

Hammasslahti

Alternative Names: Lähdekorpi

Occurrence type: deposit

Commodity	Rank	Total measure	Total production	Total resource	Importance
copper	1	63080,76 t	62120,76 t	960 t	Small deposit
zinc	2	7641,42 t	3801,42 t	3840 t	Occurrence
gold	3	NA	NA	NA	NA
silver	4	NA	NA	NA	NA
lead	5	NA	NA	NA	NA
sulphur	5	NA	NA	NA	NA

Easting EUREF: 656261,703

Northing EUREF: 6929340,026

Easting YKJ: 3656496

Northing YKJ: 6932244

Discovery year: 1966

Discovered by: Geological Survey of Finland

Province: Hammasslahti (Cu, Zn)

District: Hammasslahti (Cu, Zn)

Comments: The deposit was discovered in outcrop during regional bedrock mapping

References: 10, 13

Mineral deposit type

Group: Metallogenic deposit

Main type: SEDEX (basinal hydrothermal)

References: 6, 18, 25, 26, 28, 29, 43, 44, 45

Group: Metallogenic deposit

Main type: VMS (mixed hydrothermal)

Sub type 1: Siliciclastic-mafic

Comments: Mineralising fluids either came from the deeper parts of the basin or directly from the Tohmajärvi volcanic complex, and precipitated in the rocks of the lowermost formation of the Höytiäinen Basin rift. The mineralising fluids were precipitated below a cap rock formed by low-permeability black shales. Nearly all of these and the geochemical features fit into a hypothesis of a Besshi-type deposit.

References: 6, 18, 25, 26, 28, 29, 43, 44, 45

Dimension

Expression: exposed

Form: concordant

Shape: cylindrical

Length (m): 1800

Width (m): 250

Thickness (m): 35

Depth (m): 600

Area (ha): NA

Dip azimuth: 270

Dip: 60

Plunge azimuth: 180

Plunge dip: 25

Orientation method: NA

Dimension comments: Four distinct Cu($\pm$ Zn) ore bodies (N, O, S, and E) and one Zn ore body (Z; 5 x 50 x 250 m), all N-S trending, in an en echelon setting, following the axis of the dominant, isoclinal,

fold, dipping to the W at 45-80°, and plunging to the S at 25-30°. The main Cu ore body (S) is open at the depth of 600 m. Also the N, S and Zn ore bodies are open at depth.

Holder history

Current holder: FinnAust Mining Finland Oy

Years: 2023-2026

Holding type: Exploration permit

Previous holders:

Company	Years	Holding type	Comments
FinnAust Mining Finland Oy	2018-2021	Exploration permit	NA
FinnAust Mining Oy	2014-2017	Exploration permit	Zn, Cu, Au, and Ag
FinnAust Mining Oy	2009-2014	Claim (old law)	NA
Outokumpu Oy	1970-1986	NA	End year uncertain.
Geological Survey of Finland	1967-1970	Claim (old law)	NA

EXPLORATION ACTIVITY

Bluejay Mining

Years	Activity type	Geologist	Exploration result	Ref
2023	core drilling	NA	NA	3, 4
2023 drilling the E lode, discovered in 2014 by FinnAust Mining. 2023: Nine diamond holes, in total 2244.4 m. E lode intercepted at 75-250 m depth, is open down dip and up and down plunge, i.e., may subcrop below the glacial overburden.				
Intersections				
	HoleID	HAM0005		
	From-To	301,2-310		
	Length	8,8m		
	copper	0,43%		
	zinc	1,46%		
	lead	0,18%		
	silver	9,6ppm		
	gold	0,06ppm		
	Comments	E lode		
	HoleID	HAM0008		
	From-To	95,9-101,6		
	Length	5,7m		
	copper	0,89%		
	zinc	3,43%		
	silver	29,6ppm		
	gold	0,46ppm		
	lead	0,37%		
	Comments	E lode		
2018-2019	detailed geophysics	Urpo Kuronen	key geological features	2, 3
DHEM and ground electromagnetic surveys in 2018 and a follow-up ground EM survey in 2019. Significant potential for new sulphide mineralisation is present to the north of the E-lode				

FinnAust Mining Oy

Years	Activity type	Geologist	Exploration result	Ref
2014-2014	core drilling	Urpo Kuronen	mineralized zone identified	7, 8, 9, 46
Deep extensions of the ore bodies and, possibly another, deep ore body detected				
Intersections				
	HoleID	R317		
	From-To	166-171,5		
	Length	5,5m		
	copper	1,46%		
	HoleID	R317		
	From-To	176-187		
	Length	11m		
	copper	1,24%		
	HoleID	R325		
	From-To	196,8-202,4		
	Length	5,6m		
	copper	3,2%		

	zinc	0,7%
	HoleID	R329
	From-To	267,6-269
	Length	1,4m
	copper	2,34%
	zinc	4,05%
	HoleID	R330
	From-To	276,4-281,6
	Length	5,2m
	copper	1,02%
	HoleID	R330
	From-To	280,5-281,5
	Length	1m
	copper	2,26%
	HoleID	R331
	From-To	348,4-359
	Length	10,6m
	copper	0,5%
	zinc	1,1%
	HoleID	R331
	From-To	350-353
	Length	3m
	copper	1,19%
	zinc	0,39%

Bluejay Mining

Years	Activity type	Geologist	Exploration result	Ref
2014-2020	detailed geology	Urpo Kuronen	key geological features	2
	<i>1 km east of the old mine, at the Hammaslahti East target, FinnAust has identified potential ore zones in the contact btw hydrothermally altered rocks and sulphidic black schists intersected in two drill holes, an identical geological structure that contained the ore in the historical mine but these have never been followed up. A similar ore-potential contact zone and multiple other sulphide-rich intervals has been intercepted with one drill hole only 200 m east of the old mine.</i>			

Geological Survey of Finland

Years	Activity type	Geologist	Exploration result	Ref
1981-1998	regional geophysics	M-L Airo	key geological features	1, 16
	<i>Includes low-altitude magnetic, aeromagnetic and radiometric survey in 1991</i>			
1978-1978	core drilling	Lauri Hyvärinen, Lauri Pekkarinen	key geological features	31
	<i>Core drilling (reconnaissance drilling): seven diamond-drill holes, total 1165 m.</i>			
1976-1979	regional geochemistry	Lauri Hyvärinen, Lauri Pekkarinen	geochemical anomaly	23
	<i>Zn and Cu anomalies in till, having a higher Zn/Ni and Cu/Ni than the anomalies related to the local black schists.</i>			
1976-1995	detailed geochemistry	L. Pekkarinen, K. Loukola-Ruskeeniemi, P. Lestinen	geochemical anomaly	23, 24, 25, 26

	<i>Lithogeochemistry: Na- and K-loss, and Cu-, Zn-, S-, Au-, Fe-, Mn- and Mg-enrichment haloes (200 m wide, 1.5 km long) around the deposit. The most distinct and extensive of these is the Na-depletion halo (background threshold at 1.1% Na₂O). Soil geochemistry: Zn and Cu anomalies in till, having a higher Zn/Ni and Cu/Ni than the anomalies related to the local black schists</i>			
--	--	--	--	--

1976-1995	detailed geology	L. Pekkarinen , K. Loukola-Ruskeeniemi, P. Ward	key geological features	11, 13, 24, 25, 26, 30, 31, 42, 43, 44, 45
	<i>Detailed genetic and mineralogical studies</i>			

1976-1979	detailed geophysics	J Jokinen, M.L Airo, F. Karell	geophysical anomaly	1, 15, 16
	<i>Magnetic, electric and gravity anomalies related to the Cu lodes are difficult to interpret, due to the extensive presence of highly conductive black schist units in the region and a set of narrow, graphite- and pyrrhotite-rich beds near the ore. The Cu lodes form positive anomalies on the slingram maps, and the deposit as a whole is in a local magnetic minimum. Low (= negative anomaly) in airborne radiometric pattern for K and Th is related to altered rocks. The sulphide deposit defines a K max</i>			

Outokumpu Oy

Years	Activity type	Geologist	Exploration result	Ref
1971-1971	regional geochemistry	Kalevi Pelkonen, Tapio Karppanen	geochemical anomaly	23
	<i>Till-stratigraphy and geochemical survey. Zn and Cu anomalies in till, having a higher Zn/Ni and Cu/Ni than the anomalies related to the local black schists.</i>			

1971-1979	core drilling	Kalevi Pelkonen, Tapio Karppanen	mineral reserve defined	10, 14, 17, 33
	<i>Core drilling (reconnaissance drilling): 140 diamond-drill holes.</i>			

1971-1971	detailed geophysics	Kalevi Pelkonen, Tapio Karppanen	geophysical anomaly	10, 19, 20, 32, 34
	<i>magnetic, electric and gravimetric ground surveys</i>			

1971-1971	mining pilot	Kalevi Pelkonen, Tapio Karppanen	positive feasibility study	10, 19, 20, 32, 34
-----------	--------------	----------------------------------	----------------------------	--------------------

Geological Survey of Finland

Years	Activity type	Geologist	Exploration result	Ref
1967-1970	core drilling	Lauri Hyvärinen, Lauri Pekkarinen	mineral resource defined	12
	<i>Core drilling (reconnaissance drilling): 100 diamond-drill holes, total 18785 m.</i>			

1966-1971	regional geophysics	Lauri Hyvärinen, Toivo Siikarla	geophysical anomaly	12, 31, 39
-----------	---------------------	---------------------------------	---------------------	------------

1966-1971	detailed geology	Lauri Hyvärinen, Lauri Pekkarinen	mineral reserve defined	12, 28, 39
	<i>Mineralisation discovered in outcrop during regional bedrock mapping.</i>			

1966-1971	regional geochemistry	Lauri Hyvärinen, Lauri Pekkarinen	geochemical anomaly	12, 23
	<i>Till and stream sediment geochemical survey. Zn and Cu anomalies in till, having a higher Zn/Ni and Cu/Ni than the anomalies related to the local black schists.</i>			

