XIII. Titanium Ore

There are three types of titanium ore on the Kola Peninsula: titanium magnetite, knopite, and titanite. These ores and the deposits thereof will be described individually in the following pages.

A. Titanium Magnetite

Eight deposits of titanium magnetite on the Kola Peninsula are known to be worked or are known to be capable of being worked.

1. The Gremyacha tundra and the Vyrmes tundra have deposits of titanium magnetite containing 17-19% titanium oxide. The vanadium content of the ore is slight. None of the deposits have been investigated sufficiently. Geological investigation is in progress at the present time.

2. The Sal'maya tundra: In the northern part of this tundra very large deposits of poor titanium magnetite ore in association with pyroxenite rock have been confirmed. The ore has a low vanadium content. The deposits have not been investigated.

3. The Federova tundra: Titanium magnetite ore has been discovered there within an area of 3,000 square meters. The ore occurs in association with pyroxenites and norites. The deposit has not been investigated further.

4. Afrikanda: This is the most important titanium ore deposit on the Kola Peninsula. The ore consists partially of titanium magnetite and partially of knopite. In recent years extensive work has been carried on there; a concentration works has been constructed. Apparently production is now in progress, but no production figures are known. The deposit is situated right on the Kirov railroad line and for that reason, transportation conditions are favorable.

There are two types of titanium magnetite ore at Afrikanda. The one type contains 8-10% titanium oxide, 19-33% ferrous oxide (FeO), and 58-68% ferric oxide (Fe_2O_3). The other type contains more titanium and has the following composition: 16% titanium oxide, 30-33% ferrous

oxide, and 46-52% ferric oxide. The mineralogical composition of this latter ore is: about 50% titanium magnetite, about 30% ilmenite ($FeTiO_3$), and up to 20% magnetite (Fe_3O_4). The ore contains a little vanadium, and is practically free of sulphur and phosphorus. The reserves of titanium magnetite and knopite together in Afrikanda are estimated to represent about 50 million tons of titanium oxide.

5. Lesnaya-Varaka, at the Khabozero station on the Kirov railroad line. So far the deposit has not been investigated very much, but investigation was in progress in 1941. The results of this investigation are not known. The ore area covers 13 square kilometers and is embedded in olivine. Knopite and chromite also occur in association with the titanium magnetite. This ore, too, contains but little vanadium. The chromite content is up to 12.5%.

6. ~~Tuimpor and Rasvumchorr~~, Khibine tundra: Independent deposits of titanium magnetite are not mined on the Khibine tundra. However, titanium magnetite occurs as a constituent part of the apatite-nephelite ore and is extracted as a by-product in the concentration of the latter. The titanium magnetite constitutes about 0.5% of the apatite-nephelite ore. Because the mining of apatite-nephelite ore is on a large scale, significant quantities of titanium magnetite are extracted as a by-product. An aegerite-titanium magnetite concentrate is obtained through the magnetic separation process at the nephelite plant in Kirovsk. This concentrate is purified at the present time by the dye and steel industries in various parts of the Soviet Union. It is, however, intended that the concentrate be processed to some extent on the Kola Peninsula (Zashcheek). The aegerite-titanium magnetite is to be smelted with nephelite, whereby a phosphorus-containing pig-iron is obtained. Then this pig-iron is to be treated by the Thomas process. This process is being used right now in the Urals. Using this method, 500 kilograms of pig-iron, 100 kilograms of pure titanium oxide, and one kilogram of vanadium may be extracted from one ton of titanium magnetite. It has also been planned to set

up an electro-smelting works for the titanium magnetite concentrate.

B. Knopite Ore

Knopite is a mineral consisting of about 50% titanium oxide, 5% rare-earth metals, and about 1% niobium oxide. (For more accurate analyses, see A. E. Fersmann, "Useful Minerals of the Kola Peninsula," Moscow-Leningrad, 1941). Knopite occurs in conjunction with titanium magnetite at Afrikanda and Lesnaya Varaka.

The knopite deposits in Afrikanda are considerably larger than the titanium-magnetite deposits. They cover an area of about seven square kilometers. Nothing is known about the knopite deposits at Lesnaya Varaka.

It is possible that the knopite ore at Afrikanda is being mined. At any rate, experiments in concentrating the ore have given positive results insofar as it has been shown that knopite can be separated from the other constituents of the ore relatively easily. The intention has been to send the knopite concentrate to industries in the central parts of the Soviet Union for further processing.

C. Titanite ($CaTiSiO_5$)

This mineral contains up to 30% titanium oxide, 0.2% vanadium oxide, and 0.2% rare-earth metals - besides the calcium and silicon. Four titanite deposits on the Khibine tundra are known. The Chasnachorr deposit consists of a two-meter thick vein running through khibinite. A good 20% of the ore consists of titanium, the rest being made up of aegerite, nephelite, feldspar, and ilmenite. The deposit has not been investigated further. It is apparently rather unimportant. Transportation conditions are unfavorable.

The Vudyavrchorr and Yuditvumchorr deposits are similar deposits containing 20% and 35% titanite ore respectively. Neither of these deposits is being worked.

At Lovchorr within the apatite-nephelite ore region there are pockets of titanite associated with aegerite, nephelite, and titanium magnetite. It is doubtful that it will pay to work them. Titanite

concentrations of importance occur where the apatite-nephelite ore and the adjacent rock come together on both sides of the Loparskaya Valley, at Kukisvumchorr and Yuksporr. In titanite-rich zones the titanite constitutes 25-30% of the rock, corresponding to a content of 10-12% titanium oxide. Previously this ore was mined experimentally, but without success. An experimental concentration plant was erected in the Loparskaya Valley, on the northern side of Lake Vudyavr near Kirovsk. However, the yield was poor and the experiment was given up. At one time there was talk about using this titanite ore as a raw material for the pigment "silitan," which is a mixture of titanium oxide and silicon oxide. "Silitan" can be used as a pigment in the same manner as titanium white and it is also suited to the production of lacquer. "Silitan" can be produced from titanite concentrate by treatment with 50% hydrochloric acid. However, three tons of acid are required for two tons of titanite concentrate, which, as can be seen, makes it too costly.

Literature:

A. E. Fersmann: "Useful Minerals of the Kola Peninsula," Moscow-Leningrad, 1941 (Russian)

A. M. Brussilovski: "The Extraction of Titanium Dioxide from /illegible/ and Titanium Magnetite, and the Utilization of Titanium Compounds in Industry," Collected work, "Khibine Rare Elements and Pyrrhotine V," Leningrad, [illegible] (Russian)

XIV. Molybdenite

No less than 23 deposits of molybdenite are known on the Kola Peninsula. However, they are all small and, as yet, none of them has proven profitable to work. Only one of these deposits can be regarded as promising, namely the Takhtarvumchorr deposit on the Khibine tundra. This has not yet been sufficiently investigated for any conjectures as to its value to be made. It is also considered

possible that there are other deposits worth working elsewhere on the Khibins, Lovozero, and Oremyakha tundras. From what is now known about the mineralization of molybdenum on the Kola Peninsula, it is not likely that large deposits of this metal of potential importance to the Soviet Union will be found [TN: The preceding two contradictory sentences appear in the original].

The molybdenite in the Takhtarvumcherr and other molybdenum deposits on the Khibine and Lovozero tundras occurs in narrow veins of albite. In the other deposits on the Kola Peninsula the molybdenite occurs in association with veins of quartz and granite-pegmatite fused to the granite massif.

