Mustajärvi

Alternative Names: Akharama-1
Occurence type: mineralized zone

Commodity	Rank	Total measure	Total production	Total resource	Importance
gold	1	NA	NA	NA	NA
cobalt	2	NA	NA	NA	NA
tellurium	3	NA	NA	NA	NA
bismuth	3	NA	NA	NA	NA

Easting EUREF: 427779,684
Northing EUREF: 7500266,672
Easting YKJ: 3427923
Northing YKJ: 7503401

Discovery year: 1991
Discovered by: Outokumpu Oy
Province: Kittilä (Au, Cu)
District: Sirkka (Cu, Au, Ni, Co)
Comments: Discovery by drilling into a regional gold anomaly of till

References: 1, 5, 6, 7, 8, 9, 10, 11, 13, 15, 16, 26, 30, 31, 32

Mineral deposit type

Group: Metallogenic deposit
Main type: Orogenic (metamorphic hydrothermal)
Sub type 1: Reef-type PGE
Comments: Orogenic gold with atypical metal association
References: 30

Dimension

Expression: exposed
Form: mixed concordant discordant
Shape: lensoidal
Length (m): 2100
Width (m): NA
Thickness (m): 20
Depth (m): NA
Area (ha): NA
Dip azim: NA
Dip: NA
Plunge azim: NA
Plunge dip: NA
Orientation method: NA
Dimension comments: The W-trending mineralised Mustajärvi Shear Zone (MSZ) dips, apparently, at 35° to the south. Three mineralised parts or ore bodies so far detected, all in dilational jogs within 2.1 km strike of the MSZ. The Central Zone has an apparent plunge gently towards NE. Thickness of ore-grade zones varies form 1 to 20 m, some of these are parallel to each other within about 50 m thick domain. The occurrence is open along strike at both ends and at the depth of 300 m.

Holder history

Current holder: Firefox Gold Oy
Years: 2021-2024

Holding type: Exploration permit

Previous holders:

Company	Years	Holding type	Comments
Gold Mine Siitonen & Saiho AY	2013-2016	Claim (old law)	NA
Gold Mine Siitonen & Saiho AY	2002-2010	Claim (old law)	NA
Outokumpu Oy	1991-1995	Claim (old law)	NA

EXPLORATION ACTIVITY

Firefox Gold Oy

Years	Activity type	Geologist	Exploration result	Ref
2023	detailed geology	NA	mineral occurrences	22
	Two trenches excavated through the overburden into bedrock surface. Best sections in channel samplig: 0.84 m @ 256 g/t Au, 0.77 m @ 72.5 g/t Au, 1.02 m @ 52.8 g/t, and 1.15 m @ 45.02 g/t Au, the high gold grades possibly resulting from supergene enrichment.			

2020-2020	detailed geophysics	Petri Peltonen, Patrick Highsmith	geophysical anomaly	10, 12
	IP survey indicated chargeability and ground magnetic low indicate a >2 km long zone spatially related to mineralisation			

2020	core drilling	Patrick Highsmith	key geological features	9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22
	Drilling on structural, geochemical and geophysical tragets. 2020: 9 diamond-drill holes, in total 1370 m. Central zone: the best gold mineralization is associated with massive to semi-massive pyrite in strongly altered siliciclastic metasediments with up to 445 ppm Bi, 340 ppm Te. 2021: hole 21MJ010 has five intercepts with >1 ppm Au. 2022: 25 diamond holes drilled, in total 3904 m. 2023 spring: nine diamond holes, total 1540.6 m.			
	Intersections			
	HoleID	20MJ009		
	From-To	65-67		
	Length	2m		
	gold	33,25ppm		
	HoleID	21MJ001		
	From-To	184,2-185,5		
	Length	1,4m		
	gold	93,88ppm		
	HoleID	21MJ002		
	From-To	139,5-140,5		
	Length	1m		
	gold	13,27ppm		
	HoleID	21MJ005		
	From-To	15-16		
	Length	1m		
	gold	3,79ppm		
	Comments	*East target*		
	HoleID	21MJ006		
	From-To	56-59		
	Length	3m		
	gold	1,31ppm		
	Comments	*NE Target*		
	HoleID	21MJ010		
	From-To	154,2-170,6		
	Length	16,5m		
	gold	7,69ppm		
	Comments	*NE Target*		
	HoleID	21MJ010		
	From-To	323-324		
	Length	1m		

	gold	9,1ppm
	HoleID	21MJ010
	From-To	345-347
	Length	2m
	gold	3,92ppm
	HoleID	21MJ013
	From-To	157,2-158
	Length	0,8m
	gold	41,46ppm
	Comments	*NE target*
	HoleID	21MJ014
	From-To	168,5-170
	Length	1,5m
	gold	45,85ppm
	Comments	*NE target*
	HoleID	21MJ015
	From-To	51,8-52,8
	Length	1m
	gold	11,04ppm
	Comments	*East target*
	HoleID	22MJ001
	From-To	149,8-151,7
	Length	1,9m
	gold	8,96ppm
	HoleID	22MJ003
	From-To	13,6-17,6
	Length	4m
	gold	6,35ppm
	HoleID	22MJ021
	From-To	11-26,5
	Length	15,5m
	cobalt	0,15%
	tellurium	143ppm
	gold	13,09ppm
	Comments	*East Target*
	HoleID	22MJ022
	From-To	22,8-30
	Length	7,2m
	gold	16,43ppm
	Comments	*East Target*
	HoleID	23MJ001
	From-To	5,4-17,4
	Length	12m
	gold	9,69ppm
	HoleID	23MJ004
	From-To	12-32,5
	Length	20,5m
	gold	5,14ppm
	HoleID	23MJ004
	From-To	54-68,8
	Length	14,8m
	gold	6ppm
	HoleID	23MJ005
	From-To	68-75,1
	Length	7,1m
	gold	4,77ppm

