the eastern spurs of the Chekanovsky Ridge. From the orographic point of view, the area is a plateau with northerly-oriented cuesta ridges and absolute elevations from 20 to 238 m. The exposure of the area is from poor to satisfactory. Bedrock outcrops are found in the valleys of the Bulkur and Khatystakh rivers, along the left bank of the Lena River. The watershed surfaces are covered with boulder-gravelly scree.

The Lena River is navigable for all classes of vessels. The water regime of the river is variable, the maximum water rise of 8 -14 m is observed during the spring flood (mid-June), the second water rise occurs in late July - early August during the period of heavy rains and maximum thawing of soils. Freeze-up occurs in October, and icebreaking occurs in mid-June. The Khatystakh and Bulkur rivers, and a large number of lakes, whose waters are characterized by extremely low mineralization and can be used for domestic and operating needs, are located within the license area. There are favourable conditions for the economic development of the Khatystakh area, for, the navigable Lena river runs within a few kilometres. Most of the cargo that ensures the life of the region is transported along this river. The flora and fauna of the area is typical of the tundra zone.

Fig. 4-2 Khatystakh river valley (photo by Sergey Mulivanov, www.wikznanie.ru)

5 Historical Exploration

In the early 1940s, VSEGEI geologists V.S. Sobolev and G.G. Moor first suggested the geological similarity of the Siberian Platform to the South African Platform, where diamond-bearing placers and kimberlite pipes have been known since the 1860s. (Moore, Sobolev, 1957; De Wit, 1996). Already the initial prospecting work in 1948-1949 led to the discovery of the Sokolinaya bar placer in the middle reaches of the Vilyuy river in 1949 (G.H. Faynstein, M. M. Odintsov). In the Arctic zone of the North-East of the Siberian Platform the first diamond was found in 1951 on the Delkan River of the Khatanga River basin, Krasnoyarsk Krai. During the work conducted a little later and covered the north-west of the Republic of Sakha (Yakutia), the Anabar diamondiferous area was discovered with large and unique diamond placers.

All the main hard rock diamond deposits - Zarnitsa, Mir, Udachnaya, etc., associated with outcropping kimberlite pipes were identified in the first years of studies, in 1954-1956.

Currently, the Yakitia Diamond-bearing Province ("YDBP") is the largest province in Russia for the amount of the diamonds mined. In addition to it, the Arkhangelsk and Ural diamond provinces are also known.

PJSC AK ALROSA (“Alrosa”), the world's largest public company in the diamond sector, whose securities are traded on the Moscow Exchange (ALRS), mines most of the Russian diamond production (90%). 34% of the company shares are freely traded, while the Russian Federation owns 33% of its shareholding (www.alrosa.ru). Alrosa owns of five mining-processing plants (MPP) that process the hard rock ores and associated placers – Aykhalsky, Mirninsky, Nyurbinsky, Udachninsky, Lomonosovsky and OJSC "Almazy Anabara", which is specialized in the development of diamond placers. After the merger of OJSC "Nizhne-Lenskoe" in 2015, PJSC "AK ALROSA" is a monopoly on diamond mining in the territory of the Republic of Sakha (Yakutia).

The State balance of mineral reserves of the Russian Federation registered 79 diamond deposits, including 24 hard rock and 55 placer deposits. Of these, 70 deposits contain commercial reserves (State and use of..., 2018).

OJSC Almazy Anabara conducts successful prospecting for new placer diamond deposits and holds three licenses for geological study and assessment of deposits, and another ten licenses for exploration and mining. Currently, the company is developing the Molodo (Bulunsky ulus), Bolshaya Kuonamka, Khara-Mas (Oleneksky ulus), Ebelyakh, the Pravoberezhye Morgogora, Kholomolokh placers, tributaries of the Billyakh River (Anabar ulus) (http://alanab.ykt.ru). The sands are processed

at the Molodo and Mayat placer mines. The Mayat placer mine includes 4 rotational man camps, with a total housing capacity of 1,200 people. The placer mine has 20 seasonal sorting plants and 4 recovery workshops (Condition and use of..., 2018). One (1) rotational man camp, with a housing capacity of 450 people, 3 sorting complexes, and 1 recovery workshop are operated at the Molodo placer. The placer mines are powered by stand-alone diesel power plants. In 2018, OJSC "Almazy Anabara" mined 5,457 million carats of diamonds.

The diamonds produced at the ALROSA Group's processing plants are delivered to the Diamond Sorting Centres in Mirny and Arkhangelsk towns, where diamonds are separated by grain size classes, and the specialists run a preliminary valuation of diamonds. The Single Marketing Organization ("ESO ALROSA") in Moscow and the Yakitia Diamond Trading Company ("YAPTA") conduct the final sorting and valuation of diamonds, according to the price list of the Ministry of Finance of the Russian Federation. Industrial quality diamonds are sent to "Kommeral", a subsidiary of the ALROSA Group in Mirny, where they are partially used for the production of grinding powders. After valuation, the gem-quality diamonds from various deposits are mixed and divided into "boxes" according to similar properties (Condition and use of..., 2018).

5.1 The Beenchime area

The Yakitia Territorial Geological Administration (“TGA”) began to study the diamond potential of the lower part of the Olenek River basin in 1957. According to the results of the 1:200,000 scale aeromagnetic surveys., the first kimberlite pipes were identified in the Beenchime and Kuoyki river basins (Gutorovich et al., 1957). The diamond content of the alluvium from the Kuoyka, Beenchime, and Kelimer rivers was established during the surface prospecting works. According to the results of the heavy mineral concentrate sampling and small-volume sampling, a potential Pyropovy area was identified in the middle course of the Beenchime River, where the diamond grade in two alluvium samples was 1.01 and 0.89 ct/m^3 (Zimin, 1961). Due to the high alluvium thickness (> 2 m), the lower, more productive horizons of the placer could not be sampled. The potential diamond resources of the Beenchime River basin were estimated at 47.6 million carats at the average grade of 0.72 ct/m^3 (Zimin, 1961).

The geomorphology and Quaternary sediments of the area were studied (Mitt, Boyarsky, 1959; Mitt, 1960) and a 1:200 000 scale geological survey was conducted (Tseidler, Pokrovsky, 1961) in the same years.

The 1959-1961 works at the 129 km long Beenchime River valley area, which hosts the AGK license area, included a total of 20 prospecting-exploration test-pits and trenches that cross the riverbed, floodplain, and terraces (Kruchek, 1962). For the purpose of assessing the diamond content of the alluvial sediments, the test-pits were developed to the bedrock, the sedimentary cross-section and the diamond grades were studied in various facies. It was established that the kimberlite indicator-minerals ("KIM") and diamonds are concentrated in pebbles, the highest diamond grade was found in the Pyropovy site, which is located in the upper part of the Beenchime license area. The lower area of the Beenchime River valley is noted for the lowest diamond grades in pebbles, which averaged at 0.03 ct/m^3. According to the results, the diamond content at the Pyropovy site, on average in the riverbed was 0,82 ct/m^3, and in test-pits in the floodplain along line 3 the average diamond content was 1.24 ct/m^3. In general, the placer was classified as a non-commercial property due to the low content on most lines. It was concluded that the intermediate reservoirs – Jurassic, Cretaceous and Quaternary conglomerates, gravel beds, pebbles and pebbly sands, bedded on the ancient terraces of the Lena, Olenek, Kuyoka, and Anabar rivers, were the sources of diamonds and KIMs in the placers of the area (Kruchek, 1962).

In 1967 and in 1979, YTA conducted a 1:200 000 scale gravimetric survey (Adamov et al., 1967; Istomin, Lytkin, 1980) in order to conduct tectonic zoning of the territory and delineation of local areas for the prospecting for kimberlite-hosted diamonds.

In 1977, a 1:25 000 scale aeromagnetic survey was performed in the Beenchime River basin (Sorokin et al., 1977). According to the results of this survey, some 41 kimberlite-derived aeromagnetic anomalies were identified, which were tested in subsequent years.

The ground-based prospecting for alluvial and hard-rock diamond deposits in the Beenchime River basin resumed in 1978 (Nikolaev, 1978). According to the results of the work, the new kimberlite pipes which were identified did not contain diamonds. In one of the large-volume alluvium samples

(14.35 m^3), collected at the Olenek River, 30 km above the mouth of the Beenchime River, 17 diamonds were found with a total weight of 769.9 mg, at the average grade of 0.27 ct/m^3.

In 1980, the prospecting was continued in the lower reaches of the Beenchime and Kuoyka rivers (Nikolaev et al., 1980). Ground-based verification of aeromagnetic anomalies allowed the identification of new kimberlite pipes and dikes. In 7 kimberlite bodies - Noyabrskaya, Pervomayskaya, Skif-2, Poiskovaya, Velikan-2, Dyanga, Zhila-79, the diamond contents varied between 0.01-0.05 ct/m^3. According to the results of the work, due to the low diamond grades in the samples, the Beenchime River basin was qualified as having no economic potential, notwithstanding the fact that a large number of heavy mineral concentrate sampling anomalies and aeromagnetic anomalies had not been studied. Later on, I.M. Ostashkin and colleagues (Ostashkin et al., 1990), who identified new kimberlite bodies and small placers with low diamond contents, came to the same opinion.

In 1994, A.V. Manakov and his colleagues conducted prospecting works for diamonds near the northern border of the Beenchime license area (Manakov et al., 1994). They established an increased diamond content in modern alluvium and Neogene sediments, but no commercial diamond concentrations were established.

In 1999, M. Y. Folisevich and his colleagues conducted sampling of various types of sediments in the middle and lower reaches of the Beenchime River, but small-volume sampling data did not result in discovery of high diamond concentrations (Folisevich et al., 1999). Ten (10) diamond crystals were extracted with a total weight of 296.8 mg from four bulk samples ranging from 2.4 to 7.1 m^3, which had been collected from the license area. The maximum content of 0.15 ct/m^3 was identified in the low reaches of the Ulakhan-Yuryakh creek (Beenchime license Area).

In 2013, JSC “Nizhne-Lenskoye” conducted prospecting for diamonds in the Beenchime River basin (Grakhanov, 2013). In the north of the license area, the diamond-content of the basal horizons of the Jurassic sediments was confirmed. At the Pyropovy site, 5 small-volume samples were collected, and 8 diamonds were extracted from these samples. Seventy-eight (78) diamond crystals were extracted from the 17.1 m^3 large-volume sample at the average grade of 0.41 ct/m^3. Taking into account the crystallomorphological features of diamonds and their average weight, a conclusion was made that the cost of raw materials would be too high with the average productivity rate of the Beenchime placer.

5.2 The Khatystakh area

Systematic geological studies at the Lena and Olenek interfluve area began in the second half of the 1940s, after the establishment of the Arktikrasvedka (Arctic Exploration) Trust (1945), the Research Institute of Arctic Geology (NIIGA, 1948), the Amakinsky Expedition (1947), and the Central Aerogeological Expedition (VAGT, 1947). Starting from 1980, during specialized prospecting works for diamonds, some diamond placer occurrences, associated with Late Triassic Carnian horizon basal sediments were discovered and studied in the western and eastern flanks of the Tuorasissky uplift (Sibirtsev et al., 1982; 1985). As a result of the study of typomorphic features, it was indicated that the Carnian horizon basal horizon diamonds and KIMs are close to those from the Ebelyakh placer field. The method of prospecting for the productive Carnian formation was developed to include litho-facial, mineralogical, palaeontological, geophysical, and remote-sensing study methods. According to the results, 4 potential areas - Bulgur, Taas-Ary, Ulanakh-Aljarkhay and Alkhovy zones were identified in the lower reaches of the Lena River, where a diamond containing Carnian horizon outcrops in the core of anticlinal folds. Based on the data from surface mining workings, some increased diamond concentrations were identified at the Bulkur and Taas-Ary sites for over 12 km and 9 km length, respectively. These sites were recommended for conducting prospecting-assessment works. The Bulkur site is part of the Khatystakh license area, which is owned by AGK.

Prospecting works and the study of the Carnian horizon continued in 2007 (Grakhanov, 2009), when OJSC Nizhne-Lenskoye obtained a license for geological study, which included the Khatystakh area (Fig. 11-1). The works were conducted in 2008 and 2009 and included heavy mineral concentration sampling and low-volume sampling, bulk sampling, trenching and drilling of 5 boreholes along 1 profile across striking of the Carnian productive horizon at 10 m spacing between the boreholes. The drilling intersected a diamond-productive horizon in three of the five boreholes (Fig. 5-1) and where the average thickness was 0.5 m (verbal information from S.A. Grechanov). In addition, the productive stratum was also checked by trench sampling. The results of the bulk sampling are given in Table 5-1.

