Metsämonttu

Occurence type: deposit

Commodity	Rank	Total measure	Total production	Total resource	Importance
zinc	1	44927.23 t	44927.23 t	0 t	Small deposit
gold	2	1.13 t	1.13 t	0 t	Small deposit
lead	2	7050.43 t	7050.43 t	0 t	Small deposit
copper	3	1575.55 t	1575.55 t	0 t	Occurrence
silver	3	19.67 t	19.67 t	0 t	Occurrence
sulphur	5	113014.7 t	113014.7 t	0 t	Small deposit

Easting EUREF: 297258
Northing EUREF: 6678206

Easting YKJ: 3297345
Northing YKJ: 6681011

Discovery year: 1946
Discovered by: Suomen Malmi Oy
Province: Orijärvi (Zn, Cu, Ag, Pb)
District: Aijala (Zn, Cu, Au)
Comments: First indications were ground electric anomalies detected during exploration at Aijala and the deposit was hit by diamond drilling by SMOY
References: 7, 10, 11, 12, 15, 16, 18, 20, 23, 33, 35, 36, 37, 38

Mineral deposit type

Group: Metallogenic deposit
Main type: VMS (mixed hydrothermal)
Comments: Later deformations remobilised the sulphides and gave the orebodies their present form.
References: 2, 12, 14, 17, 18, 42

Dimension

Expression: exposed
Form: concordant
Shape: irregular
Length (m): 680
Width (m): 400
Thickness (m): 65
Depth (m): 680

Area (ha): NA
Dip azim: 150
Dip: 90
Plunge azim: NA
Plunge dip: 85
Orientation method: NA

Dimension comments: Open at depth. The shape of the Metsämonttu orebody has been affected by folding, whose direction parallels the major axes of the orebody. The axis is subvertical, about 80-85° to SW.

Holder history

Current holder: Geological Survey of Finland
Years: 2019

Holding type: Reservation

Previous holders:

Company	Years	Holding type	Comments
Oy SES Finland Ltd	2006	NA	NA
Outokumpu Oy	1999-2004	NA	NA
Geological Survey of Finland	1995-1997	NA	NA
Outokumpu Oy	1951-1975	Mining concession (old law)	NA
Suomen Malmi Oy	1945-1951	NA	NA
Geological Survey of Finland	1880-1914	NA	NA

EXPLORATION ACTIVITY

Outokumpu Oy

Years	Activity type	Geologist	Exploration result	Ref
1999-2004	regional reconnaissance	NA	key geological features	6, 13, 14, 19, 22, 35, 36, 39

Geological Survey of Finland

Years	Activity type	Geologist	Exploration result	Ref
1995-1997	detailed geophysics	NA	key geological features	14
	Anomalies by ground magnetic, slingram and IP.			

1982-1982	regional geophysics	NA	key geological features	
	Low-altitude airborne magnetic, electromagnetic and radiometric survey			

Outokumpu Oy

Years	Activity type	Geologist	Exploration result	Ref
1974-1974	core drilling	Arno Warma, Ulla Mäkelä	NA	6
	Diamond drilling (reconnaissance drilling): two underground exploration drill holes.			

1958-1959	core drilling	Arno Warma	mineral reserve defined	35
	Core drilling (reconnaissance drilling): 35 diamond-drill holes, total 5135 m.			

1950-1970	ore beneficiation tests	Arno Warma	positive feasibility study	36

1950-1982	detailed geology	Arno Warma	NA	6, 13, 14, 19, 22, 35, 36, 39

1950-1982	regional geophysics	Arno Warma, Ulla Mäkelä	geophysical anomaly	6, 13, 14, 19, 22, 35, 36, 39
	Ground magnetic, IP and slingram surveys define anomalies related to the ore			

Suomen Malmi Oy

Years	Activity type	Geologist	Exploration result	Ref
1950-1950	resource assessment	NA	mineral resource defined	36

Outokumpu Oy

Years	Activity type	Geologist	Exploration result	Ref
1950-1961	core drilling	Arno Warma	mineral reserve defined	36
	Core drilling (reconnaissance drilling) at surface: >10 km of diamond drilling.			

1950-1982	regional geochemistry	Arno Warma, Heikki Wennervirta, Ulla Mäkelä	geochemical anomaly	6, 13, 14, 19, 22, 35, 36, 39
	Regional and detailed lithogeochemical surveys. A 3 km long, 50-150 m wide, sulphidised lithological unit enriched in Zn (>60 ppm), Cu (>20 ppm), Pb (>40 ppm), Hg, As and S (>0.13 %), also including the Metsämonttu mine, envelopes the deposit. In all rocks, a good positive correlation between Zn and Hg, and Pb and Ag. Cordierite gneisses and cordierite rocks consistently contain anomalous Cu and Zn concentrations.			

Suomen Malmi Oy

Years	Activity type	Geologist	Exploration result	Ref
1947-1950	core drilling	Heikki Tuominen	mineral occurrences	34, 36
	Core drilling (reconnaissance drilling): several diamond-drill holes.			

1945-1952	detailed geology	Heikki Tuominen	NA	13, 30, 31, 34, 36
	First indications were ground electric anomalies detected during exploration.			

1945-1952	detailed geophysics	Heikki Tuominen	NA	13, 30, 31, 34, 36

Geological Survey of Finland

Years	Activity type	Geologist	Exploration result	Ref
1930-1930	detailed geology	A.F. Tigerstedt, Kauko Parras	NA	3, 4, 9, 27, 28, 29

1930-1930	detailed geophysics	A.F. Tigerstedt, Kauko Parras	NA	14

1880-1914	detailed geology	A.F. Tigerstedt, Kauko Parras	NA	3, 4, 9, 27, 28, 29

MINING

Metsämonttu

Easting EUREF: 297258
Northing EUREF: 6678206
Status: Closed
Operating years: 1951-1974
Years in production: 24
Total ore mined: 1506081 t
Comments: Only the mined tonnages and grades are known.
References: 12, 14, 17, 36

Total production:

Product	Product measure
copper	1575.55 t
lead	7050.43 t
zinc	44927.23 t
gold	1133.27 kg
silver	19.67 t
sulphur	113014.7 t

Other materials:

Material type	Material measure
wastes from mineral excavation	207294 t

Mining activity:

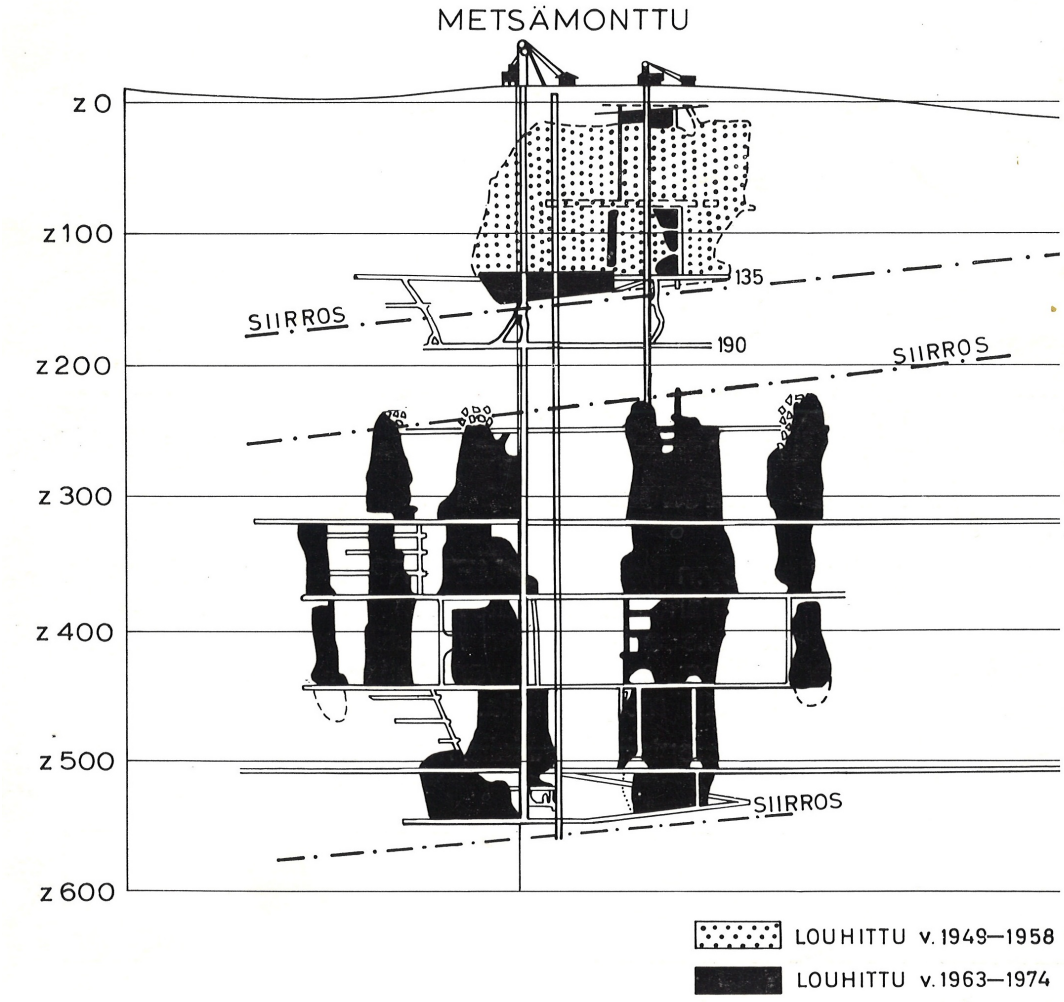
Year	Ore mined	Ore processed	Activity type	Production	Other material
1974	99490 t	102187 t	underground mining		
				zinc 4179.44 t gold 72.88 kg lead 510.93 t silver 191.31 kg	wastes from mineral excavation 1134 t
1973	115863 t	115863 t	underground mining		
				copper 17.94 t zinc 4240.58 t gold 80.03 kg lead 718.35 t silver 880.33 kg	wastes from mineral excavation 881 t
1972	120163 t	120163 t	underground mining		
				copper 10.5 t zinc 4193.68 t sulphur 14047.05 t gold 84.11 kg lead 492.66 t silver 864.05 kg	wastes from mineral excavation 5513 t
1971	100340 t	100340 t	underground mining		
				copper 230.78 t zinc 2127.2 t sulphur 8207.81 t gold 138.35 kg lead 832.82 t silver 2892.95 kg	wastes from mineral excavation 6461 t
1970	76622 t	76622 t	underground mining		

				copper 107.27 t zinc 277.79 t gold 133.7 kg lead 789.2 t silver 3087.86 kg	wastes from mineral excavation 20231 t
1969	97435 t	97435 t	underground mining		
				lead 448.2 t copper 448.2 t gold 155.89 kg silver 3117.92 kg	wastes from mineral excavation 25893 t
1968	85268 t	85268 t	underground mining		
				zinc 1210.8 t lead 673.61 t copper 247.27 t gold 119.37 kg silver 2984.38 kg	wastes from mineral excavation 15491 t
1967	78518 t	78518 t	underground mining		
				copper 77.05 t zinc 3030.79 t sulphur 6265.73 t gold 77.05 kg lead 533.92 t silver 1786.17 kg	wastes from mineral excavation 21101 t
1966	76197 t	76197 t	underground mining		
				zinc 3474.58 t sulphur 11581.94 t	wastes from mineral excavation 16644 t
1965	74614 t	74614 t	underground mining		
				zinc 4245.53 t sulphur 11192.1 t lead 14.92 t	wastes from mineral excavation 7274 t
1964	51125 t	51125 t	underground mining		
				copper 71.57 t gold 219.83 kg lead 664.62 t silver 3118.62 kg	wastes from mineral excavation 5723 t
1963	10195 t	10195 t	underground mining		
				gold 50.97 kg lead 112.14 t silver 713.65 kg	wastes from mineral excavation 5500 t
1962	682 t	682 t	underground mining		
				gold 1.09 kg lead 8.86 t silver 30.69 kg	wastes from mineral excavation 10571 t
1961	0 t	0 t	underground mining		
					wastes from mineral excavation 10729 t
1960	0 t	0 t	underground mining		
					wastes from mineral excavation 7655 t
1959	0 t	0 t	underground mining		
					wastes from mineral excavation 5977 t
1958	35152 t	35152 t	underground mining		
				zinc 773.34 t copper 119.51 t lead 326.91 t	wastes from mineral excavation 6310 t
1957	116068 t	116068 t	underground mining		
				copper 202.27 t zinc 3435.61 t sulphur 8240.82 t lead 742.83 t	wastes from mineral excavation 2027 t
1956	89303 t	89303 t	underground mining		

