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Women at the Dawn of Diamond Discovery in Siberia or how Two Women Discovered the Siberian Diamond Province

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Abstract: Exploration for diamonds in the Soviet Union started in the 1940s, however it was not until the beginning of 1950s that the government acknowledged a strong need for locally mined diamonds. In this article, based on publications from Russian literature, we recount a story of two female geologists, Larisa Popugaeva and Natalia Sarsadskhih.

Natalia was the head of the mineralogical laboratory who implemented a new methodology to search for mineral indicators of primary diamond deposits. Larisa was a young geologist who joined Natalia's team in 1953.

The work of these women led to the discovery in 1954 of the first diamond deposit in the country – a kimberlite pipe “Zarnitsa”. In 1954 Natalia was unable to go into the field, therefore the discovery was made by Larisa. Credit for this discovery, however, was claimed by the higher officials from the Amakinskaya expedition, one of the largest diamond

exploration organisations in the country. Multiple efforts to restore justice did not succeed, with Larisa only being awarded the title of the “Discoverer” in 1970, and Natalia not until 1990. This article provides a description of Larisa’s and Natalia’s life up until the discovery of Zarnitsa, and a few significant events after.

Foreword

Despite being well-publicised in Russian literature, to the authors’ knowledge there are no articles dedicated to the discovery of Siberian kimberlite field in English. One of the goals of this study is to uncover this story to English-speaking readers. Another goal is to commemorate and acknowledge the great input of women into such a difficult profession as geology in the Soviet Union.

1. Short notes on Larisa’s biography. Early years

Larisa Popugaeva (nee Grintsevich) was born on the 3rd of September 1923 in Kaluga, a small town 180 km to the South of Moscow (Treivus, 2009; Yuzmukhametov, 1998). Her mother, Olga (nee Tsvetkova), and father Anatoliy Grintsevich (Fig. 1) were closely involved with the communist party. Her father fought for the Red Army during the revolution and for his entire life was a strong Leninist who believed in people’s equality and communist values. Larisa’s nickname was Ninel, the inverse of “Lenin”, and that’s what she was called by her family and friends¹.

¹ Here and below, personal information reported in this article is mostly sourced from interviews of Natalia Popugaeva, Natalia Sarsadskhih and Fyodor Belikov. The interviews were conducted by Rishat Yuzmukhametov.

43 Larisa's family travelled a lot during her childhood. In 1924 they moved to Tula, and in 1931
44 Larisa and her mother moved to Leningrad, where Larisa first went to school. In 1936 the
45 family reunited in Odessa, where Larisa's father worked in different positions for the
46 Communist Party.

47 The life of Larisa's family was typical for any Soviet family of that time, with both parents
48 being great believers in communism, full of enthusiasm to work hard and "build" a new
49 country. However, this positive spirit came to an end in 1938, when a sudden tragedy
50 happened. Like many other innocent people during the years of the 'big terror', when the
51 country lost thousands of its citizens, her father was arrested as an 'enemy of the country'
52 and sentenced to death shortly after his arrest (Silaev, 2007). Unfortunately, the
53 bureaucratic machine of that time made all family members of the political 'criminals' carry
54 the burden of the 'country's enemy' for many years ahead. Since their father's arrest, Larisa
55 and her sister Irina were considered almost second-tier people, being stripped of their rights
56 and opportunities, and only being allowed to take certain jobs. It was not until 1959, 21
57 years after his death, that Anatoliy was reinstated and his prosecution was deemed "not
58 supported by evidence".

59 After Anatoliy's arrest, the family returned to Leningrad and settled there. They were very
60 poor and lived in a single bedroom in a dormitory-style block of apartments, sharing kitchen
61 and bathroom facilities with many other families.

62 Larisa's interest in geology started in school. In year 10 (in the Russian system, students
63 completed ten years of education after which they could apply to do a university degree)
64 Larisa took a "geology and mineralogy course" and completed it with excellence. She
65 planned to do a degree in geology. However, her plans were impeded by the Second World
66 War (WWII) that started for the USSR in June 1941.

67 June 22nd 1941, when Germany attacked the USSR, was a 'canonical' date for every Soviet
68 person, when the life of ordinary people underwent dramatic changes. Most men were
69 summoned to the army, while their families were evacuated from European Russia to the
70 Urals Mountains where they worked in factories supplying the army. In the first years of the
71 war, the Soviet Army was retreating towards Moscow, while Leningrad was under siege for
72 most of the war. Huge losses made it necessary for women to also volunteer to fight, and
73 Larisa was one of them.

74 The family were on a short visit to Moscow on 22nd June 1941 and this probably saved
75 them from being trapped in the gruelling Leningrad siege. A few months later, Larisa's
76 mother and sister were evacuated to Molotov, a small town in the Ural Mountains (now
77 Perm). Larisa joined them in September and, being a person who could not be inactive, she
78 immediately applied for a geology degree at the local university (Silaev, 2007). In her diary,
79 on the 23rd of September 1941, Larisa wrote: "... I am very interested in geology and I chose
80 the faculty of geology and soil of the Leningrad State University; however, I had to leave
81 Leningrad urgently...". During the first year of studies, Larisa also completed courses in
82 nursing and firing a machine gun, and in April 1942, she volunteered in the war. Larisa
83 fought in the 89th Artillery division, whose task was to cover the air space around Moscow
84 (Fig. 2). She received multiple War awards and rank promotions and was demobilised to
85 Leningrad in the rank of sergeant on the 23rd of July 1945, two and a half months after the
86 end of the war. As soon as she returned to Leningrad, Larisa resumed her geological studies
87 in the Leningrad State University (Silaev, 2007).

88 In their memoirs, many colleagues and friends say that Larisa was very different from the
89 other students. Physically, she was short, wore a plait circled around her head and looked
90 feeble; however, she gave an unforgettable impression of a very cheerful and active person,

smiling, positive and full of life. Coming back to academia after years spent in the war, she was noticeably older than her peers; she smoked and appeared confident in the way she acted and looked.

In 1940th, the mineralogy degree at the Leningrad State University was very strong. Lecturers and professors were some of the best specialists in the country. Professor A.A. Kukhareenko introduced the students to the method of panning for heavy concentrate, which was later used by Larisa during diamond exploration. Obtaining the degree was not easy. Between September and June students learned theory in specialised topics: mineralogy, crystallography, geochemistry, petrology and others, while in summer they spent months of field training being enrolled in geological expeditions. Many parts of the USSR, particularly remote areas, did not have detailed maps, therefore there was no time to spend on dedicated student field training courses, and geology students were sent to help professional expeditions (Kostitsyn, 2016).