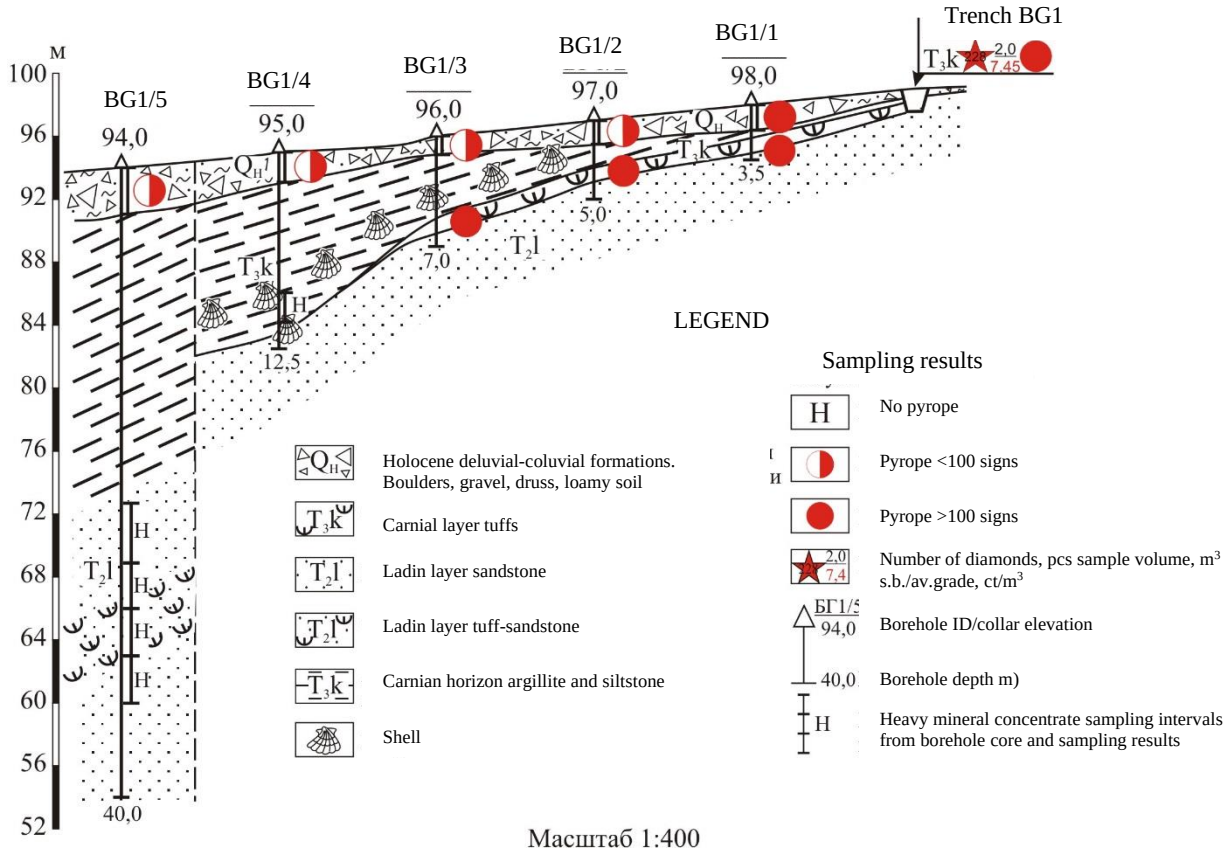

Fig. 5-1 Drilling profile, which penetrated the Cranian layer in the Khatystakh area, drilled in 2011 (from archives of S.A. Grakhanov).

Table 5-1 The results of the bulk sampling at the Bulkur site (Grakhanov, 2009).

NN	sample ID	Volume, (s.b.), m³*	Diamonds extracted		Average content in the sample, ct/m³
			quantity, pcs	weight, mg	
1	5013	0.15	40	390.0	13.00
2	5014	0.36	29	82.0	1.13
3	5014/1	0.36	25	43.0	0.60
4	5015	0.3	1	2.0	0.03
5	5015/1	0.29	10	40.0	0.69
6	5019	0.04	-	-	-
7	5020	0.29	8	164.0	2.83
8	5029	2.5	403	6317.1	12.63
Totals:		4.29	516	7038.1	8.20

Note: s.b. – "solid body"; for the purpose of determining the diamond grades in the productive horizon, the volume of samples in the unconsolidated state ("u.m." or "unconsolidated mass"), measured by a measuring bucket, was converted into the solid body ("s.b.") by applying the unconsolidation coefficient of 1.4 using the formula s.b.=u.m./1.4.

According to the results of the work carried out by the historical prospectors, it was established that the diamond productive basal sediments of the Osipai Suite of the Upper Triassic Carnian horizon are bedded on the Middle Triassic Ladin continental sandstones of the Tuus-Balyk package. The productive stratum is characterized by a complex composition and facies variability, and its thickness is also extremely variable. Even within one outcrop or trench, the thickness ranges from

0.0 to 1.0 m. The main lithological components of the formation are tuffs, tuffites, tuff-gravelites, tuff-conglomerates, gravelites, conglomerates that are cemented at various degree, and rarely boulder conglomerates. (Sibirtsev et al., 1982; 1985; Grakhanov et al., 2009; 2013). Due to the variability of the productive Carnian horizon and the low diamond value, OJSC Nizhne-Lenskoye did not add the Khatystakh site to its assets (verbal information from S. A. Grechanov).

6 Geological conditions and mineralization

6.1 Regional geology

The Beenchime and Khatystakh license areas are located in the north-eastern part of the Yakitia diamond-bearing Province ("YDBP"), which takes up the north-eastern part of the Siberian Platform and stretches for 1,500 km from south to north, at a width of up to 1,000 km (Fig. 6-1). In the north, the Leno-Anabar deflection is the boundary of the YDBP, in the east and southeast, the Angara-Vilyuisky deflection is the same, and both are the boundaries of the Siberian platform at the same time. In the west, the province extends to the eastern slope of the Tunguska syncline. The territory of the YDBP is poorly studied as about 60% of the YDBP area is covered by overburden, where kimberlite bodies are capped by a complex of terrigenous-magmatic formations.

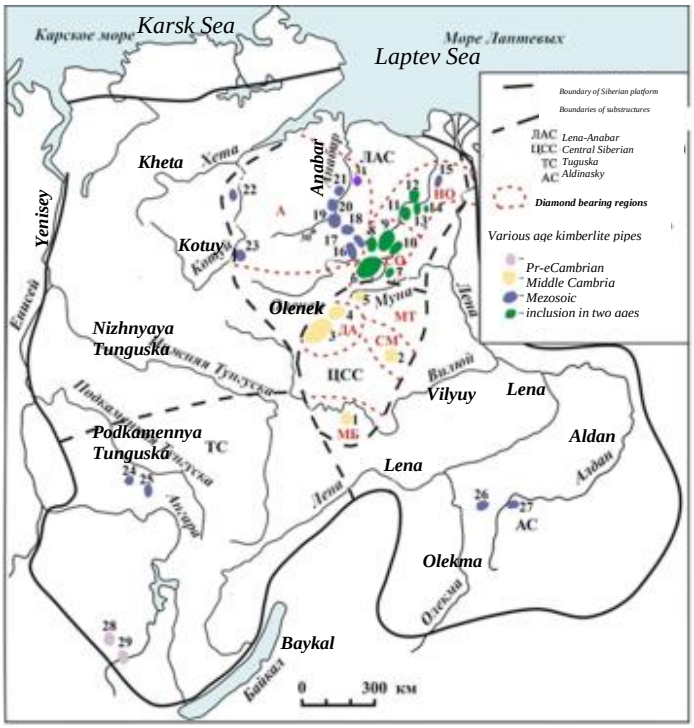

Fig. 6-1 Yakitia diamond-bearing province (http://science.ykt.ru)

A crystalline basement and a sedimentary cover are identified in the structure of the platform. The basement of the Siberian platform consists of deeply metamorphosed Archean and Early Proterozoic rocks and outcrops at surface within the Anabar massif and Oleneksky uplift, in the south-west of the AGK license areas and along the periphery of the platform. The platform cap includes sedimentary and magmatic formations from the Late Riphean to the Mesozoic inclusively. The sedimentary cap consists of two formational layers - the lower one, which is composed of Riphean-Vendian and Cambrian formations, and the upper layer, represented by the Upper Palaeozoic (Permian) and Mesozoic rocks.

Within the YDBP, there are more than 1,000 kimberlite pipes that combine to form kimberlite fields and clusters, which are controlled by deep fault systems. According to various researchers, the number of kimberlite fields varies from 15 to 25, each covering an area from 130 to 4,500 km2.

(Kolganov, 2011; Grakhanov, 2015). Most of the diamond-bearing pipes and placers are capped by sedimentary deposits and volcanics. Kimberlite pipes penetrate through the crystalline basement of the platform and the sedimentary cap rocks and are located within the regional uplifts. Most of the diamond-bearing kimberlite bodies correspond to the Late Devonian stage emplacement (350-370 Ma), including the Verkhnemunsky, Mirninsky, Nakynsky, Daldynsky and Alakit-Markhinsky fields in the southern part of the province. In addition, Late Silurian-Early Devonian (430-400 Ma), Triassic (230-270 Ma), Jurassic (about 150 Ma), and possibly Cretaceous (about 140 Ma) stages have been distinguished (Shamshina, 1986; Agashev, 2004; Grakhanov et al., 2007; Pokhilenko, 2011; Afanasyev, 2018). While there are many commercial placer deposits, the northern part of the province is characterised by kimberlite fields with kimberlite bodies which are non-diamondiferous or with low-diamond contents (Grakhanov et al., 2007).

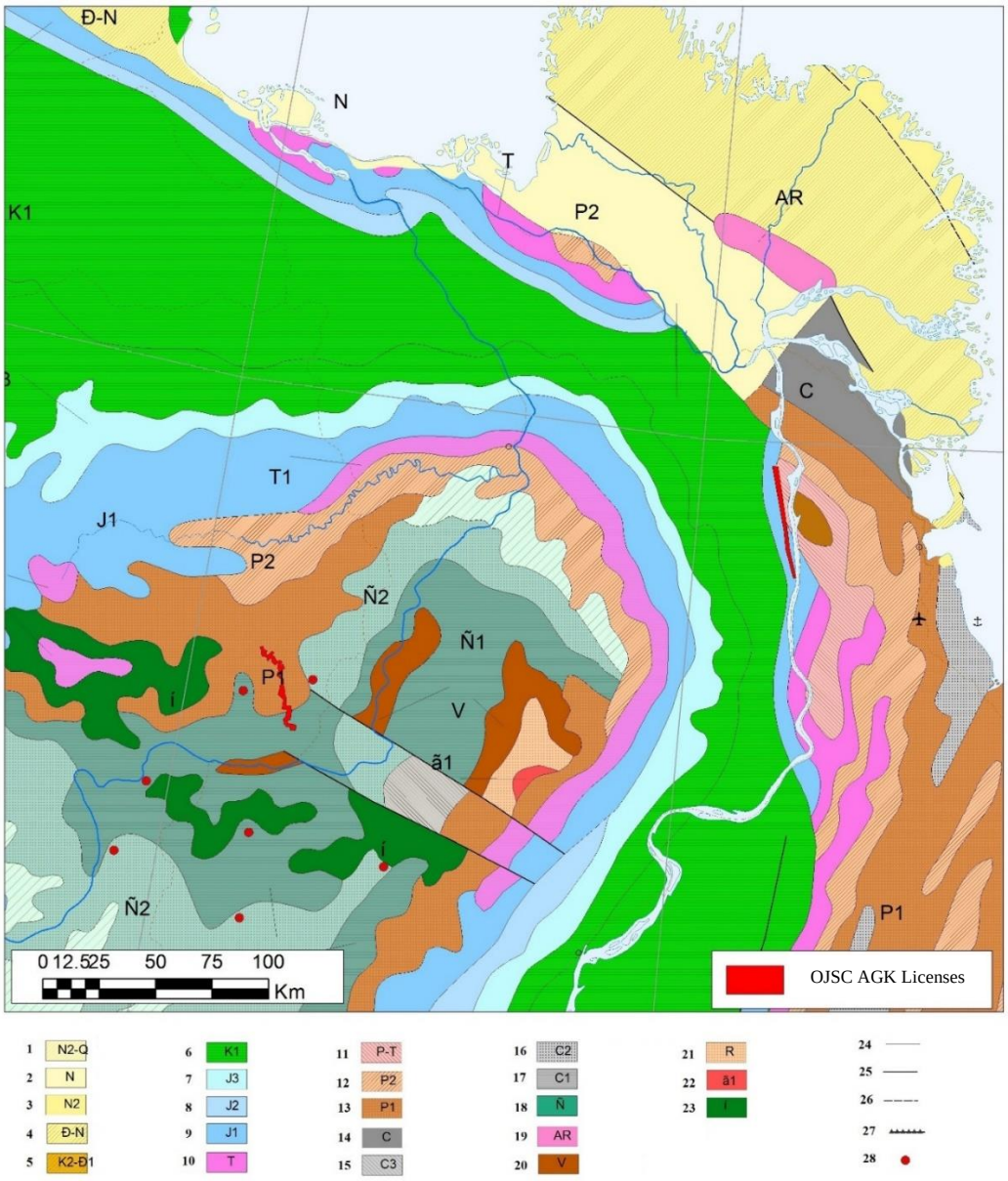

Fig. 6-2 Geological map of the north-eastern part of the Yakutia diamond province

Note: 1 - Pliocene-Quaternary deposits; 2 - Neogene; 3 - Pliocene; 4 - Paleogene-Neogene; 5 - Upper Cretaceous - Palaeocene; 6 - Cretaceous system, lower section; 7-9 - Jurassic system: 7 - Upper section; 8 - Middle section; 9 - Lower section; 10 - Triassic system; 11 - Permian-Triassic; 12-13 -

Permian system: 12 - Upper section; 13 - Lower section; 14-17 - Carboniferous system: 14 - undivided; 15 - upper section; 16 - middle section; 17 - lower section; 18 - Cambrian system; 19 - Archean system; 20 - Vendina; 21 - Riphean; 22-23 - intrusive rocks: 22 - Precambrian; 23 - main; 24 - geological boundaries; 25 - faults on surface; 26 - faults in the bottom of water areas; 27 - large astroblemes in a scale; 28 - kimberlite pipes.

