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The Innokenty Lopatin and Friedrich Schmidt 1866 Yenissei ('Turukhansk') expedition: the first evidence of discovery of Norilsk-Talnakh Cu-Ni-PGE deposits

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Abstract. The history of the the discovery of world's largest Ni-Cu-PGM deposits of Norilsk-Talnakh is revised. The 1866 prospecting and geographic expedition of Innokenty Lopatin and Friedrich Schmidt, studied the lowest Yenissei territories, and collected information and mineralogical samples (chalcopyrite from 'copper slates') proving by this the presence of a copper ore deposit in the Norilsk mountains. The deposit was developed by at least two adits since 1865 and was managed by brothers Pyotr and Cyprian Sotnikov from the settlement of Dudino (now Dudinka). This information was documented in the diaries by I. Lopatin and was reported by F. Schmidt in transactions of the Saint Petersburg Academy of Sciences. After the 're-discovery' of the deposit in the 20th century the followers have ignored, omitted and incorrectly cited the information published by Friedrich Schmidt in 1869 and 1872, as well as its republishing made by Vladimir Obrutchev in 1917. The real sequence of events resulting in the discovery of Norilsk deposits has to be rewritten.

In memoriam of Sergey Gorbunov (1952–2021), archaeologist, traveler, Sakhalin history specialist

1. Introduction

The deposits of Norilsk-Talnakh (Norilsk-1, Oktyabrskoe, and Talnakh) are known as the largest nickel-copper-palladium deposits in the world. The history of their discovery has been represented in various publications since early 1920's as a result of prospecting works headed by Nikolay Urvantsev [4 et al.], a geologist and pioneer of the Russian North, who studied hard-to reach the territories near the Arctic Ocean on the Taymur peninsula. N. Urvantsev was the only officially recognized first-discoverer of the Norilsk group deposits (1920) up to early 1990's when the equal collaboration between him and the Siberian entrepreneur and anti-communist political activist Alexander Sotnikov was revealed.

From the contemporary point of view the Norilsk group deposits are mainly considered as the world largest source of platinum group metals (PGM), especially palladium. However, the presence of PGM was first reported in the Norilsk ores only in 1923 during the late stages of exploration. The real

economic potential of PGM in Norilsk deposits was confirmed in 1930's In contrast, between the First and the Second World Wars the most valuable commodities of these deposits were copper and nickel. It was nickel, the critical ore component that allowed to substantiate the economical expedience of the Norilsk mines in the very harsh conditions of the Russian Arctic.

It is necessary to take into account that the mineralization of the Norilsk deposits was first described as a copper-bearing, and only several years after discovery, when the nickel-rich mineral pentlandite ($(Fe,Ni)_9S_8$) was found in ore, it became possible to consider a complex copper-nickel nature of ores. In the same way, the complex Ni-Cu-PGM composition was confirmed one decade later.

Hence, from the geological point of view, the moment of discovery of the Norilsk group deposits has to be described as the estimation of primary sulfide copper ores. The presence of nickel and PGM mineralization contained in ore was important for further valuation of the deposits and ore reserve estimation and classification, but not for their discovery itself.

The main goal of this study is to attempt to determine, what was the real moment of the first discovery of the Norilsk copper mineralization, i.e., of the copper ores economically significant for mining. This event and the involved persons should be described as the real discovery / real discoverer of the Norilsk group of deposits.

2. Early geological works in the Norilsk area: state of the art before 1866

Until the beginning of the 19th century the territory of Siberian Arctic had been a real 'terra incognita' for scientists. The Taymyr peninsula could can be reached only via the Yenissei river during the summer period. The first scientific expedition in this area was organized by the Saint Petersburg Academy of Sciences in 1842-1845. A zoologist and geographer Alexander Theodor von Middendorf, as the head of the expedition carried out an extraordinarily enduring and difficult travel and upon returning published a detailed report [1]. However, A. Middendorf did not visit the area near the Pyassina river, the location of the Norilsk deposits. He reported the information from local inhabitants ('I was told about three Pyassina lakes', p. 245 of the report published in Russian) about the presence of a 'coal stratum' at the eastern riverside of Yenissei 'beyond 70 degrees north latitude' (ibid, p. 243).

As the economic colonization of the lower reaches of Yenissei raised in the middle of 19th century, more governmental and business attention began to focus on this territory. Coal was one of the most critical resources necessary for the sustainable development in the described period. On this basis, the Russian Geographical Society begun to prepare plans for a reconnaissance expedition to the lower Yenissei. The Society offered Innokenty Lopatin, an experienced traveler and geologist known by a series of difficult and complex expeditions in Transbaikalia, Russian Far East and Sakhalin Island to head the expedition. Independently, the Saint Petersburg Academy of Sciences has sent Prof. Friedrich Schmidt to the same area with the mission to find a well remained mammoth whose presence was reported by a steam driver Maximov from the city of Turukhansk [2] (Turukhansk is a former capital of the territories near the lower Yenissei and Tunguska rivers). In early 1866 both expeditions were started.