On the 28th of May 1950, Larisa completed her 5-year honours degree as a “geologist” specialised in “geochemistry” (Kostitsyn, 2016). She was ready to start her new life.

2. VSEGEI and Diamonds

Another peculiar procedure in the Soviet Union concerned the distribution of jobs. The jobs were provided to specialists after their graduation, but their choice of job location was very limited, and many young people had to travel far from their homes to different regions of the country. Larisa was luckily (or given the later events of her life, perhaps, unluckily) offered a mineralogist position at the All-Russia Geological Institute (VSEGEI). VSEGEI was a research institute and was subdivided into multiple expeditions working on mapping, prospecting and exploration in different regions of the country. Larisa was attached to

Tungusko-Lenskaya expedition led by a very experienced field geologist, A.A. Krasnov. Among other goals, this expedition's objective was to conduct diamond exploration and prospecting in a large area in Eastern Siberia (Fig. 3).

2.1. Diamonds in the USSR

Before delving into the details of Larisa's work at VSEGEI, we need to take a step back and to elaborate on why having a local supply of diamonds was such a vital necessity for the USSR economy.

Diamonds have been extensively used in the Russian Empire industry since the 19th century. With large industrial growth in the 1920s and 30s, there was also a strong demand for diamonds in the Soviet Union, however, this was not supported by findings of diamond deposits. Episodic diamond exploration expeditions had been taking place since the early 1920s and targeted areas in the Urals and Eastern Sayan Mountains, but it was only in 1938 that diamonds became a strategic resource prioritised by the government. Diamonds were used in drilling, radioelectric industry, tool production, optics and many other industries.

Before 1938, USSR imported diamonds costing more than two million rubles a year, and that only covered about 50% of the country's needs. Before WWII, USSR consumed roughly 23 thousand carats a year (Yuzmukhametov, 2013).

The first long-lasting government expedition for diamond exploration was formed in 1940 and it targeted the Ural Mountains. It consisted of geologists from Leningrad and Moscow and, during the period between 1940-1946, was the only organisation responsible for diamond exploration in the USSR. It is important to note that at that time diamond exploration was a rather difficult task.

137 The main rock that hosts diamonds is kimberlite, which erupts as a volcano and forms an
138 explosive crater or a diatreme with an associated dike system and deep subvolcanic root.
139 Therefore, kimberlite locations are usually referred to as kimberlite pipes. These are some
140 of the deepest originating rocks found on Earth. The stability field of diamond (as opposed
141 to lower-pressure polymorph of carbon, graphite) starts at around a depth of 120-150 km,
142 meaning that kimberlite magmas have to travel to the surface from those depths (Yaxley et
143 al., 2019). These are very unusual rocks, bound to stable and geologically rigid continental
144 regions of the Earth called cratons. The first discovery of diamonds associated with its
145 source rock (kimberlite), as opposed to the sedimentary placer deposits with often
146 unknown sources, was made in South Africa in Kaapvaal craton. Later kimberlite pipes were
147 found in Zimbabwe craton, West African craton and other locations. Kimberlites have now
148 been found in most cratons on Earth, including Antarctica (Yaxley et al., 2013). There are
149 several cratons in the territory of the former Soviet Union, with the largest one being the
150 Siberian Craton.

151 Kimberlites were first found in South Africa at the end of the 19th century. Kimberlite
152 exploration tools were slowly being developed (Williams, 1902), however none of the
153 methods were familiar to the Soviet geologists. Furthermore, the political tension between
154 the USSR and the Western block did not permit any communication or collaboration with
155 the geologists abroad. This resulted in a complete lack of any knowledge of how and where
156 to conduct a diamond search. Additionally, there was also a strong lack of knowledge about
157 diamond formation and relation to any rocks.

158 The process of diamond discovery in the USSR is significantly more complicated than for any
159 other mineral resource. As stated above, the entire exploration was purely based on the
160 local experience and that was not enough to create a comprehensive methodology.

161 Some astonishing details about that time can be found in the memoirs of a famous Soviet
162 and later Russian geologist Viktor Masaitis (2004), who worked in the diamond field and
163 lived in Leningrad (Saint Petersburg) until his death in 2019²: *“Newly arrived exploration*
164 *geologists did not receive any instructions that considering the experience from South Africa*
165 *could have significantly helped their work. They did not have any rock samples. If most other*
166 *ores could be taken into their hands and studied mineralogically and petrographically, or*
167 *could be found in multiple geological and mineralogical museums, the situation with*
168 *kimberlites was completely different. The vast majority of field geologists never saw*
169 *diamonds, let alone kimberlites. (...)*
170 *One should not forget that search for diamonds was a “secret” job and should have been*
171 *kept concealed from the “enemy”. This aura of secrecy significantly hindered the exchange*
172 *of any information, especially at that stage when there was initially very little information*
173 *about the distribution and formation of diamonds. Most of geological and topographical*
174 *maps and books on diamonds and their mining were “classified”. In every room where*
175 *geologists who were allowed to use this information were admitted, there was a special*
176 *person, usually very poorly educated, who vigilantly checked everything around them and*
177 *reported to the government officials. Obviously, nobody said the word “kimberlite” aloud, let*
178 *alone the word “diamond”.*
179 Over the following five years, the political situation was not getting better. If, during WWII,
180 Great Britain sold approximately 2800 carats of technical diamonds (charging 1 pound
181 sterling per 2 carats) to the USSR in the form of military aid, with the beginning of the “cold
182 war” this aid was no longer available (Yuzmukhametov, 2013). The only remaining way of

² Here in below, in relation to the quoted text. The text was translated in the closest possible way, however, in some instances may not be an exact translation in order to preserve the alleged meaning in Russian.

obtaining diamonds was to pay the market price, which was too financially gruelling for a country devastated by WWII. As a result, in 1946 the former head of the Urals diamond expedition M.F. Shestopalov wrote a letter to Stalin, outlining three key goals for the diamond industry:

- 1) To cease the import of diamonds into the USSR in the short term
- 2) To create a Diamond Trust and expand exploration to multiple areas within the USSR
- 3) To target every area of the country where diamonds were previously found.

