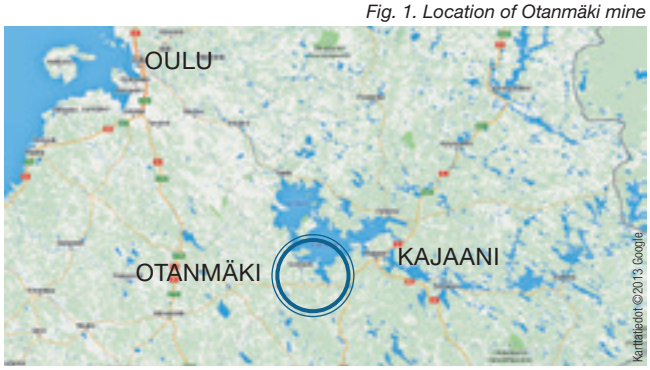
OTANMÄKI MINE

Otanmäki Mine Oy

Otanmäki Mine

- Otanmäki Mine Oy plans to reopen Otanmäki Fe-Ti-V-mine sometime between 2020-2022
- Main products of Otanmäki mine will be vanadium-pentoxide, ilmenite and iron concentrate (Fe-pellets)
- Mining will start from open pit and will later move underground (open pit phase 2-3 years)
- Basic infrastructure including railway, 110kV powerline, 3 hoisting towers, office buildings and accomodation for mine workers are already in place
- Proven historical concept of mining, processing and vanadium extraction reduce technical and financial risk
- Otanmäki mine and vanadium factory would employ directly ca. 350-400 persons
- Strong social acceptance of local people for reopening the Otanmäki mine
- Estimated mine life minimum 15 years
- Estimated mine and vanadium factory construction CAPEX 180-220 MEur

Fig. 1. Location of Otanmäki mine



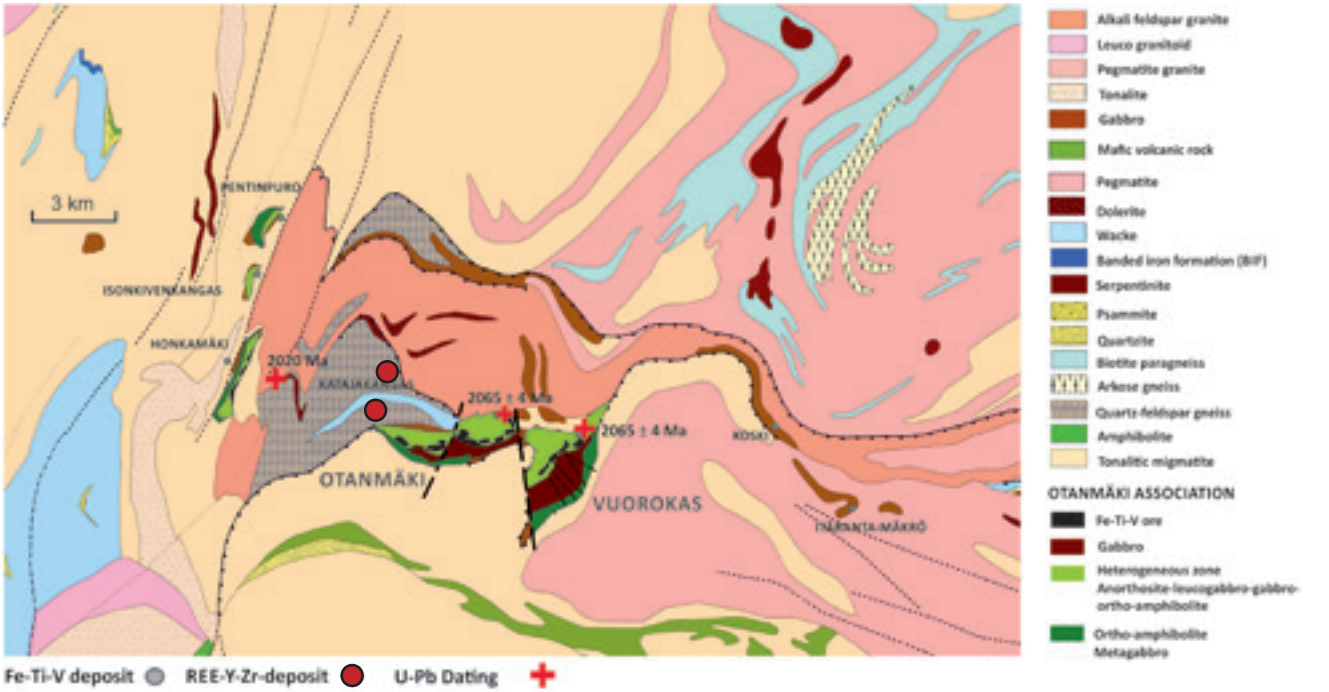
Location

- Otanmäki mine is situated some 450km north of Helsinki
- Nearest major town with airport is Kajaani, some 35km east of Otanmäki
- Town of Oulu, with major port, is situated some 150km northwest

Regional geology

- Regional geology of Otanmäki area is comprised of archean and proterozoic rocks
- Main rocktypes of the area include gabbros, anorthosites, granite gneisses, mica schists and granitoids
- Geology of the Otanmäki region is shown in the map below

Fig. 2.Regional geology of the Otanmäki area



Local geology

- Local geology of the main Fe-Ti-V-deposits of Otanmäki and Vuorokas are dominated by hornblende rich rocktypes and anorthosites
- Local geology of the main deposits of Otanmäki and Vuorokas are presented below in Fig. 3 and 4