2018-2020	detailed geochemistry	Petri Peltonen	geochemical anomaly	1, 3, 4, 6, 23, 30, 32

	Bottom-of-Till sampling program in 2019: 598 till samples from 325 sites at 20 m intervals along north-south lines. Infill and extending an area of anomalous gold in historic till data around the previously drilled mineralised zone. This resulted into a significant extension of the target size. Detailed lithogeochemical investigation indicates strong enrichment in Au, B, Bi, Co, CO2, Ni, Se, Te, and less consistent enrichment in As, Sb, and W. In 2020, geochemical survey on till.

2018-2020	detailed geology	Matthias Mueller	key geological features	7, 9, 10, 30
	Detailed geological and mineralogical investigation, mainly based on drill core examination. Relogging of Outokumpu core. The location of the mineralised Mustajärvi fault is indicated by demagnetization, a low apparent resistivity, a high chargeability, and zones of strong deformation and brecciation. Exploration trench excavation through the overburden into bedrock surface. 2020: structural geology evaluation.			

2018-2018	detailed geophysics	Petri Peltonen	geophysical anomaly	1, 6, 24
	Ground magnetic and IP surveys suggest four possible lodes and suggest a 900 m long mineralised domain. The 5.85 line-km IP survey identified four high-chargeability targets along a previously defined fault structure. The IP anomalies extend to a depth of at least 200 m.			

2018-2019	core drilling	Petri Peltonen	mineral occurrences	1, 5, 6, 8, 25, 32
	8 diamond-drill holes (total 1100 m) in 2018. Until end of 2019, drilling has tested only 500 metres of the 2,900-metre-long potential trend identified by Bottom-of-Till (BOT) sampling anomalies and geophysical surveys. Stage 2, in 2019: nine diamond-drill holes (total 1500 m): presence of a NE orebody confirmed at about 500 m along the controlling structure to the NE			
	Intersections			
	HoleID	18MJ002		
	From-To	30,6-34,7		
	Length	4,1m		
	gold	1,87ppm		
	HoleID	18MJ002		
	From-To	62,7-63,5		
	Length	0,8m		
	gold	3,96ppm		
	HoleID	18MJ010		
	From-To	124-129		
	Length	5m		
	gold	18,09ppm		
	HoleID	18MJ010		
	From-To	125,5-127,5		
	Length	2m		
	gold	45,1ppm		
	HoleID	19MJ001		
	From-To	142,2-142,8		
	Length	0,6m		
	gold	4,5ppm		
	HoleID	19MJ006		
	From-To	125,8-127,9		
	Length	2,2m		
	gold	12ppm		
	Comments	*Includes 0.2 m core loss*		
	HoleID	19MJ009		
	From-To	105-106		
	Length	1m		
	gold	1,07ppm		
	HoleID	19MJ009		
	From-To	112,1-112,6		
	Length	0,5m		
	gold	2,36ppm		
	cobalt	0,1%		
	HoleID	19MJ009		
	From-To	145-146		
	Length	1m		
	gold	3,49ppm		

Gold Mine Siitonen & Saiho AY

Years	Activity type	Geologist	Exploration result	Ref
2002-2012	mining pilot	Harri Siitonen	mineral occurrences	
	Excavated a 20 x 70 m, 2-5 deep pit along the surface trace of the mineralisation in the drilled area; only excavated til land the weathered bedrock.			

Geological Survey of Finland

Years	Activity type	Geologist	Exploration result	Ref
1996-1996	regional geophysics	NA	key geological features	
	Low-altitude airborne magnetic, electromagnetic and radiometric survey			

Outokumpu Oy

Years	Activity type	Geologist	Exploration result	Ref
1991-1992	detailed heavy mineral sampling	Rauno Hugg	NA	26, 27

1991-1992	core drilling	Rauno Hugg	mineral occurrences	26, 27
	Core drilling (reconnaissance drilling): 12 diamond-drill holes, total 706 m. Native gold is in sulphidic quartz-tourmaline-carbonate veins			
	Intersections			
	HoleID	NA		
	From-To	NA		
	Length	12m		
	gold	2,7ppm		
	Comments	*Regolith; drill core sample of weathered rock containing kaolin and lumps of quartz*		
	HoleID	NA		
	From-To	NA		
	Length	2,7m		
	gold	14,6ppm		
	Comments	*Fresh rock.*		

1991-1991	excavation	Rauno Hugg	NA	26, 27
	7 trenches, total 72.5 m			

1991-1994	detailed geophysics	Rauno Hugg	key geological features	1, 26, 27
	Ground magnetic and IP survey. A NE-trending magnetic low passes along the axis of the Mustajärvi property for 2.6 km, possibly representing a second-order structure like that which hosts the Suurikuusikko deposit 33 km to the north.			