1966-1971	excavation	Lauri Hyvärinen, Lauri Pekkarinen	key geological features	12, 15, 17, 23, 27, 28, 30, 31, 33, 39
1966-1971	detailed geophysics	Lauri Hyvärinen, Toivo Siikarla	geophysical anomaly	39
	<i>Ground magnetic, slingram, gravimetric and radiation survey. The Zn lode has no response on magnetic methods due to its very low pyrrhotite content, but causes a distinct electric and gravity anomaly.</i>			
1966-1971	regional geology	Osmo Nykänen	key geological features	14, 27, 28
	<i>Regional bedrock mapping</i>			

RESOURCES AND RESERVES

Most recent

Type:	Company:	Year:	Date:	Calc Method:	Reference:
Resource	Outokumpu Oy	1973	NA	Non-compliant resource estimate	
<i>Comments: Three distinct, mineable Cu($\pm$Zn) lodes (N, O and S) and one Zn lode (Z).</i>					
Category:		Measured, indicated and inferred mineral resource			
Tonnage:		0,16 Mt			
zinc		2,4 %			
copper		0,6 %			
Cutoff:		NA			

MINING

Hammaslahti

Easting EUREF: 656261,703

Northing EUREF: 6929340,026

Status: Closed

Operating years: 1971-1986

Years in production: 16

Total ore mined: 5591340 t

References: 14, 36, 37, 38, 41

Total production:

Product	Product measure
copper	62120,76 t
zinc	3801,42 t

Other materials:

Material type	Material measure
Waste rock	2297523 t

Mining activity:

Year	Ore mined	Ore processed	Activity type	Production	Other material
1986	301700 t	301700 t	underground mining	copper 3318,7 t sulphur 0 t zinc 3801,42 t	Waste rock 37426 t
1985	450100 t	450100 t	underground mining	copper 4951,1 t	Waste rock 53891 t
1984	438400 t	438400 t	underground mining	copper 3945,6 t	Waste rock 85719 t
1983	412100 t	412100 t	underground mining	copper 4121 t	Waste rock 543953 t
1982	416400 t	416400 t	underground mining	copper 4996,8 t	Waste rock 84476 t
1981	406100 t	406100 t	underground mining	copper 4873,2 t	Waste rock 71670 t
1980	382750 t	382750 t	underground mining	copper 4593 t	Waste rock 52980 t
1979	417000 t	417000 t	underground mining	copper 5040 t	Waste rock 58876 t
1978	422480 t	422480 t	underground mining	copper 6300 t	Waste rock 52662 t
1977	420500 t	420500 t	underground mining	copper 5466,5 t	Waste rock 28930 t
1976	407500 t	407500 t	open-pit mining	copper 4890 t	Waste rock 64930 t
1975	388300 t	388300 t	open-pit mining	copper 4154,81 t	Waste rock 392311 t
1974	413910 t	413910 t	open-pit mining	copper 3145,71 t	Waste rock 349059 t
1973	314100 t	314100 t	open-pit mining	copper 2324,34 t	Waste rock 346341 t
1972	0 t	0 t	open-pit mining		

				Waste rock 55274 t
1971	0 t	0 t	open-pit mining	
				Waste rock 19025 t

Figures



GEOLOGY

Ore: Sulphide ore

Host rock: Tremolite Skarn, Quartz-wacke, Arkose quartzite

Wall rock: Black schist

Sulphide ore (Ore)

Rock type: Ore

Proportion: major

Grain size: NA

Color: NA

References: 12, 13, 14, 17, 21, 24, 26, 28, 32, 33, 42

Comments: A pipe-like, originally cross-cutting sulphide mineralisation in sedimentary environment. Massive, banded, Zn-rich lode and Cu-dominated stringer lodes. The degree of shearing is high within the ore and its immediate wallrocks.

Ore minerals:

Mineral	Proportion	Mineral texture
Arsenopyrite	minor	
Cassiterite	minor	
Chalcopyrite	major	Dissemination, Vein, Massive
Cubanite	minor	
Galena	minor	
Gold	minor	
Hematite	minor	
Ilmenite	minor	
Mackinawite	minor	
Magnetite	minor	
Pyrite	major	Dissemination, Vein, Massive
Pyrrhotite	major	Dissemination, Vein, Massive
Silver	minor	
Sphalerite	major	Vein, Massive, Dissemination
	<i>In the Zn-lode, sphalerite forms free grains 4-6 mm in diameter and may contain chalcopyrite, pyrrhotite and galena inclusions. Where pyrrhotite is abundant, sphalerite grains are much smaller and may occur as inclusions in pyrrhotite</i>	
Tetrahedrite	minor	

Other minerals:

Mineral	Proportion	Mineral texture
Albite	present	
Biotite	present	
Calcite	present	
Chlorite	present	
Fluorite	present	
Plagioclase	present	Alteration product
Quartz	present	
Rutile	present	
Sericite	present	
Siderite	present	
Tremolite	present	Alteration product

Structures
Sheared

Textures
Massive
Banded

Alteration:	Distribution:	Degree:	Relation to mineralization:
chloritic alteration	NA	NA	NA
<i>Comments: Plagioclase is replaced by sericite and biotite and tremolite by chlorite.</i>			
silicification	NA	NA	NA
<i>Comments: Quartz replaces plagioclase and tremolite (in those beds where the latter was present).</i>			

Metamorphic description:

Type:	Facies:	Degree:	Relation to mineralization:	Min P- Max P (kbar)	Min T- Max T (°C)
Regional	amphibolite metamorphic facies	medium metamorphic grade	NA	-8,7	

Geological age:

Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:		
Paleoproterozoic (2500-1600 Ma)	2105-2257	2180	Y		
<i>Comments: Mineralising fluids are possible syngenetic to and derived from the Tohmajärvi volcanic complex.</i>					
Radiometric age:	Method:	Age:	Error (Ma):	Mineral:	Reference:
	U-Pb	2105	15	Zircon	11, 18
	Pb-Pb	2179			43
	Pb-Pb	2257			43

Tremolite Skarn (Host rock)

Rock type: Host rock

Proportion: minor

Grain size: NA

Color: NA

References: 12, 14, 17, 21, 24, 26, 28, 42

Comments: The deposit is bounded by shear zones on both western and eastern sides, and located in a sequence comprising arkosite, metagreywacke, tremolite-chlorite rock, and black shale.

Metamorphic description:

Other minerals:

Mineral	Proportion	Mineral texture
Tremolite	present	Alteration product

Type:	Facies:	Degree:	Relation to mineralization:	Min P- Max P (kbar)	Min T- Max T (°C)
Regional	amphibolite metamorphic facies	medium metamorphic grade	NA	-8,7	
<i>Comments: Tremolite-chlorite rock: tremolite-quartz-feldspar-carbonate-chlorite ± muscovite, biotite, serpentine, epidote.</i>					

Geological age:

Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:
Paleoproterozoic (2500-1600 Ma)	1600-2500		N

Quartz-wacke (Host rock)

Rock type: Host rock

Proportion: major

Grain size: NA

Color: NA

References: 12, 14, 17, 21, 24, 26, 28, 42

Comments: The deposit is in hydrothermally altered metaturbidites, bounded in the hanging wall by a sheared metamorphosed black shale layer along which runs a steeply W-dipping reverse fault.

Other minerals:

Mineral	Proportion	Mineral texture
Quartz	present	Alteration product

Structures

Cross-bedding

Laminar

Textures

Clastic

Metamorphic description:

Type:	Facies:	Degree:	Relation to mineralization:	Min P- Max P (kbar)	Min T- Max T (°C)
Regional	amphibolite metamorphic facies	medium metamorphic grade	NA	-8,7	
<i>Comments: Greywacke: quartz-plagioclase-biotite-chlorite-sericite ± tremolite, hornblende, staurolite.</i>					

Geological age:

Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:
Paleoproterozoic (2500-1600 Ma)	1600-2500		N

Arkose quartzite (Host rock)

Rock type: Host rock

Proportion: major

Grain size: NA

Color: NA

References: 12, 14, 17, 21, 24, 26, 28, 42

Comments: The deposit is bounded by shear zones on both western and eastern sides, and located in a sequence comprising arkosite, metagreywacke, tremolite-chlorite rock, and black shale.

Other minerals:

Mineral	Proportion	Mineral texture
K-Feldspar	present	

Structures

Cross-bedding
Laminar

Textures

Clastic

Metamorphic description:

Type:	Facies:	Degree:	Relation to mineralization:	Min P- Max P (kbar)	Min T- Max T (°C)
Regional	amphibolite metamorphic facies	medium metamorphic grade	NA	-8,7	

Geological age:

Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:
Paleoproterozoic (2500-1600 Ma)	1600-2500		N

Black schist (Wall rock)

Rock type: Wall rock

Proportion: minor

Grain size: NA

Color: NA

References: 12, 14, 17, 21, 24, 26, 28, 42

Comments: The deposit is in hydrothermally altered metaturbidites, bounded in the hanging wall by a sheared metamorphosed black shale layer along which runs a steeply W-dipping reverse fault.

Structures

Cross-bedding
Laminar

Textures

Clastic

Metamorphic description:

Type:	Facies:	Degree:	Relation to mineralization:	Min P- Max P (kbar)	Min T- Max T (°C)
Regional	amphibolite metamorphic facies	medium metamorphic grade	NA	-8,7	

Comments: Black shale: quartz-biotite-chlorite-sericite-graphite-sulphides $\pm$ tremolite, feldspars.