Fig. 3. Geology of the Otanmäki mine

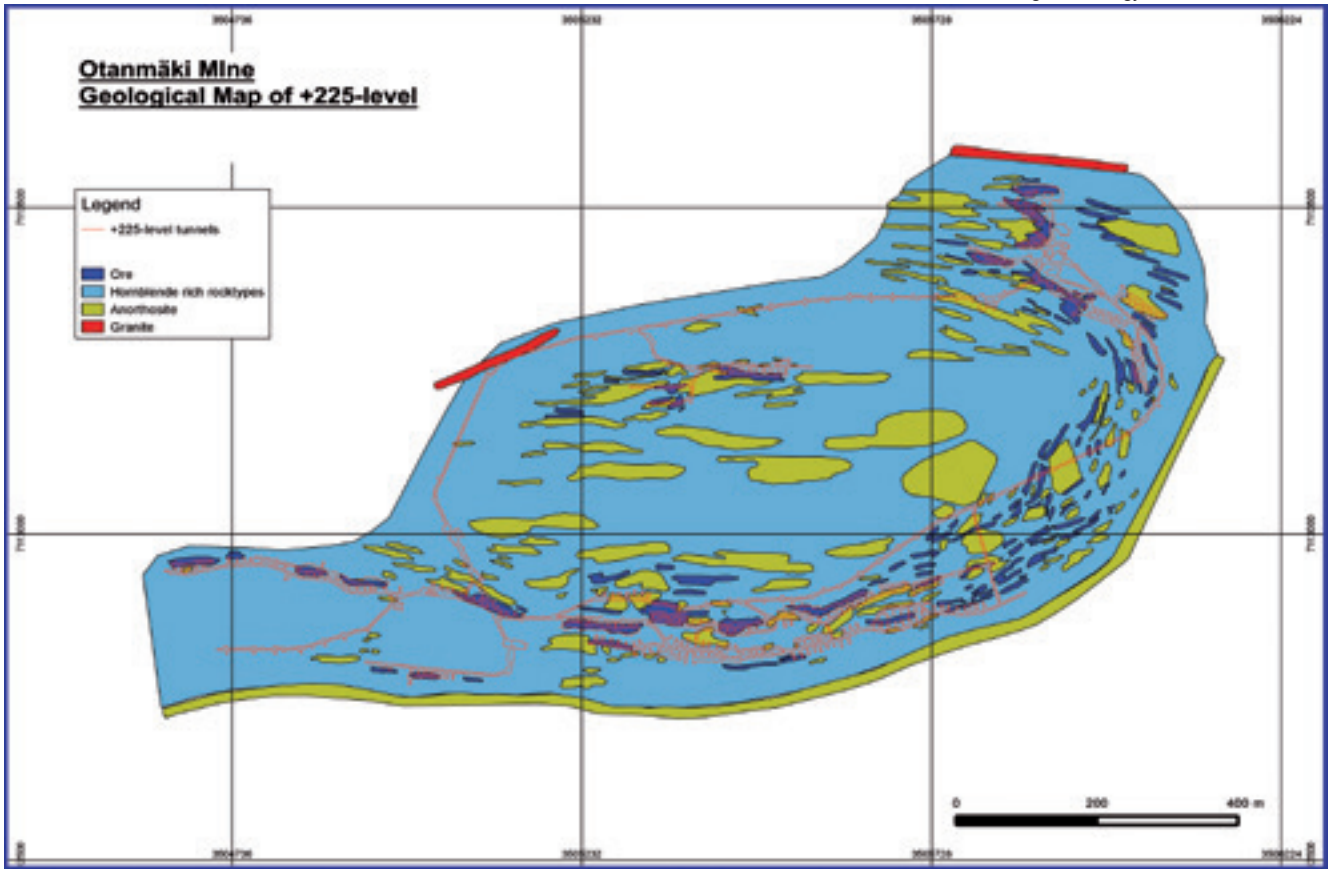
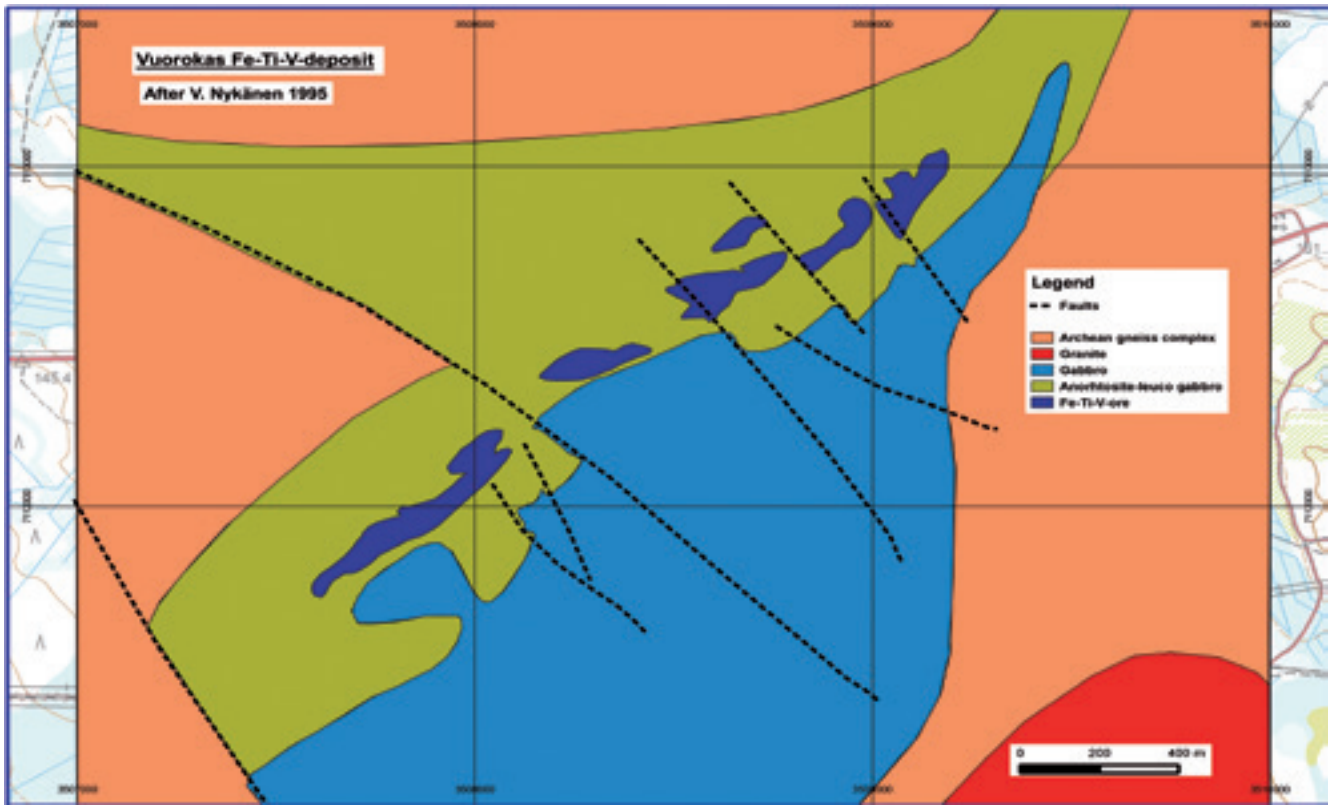