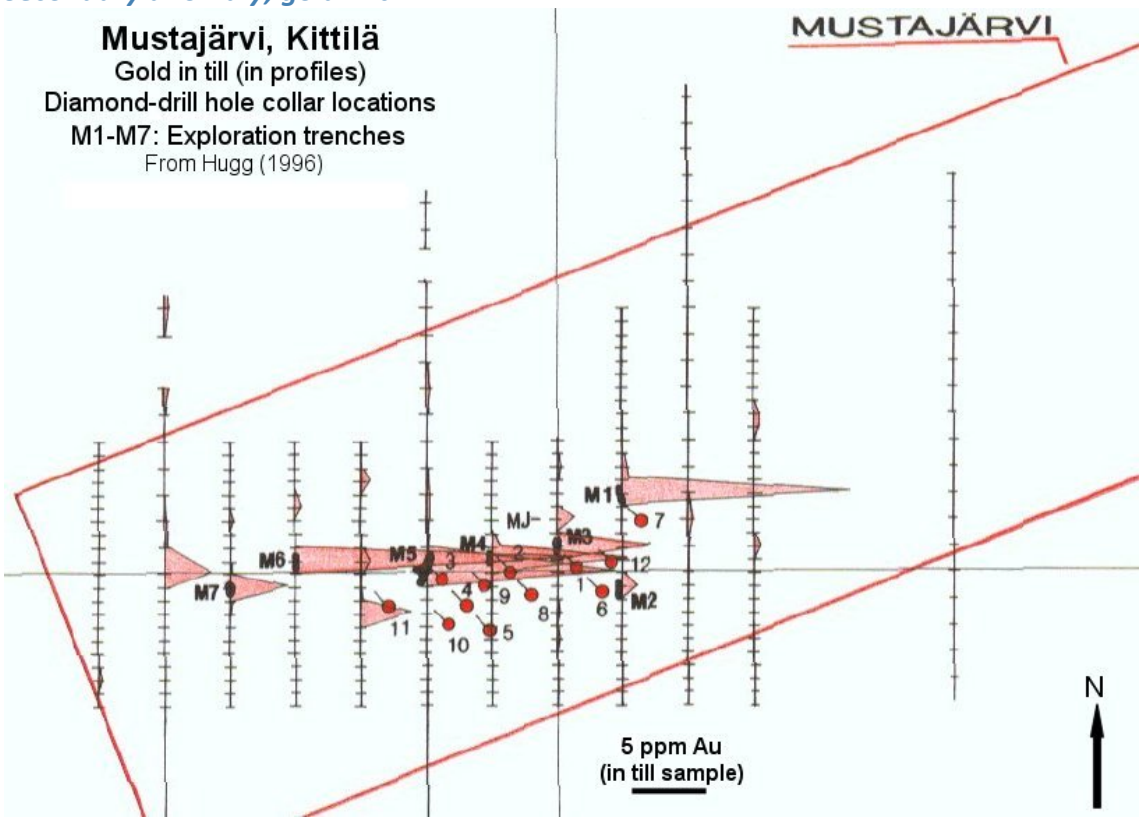
1990-1991	detailed geochemistry	Rauno Hugg	mineral occurrences	1, 26, 27
	Local Au anomaly in till. Outokompu's TOB sampling defined a gold-bearing mineralized envelope which strikes east-west for approximately 500 m with a width of 10-60 m. It appears to surround a third-order fault or shear conjugate to the NE-trending second-order structure. 23 N-S lines of till samples; samples were taken at 10 or 20 metre intervals along lines spaced 50-300 m apart. Elevated Au values were returned from ten consecutive lines			

Geological Survey of Finland

Years	Activity type	Geologist	Exploration result	Ref
1979-1991	regional geochemistry	NA	geochemical anomaly	28
	Regional till geochemical survey			