Geological age:

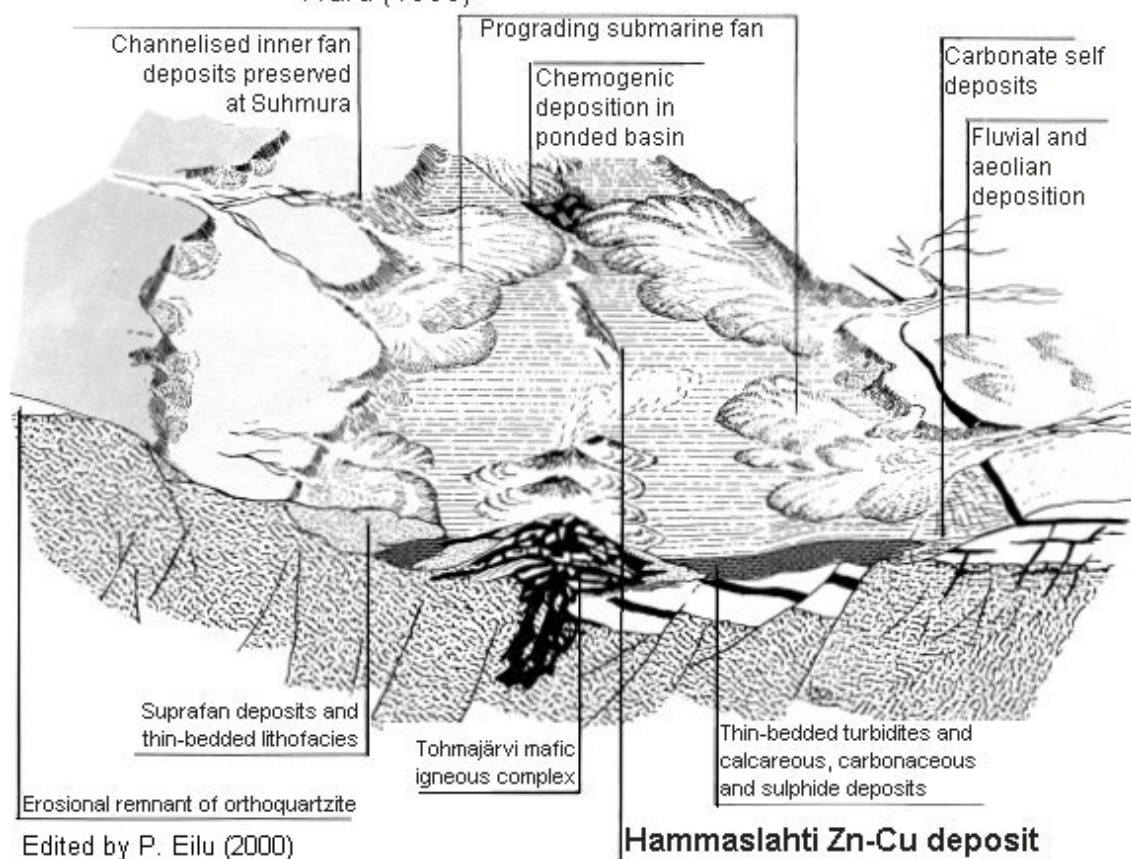
Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:
Paleoproterozoic (2500-1600 Ma)	1600-2500		N

Figures

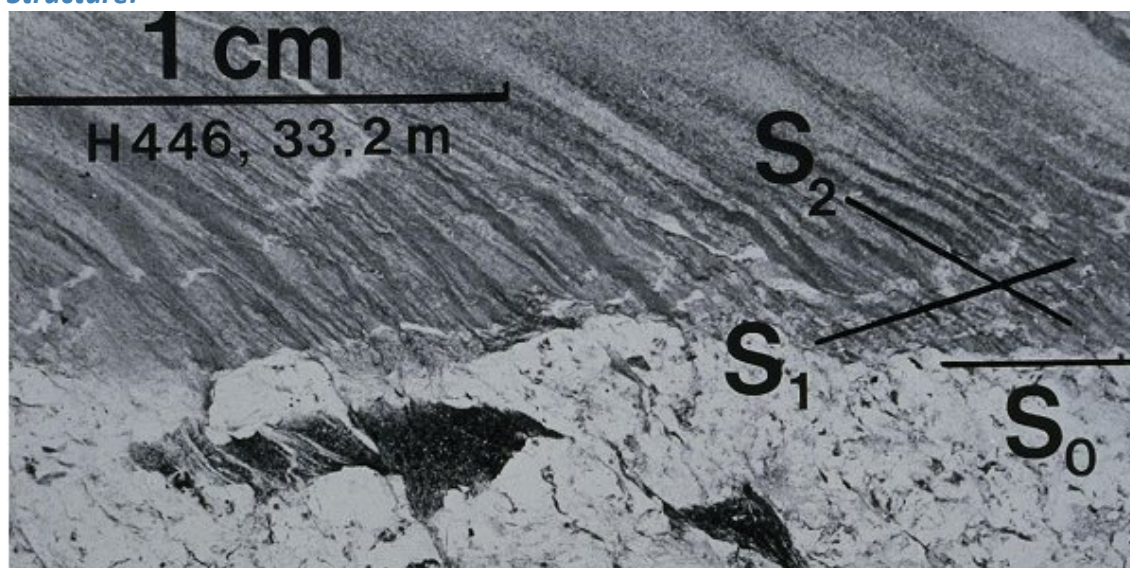
Regional geology:

Geotectonic setting of the Hammaslahti region

Ward (1988)



Structure:



Hammaslahti. S_0 = boundary between a pelitic and a psammitic layer. Quartz veins subparallel to the S_1 foliation. S_2 is crenulation cleavage and axial-plane foliation to regional F_2 folds. From Loukola-Ruskeeniemi et al. (1990).

Structure:



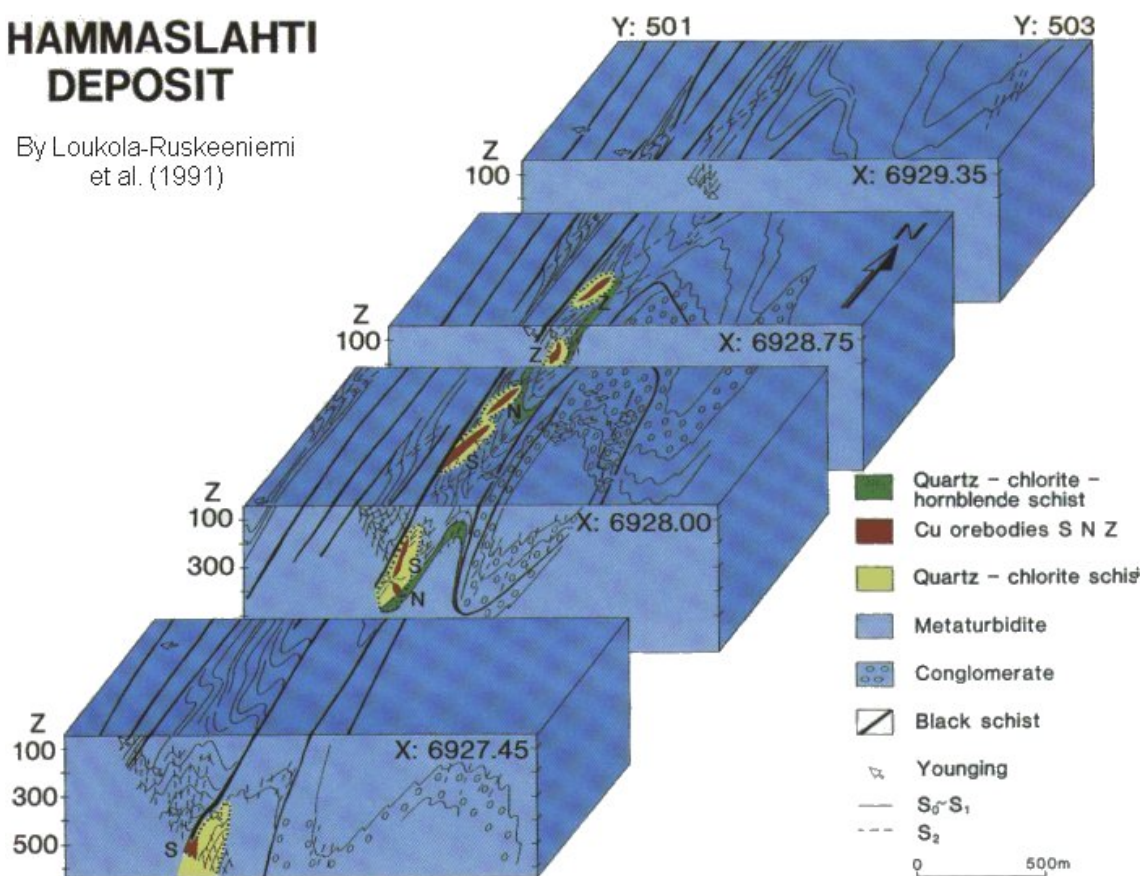
Hammaslahti, intrafolial F1 folds cut by S2 axial-plane cleavage. From Loukola-Ruskeeniemi et al. (1990).

Local geology:

Geological Survey of Finland, Special Paper 12
Geochemistry, structure and genesis of the Hammaslahti copper mine — explorational tools...