Fig. 4. Geology of the Vuorokas Fe-Ti-V-deposit



Ore mineralogy and composition

- Main minerals of the ore are magnetite and ilmenite with some minor amounts of sulphides
- Main gangue minerals are chlorite, hornblende and plagioclase

Selected best drill intersections

Otanmäki mine

HOLEID	From	To	Length (m)	Fe_tot %	V %	V_2O_5%	TiO_2%	S %	Ilmenite % (calc.)	Magnetite % (calc.)
OTA/X-19	196.06	230.14	32.3	50	0.39	0.70	18.3	0.38	40.63	48.37
OTA/XI-153	44.8	100.53	52.5	43.3	0.31	0.55	17	0.91	37.74	37.58
OTA/XI-178	236.62	279.6	42.01	42.3	0.32	0.57	16.2	1.06	35.96	36.47
OTA/XI-177	144.95	176.39	30.42	48.6	0.38	0.68	18	0.45	39.96	46.19

Vuorokas mine

VU/62	35.74	62.22	25.17	46.2	0.32	0.57	17.1	0.58	37.96	42.81
VU/33	92.3	111.08	16.01	46.9	0.38	0.67	16.3	0.56	36.19	44.79
VU/260-9	94.69	110.68	15.3	47.1	0.37	0.66	18.3	0.64	40.63	43.13

Average grade of Otanmäki and Vuorokas ore

Mine	Length ore (m)	Fe_tot %	V %	V_2O_5%	TiO_2%	S %	Ilmenite % (calc.)	Magnetite % (calc.)
Otanmäki	6.53	38.35	0.28	0.50	13.99	0.76	31.06	32.17
Vuorokas	5.16	37.62	0.27	0.49	14.26	0.67	31.65	30.78

Otanmäki average of 1536 analysis. Vuorokas average of 424 analysis.

Historical production

- Otanmäki Fe-Ti-V-deposit was discovered in 1938 after first boulder discovery in 1937
- Mine opened to production in 1953 and was operational until april 1985
- Main products from 1956 onwards were V_2O_5, Fe-pellets and ilmenite
- Total mined ore+wasterock from 2 deposits were 33.1 million tons
- Almost all mining was undergound, first in Otanmäki deposit and later also from Vuorokas deposit
- Only some 250 000 tons were mined from openpit
- Mining methods used at the beginning were shrinkage stoping and later from 1970'ies sublevel stoping
- All processing was done in a processing plant built nearby
- Processing included underground primary crushing, hoisting of ore to the secondary crusher on the ground level, 2-stage milling, dry magnetic separation, wet magnetic separation and 2-stage flotation to produce ilmenite and pyrite
- Ilmenite and pyrite were sold to customers and magnetite concentrate was transferred to vanadium factory
- Otanmäki mine's main product vanadiumpentoxide was produced at the vanadium factory built beside the processing plant

Historical production statistics

- Table 3 shows last 5 years production statistics (1980-1984)

Ore or product	1980	1981	1982	1983	1984
Ore from Otanmäki (t/a)	1,162,700	954,100	1,010,800	1,044,000	998,400
Ore from Vuorokas (t/a)	243,800	245,900	221,600	209,000	245,900
Waste rock (t/a)	145,500	258,600	67,700	0	0
Total haulage (t/a)	1,552,000	1,358,600	1,300,100	1,253,000	1,244,300
Feed to processing (t/a)	1,072,500	1,027,300	1,020,000	976,900	989,100
Magnetite concentrate (t/a)	302,100	304,100	326,300	316,000	320,200
Ilmenite concentrate (t/a)	159,200	161,500	167,800	163,900	167,000
Pyrite concentrate (t/a)	8,150	7,350	6,700	6,900	6,500
Feed to vanadium factory (t/a)	282,400	299,900	322,700	325,400	320,900
Fe-pellet production (t/a)	287,900	306,000	333,800	332,100	324,400
V_2O_5-production (t/a)	2,569	2,599	2,633	2,787	2,873

Table 3. Production statistics from last 5 years (1980-1984)

Chemical Composition of the products

Fe-pellet

Element	Grade%	Element	Grade%
Fe_tot	66.45	MnO	0.06
FeO	0.45	Cr_2O_3	0.03
Fe_2O_3	94.5	Na_2O	0.19
TiO_2	3.15	K_2O	0.005
SiO_2	0.35	CuO	0.005
V_2O_3	0.2	CoO	0.01
V	0.11	NiO	0.02
Al_2O_3	0.6	ZnO	0.02
CaO	0.1	S	0.01
MgO	0.28	P_2O_5	0.001

Table 4. Average chemical composition of the Otanmäki mine products from year 1984

V_2O_5

Element	Grade%
V_2O_5	91.3
V_2O_4	8.08
V_tot	56.1
Na_2O	0.22
K_2O	0.04
SiO_2	0.06
Fe_2O_3	0.06
Al_2O_3	0.23
Cr_2O_3	0.02
P2O5	0.02
P	0.009
As_2O_3	0.001
S	0.01