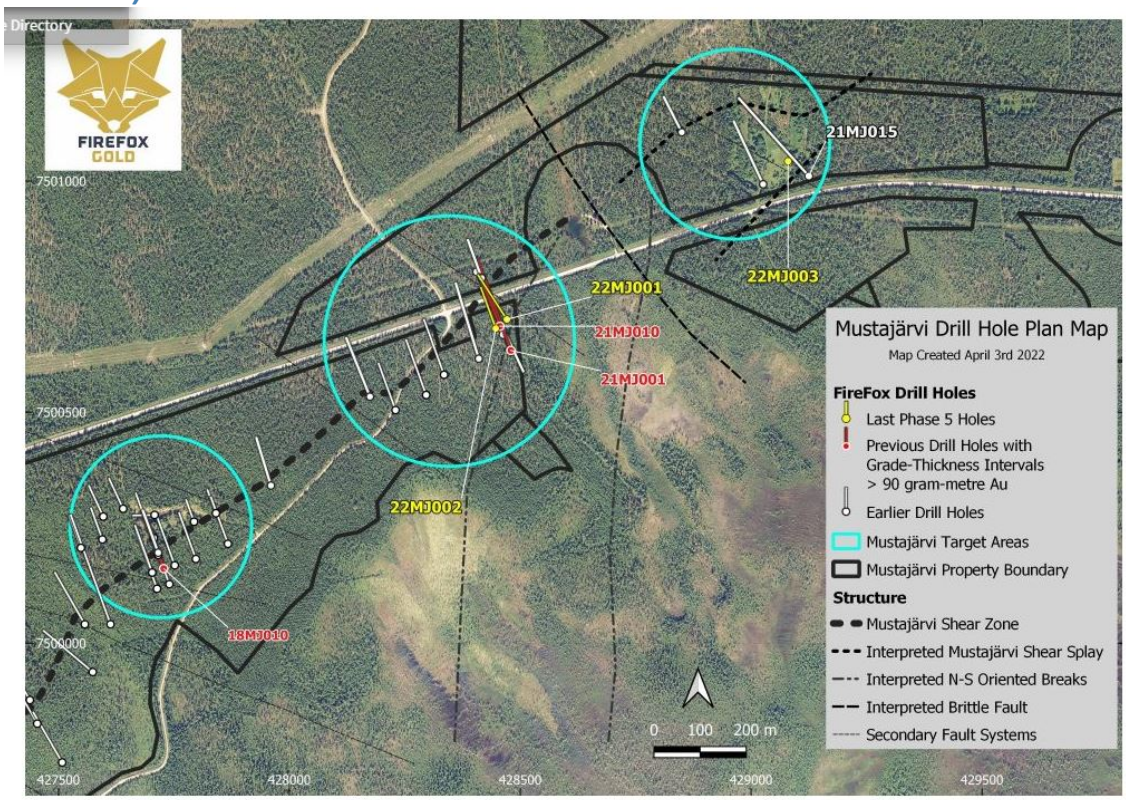
Figures

Secondary anomaly; gold in till:



Mustajärvi Gold Project; targets, drill holes, structures, (FireFox Gold, Press Release

05042022):


FIREFOX GOLD
21MJ015
22MJ003
22MJ001
21MJ010
21MJ001
22MJ002
18MJ010
7501000
7500500
7500000
427500
428000
428500
429000
429500
Mustajärvi Drill Hole Plan Map
Map Created April 3rd 2022
FireFox Drill Holes
Last Phase 5 Holes
Previous Drill Holes with Grade-Thickness Intervals > 90 gram-metre Au
Earlier Drill Holes
Mustajärvi Target Areas
Mustajärvi Property Boundary
Structure
Mustajärvi Shear Zone
Interpreted Mustajärvi Shear Splay
Interpreted N-S Oriented Breaks
Interpreted Brittle Fault
Secondary Fault Systems
0 100 200 m

MINING

Mustajärvi

Easting EUREF: 427779,684
Northing EUREF: 7500266,672
Status: Test mining
Operating years: 2002-2002
Years in production: 1
Total ore mined: 0 t
References: 2

Mining activity:

Year	Ore mined	Ore processed	Activity type	Production	Other material
2002			NA		

GEOLOGY

Host rock: Arkose quartzite, Mafic tuff, Komatiite, Basaltic komatite, Intermediate graphite tuff, Komatiite, Chert
Wall rock: Gabbro

Arkose quartzite (Host rock)

Rock type: Host rock
Proportion: major
Grain size: Fine grained 0.2 - 1 mm
Color: Greyish
References: 1, 4, 5, 13, 14, 15, 16, 24, 26, 27, 28, 30, 32
Comments: The siliciclastic units are interlayered and commonly have gradual contacts btw each other. Auriferous quartz-tourmaline-carbonate veins host the ore. The occurrence is hosted by tertiary structures (Riedel R-type shears?) branching from the controlling, secondary, Mustajärvi Shear Zone possibly branching from the WNW-trending, transcrustal, Venejoki Thrust. It is at contact zone between the Sodankylä Group siliciclastic metasediments and the Savukoski Group ultramafic and mafic volcanics.

Ore minerals:

Mineral	Proportion	Mineral texture
Calaverite	present	
	montbrayite and calaverite are the major known gold carriers at Mustajärvi	
Gold	present	
	Most of native gold is in weathered host rocks	
Kawazulite	present	
Melonite	present	
Montbrayite	present	
	montbrayite and calaverite are the major known gold carriers at Mustajärvi	
Pyrite	minor	
	Py is the main host to cobalt	
Tellurobismuthite	present	

Other minerals:

Mineral	Proportion	Mineral texture
Albite	major	
Calcite	minor	
Dolomite	minor	
Quartz	major	

Structures
Bedded
Sheared
Breccia
Veined

Comments: Mineralisation-related veining: Distal: tourmaline in thin veinlets, commonly along quartz-albite ± carbonate vein selvages. Proximal: tourmaline veining becomes more abundant and locally more massive. In extreme cases, tourmaline forms massive clusters or veins that completely brecciate the host rock. Within intermediate to proximal alteration, barren to auriferous quartz-pyrite ± tourmaline ± carbonate ± albiteveins are typical

Alteration:	Distribution:	Degree:	Relation to mineralization:
albitic alteration	Pervasive	Moderate	Pre
Comments: Albitisation at variable degree, albite 20–60 vol% of the rock. Albite-sericite alteration in the footwall along more than 2km of the Mustajärvi Shear Zone			
biotite alteration	Disseminated	Moderate	Syn
Comments: The proximal mineral assemblage is biotite-albite-quartz-tourmaline-sricite-dolomite-rutile-haematite-magnetite-pyrite			
sericitic alteration	Disseminated	Moderate	Syn
Comments: apparently also pre-gold, weak sercitisation			
carbonate alteration	Pervasive	Moderate	Syn
Comments: Probably also pre-gold carbonatisation. Intense carbonatisation in the gold-mineralsied domains			
tourmalinisation	Fractures	Moderate	Syn
Comments: tourmaline almost exclusively occurs in veins			
carbonate alteration	Pervasive	Moderate	Syn
Comments: Distal calcite to proximal dolomite alteration			

Metamorphic description:

Type:	Facies:	Degree:	Relation to mineralization:	Min P- Max P (kbar)	MIn T- Max T (°C)
Regional	greenschist metamorphic facies	low metamorphic grade	Pre		
Comments: Metamorphic peak during D2, thrusting during D3 was at least partly post-peak, late metamorphic. Presence of biotite suggests upper-greenschit facies.					