HAMMASLAHTI DEPOSIT

By Loukola-Ruskeeniemi
et al. (1991)

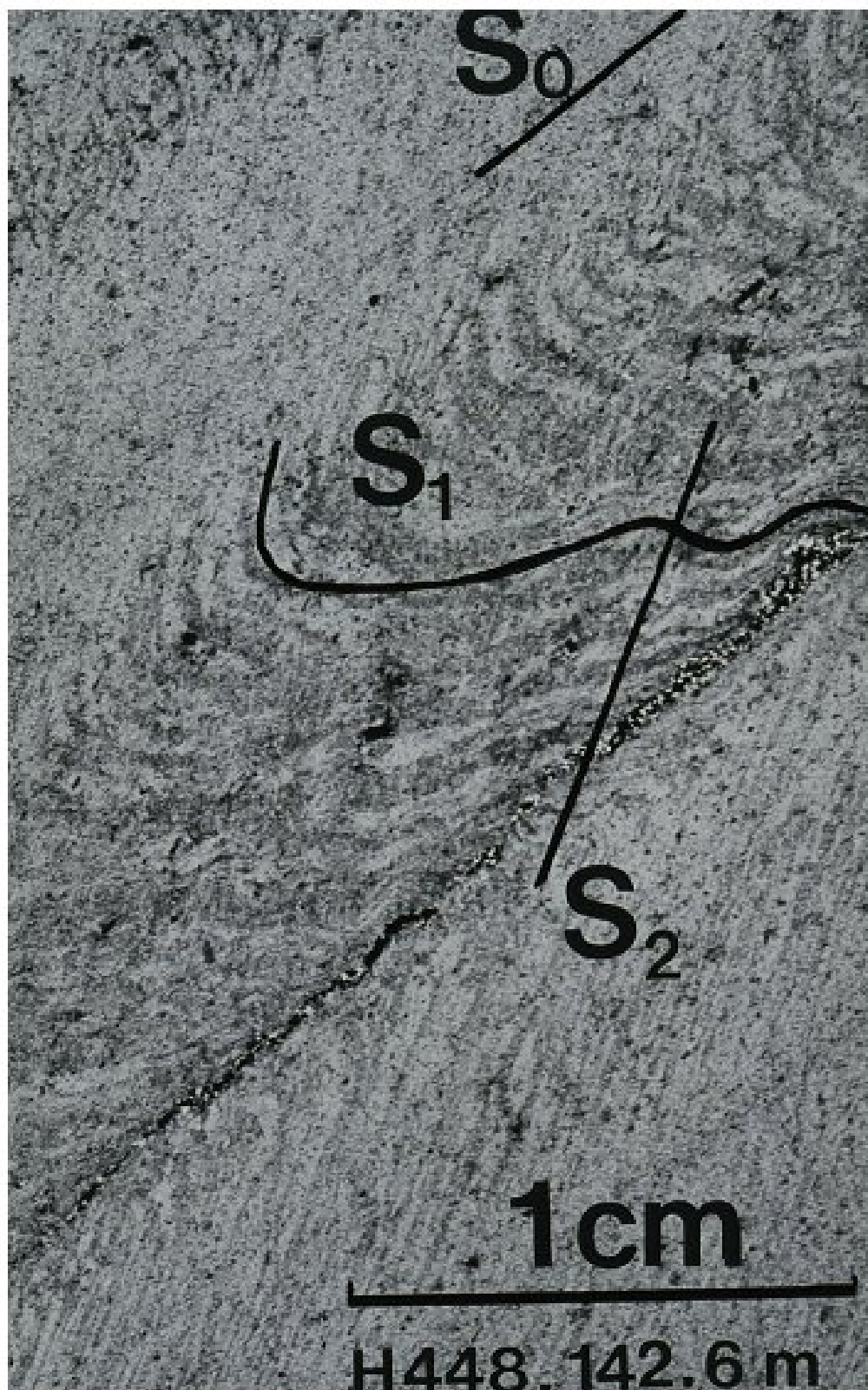


Outcrop photo:



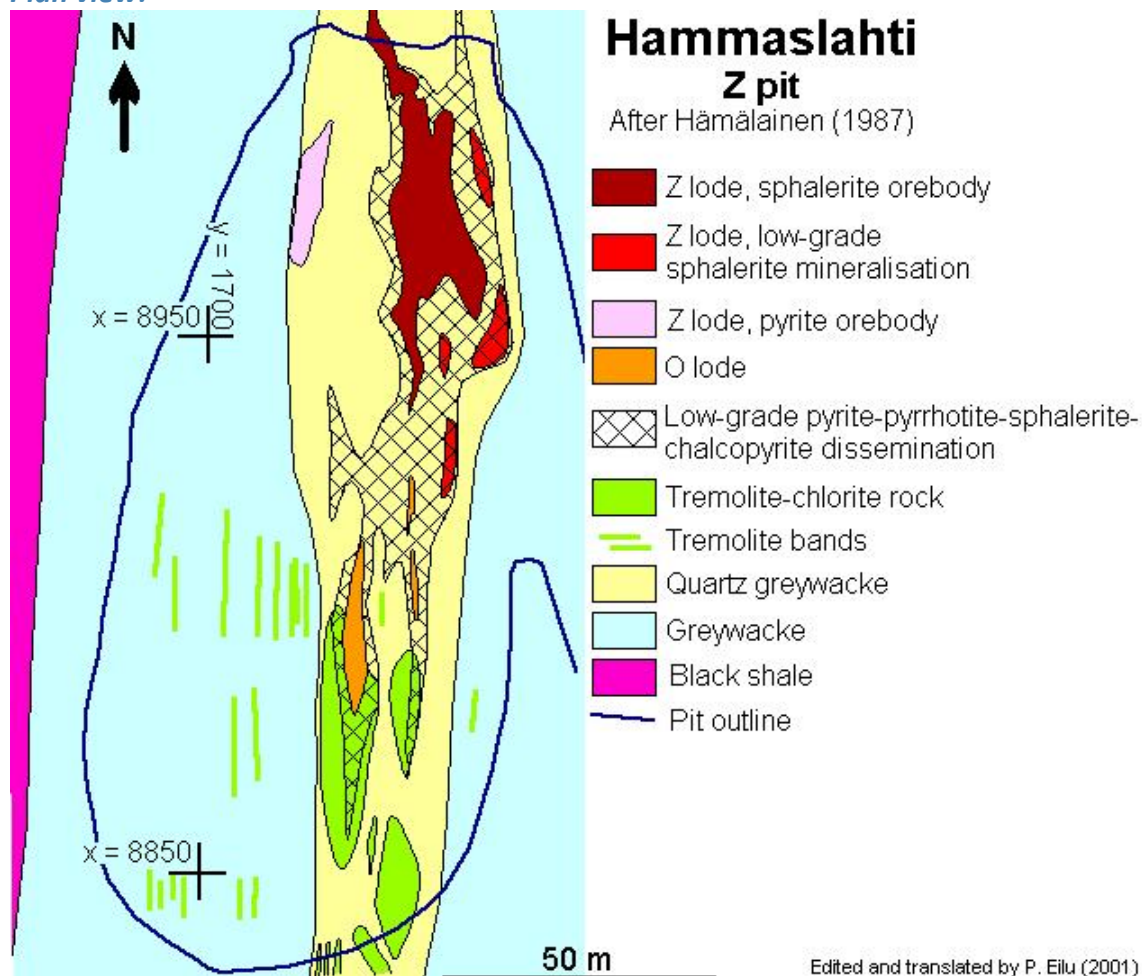
Hammaslahti. Outcrop of mineralisation.
Photo Gabor Gaál

Metamorph photo:

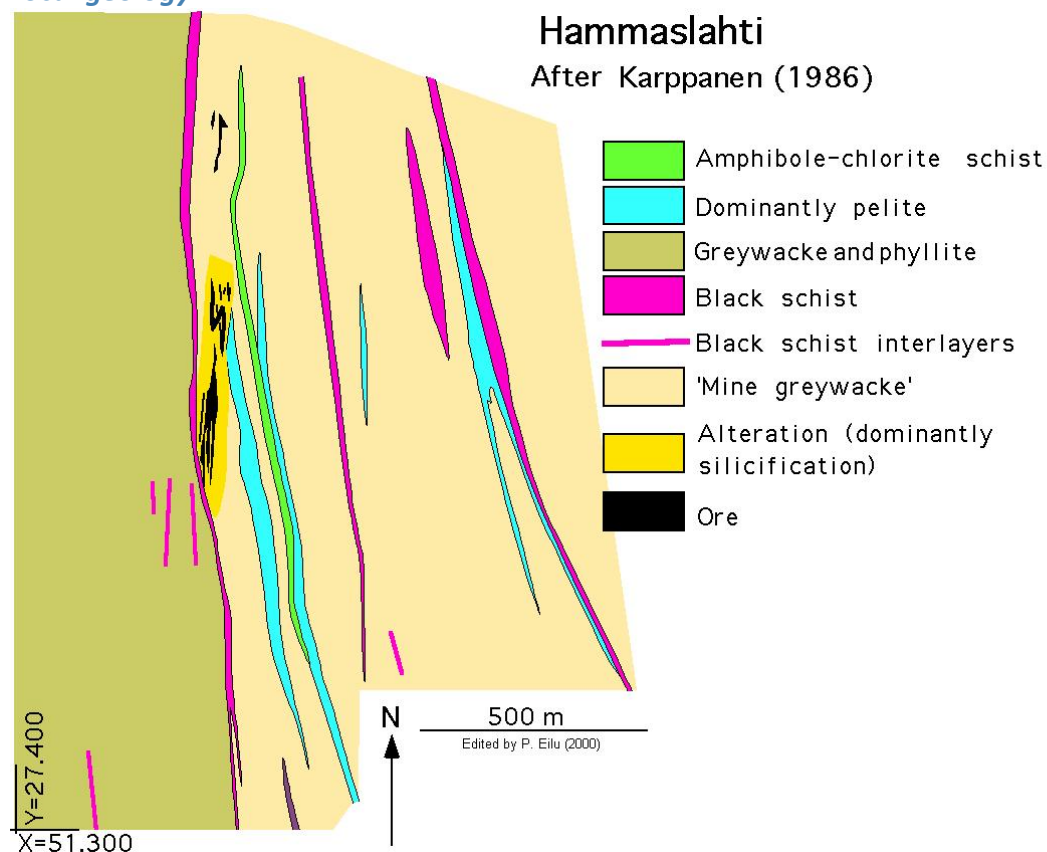


Hammaslahti, primary layering and two foliation planes in metaturbidite. From Loukola-Ruskeeniemi et al. (1990).

