PRO AGRO LECTORIUM

Production of mineral fertilizers

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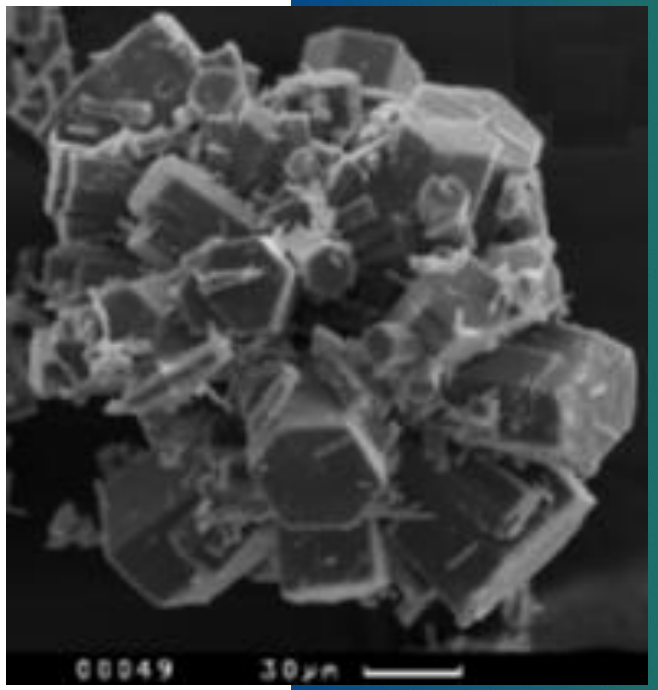
Illustrated by Dmitry Dorofeyev using Kandinsky 2.1 neural network

Apatite concentrate production



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PhosAgro Group

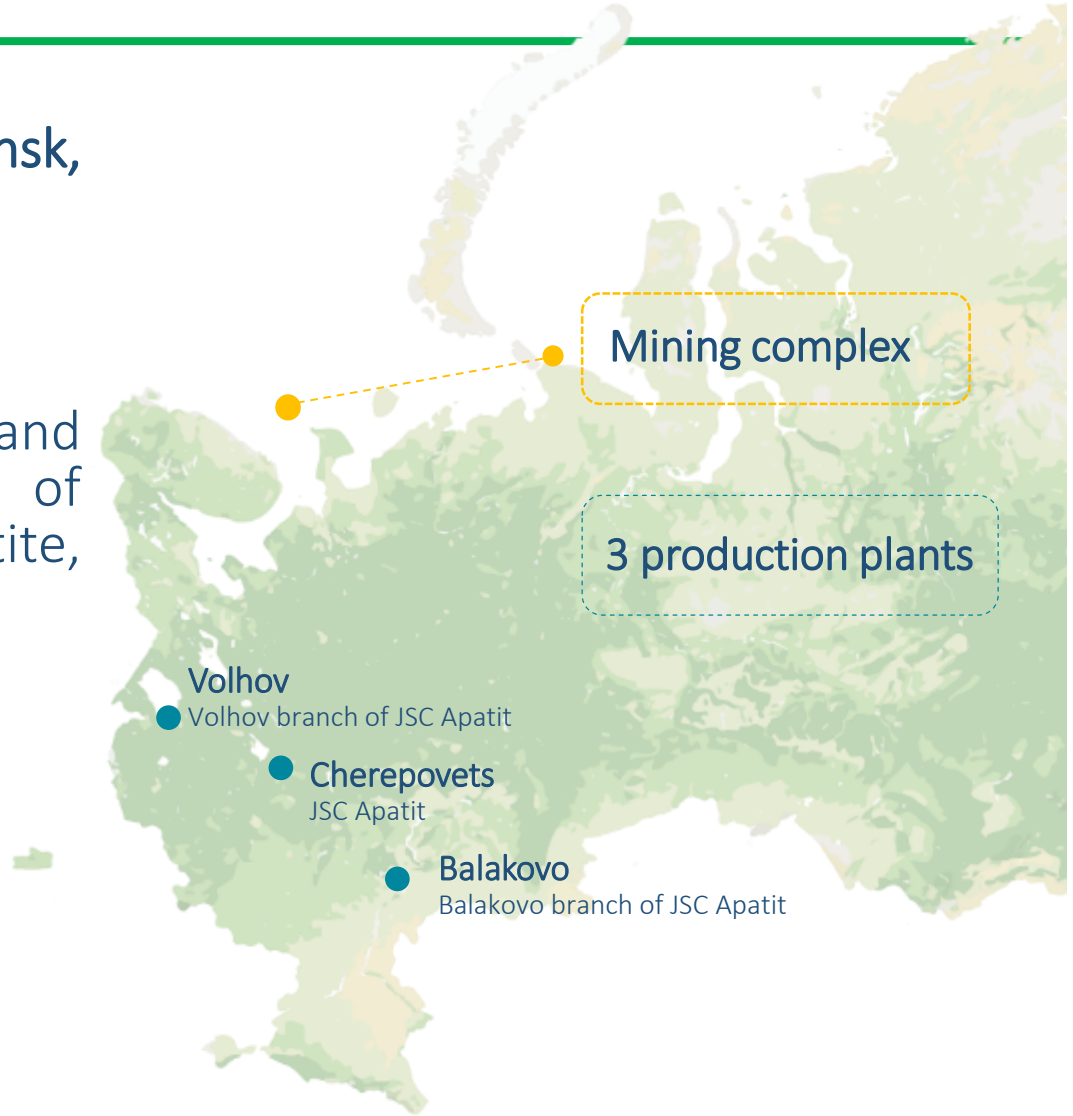
Main production assets located in Murmansk, Vologda, Leningrad and Saratov regions.