A number of attempts at concentrating the molybdenum ore from Takhtarvumcherr have been made. Experiments have showed that it is difficult to concentrate this ore by flotative means and that the yield of concentrate is poor.

XV. Lead and Zinc Ores

Steinmannite and zincblende are found in veins of quartz and calcite in several places on the Kola Peninsula. All of the deposits are unimportant and it is not profitable to work them. As a rule, the veins are no more than a couple of centimeters thick. Deposits occur in four areas on the Kola Peninsula:

a. The Murmansk area (the Titovka Fjord, at the southern end of Titovskiy Island and on the Rybachiy Peninsula)

b. Around the egress of the Ponoy River

c. Along the northern coast of the Kandalaksha Fjord, Umba. In 1880 the inhabitants extracted ten tons of ore.

d. Medvezhiy Island in Pertya Bay

XVI. Iron Ore

There are four large iron ore areas on the Kola Peninsula: Kolderovo, which is situated about 150 km west-northwest of Kandalaksha; Prirnandra and Shonguy-Loparskaya on the Kirov Line between Kandalaksha and Murmansk, and the area around the Kola Fjord. Besides these, the titanium-magnetite, previously described, and the aegerite of the Khibine area are regarded as iron ores.

All of the four deposits mentioned consist of magnetite ore (Fe_3O_4). Only the Kolderovo ore may be considered a rich iron ore. The other three deposits contain ore of poorer quality, with an iron content of about 35%. The four deposits will now be discussed individually.

A. The Kolderovo deposit

The Kolderovo deposit is the largest iron ore deposit on the Kola Peninsula. It is situated near Lake Kovdor on the Pilkuma Selga Mountain. The ore is associated with limestone; it is a so-called "refuse ore" (skarnmalm). The ore occurs in grains, crystals, and small veins in the limestone. One distinguishes between three types ore:

a) a medium-grained ore containing 35-50% iron, 1-2% phosphorus, and a trace of sulphur.

b) a varigated ore containing 40-60% iron, 0.25% phosphorus, and a trace of sulphur.

c) an ore type containing 60% iron, practically free of phosphorus, and with a trace of sulphur.

The average mineralogical composition of the ore is:

magnetite	68-80%
calcite	15-20%
apatite	0.5-1%
waste minerals	3-18%

Besides this, the ore contains about 2% titanium and smaller quantities of tin, copper, cobalt, and zinc. Judging from the types of ore so far investigated, the ore is almost entirely free of sulphur. However, it is estimated that there will be a certain sulphur content in the lower strata.

1. Mining

The ore will be mined from large outcroppings. It has been estimated that the ore deposit is 500-600 meters thick. Until 1940 the deposits were being investigated very thoroughly. Two drifts (horizontal shafts) were driven into the side of Pilkoma Selga Mountain. Two shafts were on the point of being sunk from the peak to the level of the drifts. A steel mill (blast furnaces) was in the early stages of construction to the west of Pilkoma Selga. Work was discontinued with the outbreak of war in 1941. Apparently work was resumed again in 1944 and the mill is now in operation.

2. Concentration and Further Processing

Nothing has been reported about any difficulties in separating the waste constituents from the magnetite. The ore can be readily concentrated. The quality of this concentrate is said to be approximately the same as concentrate "D" of the Swedish Kiruna ore concentrate.

An iron works, the blast furnaces of which are fired by charcoal, has been erected on the site for the smelting of the concentrate. However, plans for transporting a portion of the concentrate to a smelting works in Zashuyek for further processing to iron alloys have also been discussed. There has also been some talk about transporting some of the concentrate by train and by boat through the Stalin Canal to steel mills in the Moscow area. The possibility of smelting some of the ore together with the more difficultly smeltable ores from the Pridmandra area has also been discussed subsequently. It is the high lime content of the Kalderovo ore that will be utilized in this manner. It is not known where this smelting works will be located. Before the war it

was also planned that some of the ore should be shipped abroad. This was effected through Finland, over the Kandalaksha-Salla-Rovaniemi-Kemi railroad line, and by boat from there.

3. The Ore Reserves and Production

The reserves of iron ore in the Koldorovo field has been estimated at one billion tons. As previously mentioned, it is not known if production is now in progress, but it must be regarded as very, very likely. The planned production capacity is also not known. However, it may be estimated that the production at least will amount to 300,000 tons of ore per year; it is probably much greater - of the magnitude of one million tons per year.

4. Transportation Conditions

In 1940 a branch line from Pinozero Station on the Kirov railroad line to Koldorovo was completed. Pinozero is situated between Kandalaksha and ~~Sashcyek~~ Zashcyek. The length of the branch line is about 150 km. Likewise, a road has been built from Upolaksha, on the northern shore of Upper Pirengo Lake, to Koldorovo. Upolaksha has a direct connection to the water transport system of Lake Imandra. A road from Upolaksha to Apatity with a ferry connection across Lake Imandra at the narrowest point west of Apatity was planned. A road on the southern side of Lake Imandra, from Upolaksha to ~~Sashcyek~~ Zashcyek, also was planned.

B. The Priimandra Deposits

The Priimandra area encompasses several iron ore deposits. It is 25-30 km long and 8 km wide. It is situated around the Kirov line, east of Lake Monche, about one the same altitude as the ~~Station~~ Olen'ya Station. The largest deposits are situated to the west of the Kirov Line. Kenaemal'skoye lies to the east of it. The ore consists of steaks of magnetite in quartzitic shale. All the ores are low in phosphorus and sulphur. Until 1943 there was no industry in the area. However, the various deposits had been investigated and an attempt had been made to concentrate the ore from the Kirov Mountain. It is possible that the Kirov mountain is being worked at the present time.

The most important deposits are:

The Kirov mountain, with ore containing 33% iron, 0.03% phosphorus, and 0.04% sulphur.

The so-called "Mountain of the 15th Year Jubilee," with ore containing 30.5% iron, 0.05% phosphorus, and a trace of sulphur.

Baumann Mountain, with an ore containing 32.5% iron, 0.04% phosphorus, and 0.002% sulphur.

In 1943 Olenegorsk still had not been completely investigated. Besides magnetite, this ore also contains up to 14% hematite (Fe_2O_3). It has a higher phosphorus content than the other ores mentioned. The ore contains 33.5% iron, 0.6% phosphorus, and 0.03% sulphur.

The Komsomol'skoye deposit also has not been sufficiently investigated; the iron content of its ore is only 27%.

Besides these, there are also the Zheleznaya Varaka deposit 6 km from the Kuna Station, and the Pechagubskaya deposit, 3 km from the Kuna Station. Neither of these two deposits is believed to be promising.

1. Concentration

The ore is difficult to concentrate. Because of its high quartz content the ore is hard and difficult to mill. The ore must be ground very fine for successful concentration. Attempts at concentration have resulted in a 90% yield of concentrate containing 63-65% iron of approximately the same quality as the concentrate obtained from Sörvaranger ore.

Because of the high quartz content, the concentrate is difficult to smelt. As mentioned in the description of the Kolderovo field, it was planned to smelt this concentrate together with the Kolderovo ore, presumably in the plant at Kolderovo.

2. Ore Reserves

Deposit	In millions of tons			
	Best Ore 35-40% Fe	Good Ore	Average Ore	Poor Ore 27% Fe
Kirov Mountain	4.1	32.3	22.4	29.4
15th Yr. Jubilee Mountain	--	--	42.5	21.2
Baumann Mountain	--	--	13.4	9.3
Olenogorsk	5.7	37.8	74.4	58.9
Komsomol'skoye	--	--	--	66.0
Total	9.8	70.1	152.7	184.8

The Zhelesnaya Varaka and Pechengubskoye deposits are reported to have ore reserves of 45 and 25 million tons respectively.