Less than a month later, Stalin invited Shestopalov to the Kremlin and approved his proposal (Yuzmukhametov, 2013). Diamond exploration works were expanded to the following regions of the country: Yenisey River, East Sayan mountains, the Angara and Podkamennaya Tunguska Rivers and Kola Peninsula. Additionally, some work was planned in the Far East, in Eastern and Western Siberia, in Kazakhstan, North Caucasus and Tajikistan.

By the beginning of the 1950s, alluvial diamonds were found within a large area in Siberia between the rivers Yenisey and Lena, and a range of Moscow and Leningrad research institutes were given the task of expanding the diamond exploration in that region. This coincided with the new embargo that in 1950 the USA put on diamond trading with all countries of the Socialist block, leaving the USSR no option except to push the exploration forward at the fastest rate.

2.2. Larisa Popugaeva meets Natalia Sarsadskih

In February 1950, the Central Expedition established a branch aimed to create a “heavy fraction map of Siberian platform”. Natalia Sarsadskih (Fig. 4), an experienced geologist, was appointed as the head of this branch (Melua, 2003; Yuzmukhametov, 1998).

206 Natalia Sarsadskhih was from a family of geologists. Her father and her husband were
207 geologists, and both of her children later chose the same profession. All members of the
208 family graduated from Leningrad (currently Saint-Petersburg State University).
209 Natalia graduated as a geologist and petrographer.
210 After graduation in 1938, Natalia was offered her first job at Solikamsk (Perm region), where
211 she had a chance to try herself as a mineralogist. During WWII, together with her husband
212 and a 1-year old son, she was evacuated from Leningrad to Urals. In contrast to Western
213 culture at that time, it was not uncommon for Soviet women to keep their maiden name
214 after marriage. For instance, Natalia was married to a famous geologist, Alexander
215 Kukhareenko, yet, kept her maiden name Sarsadskhih. The family settled in a small village of
216 Kusye-Alexandrovsky, the headquarters of Diamond expedition of Urals. Natalia's husband
217 became the head of the mineralogical laboratory, while Natalia started working in the same
218 laboratory as a mineralogist.
219 In the Soviet system there was a clear distinction between a geologist and a mineralogist.
220 Geologists were more specialised in field mapping and an exploration, while mineralogists
221 were more orientated toward laboratory analysis of the rocks and minerals brought from
222 the field. Communication between the two was not always clear and transparent, which
223 inevitably led to mistakes and poor decisions about the locations for the next exploration
224 season.
225 Natalia returned to Leningrad in 1945 where she started working as a mineralogist. Natalia's
226 first trip to Siberia was in 1948, when she agreed to spend one field season in diamond
227 exploration.
228 After being appointed the head of the "heavy fraction" laboratory, Natalia's task was to
229 investigate the heavy fraction of the basement rocks in the Siberian platform and to link it

230 to the alluvial minerals. Additionally, the goal was to locate mineral-indicators of diamonds
231 in the potential alluvial diamond deposits. The scale of the map was supposed to be
232 1:500000, which was an enormous task for an area of almost 1500 km in length
233 (Sarsadskhih, 1997; Sarsadskhih, 2004).

234 In the summer of the same year, Larisa was working in the Lower Tunguska region in
235 Krasnov's expedition. This is how she first met Natalia Sarsadskhih, who spent some time in
236 the same expedition.

237 In April 1951, Larisa changed her job and also started working in the VSEGEI branch of the
238 Central expedition. The main reason for this move is still unknown, however it was likely
239 due to the pressure created by her status of a daughter of the "country's enemy", that
240 prevented her from working on certain jobs, in particular those that had "classified"
241 information. That year she travelled to the Polar Urals on a task unrelated to diamond
242 exploration (Kostitsyn, 2016).

243 In spring 1952, Larisa and her future husband Viktor Popugaev moved in together, and in
244 September Larisa gave birth to daughter Natalia. Larisa called her after her dear friend
245 Natalia Sarsadskhih. On the same day, the 27th of September 1952, Larisa and Viktor got
246 officially married, and Larisa changed her family name from Grintsevich to Popugaeva. This
247 marriage was not the most successful as her husband used to drink excessively. Later, he
248 also changed his career to academia and worked as a lecturer in the engineering institute of
249 Leningrad. Viktor outlived Larisa by 17 years.

250 From the memoirs of Larisa's daughter Natalia: *"The entire history of the discovery of*
251 *Zarnitsa I learned only after my mother's death. She used to repeat the same phrase: "don't*
252 *be afraid of your enemies; in the worst case, they can kill you. Don't be afraid of your friends;*
253 *in the worst case, they can betray you. Be afraid of those who are indifferent. They do not kill*

254 *and do not betray, but from their quiet consent, there happen betrayals and murders". For*
255 *me, my mother's main qualities were emotionality and honesty. She really loved children and*
256 *animals. During my mother's short life she helped a lot of people. I was always amazed by*
257 *how fully she dedicated herself to work. Nothing could stop her – neither her husband nor*
258 *her daughter..."*

259 *2.3. The 1953 field season and Larisa's first diamond-exploration expedition*

260 In spring 1953, Natalia Sarsadskhih received a letter from Larisa requesting she join her on
261 the field trip to Yakutia. Natalia agreed to include Larisa on her expedition, and from the 1st
262 of April 1953, the two women started working together. For the following year and a half,
263 Larisa and Natalia became the closest of friends going through the tough field work
264 conditions in Siberia together.

265 As mentioned earlier, Natalia addressed diamond exploration from the mineralogical side;
266 her main goal was to find a mineralogical exploration tool, in particular mineral-indicators of
267 diamondiferous rocks. Thorough study of previous findings made her believe that previous
268 conclusions about mineral indicators were inaccurate, therefore the entire 1953 field
269 season was aimed at a new search. For this purpose she chose the upper Markha river, not a
270 random location, given that in the lower Markha river the diamonds had already been
271 found.

272 Getting to the location was not a trivial task. The first leg of the journey was to fly to
273 Yakutsk, a major city and the capital of Yakutia (Sakha Republic) (Fig. 4), then a local flight to
274 the small town of Olenek, located on the Olenek river (Fig. 5), and from there 250 km of a
275 journey through taiga, heading south towards river Daldyn, a tributary of Markha, using
276 local reindeer to carry the food and supplies. The actual work was supposed to be carried

277 out along the two rivers, Daldyn and Markha (Fig. 5), collecting the river sediment and
278 panning it for the heavy fraction.