6.2 Geology of the licence areas

6.2.1 The Beenchime area

The sedimentary formations of the Kessyusinsk Suite (V-Є$_1$ks), composed of greenish and variegated quartz and oligomictic siltstone, sandstone with interlayers of marl, limestone, dolomite, and calcareous conglomerates, are the oldest rocks that are exposed in the work area. Different authors estimated the thickness of the Suite at 50-60 m (Kruchik, 1962) and 115-120 m (Folisevich et al., 2000). The carbonate formations of the Yerkeket Suite of the Lower Cambrian (Є$_1$er) are bedded higher up with an angular unconformity. This suite is represented by conglomerates, yellowish-grey limestone and brick-red marls, with a total thickness of 110-155 m.

The Permian terrigenous deposits that occur on Cambrian rocks with angular unconformity continue this section. They are represented by the interlayering of sandstones, conglomerates, siltstones, argillites and grey colour clays, which contain lenses and layers of coal and carbonaceous plant detritus. The total thickness of the Permian deposits is 300-350 m.

The Early Triassic volcanogenic complex (T_1) is widely developed along the left bank of the Beenchime River. The volcanics are confined to an intense basaltic magmatism zone, located in the interfluve of the Beenchime and Kuyoka rivers. The complex is represented by massive dolerite and dolerite porphyrite tuffs with rare small-thickness inclusions of rapidly wedging lenses of tuffite and tuffaceous sandstone. Tuffs are bedded on the uneven (pocketed) eroded surface of Permian sandstones and are broken by numerous subvolcanic stocks, sills, veins and dikes of basaltic composition. The tuff thickness reaches 200 m.

In the work area, the Mesozoic deposits are represented by the Lower Jurassic deposits (Kruchek, 1962), which are bedded unconformably on the eroded surface of the Palaeozoic. The deposits are combined into 2 suites – predominantly a sandy lower suite and a siltstone upper suite. The rocks contain lenses of limestone and carbonaceous plant detritus. The thickness of the Jurassic sediments is 450-480 m.
In the direct vicinity of the Beenchime site, eight Kuoysko-Molodinsky kimberlite field kimberlite pipes were found - the Vechernyaya, Noyabrskaya, Sargylana, Irina, Tokur, Muza etc., pipes. In plan view, the kimberlite bodies have a rounded-elongated shape, with sizes from 5 x 3 m^2 to 100 x 200 m^2, and form the north-easterly-oriented clusters. The kimberlites have low diamond contents (0.01-0.05 ct/m^3) or do not contain diamonds. The host rocks are Cambrian-aged carbonate deposits. The structure of the kimberlite bodies consists of alnöites, kimberlite breccias with a massive cement texture, and autolith kimberlite breccias. The age of the kimberlite formations in the middle reaches of the Beenchime River are dated at Middle-Late Jurassic (Brakhvogel, 1984). The kimberlite bodies of the Beenchime River basin are controlled by sub-latitudinal and north-western striking fault systems.

Several types of Quaternary sediments are identified in the Beenchime River basin. Among these, the lake-lagoon sediments, lake- and fluvio-glacial sediments, and alluvial sediments are distinguished. The alluvial deposits represent practical interest in terms of diamond content. The maximum diamond grades are observed in the riverbed and bar alluvium (QIV). The composition of the riverbed and bar alluvium is identical with predominance of variegated composition pebble-boulder material, with the thickness being up to 5.0 m.

The recovery of the heavy fraction from the bar and riverbed alluvium into grain size class -2.0 mm is 0.25 kg/m3 on average. Magnetite, almandine-pyrope, ilmenite, rutile, zircon, picroilmenite, and chromite are dominant in the composition of the fraction. Olivine is observed rarely. The grades of pyrope and ilmenite are highest in the diamond-bearing streams. The highest concentrations of diamond indicator minerals and diamonds are concentrated in the head parts of the bars.

According to research work, conducted at the ALROSA's Scientific and research geological company (NIGP ALROSA), the Beenchime river diamond placers have the typical "northern" look (nature) but,

in contrast to diamonds of the Ebelyakh placer, their average weights are higher. In addition, among them, the content of the fifth and seventh varieties of technical raw materials is low and the content of gem-type crystals (laminar and Ural types) is fairly high – 60.1%. On this indicator, diamonds of the Beenchime placer are close to the Molodo and Bolshaya Kuonamka placers, where the share of gem-quality diamonds is respectively of 73.2 and 72.8% and differ from Ebelyakh placer, where the share of gem-type stones is 30.3% (Koptil et al., 1978, Grakhanov et al., 2013).

Table 6-1 Granulometric composition of diamonds from placers in the north-east of the Yakitia diamond-bearing province (Koptil et al., 1978)

Placers	Total studied		Aver. weight, mg	Quantity / Weight (%)			
	pc.	mg		-8 +4 mm	-4 +2 mm	-2 +1 mm	-1 +0.5 mm
Beenchime	513	12300	24.0	0.8/9.9	25.0/61.5	66.2/27.8	8.0/0.8
Ebelyakh	95177	1909008	19.9	0.7/10.7	20.8/56.7	61.9/31.1	16.6/1.5
Molodo	3086	80773	26.3	1.5/16.5	28.2/62.0	53.5/20.4	16.8/1.1

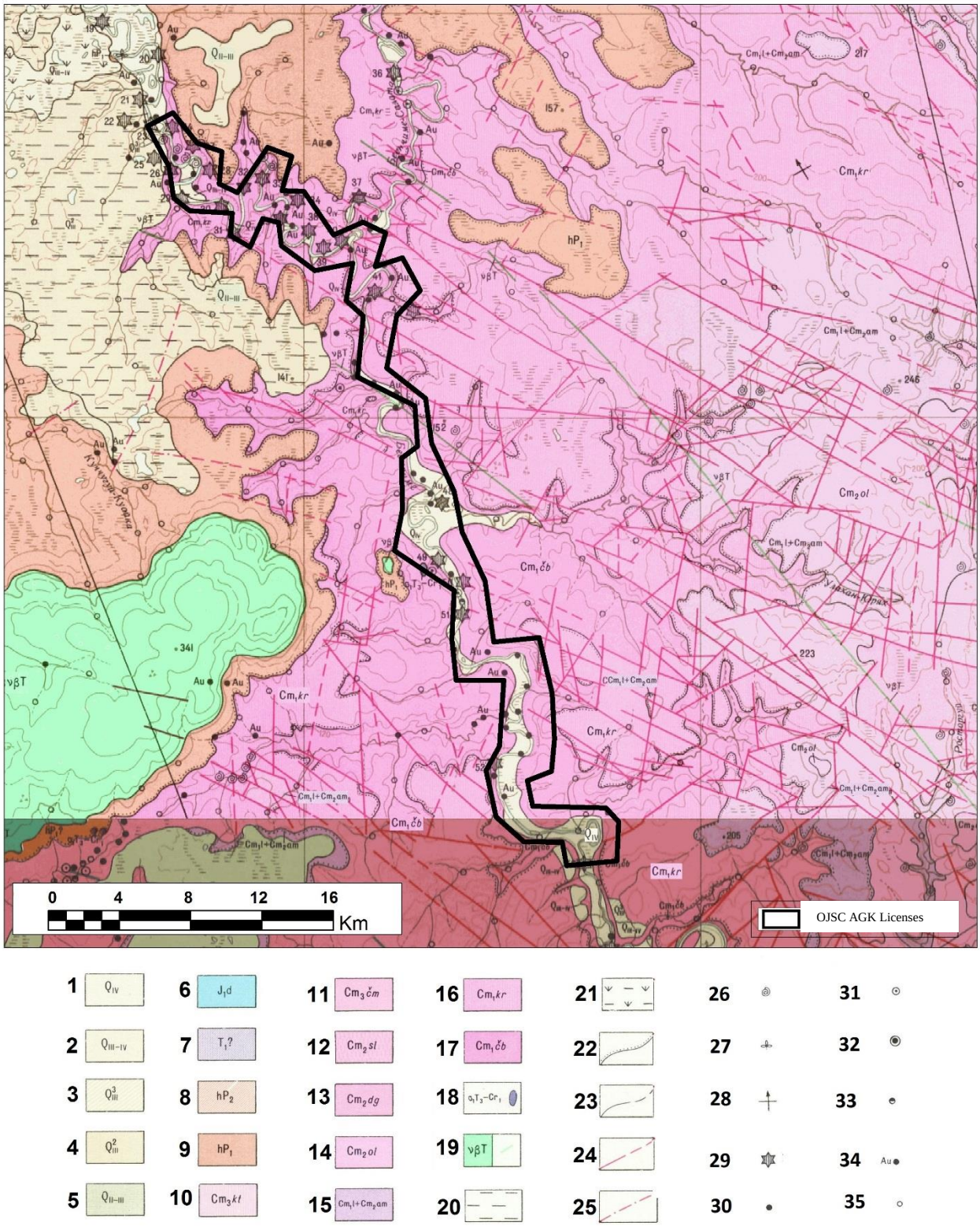

Fig. 6-3 The geological structure of the Beenchime area

Note: 1-5 - the Quaternary system: modern alluvial, lacustrine-alluvial, lacustrine-marsh and fluvioglacial deposits; 6 - Jurassic system, lower section: sands, sandstones, limestones and conglomerates; 7 - Triassic system, lower section: tuffs and tuffaceous sandstones; 8-9 Permian system: 8 - upper section: sandstones, siltstones, shale, clay; 9 - lower section: sandstones, siltstones,

coals; 10-17 - Cambrian system: 10-11 - upper section: limestone, shale; 12-14 - middle section: limestone, marl; 15-17 - lower section: limestone, clayey siltstones, sandstones; 18 - Mesozoic kimberlites; 19 - Mesozoic sills and dolerite dykes; 20 - Quaternary lacustrine and alluvial deposits; 21 - Quaternary lacustrine-swamp deposits; 22 - boundaries of non-conformant bedding; 23 - boundaries of normal contact; 24 - line of confirmed and assumed tectonic contact; 25 - concealed faults; 26 - accumulation places of fossil fauna; 27 - places of remnants of the fossil flora; 28 - flat bedding of the layers; 29 - rare diamond crystals in placers; 30 - 35 heavy mineral concentration samples that contain: 30, from 1 to 20 grains of pyrope; 31 - from 20 to 100 grains of pyrope; 32 - more than 100 grains of pyrope; 33 - grains of chrome-diopside; 34 - traces of gold; 35 - barren.

6.2.2 The Khatystakh area

The Khatystakh license area is located in the western wing of the Bulkur anticline, where the Triassic, Jurassic and Cretaceous system formations are developed (Fig. 6-4). The Carnian horizon Osipay Suite Mesozoic deposits of the Upper Triassic are discussed below. They are of interest in terms of diamond content.

The Carnian horizon Osipay Suite deposits of the Upper Triassic can be traced from Eastern Taimyr to the east along the entire coast of the Laptev Sea. The suite was exposed by mine workings and in natural outcrops and is bedded unconformably on previously formed sediments. For the greater part of this territory, the Osipay Suite rock formation conditions are defined as coastal-maritime. The thickness of the suite is 20-60 m and increases to the south-east. At its base, there is a horizon of volcanogenic-sedimentary origin ("Carnian horizon" or "productive horizon"), which contains tuffs, tuffites, tuffogravelites, tuffoconglomerates, gravelites, conglomerates that are cemented to varying degrees, and rarely boulder tuffoconglomerates that contain diamonds and kimberlite indicator minerals (Sibirtsev et al., 1982; 1985; Grakhanov et al., 2009; 2013). The largest number of diamonds and KIMs were found in tuffites.

The pyroclastic material of tuffites is represented by lithoclasts (pebbles, 3-5 cm in size) with a predominance (80-90%) of porphyritic basaltic andesite with a fine-porphyritic, rarely aphyric texture and with a microlithic, in combination with the variolitic texture, of the main mass. Lithoclasts are isometric, oval, spherical, ellipsoid, rarely irregular in shape and are coloured with iron hydroxides to brownish to black shades. The highest diamond and pyrope contents tend to be in tuffites, while the top-cut bonanza contents of rutile and other titanium minerals are also concentrated here.

In the western limb of the Bulkur anticline, the Osipai Suite is traced through the entire license area and goes beyond to a distance of more than 50 km. The natural outcrops of the basal horizon of the Osipai Suite are rare, usually, the outcrops are of the upper contacts of the underlying Ladin Suite sandstones which are capped with thick screes of sandstones of the Tuus-Balyk package. Most of the information about the composition and parameters of the productive horizon was obtained by various researchers based on the results of mining operations.

The productive horizon is variable in nature. According to the results of data, obtained from 48 trenches developed in the license area in the period from 1982 to 2009, its thickness ranges from 0.03 m to 0.50 m and averages 0.20 m. Most of the trenches were developed in the highly prospective Bulkur zone, which runs for a length of about 20 km. According to the results of JSC "Nizhne-Lenskoe" core drilling in 2011 (1 profile across the striking of the stratum) the stratum was traced for 30 m and which wedged out at its dipping (Fig. 5-1).

The Quaternary system sediments are widely distributed over the entire work area and are mainly represented by alluvial, eluvial, diluvial, rarely glacial and other sediments. No diamond occurrences, associated with modern sedimentations were identified in the Khatystakh license area.