3. Transportation Conditions

The Primandra field is situated close to the Kirov Line and close to the branch line to Monchegorsk. Therefore, the transportation conditions are good. It is necessary only to lay small spurs to the Kirov Line, possibly to Monchegorsk.

C. The Kola Fjord Deposits

This ore area extends from the Finnish border in an easterly direction via the Kola Fjord to the north of Murmansk. The area investigated is 115 kilometers long and 6-10 kilometers wide - from the Titovka River to Lake Malaur. The ore is a sandy shale containing magnetite and lime. The ore occurs in long, separate pockets ("lenses") and contains some sulphides - pyrites - and, for that reason, has a higher sulphur content than usual. Its average composition is 35% iron, 0.1% phosphorus, and 0.5% sulphur.

At the present time this field is not being worked, although concentration tests were made indicating that a concentrate containing 55-60% iron can be prepared from this ore.

The ore reserve of the area is estimated at 30 million tons.

The most important deposits are:

Litsa, 6 km south of the mouth of the Zapadnaya Litsa River. The ore pockets there are 2-3 km long.

Livlenskaya, Severnaya, Srednaya, Yushnaya - all of which are located 11-17 km from Murmansk. The ore reserve of these deposits is estimated at 27 million tons.

Ittranta, on the eastern side of the Kola Fjord, 6 km from Murmansk. The ore reserve there is said to be seven million tons.

Other smaller deposits are said to be at the Ura River near the Ketelli River, on the Titovka River near the Finnish border, and at Malyaurvyd.

D. The Shonguy-Loparskaya Deposits

This ore area is located due east of Shonguy and Loparskaya Stations on the Kirov Line. There are three deposits there. The ore is magnetite in sandy, limey shale. The ore contains 23-34% iron, 0.13% phosphorus, and 0.5% sulphur.

So far nothing has been said about working the area.

The three deposits allegedly contain 35, 4, and 49 million tons, respectively.

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S. V. Konstantino: "On the Question of the Processing of the Substances of the Iron Ore Deposits of the Kola Fjord (Russian)

P. N. Chirvinskiy: "The Petrographic Characteristics of the Kola Fjord Iron Ore Deposits," (Russian)

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XVII. Nickel and Copper Ores

A. By far the most important nickel and copper deposit on the Kola Peninsula is located on the Monche Tundra, near the city of Monchegorsk. There is another important on the Volch'ye tundra, somewhat east of the Monche tundra. In addition to these, there is a series of deposits of nickel-copper ore on the Kola Peninsula, but these have not been thoughly investigated. They apparently are not important. The location of the various deposits is Shown in Fig 13. They are:

a) Monche tundra
b) Volch'ye tundra
c) Lozevaya tundra
d) Sal'naya tundra
e) Fedas tundra
f) Pulmas tundra
g) Fedorove tundra
h) At the mouth of the Ponoy River

According to Finnish sources, but not reported in more recent Russian literature, there is a series of copper deposits in the Kandalaksha area. It is fairly certain that these are all unimportant. They are:

Kuuta, to the west of Kandalaksha. There are small, old copper mines which were worked at the end of the last century, for copper, silver, lead, and gold.

Pen'ya Guba, on the Kandalaksha Coast - a small nickel-copper deposit with galenite.

Suikujärvi, 35 km from Soanovets Station on the Kirov line. A small, old copper mine which was abandoned a long time ago. It also yielded some molybdenium ore. The reserve is said to be only 8,000 tons of ore containing 5 percent copper.

Tsirka Varaka, an unimportant deposit of copper ore.

There is also said to be rather small deposits of copper ore in the Kem' district, south of Kandalaksha: Vaynozerskoye, Tsirkajärvi, Paavaara,

Alajarvi, Ylajarvi, Nikalmen, Sapesalmi, and Yaskivaara.

Renovaara, Kriitima, and Munjarvi are mentioned in the Ukhta district.

A description of the deposits on the Monche and Volche tundras follows:

B. The Monche Tundra Deposits

There is a series of nickel deposits, all associated with basic rock- norites and peridatites - on the Monche tundra. The location of the various deposits is shown on Fig 14. The deposits which have been investigated most thoroughly are located at Nyuduayvench, Sapchuayvench, Tremanaya, Mittis, and Kumushya Varaka Mountains.

The ore is concentrated in flat layers, 2-4 m thick; it also occurs in veins. The mineralogical composition of the ore is, for the most part the same as in the other deposits. It consists of magnetic pyrites (pyrrholine) with pentlandite (Fe Ni S) and copper pyrites and gangue minerals: pyroxene, plagioclase, and hornblende. On the average, most of the deposits contain 0.2-0.5% nickel and 0.3 percent copper, as well as 0.01 percent cobalt and 0.01-0.001 percent selenium. This is very poor nickel ore. The Norwegian deposits in Evje, which now have been abandoned, and which formerly were the poorest nickel deposits in the world being worked, contain about 0.8 percent nickel.

In 1936 significantly richer nickel deposits were discovered in the Mittis and Kumushya Varaka mountains. This ore contains 10 percent magnetite, 75 percent magnetic pyrites, 7-8 percent pentlandite, and 6-7 percent copper pyrites. The ratio of nickel to copper is 2:1 and the ratio of nickel to cobalt is 25:1. The nickel content is said to be 4.8 percent, or as rich as the Petsamo ore. Operation of these deposits began in 1938.

1. The Ore Reserves

Until 1938 it was believed that there were between five and ten million tons of low-grade ore on the Monche tundra. If one figures out the metal content of this ore, the corresponding quantities of pure nickel and pure copper would be 50,000 tons and 5,000-10,000 tons respectively. The reserves of the then recently discovered high-grade ore (4.8 percent nickel) had not yet been figured out. No figures on this ore are available. It is

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obvious, however, that these deposits are important, so the total reserves will be considerably larger than the figures quoted. The nickel reserves figured out in 1938 reputedly constituted 45 percent of the total nickel reserves of the Soviet Union. As far as is known, no other important nickel deposits have been discovered elsewhere in the Soviet Union since that.time. Therefore, if one counts in the high-grade nickel deposits later discovered on the Monche tundra and the Petsamo ores, which now belong to the Soviet Union, it becomes clear that the Kola Peninsula and Petsamo are now the Soviet Unions most important sources of nickel by far. The following figures for the reserves (the calculated metal content in the ore reserve) at two of the deposits on the Monche tundra were reported in 1932.

Sapchuayvench - 1,000 tons of nickel and 200 tons of copper. It was reported that possibly the ore reserves there were ten times greater.

Kyuduayvench - 6,000 tons of nickel and 7,000 tons of copper.

2. Production.

It is very difficult to give figures for the production of nickel and copper ore on the Monche tundra. In 1938 the production of the low-grade ores (about 0.3 percent nickel) apparently was of the magnitude of 300,000 tons, corresponding to somewhat less than 1,000 tons of pure nickel. (For purposes of comparison, it may be mentioned that normal production at Petsamo corresponds to nearly 10,000 tons of pure nickel. In 1938 a quantity of the high-grade ore (4.5 percent nickel) corresponding to 500 tons of pure nickel was mined. Prior to 1938 the major stress was laid on the mining of the low-grade ores, and installations were also set up in Monchegorsk to process these ores. One source dated 1941 reports that the emphasis now is on the mining of the richer ores in Nittis and Kumuzhya Varaka Mountains. As previously mentioned, there is no exact data on the reserves of these deposits. If they are large enough, it may very well be that the production on the Monche tundra now corresponds to a quantity of pure nickel in the neighborhood of 10,000 tons - approximately the same as Petsamo - that is, a production of about 300,000 tons of the high-grade nickel ore.