279 The expedition started in late June, when both Larisa and Natalia flew to Olenek, and they
280 only reached Daldyn by mid-August.

281 In 2007 Larisa's daughter Natalia found her mother's diary from this trip and below, we will
282 list some of the entries. The entries between July and mid-August were made during a 250
283 km hike between Olenek and river Daldyn.

284 *26.07.53 – we sleep in tents, laying on the ground everything we can because only 10 cm*
285 *below the moss is permafrost or permanent ice. It is very cold at night, while during the day*
286 *it is unbearably hot. Along the route, we see the same limestones; there are a lot of trap*
287 *fragments³. Our caravan consists of 43 reindeer, out of these, five sled reindeer called*
288 *“uchugs” are assigned to our expedition. I have a lucky one: ugly, with small horns, but a*
289 *very frisky one. At first, I was not getting along with it, but now I have got comfortable, and*
290 *my feet are not getting too tired. It is the first time in seven years of my work that I have a*
291 *reindeer to ride during a field trip*

292 In her memoirs, Natalia Sarsadskhih wrote:

293 *“Larisa and I at times allowed ourselves to ride reindeer. However, this “rest” was very*
294 *doubtful; we were not told how to ride a reindeer. Once, when stopped at an outcrop, I*
295 *unleashed a reindeer and wanted to climb on it from a stump. That didn't go well. It kicked*
296 *me from the saddle and ran after the rest of the reindeer herd. I suddenly felt a sharp pain in*
297 *my lower back and barely crawled back to the base. That frightened me a lot because I was*
298 *not alone, my unborn daughter was travelling with me. I was afraid for her”.*

³ Larisa refers to the trap basalts that cover the area

299 Natalia's statement shows how strong these women were and how much hardship they had
300 to go through doing their job. Pregnancy was not an excuse not to take a 3-month long trip
301 to gruelling conditions in Siberia: to be bitten by midges and mosquitos, to starve, to pan
302 buckets of sediment in freezing cold water, or to set up tents in snow not having proper
303 clothes and boots.

304 The 250 km journey between Olenek and Daldyn river was exhausting. Continuing Larisa's
305 diary:

306 *1.08.53. We are trying to get close to river Siligir⁴, hoping for better hunting and fishing,*
307 *because now we do not have many supplies left, and the food is vanishing very fast.*

308 *11.08.53. The time flies so fast, and we are still far away from work. The reindeer are lost.*

309 *Hunters search for their reindeer, while the latter are running in search for mushrooms.*

310 *Today we ate three ducks. But in general – it's a dense and lifeless taiga. I feel fearful and*
311 *pitiful.*

312 *15.08.53 We haven't moved from this spot for three days. Terrible, and everything is futile.*

313 *We are missing 19 reindeer. We are consuming the groceries, while the work isn't being*
314 *done. I really want to go home. We still have 60 km to Daldyn. Yesterday we searched for*
315 *reindeer, walked about 10 km and found only three of them. It is cold, and it rains all the*
316 *time.*

317 *26.08.53. We finally got to Daldyn. It's beautiful here. Taiga is dressing into its autumn*
318 *decor. The grass is dark-red. We have panned some sediment.*

319 *30.08.53. In the morning I planned to go into a 4-day long route without the sacks, only with*
320 *a tent. Grrrrr... I can only imagine... The weather is terrible. It does not stop snowing.*

⁴ Siligir is a tributary of Olenek River, see Figure 4.

321 05.09.53. *Nothing has changed; we sifted about 100 buckets of sediment. It is cold, but it's*
322 *tolerable.*

323 14.09.53. *I am in a tent. The boots are torn to pieces. Outside the tent the snow is up to the*
324 *knee. It looks nice and soft, but if you step into it, it's grrrrr, cold. Today we'll have to walk*
325 *another 20-25 km through the snow, but this is not the worst. There's barely any food left.*
326 *It's been three days already that we didn't have any bread. We're using flour to make soup.*
327 *But it's all right, we'll cope! I really hope that today's hunt will be successful.*

328 20.09.53. *It's frosty, the river has frozen near the banks up to 15 metres, and we have*
329 *another 900 km to raft. There is no more food left, only a few cans of preserves and some*
330 *salt. In 8 days my daughter is turning one – such a big girl, such a pity that I am not at home.*
331 *How is my family going to celebrate this day?*

332 After reaching Daldyn, Larisa and Natalia split into two groups; Natalia went on a route
333 along river Sytykan, which flows parallel to Daldyn, while Larisa and her assistant Fyodor
334 Belikov were rafting along Daldyn.

335 Fyodor had a remarkable background. Being twelve years old, he faked his documents (to
336 appear older), travelled from Ukraine to Leningrad and got a job in forestry. During WWII he
337 served as a driver and, after the war ended, carried on his job as a driver for the Central
338 geological expedition. The head of the expedition allowed Fyodor to spend the summer
339 season doing field work to earn a little more money.

340 While working in Daldyn river, Larisa and Fyodor panned about three cubic meters of sand.
341 This is 300 10-liter buckets. Even if the sand is clean and does not contain any mud, this job
342 would take about 150 hours of work (Kostitsyn, 2016).

343 Having regrouped, the geologists stopped in a village called Shologontsy, 130 km to the
344 south from Daldyn's estuary. By that time, the village was abandoned and hosted only a

geological base. Later in 1975, during an interview, Larisa confessed that they arrived at Shologontsy so hungry that she stole a loaf of bread from one of the local geologists. Together with Fyodor, she immediately ate it.

The geologists at Shologontsy had photoluminescence equipment. Larisa investigated the heavy fraction sifted at Daldyn river and found a small diamond crystal. They were delighted. Natalia remembered that she and Larisa were dancing with happiness when they discovered this diamond. One of their dreams had come true. They found a diamond!

From Shologontsy, they flew to Nyurba, a town that hosted the headquarters of the Amakinskaya expedition, the main diamond exploration party in the USSR (Yuzmukhametov, 2010). Given the degree of rivalry between the expeditions located in different cities, the relationship between Leningrad and Nyurba geologists was relatively cold. Therefore, the geologists tended not to share any information about their exploration routes and discoveries. As this field work was led by Natalia, she was very vigilant and experienced, minimising communication with the Amakinskaya group. The following year, Larisa would make the mistake of being much more open, and pay a high price.