				copper 43.19 t zinc 3554.25 t sulphur 12779.25 t lead 180.46 t	wastes from mineral excavation 5187 t
1955	92210 t	92210 t	underground mining		
				zinc 3070.59 t sulphur 13001.61 t	wastes from mineral excavation 2085 t
1954	83284 t	83284 t	underground mining		
				zinc 3431.3 t sulphur 12409.31 t	wastes from mineral excavation 8031 t
1953	73308 t	73308 t	underground mining		
				zinc 2749.05 t sulphur 11516.68 t	wastes from mineral excavation 4757 t
1952	30244 t	29704 t	underground mining		
				zinc 932.7 t sulphur 3772.4 t	wastes from mineral excavation 5592 t
1951	0 t	0 t	underground mining		
					wastes from mineral excavation 6527 t

Figures

Metsämonttu mine long section (Warma 1975). :



Metsämonttu plant:

Buildings at the Metsämonttu mine:


Buildings at the Metsämonttu mine. Photo by permission of Outokumpu Oyj.

GEOLOGY

Host rock: Skarn, Felsic volcanic rock, , Tholeiitic basalt
Wall rock: Dolomitic marble

Skarn (Host rock)

Rock type: Host rock
Proportion: major
Grain size: NA
Color: NA
References: 1, 2, 6, 8, 9, 12, 14, 17, 19, 20, 21, 24, 25, 26, 32, 36, 40, 41, 42
Comments: The deposit is located close to contact between felsic and intermediate to mafic volcanic units, but chiefly hosted by skarns. Main types are breccia (the most important), massive vein-like pyrite and polymetallic disseminated ore. Three different ore types: Zn (main), Zn-Pb-Cu-Au-Ag and Cu ore.

Ore minerals:

Mineral	Proportion	Mineral texture
Andorite IV	minor	
Antimony	minor	
Arsenic	minor	
Arsenopyrite	minor	
Bornite	minor	
Boulangerite	minor	
Chalcopyrite	major	Massive, Dissemination, Breccia
	Chalcopyrite and pyrrhotite exsolution are common in sphalerite.	
Cubanite	minor	
Electrum	minor	
Galena	major	Breccia, Massive, Dissemination
Geocronite	minor	
Gold	minor	
Gudmundite	minor	
Ilmenite	minor	
Magnetite	minor	
Marcasite	minor	
Meneghinite	minor	
Pyrargyrite	minor	
Pyrite	major	Massive, Dissemination, Breccia
Pyrrhotite	major	Massive, Dissemination, Breccia
	Chalcopyrite and pyrrhotite exsolution are common in sphalerite.	
Ramdohrite	minor	
Rutile	minor	
Silver	minor	
Sphalerite	major	Breccia, Massive, Dissemination
Tetrahedrite	minor	

Other minerals:

Mineral	Proportion	Mineral texture
Anthophyllite	present	
Chlorite	present	
Diopside	present	
Phlogopite	present	

Quartz	present
Tremolite	present

Alteration:	Distribution:	Degree:	Relation to mineralization:
silicification	NA	NA	NA
Comments: Inner alteration zone, varying degrees of silicifation and maagnesium-iron metasomatism.			
sericitic alteration	Pervasive	NA	NA
Comments: Outer alteration zone. The total extent of alteration is along strike 3 km and laterally 80-400 m.			

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	3-5.8	-600
Comments: Peaked at mid-amphibolite facies during or slightly before the D3 peak; this was followed by partial retrograde metamorphism at greenschist facies, below the biotite isograd, close to and within the D4 axial planes, shear zones and faults; Hornblende-biotite-diopside-tremolite-calcite-epidote-prehnite-andradite ± quartz, feldspars.					

Geological age:

Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:		
Paleoproterozoic (2500-1600 Ma)	1891-1894	1893	Y		
Radiometric age:	**Method:**	**Age:**	**Error (Ma):**	**Mineral:**	**Reference:**
	NA	1891	13		5, 14, 43
	NA	1894	11		5, 14, 43

Felsic volcanic rock (Host rock)

Rock type: Host rock
Proportion: minor
Grain size: NA
Color: NA
References: 1, 2, 6, 8, 9, 12, 14, 17, 19, 21, 24, 25, 26, 32, 40, 41, 42
Comments: The deposit is located close to contact between felsic and intermediate to mafic volcanic units, but chiefly hosted by skarns. Main types are breccia (the most important), massive vein-like pyrite and polymetallic disseminated ore. Three different ore types: Zn (main), Zn-Pb-Cu-Au-Ag and Cu ore.

Structures
Pillow lava
Volcanic breccia

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	3-5.8	-600
Comments: Peaked at mid-amphibolite facies during or slightly before the D3 peak; this was followed by partial retrograde metamorphism at greenschist facies, below the biotite isograd, close to and within the D4 axial planes, shear zones and faults; Quartz-plagioclase-microcline-biotite-muscovite ± hornblende.					

Geological age:

Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:
Paleoproterozoic (2500-1600 Ma)	1870-1930		N

(Host rock)

Rock type: Host rock
Proportion: minor
Grain size: NA
Color: NA
Comments: The volcanism in the belt is dominantly calc-alkaline and has a distinct island-arc affinity, although there locally also are distinctly tholeiitic mafic units. Main types are breccia (the most important), massive vein-like pyrite and polymetallic disseminated ore. Three different ore types: Zn (main), Zn-Pb-Cu-Au-Ag and Cu ore.

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	3-5.8	-600
Comments: Peaked at mid-amphibolite facies during or slightly before the D3 peak; this was followed by partial retrograde metamorphism at greenschist facies, below the biotite isograd, close to and within the D4 axial planes, shear zones and faults.					