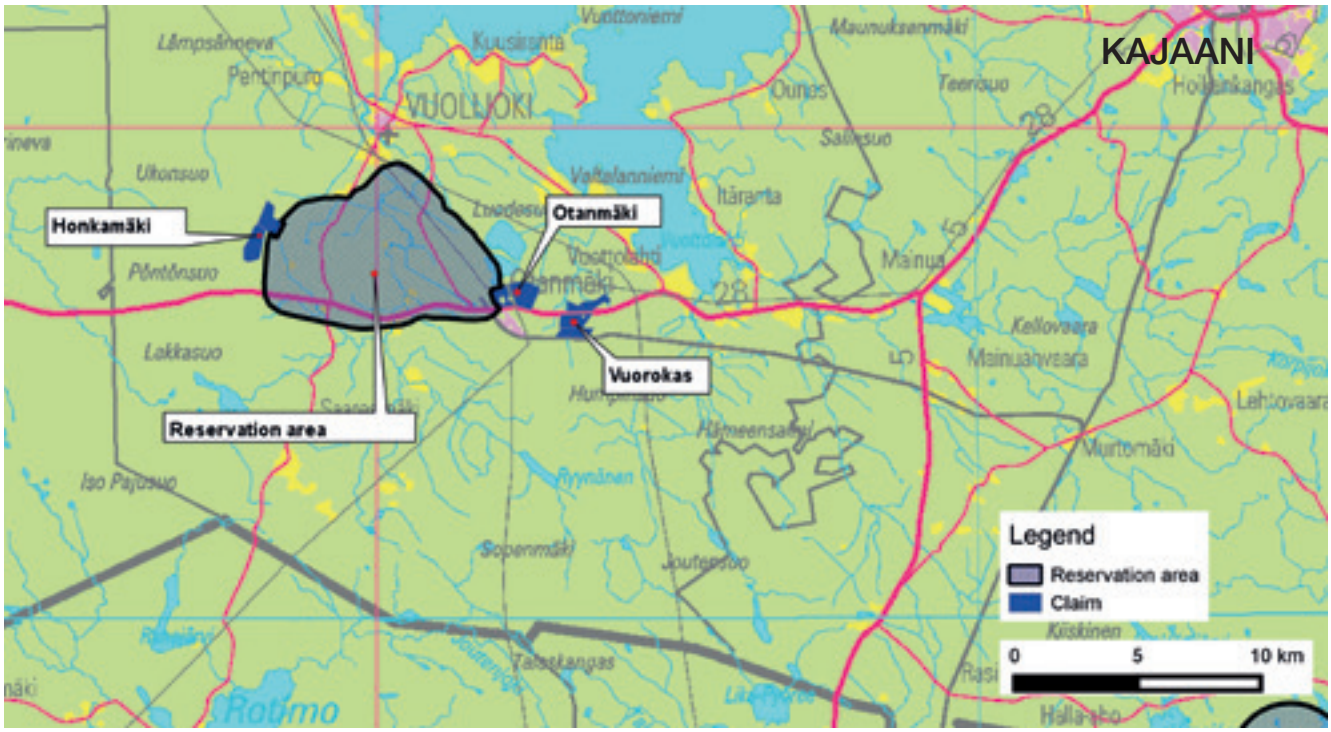
Ilmenite

Element	Grade%	Element	Grade%
Fe_tot	35.5	MnO	0.75
FeO	9.3	Cr_2O_3	0.005
Fe_2O_3	37.3	Na_2O	0.04
TiO_2	45.1	K_2O	0.01
SiO_2	2	CuO	0.01
V_2O_3	0.25	CoO	0.01
V	0.17	NiO	0.01
Al_2O_3	2.65	ZnO	0.06
CaO	0.65	S	0.16
MgO	1.8	P_2O_5	0.05

Planned new production

- Otanmäki Mine Oy holds currently 8 claims in the Otanmäki area
- Total area of the claims is 386 ha and they cover all the main deposits and also major satellite deposits
- Besides of the claims Otanmäki Mine Oy also has a claim reservation area in Otanmäki region, that covers ca. 45 km^2 of potential exploration area

Fig. 5. Claims and claim reservation area



Mining and exploration

- Mining is planned to start as open pit mining from the main Otanmäki deposit
- Additional open pits may be opened also at major satellite deposits
- After initial 2-3 years operation, mining will move undergound at Otanmäki and Vuorokas deposits
- Planned new mining capacity will be 1.5-2.0 Mt/a
- Otanmäki Mine Oy is currently doing exploration on the main deposits and some of the satellite deposits
- Main focus on exploration is to confirm sufficient mineral resources for further mine development and future production
- In a table below is shown compilation of historical mineral resource estimates for the main deposit of Otanmäki and Vuorokas and some satellite deposits

Mineral Resource Estimate

Table 5. Historical mineral resource estimate of the Otanmäki and Vuorokas mines and satellite deposits. Not compliant to JORC- or NI-43-101-standards

Deposit	Indicated resource Mt	Inferred resource Mt	Total ind+ inferred Mt	Fe %	Ti %	V %
Otanmäki	11	3	14	40	7.6	0.26
Vuorokas	6		6	32	5.5	0.26
Pentinpuro	3		3	34.8	7	0.22
Isoaho		0.1	0.1	19.7		0.17
Honkamäki	0.5	12	12.5	33	8.25	0.27
Mäkrö	0.11		0.11	30.3	6.78	0.25
Koski	0.84		0.84	29	7	0.24
TOTAL	**21.5**	**15.1**	**36.6**	**36**	**7.3**	**0.26**

Compiled by Jyrki Parkkinen, geologist, PhD, qualified person according the European Federation of Geologists (EFG)

Processing

- Production will rely on proven historical methods with modern equipment and process optimization
- Processing will start with primary and secondary crushing phases
- After crushing, ore will be transported to dry magnetic separation and to 2-stage milling by rod- and ball mill
- After milling, ore is transferred to wet magnetic separation in which magnetite is separated from ilmenite, sulphides and gangue minerals
- Non magnetic fraction of the ore undergoes 2-stage flotation process in which ilmenite and pyrite concentrates are separated from gangue
- Ilmenite and pyrite are sold to customers and magnetite is being transferred to vanadium factory
- Tailings sand will be stored in a nearby tailings storage facility on the surface or in already existing empty sotopes underground