On their way to Leningrad, Natalia and Larisa stopped for a few days in Irkutsk. There, Larisa met with Natalia Kind and Ekaterina Elagina. These two women were future discoverers of the second largest diamond mine in the USSR – the Mir kimberlite. They became very close friends with whom Larisa kept close contact for the rest of her life.

The 1953 field season was over, and it brought one diamond.

2.4. 1954 field season. Leading the exploration

As stated earlier, one of the main difficulties in the exploration work was the lack of any exploration methods that target diamonds. While in South Africa it has long been known

369 that chromium-rich purple pyrope garnets were the key indicator minerals, in the Soviet
370 Union, this mineral was largely overlooked. This was not entirely due to the lack of evidence
371 or knowledge, but partially due to the fear of taking any responsibility and proposing
372 something new, especially based on the experience of western geologists. As an example, in
373 1938, A.P. Burov, a leading diamond exploration geologist in the USSR between 1937 and
374 1956, prepared a report in which he stated that *“the most typical minerals that accompany*
375 *diamonds are olivine, ilmenite, chromite, pyrope, phlogopite, perovskite and diopside”*
376 *(Strnad, 1991)*. All these minerals are typical for kimberlites, and if this report had been
377 published, it would have substantially helped future exploration. However, Burov decided
378 not to expose it and the report was only found in 1992 in archives. Historians hypothesised
379 that the reason this report was never published was that, earlier in 1937, two experienced
380 diamond exploration geologists who proposed to link parental diamondiferous rocks in the
381 USSR to the similar rocks reported by South Africans, were arrested. Back in those times, it
382 took as little as a minor complaint by someone to be arrested and prosecuted.

383 Coming back to Natalia and Larisa’s expedition, in the heavy fraction they found both
384 ilmenite and pyrope, however pyrope was not a well-known mineral, and although
385 determined as garnet, it only reminded the geologists of the so-called “bohemian garnets”
386 found in Bohemian massif in Czechoslovakia. The only samples of African kimberlite-derived
387 pyropes were kept in the Department of Mineralogy of the Leningrad State University.
388 These samples derived from Jagersfontein kimberlite pipe and were bought by the Russian
389 empire in 1912. Alexander Kucharenko, Natalia’s husband, had access to those pyropes.
390 However, as a rule in their family, they decided not to bring work home and , therefore,
391 Alexander was not familiar with Natalia’s projects. Surprisingly, it was Larisa who contacted

392 Alexander to compare minerals found in Daldyn River with the pyropes from Jagersfontein
393 mine. They were identical.

394 Later Natalia Sarsadskhih wrote in her memoirs: *"I only learnt about pyropes from Alexander*
395 *when he came home from work. That evening Larisa visited us. Our second dream came true*
396 *– we found mineral-indicators of diamonds – and consequently, we now have an exact area*
397 *where to search for kimberlites. We have excellent results! The task of our 1953 expedition is*
398 *fully accomplished! There is no end to my and Larisa's joy!"*

399 This discovery set the goals for the 1954 expedition. Geologists had to return to the area
400 and pan the heavy fraction along Daldyn River basin. The rationale was the following: the
401 number of minerals, ilmenites and pyropes in the heavy fraction will depend on the
402 proximity to the ore body. Pyropes are more resistant to transportation than ilmenites, and
403 additionally, being red, or purple, they are easier to notice. Therefore, Natalia called this
404 "pyrope mapping", or a "red guiding thread", which was supposed to lead to the diamond
405 ore body.

406 The "panning of heavy mineral concentrate" revolutionised diamond exploration in the
407 USSR. Importantly, it was incredibly cheap and mainly required labour.

408 In February 1954, Natalia gave birth to a daughter, Lena, which made it impossible for her to
409 travel to Daldyn. Natalia hoped to ask Larisa to do this work, but Larisa suddenly refused.

410 Later, Natalia wrote that Larisa was very distressed, and that she apologised for not being
411 able to go, visited Natalia at home and cried. Natalia tried to convince Larisa that they
412 should finish the work that they started, while Larisa was saying that she would not cope
413 alone. It was only later that Natalia found out the two main reasons for her refusal, Larisa
414 applied to do a PhD in Leningrad Mining Institute, but more importantly, she was pregnant
415 with her second child, and she had not dared to tell anyone. Therefore, being torn between

416 her life, family and work, she was stressed and upset. Eventually, Larisa's hardworking and
417 heroic nature took over; she had an abortion and started getting ready for her Siberian trip
418 (Kostitsyn, 2016).

419 Another problem arose from the bureaucracy. The abovementioned head of the Central
420 expedition, Burov, refused to financially cover the trip because the Daldyn location was not
421 in the plan for exploration works in 1954 (Elagina, 2003). Larisa only managed to find money
422 for two members of the expedition – herself and her loyal assistant and good friend Fyodor
423 Belikov, who did the field work with her during the previous year. But even that money did
424 not come from one source. Larisa had to be partially funded by the rival Amakinskaya
425 expedition, while the head of Tungusko-Lenskaya expedition, Ivan Krasnov, covered
426 Fyodor's subsistence and travel (Sarsadskhih, 1990; Sarsadskhih, 1997; Sarsadskhih, 2004).

427 These details to the story are important, because it was this connection with the
428 Amakinskaya expedition that later allowed the head geologists of this organisation to assign
429 Larisa's discovery to themselves.

430 Larisa left for the field at the end of June 1954, accompanied by Fyodor and her husband,
431 who was worried about Larisa and preferred to travel with her (Kostitsyn, 2016). However,
432 according to Larisa, her husband was more of a burden and, therefore, she asked him not to
433 continue the trip and to return home. In Nyurba, geologists collected all the necessary
434 "equipment" for the trip: bucket, shovel, pickaxe, a tray to pan the heavy fraction, and a
435 magnifying glass. They also picked up a homeless dog Pushok, whom Larisa managed to take
436 on the plane to Daldyn, making this dog a witness to the first kimberlite discovery in Siberia
437 (Fig 5). The field work lasted until September 1954 (Fig. 6a).