Plan view:

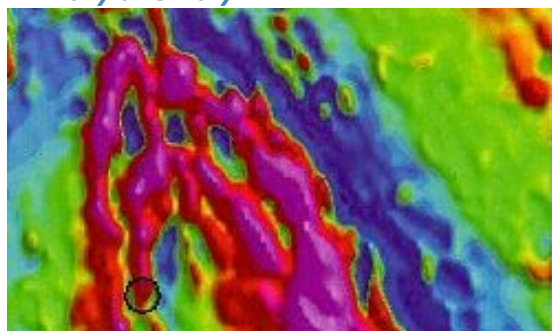


Local geology:

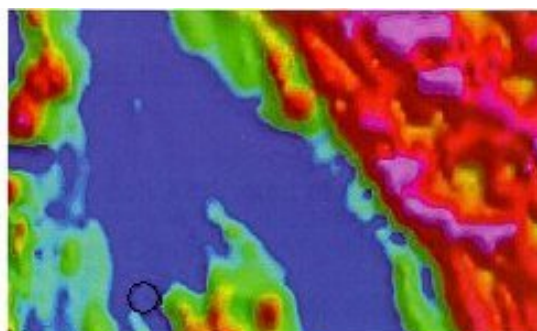


Chalcopyrite ore at Hammaslahti. Field of view about 10 cm. Photo Jari Väättäinen.

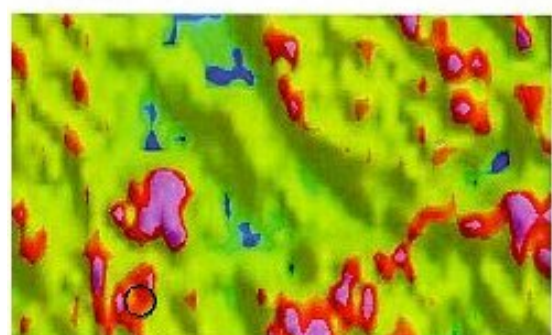
Primary anomaly:



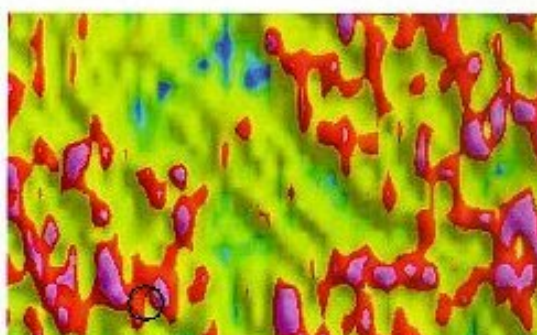
Magnetic map



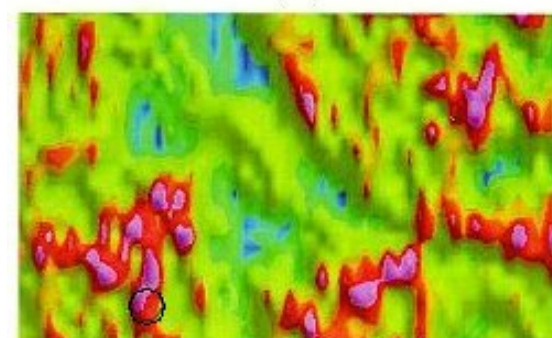
Resistivity map. Good conductors in blue.



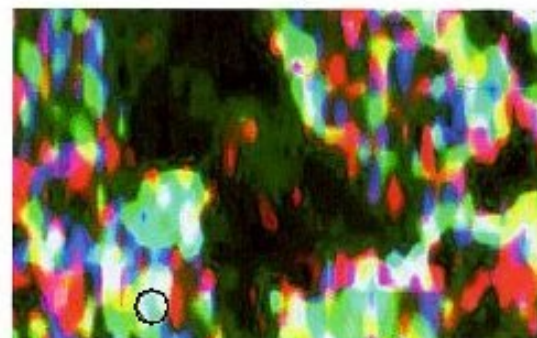
Radiometric map: potassium



Radiometric map: uranium



Radiometric map: thorium



Radiometric map: U-Th-K combined

Low-altitude airborne geophysical view at Hammaslahti. Size of the area depicted is 3x5 km. The deposit is marked by a small circle in each figure. From Karell (2001) after data from the GTK.

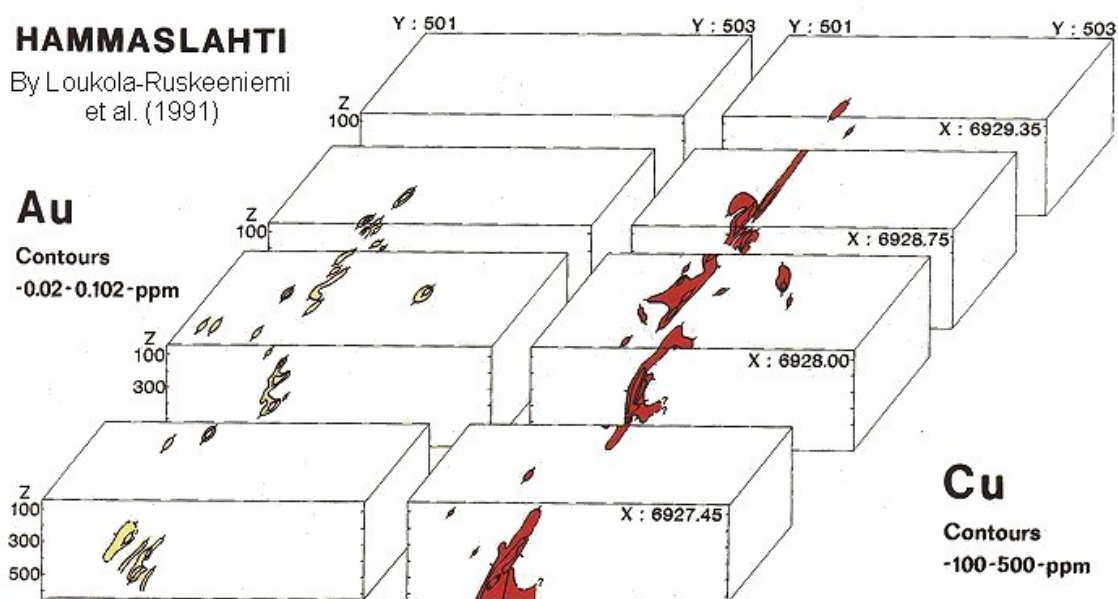
Primary anomaly:

HAMMASLAHTI

By Loukola-Ruskeeniemi
et al. (1991)

Au

Contours
-0.02-0.102-ppm



Cu

Contours
-100-500-ppm

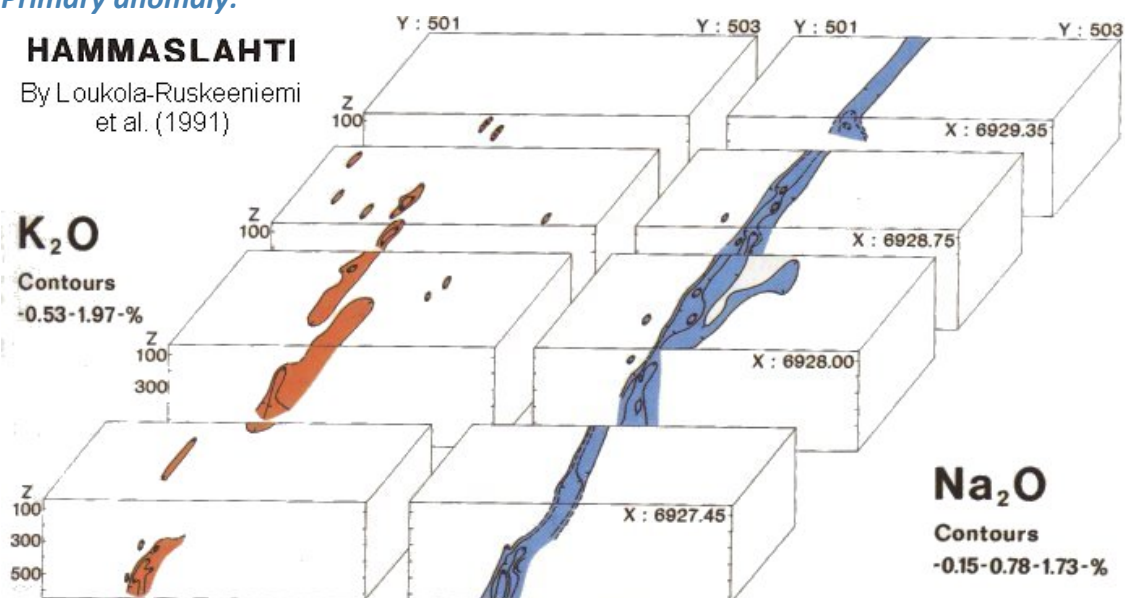
Primary anomaly:

HAMMASLAHTI

By Loukola-Ruskeeniemi
et al. (1991)