Mining:

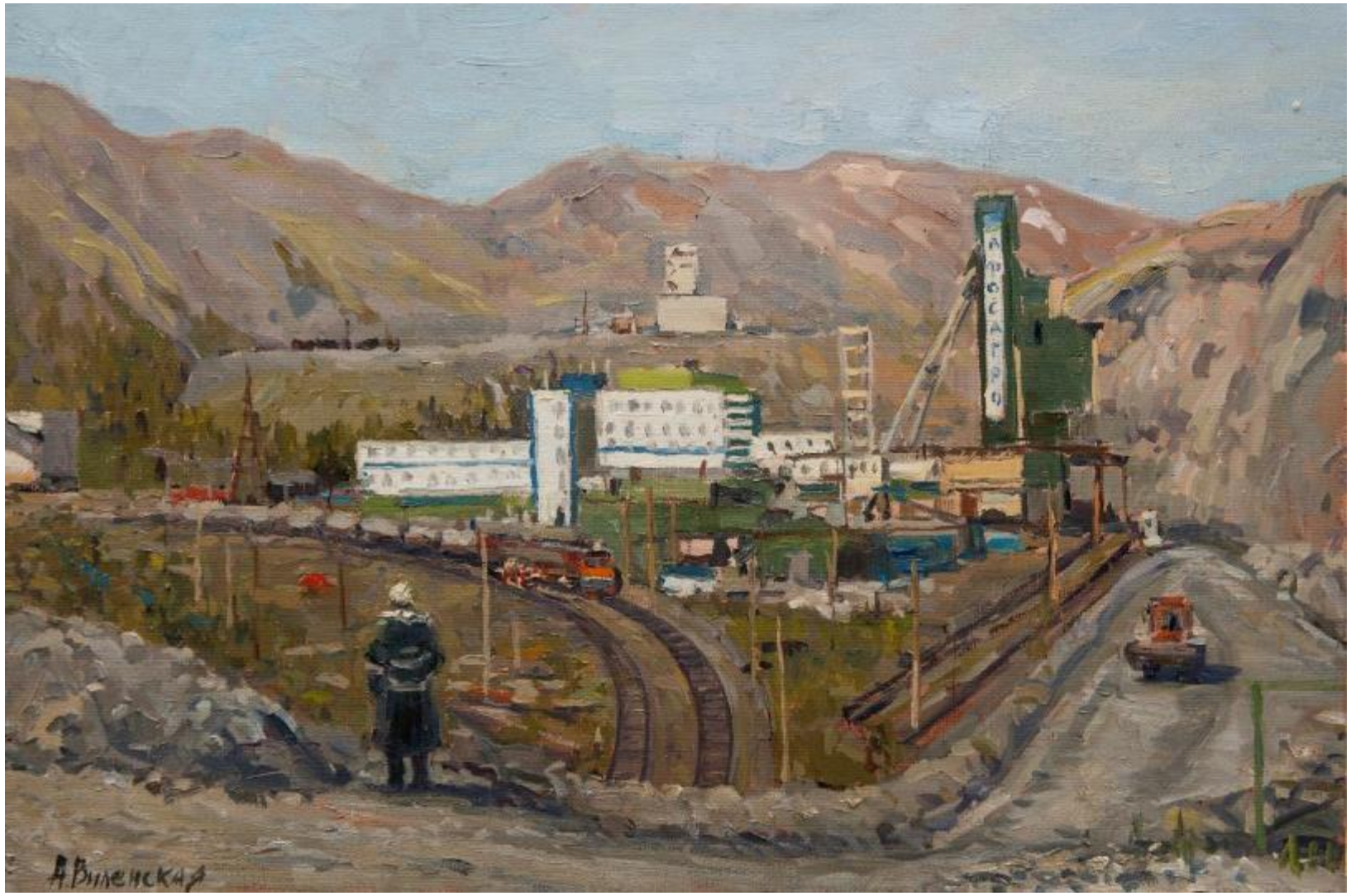
- Kirovsk branch of JSC Apatit – mining and beneficiation apatite and nepheline ores of Khibins resources, production of apatite, nepheline and syenite concentrates.