438 While staying in Nyurba and waiting for the plane to Daldyn, Larisa did not make a secret of
439 the previous season of work. She told her peer geologists from Amakinskaya expedition

440 about Daldyn, diamond and pyropes (Treivus, 2014). Many of her friends called her naïve,
441 but is it really naïve to trust your colleagues and to share your achievements with others?

442 Already in the field, Larisa wrote a short poem that tells us about women-geologists in the
443 field:

444 I live in a tent as a man,

445 I wear men's boots

446 Lumps of mud get stuck to them

447 Creating circles in water

448

449 I touch a quiet rock

450 When taiga is humming in rain

451 And geologists say that this rock

452 Is the same rock as in my chest

453

454 As a pine in the wind,

455 I succumb to tension

456 It is difficult for me

457 To be such as a man

458

459 I would really want

460 Even for a moment

461 To fall into your arms

462 And to be weak again.

463

464 This season's field work was not the same as in the previous one. From time to time, Larisa
465 and Fyodor had unexpected visitors from the Amakinskaya expedition (Fig. 6b) (Treivus,
466 2014). Higher authorities explained this with the reasoning that Larisa needed help, nobody
467 doubted that geologists in Nyurba realised how close Larisa was to discovery. The head of
468 the Amakinskaya expedition A. Bondarenko could not allow a "stranger" from Leningrad to
469 take the glory of discovery. Therefore, he sent his people to check on her and to follow her
470 routes along the river.

471 Once, when Larisa saw four more tents in her camp after another long route, she and
472 Fyodor collected their tents and went a different way. She could not tolerate an increasing
473 number of guests.

474 This field season was somewhat better than the previous one in respect to the supplies. In
475 her letter to her mother, Larisa wrote that the entire summer they had meat, because
476 Fyodor hunted two reindeer (Treivus, 2014).

477 Larisa and Fyodor crossed Daldyn and went towards a creek called Dyakha (Fig. 7). It should
478 be noted that in her work Larisa did not have any mercy on herself. She went into the taiga
479 without sleeping bags, far from their tents, and frequently spent nights just sitting under the
480 sky. Her hands were scratched and knees were full of laches because she searched for
481 pyropes sitting on her knees. Along Dyakha, Larisa and Fyodor found a lot of ilmenites.

482 Larisa made a correct conclusion that the parental rocks should be somewhere in the
483 watershed of these two rivers – Daldyn and Dyakha.

484 From Fyodor Belikov's memoirs: *"We climbed to the top of the hill. Larisa immediately found*
485 *an ilmenite there. Ah, what was next? We started to search the moss, even forgot to smoke.*
486 *There were a lot of ilmenites there, and Larisa said: "What a mysterious place! Let's go down*
487 *towards the river, rest, and return here in the morning". The next day we spent on this hill,*

488 *while the following day we went towards a small valley with short and rare larches. By*
489 *lunchtime, it had started raining. We had a piece of tarpaulin and used it as a cover. To*
490 *warm up, I decided to light a fire and heat up a large stone, so that it would act as an oven. I*
491 *lit a fire and invited Nelya⁵ to stay next to this stone below the tarpaulin. She sat down and*
492 *suddenly jumped, picking up a magnifying glass: “Look, Fedyunya! ⁶ Blue mud, and full of*
493 *pyropes”.*

494 This was the first kimberlite pipe found in Siberia. Larisa and Fyodor took samples and
495 erected a post, under the post they left a note stating that here they found a very rich
496 pyrope-ilmenite and possibly a diamond deposit.
497 The pipe was called “Zarnitsa” by geologist M. Gnevushev, which means a distant, sudden
498 and ephemeral flash in the sky, a gleam of a distant thunderstorm. Larisa Popugaeva herself
499 was as a “zarnitsa”, a “gleam” in the diamond history of the USSR. Larisa wanted to call the
500 pipe “pipe of Shestopalov” commemorating the name of the chief of the Central expedition,
501 who died in 1954.

502 *3. “Had I known what would happen, I would have never wanted to*
503 *discover Zarnitsa”.*

504 It was the end of 1954 and time to return to Leningrad. Larisa and Fyodor took 60 kg of the
505 heavy mineral concentrate, carrying them in rucksacks, and specimen of the found rock.
506 Larisa could not contain her feelings: “*Flowers and champagne are waiting for me!*”.

⁵ Here and below, Nelya is a shortened diminutive version of Ninel, Larisa’s nickname given to her by her father. In fact, Nelya is a version of a different Russian name Nelly, yet Larisa seemed to have adopted this short name among her friends and colleagues.

⁶ Fedyunya is a diminutive form of Fyodor, usually used for children or very close friends.

507 On their way back they stopped in a little town Yaralin, from where the plane was supposed
508 to take them to Nyurba. According to local geologists, Larisa was impatient to check that the
509 heavy mineral concentrate collected near Dyakha contained diamonds. Therefore, she went
510 directly to Yaralin, where the plane could collect her faster than in Shologontsi, the place
511 where she and Natalia stopped in 1953 (Kostitsyn, 2016).

512 In Yaralin they found one diamond in the heavy concentrate, which confirmed that the
513 found ilmenite-pyropite deposit was diamond-bearing. Yaralin was also considered fatal for
514 the future of Larisa and her work. Nobody knows what happened and what plans Larisa had,
515 but knowing that she discovered a diamond-bearing location, most likely a diamond deposit,
516 she did not contact Natalia and did not send her a rock sample. In fact, Larisa spent more
517 than two months in the taiga and never sent a single message to Natalia, who was
518 desperately waiting for the news.

519 Later Natalia wrote that it was from another geologist who incidentally was in Leningrad
520 that she found out about Larisa's discovery. Natalia was shocked and devastated by the fact
521 that her best friend had never got in touch with her, and that the only hand specimen she
522 had was transported to Leningrad by a distant person. *"How could Larisa share this*
523 *specimen with him and not with me?"* wrote Natalia.

524 By the time Larisa arrived at headquarters of Amakinskaya expedition Nyurba, the decision
525 had already been made. The superiors decided to force Larisa to quit her job for the Central
526 expedition in Leningrad and to sign up as an employee of the Amakinskaya expedition. That
527 would allow them to claim the discovery and to keep Natalia and Leningrad's expedition
528 away.

529 The events that happened in Nyurba during the following few months, although recorded
530 quite well, do not depict the exact detail of the situation. It is well known that Larisa was

531 threatened, blackmailed and not allowed to fly back to Leningrad. She could only travel back
532 to her family after she signed all the papers assigning the discovery to the Amakinskaya
533 expedition.