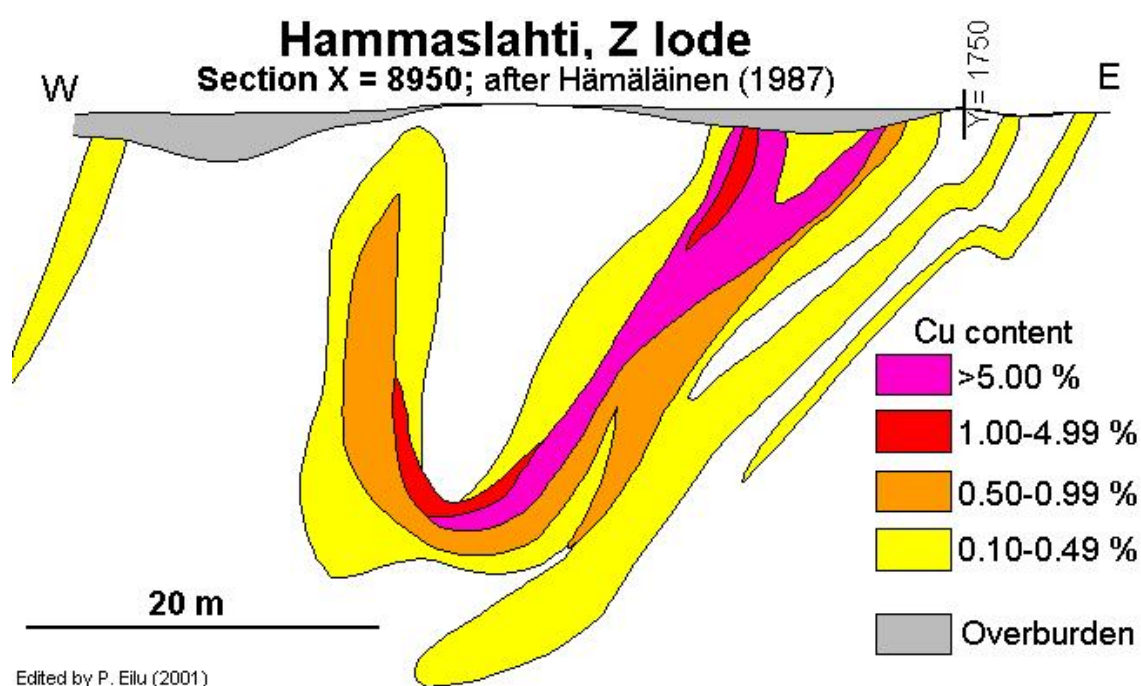
K₂O

Contours
-0.53-1.97-%

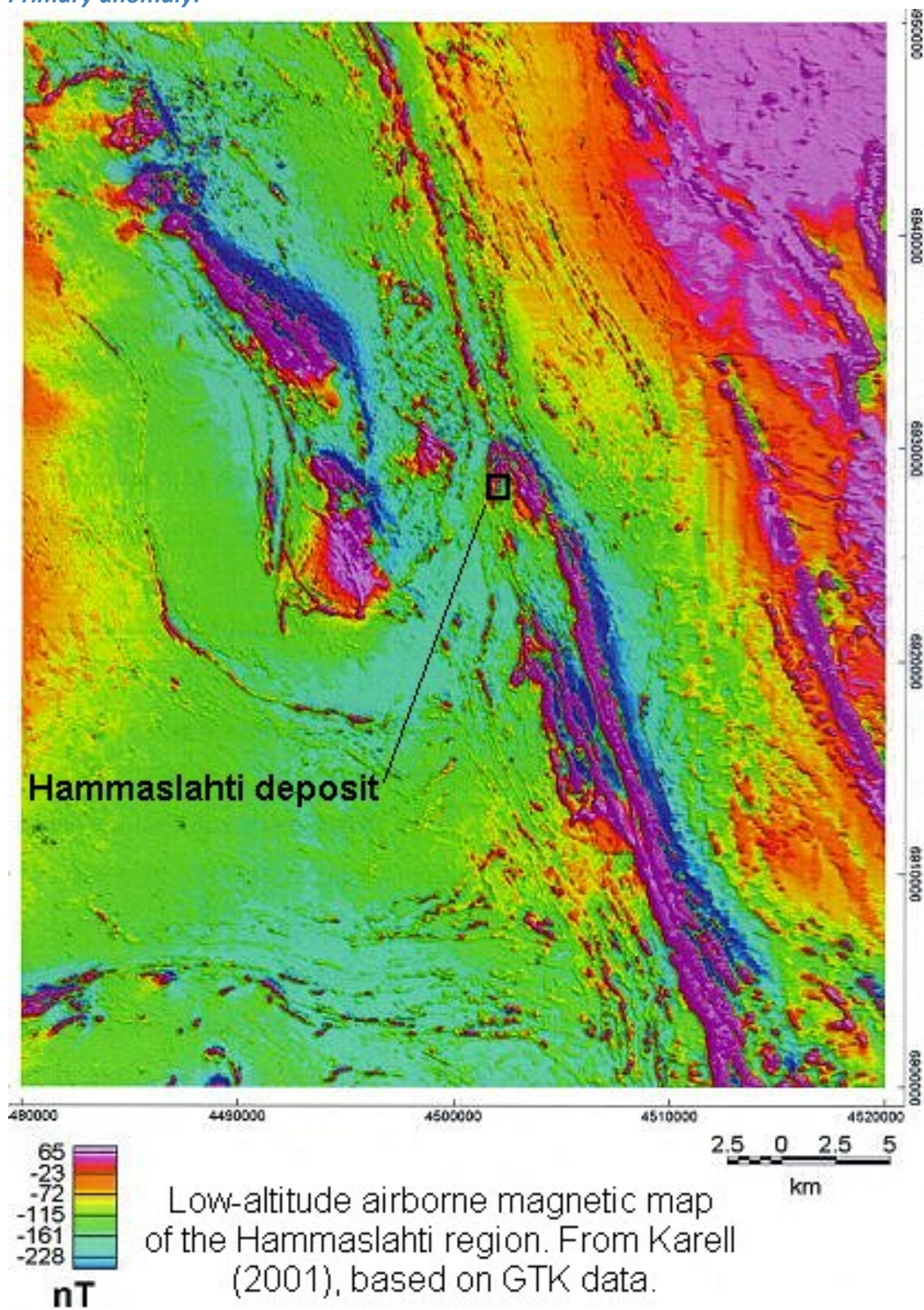


Na₂O

Contours
-0.15-0.78-1.73-%

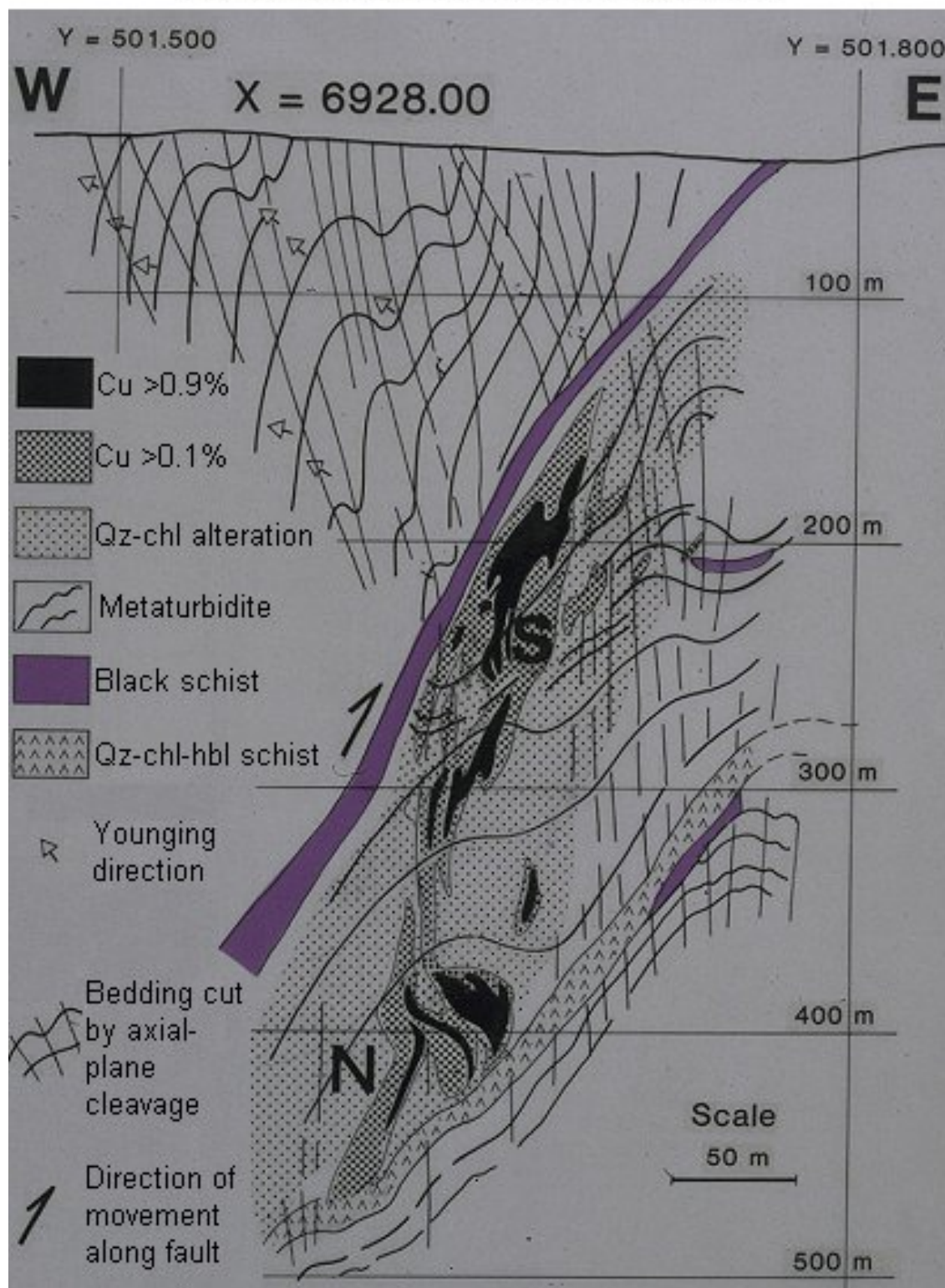


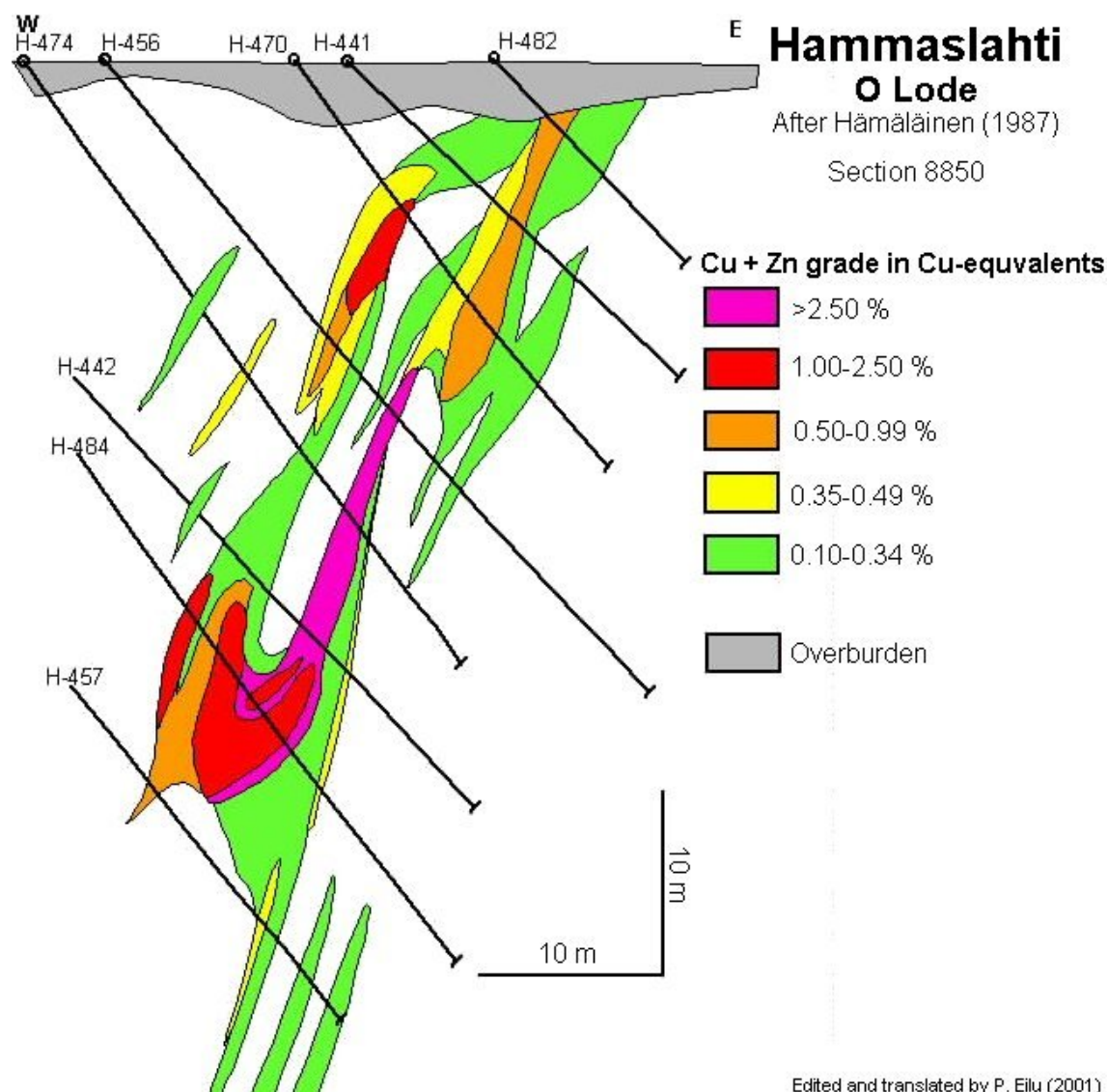
Primary anomaly:

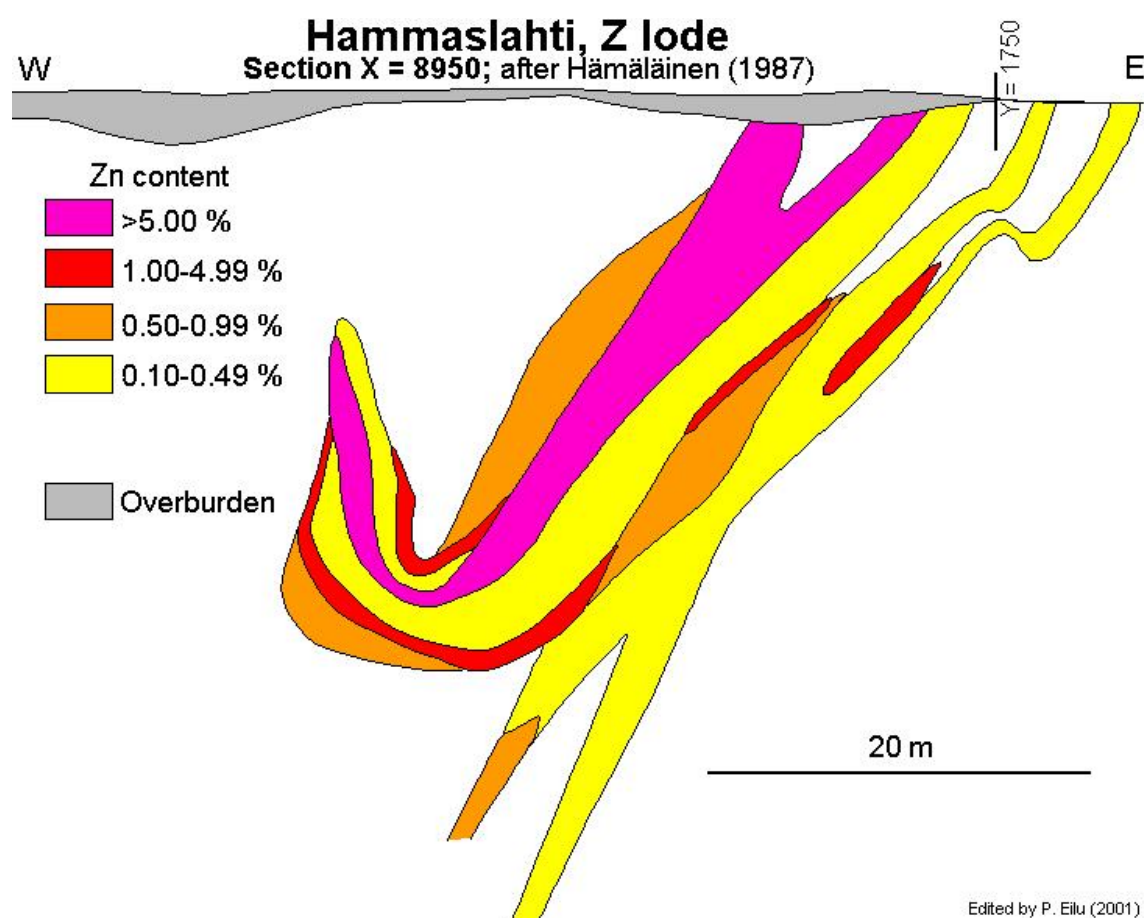


Section across the Hammaslahti deposit

By Loukola-Ruskeeniemi et al. (1990)







REFERENCES

1. Airo, M.-L., Karell, F. 2001. Interpretation of airborne magnetic and gamma-ray spectrometric data related to Hammaslahti Cu-Zn-Au deposit in eastern Finland. In: Geological Survey of Finland. Special Paper 31, 97-103. http://tupa.gtk.fi/julkaisu/specialpaper/sp_031_pages_097_103.pdf
2. Bluejay Mining 2020. Media release 16 Nov 2020
http://tupa.gtk.fi/karttasovellus/mdae/references/524_Hammaslahti/524_BlueJay032_2020_11_16.pdf
3. Bluejay Mining 2023. Media release 2 October 2023
http://tupa.gtk.fi/karttasovellus/mdae/references/524_Hammaslahti/524_BlueJay046_2023_10_02.pdf
4. Bluejay Mining 2023. Media release 30 May 2023
http://tupa.gtk.fi/karttasovellus/mdae/references/524_Hammaslahti/524_BlueJay045_2023_05_30.pdf
5. Closedure-project. Sivukivitulokset. GTK.
6. Ekdahl, E. 1993. Early Proterozoic Karelian and Svecofennian formations and the evolution of the Raahe-Ladoga Ore Zone, based on the Pielavesi area, central Finland. Geological Survey of Finland, Bull. 373. 137 p. http://tupa.gtk.fi/julkaisu/bulletin/bt_373.pdf