Processing:

- JSC Apatit (Cherepovets)
- Balakovo branch of JSC Apatit
- Volhov branch of JSC Apatit

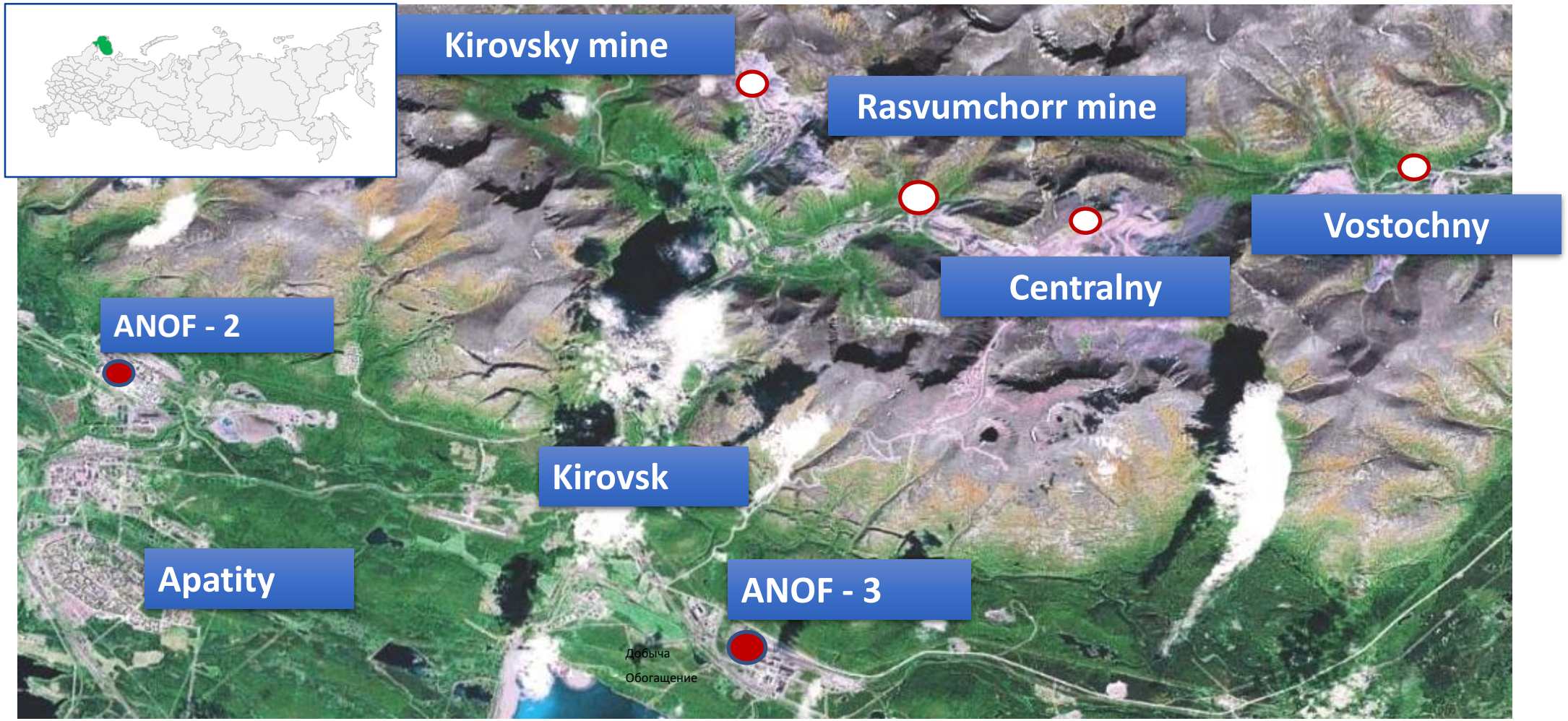


Kirovsky Mining



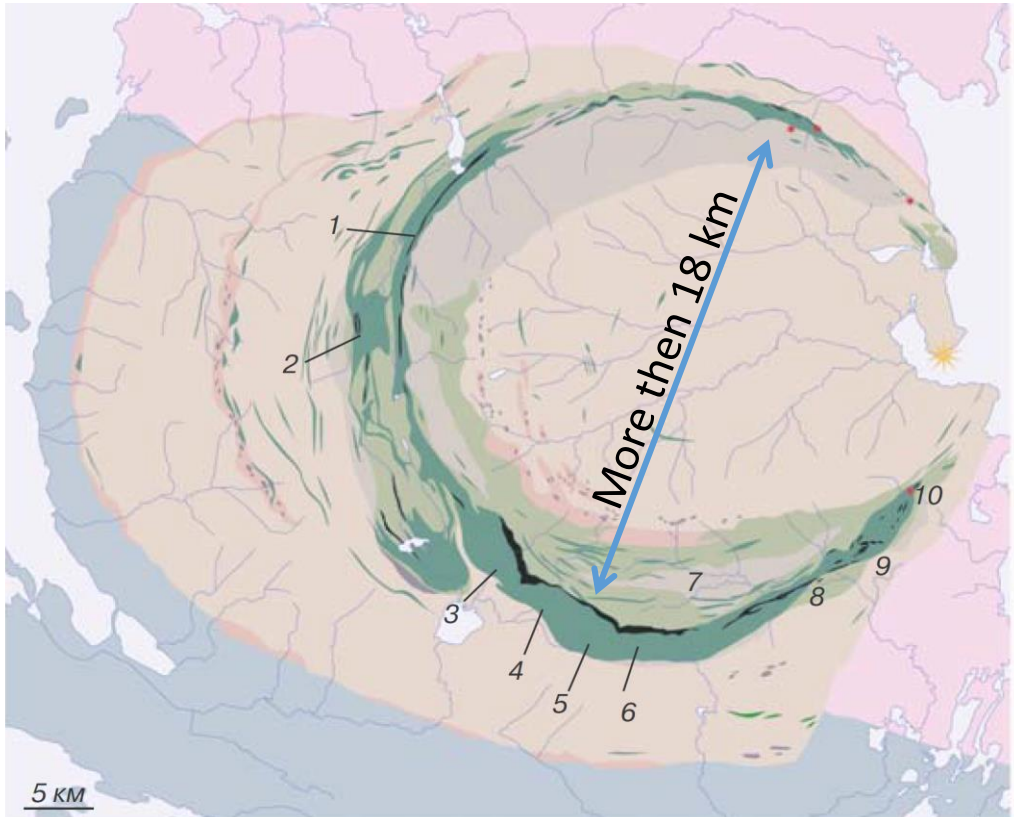
VILENA ANNA
KIROVSKY MINING
(2017)