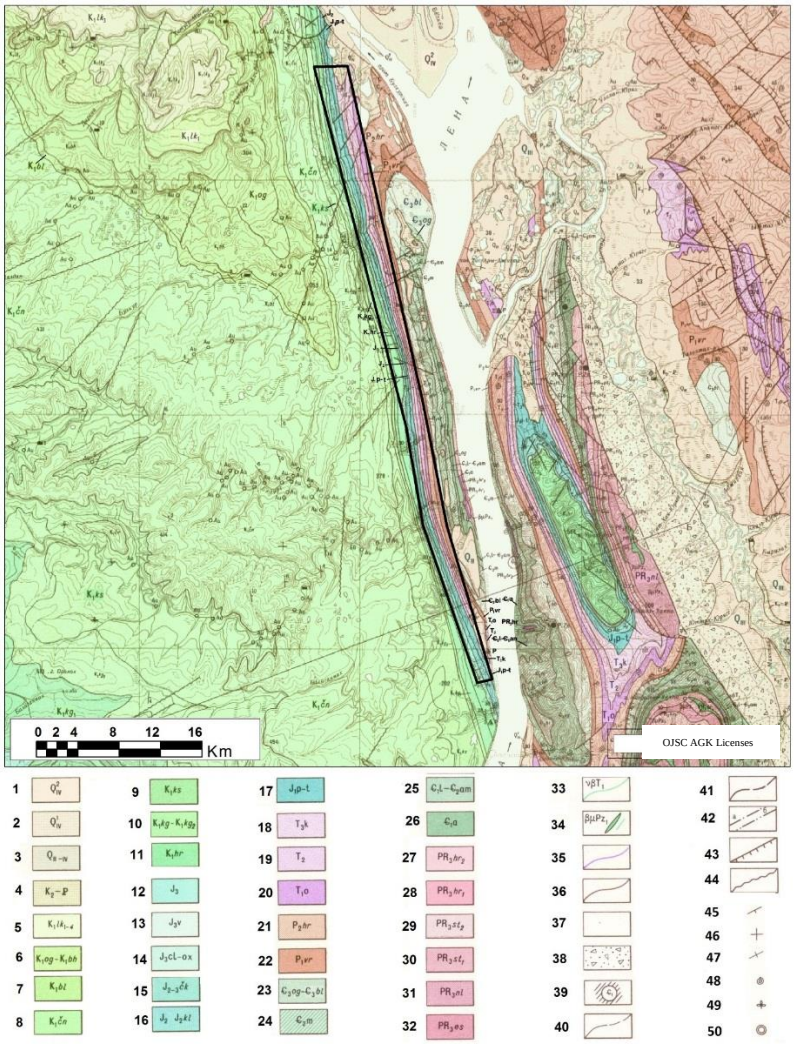

Fig. 6-4 Geological map of the Khatystakh license area

Note: 1-3 - the Quaternary system, modern deposits: alluvial sands, pebbles, sandy loam; 4 - Cretaceous-Palaeogene system: clays, sandstones, straight coal; 5-11 - Cretaceous system, lower section: siltstones, sandstones, coals, argillites; 12-14 Jurassic system, upper section: siltstones, argillites; 15-16 - Jurassic system, middle section: sandstones, siltstones, argillites; 17 - Jurassic system, the lower section: siltstone, limestone; 18-20 Triassic system: 18 upper section: siltstones, mudstones, sandstones; 19 - middle section: sandstones, mudstones, conglomerates; 20 - lower section; argillites, siltstones, sandstones; 21-22 Permian system: 21 upper section: sandstone, siltstone; 22 - lower section: siltstone, conglomerates; 23-26 - Cambrian system: 23 - upper section: dolomite, limestone, marl; 24-25 middle section: limestone, marl; 26 - lower section: limestone, conglomerates, sandstones; 27-32 Upper Proterozoic: limestones, dolomites, sandstones, marls; 33 - Early Triassic intrusions; 34 - Early Proterozoic intrusions; 35 - main composition lava caps; 36 - sandstone marker horizons; 37 - river sediments; 38 - proluvial deposits; 39 - weathering crust; 40 - conformed and assumed boundaries; 41 - conformed and assumed tectonic contacts; 42 - capped tectonic contacts: a - confirmed, b - assumed; 43 - tectonic contacts with the displacer surface; 44 - faults without displacement; 45-47 elements layers: 45 - inclined; 46 - horizontal, 47 vertical; 48 - places of fossil fauna; 49 - places where fossil flora was found; 50 - bore holes.

7 Types of diamond deposits

7.1 Geological-commercial types of diamond deposits

Hard rock and placer types are distinguished among the geological-commercial types of diamond deposits. The hard-rock deposits are associated with magmatic rocks - kimberlites and lamproites, metamorphic rocks and impactites. Kimberlite and lamproite pipes, as well as placers, are the main sources for the mining of gem diamonds.

Placer diamond deposits are formed as a result of the destruction of bedrock or reservoirs that contain diamonds. The reservoirs are sedimentary rocks that contain diamonds that got there upon the destruction of the diatremes. Impact and metamorphogenic diamond deposits are a source of low-cost industrial diamonds (Kozlov, 2002).

Kimberlites and lamproites are deep magmatic rocks, commonly found in ancient continental platforms and occur in the form of diatremes. The kimberlite pipe represents a vertical column that ends in a conical shape extension at the top. The pipe diameters vary from a few meters to a kilometre.

It is established that diamonds are not genetically associated with kimberlite or lamproite pipes, while the latter serve only as a transportation mechanism for delivering diamonds to the surface (Kirkley et al., 1991). Diamonds, associated with kimberlites and lamproites are formed in the upper mantle at depths of 100-200 km, where the pressure reaches 35-50 kilobars, and the temperatures reach 1100-1300 degrees Celsius.

Placer diamonds account for about 10-15% of global production, while more than 30% of the stones, mined from placers are gem diamonds (Vaganov et al., 2002). The quality of diamonds in placer deposits is usually higher than that of in hard rock deposits, owing to natural enrichment and attrition of lower quality stones through abrasion and collision.

In terms of the amounts of diamond production alluvial placers are the leading source among the various types of placers. Unlike indicator minerals, diamonds can repeatedly be re-displaced and accumulated in intermediate reservoirs. The linear dimensions of placers can reach several dozens of kilometres in length and be bedded at depths from 0 to 100 meters or more. Placers can be located at a distance of the first hundred meters to the first kilometres from the provenance area (termed near provenance placers) and be at a far distance from the source up to 100 kilometres or more (remote provenance placers). Unique placers in terms of resources can be formed due to the erosion of several bed rock sources and (or) intermediate reservoirs. The presence of a large amount of heavy concentrate fraction in the composition of the bar and riverbed alluvium with a predominance of pyrope, limonite, rutile, zircon, picroilmenite, etc. KIM, as well as the high contents of gravel and boulder material of the rocks, which are not specific (exotic) to the given area is a common criterion for high-diamond content of placers of Northern Yakutia, and in particular of the Beenchime River area.

7.2 The Beenchime area

The diamond occurrences in the Beenchime licence area are of the alluvial river-bed placer deposits type. The main commercial diamond content of the area is associated with the riverbed and bar alluvium (QIV). The placer is shallow-bedded (from 0.0 to 10 m), long-distance transport: intermediate reservoirs – Jurassic, Neogene and Quaternary conglomerates, gravels, pebbles and pebbly sand, bedded on ancient terraces and watersheds of the Olenek, Beenchime and Kuoika rivers were the sources of diamonds and KIMs.

Diamonds form small thickness and width accumulations/plumes, where high concentrations of indicator minerals, especially pyrope and limonite, are also noted. The highest concentrations of diamond and indicator minerals are found in the head parts of the bars. The most favourable situation is observed in the northern part at the Piropovy site, where, according to the results of AGK work, the average diamond grade is 1.0 ct/m^3 and can reach 2 or more ct/m^3 (up to 2.42 ct/m^3). Low diamond grades (up to 0.01 ct/m^3) were identified in rare cases in the depositions of the first terrace above the floodplain (Kruchek et al., 1962), but the main commercial diamond content potential is associated with the riverbed and bar alluvium.

According to reports, the degree of diamond content potential of the Beenchime river placers is generally low. The grade above 1 ct/m^3 is established in the sands in a few mine workings only.

7.3 The Khatystakh area

The diamond content at the Khatystakh site is associated with the horizon of volcanic-sedimentary rocks at the base of the Carnian horizon Osipay Suite (Upper Triassic) in the western limb of the Bulkur anticline. The nature of the Carnian horizon is highly debatable and currently, and there is no unequivocal interpretation for its formation.

The Carnian horizon contains the Ebelyakh ("northern") type diamonds with light isotopic composition of carbon and specific morphology, which are widely spread in Quaternary- and Neogene-aged placer deposits in the north-west of the Siberian Platform and are not found in kimberlite bodies. Most researchers consider the diamond-bearing Carnian horizon as a placer. According to S.A. Grakhanov and co-authors (2007, 2010, 2013, 2015), diamonds and KIMs were released during the formation of the weathering crust in unidentified magmatic bodies and, together with tuff material from nearby volcanic foci were transferred into sedimentation basins ("near transfer"). E.F. Lentikova (2013) thinks that the Carnian diamond-bearing horizon was formed by the erosion of lamproite bodies.

8 AGK exploration work at the licensed areas

AGK conducted reconnaissance work at the Khatystakh (2016 and 2017) and Beenchime (2016) areas. The types and scopes of field work are given in Table 8-1.

Table 8-1 Types and scopes of AGK field-work at the Beenchime and Khatystakh areas (2016-2017)

№	Types of work	Unit of meas.	Beenchime	Khatystakh
1	Mining workings (trenches, test-pits)	m^3*	21.8	180.4
2	Number of workings	pc.	14	3
3	Sampling and enrichment	m^3*	21.8	41.3
4	Prospecting routes	linear km	2.4	16.4
5	Mapping concentrate sample collection and panning 10 l (100 l)	pc.	25(-)	13(4)
6	Collection of small samples (>1 m^3)	sample (m^3)	14(30.5)	-

*Note: * - the volume of loose material was measured with a bucket and converted to a solid body using 0.71 coefficient.*

8.1 Methodology of works

At the first stage, AGK conducted prospecting traverses with heavy mineral concentration sampling and mapping of sediments, while identifying the most favourable areas for sampling. At the second stage, they developed trenches and test-pits, conducted productive sediment sampling and processing, field processing of the samples, and obtaining heavy mineral concentrates. For the purpose of determining the diamond grades in the productive horizon, the volume of samples in the unconsolidated state ("u.m." or "unconsolidated mass"), measured by a measuring bucket, was converted into the solid body ("s.b.") by applying the unconsolidation coefficient of 1.4 using the formula s.b.=u.m./1.4. The initial sample processing was conducted at the water site, closest to the sample collection point (Fig. 8-1). At the first stage of sample preparation, all samples were washed on a shaker unit, the material was classified into 5 grain size classes, using 10 mm, 5 mm, 2 mm and 1 mm sieves. The fractions of +10 mm and -1 mm grain size were rejected. The grain size class of -10/+5 mm material was examined visually for diamonds and pyropes. At the second stage of sample preparation, grain size classes -5/+2 mm and -2/+1 mm were deposited on a jig (concentrator) to obtain a concentrate and the light fraction. The light fraction was rejected, the concentrate of the grain size class of -5/+2 mm and -2+1 mm, was packaged into bags, weighed, sealed, and then helicopter-shipped to the OJSC "Almazy Anabara" recovery workshop (Molodo mine) for studying by using an X-ray diffraction separator and sorting of diamonds.

A portable field jig was used as a concentrator for gravity processing of samples. After sieving, the sample material was placed on a certain size sieve, the unit was submerged in water and the sieve was put into vertical-turning movements and the heavy mineral fraction was concentrated in the central part of the mesh. After the jigging was completed, the mesh was abruptly turned over onto the flat surface, and a scoop was used to collect the heavy mineral fraction concentrated in the central part of the mesh into bags.

In 2017, some 865 kg of concentrates from the Beenchime site, and 52.5 kg of such material from the Khatystakh site were sent to the recovery workshop.

a

b

c

d

e

f

Fig. 8-1 Stages of sample preparation: a - collection and washing of the sample; b-sieving (screening); c-jigging on a portable jig; d-visual check of coarse mineral fraction; e, f-concentrates after screening and jigging on a portable jig.

8.2 The Beenchime area

Based on the results of the previous work, the diamond placer at the Beenchime license area was preliminarily divided into three sectors: Nizhny (Lower) (from the southern border of the license area to the project line 256), Sredny (Middle) (from line 256 to the mouth of the creek. Beenchime-Salaat),

and Verkhny (Upper) or Pyropovy (from the mouth of the creek Beenchime-Salaat) top the northern border of the License area). AGK conducted verification work at the Pyriopovy area.

According to the results of the reconnaissance traverses, coarse-grained river-bed facies were identified, which have the most potential for the detection of alluvial diamonds. A total of 13 small samples were selected and washed at four points of these facies. Samples were taken from the core part of the river (points BenG-9) and from the river bars (BenG-5, -10, -11). Sampling locations in the Beenchime area were close to the sampling points of the previous workers (Fig. 8-2).

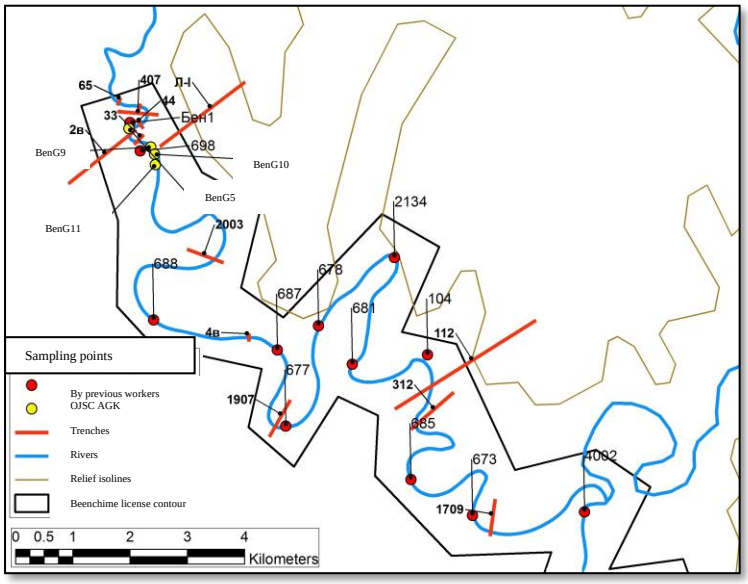

Fig. 8-2 Sample collection points at the Pyropovy, conducted in various years. The yellow dots represent the AGK sampling points.