7. FinnAust Mining plc 2004. Press Release 21.7.2014.
http://tupa.gtk.fi/karttasovellus/mdae/references/524_Hammaslahti/524_JulyHammaslahtiDrilling21.07.14.pdf
8. FinnAust Mining plc 2014. Press Release 1.10.2014.
http://tupa.gtk.fi/karttasovellus/mdae/references/524_Hammaslahti/524_R331DrillingUpdate01.10.14draft2.pdf
9. FinnAust Mining plc. Press Release. 29.4.2014.
http://tupa.gtk.fi/karttasovellus/mdae/references/524_Hammaslahti/524_HammaslahtiDrilling29.04.14_000.pdf
10. Geological Survey of Finland. Ore Deposit Database.
11. Huhma, H. 1986. Sm-Nd, U-Pb and Pb-Pb isotopic evidence for the origin of the Early Proterozoic Svecokarelian crust in Finland. Geological Survey of Finland, Bulletin 337. 48 p.
http://tupa.gtk.fi/julkaisu/bulletin/bt_337.pdf
12. Hyvärinen L. 1970. Selostus Pyhäselän kunnan Lähdekorven kupariesiintymän malmitutkimuksista vv. 1967-1970. Geological Survey of Finland, Report M19/4241/70/1/10. 35 p. (in Finnish)
http://tupa.gtk.fi/raportti/arkisto/m19_4241_70_1_10.pdf
13. Hyvärinen, L., Kinnunen, K. & Mäkelä, M. 1977. The geochemistry, fluid inclusions, sulfur isotopes and origin of the Hammaslahti copper ore deposit, Finland. Geological Survey of Finland, Bulletin 293. 23 p. http://tupa.gtk.fi/julkaisu/bulletin/bt_293.pdf
14. Hämäläinen, I. 1987. Hammaslahden sinkkimalmi. MSc thesis. Department of Geology, University of Turku. 110 p. (in Finnish)