3. Concentration and Further Processing.

The concentration and further processing of the Monche tundra ore takes

takes place chiefly in the city of Monchegorsk and the surrounding settlements. The city allegedly had a population of no less than 70,000 in 1941 (30,000 in 1938). This number of inhabitants far exceeds what would be necessary to operate the mines and the associated industries. From the quoted production figures one would figure on European standards, a population of no more than 10,000. Even if one takes every conceivable industry into consideration, the population figures seems excessively high. However, there is reason to believe that it is true. Therefore, the question arises as to what the surplus population does to earn a living.

The trust Severonikkel is responsible for all work connected with the mines and the processing of the ore at Monchegorsk.

The concentration and further processing of the ore is indicated by the diagram in Fig 15. Only the low-grade ore (0.2-0.5 percent nickel) is concentrated. This is done by flotation. It is not known what the nickel and copper content of the concentration is. This concentrate is mixed with the high-grade ore (which is melted right after being milled) and is melted in electric furnaces, quartzite being added as flux. The necessary quartzite is obtained at Monche Bay. The melt is treated in converters, where a blast of air or oxygen is passed through it, the sulphur of the concentrate passing off as sulphur dioxide. In this way a nickel-copper matte also containing cobalt, platinum, palladium, other metals of the platinum family, selenium, silver, and gold is obtained.

The sulphur dioxide goes to the sulphuric acid plant.

Formerly the matte was shipped to other parts of the Soviet Union for further processing. Since then plans have been made for setting up an electric furnace and a cobalt plant in Monchegorsk for further processing the matte. Under the plan, these were to be in operation during 1941. It is extremely likely that these installations have been in operation for a long time. In 1943 all work at the plants in Monchegorsk ceased

4. Transportation Conditions

There is a 30 km long branch line running from Olenya Station of the Kirov Line to Monchegorsk. A road is supposed to run between Olenya and Monchegorsk, but it is impassible to autos.

C. The Volchye Tundra Deposits

The nickel deposits are situated on both sides of the Nikolevaya River, on the south side of an eastern spur of Kiiuzivench Mountain and on the north side of an eastern spur of Mochesnyunocharr Mountains. The southern part of the ore region is heavily covered with moraine. There is also a small ore area at Sovelyunayvench.

The nickel ore on the Volchye tundra occurs in association with norite rock in the same manner as the ore on the Monche tundra. The ore area occurs at the boundary between norite and gneiss rock types. The ore zone is 8 km long and 150-200 meters wide. However, it is irregularly mineralized; large parts of it bear no ore at all.

For the most part, the ore is of the same type as the low-grade ore on the Monche tundra, but differs from it in that it contains chromite. The usual composition is reported to be 0.3-0.5 percent nickel, about 0.2 percent copper, and 0.4-0.6 percent chromium.

No estimates of the ore reserves of the Volchye tundra are available. So far nothing has been said about working these deposits. They are regarded as a future source of ore for the nickel works in Monchegorsk.

The ore field has been quite thoroughly investigated, but as far as is known, no attempts to concentrate the ore have been made. It is however, not very likely that any appreciable difficulties will be encountered in concentrating the ore. Apparently, the same methods employed in concentrating the low-grade ore of the Monche tundra can be used.

At the present time there is neither a road nor a railroad to the Volchye tundra.

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Supplement

B. The Petsamo Nickel Mines

The Petsamo nickel deposit was discovered by Finnish geologists in 1921. It has since proven to be the largest nickel deposit in Europe. Preparation of the deposit began only in 1934, when the Mond Nickel Company got the concession to work the deposit. The mines were ready to start producing at the outbreak of war in 1939, but not at full capacity. An electric smelting works was constructed at Kolosjaki (which still was not completely finished). The smelting works drew electrical power from the large, new power plant at Jäniskoski, 80 km [8 Norwegian miles] southwest of the mines near the Norwegian border. The power plant was not finished in 1939, but could deliver sufficient power for the limited operation planned.

The development of the mine continued under the direction of the Mond Nickel Company until the beginning of 1941. No appreciable production was taking place at that time.

In 1941 the Finns took away the concession from the Mond Nickel Company and formed a Finnish Corporation, the "Petsamo, Nickel Company." The corporation was financed by the I. G. Farben Company. In conferences with Germany and the Soviet Union it was decided that 60 percent of the production was to go to Germany and 40 percent to the Soviet Union. However, no nickel was delivered to the Soviet Union, as the Russo-German War broke out shortly thereafter - in June 1941.

During the war all the nickel produced by the mines was delivered to Germany. At first the nickel-copper matte (the product after the ore is processed in the smelting works) was exported. The matte was trucked to Rovaniemi, from there shipped by rail to Kemi, and shipped out by boat from there. In October 1942 the smelting works broke down completely, probably because of clumsy handling. It was not put into operating condition before the end of 1943. During this time the raw ore was exported directly to

Both articles appeared in "The Petrography and Geochemistry of the Kola Peninsula," Part III, published by The Academy of Science of the USSR, Leningrad, 1933.

Supplement

D. The Petsamo Nickel Mines

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Germany and was smelted there. Some crude ore was shipped from Liinahamari, but most of it was trucked to Kirkenes and was shipped from there.

When the Germans retreated from Finland in September 1944, they destroyed the smelting works in Kolosjoki and the power plant in Jäniskaski. However, they left the dam installation undamaged.

Under the terms of the Finnish-Russian peace treaty the entire Petsamo area fell into Russian hands. However, the power plant at Jäniskaski remained in Finnish territory. In a later, supplementary agreement, in connection with the negotiations on German property in Finland, the Russians also laid claim on that area.

Already in the fall of 1944 the Russians began to rebuild the smelting works and to put the mines in operating condition again. According to a reliable source, the smelting works was rebuilt in the summer of 1947.

The Jäniskaski power plant is being rebuilt by the Finns under the "damages agreement". It is estimated that this project will be completed by 1950. Nonetheless it is possible that some power could be delivered by the beginning of 1949.

It is not likely that the smelting works can achieve any noteworthy production before the completion of the Jäniskaski power plant. A power line has been laid from Murmansk to ~~Kolosjoki~~ Kolosjoki, but its capacity is not known. It is very unlikely, though, that sufficient power to satisfy the requirements of the smelting works can be delivered over this line.

A Diesel-electric power plant developing a couple of thousand kilowatts, has been set up at the mines. This is the reason for believing that the mines are being worked at peak capacity. Apparently the crude ore is being shipped partially by sea to Arkhangelsk and from there via the Vologda Line to the Moscow area, or to Belomorsk and from there via the Stalin Canal to Leningrad, and partially by highway to Murmansk and also by sea to the Kirov Line. It had been assumed that some of the ore went to Monchegorsk to be smelted at the nickel works there.

This is possible, but not likely. The nickel mines on the Monche tundra, fairly certainly produce so much that the smelting works in Monchegorsk could not consider smelting ore from elsewhere to any appreciable extent.