Description of sampling points of AGK on the Beenchime River is given below.

Sample BenG5 was collected at the head of a boulder-and-pebble bar/split, 0.5 km south of the northern border of the license area. A total of 7 samples with total volume of 7.86 m^3 (s.b.) were collected and washed.

Sample BenG9 was located in the core part of the river, where there are bedrock outcrops of the Cambrian carbonate rocks. Productive pebbles are bedded on the carbonate clay, formed in the Cambrian carbonate rocks. A 4 m long and 2 m wide trench was developed across the riverbed, at the average depth of 0.25 m. The 1.0 m^3 (s.b.) sample material was accumulated in the bottom of the rubber boat (Fig. 8-3) using a shovel, and then processed on the shore.

Fig. 8-3 Sampling of the Beenchime riverbed

Sample BenG10 was collected at the head of a heavily sandy bar, developed along the right bank of the river. In total, 4 samples were taken from a series of test-pits with a total volume of 4.43 m^3 (s.b).

Sample BenG11 was collected on an island. A sample of 1.14 m^3 (s.b.) was collected from a trench (5 x 1 m, 0.3 m deep) across the centre of the bar head. The sample material is represented by some gravel-pebble-sand mixture with domination of unrounded fragments of carbonate rocks (70%), which outcrop in the bedrock bedding between the BenG10 and Beng11 sample points, also - well and perfectly rounded (30%) exotic varieties - flints (silica), quartzite, chalcedony, carnelian.

The results of AGK works at the Pyropovy are was given in Table 8-2. The table also includes the historical results for the purposes of comparison. It should be noted that the diamond grades in AGK samples are close to or slightly higher than those of the historical workers, which can, in the opinion of SRK ES, be explained by the reduction of losses owing to the refinement concentrates on the ALROSA processing equipment, also, that sampling was conducted in the most favourable/prospective areas, identified by heavy mineral concentration sampling based on increased KIM contents. According to the OJSC "Almazy Anabara" expert assessment, the total weight of diamonds obtained from AGK samples was 21.6 carats, at the average prices of 90.2 USD/ct, according to the international classifier (Fig. 8-4).

Table 8-2 The results of AGK and historical workers in the Beenchime area

№№	Sample ID	Diamonds extracted		Volume, m^3 (s.b.)	Grade, ct/m^3
		pcs.	carat		
1	**65**	10	0.936	5.2	0.18
2	**53**	9	0.371	3.1	0.12
3	**407**	17	3.142	6.5	0.48
4	**44**	25	1.957	8	0.24
5	**Ben 1**	78	7.0105	17.1	0.41
6	**BenG5**	75	11.05	7.86	1.00
7	**2v**	40	7.101	8	0.89
8	**33**	5	0.7175	3	0.24
9	**698**	3	0.171	1.43	0.12
10	**BenG9**	3	0.82	1.00	0.58
11	**BenG10**	65	10.04	4.43	1.62
12	**BenG11**	9	0.61	1.14	0.38
13	**2003**	17	1.6535	4	0.41
14	**688**	1	0.0265	1.43	0.02
15	**4v**	62	8.087	8	1.01
16	**687**	1	0.1125	1.43	0.07
17	**1907**	20	1.9465	4.5	0.43
18	**677**	4	0.177	1.5	0.12
19	**678**	3	0.622	1.36	0.46
20	**2134**	1	0.0415	1	0.04
21	**681**	1	0.043	1.43	0.03
22	**104**	2	1.08	0.04	0.00
23	**112**	1	0.1085	1.42	0.08

24	**312**	15	2.604	2.1	1.24
25	**685**	2	0.1115	1.5	0.07
26	**673**	4	0.1125	1.43	0.08
27	**1709**	17	0.475	2.5	0.19
28	**4002**	1	0.0255	1	0.02

Note: The samples of OJSC Nizhne-Lenskoye (Ben1) and AGK (BenG5, BenG9, BenG10, BenG11) are highlighted in colour

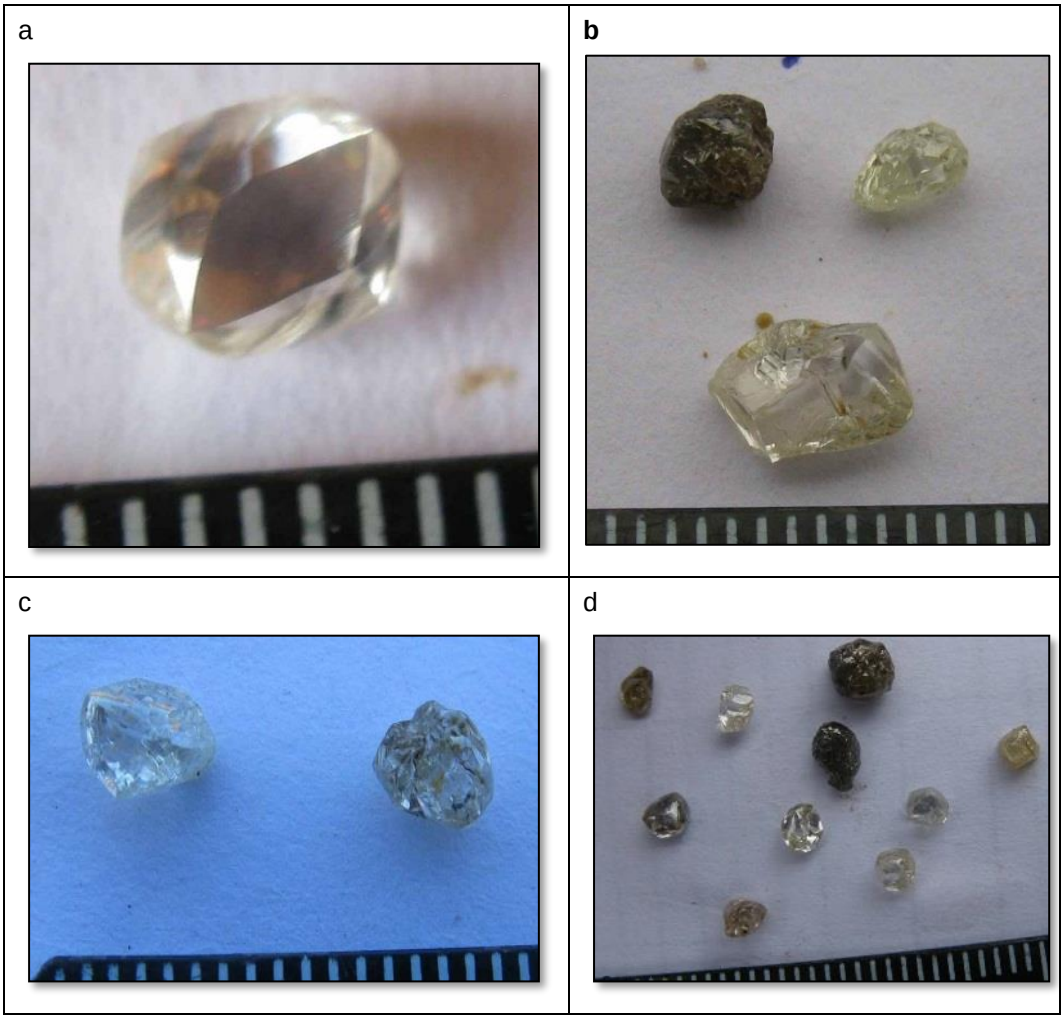

Fig. 8-4 Visual findings of large diamond crystals in samples BenG5 (a, b), BenG9 (v), BenG10 (g).

*Note: a - one carat Ural-type dodecahedron; b - fragment of the big clean laminar 6*4*2 mm octahedron, Ebelkyakh-type industrial individual and clean variety 1 crystal jam (according to Y.L. Orlov).*

8.3 The Khatystakh area

At the Khatystakh area, the productive Triassic sediments were exposed by manual excavation of three trenches - KhG56, KhG94, and KhG120, located approximately 2-3 km apart along striking of the Carnian horizon. The AGK trenches were developed in close proximity to the historical trenches (Fig. 8-5).

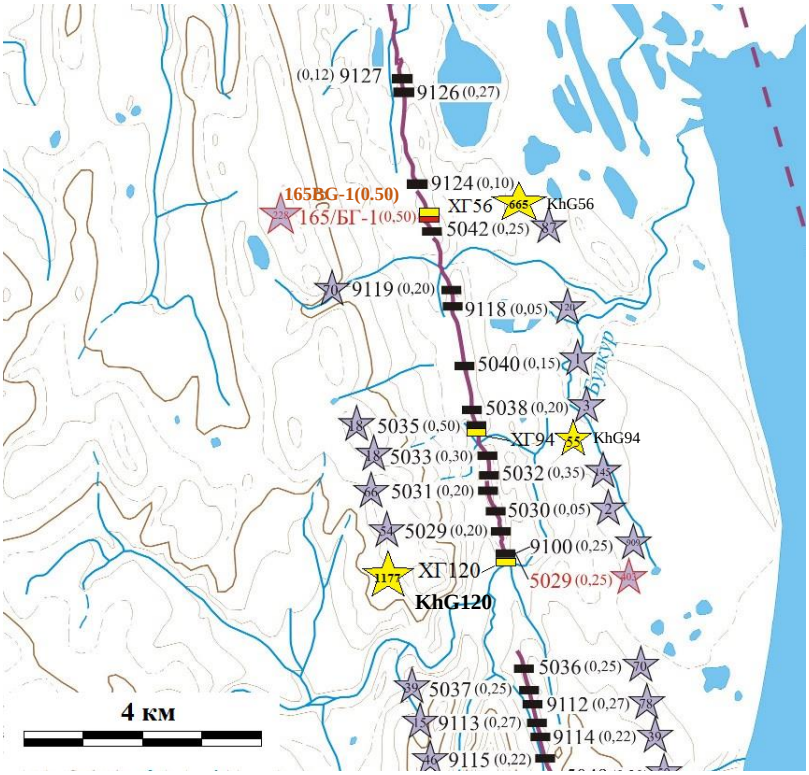

Fig. 8-5 Location of trenches along the strike of the Carnian horizon in the western flank of the Bulkur anticline (Bulkur area).

Note: the yellow colour shows the AGK trenches. The number in the asterisk is the quantity of diamonds. Large font – the trench ID, in parentheses – the thickness of productive stratum (m).

a b

c d

Fig. 8-6 Development of Trench KHG56

Note: a) AGK field camp; b) general view of the trench, in the near right corner – the historical trench 165-BG1; c) the bulk sample prepared for washing; d) the Carnian horizon (the western wall of the trench), a stratum of dark grey, sometimes sandy colour – the Carnian horizon of tuffites, productive for diamonds, at thickness of 0.5 m thickness.

Trench KhG56

Trench KhG56 borders on the historical trench 165-BG1 (Fig. 8-6) and exposed a productive stratum, its thickness varies from 0.15 to 1.15 m in different places of the trench. The following was identified in the productive stratum (from top to bottom):

- lappilli tuff (tuff-gravelite), with a thickness of 0.3-0.7 m (0.4 m average), which contains diamonds and pyrope;
- dense thick-plate tuff-siltstone, with the thickness of 0.1-0.2 m with a basalt lens, pyrope were identified in the heavy fraction;
- tuff conglomerate, 0.2 m thick, lithified, contains pyrope and diamonds.

Two bulk samples were collected from the trench: BG1/1 at a volume of 5.4 m^3 (s.b.) and BG1/2 at a volume of 12.1 m^3 (s.b.), a total of 17.5 m^3 (s.b.) material was collected from the productive part. About 40-50% of the rock volume was lithified to varying degrees. Most of the lithified material was not sampled and rejected to the dump. Small-volume crushed samples were collected from the lithified rocks for checking for the presence of pyrope and diamonds.

Trench KhG94

A 2.2 m deep trench with dimensions 3.6 m x 1.5 m at the surface and 1.1 m x 0.6 m at the bottom, exposed a layer of lapilli tuffites (Fig. 8-7). The trench was developed in close proximity to historical

trench 5035, developed by previous workers. The following was identified in the composition of the productive stratum, with a total thickness of 2.2 m (from top to bottom):

- tuffites, with a thickness of 1.0 m; in the upper part of the interlayer (0.0 - 0.75 m), the tuffites are disintegrated and loose, small amounts of pyrope, rare grains of chrome spinel and picroilmenite were noted; in the lower part (0.75-1.0 m) – tuffites are poorly lithified, the size and number of pyrope grains increases significantly;
- tuff siltstone, with a thickness of 0.3 m;
- poorly lithified tuff conglomerates, 0.2 m thick;
- dense, highly lithified tuff conglomerates, 0.7 m thick.

The development of the trench was suspended due to the strong lithification of the lower tuffite horizon and the large influx of water (constant rains). The trench was developed during two seasons (2016-2017), and in total, a sample with a volume of 4.4 m^3 (s.b.) was collected and processed.

Fig. 8-7 Trench KhG94

Notes: on the left –the face of trench KhG94; on the right - the tuffite layer, the interval of 0.0–1.0 m is marked with a measuring tape.