Otanmäki Mine Process Flow Sheet

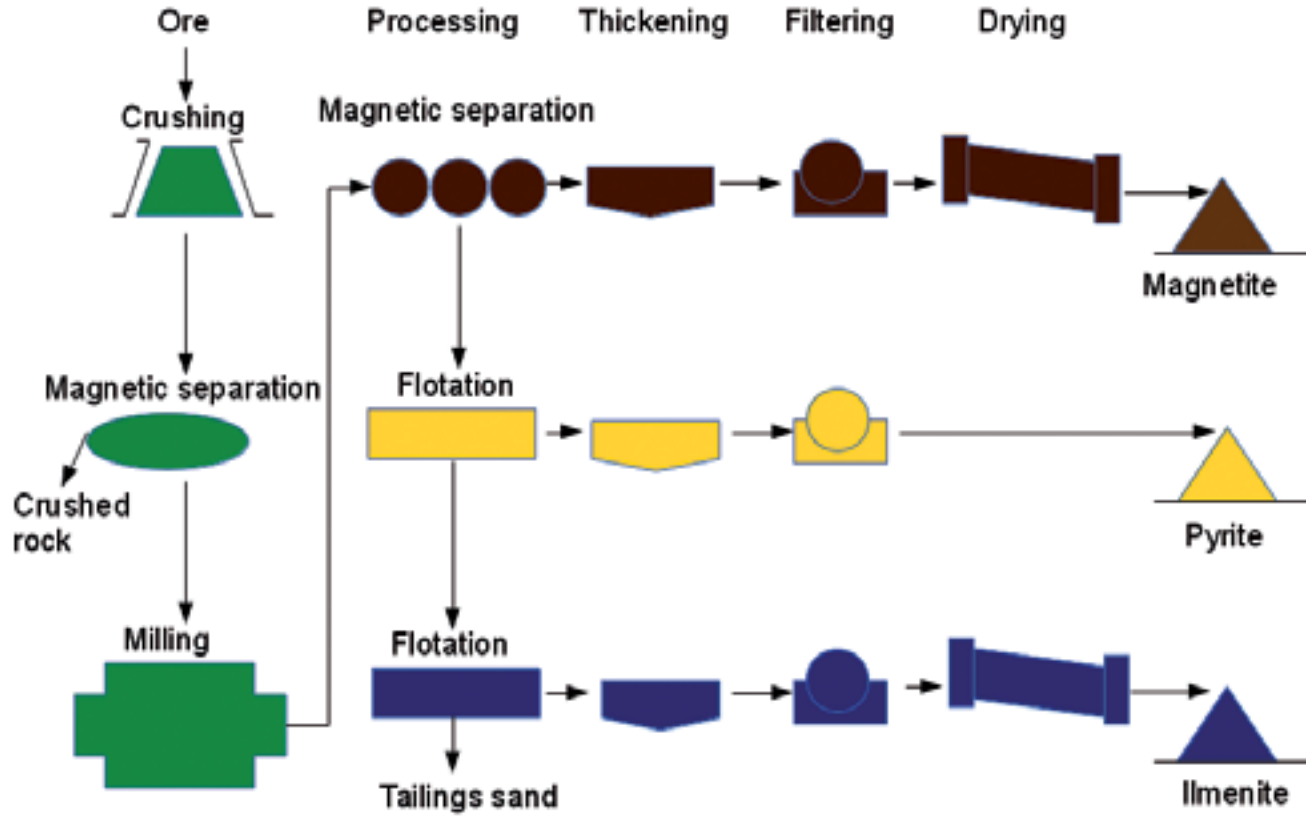


Fig. 6. Otanmäki mine process flow sheet

Vanadium production

- At the vanadium factory magnetite will be mixed with sodium carbonate, pelletized and sintered in an oven at 1300C°
- After sintering Fe-pellets go to leaching process where V_2O_5 is leached out from the pellets
- Leachate undergoes precipitation of V_2O_5 and melting (fusing) in an oven
- Company will also consider production of ferrovanadium from V_2O_5 at a later stage