Location of the PhosAgro mines



Apatite and nepheline ore

- Apatite-nepheline ore is mined in 4 mines.
- Over 90 years, 2 billion tons of apatite-nepheline ore were mined.
- Apatite deposits in the Khibiny were discovered in the 1920s. This discovery formed the production of mineral fertilizers in Russia based on the processing technology of apatite concentrate.
- In the world, the production of phosphate fertilizers is mainly based on the processing of phosphorites.
- Khibiny resource owns more then 10 deposits.
- Main mines: Kukisvumchorr, Yuksporsk, Apatite Circus, Rasvumchorr Plateau, Koashvinsky, Nyorkpakhk, Oleniy Ruchey, Kuelpor, Eveslogchorr and Partomchorr.
- The reserves of apatite-nepheline ores will last even more than 60 years.

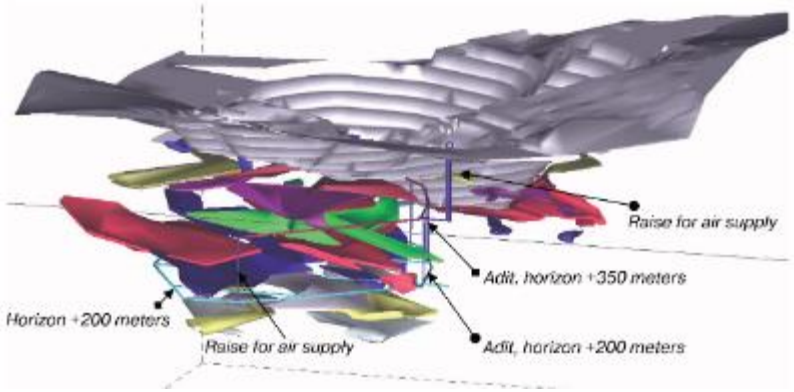


Deposits of apatite-nepheline ores of the Khibiny massif

Source: Mining Journal, 2009 №9 // "Implementation of the investment program for the development of enterprises of the company PhosAgro"

Mining – 38 mln t for 2019, 10.5 mln t apatite concentrate

Open pit mine



Geological model of the Nyorkpakhk open pit mine

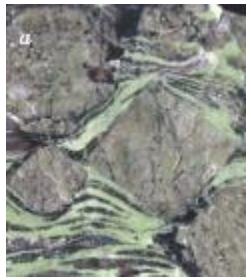
Closed mine

Source: Mining magazine, 2010 №2//«THE COMBINED OPENCAST-UNDERGROUND MINING OF NEARBOARD AND SUB-QUARRY RESERVES OF APATITE-NEPHELINE ORES »

Ore parameters

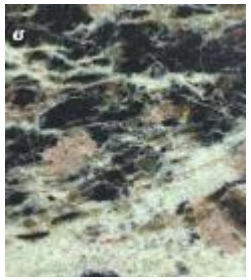
Texture variety	Content, %	Mineral content, %					
		Apatite	Nepheline	Pyroxene	Field	Sphen	
Titanomagnetite spar							
Spotted	11-20	74,6	14,6	5,9	1,6	1,4	0,4
Brecciform	3-13	47,0	33-37	11-17	2,5	4,5	1,1
Lenticular	35-36	43,3	42,1	7,7	0,7	2,2	2,0
Striped	44	39,8	8,7	1,2	3	1,2	
Block	10-34	31,7	51,8	9,3	0,5	2,6	2,6
Reticulated	21,9	30,0	17,7	2,2	18,2	4,2	
Sphen Apatit	2-10	20,4	31,4	17,3	1,5	18,6	5,2

Varieties of apatite-nepheline ores of the Khibiny deposits:



Block

Lenticular banded



Spotted banded

Spotted

Apatite urtitis

Ore beneficiation

Mined ore is processed at two apatite-nepheline beneficiation plants – ANOF-2 and ANOF-3.