Trench KhG120

The trench is 40 meters long, developed along the dip of the Carnian horizon (Fig. 8-8) and is continuation of the historical mining workings No 9100, 5029, and PG2-2010. The productive stratum, intermittent along its strike, was identified at the intervals - 5-10 m and 20-30 m of the trench, where its thickness varies from 0.05 m to 0.4 m and 0.25 m - 0.30 m on average. The stratum is represented by weathered and oxidized tuffites and consists of clayey sands with fragments and relicts of poorly weathered tuffs and tuffites, gravel and andesite-basalt pebbles of yellow-brown colour with some rusty shade.

The average overburden thickness was 1.35 m. The total volume of the KhG–120 sample was 26.5 m^3 (s.b.) or 18.9 m^3 (s.b.).

a b

c d

Fig. 8-8 Trench KhG120.

Note: a) the western limb of the Bulkur anticline (Bulkur River); b) development of trench KHG120 along the Carnian horizon; c) the 30-40 cm thick productive Carnian horizon is represented by weathered and oxidized tuffites; d) the productive Carnian horizon in the outcrop (shown by a measuring tape).

The results of small-volume sampling of the Carnian productive horizon at the Khatystakh are shown in Table 8-3. For the purposes of comparison, the table also includes the historical results on the trenches, located in the direct vicinity of the AGK trenches.

Table 8-3 AGK results at the Khatystakh area

Sample ID	Total diamonds		Volume	Grade	Thickness
	pc.	carat	m^3 (s.b.)	ct/m^3	m
165/BG1	228	14.89	2.8	7.45	0.5
KhG56	**665**	**35.26**	**17.5**	**2.01**	**0.7**
5035	18	0.69	0.4	1.73	0.5
KhG94	**55**	**2.69**	**4.4**	**0.61**	**2.2**

5029	403	31.58	2.5	12.63	0.2
9100	909	77.57	6.7	11.58	0.25
PG2-2010	22	0.67	0.21	3.19	n.d.
KhG120	**1177**	**111.31**	**18.9**	**5.89**	**0.3**

Note: n.d. – there is no data available.

AGK made the following main conclusions on the work at the Khatystakh area:

- The thickness of the productive horizon in some areas can be as high as 2 m or more.
- The composition and colours of the productive volcanogenic-sedimentary stratum are significantly variable; the stratum is largely lithified, and up to 30-50% of the volume of the productive horizon is represented by large fragments/blocks that were rejected to the dump.
- The presence of a horizon of diamond-bearing tuffites, tuffaceous material, pyropes and lapilli are the characteristic features of the diamond-bearing stratum. Lapilli are products of volcanic ejecta, while their sizes range from a few millimetres to 5-6 cm. For the first time, it was established that tuff conglomerates and tuff siltstones also contain diamonds and contain a significant amount of pyrope in the heavy concentrate fraction, and in trench KhG54 diamonds were found in tuff conglomerates.
- The sizes of diamonds from the base of the tuff-sedimentary rocks of the Carnian horizon vary widely - from a fraction of a carat to 5.16 carats (1000 mg) (Sibirtsev et al., 1982), the typomorphic features of diamonds are significantly variable along striking of the placer:
  - trench KhG56 is noted for dominance of small technical stones of classes -2/+1 mm, the average weight of diamonds is 0.05 carats (10.6 mg);
  - trench KhG120 is noted for dominance of grain size class -4/+2 mm, with a significant proportion of gem stones (Fig. 8-9), the average weight of diamonds is 0.09 carats (18.9 mg), an industrial diamond of 5.16 carats (1032 mg) was extracted in this trench (Sibirtsev et al., 1982);
- According to the processing results, it was also noted that even in relatively small sections of the placer, the average diamond content varies significantly and does not depend on the thickness of the stratum (Table 8-3). Sampling in trench KhG120 showed unique diamond-bearing parameters: the grades varied from 3.73 to 8.84 ct/m^3 at an average value of 5.89 ct/m^3 over ten–meter sampling intervals, while the stratum thickness ranged from 0.05 to 0.4 m at the average thickness of 0.3 m.
- The diamond contents in trenches KhG56 and KhG120 were two to three times lower than the contents in historical trenches (Sibirtsev et al., 1982; Grakhanov et al., 2009f), which is possibly associated with the fact that the historical workers added the material of disintegrated and enriched weathering crust, where the diamonds were in the "opened" state, into the samples.
- On the western slope of the Bulkur anticline, the bedding elements of the productive stratum and the ridge slope are close to or coincide with each other, while the volume of capping rocks is insignificant, which is a favourable factor for mining.
- The small average thickness of the productive stratum according to the historical data (0.2 m) is explained by the fact that the trenches were planned and developed along the basal contact of the Carnian horizon with the Ladin sandstone for the purpose of mapping it, but did not cross it, which was achieved by AGK works.

a b

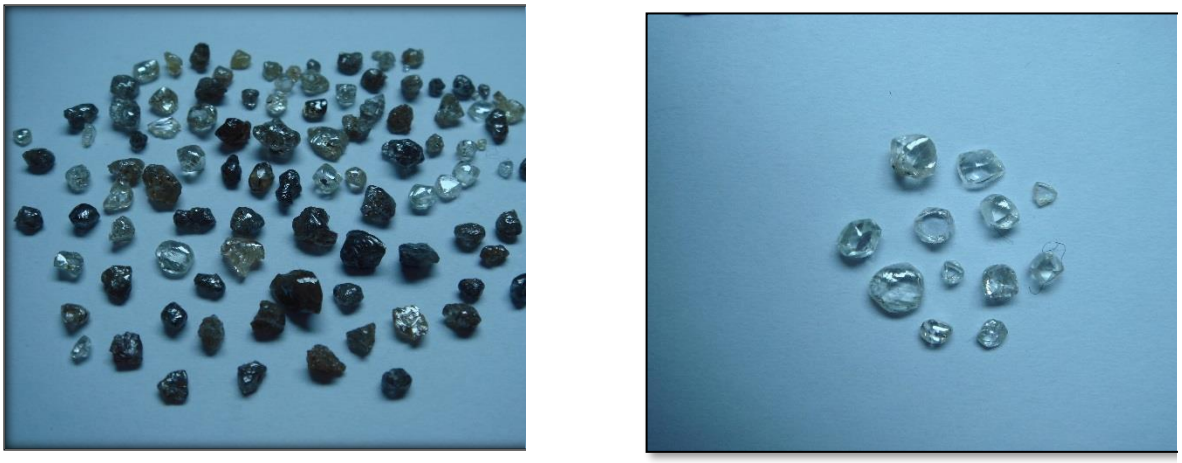

Fig. 8-9 Diamonds from trench KhG120 – general view (a) and gem varieties of (b)

According to the experts of OJSC "Almazy Anabara" the average value of diamonds from the trenches KhG56 and KhG120 of the Khatystakh area was 15.3 USD/ct according to the international classifier, while the average cost of diamonds in trench KhG56 was 18.6 USD/ct, and 14.6 USD/ct in trench KhG120. The total weight of the diamonds obtained from trenches KhG56 and KhG120 was 138.11 carats.

9 AGK estimation of potential resources

It is a common practice in the Russian Federation to assess the P1 and P2 potential resources at early stages of a study, whether it is a new property or the margins of a known deposit. The purpose of such assessment is to forecast the scale of mineralization and potential for development based on the data from surface sampling and sampling of a limited number of mine workings, rare boreholes (P1), geochemical and geophysical data (P2) for planning further work. Brief information about the data, which was used as the basis for identifying different categories of potential resources and reserves and the degree of their reliability and the sequence of assessment, is summarized in Table 9-1. Below is the potential resource assessment for the Beenchime and Khatystakh areas, completed by S.A. Grakhanov, the author of the AGK Geological Exploration Program.

9.1 The Beenchime area

For the purposes of estimating the potential resources, the AGK expert used the average sand thickness values and the average diamond content along the historical mine workings lines. According to AGK assessment, the P1+P2 category potential resources of the licensed area Beenchime totalled:

- sands – 4,698.48 thousand cubic metres (“tcm”);
- diamonds – 1,705.86 thousand carats (“kct”) (including category P2 – 852.93 kct),
- an average diamond grade of 0.36 ct/m^3.

At the same time, the provisional exploration parameters for similar, analogue deposits - the Kula and Olom diamond placers, currently under development by OJSC "Almazy Anabara", are as follows:

- the diamond cut-off grades in the sands is 0.16 ct/m^3;
- minimum commercial grade (MCG) - 0.6 ct/m^3;
- the value of diamonds is 67 USD/ct.

Thus, diamond grades on most of the prospecting lines are below the minimum commercial values (Table 8-2), therefore the area can be classified as a non-commercial or sub-economic site. However, with extensive experience in working at placer diamonds properties, the AGK expert doubts the representativity of historical sampling and shows the Khara Mas, Bolshaya Kuonamka and Mayat diamond placers as examples, which were studied in the 1960s, simultaneously with the Beenchime

placer. Until the early 2000s, these placers were considered sub-economic, but after repeated studies, they were transferred to the category of economically viable and are currently under development. This being said, in terms of cost value the Bolshaya Kuonamka placer was included in the category of the largest placers of the RF (Podchasov and Suleymanov, 2014). Thus, the negative assessment of the prospects of placers, based on the results of sampling in the 1960s, may be associated with the loss of useful material during sample collection and processing of the sands.

Table 9-1 Categories of reserves and potential resources used in the Russian Federation

Categories	Types of works, conducted during the study of the property	Types of work, recommended for further study	Degree of confidence
A+B+C1	Detailed mapping, geophysical work, development of trenches, underground mine workings, borehole drilling, sampling	The property is prepared for commercial development. Mining is possible under favourable economic conditions (product prices, infrastructure, etc.).	High degree of confidence.
C2	Detailed mapping, geophysical work, development of trenches, borehole drilling at a sparse grid, sampling (process, channel, and core sampling)	Infilling of borehole grid, development of underground workings (if necessary). Conducting various types of sampling.	Average level of confidence. Preliminarily exploration works are completed at the property and it is transferred to the category of deposits. Under favourable conditions, it is recommended to conduct detailed exploration works.
P1	Geological surveys, lithogeochemical sampling, a widely spaced trenching grid, rare boreholes, geophysical surveys.	Infilling of trench spacing, borehole drilling grid, process, channel, and core sampling, geophysical surveys, detailed mapping.	A satisfactory level of confidence; often refers to the unexplored deep horizons of the assessed deposits under exploration. According to the data from the completed works, it is possible to confidently predict the presence of a commercial facility. Resources are calculated for the properties of the category of ore fields and deposits during detailed prospecting works.
P2	Geological surveys, lithogeochemical sampling. Rock chip and channel sampling. Rare trenches and test-pits.	Detailed mapping, infilling of sampling grid, development of trenches, test-pits, and drilling of rare wells. Geophysical work: magnetic survey, electrical surveys.	Poor level of confidence. Resources of this category are taken into account upon conducting 1:50,000 - 1:25,000 scale prospecting works.
P3	Resource calculation: the method of expert assessments, according to geochemical data (productivity of complexes), and other remote methods. It is used for the assessment of ore districts and clusters.	Geological surveys, lithogeochemical sampling.	A fairly low level of confidence. The area may not necessarily contain the identified properties (occurrences and geochemical halos may be present). It is used for small-scale works (1:500,000-1: 200,000). Indirect methods are used. It is of a recommendatory nature.

9.2 The Khatystakh area

According to AGK assessment, the P1 category Inferred diamond resources for the open-pit mining method (depth up to 10 m) are 7.69 million carats ("Mct"). For the assessment of potential diamond resources at the Khatystakh area, AGK used the results of sampling of trenches KhG56, KhG120 and test-pit KhG94:

- the average diamond grade in the stratum is 3.66 ct/m^3;
- the average thickness of the productive stratum is 1.05 m;
- the width of the productive stratum is 40 m (according to the drilling data by OJSC " Nizhne-Lenskoe»);
- the length of the placer is 50,000 m (according to the historical results).

According to AGK, an increase in the diamond grade of 20-40% can be expected as opposed to the estimated grades (3.66 ct/m^3), for the 2016-2017 sample processing was carried out manually, without crushing the source material, due to fractions of diamonds which may have been rejected to the tailings products.

According to AGK estimates, the P2 category Reconnaissance resources for the underground mining method are 24.45 Mct. The following parameters were applied in the calculations:

- the average diamond grade in the stratum - 4.89 ct/m^3;
- the average thickness of the productive stratum is 0.5 m;
- the width of the productive stratum – 200 m;
- the length of the placer is 50,000 m.

9.3 SRK ES comments

9.3.1 The Beenchime area

SRK ES is of the opinion, that in general, the AGK assessment potential resources at the Beenchime area was completed correctly by taking into account the requirements and methodological recommendations of the GKZ (State reserves committee) and the actually available material. SRK ES also agrees that in the early periods of prospecting for diamonds, the prospectors lacked the equipment, all work was done manually, and the sand concentration and diamond extraction technologies were not perfect, which could lead to some loss of the valuable component in sample processing. Probably, some material may have been lost during sample collection from the riverbed and mine workings in the summer season, when there is abundant water. Taking this into account, it can be assumed that this placer had been undervalued due to the inaccuracies in sampling and sample concentration, however, at this stage of works, it is impossible to assess the extent of possible losses for there is no data of verification of historical mine workings.

9.3.2 The Khatystakh area

According to SRK ES, the thickness of the productive stratum at the Khatystakh area and, consequently, the potential resources in the author's version are overestimated.