534 A fellow female geologist from this expedition Natalia Kind wrote: *"In Nyurba they drove*
535 *Nelya to hysteria"*. A large report issued immediately after the field work and sent to the top
536 officials stated that Amakinskaya expedition had discovered two diamondiferous fields in
537 the region. In the meanwhile in Leningrad, Natalia Sarsadskih was not aware of the events
538 occurring in Nyurba. Only later in October she received a telegram congratulating her on the
539 great achievements of her group. Larisa never wrote to her. Natalia was absolutely sure that
540 it was due to Larisa's vanity, pride and desire to be the only discoverer that she did not want
541 to communicate with Natalia any more.

542 From the memoirs of Ekaterina Elagina: *"Being a difficult, stressful condition, Popugaeva*
543 *was so frightened that she was afraid to talk to anyone. (...) The officials lost their patience*
544 *and promised her that she would never see her daughter or husband again, and would share*
545 *her father's destiny"* (Elagina, 1999; Elagina, 2003).

546 Ultimately, Larisa gave up and signed the documents transferring her to Amakinskaya
547 expedition. This gave the priority of the first kimberlite pipe discovery to an organisation
548 that did not have any rights to claim it. Moreover, the geologists from Amakinskaya
549 expedition had removed the post set by Larisa and Fyodor and announced that the location
550 was incorrect, moving it 200-300m to the side.

551 Only after signing the documents was Larisa allowed to travel back to Leningrad, where she
552 was not well-received.

553 In December 1954 - February 1955, Larisa and Natalia worked on the field report, compiling
554 Larisa's field results. However, Larisa was still employed by the Amakinskaya expedition, and

555 Bondarenko was demanding her return to Nyurba. At the end of April 1955, Larisa flew to
556 Nyurba and worked the 1955 summer field season in the close vicinity of Zarnitsa,
557 continuing to work in diamond exploration. She also worked the 1956 field season in the
558 same area. It was not until the end of 1956 that Bondarenko agreed for Larisa's transfer
559 back to the Central Expedition, which at that time had its headquarters relocated to VSEGEI.
560 Larisa could finally return to Leningrad.

561

562 4. Burden of being the first

563 Natalia never forgave Larisa for changing affiliation. This event haunted her for her entire
564 life, poisoning her relationship with her colleagues and making her change the job and leave
565 the diamond exploration field.

566 Many people later stated that although Larisa behaved disrespectfully, she was
567 manipulated, forced and ultimately threatened. This was not a willing choice and she
568 certainly was not driven by a desire to have all the glory to herself. In 1954 Larisa was a 31-
569 year old young professional who conducted her first independent field work. Defending
570 herself in front of much older, more experienced and forceful superiors was not easy.

571 During the following years, Larisa tried to reconcile with Natalia and to re-establish justice.
572 She talked to people, wrote letters to the higher officials and tried to publicise Natalia's
573 achievement.

574 To slightly smooth the conflict, in 1955 Natalia and Larisa received an official thank you and
575 award of one-month payment for conducting exploration work in the 1953-1954 seasons.
576 Fyodor Belikov also received a thank you and two-months' salary (because his salary was
577 substantially lower than the lead geologists of the trip).

578 In April 1957, six leading male geologists of Amakinskaya expedition received one of the
579 most prestigious Soviet awards – the Lenin Prize. However, both Larisa (although
580 acknowledged as a discoverer) and Natalia were left aside (Yuzmukhametov, 1998;
581 Yuzmukhametov, 2004). It should be noted that a “mineral deposit discoverer” was an
582 honoured title in the USSR.

583 In the summer of 1955, using Larisa’s and Natalia’s panning method and data, three other
584 kimberlite pipes were discovered in the region: Udachnaya, Mir and Sytykanskaya. Neither
585 woman was ever acknowledged for these discoveries. Three years later, by the end of 1958,
586 there were already 120 pipes registered, and within the first 25 years after the discovery of
587 Zarnitsa, the total number of registered kimberlite pipe in the Yakutian province reached
588 450 (Strnad, 1991).

589 In 1957 Larisa wrote a letter to Nikita Khrushchev, the leader of the USSR, requesting to
590 investigate the events of 1954. The reply was disappointing, the government committee did
591 not find any law infringements and hence the reason to revert to the prize awardees.

592 Yet, during the next round of government awards, Larisa was granted with the Order of
593 Lenin, the highest civilian award by the Soviet Union, and Natalia received The Order of the
594 Great Banner of Labour, an award given for services to the country and society. None of the
595 women were recognised to be the discoverers of diamonds in Siberia.

596 In 1970 Larisa finally received the status of the Discoverer of a mineral deposit. On the 16th
597 of April 1970, she was granted a diploma “For discovery of diamond deposit kimberlite pipe
598 Zarnitsa in Yakutskaya ASSR”.

599 Only some 35 years later, in 1990, did Natalia receive the same status. Also, a large diamond
600 found in Yakutia diamond province was named in honour of Natalia.

601 The price of this discovery ended up being enormous. Larisa and Natalia could not continue
602 in the diamond exploration field and, importantly, lost each other as friends. The bright
603 flashing light of “Zarnitsa” had separated them forever.

604 In 1970s the news of Larisa’s discovery and her name were widespread all over the world. In
605 1973 alone her name was mentioned in more than 100 Soviet and international
606 publications, there were radio and TV programs dedicated to her. Larisa did not like being a
607 celebrity. She rejected the proposal of a Moscow sculptor Vera Isaeva to erect her
608 monument. In her letter to Vera Isaeva, Larisa wrote: *“Yes, I happened together with Fyodor
609 Belikov to discover the first diamond deposit in the USSR. (...) However, the subsequent
610 events, linked to this discovery, brought into my life such a huge amount of dirt, careerism,
611 lies and distorted facts that I cannot speak about this topic without bitterness and deep
612 insult. Don’t misunderstand me, for God’s sake, Vera Vasilyevna. You will find many subjects,
613 who would like their faces and bodies captured. Bless them. They, perhaps, should be
614 carolled and sculpted. But this is not for me”.*

615 5. New job and new life.