Otanmäki Mine Vanadium Factory Flow Sheet

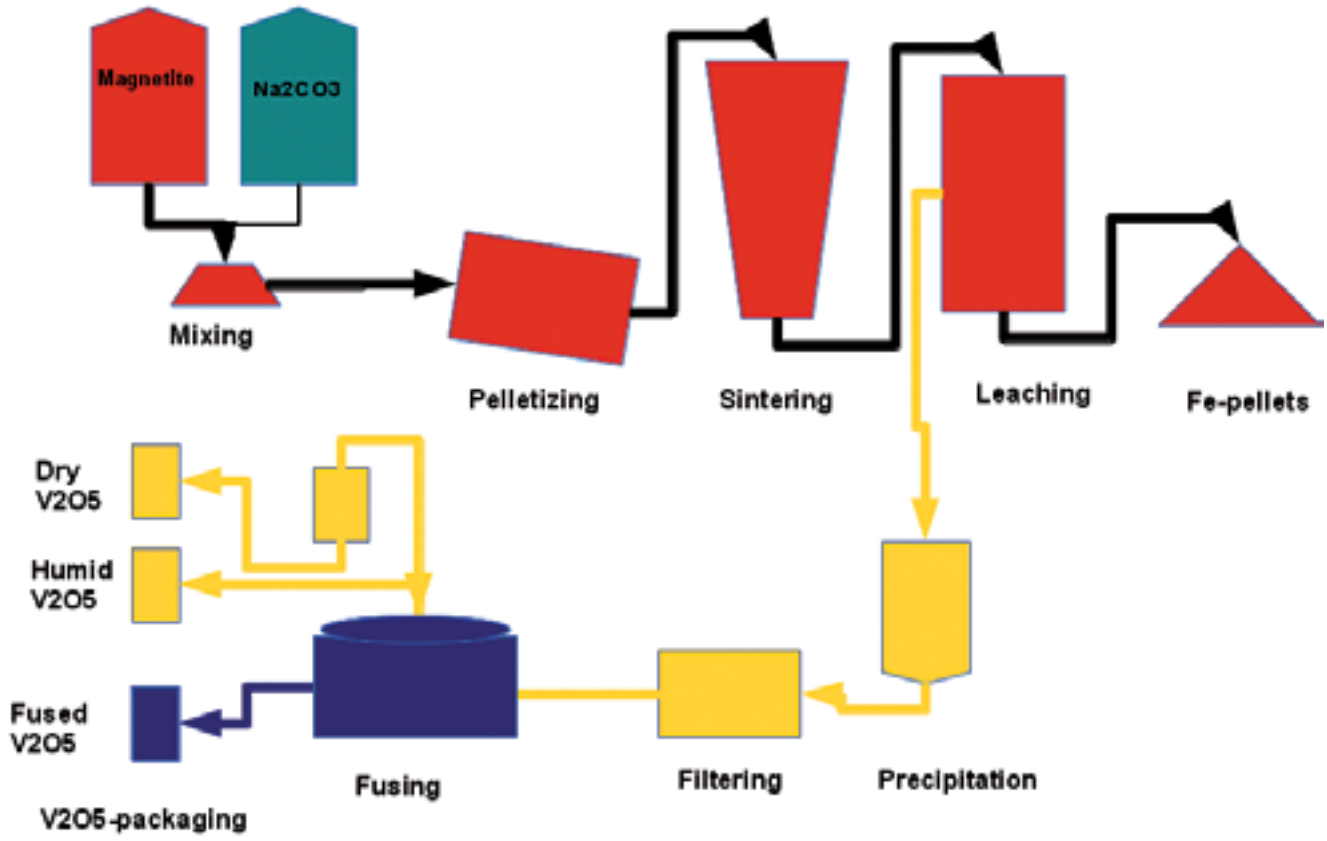


Fig. 7. Otanmäki mine vanadium factory process flow sheet

Products

- Main product of the Otanmäki mine will be vanadiumpentoxide
- Other significant products are ilmenite and Fe-pellets
- Pyrite will also be produced as a minor side product
- All products will be sold to global markets
- In table 6. there is an estimate of the production based on 1.5 million ton ore feed to the processing plant

Table 6. Planned new production based on 1.5 million ton ore feed to processing

Product	Quantity tons/year
Fe-pellets	465 000
Ilmenite concentrate	400 000
V_2O_5	4 800
Pyrite	20 000

New minesite infrastructure

- Otanmäki Mine Oy will build openpit and underground mines at Otanmäki and Vuorokas deposits
- Old historical mines of Otanmäki and Vuorokas comprise of 108 km of tunnels and 17 km of shafts undergound, which can be exploited in the new mining plan
- Additional open pit mines are possible in some of the surrounding satellite deposits
- All processing and vanadium extraction facilities will be built in Otanmäki
- Below is a preliminary view of the minesite, processing plant and vanadium factory infrastructure including tailings and water treatment facilities
- In fig. 8. is shown a preliminary layout of the Otanmäki new processing plant and vanadium factory

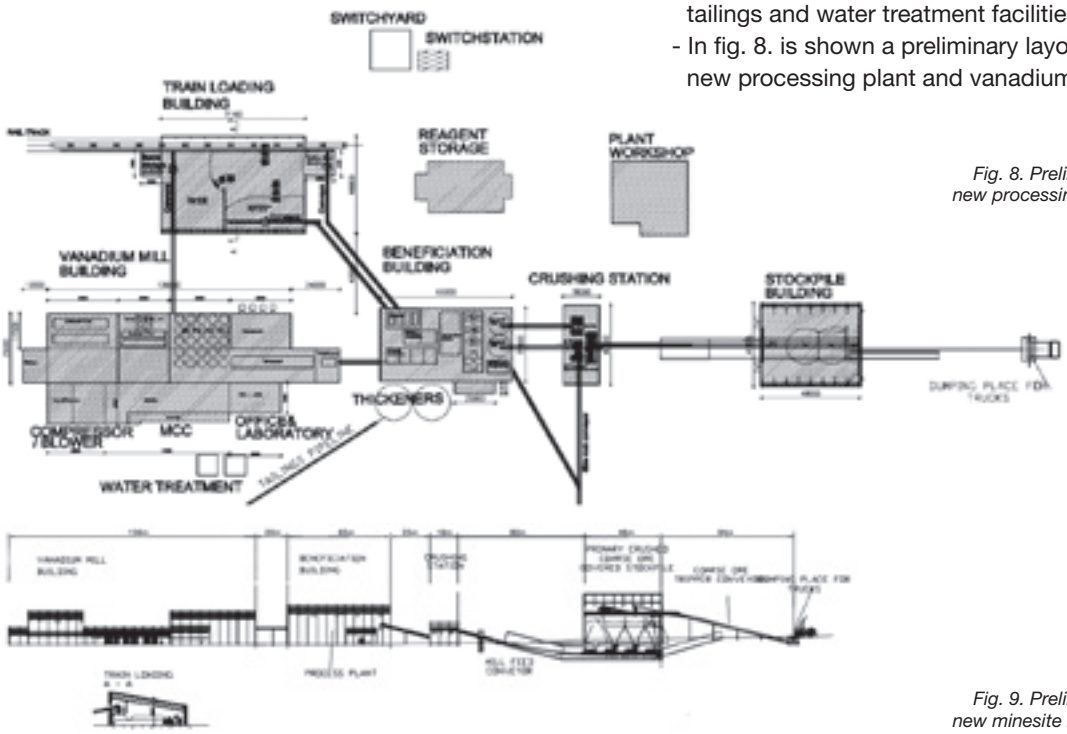


Fig. 8. Preliminary layout of the Otanmäki new processing plant and vanadium factory (Pöyry Oy 2013)