Geological age:

Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:
Paleoproterozoic (2500-1600 Ma)	2200-2300		
Comments: Sodankylä group rocks			

Mafic tuff (Host rock)

Rock type: Host rock
Proportion: minor
Grain size: Fine grained 0.2 - 1 mm
Color: Dark coloured
References: 5, 27, 30

Comments: Mineralisation is geochemically characterised by high Au, Bi, Co, Mo, Ni, and Te contents and low As and and Cu.

Ore minerals:

Mineral	Proportion	Mineral texture
Gold	present	
	Native gold in sulphidic quartz-tourmaline-carbonate veins. Most of hypogene gold is hosted by Au- and Au-Bi-telluride micro-inclusions in pyrite. Most of native gold is in weathered host rocks	

Other minerals:

Mineral	Proportion	Mineral texture
Dolomite	minor	
	Fe-bearing dolomite	
Pyrite	minor	
	Py is the main host to cobalt	
Quartz	major	
Tourmaline	minor	

Structures
Sheared
Veined

Textures
Foliated

Alteration:	Distribution:	Degree:	Relation to mineralization:
sericitic alteration	Disseminated	Weak	Syn
biotite alteration	Disseminated	Moderate	Syn

Metamorphic description:

Type:	Facies:	Degree:	Relation to mineralization:	Min P- Max P (kbar)	MIn T- Max T (°C)
Regional	greenschist metamorphic facies	low metamorphic grade			
Comments: Presence of biotite suggests upper-greenschit facies					

Komatiite (Host rock)

Rock type: Host rock
Proportion: minor
Grain size: Fine grained 0.2 - 1 mm
Color: Dark coloured
References: 1, 4, 5, 14, 15, 23, 30, 32
Comments: Both host and wall rock. Mineralisation is geochemically characterised by high Au, Bi, Co, Mo, Ni, and Te contents and low As and and Cu.

Ore minerals:

Mineral	Proportion	Mineral texture
Pyrite	minor	

Other minerals:

Mineral	Proportion	Mineral texture
Albite	minor	

Structures
Veined
Comments: Extensive carbonate veining related to biotite alteration. Mineralization-related carbonate veins are generally more discordant than carbonate veins related to the regional alteration.

Alteration:	Distribution:	Degree:	Relation to mineralization:
biotite alteration	Disseminated	Moderate	Syn
Comments: Biotite replaces chlorite, occurs together with extensive carbonate veining			
sulphidation	Disseminated	Moderate	Syn
Comments: dissemination in variable degree			
sericitic alteration	Disseminated	Moderate	Syn
Comments: This is, in fact, fuchsite in ultramafic rocks			
albitic alteration	Pervasive	Moderate	
Comments: Possibly predates gold mineralisation			
carbonate alteration	Disseminated	Moderate	
Comments: At least, iron-bearing carbonates			

Metamorphic description:

Type:	Facies:	Degree:	Relation to mineralization:	Min P- Max P (kbar)	MIn T- Max T (°C)
Regional	greenschist metamorphic facies	low metamorphic grade			

Geological age:

Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:
Paleoproterozoic (2500-1600 Ma)	2060-2200		
Comments: Savukoski group rocks			

Basaltic komatite (Host rock)

Rock type: Host rock
Proportion: minor

Other minerals:

Mineral	Proportion	Mineral texture
Actinolite	major	

Structures
Veined

Comments: Extensive carbonate veining related to biotite alteration. Mineralization-related carbonate veins are generally more discordant than carbonate veins related to the regional alteration.

Alteration:	Distribution:	Degree:	Relation to mineralization:
sericitic alteration	Disseminated	Moderate	Syn
Comments: This is, in fact, fuchsite in ultramafic rocks			
biotite alteration	Disseminated	Moderate	Syn
Comments: Biotite replaces chlorite, occurs together with extensive carbonate veining			

Metamorphic description:

Type:	Facies:	Degree:	Relation to mineralization:	Min P- Max P (kbar)	MIn T- Max T (°C)
Orogenic	greenschist metamorphic facies	low metamorphic grade			

Geological age:

Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:
Paleoproterozoic (2500-1600 Ma)	2060-2200		
Comments: Savukoski group rocks			

Intermediate graphite tuff (Host rock)

Rock type: Host rock
Proportion: major
References: 16, 21, 22, 30, 32
Comments: Mineralisation is geochemically characterised by high Au, Bi, Co, Mo, Ni, and Te contents and low As and and Cu. Brittle post-mineral faults cutting across the mineralised zones; at least one of these has a NE strike.