Tholeiitic basalt (Host rock)

Rock type: Host rock
Proportion: minor
Grain size: NA
Color: NA
References: 1, 2, 6, 8, 9, 12, 14, 17, 19, 21, 24, 25, 26, 32, 40, 41, 42
Comments: The volcanism in the belt is dominantly calc-alkaline and has a distinct island-arc affinity, although there locally also are distinctly tholeiitic mafic units. Main types are breccia (the most important), massive vein-like pyrite and polymetallic disseminated ore. Three different ore types: Zn (main), Zn-Pb-Cu-Au-Ag and Cu ore.

Structures
Pillow lava
Volcanic breccia

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	3-5.8	-600

Comments: Peaked at mid-amphibolite facies during or slightly before the D3 peak; this was followed by partial retrograde metamorphism at greenschist facies, below the biotite isograd, close to and within the D4 axial planes, shear zones and faults; Plagioclase-cummingtonite-hornblende.

Geological age:

Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:
Paleoproterozoic (2500-1600 Ma)	1870-1930		N

Dolomitic marble (Wall rock)

Rock type: Wall rock
Proportion: minor
Grain size: NA
Color: NA
References: 1, 2, 6, 8, 9, 12, 14, 17, 19, 21, 24, 25, 26, 32, 40, 41, 42

Metamorphic description:

Other minerals:

Mineral	Proportion	Mineral texture
Dolomite	present	

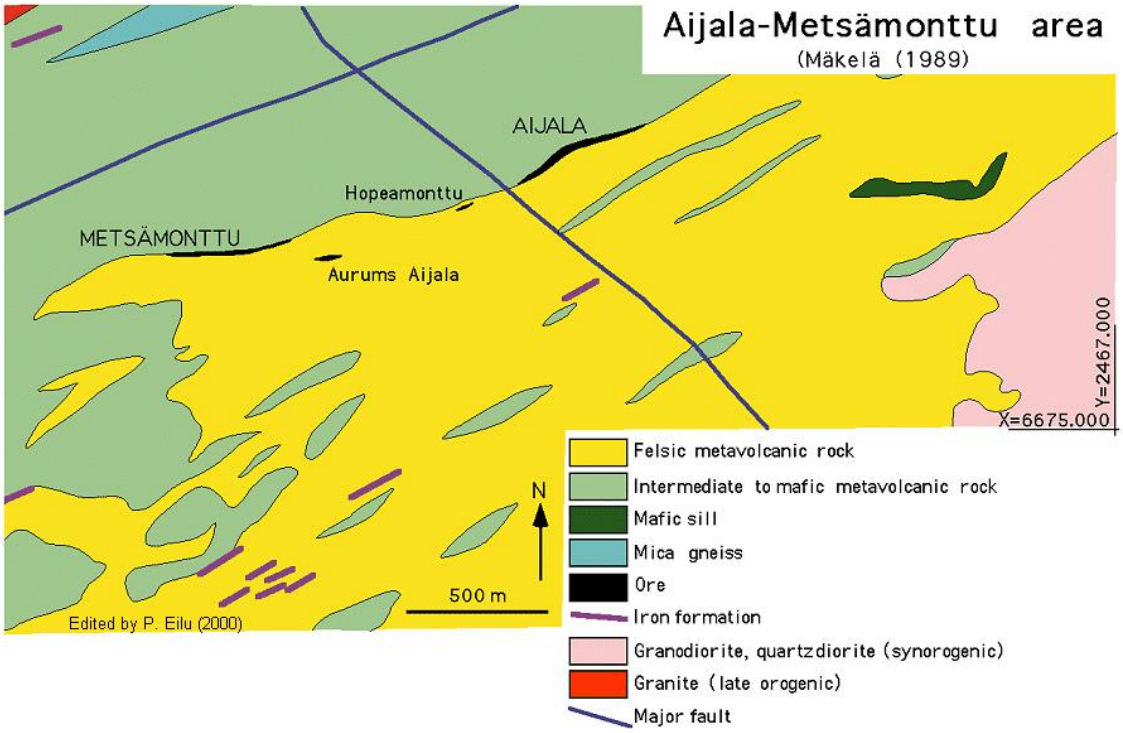
Type:	Facies:	Degree:	Relation to mineralization:	Min P- Max P (kbar)	MIn T- Max T (°C)
Regional	amphibolite metamorphic facies	medium metamorphic grade	NA	3-5.8	-600
Comments: Peaked at mid-amphibolite facies during or slightly before the D3 peak; this was followed by partial retrograde metamorphism at greenschist facies, below the biotite isograd, close to and within the D4 axial planes, shear zones and faults.					

Geological age:

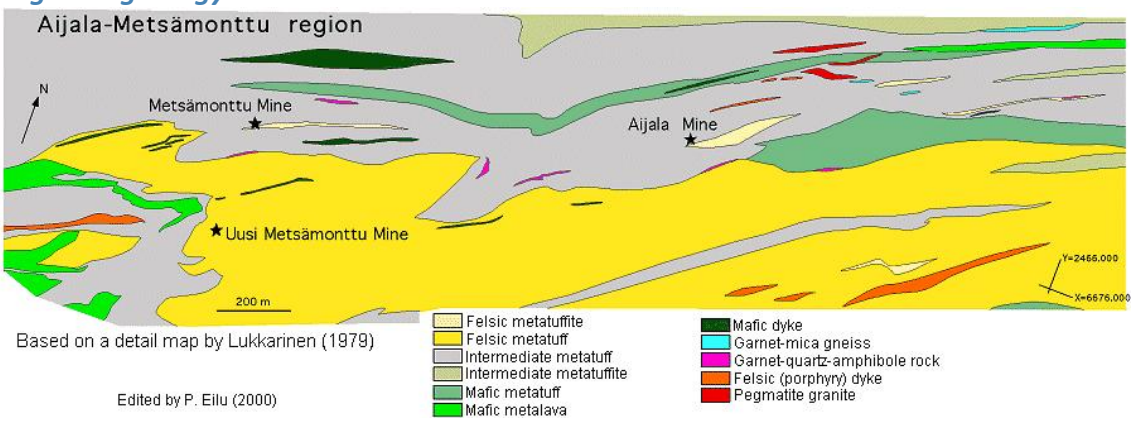
Geological era:	Max age - Minage (Ma):	Inferred age (Ma):	Age of mineralization:
Paleoproterozoic (2500-1600 Ma)	1870-1930		N