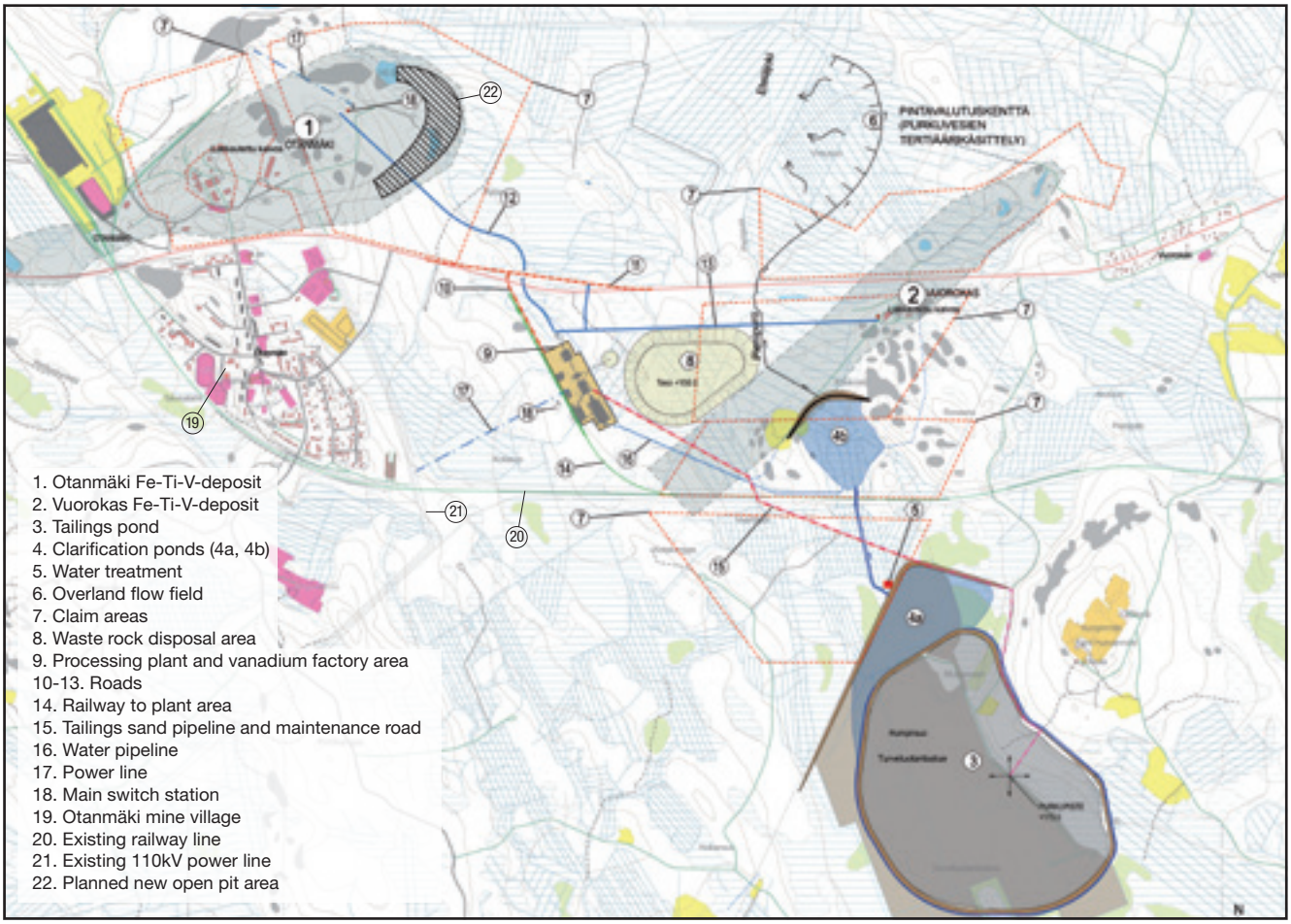


Fig. 9. Preliminary layout of the Otanmäki new minesite infrastructure (Pöyry Oy 2013)