3. The Innkenty Lopatin and Friedrich Schmidt 1866 Yenissei ("Turukhansk") expedition

Both expeditions' groups reached Dudino, the lowest significant settlement on Yenissei close to its flow into to the Arctic Ocean. The main goal of the Lopatin group was the documentation of the Yenissei shores with the main respect to possible fuel sources (coal strata of possible economic interest and graphite mineralization as a 'coal vector'). The Schmidt group had to locate and reach the 'mammoth locality' tundra in some distance from the river, after which the transportation of mammoth to Saint Petersburg had to be organized. However, after first the communications with the residents of Dudino F. Schmidt realized that the main goal of expedition was impracticable: the carcass of a mammoth, if ever existed, was not preserved (and there probably was a newer one existing in a formerly reported 'well-preserved' form). This 'ready to start' condition in combination with the abolition of the primary goal forced F. Schmidt to repurpose his mission. He decided to make a

systematic geographic, biological, paleontological and ethnographic description of the lower Yenissei territories. In such circumstances I. Lopatin and F. Schmidt met in Dudino on July, 11th and made a decision to unite their expeditions. The travelers outlined the expedition's schedule. Innokenty Lopatin would now lead the linear survey of the Yenissei shores, and Friedrich Schmidt would accompany him making permanent short-distance travels into the adjacent territories of tundra to make necessary observations. From the modern point of view, it was an almost perfect model of mutually enriching and therefore most effective collaboration between scientific and industrial research programs. This estimation was confirmed later when the results of the expedition were published.

Further events were predicted by the actual situation existing in the on territories near Dudino. In fact, both the governmental and economic aspects of the people's existence in the region were controlled by the members of a respected Cossack family Sotnikov: brothers Pyotr and Cyprian. The former was a merchant, the latter – an administration representative. The brothers practically took over the responsibility to supply the expedition with everything needed all. It is no surprise that the expedition further conducted in close contact with one of the brothers, Pyotr Sotnikov, who was in reality an unofficial economic master ('Creosus' after F. Schmidt) of Dudino and the adjacent territories. Among other things, brothers Sotnikov informed Innokenty Lopatin and Friedrich Schmidt that they operated a copper mine in the mountains to the East from Dudino near the Pyassina river [2, 3].

4. Brothers Sotnikov's copper mine in Norilsk mountains

Friedrich Schmidt reported [3] some 'comments about the Norilsk mountains': he visited the site twice (in May and early September) 'up the river Bystraya between lakes Pyassina and Bystroye'. Unfortunately, the two notebooks of I. Lopatin diaries corresponding exactly to the specified periods are missing in the archive of the Russian Geographical Society in Saint Petersburg (the cause of the missing is still not known). After F. Schmidt: 'The Sotnikov's coal and copper mines are located near the Bystraya river in a narrow canyon'. F. Schmidt described a sheet of sandstones overlapping the coal strata, wherein the sandstone 'contained [disseminated] chalcopyrite'. This was the first published communication about the presence of sulfide copper mineralization in Norilsk mountains. F. Schmidt: 'at the East end of the valley Sotnikov has find copper slates containing about 5% of copper', 'the analytical results will be reported by me in a detailed work'. Unfortunately, F. Schmidt never published a special work concentrated on the copper mineralization of the Norilsk mountains.

The archive of the Russian Geographical Society in Saint Petersburg contains several diaries of Innokenty Lopatin and an inventory of geological and palaeontological samples collected during the expedition. Sample No. 19 is described as a 'copper slate'. It is undoubtedly the same sample as the disseminated chalcopyrite collected by F. Schmidt during his visitation of the Sotnikov's mines. The inventory contains a pencil-made mark and comment, that corresponded with the sample handed over to F. Schmidt. In fact, the second list of samples, made after the transfer of Lopatin's collection to the Museum of the Saint Petersburg University does not contain the specified 'copper slate' item. Obviously, the sample was returned by I. Lopatin back to F. Schmidt. Further history of sample is still unknown, and no scientific paper or report was published.