Figures

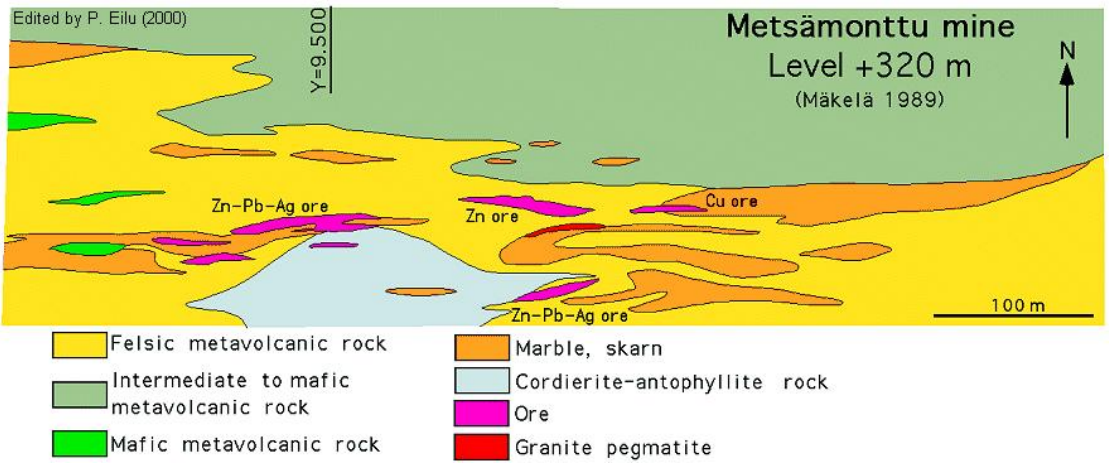
Regional geology:



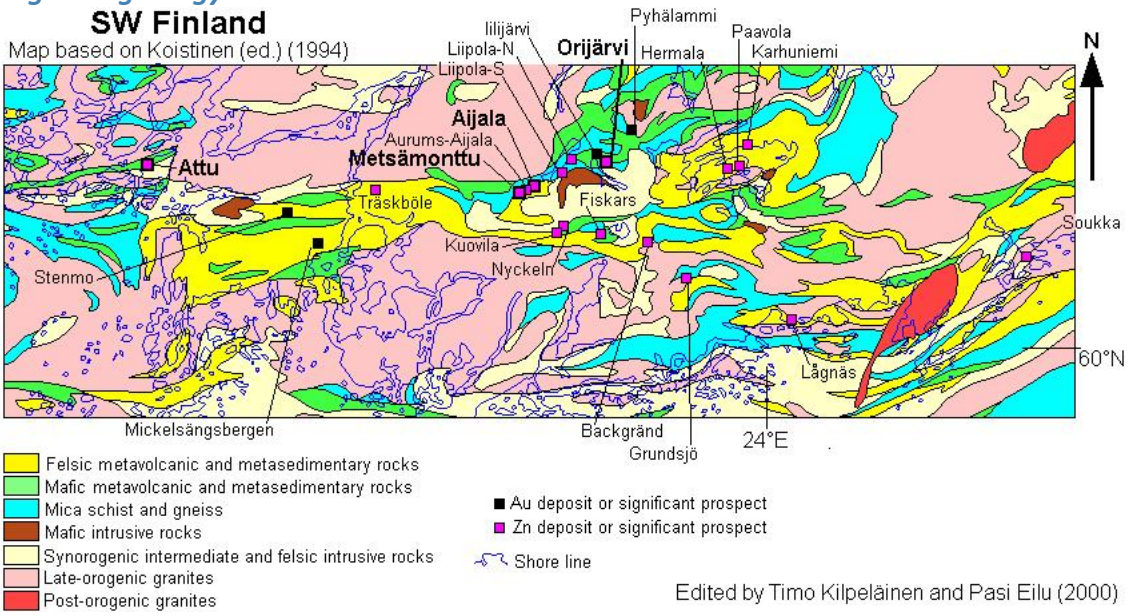
Regional geology:



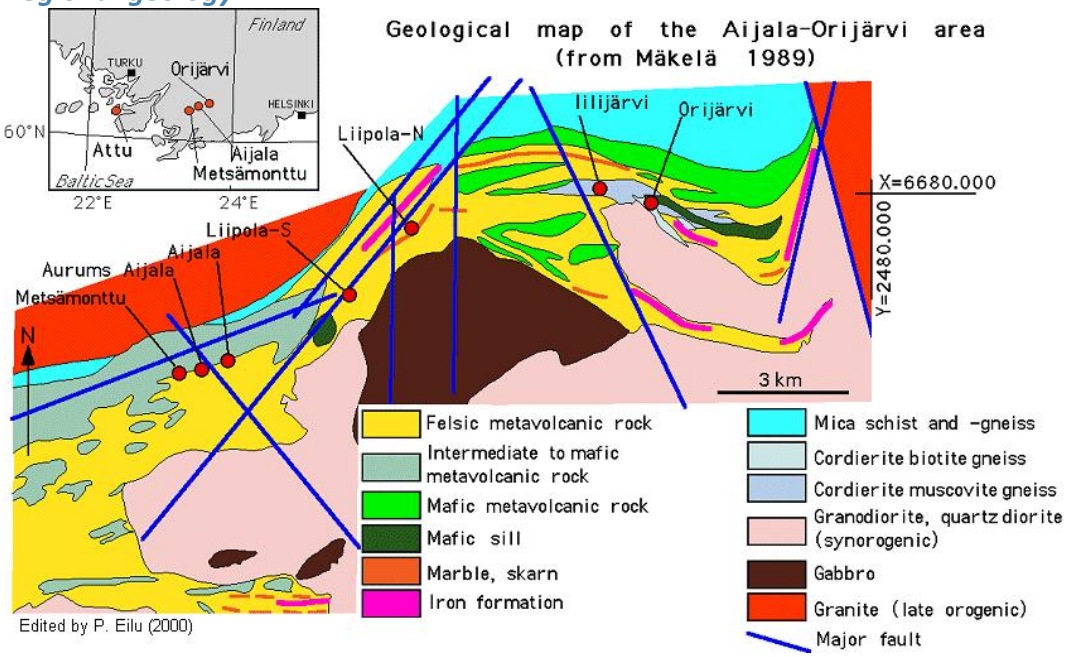
Local geology:



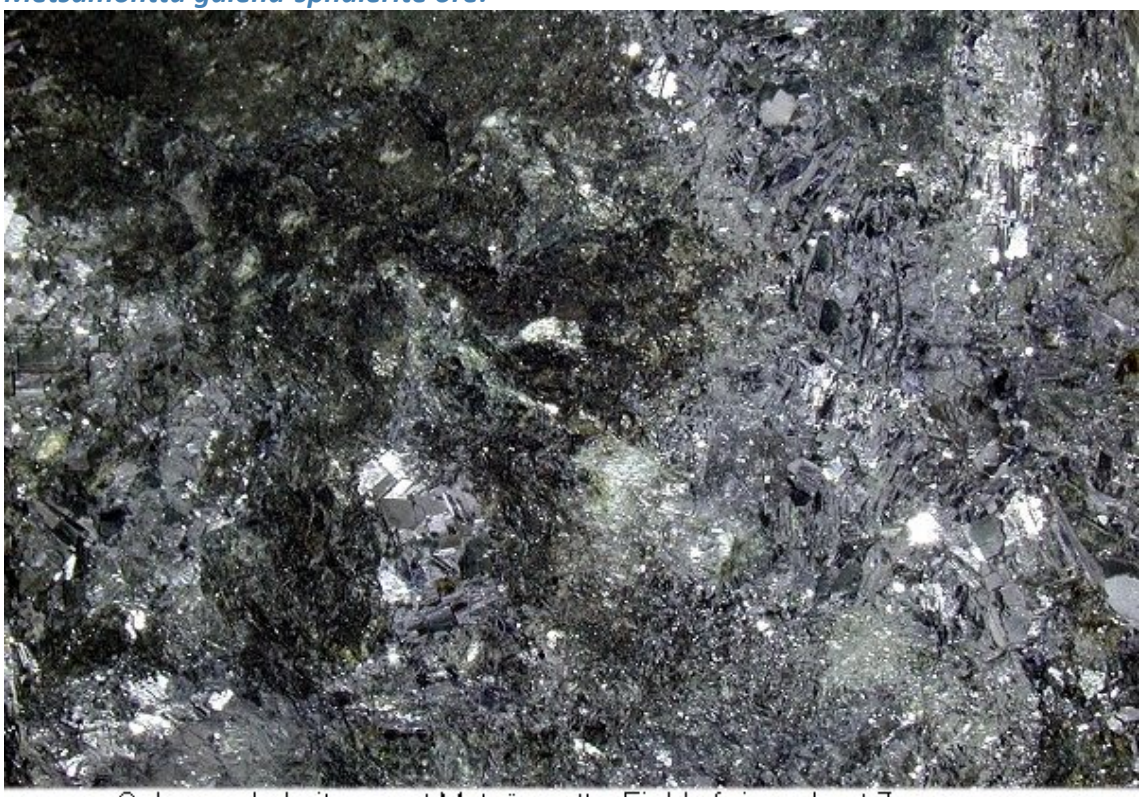
Regional geology:



Regional geology:

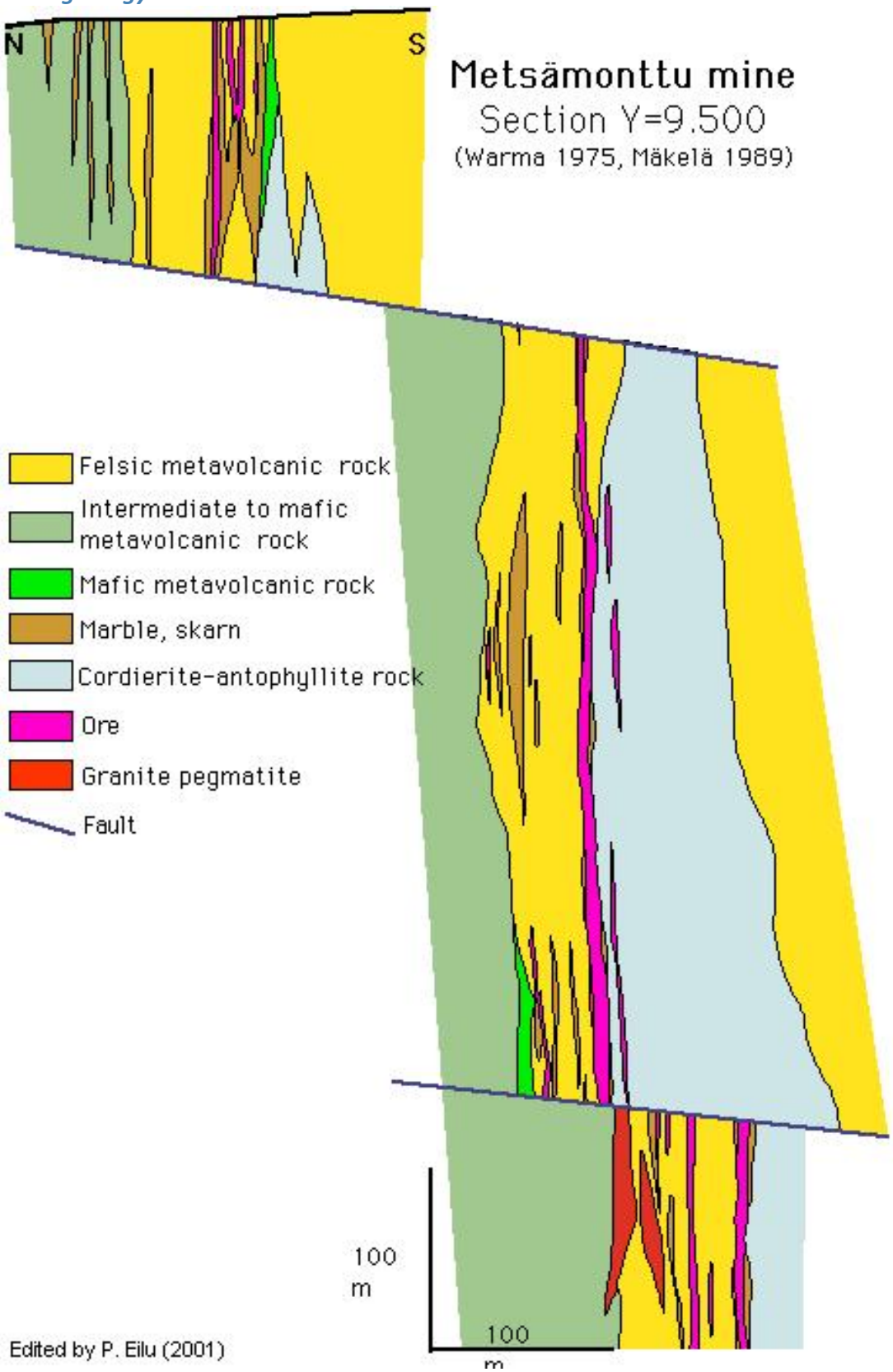


Metsämonttu galena-sphalerite ore:



Galena-sphalerite ore at Metsämonttu. Field of view about 7 cm.
Photo Jari Väätäinen.

Local geology:



REFERENCES

1. Claesson, S., Huhma, H., Kinny, P.D. & Williams, I.S. 1993. Svecofennian detrital zircon ages-implications for the Precambrian evolution of the Baltic Shield. Precambrian Research 64, 109-130.

2. Colley H. & Westra, L. 1987. The volcano-tectonic setting and mineralisation of the early Proterozoic Kemiö-Orijärvi-Lohja belt, SW Finland. In: T.C. Pharaoh, R.D. Beckinsale & D. Rickard (eds) Geochemistry and Mineralisations of Proterozoic Volcanic Suites. Oxford: Blackwell. Geological Society of London Special Publications 33, 95-107.

3. Eskola, P. 1914. On the relations between the chemical and mineralogical composition in the metamorphic rocks of the Orijärvi region. English summary. Bulletin de la Commission Géologique de Finlande, 44. 145 p.*http://tupa.gtk.fi/julkaisu/bulletin/bt_044.pdf*

4. Frosterus, B. 1904. Vanhoja työkarttoja (6 nippua), Brödtorp, Lojo, Mustiala, Orijärvi, Skogböle, Svartå. 1 kansio. Geological Survey of Finland, unpublished field maps, report X11. (in Swedish)

5. 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*

6. Huhma, M. & Latvalahti, U. 1975. Uuden Metsämontun jatkotutkimukset 1974. Outokumpu Oy Exploration, Report 001/2014/MH, UL/1975. 23 p. (in Finnish)

7. Huhma, M. 1969. Litogeokemialliset jatkotutkimukset Metsämontussa. Outokumpu Oy Exploration, unpublished report. 40 p. (in Finnish)
http://tupa.gtk.fi/raportti/arkisto/070_2014_mh_69.pdf

8. Kilpeläinen, T. & Rastas, J. 1990 Etelä-Suomen leptiittijakson tektonis-metamorfisesta kehityksestä. University of Turku, Institute of Geology and Mineralogy, Publication 21. 37 p. (in Finnish)

9. Koistinen, T. 1991. Tammisaari. Geological Map of Finland 1:100000: temporary map. Pre-Quaternary Rocks, Sheet 2014. Geological Survey of Finland.
http://tupa.gtk.fi/kartta/kallioperakartta100/kp_2014.pdf

10. Lahtinen, R., Korja, A. & Nironen, M. 2001. Evolution and metallogeny in the Paleoproterozoic Svecofennian Orogen. In: Williams P.J. (ed.) 2001: A Hydrothermal Odyssey. May 17-19th, 2001,Townsville. Extended abstracts. EGRU and JCU. 110-111.

11. Latvalahti, U. 1976. Kairausraportti. Aijala-Metsämonttu -alueella (2014 03 a,b) kairaukset 1975-1976. Outokumpu Oy Exploration, unpublished report. 1 p., 16 app. (in Finnish)
http://tupa.gtk.fi/raportti/arkisto/020_2014_03_ul_76.pdf

12. Latvalahti, U. 1979. Cu-Zn-Pb ores in the Aijala-Orijärvi area, southwestern Finland. Economic Geology 74, 1035-1059.

13. Lukkarinen, H. 1979. Aijalan ja Metsämontun liuskeista. Unpublished MSc thesis. Department of Geology, University of Turku. 89 p. (in Finnish)

14. Mäkelä, U. 1989. Geological and geochemical environments of Precambrian sulphide deposits in southwestern Finland. Annales Academiae Scientiarum Fennicae. Series A. III. Geologica-Geographica 151. 102 p.

15. Outokumpu Oy 1975. Metsämonttu 2 kaivospiiri. Outokumpu Oy Exploration, unpublished report. 10 p. (in Finnish)*http://tupa.gtk.fi/raportti/valtaus/1145_1.pdf*

16. Outokumpu Oy 1976. Metsämonttu 1 kaivospiiri. Outokumpu Oy Exploration, unpublished report. 84 p. (in Finnish)*http://tupa.gtk.fi/raportti/valtaus/712_1a_1.pdf*

17. Papunen, H. (ed.) 1990. Sinkkiprojektin loppuraportti. University of Turku, Institute of Geology and Mineralogy, Publication 22. 143 p. (in Finnish)

18. Papunen, H. 1986. Suomen metalliset malmiesiintymät. In: Papunen, H., Haapala ja, I., Rouhunkoski, P. (eds.) Suomen malmigeologia: metalliset malmiesiintymät. Geological Society of Finland. 133-214 (in Finnish).

19. Parkkinen, J. 1974. Metsämontun puhkeaman pintakartoitus 16.4.1974. Outokumpu Oy Exploration, Report 070/2014/OJP/74. 27 p. (in Finnish)
http://tupa.gtk.fi/raportti/arkisto/070_2014_ojp_74_2.pdf

20. Parkkinen, J. 1975. Uusi Metsämonttu. Rakennegeologinen ja malmipetrografinen tutkimus. Outokumpu Oy Exploration, unpublished report. 61 p. (in Finnish)
http://tupa.gtk.fi/raportti/arkisto/070_2014_03_ojp_75.pdf

21. Ploegsma, M. & Westra, L., 1990. The Early Proterozoic Orijärvi triangle (southwest Finland): a key area on the tectonic evolution of the Svecofennides. Precambrian Research 47, 51-69.