Other minerals:

Mineral	Proportion	Mineral texture
Albite	major	
Biotite	major	
	Biotite-muscovite ratio varies extensively	
Calcite	minor	
Chlorite	minor	
Muscovite	major	
	Biotite-muscovite ratio varies extensively	
Pyrite	minor	
	Py is the main host to cobalt	
Quartz	major	

Structures
Veined

Alteration:	Distribution:	Degree:	Relation to mineralization:
albitic alteration	Pervasive	Moderate	Pre
Comments: Variable degree of alteration, albite 20-60 vol% of the rock; where hosting mineralisation, but also elsewhere, seem to be intensely albitised			
carbonate alteration	Disseminated	Moderate	Pre
Comments: Weak to strong			
carbonate alteration	Pervasive	Moderate	Syn
Comments: Distal calcite to proximal dolomite alteration			
biotite alteration	Disseminated	Moderate	Syn
sericitic alteration	Disseminated	Moderate	Syn
Comments: There also is weak pre-mineralisation sericitisation			

Metamorphic description:

Type:	Facies:	Degree:	Relation to mineralization:	Min P- Max P (kbar)	MIn T- Max T (°C)
Regional	greenschist metamorphic facies	low metamorphic grade			

Geological age:

Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:
Paleoproterozoic (2500-1600 Ma)	2200-2300		
Comments: Sodankylä group rocks			

Komatiite (Host rock)

Rock type: Host rock
Proportion: minor
References: 30, 32

Other minerals:

Mineral	Proportion	Mineral texture
Chlorite	major	
Chromite	present	
Dolomite	minor	
Magnetite	minor	
Tremolite	major	

Structures
Veined
Comments: Extensive carbonate veining related to biotite alteration. Mineralization-related carbonate veins are generally more discordant than carbonate veins related to the regional alteration.

Alteration:	Distribution:	Degree:	Relation to mineralization:
sericitic alteration	Disseminated	Moderate	Syn
Comments: This is, in fact, fuchsite in ultramafic rocks			
biotite alteration	Disseminated	Moderate	Syn

Comments: Biotite replaces chlorite, occurs together with extensive carbonate veining

Metamorphic description:

Type:	Facies:	Degree:	Relation to mineralization:	Min P- Max P (kbar)	MIn T- Max T (°C)
Regional	greenschist metamorphic facies	low metamorphic grade			

Geological age:

Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:
Paleoproterozoic (2500-1600 Ma)	2060-2200		
Comments: Savukoski group rocks			

Chert (Host rock)

Rock type: Host rock
Proportion: minor
References: 32

Metamorphic description:

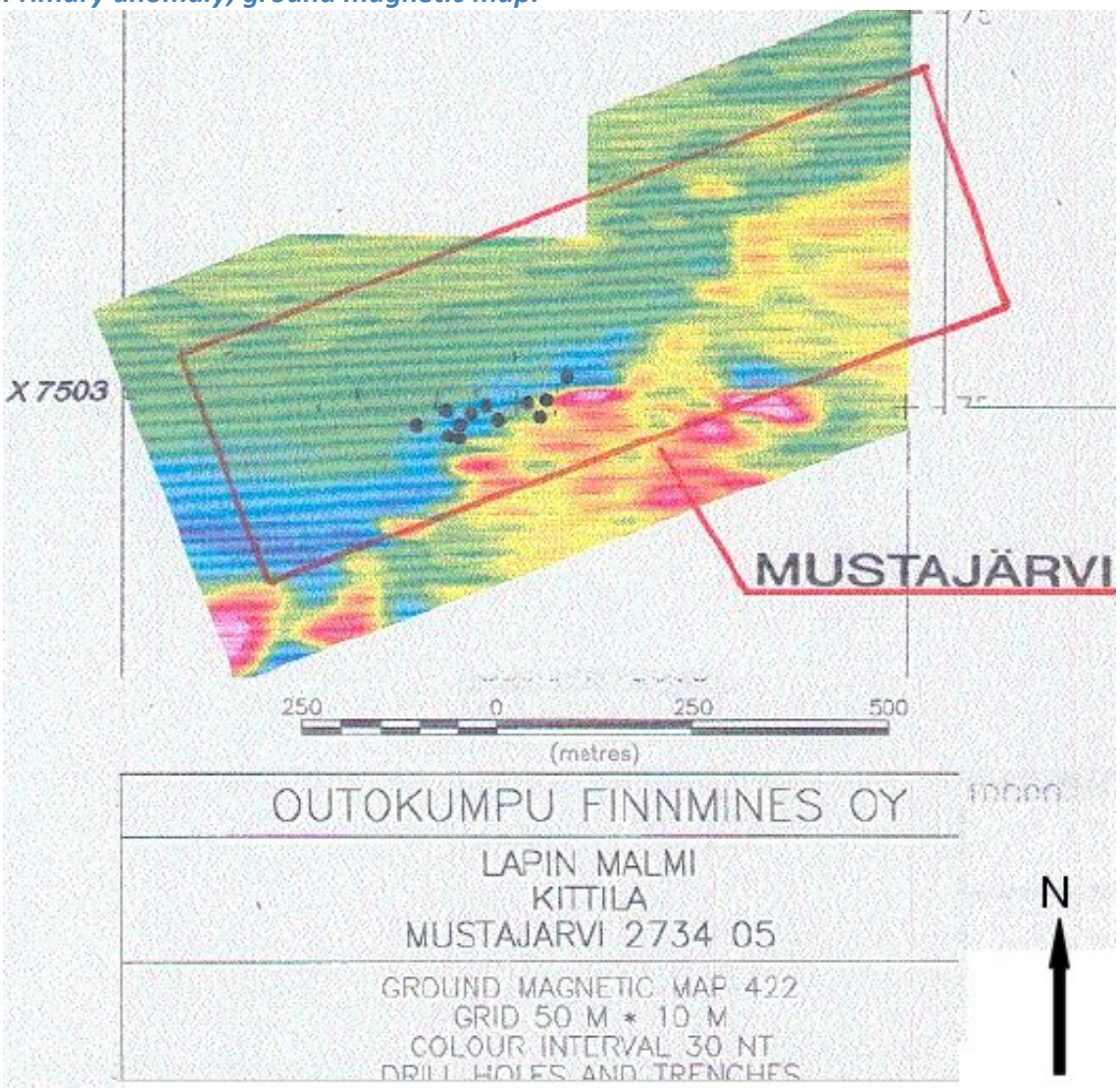
Type:	Facies:	Degree:	Relation to mineralization:	Min P- Max P (kbar)	MIn T- Max T (°C)
Regional	greenschist metamorphic facies	low metamorphic grade			