As N. Urvantsev corresponded [4], the site of the deposit had been staked out in 1865. That means that the first samples with copper ore had been obtained by brothers Sotnikov at least one year before the Lopatin-Schmidt 1866 expedition. Unfortunately, the mine was closed several years (?) after the expedition. In is highly likely the this happened soon after the death of the elder brother, Cyprian Sotnikov. The fact of his death was reported in the letters published in the Russian Geographical Society's annual reports. Unfortunately, I. Lopatin neither published the expedition diaries, nor the expedition report. The diaries of I. Lopatin were first prepared for publication by I. Kleopov in 1964 [5]. In 19th century the only short communication published by the Russian Geographical Society reported the following: 'Lopatin was shown good samples of coal, copper ore and graphite by a local resident Sotnikov, who found them in the mountains near the Norilsk lakes (along the water system of Pyassina, 100 verst [about 110 km] away to the East from the Dudinskoye settlement)' [6]. F. Schmidt

has made a presentation about the expedition results in the Saint Petersburg Academy of Sciences. Short theses of his presentation were published in German and in Russian including cited above characteristics of his visit to the Norilsk mountains [3]. A detailed monograph by F. Schmidt published later [2] does not include a description of Sotnikov copper mines, but the mines were indicated on a sketch map (figure 1).

Figure 1. Part of the map showing the 1866 Lopatin-Schmidt expedition route. The settlement of Dudino ('Dudinskoye'), border of forest ('Waldgrenze'), lake Pyassino ('S[ee]. Pjässino'), and Sotnikov coal and copper mines ('Sotnikow's Kohlen und Kupfergruben') are indicated [2].

5. Further history of geological prospecting in the Norilsk Mountains

The next stage in the history of Norilsk deposits began in 1915, as a grandson of Cyprian Sotnikov, Alexander has visited and staked out the deposit site and after that submitted an application for the coal prospecting in the Norilsk mountains. Obviously, he knew some 'family memoires' about the deposit. A. Sotnikov obtained the prospecting license only in 1918 from the (White) Siberian Regional Government, during the Civil War in Russia.

Independently, Vladimir Obrutchev, a famous Russian geologist, professor and researcher of Siberia, being forcedly unemployed, prepared a series of archival researches and published in 1917 a short communication in a private Saint Petersburg scientific magazine 'Rudny vestnik' (Russian 'Ore Herald' [7]), where he made a direct citation (in Russian) of the formerly published report by F. Schmidt. This was the first communication report in a geological magazine where the mineral name 'chalcopyrite' appeared in connection with the Norilsk mountains.

We suppose that Alexander Sotnikov neither had the 1869 publication by F. Schmidt [3], nor the short report by V. Obrutchev when preparing his expedition from Tomsk to Norilsk. He published in 1919 a booklet, in which the importance of coal and copper exploration in the Norilsk mountains for the needs of steam ship transportations was proclaimed [8]. A. Sotnikov described there a sought copper ore as malachite mineralization (i.e. secondary carbonates, not primary sulfides) disseminated in magmatic rocks [8]. A. Sotnikov arranged N. Urvantsev to assist him in prospecting. In 1919 they got a permission and visited the site. Surprisingly, N. Urvantsev also reported [4] only the presence of

secondary malachite mineralization although he found and visited the old Sotnikov adit (actually, two adits had been preserved). It is interesting that during the 1950-1960's the geological prospection the Sotnikov adit was documented again, now in details, whereby some narrow but clearly seen chalcopyrite veins were reported [9]. It should be noted the N. Urvantsev observed in 1919 old installed poles near the adit with a Russian inscription '**К | | С**' [4], which can be understood as a poorly remained '**К П С**' (i.e. '**C P S**' which corresponds to 'Cyprian [and] Pyotr Sotnikovs').

Alexander Sotnikov was arrested and executed after the fall of the Kolchak Government in Siberia. In 1920 Nikolay Urvantsev was sent, now by the Soviet government, to complete the prospecting works in the Norilsk mountains. He carried out a primitive prospector mining whereby found several chalcopyrite-bearing veins located in rocks near the old Sotnikov adit. This event was officially recognized later as the first-discovery of the Norilsk Cu-Ni-PGM deposits.

Conclusions

The first report about the presence of sulfide copper ores in the Norilsk mountains was made by Friedrich Schmidt in 1869 after his return to Saint Petersburg from the 1866 Yenissei expedition carried out together with Innokenty Lopatin. A short report in the Russian Geographical Society 1867 annual report confirms this fact. In 1917, Vladimir Obrutchev cited the information by F. Schmidt about the copper ores of Norilsk in a Russian geological journal 'Rudny Vestnik'.

More details on the 1866 Lopatin-Schmidt expedition, brothers Sotnikov activity and the 20th century investigations of the Norilsk deposits discovery history were first published by A.V. Kurguzova and M.V. Morozov in [10].

The real first-discoverer of the Norilsk group of copper (containing Ni and PGM) deposits are brothers Cyprian and Pyotr Sotnikov (1865). The exact date and the details of their discovery will still apparently remain unknown.

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