616 After returning to VSEGEI in 1956, Larisa was treated as a traitor, and eventually was
617 compelled to quit that job. In 1957 she started a PhD in mineralogy in the State Mining
618 Institute, supervised by a famous mineralogist professor Grigoriev. The topic of her PhD
619 research was related to the mineralogy of Zarnitsa and Udachnaya kimberlite pipes. In 1960
620 Larisa finished the PhD programme and started her work in the Central Research Laboratory
621 of Gemstones and Semiprecious stones. It should be noted that her PhD defence (or viva)
622 would not take place until 1970.

623 In the Central Research Laboratory of Gemstones and Semiprecious stones Larisa became
624 the head of the group that consisted only of two people, including herself. She turned 37
625 that year, and her life was not easy. Her family included her elderly mum, young sister,
626 husband and an 8-year old daughter. All of them lived in two rooms in a shared communal
627 flat that overall had six rooms. At around that time, Larisa ran into a friend, who later
628 described that meeting: *"Larisa was dressed very poorly, one could notice that her life was*
629 *difficult"*.

630 These stressful events and her difficult life left their mark. Larisa developed hypertension. In
631 1971 she was first admitted to hospital and stayed there for four months. Her friends
632 noticed that after that event she could not work as hard as usual.

633 In 1974 Larisa's family was offered a 3-bedroom flat – a luxury for those times, perhaps –
634 triggered by her award.

635 Later in 1974, she was admitted to the hospital again, with a diagnosis of aortic valve
636 sclerosis. She had been suffering from headaches for a long time, as well as severe pain in
637 her neck, which she thought was a consequence of carrying very heavy backpacks on
638 fieldtrips. Doctors forbade her to smoke, but she never adhered to this advice.

639 Larisa's last visit to Moscow was in September 1977, two weeks after her 54th birthday. She
640 had a work-related trip, but as usual, she stayed at her friend Natalia Kind's flat. Her
641 husband and daughter waited for her on the platform when she returned to Leningrad by
642 train. She went straight to work, and on her way home from work decided to buy a few
643 groceries. She never got home. Larisa died instantly on the street from aortic aneurysm. She
644 was buried in Leningrad (Fig. 8).

645 Natalia Sarsadskih lived in Leningrad (later Saint-Petersburg) for the rest of her life and died
646 in 2013 aged 97.

647 Fyodor Belikov never travelled to Yakutia again until 1985, when he was invited to star in a
648 documentary film – “Yakutian Diamonds”. He lived his entire life with his wife in a shared
649 communal flat on Vasilyevskiy Island in Leningrad. His “house mate” was an aggressive
650 alcoholic, while Fyodor worked as a driver of a waste disposal truck. The last “celebration”
651 in Fyodor’s life occurred in summer 1994, when he was invited to celebrate 40 years since
652 the discovery of Zarnitsa. He died in the beginning of 1995.

653 6. Legacy

654 The story of Larisa’s life and diamond discovery was largely publicised. There were multiple
655 authors, both geologists and historians working on the topic, recovering letters and notes
656 from archives. A few films, both fiction and documentary, have been released in the last 20
657 years.

658 Exploration for diamonds in the field is still continuing and multiple kimberlite pipes have
659 been found in the area by many expeditions and parties since the Zarnitsa discovery
660 (Yuzmukhametov, 2006; Yuzmukhametov, 2010).

661 The first monument to Larisa was erected at the beginning of the 1990s in the town of
662 Mirniy, built around the kimberlite pipe Mir.

663 In spring 2006 at VSEGEI there was a large celebration of Natalia Sarsadskikh’s 90th birthday.
664 Natalia raised her glass and drank to Nelya Grintsevich, the name she used to call Larisa.

665 In 2007 a school in a small town of Udachny in Yakutia was named in honour of Larisa.

666 In 2011, in the museum of the State Saint-Petersburg University, an archive was created
667 dedicated to Larisa Popugaeva – the most famous graduate of this university during the last
668 100 years. The archive contains Larisa’s photos and personal documents and the documents

related to her work in the Central Research Laboratory of Gemstones and Semiprecious Stones.

Larisa Popugaeva and Natalia Sarsadskhih are well-known and remembered in VSEGEI and across geological institutions in Russia. These two women inspired several generations of Soviet and Russian geologists. Today VSEGEI employs hundreds of geologists and engineers, among whom around 50% are women.

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The story of “Zarnitsa” has already been told by many authors. There are excellent books by Kostitsin, Treibus, Masaitis, Sarsadskhih, Elagina, Silaev and others. The authors apologise if any of the publications are missed from the reference list.

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731 Figure captions

732 Fig. 1. Olga Grintsevich (a) and Anatoliy Popugaev (b), Larisa’s parents.

733 Fig. 2. Larisa Grintsevich (a) after graduating from school, June, 1941 (from Kostitsyn, 2016).
 734 (b) In the army, December 1942 (from personal archives of Natalia Popugaeva)

735 Fig. 3. Current day map of Russia with the region of Tungusko-Lenskaya expedition
 736 mapping area highlighted in red. The map is adopted from Wikipedia and is in public
 737 domain. Leningrad (now St. Petersburg) is denoted with green circle.

738 Fig. 4. (a) Natalia Sarsadskhih, 1953 (from Kostitsyn, 2016). (b) Natalia Sarsadskhih (right)
739 and Larisa Popugaeva (left) with geologists from Yakutian meteorological station om
740 Shologontsy, 1953. At the front –Larisa’s favourite dog called Verniy (“faithful” in Russian)
741 (photo from Treivus (2014).

742 Fig.5. Part of Eastern Siberia with the area where the diamond exploration was conducted
743 (see text for description). With stars are shown some of the largest kimberlite pipes of the
744 area. Kimberlite pipes are shown in stars with Zarnitsa (1) as a red star. 2 – Udachnaya, 3 –
745 Sytykanskaya, 4 – Yubileynaya, 5 – Aikhal, 6 – Druzhba, 7 – Internatsionalnaya, 8 – Mir,

746 Fig.6. 1954 field season. (a) Larisa in the field – September 1954. (b) Larisa, Fyodor and
747 Pushok in the field during the visit of the authorities from Amakinskaya expedition. August
748 1954.

749 Fig.7. A sketch of the main geological routes Popugaeva took in 1954 along the river Daldyn.
750 Adopted from Treivus et al., (2014)

751 Fig. 8. Larisa Popugaeva’s grave in Saint Petersburg (from Kostitsyn, 2016).

752

753

754