22. Puustjärvi, H. 1981. Aijalan-Orijärven alueen kordieriittia ja antofylliittiä sisältävistä kivistä. MSc thesis. Department of Geology, University of Turku. 100 p. (in Finnish)

23. Rasilainen, K.; Eilu, P.; Halkoaho, T.; Karvinen, A.; Kontinen, A.; Kousa, J.; Lauri, L.; Luukas, J.; Niiranen, T.; Nikander, J.; Sipilä, P.; Sorjonen-Ward, P.; Tiainen, M.; Törmänen, T. & Västi, K. 2014. Quantitative assessment of undiscovered resources in volcanogenic massive sulphide deposits, porphyry copper deposits and Outokumpu-type deposits in Finland. Geological Survey of Finland, Report of Investigation 208. 60 p.
http://tupa.gtk.fi/julkaisu/tutkimusraportti/tr_208.pdf

24. Schneiderman, J.S. & Tracy, R.J. 1991. Petrology of orthoamphibole-cordierite gneisses from the Orijärvi area, Southwestern Finland. American Mineralogist 76, 942-955.

25. Schreurs, J. & Westra. L. 1986. The thermotectonic evolution of a Proterozoic, low pressure, granulite dome, West Uusimaa, SW Finland. Contribution to Mineralogy and Petrology 93, 236-250.

26. Smith, M.S. & Dymek, R.F. & Schneiderman, J.S. 1992. Implications of trace element geochemistry for the origin of cordierite-orthoamphibole rocks from Orijärvi, SW Finland. Journal of Geology 100, 545-559.

27. Tigerstedt, A.F. 1889. Magnetiska Mätningar och Diamantborrningar vid Orijärvi Grufvefält år 1889. Geological Survey of Finland, Report Dc N:o 71. 19 p. (in Swedish)
http://tupa.gtk.fi/raportti/arkisto/dc_71.pdf

28. Tigerstedt, A.F. 1890. Om de geologiska förhållandena kring Orijärvi grufvefält. Geological Survey of Finland, Report Dc N:o 73. 10 p. (in Swedish)*http://tupa.gtk.fi/raportti/arkisto/dc_73.pdf*

29. Tigerstedt, A.F. 1891. Praktiskt-geologiska undersökningar av Orijärvi grufvefält och kringliggande trakter. Geological Survey of Finland, Report Dc N:o 72. 79 p. (in Swedish)
http://tupa.gtk.fi/raportti/arkisto/dc_72.pdf

30. Tuominen, H. & Mikkola, T. 1950. Metamorphic Mg-Fr enrichment in the Orijärvi region as related to folding. Comptes Rendus de la Societe geologique de Finlande 23, 67-92.
http://tupa.gtk.fi/julkaisu/bulletin/bt_023.pdf

31. Tuominen, H. 1957. The structure of an Archean area: Orijärvi, Finland. Bulletin de la Commission Geologique de Finlande 177. 32 p.*http://tupa.gtk.fi/julkaisu/bulletin/bt_177.pdf*

32. 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

33. Van Staal, C.R. & Williams, P.F. 1983. Evolution of a Svecofennian-mantled gneiss dome in SW Finland, with evidence for thrusting. Precambrian Research 21, 101-128.

34. Warma, A. 1954. The copper-zinc-lead ore deposit of Orijärvi. In: Aurola, E. (ed.) The Mines and Quarries of Finland. Geological Survey of Finland, Geoteknillisiä julkaisuja 55, 17-19.
http://tupa.gtk.fi/julkaisu/geoteknillinen/gt_s_055_pages_017_019.pdf

35. Warma, A. 1959. Aijalan ja Metsämontun tähänastiset tutkimukset. Outokumpu Oy Report 10.11.1959. 4 p. (in Finnish)

36. Warma, A. 1975. Outokumpu Oy:n Aijalan ja Metsämontun kaivosten vaiheita. Vuoriteollisuus 33 (2), 94-98. (in Finnish)

37. Weihed, P., Arndt, N., Billström, C., Duchesne, J.C, Eilu, P., Martinsson, O., Papunen, H. and Lahtinen R. 2005. Precambrian geodynamics and ore formation: the Fennoscandian Shield. Ore Geology Reviews 27, 273-322.

38. Wennervirta, H. & Papunen, H. 1974. Heavy metals as lithogeochemical indicators for ore deposits in the Iilinjärvi and Aijala fields, SW-Finland. Geological Survey of Finland, Bulletin 269. 21 p.
http://tupa.gtk.fi/julkaisu/bulletin/bt_269.pdf

39. Wennervirta, H. 1970. Orijärven vyöhyke. Litogeoemiallinen tutkimus II, kohteelliset tutkimukset. Outokumpu Oy Exploration, Report. 72 p. (in Finnish)

40. Väisänen, M., Mänttäri, I. & Hölttä, P. 2002. Svecofennian magmatic and metamorphic evolution in southwestern Finland as revealed by U-Pb zircon SIMS geochronology. Precambrian research 116, 111-127.

41. Väisänen, M. 1988. Geology of the Orijärvi-Aijala area. In: Gaal, G. and Gorbatschev, R. (eds.) Tectonic Setting of Proterozoic Volcanism and Associated Ore Deposits. IGCP Field Conference in Sweden and Finland. Geological Survey of Finland, Guide 22, 81-86.
http://tupa.gtk.fi/julkaisu/opas/op_022_pages_081_086.pdf

42. Väisänen, M. 1998. Formation of primitive arc, evolved arc and back-arc basin in the Orijärvi area, SW Finland. International Ophiolite Symposium and Field Excursion, 10-15.8.1998 Oulu, Finland. Abstracts. Geological Survey of Finland, Special Paper 26, p. 62.
http://tupa.gtk.fi/julkaisu/specialpaper/sp_026.pdf

43. Väisänen, M. 2001. Tectonic evolution of the Svecofennian Orogen in SW Finland: structural, petrological and U-Pb zircon dating (SIMS) constraints. Unpublished licentiate thesis. Department of Geology, University of Turku. Four separately paginated parts.