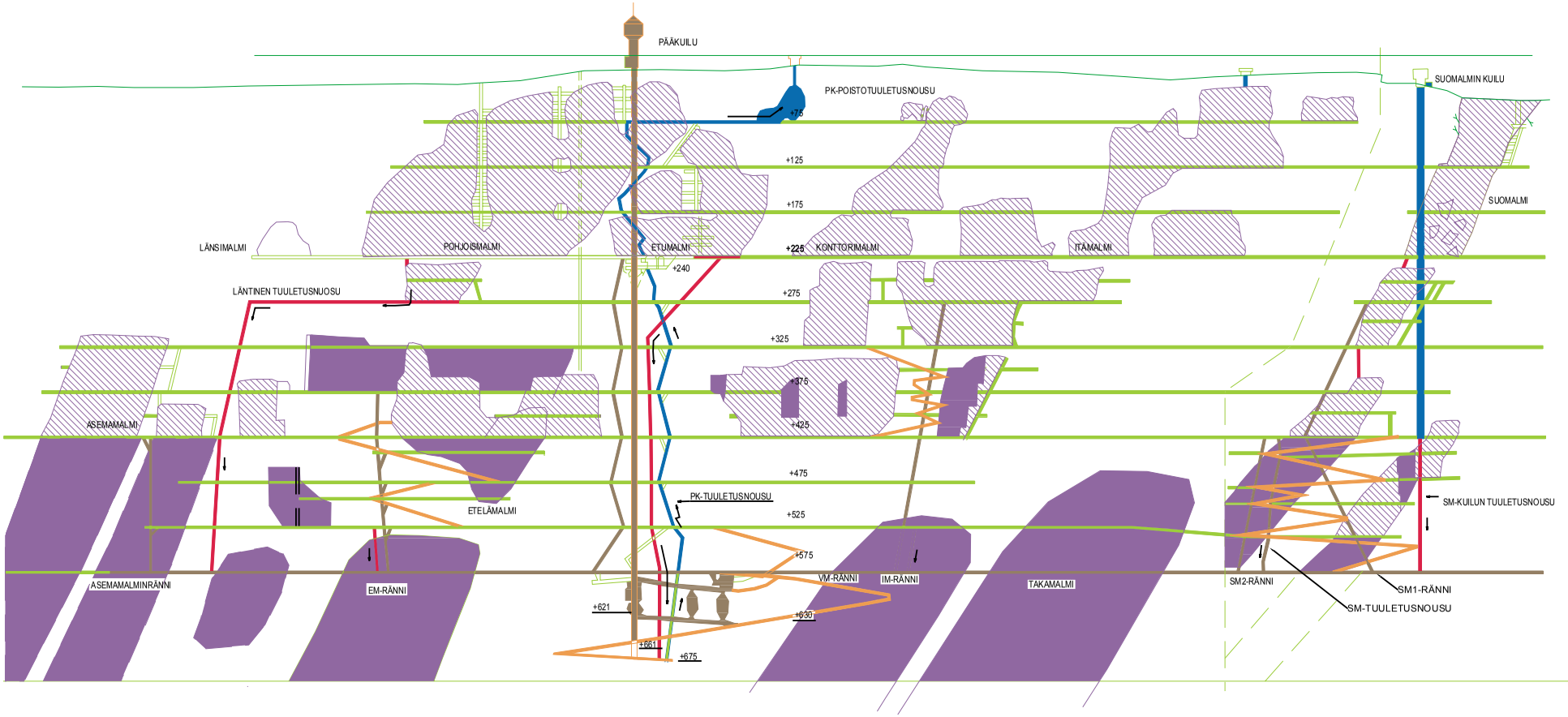


Fig. 10. Longitudinal cross section of the Otanmäki mine

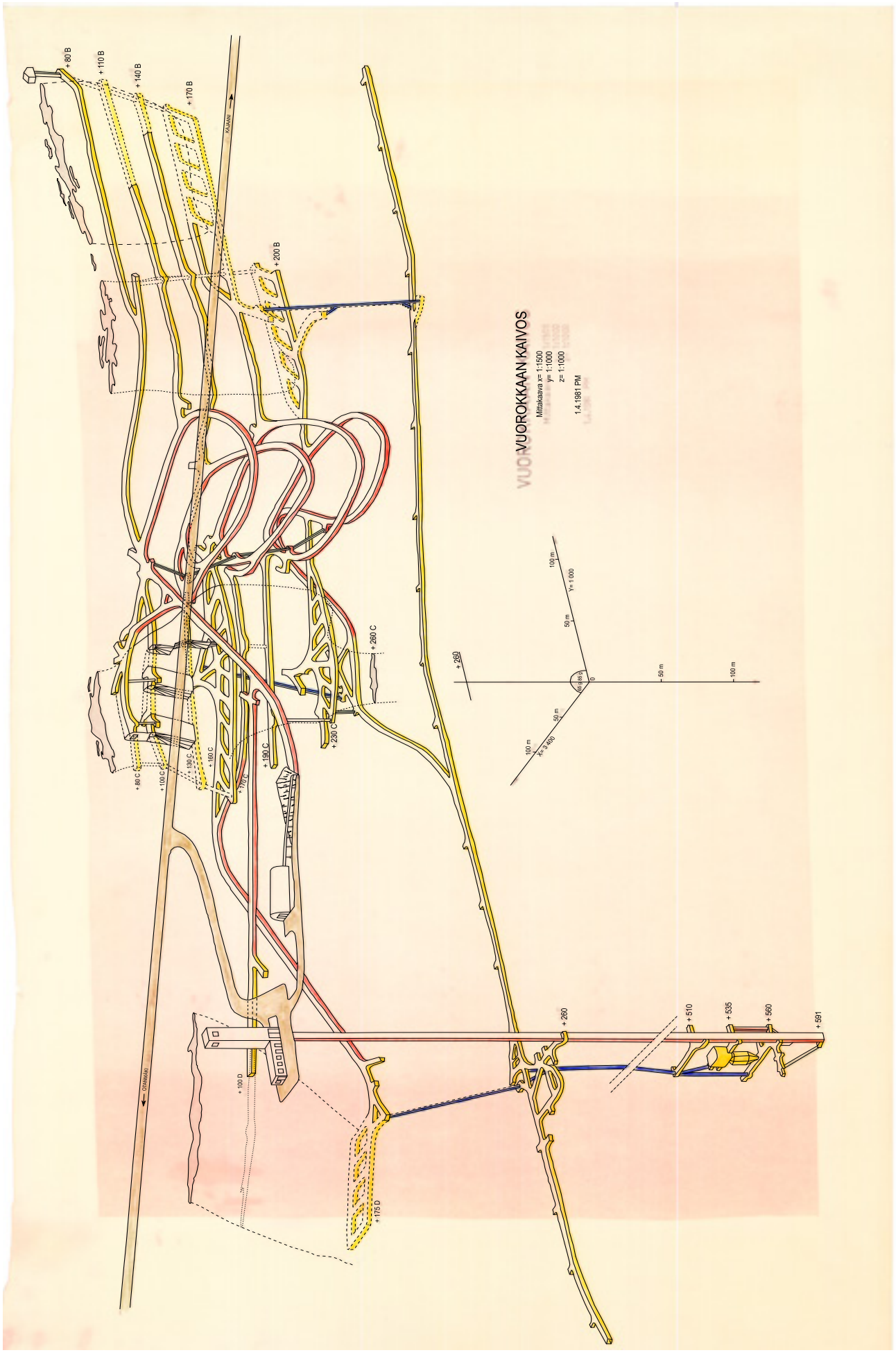


Fig. 11. Longitudinal cross section of the Vuorokas mine (P. Makkonen 1981)

Price statistics (USD/ton)

V_2O_5 (1972-2017)

Fe-pellets (1972-2017)

Ilmenite (1972-2017)

Preliminary timetable for the Otanmäki mine project

Ongoing work in the Otanmäki mine project include:

- Work for the environmental baseline study started in spring 2013
- Ground magnetic surveys in 3 satellite deposits finished during summer 2013
- Scanning of historical mine maps, reports and other data completed during winter 2012-2013
- Analysis and 3D-modelling of airborne geophysical data completed by GTK in January 2013
- Scoping study completed by Pöyry Oy in May 2013
- Three exploration trenches completed at the main Otanmäki deposit and one in Honkamäki satellite deposits during summer 2013
- Geological mapping and sampling conducted at the planned open pit area in eastern part of Otanmäki main deposit (so called Metsämalmi area) in summer and fall 2013
- 3Dmodelling of Otanmäki and Vuorokas underground infrastructure started
- Drill core database of Otanmäki and Vuorokas completed in 2015
- Virtual model of Otanmäki region completed in 2014
- New JORC-code compliant mineral resource estimate will be finished at the end of 2017
- New ore reserve estimate will be ready early 2018
- Pre Feasibility Study will be completed during the first half of 2018

	2017	2018	2019	2020	2021	2022
New mineral resource estimate						
New ore reserve estimate						
Pre Feasibility Study						
EIA and environmental permitting process						
Mining concession application and permitting						
Definitive Feasibility Study						
Construction						
Start of production						

Table 7. Preliminray timetable for Otanmäki mine project

Company info

- Otanmäki Mine Oy is a finnish mining and exploration company established in 2012
- Main goal of Otanmäki Mine Oy is to reopen the historical Otanmäki Fe-Ti-V-mine

Contact Information

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Otanmäki Minesite 1981

Otanmäki Mine Oy