Gabbro (Wall rock)

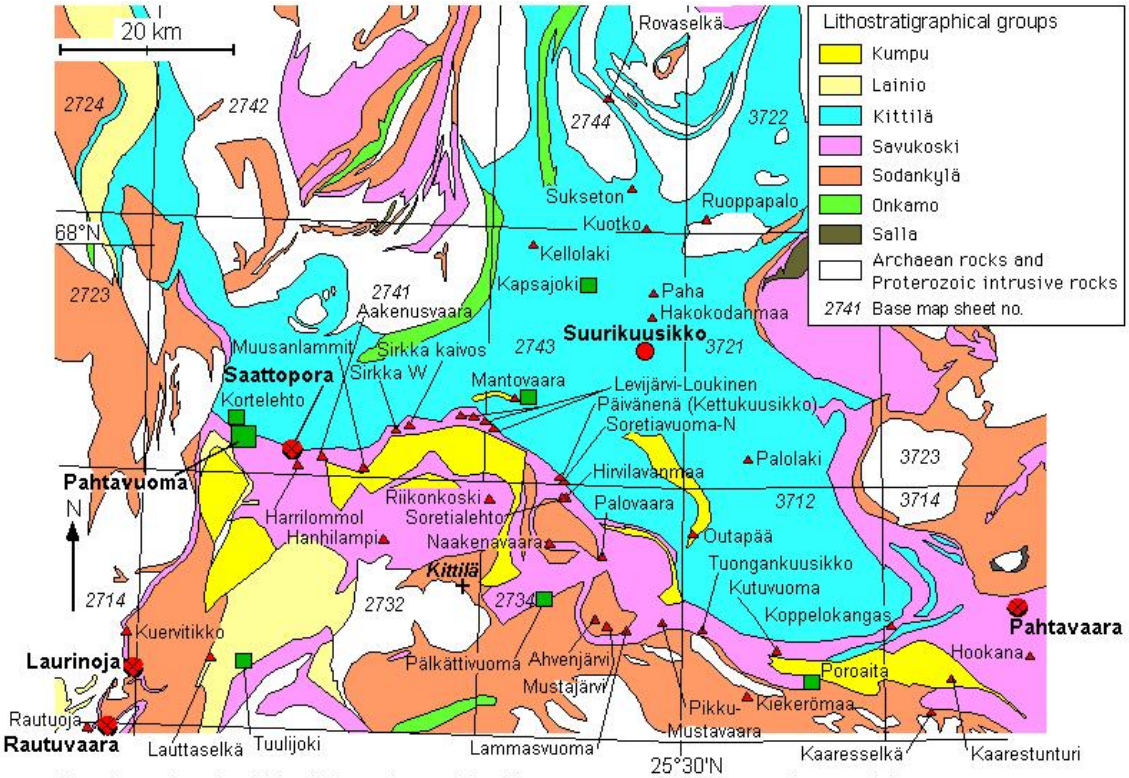
Rock type: Wall rock
Proportion: minor
References: 12, 28, 29
Comments: Either a real plutonic intrusion or a major dirrerentiated sill. The latter are common in the region.

Figures

Primary anomaly; ground magnetic map:

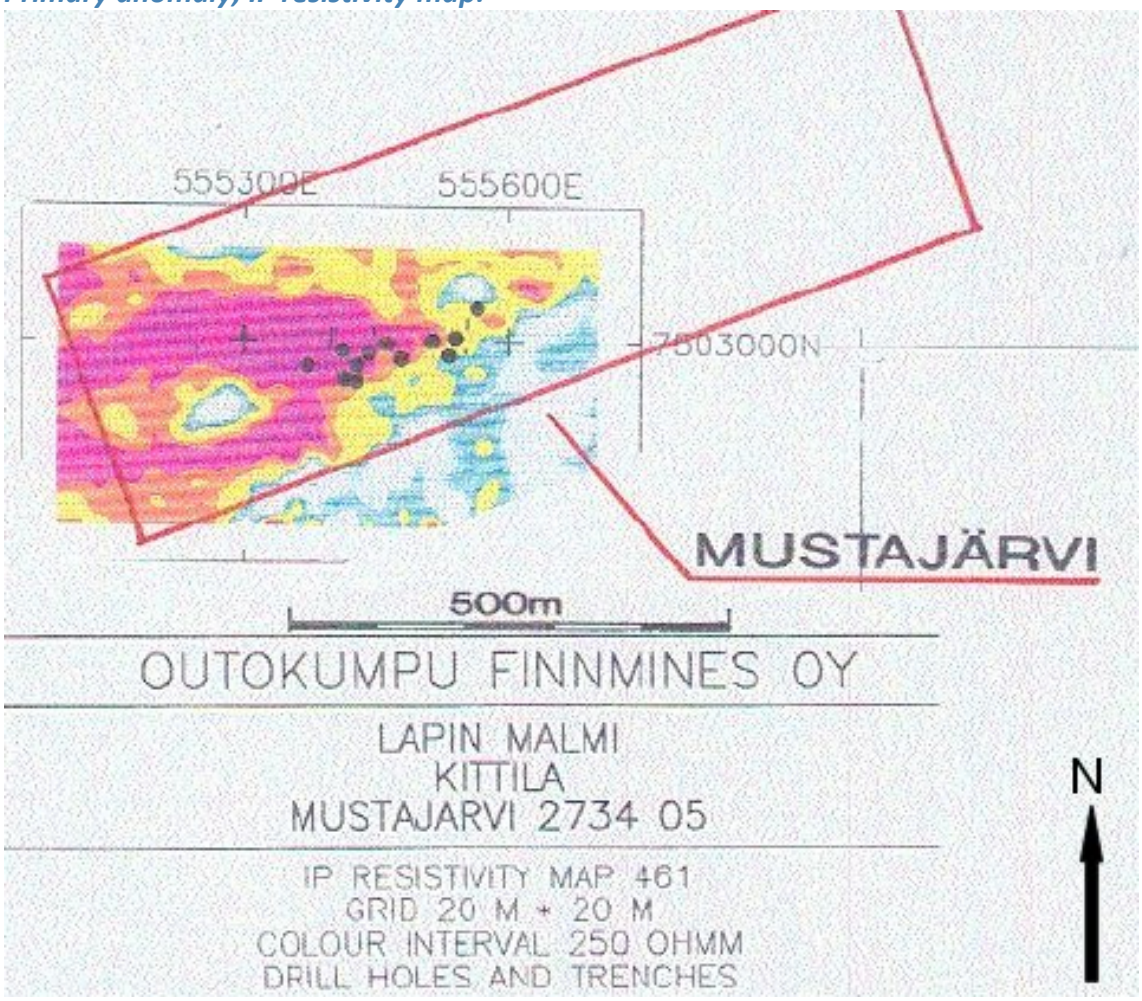


Regional geology:

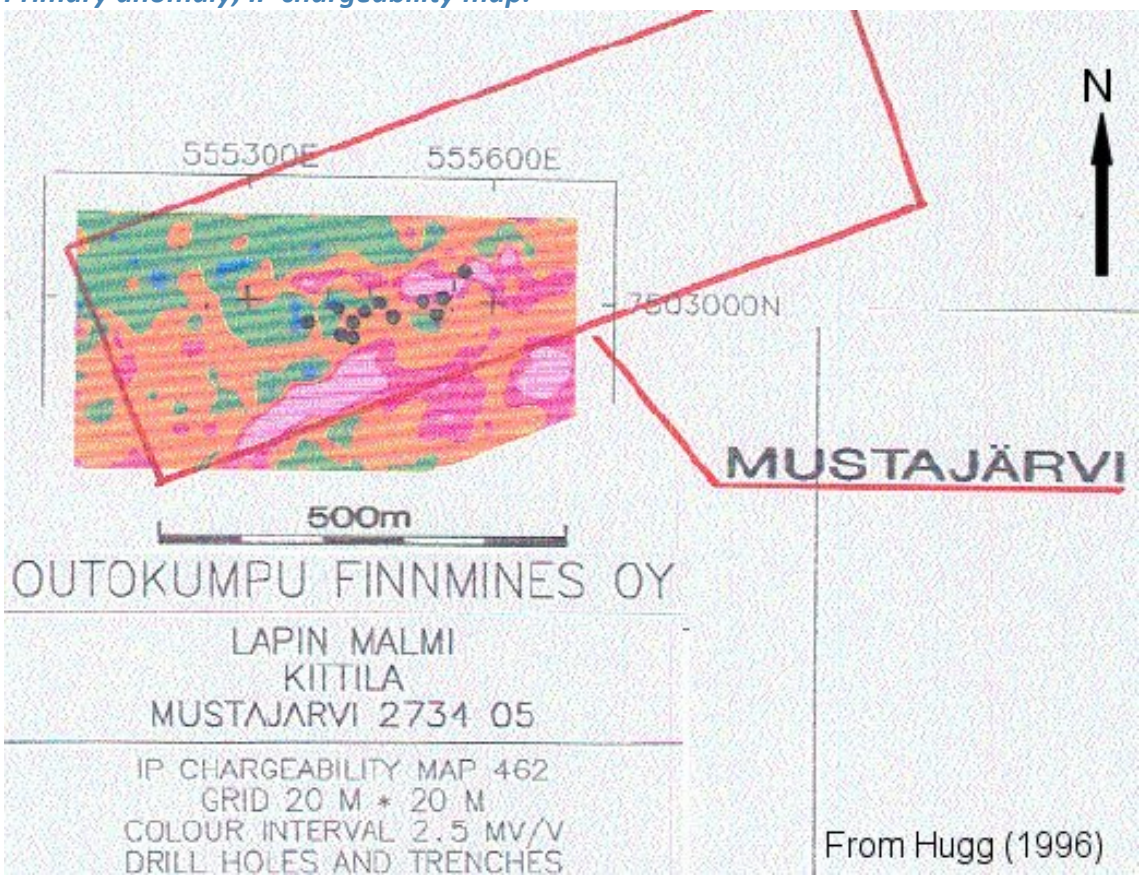


Zinc (green) and gold (red) deposits and significant prospects in the central parts of the Central Lapland greenstone belt. Lithostratigraphy from Lehtonen et al. (1998). Edited by P. Eilu (2007)

Primary anomaly; IP resistivity map:



Primary anomaly; IP chargeability map:



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