First apatite-nepheline beneficiation plant ANOF-1 was launched in 1931.

In 1963 was launched ANOF-2.

In 1984 was launched ANOF-3.

In 2019 was mined and enriched **38 mln t** ore and produced **10.5 mln t apatite concentrate** and almost **1 mln t** nepheline concentrate.

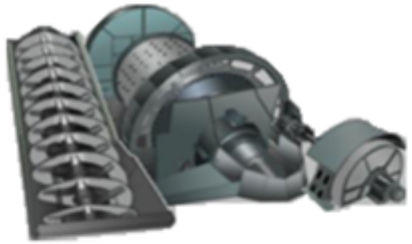
Apatite-nepheline beneficiation plant ANOF-3

Ore beneficiation and production of apatite concentrate

Increasing of P_2O_5 from 14,6% in ore to 39% P_2O_5 in apatite concentrate. Production of $Ca_5(PO_4)_3F$

Ore

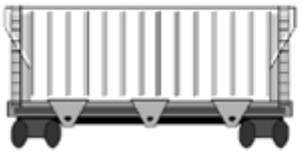
Grinding



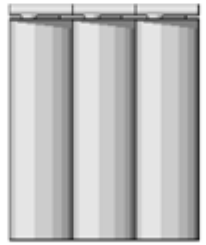
Milling

Flotation

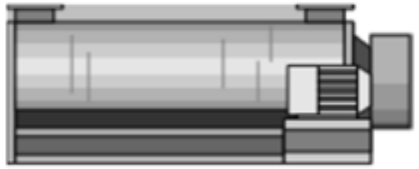
Concentrating



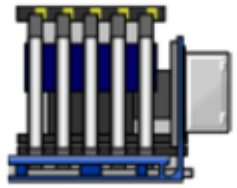
Shipment



Silo



Drying



Filtration

Video file

Heavy metals

REGULATION (EU) 2019/1009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL (5 June 2019).

Regulation object

mineral fertilizers with phosphorus content > 5% P_2O_5.

Harmful elements	2022	2026
Cadmium (Cd), mg/1 kg P2O5	<60	<40
Mercury (Hg), mg	<1	
Arsenic (As), mg	<40	
Lead (Pb), mg	<120	
Nickel (Ni), mg	<100	
Chromium (Cr VI), mg	<2	

State	Mine	Content of P_2O_5(%)	Cd (ppm)	Source
Senegal	Taiba	35.9	86.7	1
Togo	Kpeme	36.7	58.4	1
Tunisia		29.9	39.5	1
Israel	Zin	31.1 - 32.8	24.2 - 30.8	
Peru	Sechura	30.2	25.0	
Algeria	Djebel Onk	28.8	22.5	1
Morocco		31.2 - 32.7	15.1 - 37.5	1.2
United States	Central Florida	29.8 - 32.1	6.1 - 38.2	2
Jordan	El-Hasa	30.5 - 31.9	5.4 - 6.0	2
Egypt	Abu Tartur	22.2 - 29.9	5.7	2
Australia	Duchess	31.2	4.2	2
Venezuela	Recieto	27.9	4.0	2
Burkina Faso	Kodjari	29.2	2.5	2
Tanzania	Minjingu	28.6	1.0	2
Zimbabwe	Dorowa	33.1	1.0	2
Sweden	Kiruna	35.3	0	2
Uganda	Sukulu Hills	38.6	1	2
Russia	Khibiny	39.2	1.2	2

1. Landbauforschung Völkenrode - FAL Agricultural Research, 2007
2. IFA Technical Conference, Chennai, India 24-27 September 2002


ФОСАГРО

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Thank you!