1. The Composition of the Ore

The Petsamo ore is very rich. It contains 1.5-3 percent nickel and 1-2 percent copper, corresponding to a metal content of 4-5 percent. Individual portions of the ore are richer, over 10 percent. The Canadian deposits - Sudbury - which produce over 85 percent of the nickel production of the world, about 100,000 tons of metallic nickel - have a metal content of 2-3 percent. The Norwegian deposit in Evje, which are no longer being worked, were operated on a 0.8 percent metal content.

2. The Ore Reserves and Production

The ore reserves are estimated at over five million tons. It is possible that the reserves are considerably larger.

The mining installations admit a production of about 400,000 tons of crude ore per year or 1,200 tons per day. The production during the period 1942-44 was estimated at 300,000 tons per year. This corresponds to about 9,000 tons of nickel and 3-4,000 tons of copper.

3. Concentration

The ore is smelted at the electric furnace works in Kolosjaki, where the nickel-copper matte is delivered. As previously mentioned, the plant was destroyed by the Germans in 1944, but it is now fairly certain that it has been rebuilt. However, it is not likely that it is in full operation, as the Janiskoski power plant still is not in operation. The Janiskoski power plant was designed to have a capacity of about 40,000 kw prior to its destruction. The present reconstruction of the power plant makes provision for a equal or possibly somewhat greater power capacity.

4. Transportation Conditions

The transportation conditions are favorable, provided the crude ore is processed to matte on the spot. The matte has a combined nickel-copper content of about 30 percent. Thus, an annual production of 300,000 tons of crude ore yields about 40,000 tons of nickel-copper matte. This tonnage may readily be transported by sea via the port of Liinahammari.

Apparently the mines are producing at peak capacity, but it is hardly possible that the smelting works could be operating at peak capacity.

It is not plausible that the harbor of Liinahammari can handle a volume of 300,000 tons of ore per year. This would necessitate its having a loading capacity of about 1,000 tons per day.

It is likely that some ore is being smelted at the smelting works and is being exported as matte, while the major portion is being exported as crude ore to Murmansk, partly by sea and partly by highway via Titovka.

XVIII. Magnetic Pyrites (Pyrrhotine)

A. Magnetic pyrites are of considerable importance as a raw material in the production of sulphuric acid. However, the magnetic pyrites are rather low in sulphur. They contain only 18-20 percent, while the Norwegian pyrites ores contain over 40 percent sulphur. However, industry on the Kola Peninsula urgently requires sulphuric acid, and it may very well be then that operation of some of these deposits will be discussed.

So far magnetic pyrites have been used in only one place on the Kola Peninsula - Monchegorsk - for the production of sulphuric acid. At Monchegorsk magnetic pyrites occur in conjunction with the nickel ore. Sulphuric acid is extracted as a byproduct in nickel refining. Corresponding magnetic pyrite deposits are also found on the Volche tundra.

Magnetic pyrites are found on the Khibine tundra in the so-called "inner" apatite ring, at Richarr, Kukisvumcharr, Yuksporr, and Aveslogchorr. Significant magnetic pyrites mineralization only occurs in a vein 8 km long and 1-20 m thick. At individual points there the ore is quite pure and contains 60-70 percent magnetic pyrites. At other points molybdenite and zinc blende occur together with the magnetic pyrites. No data on the ore reserves are available, but they can hardly exceed a couple of million tons and, hence, are not important.

There are rather large deposits of magnetic pyrites in the south and west where the Khibine massif contacts the surrounding rock. There are deposits in the vicinity of Lovcharr containing 27 percent sulphur at Takhtarvumchorr, not far from Apatity Station, containing 18 percent sulphur, and a deposit on the island of Vysokyy in Lake Imandra. The ore reserves of these deposits are in the neighborhood of ten million tons.

Besides these deposits mentioned magnetic pyrites are also found in a number of places on the Kola Peninsula. However, most of them are small or are so inaccessible that it is hardly worth while to talk about working them. This holds especially true for the depósits around Kandalsha Fjord (ore reserves too small), the deposits on Pulmas tundra, Federovo tundra, and

the deposits on Kuchin and Keulik tundras (low-grade and inaccessible)

B. Concentration: *See chapter on copper-nickel ores.*

Experiments have been made on the magnetic pyrites ore from Takhtarvumcharr (1939-1940), but they did not turn out very well. Only a poor concentrate with a tendency to ignite spontaneously was obtained. Nevertheless, experimentation is to continue.

Literature:

A.E. Fersmann: "Useful Minerals of the Kola Peninsula," Moscow-Leningrad (Russian)

A. N. Labunsov: "The Pyrrhotine of the Khibine Tundra" (Russian)

V. H. Godovikov and D.N. Mikhalov: "Substances of the Pyrrhotine Deposit on the Southern Slope of the Khibine Tundra" (Russian)

V.O. Sedlis: "Pyrrhotine as a Raw Material for the Sulphuric Acid Industry" (Russian)

The last three studies appear in Collected Works V, "Khibine Rare Elements and Pyrrhotine," Leningrad, 1933

XIX. Quarts

Quarts occurs in granite-pegmatite veins, particularly in the southern part of the Kola Peninsula in the Kandalaksha area. These pegmatite veins run through feldspar and mica. The quarts used to be thrown aside as waste. Nowadays some of this quartz is kept. By far the largest deposits of quartz on the Kola Peninsula occur in the Keyev Massif, which is situated in the eastern part of the peninsula, around the upper course of the Ponoy River. There are thick veins of quarts, containing only some mica in addition to the quarts. These veins are up to 1,000 meters in length and up to 30 meters in thickness. They represent enormous quantities of quarts. However, the deposits are located in inaccessible places, and quarts is not such a valuable mineral that anyone now plans to work these deposits. If the exploration now in progress in this part of the Kola Peninsula were to lead to the discovery of valuable metal deposits, however, the quarts deposits would assume great importance.

XX. Quartzite

There are important deposits of quartzite and quartz-rich sandstone on the Kola Peninsula, and they are worked at several places. The main use of quartzite is as a raw material for the production of acid-resistant substances and as a flux in the smelting of the nickel copper ores extracted from the Monche tundra. It also finds use as an abrasive and has long been used by the local population for grindstones.

The largest quartzite quarries are at Monchegubа and Rushgubа (at Lake Monche on the Monche tundra), which are being worked to provide the smelting works at Monchegorsk with flux. As a rule, this quartzite contains 85 percent SiO_2, and at some points, 92 percent.

The quartz-rich sandstone on the Rybachyy Peninsula and Kil'din Island are well-suited for the production of abrasives. The sandstone on Kil'din Island also are of a pronounced slate-like structure, thereby being well suited for use as roofing shingles. There is an area of 600,000 square meters of good shale.

The sandstone in the Pana and Varzuga areas and on the Tersheh Coast in the southeastern part of the Kola Peninsula is quarried by the native population for whetstones.

Quartzite is also found around Umbozero, at the egress of the Ponoy River, and in the area around Kandalaksha, particularly at Prolivy Station. As far as is known none of these deposits is being worked, in any case not extensively.

The quartzite deposits on the Kola Peninsula are colossal and are estimated at several billion tons, but the quartzite is not sufficiently pure for use in the glass industry.

Quartz sand occurs in the area south of Murmansk, due east of the Kirov Line, particularly at kilometer points 1,286 and 1,316. It is used as a construction material, as it is not pure enough to be used in the glass industry.

XXI. Kieselguhr (Diatomite)

Kieselguhr has formed in practically all the lakes on the Kola Peninsula and Northern Karelia. Deposits of importance occur only at Kem' and northwards. The kieselguhr contains 50-96 percent SiO_2, up to 40 percent organic matter, and 2-6 percent iron.