According to the historical data (48 trenches) the average thickness of the diamond-bearing horizon was 0.2 m, according to the results of drilling by OJSC "Nizhne-Lenskoe" (3 wells) it is 0.5 m. According to the results of the work, conducted by AGK (Table 8-3), the average stratum thicknesses in trenches KhG56 and KhG120 are 0.7 and 0.2 m, respectively, while 2.2 m depth trench KhG94 still remained in the productive stratum, and its thickness in this trench was taken as 2.2 m. At present, it is yet unclear whether an increased average thickness of the productive horizon (>0.5 m) can be expected due to insufficient factual data for such an assumption. With that in mind, SRK ES believes that the thickness of 1.05 m taken by AGK for assessment of resources for the open cast mining method is overestimated by at least 2 times. SRK ES are of the opinion that in assessing the average thickness of the productive stratum it is most appropriate to use the historical data.

It should also be taken into account that the historical workers developed most of the trenches in the northern part of the license area, at the 20 km long Bulkur zone, which has most potential for diamonds. The historical workers studied the thickness of the 20 km long diamond-bearing horizon in the southern part of the Khatystakh license area by only 5 trenches, developed in the northern (3) and southern (2)

flanks and averaged 0.1 m. Therefore, SRK ES believes that with such a thickness, the development of the southern part of the placer will be unprofitable and therefore recommends conducting prospecting works in the southern part of the license area to check its potential.

SRK ES recommends AGK to refrain from the estimation of potential resources for the underground mining method for the issue of extracting the resources using the underground mining method has not yet been resolved in principle.

10 AGK Works Program at the license areas

10.1 The Beenchime area

On the Beenchime area AGK are planning to conduct prospecting and evaluation works for diamonds. The main objectives of the planned works are to study the geological structure of the alluvial deposits that host the diamond occurrences, to establish commercially significant placer areas, to determine the general parameters of diamond content, to estimate the potential resources and to calculate the diamond resources in C1, C2 categories.

In addition, the Works Program envisages studies of the processing properties of diamond-bearing sands, the determination of mining conditions of the deposit, the determination of the value of diamonds, analytical investigations and the development of a feasibility study of provisional exploration conditions.

In accordance with the Work Program, it is planned to achieve these objectives by conducting the following set of works:

- prospecting traverses -100 linear km;
- heavy mineral concentrate sampling - 500 samples;
- low-volume sampling (V = 2 m^3) - 100 samples;
- development of test-pits at cross section of 4 sq. m. using fire – 1,237 linear m.;
- development of trenches in ice – 1,278 m^3;
- development of test-pits at the cross-section of 2 m^2 using drill-blast works-3,542 linear m;
- transportation of sands – 6,776 m^3;
- processing of the sands 9,486 m^3 u.m.

It is planned to conduct the works in 2 stages. During the first prospecting stage, the prospecting traverses will be run with heavy mineral concentration sampling and bulk sampling, test-pits lines will be developed at the grid of 3,200 m x (10-40) m over the entire license area. Based on the results of the work, the areas of the placer with potential commercial diamond contents will be identified, and potential resources will be estimated in categories P_1 and P_2. During the exploration-assessment stage, the mine workings grid will be infilled within the areas with potentially commercial diamond contents to (800-1,600) m x (10-40) m.

Based on the historical results, AGK believe that the Sredny (Middle) and Verkhny (Upper, Pyropovy) zones have more potential than the Nizhny (Lower) zone. The Verkhny zone has the highest potential, within the area from the mouth of the creek Beenchime-Salat to the northern border of the License area, where, according to the data of rare mine workings, developed by the historical workers, economic accumulations with above 1 ct/m^3 grade were identified (Zimin et al., 1961; Kruchek et al., 1963). Therefore, AGK believe that they will use the 1600 m x 10-40 m grid in the Sredny zone, and 800 m x 10-40 m grid in the Verkhny zone.

Taking into account the fact that AGK has no analogue properties nor the experience of studying such, the company will conduct experimental methodological works at the most prospective part of the placer on establishing and optimizing the exploration grid for the C_2 and C_1 category resources and work on the calculation of the required scope of sampling at different grids of mine workings.

Prospecting traverses with heavy mineral concentration sampling and small-volume sampling. The objective of the prospecting traverses is the lithological-facies mapping of the alluvium of the bars, riverbeds, and terraces. The routes will be accompanied by heavy mineral concentration sampling and small-volume sampling which will enable the identification of diamond-bearing areas indicated by

increased contents of coarse pyrope and limonite. For the area of work, correlation of the increased contents of these minerals in the -8/+4 mm and -4/+2 mm fractions with the diamond content is typical (Grakhanov et al., 2007). Instead of uniform sampling of the hydrographic system, the author of the Works Program plans to localize low-volume sampling at the most favourable microfacies within the bars. Sampling is necessary for identification of medium and small streams that can be missed by the wide-spaced grid of the prospecting test-pit lines.

Development of test-pits at cross-sections of 2 m² and 4 m². It is planned to develop the test-pit lines by full crossing of the riverbed, floodplain and terrace parts of the valley. The 4 m² cross section test-pits will be developed in the riverbed parts of the bars and low floodplain at10 m spacing. This cross-section was chosen is due to the low diamond content, which requires increasing the volume of samples. In the high floodplain and the terraces, where the alluvium thickness increases, it is planned to develop 2 m² cross-section test-pits. It is planned to develop mine workings for three years in the winter period, which will enable avoidance of processing losses, associated with waterlogging of mine workings in the warm season of the year.

Processing of the sands. The Works Program provides for the jigging and processing of 9,486 m³ of sand. An ore stock-yard and the seasonal processing plant, including an X-ray diamond separation unit, will be equipped at the company base near the mouth of the Beenchime-Salat River. For the avoidance of diamond loss, it is envisaged to run internal control during sand processing at various stages.

10.2 The Khatystakh area

On the Khatystakh area, AGK are planning to conduct prospecting and evaluation works for diamonds. The main objectives are to run detailed studies of the material composition of diamond-bearing Carnian horizon tuffaceous-sedimentary formations, to determine the most significant sites in terms of prospecting, and to determine the general parameters of diamond content.

In addition, the Works Program envisages studies of processing properties of the diamond-bearing rocks, determining the mining conditions of the deposit, performing analytical investigations, stipulated in the relevant instructions, as well as developing a feasibility study of provisional conditions.

In accordance with the Works Program, it is planned to achieve these objectives by conducting the following set of works:

- prospecting traverses -100 linear km;
- collection and processing of 10 and 100 litres of heavy mineral concentrate samples – 100 and 60 heavy mineral concentrate samples respectively;
- manual trench development – 400 m³ (s.b.);
- bulk sampling in the manually developed trenches - 80 m³ (u.m.);
- development of bulldozer trenches – 4,560 m³;
- development of bulldozer costeans 1,800 m³ (s.b.);
- prospecting core drilling (132 mm) – 25,930 m;
- assessment core drilling (>230 mm) – 3,340 m;
- heavy mineral concentrate sampling of the core of mapping bore holes – 733 samples;
- processing of bulk samples – 1,925 m³ (s.b.)
- semi-quantitative mineralogical analysis of samples 6-20 (200) l. – 833 (60) samples.

It is planned to conduct the works in 2 stages. Prospecting traverses and scout drilling will be the main types of works at the first stage. The main objective of the prospecting traverses is the mapping of the assumed boundary of the Carnian tuffs and underlying Ladin rocks and siting of scout drilling holes in a way so that the first borehole in the profile is at a distance of 10 metres west of the assumed contact, and all subsequent bore holes are drilled along the profile at spacing of 10 m. The purpose of scout drilling is to determine the depth of bedding and thickness of the productive horizon based on the presence of characteristic associations of minerals and rocks in the core of the boreholes. The interval of bedding of tuffaceous rocks will be determined by the presence of indicator minerals in the heavy

mineral concentrate sample, while qualitative analysis for diamond content will be conducted due to the small volume of samples. The depth of investigation for the Carnian horizon by scout boreholes will be from 0 to 100 m at dipping of the stratum. The prospecting traverses will be accompanied by a heavy mineral concentration sampling. The results of such sampling will serve basis for developing trenches and collection of low-volume and bulk samples for assessing the content of diamonds in the productive stratum, preparation of a collection of diamonds and valuation/assessment of such. The license area is divided into three sectors - Severny, Centralny and Yuzhny (Northern, Central and Southern). AGK are planning to apply different drilling grids for in each sector for the first and second stages for mapping and assessment of the diamond content of the Carnian horizon (Table 10-1).

Table 10-1 The volume of core drilling in different parts Khatystakh license area

Area name	Mapping bore holes 132 mm (Stage 1)				Assessment bore holes >230 mm (Stage 2)			
	Grid spacing (m)	Depth (from–to, m)	Number of lines	Scope (m)	Grid spacing (m)	Depth (from–to, m)	Number of lines	The scope of drilling
Severny (Northern)	200x(10-40)	5-81	59	16048	400x(10-40)	9-33	30	2160
Centralny (Central)	400x(20-40)	5-77	28	6440	800x(20-40)	13-29	14	588
Yuzhny (Southern)	800x80	5-69	31	3441	1600x80	37	16	592
Totals				**25929**	Totals:			**3340**

At the second stage of the work, provided there are "normal" thickness (>0.3 m) tuffaceous-sedimentary rocks, large-diameter core assessment drilling (>230 mm) will be conducted and bulldozer trenches will be developed along the prospecting lines, following the dipping of the productive horizon. Large-diameter boreholes (LDBH) will duplicate the scout boreholes, but only up to a certain depth by judging by the scope of the LDBH drilling, and, apparently, starting with the second scout borehole in the profile. Here, every second line of scout drilling will be verified using the large-diameter drilling.

For the verification of the results of large-diameter drilling, it is planned to develop bulldozer trenches every 800-1,600 m along the dipping of the formation. The trenches will be developed along the drilling mapping lines, from the outcrop of the stratum to the surface to the first borehole in the profile. Bulk samples will be collected from each trench at the outcrops of productive Carnian sediments. According to AGK, the average length of the trenches will be 6.2 m. Based on the data from borehole and trench sampling in the Serverny and Centralny sectors, it is planned to assess the C1 and C2 category diamond resources, respectively, while in the area with a rarer mine workings grid - the P1 and P2 potential resources will be assessed.

For the purposes of a representative assessment of diamonds and testing the processing flowsheet, the Works Program provides for the development of bulldozer costeans for collecting two metallurgical bulk samples for a total volume of 1,800 m^3 (s.b.) at the Severny site. It is planned to develop these cuts along strike of the productive stratum, 2-3 m from the outcropping of the stratum to the level of the modern section/slice, at places with increased stratum thickness and minimal overburden.

It is planned to run sample processing at a field modular gravity concentrator that operates at the rate of up to 5 m^3/h, which will be installed at the Severny section. Due to the presence of lithified rocks, AGK plans to process the material in a scrubber-trommel and a mill.

In addition, AGK will conduct experimental and methodological studies to substantiate deposit groupings based on the complexity of the geological structure and the choice of parameters of the exploration grid for the resource classification. For these purposes, the author of the Works Program selected a 10-km section on the Severny section, where a stable continuity diamond content is noted

in the bottoms of the Carnian tuffaceous rocks and P1 category resources will be tested at this site. According to the Works Program, boreholes will be drilled here (prospecting and mapping and LDBH) at the spacing of 200-400 m between the lines and with 10-40 m distances between the trenches. It is also planned to determine the reliability of sampling of the LDBH material at different grids of mine workings. According to the author of the Works Program such works had been conducted during the prospecting and exploration of the Ebelyakh, Gusinaya, Holomolokh, etc., placers, and in general, resulted in reliable assessments.

10.3 SRK ES comments

10.3.1 The Beenchime area

Despite the negative assessment of the historical workers, the presence of placer occurrences with high diamond grades indicates the possibility of finding economic deposits within the Beenchime license area. Accumulations of diamonds and KIM are confined to the riverbed, bar, and floodplain alluvium, which is widespread along the entire length of the river. SRK ES believes that it is possible that the placer had not been studied by the historical explorers in sufficient detail to give a clear-cut answer to the question on cost-effective mining of its individual sections.

SRK ES is of the opinion that, the AGK Work program has been prepared by taking into account a good knowledge of placer geology and work experience in northern conditions and will allow studying the license area with sufficient detail to identify a deposit class property, conduct its exploration and calculate the resources and reserves.

However, SRK ES believes that the interests of investors in the fast generation of profits and minimization of investment risks, associated with non-confirmation of the potential resources should be taken into account when planning the stages of work. SRK ES is of the opinion that in the case of possible marginal economic parameters of the project, priority will be given to a detailed study of the prospective areas, which have already been identified, at the first stage of works and their commissioning in case of being economic. In this regard, for the purposes of reducing the cost of works and the fastest commissioning of the deposits, SRK ES recommends conducting the following works:

- mapping of alluvial depositions over the entire license area with the identification of prospective areas based on a cumulative set of features;
- development of test-pit lines at the 800 (1,600) m x 10-40 m grid within the Sredny (Middle) and Veerkhny (Upper) zones, primarily in those places of the Beenchime River valley, where the historical and AGK works confidently fixed small width, length and thickness streams with diamond contents, which are close to economic values or where increased concentrations of indicator minerals had been identified;
- study of the morphological features of the river valley profile and identification of regularities (patterns) of distribution of high-grade areas in order to delineate such areas using the method of analogies.

Upon discovery of econpomically significant diamond streams, SRK ES recommends assessing the economic profitability of their mining and, in case of obtaining positive results, conducting prospecting mining works in other areas of the license area. Upon reduction of the volume of sampling, it is possible that it will be more appropriate to process samples at the facilities of OJSC "Almazy Anabara", by delivering the samples using the winter road.

10.3.2 The Khatystakh area

The Khatystakh area is of a new type of diamond placer with an unknown origin. It is established that the Carnian horizon diamond-producing basal horizon is of volcanogenic-sedimentary origin and is characterized by a complex composition and high variability of facies, and the thickness and grades of the commercial component significantly vary along strike and dip. SRK ES believes that the site represents an indubitable interest for prospecting and has significant potential for profitable development.