- 15.** Jokinen, T. 1981. Geofysikaaliset mittaukset Pyhäselän alueella 1976-1978. Geological Survey of Finland, Report Q 19/4223/81/1. 1 p. (in Finnish)
http://tupa.gtk.fi/raportti/arkisto/q19_4223_81_1.pdf
- 16.** Karell, F. 2001. Tolkning av radiometriska och magnetiska data relaterade till Hammslahti sulfidmineralisering i östra Finland. Unpublished MSc thesis. Department of Geology, Åbo Akademi University, Turku, Finland. 68 p. (in Swedish)
- 17.** Karppanen, T. 1986. The Hammaslahti mine. In: Kojonen, K. (ed.) Prospecting in areas of glaciated terrain 1986: guide to the field excursion for the symposium in eastern Finland, September 3-5, 1986. Geological Survey of Finland, Guide 17, 34-40.
http://tupa.gtk.fi/julkaisu/opas/op_017_pages_034_040.pdf
- 18.** Kohonen, J. 1995. From continental rifting to collisional crustal shortening - Paleoproterozoic Kaleva metasediments of the Höytiäinen area in North Karelia, Finland. Geological Survey of Finland, Bulletin 380. 79 p.
http://tupa.gtk.fi/julkaisu/bulletin/bt_380.pdf
- 19.** Koistinen, T. 1971. Hammaslahden kuparimalmi. Outokumpu Oy Exploration, Report 001/4241/TJK/71. 4 p. (in Finnish)
http://tupa.gtk.fi/raportti/arkisto/001_4241_tk_71.pdf
- 20.** Kokkola, M., & Penninkilampi, S. 1984. Sinkki-kuparimalmin kuvastuminen moreenissa Hammaslahden kaivoksella. Summary: Hammaslahti mine. Vuoriteollisuus 42, 81-83.
- 21.** Korsman, K. (ed.) & Glebovitsky, V. (ed.) 1999. Raahe-Ladoga Zone structure-lithology, metamorphism and metallogeny: a Finnish-Russian cooperation project 1996-1999. Map 2: Metamorphism of the Raahe-Ladoga Zone 1:1000000. Geological Survey of Finland.
- 22.** Kuusisto, E. 1991. Metalli- ja rikkimalmikaivosten ja -louhosten jätealtaiden ja jätekasojen vaikutusta ympäristöön tutkivaan hankkeeseen liittyvä esiselvitys. Geologian tutkimuskeskus, Espoo. Julkaisematon raportti. 88 s.
https://tupa.gtk.fi/raportti/arkisto/s42_0000_1_1991.pdf
- 23.** Lestinen, P. 1979. Väli-Suomen kohdetutkimusryhmä raportti 2/1979 Hammaslahti-N. Geological Survey of Finland, Report S41/4241/2/1979. 3 p. (in Finnish)
http://tupa.gtk.fi/raportti/arkisto/s41_4241_02_1_1979.pdf
- 24.** Loukola-Ruskeeniemi, K. 1999. Origin of black shales and the serpentinite-associated Cu-Zn-Co ores at Outokumpu, Finland. Econ. Geol. 94, 1007-1028.
- 25.** Loukola-Ruskeeniemi, K., Gaal, G. & Karppanen, T. 1991. Geochemistry, structure and genesis of the Hammaslahti copper mine - explorational tools for a sediment-hosted massive sulphide deposit. Geological Survey of Finland, Special Paper 12, 101-106.
http://tupa.gtk.fi/julkaisu/specialpaper/sp_012_pages_101_106.pdf
- 26.** Loukola-Ruskeeniemi, K., Gaal, G. & Karppanen, T. 1992. Geochemical and structural characteristics of a sediment-hosted copper deposit at Hammaslahti, Finland: comparison with Besshi-type massive sulphide deposits. In: Maurice, Y. T. (ed.) Proceedings of the Eighth Quadrennial IAGOD Symposium, Ottawa, Canada, August 12-18, 1990. Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung, 551-569.
- 27.** Nykänen, O. 1971. Kiihtelysvaara. Geological Map of Finland 1:100000: Pre-Quaternary Rocks, Sheet 4241. Geological Survey of Finland.
http://tupa.gtk.fi/kartta/kallioperakartta100/kp_4241.pdf

- 28.** Nykänen, O. 1971. Pre-Quaternary Rocks of the Kiihtelysvaara Map-Sheet area. Geological Map of Finland 1:100000: Explanation to the Maps of Pre-Quaternary Rocks, Sheet 4241. Geological Survey of Finland. 68 p http://tupa.gtk.fi/kartta/kallioperakartta100/kps_4241.pdf
- 29.** Papunen, H. (ed.) 1990. Sinkkiprojektin loppuraportti. University of Turku, Institute of Geology and Mineralogy, Publication 22. 143 p. (in Finnish)
- 30.** Pekkarinen, L. 1978. Selostus Pyhäselässä suoritetuista malmitutkimuksista vuosina 1976-1978. Geological Survey of Finland, Report M19/4223/-78/1/10. 7 p. (in Finnish)
http://tupa.gtk.fi/raportti/arkisto/m19_4223_78_1_10.pdf
- 31.** Pekkarinen, L. 1979. Selostus Pyhäselän alueella suoritetuista malmitutkimuksista vuosina 1976-1979. Geological Survey of Finland, Report M19/4223/79/1/10. 24 p. (in Finnish)
http://tupa.gtk.fi/raportti/arkisto/m19_4223_79_1_10.pdf
- 32.** Pelkonen, K. 1976. Malminetsintä Hammaslahden ympäristössä. Outokumpu Oy, Hammaslahti mine Report 020/4241, 4232/KAP/76. 7 p. (in Finnish)
http://tupa.gtk.fi/raportti/arkisto/020_4241_4232_kap_76.pdf
- 33.** Pelkonen, K., Alopaeus, E., Penttilä, S. & Korhonen, O. 1973. Outokumpu Oy:n Hammaslahden kaivos. Vuoriteollisuus 31 (2), 90-96. (in Finnish)
- 34.** Peltola, E. 1971. Raportti Hammaslahden kuparimalmin tutkimustöistä ja niiden tuloksista. Outokumpu Oy Exploration, Report. 2 p. (in Finnish)
- 35.** Romu, I. 2014. Yksinkertaistettu petrografinen analyysi. Näytteet: TEKA-2013-1.1; -2.1; 3.1;... Geologian tutkimuskeskus. Itä-Suomen yksikkö Kuopio. 16.4.2014.
- 36.** Räisänen, M. L., Beucher, A., Tornivaara, A. & Kauppila, P. 2015. Suljettujen ja hylättyjen metallikaivosalueiden nykytila ja arvio jätealueiden ympäristöriskipotentiaalista. Geologian tutkimuskeskus, arkistoraportti 46/2015, 129 s
- 37.** Räisänen, M. L., Niemelä, K., & Saarelainen, J. 2003. Rautasulfidipitoisen rikastushiekan läjitysalueen rakenne ja ympäristön pintavesien nykytila. Vuosien 2000 ja 2001 seurantatulokset, Hammaslahden vanha kuparikaivos. GTK:n Arkistoraportti S/44/0000/1/2003
https://tupa.gtk.fi/raportti/arkisto/s44_0000_1_2003.pdf
- 38.** Räisänen, M.L., Mäkinen, J. & Bomberg, M. 2015. Biogeochemistry and biologic sulphate reduction in Hammaslahti pit lakes, eastern Finland. Mine Closure Wiki pages, Closedure, Geological Survey of Finland <https://mineclosure.gtk.fi/hammaslahti/>
- 39.** Siikarla, T. 1970. Selostus geofysikaalisista tutkimuksista Pyhäselän Lähdekorvessa vuosina 1968-1970. Geological Survey of Finland, Report M19/4241/70/3. 18 p. (in Finnish)
http://tupa.gtk.fi/raportti/arkisto/m19_4241_70_3.pdf
- 40.** Tenhola, M. & Räisänen, M.L. 2006. Rikastushiekan läjitysalueen suotovesien vaikutus ympäröivän turpeen kemialliseen koostumukseen, vanha Hammaslahden Cu-Zn -kaivos, Pyhäselkä. Geologian tutkimuskeskus, arkistoraportti S44/0000/1/2006. 28 s. According to Räisänen et al. (Closedure)
- 41.** Tornivaara, A., Räisänen, M. L., Kovalainen, H. & Kauppi, S. 2018. Suljettujen ja hylättyjen

kaivosten kaivannaisjätealueiden jatkokartoitus (KAJAK II). Suomen Ympäristökeskuksen raportteja 12/2018 <https://helda.helsinki.fi/handle/10138/235617>

42. Törnroos, R. 1982. Sphalerite geobarometry of some metamorphosed sulphide ore deposits in Finland. Geological Survey of Finland, Bulletin 323. 42 p.
http://tupa.gtk.fi/julkaisu/bulletin/bt_323.pdf

43. Vaasjoki, M. 1981. The lead isotopic compositions of some Finnish galenas. Geological Survey of Finland, Bulletin 316. 30 p.http://tupa.gtk.fi/julkaisu/bulletin/bt_316.pdf

44. Ward, P. 1986. Kalevian lithofacies and their relationships in the Hammaslahti-Rääkkylä district, North Karelia. In: ed. K. Laajoki & J. Paakkola & S. Gehör Suomen kallioperän sedimentologia. Res Terrae Ser. B 9, 9-10.

45. Ward, P. 1988. Early Proterozoic Kalevian lithofacies and their interpretation in the Hammaslahti-Rääkkylä area, eastern Finland. Geological Survey of Finland, Special Paper 5, 29-48.
http://tupa.gtk.fi/julkaisu/specialpaper/sp_005_pages_029_048.pdf

46. Western Areas 2015. Annual report.
http://tupa.gtk.fi/karttasovellus/mdae/references/524_Hammaslahti/524_Western_Areas_2015_AnnualReport.pdf