Kieselguhr is characterized by an especially great absorbability, and for that reason it suited for the absorbtion of chemical reagents. It is used in the explosive industry as an absorbant fill for highly explosive liquids - nitroglycerine, etc.

On the Kola Peninsula itself only one plant for processing kieselguhr is known, at the Laplandiya Station on the Kirov Line. This used to be an experimental plant for the dry distillation of peat. Back in 1937 this plant was converted to the dry distillation of kieselguhr. The organic matter in the kieselguhr is burned off before further processing.

In many lakes, the kieselguhr is four meters thick. The largest concentrations of kieselguhr are found at the bottom of "closed" bays in the lakes.

Kieselguhr is extracted at several places, but so far to a relatively small extent. Planned, systematic operation on a large scale had still not been effected in 1943.

The known reserves of kieselguhr in the lakes on the Kola Peninsula and in the lakes of Northern Karelia are 50 million cubic meters and five million cubic meters respectively. The actual reserves in all the lakes probably run in the neighborhood of several hundred million cubic meters. At the present time kieselguhr is extracted only from the lakes in Laplandiya.

The most important deposits and their reserves are:

The Water Course of the Kola River:

In the area south of Murmansk, from Laplandiya Station to the town of Kitsa there are 16 deposits of kieselguhr, all situated near the Kirov Line. The deposits in Murdozero and Pulozero have been investigated most ~~thoroughly~~ thoroughly. There the reserves are 3.5 and 3 million cubic meters respectively.

The Imandra watercourse: In the lakes around the Pecha River ten deposits of kieselguhr with reserves totalling 3 million cubic meters are

known. Eleven deposits north of Lake Imandra are known, that of Lake Nyudozero being known the most thoroughly. At the southern end of Lake Imandra ten deposits are known and at Babinskaya Imandra five. The latter have estimated reserves of two million cubic meters; that of Sembozero is the best known.

The Umbozero Watercourse: There are large deposits of kieselguhr, particularly around the Chud River. The reserves are estimated at 3.5 million cubic meters.

The Lovozero Watercourse: There are numerous small lakes with kieselguhr, there, especially around the Sergevan and Seidozero Rivers. The former has a reserve of over six million cubic meters and the latter somewhat less than six million cubic meters.

The Watercourse Around Lakes Kolvitskoye and Kanozero: There are thirteen large kieselguhr deposits with reserves of ten million cubic meters.

Moncheguba: The reserves at Lake Monche are about eight million tons.

Transportation Conditions: The kieselguhr deposits in the vicinity of the Kirov Line are so large that so far the more outlying deposits have not been considered for exploitation. For that reason there are no serious transportation problems.

Literature:

A.E. Fersmann: "The Useful Minerals of the Kola Peninsula," Moscow-Leningrad, 1941 (Russian)

P.A. Vardanyants: "The Diamotite of Northern Karelia", "Useful Minerals of the Karelian ASSR - ONTI-NKTP-SSSR," 1936 P.83-93 (Russian)

XXII. Feldspar and Mica

These two minerals are mined at numerous granite-pegmatite veins on the Kola Peninsula, particularly in the southern part, in the Kandalaksha area. The largest deposits are found in Northern Karelia.

Some veins of pegmatite are mined only for feldspar, as the mica is not of sufficiently high quality, while others are mined only for feld-

spar /$\overline{Si}$g/ - and still at others both minerals are mined at the same time. The main constituents of pegmatite veins are quarts, feldspar, and mica. In the past nothing was done with the quarts, but now it is mined at some quarries. The Kola feldspar is used particularly by the ceramic industry.

In 1938 the Kola Peninsula and Karelia provided over 80 percent of the feldspar production of the Soviet Union. It is not known what proportion of this came from the Kola Peninsula, but it probably did not exceed ten percent. However, the Kola Peninsula has great reserves of mica and feldspar which have not been utilized, primarily because of the lack of transportation facilities.

Mica and feldspar on the Kola Peninsula are mined only in the Kandalaksha area and the Yena area. There are pegmatite veins in the immediate vicinity of Kandalaksha, in Parya Guba, and on islands in the Kandalaksha Fjord. There are numerous pegmatite veins extending all the way to Babinskaya Imandra in the Yena area. The best deposits are on the Leivoiva tundra and around the Strelin'na and Sludyanka Rivers. In the latter field there is a total of over 600 pegmatite veins of various sizes.

The Leivoiva area is the most important producer. It is located near the branch line to Koldorovo and, for that reason, the transportation facilities are good. There are no figures on the production of feldspar available. Six hundred tons of crude mica are produced there per year. As a rule, the pegmatites contain 0.2-0.8 percent crude mica, or 5-20 kilograms of crude mica per cubic meter of pegmatite. Up to 1941 the mica was shipped to the mica plant in Kondapoga at the northern end of Lake Onega. This plant was destroyed by the Finns in 1941. The stores of mica found at Kondopoga were transported by the Finns to the mica plant in Petrozavodsk. It is not known to what extent the Russians have rebuilt the mica plant in Kondopoga, or if they are only using the mica plant in Petrozavodsk. It is estimated that the mica reserves in the Yena area run in the neighborhood of 10-15,000 tons of crude mica of which about 4,000 tons represent high-grade mica.

Other large pegmatite deposits on the Kola Peninsula containing feldspar and mica which may assume economic significance in the future are as follows:

At Zapadnaya Litsa and around the Kola Fjord - in the northernmost part of the Kola Peninsula - there are numerous veins of pegmatite containing a very high grade of feldspar, well suited for the ceramic industry. The reserves at Zapadnaya Litsa are estimated at nearly ten million tons. At Belokamenka, 15 km north of Murmansk, there are reserves of about 70,000 tons and at Cape Mishukov, Cape Pinagoryy, and Rosta the reserves are estimated at 150,000 tons.

North of the Khibine tundra, at the Pecha River and in the vicinity of Yagol'nyy Bor there are over 200 veins of pegmatite with mica and feldspar. The same is also true of the Virunaiv tundra and between Pulozero and Levozero.

There is an enormous area with numerous veins of pegmatite in the eastern part of the Kola Peninsula in the Keyev Massif along the upper course of the Ponoy River. The feldspar there is not of particularly high quality, but the mica is usable.

Literature:

A.E. Fersmann: "The Useful Minerals of the Kola Peninsula," Moscow-Leningrad, 1941 (Russian)

A.N. Labuntsov: "The Pegmatites of the USSR". "The Pegmatites of Northern Karelia and Their Minerals", Moscow-Leningrad, 1933 (Russian)

A.L. Krist: "New Feldspar Deposits, The Minerals of the Karelian ASSR," Printing House ONTI-NKTP-SSSR, Leningrad-Moscow, 1936 (Russian)

XXIII. Limestone and Dolomite

So far, high-grade limestone has not been found on the Kola Peninsula. There is a great need for it by the chemical industry on the Kola Peninsula, and they have sent out their own expeditions to look for it.

There are large deposits of lower-grade chalk. Those which have been investigated most thoroughly are:

a) At Titan Station on the branch line to Kirovsk

b) At Varzuga and Pana in the southeastern part of the Kola Peninsula

c) At Apatity Station on the Kirov Line.

d) At Kildin Island on the Murmansk Coast

e) At Koldarovo - iron pits, ~~see p. 38~~.

The deposits at Titan Station have reserved of about 50 million tons. The limestone there is very impure, being mixed with quartz and clayey shale. There is also low-grade dolomite there, gray in color, and mixed with quartz, mica, and magnetite.