SRK ES believes that methodology of work, the exploration technique and the sampling grid, chosen by AGK are rational and meet the requirements of the relevant guidance materials (Methodological guidelines ... 2007), but the raising investment for the entire complex of planned works may prove to be difficult, taking into account the early stage of the project, the lack of infrastructure and the severe

northern conditions. SRK ES are of the opinion that it is necessary to minimize the costs of the first stage by studying and preparing for commercial mining of the most prospective areas in the northern part of the license. In this regard, SRK ES recommends:

- to conduct the entire planned scope of the prospecting routes and mapping drilling on the Severny site at the 200 m x (10-40) m grid, to study the parameters of the productive horizon;
- provided that positive results are obtained from scout drilling, it is necessary to develop a set of trenches with a distance of 400-800 m between the profiles, which will enable getting the correct materials for assessment of mineral resources and calculating reserves.;
- to perform the required scope of works on studying the properties and characteristics of the productive horizon in the Severny section, by evaluating, in particular, the approximate share of the diamond containing lithified material and to develop an optimal flow sheet for processing and recovery of diamonds and the mining method.
- take a decision on conducting the second prospecting-assessment stage of works at the Severny site (large-diameter core drilling and bulldozer trenches along the prospecting lines) after summarizing the results of the first stage works, if positive results are obtained;
- drilling at the Centralny and Yuzhny sites should be performed after confirmation of the possibility of profitable development of the sites in the northern part of the license area.

SRK ES believes that the project has prospects for identifying significant diamond resources, but at the prospecting-assessment stage it presents a technically difficult task, bearing in mind the following facts:

- different degrees of integrity of Carnian horizon diamond-bearing tuffaceous rocks, which will require the use of a special drilling rig (triple-core barrel system), and ideally - the SONIC vibration drilling units to ensure maximum core recovery, also separate sample preparation for diamond-containing loose and monolithic rocks when drilling the mapping boreholes and LDBH and further development;
- the diverse outlook of the productive horizon in the bedrock bedding, due to the variability of the composition and the different oxidation degree of minerals;
- the small and variable thickness of the horizon will possibly lead to significant dilution of the sands during mining operations and increase the cost of work.;
- highly uneven feature of the stratum - at relatively small distances, its thickness varies from 0.0 to 2.2 m, even within one outcrop;
- the fault tectonics, established in the work area can also significantly complicate the assessment and development of the field; in the presence of downfault type faults, the overburden thickness may significantly increase, which will lead to increase of operating costs.

11 Adjacent licences

The north-eastern part of the Yakitia diamond-bearing province is a prospective territory for the discovery of hard rock and alluvial diamond deposits. The new type of diamond-bearing formations - the placers, associated with the Upper Triassic Carnian horizon volcanic-sedimentary formations and their bed rock sources are of particular interest. The number of licenses issued for prospecting for hard rock and alluvial diamond deposits indicates the great interest of OJSC "Almazy Anabara", Alrosa and Rosgeology in this area. During the period of 1998-2018, over 20 licenses were issued in the territory of the Bulunsky and Oleneksky districts for geological study, prospecting and assessment of diamond deposits, placer diamond deposits, which were owned by ALROSA, "Nizhne-Lenskoye" and OJSC "Almazy Anabara". The Fig. 11-1 unshaded red outlines show the prospecting licences (geological study, prospecting, and assessment of diamond deposits), which are currently revoked.

Currently, in the north-eastern part of the Yakutia diamond-bearing province, in the area of the AGK license areas, in an area covering about 180,000 km^2, there are 16 currently valid licenses for diamonds, which are owned by:

- JSC "Rosgeologiya" (state-owned holding) - 10 licenses for geological study, prospecting, and assessment of alluvial diamond deposits;

- OJSC "Almazy Anabara" - 2 licenses for geological study, prospecting, and assessment of alluvial diamond deposits; and
- JSC "Almazy Anabara" - 4 licenses for exploration and mining of alluvial diamonds.

The Molodo placer mine (OJSC "Almazy Anabara"), where sands from several placers of the Molodo River basin are processed, is located about 150 km south-east from the centre of the Beenchime license area.

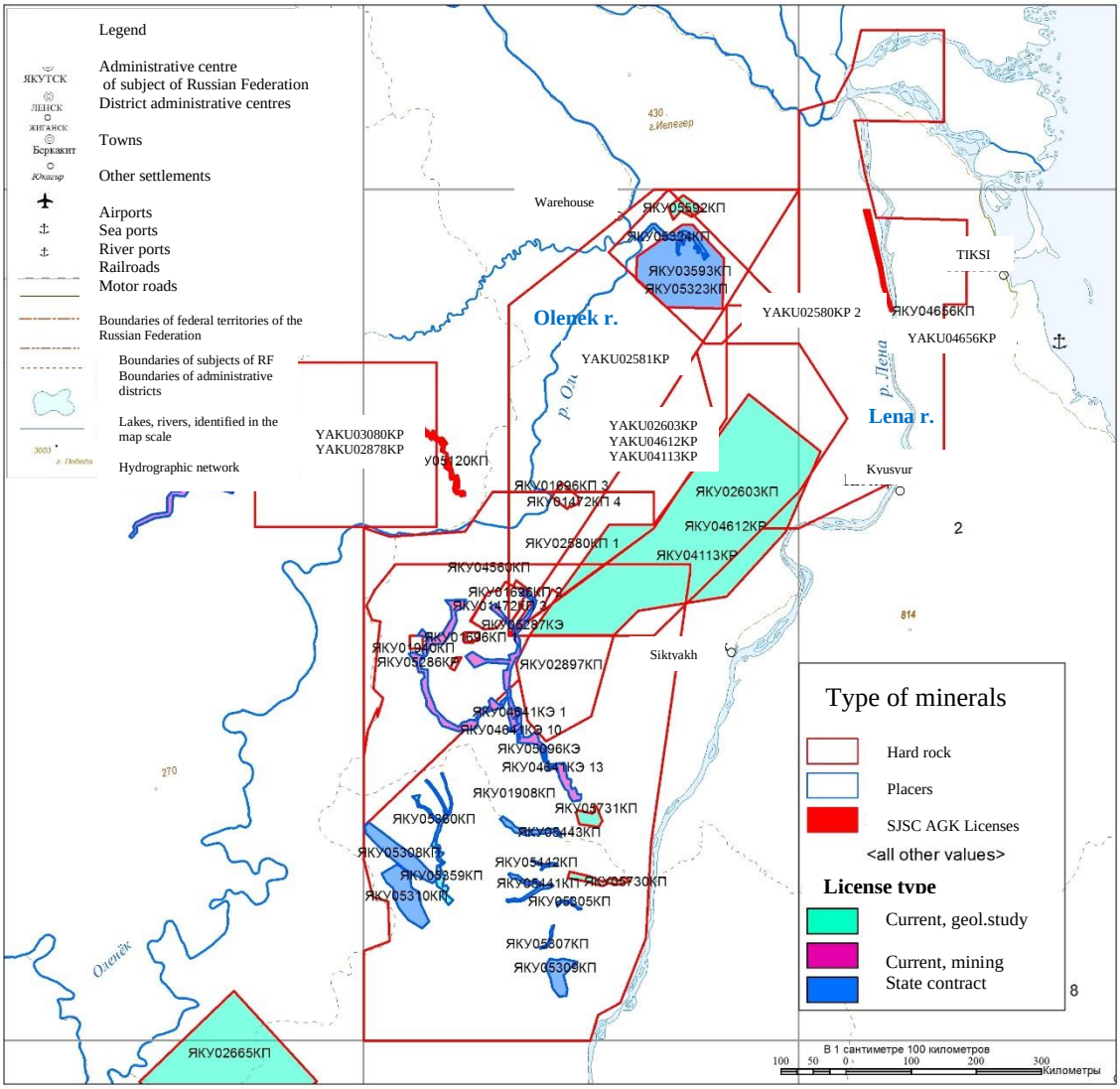

Fig. 11-1 Currently valid (filled-in contour) and revoked (unfilled contour) licenses for geological study and mining of diamonds in the area of AGK works (https://openmap.mineral.ru)

12 SRK ES conclusions and recommendations

The Beenchime and Khatystakh Projects are early-stage study projects. Despite the negative assessment of the historical workers, the presence of placer occurrences with high diamond grades indicates the possibility of finding economically mineable deposits within the Beenchime and Khatystakh license areas.

There is no doubt that both sites represent interest from prospecting point of view, and have significant potential for economic development, therefore, the need for their further study seems quite appropriate. For registration of diamond resources and reserves at the State Balance of the Russian Federation, obtaining a mining license and commencement of mining it is necessary to conduct prospecting assessments and exploration work, including core drilling, development of mine workings, and processing studies to complete modelling of geological setting and reserves, to study the economic aspects of the Projects and make sure of their economic viability.

12.1 Assessment of the expediency of selecting the areas and criteria for their diamond content

Both license areas are known for their diamond content and, apparently, are not attractive for large mining companies due to the small amounts of resources (Beenchime), the complexity of the geological structure, the high-level of variability of the placers, the low value of the diamonds, and the high processing costs (Khatystakh).

12.2 Correctness in the substantiation of potential resources

SRK ES believes that generally, assessment for the Beenchime license area was completed correctly, by taking into account the requirements and methodological recommendations of the GKZ (SRC) and the actual data, however, SRK ES agrees that during the early periods of prospecting works, the prospectors had no equipment, conducted sampling in the summertime in waterlogged sand conditions, both of which may have led to recovery losses of economically significant portions of samples, as it had happened at the Bolshaya Kuonamka, Mayat and Khara Mas placer deposits. Taking this into account, there is a probability that the results of historical sampling at the Beenchime placer may also have been underestimated. AGK plans to build an "Arctic-type" field camp, in analogy to similar projects in Canada and Russia (the Dvoynoye and the Kupol deposits of Kinross in Chukotka), which does not require the construction of capital buildings using bricks and concrete and will ensure modern and comfortable living conditions for the staff.

SRK ES are of the opinion that in the author's version, the thickness of the productive stratum and the estimate of the potential resources for open-cast mining at the Khatystakh area are overestimated by at least 2 times. According to the historical data, the average thickness of the productive horizon is 0.2 m, while in their resource estimates AGK used 1.05 m, referring to the results of their own work in 2016-2017 and the results of drilling of 3 core boreholes, drilled by JSC "Nizhne-Lenskoye". SRK ES are of the opinion that in assessing the average thickness of the productive stratum it is most appropriate to use the historical data.

The estimation of the potential resources for the underground mining method at the Khatystakh area was conducted incorrectly due to the lack of confirmation data. The only drilling profile, which was used to study the behaviour of the Carnian horizon along its dipping, showed that the productive stratum is not intersected by the two deepest boreholes out of five, not reaching 12 m depth from the surface. Therefore, we think that the calculation of the potential resources in the interval of 100-200 m is not substantiated.

According to international reporting practices (NI 43-101, JORC), a substantiated assessment of the quality and value of diamonds is possible only after processing a batch of diamonds from 3,000-5,000 carats. This is primarily associated with the possibility of the presence of rare large stones, the value of which can be >30-40% of the value of the deposit. This is confirmed by the example of the Khatystakh license area, where a category V diamond weighing 5.16 carats had been found (Sibirtsev et al., 1982), also the AGK staff encountered a diamond weighing 1 carat.

12.3 Assessment of the methodology of prospecting-assessment works and recommendations for its improvement

SRK ES believes that the work methodology chosen by AGK, including the sampling methods and sampling grid, is rational and meets the requirements of the relevant guidance materials (Methodological recommendations..., 2007, etc.), however, SRK ES is of the opinion that the interests of investors in reducing risks, fast return of investments, and making profits should be taken into account during planning of the stages of work. SRK ES is of the opinion that in the case of possible marginal economic parameters of the Projects, the priority will be given to assessment and resource evaluation of the most potential areas at the first stage of works and their commissioning in case of profitability. In this regard, for the purposes of reducing the cost of works and fastest commissioning of the properties, SRK ES recommends to significantly reduce the scopes of work at the first stage, which is detailed in section10.3.

12.4 The accuracy of development of the cost estimates of the Projects

SRK ES believes that the project cost estimates for the planned scopes of work require a number of improvements. This is primarily related to the scopes of planned drilling operations at the Khatystakh area. As indicated above (see Chapter 10.3.2), the expediency of drilling the boreholes at the Yuzhny site of the specified license area will depend on the results of the assessment work in the Severny site (Bulkur). On all the parameters, the Severny site is recognized as a priority in the implementation of the work program, however, as is known from the history of prospecting works, frequently, the expectations that were present at the beginning of exploration stage do not always turn out to be correct. Therefore, taking into account the interests of investors, it would be rational to adjust the estimated costs for this type of work in terms of reduction. To some extent, the same applies to the Centralny site of the Khatystakh license, where SRK ES recommends spacing out the prospecting drilling grid.

12.5 Assessment of the risk reduction of potential resources

The risk reduction of potential resources is associated with increasing of the exploration knowledge and confidence. Unfortunately, the use of the average thickness and other parameters of placers based on the historical data only, apparently, qualifies both projects into the class of subeconomic deposits. New data obtained by AGK in recent years and the experience of similar projects in neighbouring license areas, however, shows that both placers may have been significantly underestimated during historical works. SRK ES believes that given large amounts of historical data on the Khatystakh license area and the small amount of new AGK data (one intersection > 2 m), the latter will not have any significant impact on the size of the potential resources. Nevertheless, SRK ES believes that in the light of new data, obtained by AGK in recent years, both projects have the potential for economic diamond contents and require additional studies for the correct assessment of their prospects.

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