The Varzuga and Pana deposits are the largest chalk deposits on the Kola Peninsula. Exact figures on the reserves are not available, but they are considerably in excess of 500 million tons. The limestone and dolomite is the same type as that found at the Titan Station deposits.

The deposits at Apatity Station are called Dolomitovaya Varaka. There is a packet of dolomite - limestone 250 meters long and 1-11 meters thick. The chalk is rather impure.

The deposits on Kildin Island consist of dolomites and dolomitic limestone. The limestone is of poor quality but can be used in the production of unslaked lime. The reserves are 3-4 million tons.

The Koldarovo deposit is the only chalk deposit on the Kola Peninsula being worked on a large scale. It is being used to some extent by the chemical industry. The reserves there run in the neighborhood of 500 million tons. There chalk can be mined at the same time as iron ore. It can also be extracted from outcroppings. The chalk is coarse in grain and crystalline, almost marble-like, and contains apatite, mica, magnetite, and other minerals as impurities. The content of magnesium and silicon is not particularly high,

but the chalk is still not perfectly suitable for the chemical industry. The deposit consists of several pockets 250-600 meters long and 50-100 meters thick.

There are good transportation facilities at all the chalk deposits except Varzuga and Pana.

Literature:

"Useful Minerals of the Kola Peninsula" by A.E. Fersmann, Moscow-Leningrad 1941, (Russian).

Olivine

This rock is used for the production of fireproof materials capable of resisting temperatures up to 1800° C. There are three important deposits on the Kola Peninsula. None of these deposits was being worked until 1943. The most important deposit is Lesnaya Varaka, which is located about six kilometers east of the Kirov Line, approximately at the same altitude as Olenya Station. The reserves are reported at several million tons. The The olivine rock there contains about 95% olivine, $(Fe, Mg)_2 SiO_4$. Some olivine-pegmatites contain up to 98% olivine. The iron content is about 15%. The deposit can be worked as an open pit.

Some peridotite rock around the nickel deposits on the Monche tundra contain about 50 percent olivine. The olivine can be extracted to some extent as a by-product in the mining of nickel ore.

Olivine rock also occurs in conjunction with peridotite rock on the Podas tundra in the western part of the Kola Peninsula. Nothing has been reported on the quality of this olivine rock or the size of the deposit. There is not much likelihood that this deposit will be worked because of its location.

Apparently the Lesnaya Varaka deposit is being worked at the present time, and possible that those on the Monche tundra are too.

Literature:

A.E. Fersmann, "The Useful Minerals of the Kola Peninsula," Moscow-Leningrad, 1941 (Russian)

XXV. Cyanite and Sillimanite

These two aluminum silicates are of importance as raw materials in the manufacture of fireproof substances and of electrical insulators, etc.

The Kola Peninsula has by far the largest deposits of these minerals in the world, just as it does for apatite and nephelite. They are cyanite reserves of 15-20 million tons in the Keyev (~~Kiev~~) Massif in the eastern part of the Kola Peninsula. The area is practically uninhabited and the nearest railroad station is 150 km away. The deposits were not worked at all until 1943, but attempts at concentration of the ore had been carried out with success. It had been planned that these deposits were to be worked as soon as possible. However, extensive road and railroad installations were required for this. It is hardly likely that the deposits are being worked yet, but it is quite possible that they will be in a year or two.

Besides these deposits there are also relatively small deposits of cyanite and sillimanite in three other areas on the Kola Peninsula. So far as is known, none of these deposits is being worked.

Cyanite is the more valuable of these two minerals. It is used primarily for the manufacture of heat-resistant ceramics and for electrical insulators, as well as a raw material in the aluminum industry and in the production of silumin. (Silumin is an aluminum-silicon alloy). The sillimanite is used mostly for the manufacture of fire-resistant substances.

The cyanite shales of the Keyev (~~Kelv~~) Massif contains for the most part 40-50 percent cyanite, but some rich portions may contain up to 80 percent cyanite. The iron content, which is often excessively high in cyanite deposits, is only 1 percent in this deposit. The enriched cyanite concentrate contains only 0.2 percent iron. The aluminum oxide content is 63 percent.

Cyanite and sillimanite shales from other deposits contain only 15-30 percent cyanite or sillimanite and, for that reason, cannot be compared with the Keyev ore.

A number of large and small cyanite deposits are now known in the Keyev (~~Kelv~~) Massif; figured from west to east, they are:

Valyurt tundra, Chervurt, Konchurt (Karmanyuk), Bol'shoy Rov,

Yagelurt, Kyrpuaiv, Shuusurt, Malyurt, Akkurt, Kainurt, Nussa Mountain, Igiurt, and the eastern part of Manyuk Mountain. The following five of these deposits have been investigated rather closely:

1) Chervurt, which is located 65 km north of the town of Krasnoshchelye and 200 km from the Kirov Line. There the cyanite shale contains 54 percent pure cyanite. By boring with ~~diamontarille~~ diamond drills, it has been determined that the ore reserves are at least 10 million tons.

2) Bol'shoy Rov is situated 12 km east of Chervurt. The cyanite content of the shales there is about 41 percent. The reserves up to seven meters below the surface of the ground are estimated at 350,000 tons. It is possible that the reserves are considerably greater.

3) Kyrpuaiv is situated about 12 km east of Bol'shoy Rov and 3 km west of Shuusurt. This deposit has been investigated for a distance of 700 meters. The average cyanite content of the shale is 42 percent. The reserves are estimated at 350,000 tons.

4) Shuusurt is located 22 km southeast of Churvurt, 70 km from the town of Kanevka, and 55 km from the town of Krasnoshchelye. So far an area containing 1,200,000 tons of cyanite has been investigated. There the cyanite content of the shale is 45 percent. It is possible that the reserves there are several million tons.

5) Manyuk is the easternmost cyanite deposit in the Keyev (~~Kola~~) Massif. It is situated 25 km northeast of the town of Kanevka. An area 600 m long and 70 m wide has been investigated. The cyanite reserves up to 9 meters below the surface of the ground have been estimated at about 500,000 tons. This estimate was made in 1938. Other important deposits were discovered there in 1939.

Besides those cyanite deposits on the Kola Peninsula just described, there are three other cyanite and sillimanite deposits on the peninsula, namely:

1) The Tuloma Valley, south of Murmansk. There there are concentrations of cyanite-silfimanite in gneiss. However, the ore is so poor that it is hardly worth while to talk about working the deposit.

2) Palkinskaya Guba in the upper part of the Kandalaksha Fjord. There there is a cyanite-garnet-gneiss deposit which was trace for one kilometer. The deposit is poor, containing only 15 percent cyanite and garnet together.

3) The northern contact-zone of the Lovozero Massif. There there is a rather large deposit of sillimanite and also some cyanite. The deposit, 30-40 meters thich was traced for two kilometers. Sillimanite constitutes about 30 percent of the sillimanite-bearing rock. Attempts have been made to concentrate this sillimanite, but thus far only with disappointing results. The following three sites would be most favorable for possible exploitation within this area:

a) Karnazurt Mountain

b) A runner of the Piyalkimpar Mountain

c) Flora.

The places are located near the Pulozero (Kirov Line) - Lovozero road.

Sillimanite is more suitable for the production of fire-resistant materials than is cyanite.

Literature:

A.E. Fersmann: "The Useful Minerals of the Kola Peninsula," Moscow-Leningrad 1941 (Russian)

XXVI. Garnet

Garnet is important as a raw material for abrasives. There are three areas on the Kola Peninsula containing garnet deposits, but none of these was being worked in 1943.

By far the most important deposits are situated around Lake Seyyavr and the Sakharyok River. So far there are no transportation facilities in the area, but it is not very far from the Lovozero tundra.

Garnet occurs there in large crystals up to 6 kg in weight in mica schist. The schist may contain up to 70 percent garnet. The garnet may be separated readily from the schist.

Investigations conducted so far around Seyyavr have indicated reserves of 1.4 million tons of garnet. Possibly the reserves are considerably larger. The deposits which have been investigated so far are:

1) Maksabak Mountain, 12 km southeast of Lake Seyyavr (on the watershed between the Ponoy and Makanga Rivers). The reserves estimated to a depth of 50 meters are 300,000 tons.

2) Takhlintuaiv, 9 km west of Maksabak. Up to a depth of 10 meters there is a reserve of 150,000 tons.

3) Rovozersk 8-10 km east of Maksabak. There are reserves of 500,000 tons up to a depth of 10 m. The garnet crystals sometimes occur in masses 5 m^3 in volume which are almost perfectly pure garnet.

4) Berezovaya Mountain, west of Lovozero Station. The mica schist there has a garnet content of about 40 percent. The reserves are 300,000 tons up to a depth of 15.

Besides the deposits around Lake Seyyavr, there is another large area with garnet deposits which extends from the Tuloma Valley to Pulozero south of Murmansk.

There the garnet occurs in sillimanite-bearing gneiss. The garnet crystals for the most part are of about the size as those at Lake Seyyavr, about one kilogram in weight. To what extent more thorough investigation of this area have been made is not known.

Finally, a smaller deposit near Kandalaksha may be mentioned. There there are concentrations of small garnet crystals in gneiss and amphibolite. Nothing further about the deposit is known. Apparently it is unimportant.

Literature:

A.E. Fersmann, "The Useful Minerals of the Kola Peninsula," Moscow-Leningrad 1941 (Russian)

XXVII. Granite

A. As A Construction Stone:

There are immeasurably immense quantities of granite suitable as a construction stone on the Kola Peninsula. There is more than enough to cover every conceivable requirement. It would amount to several billions of tons.

In this instance we shall discuss several deposits situated favorably with respect to transportation. All of are being quarried on a more or less large scale:

a. Sayda Guba
b. Olen'ya Guba (Kola Fjord)
c. Volkovaya Guba
d. Umba (Kandalaksha Fjord)
e. Berezovyy Ostrov
f. Kolvitskaya Guba (end of Kandalaksha Fjord)
g. Myagkominka

Keret' Island and the town of Sosnovaya on the south side of Kandalaksha Fjord may also be mentioned.

B. As an acid-resistant material and for the ceramic industry.

Granite of this type is quarried in Sayda Guba, due east of Laplandiya Station on the Kirov Line, and at Umba. There is also a deposit of white granite well suited for the same purpose somewhat north of the Lovozero tundra. However, it is still inaccessible. The reserves of granite of this type are estimated at 50 million tons.

Literature:

A.E. Fersmann: "The Useful Minerals of the Kola Peninsula," Moscow-Leningrad 1941 (Russian)

XXVIII. Khibinite

Khibinite is a coarse-grained nephelite-syenite of wide occurrance on the Khibine tundra. This rock consists essentially of nephelite, feldspar, and aegerite. Khibinte has slight heat-conductance properties and is suited, therefore, as a home construction material, particularly for foundations. It played a major role in the construction of the city of Kirovsk.

It is quarried only in one big quarry - Aikuaivenchorr - near the city of Kirovsk. The deposits are practically unlimited.

XXIX. Lestivarite

Lestivarite is a light rock. It is composed of feldspars, albite (sodium feldspar) and microcline (potassium feldspar), and a little quartz, often none. This rock is a fine raw material for the ceramic industry and for the manufacture of acid-resistant substances.

One deposit - Lesnaya Varaka - situated right on the Kirov Line between Kirovsk and Murmansk, directly south of the branch line to Monchegorsk, is being worked. Transportation facilities are favorable.

The reserves of lestivarite are not known, but in any case, are in the neighborhood of one million tons. The production is not known.

XXX. Kaolin

The deposits of kaolin, which finds primary usage in the porcelain industry, is known at only one place on the Kola Peninsula, namely near the station of Yena - about 2 km from there. Yena is situated to the northwest of Kandalaksha in the western part of the Kola Peninsula, up towards the Finnish border. Yena Station is located on the branch line to Koldarovo running from Pinozero.

XXXI. Clay

Deposits of clay worth working are found at the bottom of the Kola, Tuloma, Niva, Kolvitsa Rivers, in the Lake Imandra area, and in the northeastern part of Karelia. The total reserves of clay on the Kola Peninsula are estimated at 18 million cubic meters. The valley of the Kola River is particularly rich in clay deposits. There are two brickyards there, each of which produces 100 million bricks per year. There is a brickyard producing ten million bricks per year in the valley of the Tuloma River.

The various deposits are: (+ indicates that there is a brickyard at the site).

The area from the Kola Fjord to the Shonguy Station, largely around the Kirov Line:

		Reserve
a.	Alysh Bay +	
b.	Ura Bay +	
c.	Lavna River	
d.	Varnichnyy Ruchey (Rosta) +	3 million m^3
e.	Fadyev Ruchey +	1.9 " "
f.	Kildin Ruchey +	1 " "
g.	Naumkovo Tuloma	700,000 million m^3
h.	Ristikent	
i.	Shonguy Station +	
	Imandra Area	
j.	Monche ~~Guba~~ Guba +	400,000 m^3
k.	Vysokiy Ostrov +	
l.	Khibiny Station	
	Kandalaksha area	
m.	Nivastroy	
n.	Kandalaksha +	300,000 m^3
o.	Umba	190,000 "

Some of the clays on the Kola Peninsula are so solid that they form slate and can be used for roofing shingles. This is the case, for example, at the Kildin Ruchey deposit. The clay is processed for the most part in rather small brickyards.

Literature:

A.E. Fersmann: "The Useful Minerals of the Kola Peninsula," Moscow-Leningrad, 1941 (Russian)

XXXII. Peat

The deposits of peat on the Kola Peninsula (and in Karelia) are practically unlimited. Peat bogs extend all over the whole peninsula. It has been figured that there are at least 78,000 hectares of peat bog, which should correspond to about 150 million tons of air-dried peat. The largest extent of peat is in the eastern part of the peninsula, around the Varzuga, Strelna, and Ponoy Rivers. At the present time only the peat bogs in the vicinity of the settled areas have been considered for exploitation. The peat bogs represent great reserves of fuel. Thus far there has been no large-scale, systematic working of the bogs. However, there has been talk of this; already in 1933 a factory for the drying and carbonization of peat was erected at Laplandiya Station on the Kirov Line. The peat tar extracted there was purified in Kirovsk, whereby peat acid was extracted. This peat acid is used as a flotation reagent in the concentration of apatite-nephelite ore. Acetic acid and paraffin are also obtained during the purification of the peat tar. The plant was not a success, and in 1937 it was converted for the dry distillation of kieselguhr.

Figures on the production of peat on the Kola Peninsula are not known. However, it has been reported that 16,200,000 m^3 of air-dried peat were produced in 1932 in Karelia and the Kola Peninsula together.

Literature:

A.E. Fersmann: "The Useful Minerals of the Kola Peninsula," Moscow-Leningrad, 1941 (Russian)

Atlas of the Leningrad Area and of the Karelian ASSR-GENIT, 1934 (Russian)

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