8.

ON THE GEOLOGY OF THE AIJALA-ORIJÄRVI AREA, SOUTHWEST FINLAND

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INTRODUCTION

The Aijala-Orijärvi area, of appr. 400 km^2, is located in Southwest Finland, appr. 100 km west of Helsinki (Fig. 8.1). It is a part of a zone composed principally of acidic metavolcanic rocks, the leptite zone, the main part of which is located in Central Sweden, while its easternmost continuation is found in Southwest Finland, representing a deeper erosional level.

The geology of the Aijala-Orijärvi area was made famous by the publications of Eskola (1914, 1915) in which he discussed the petrology of the area and laid the foundations for metamorphic petrology. Tuominen (1950, 1954, 1957) wrote about the tectonic history of the area, and the origin of cordierite-anthophyllite rocks, and Latvalahti (1979) described the volcanogenic ore deposits of the area.

The present study results from work carried out by Outokumpu Oy, Exploration, in the area in 1974-1980, with the aim of locating new ore bodies based on information obtained from known occurrences.

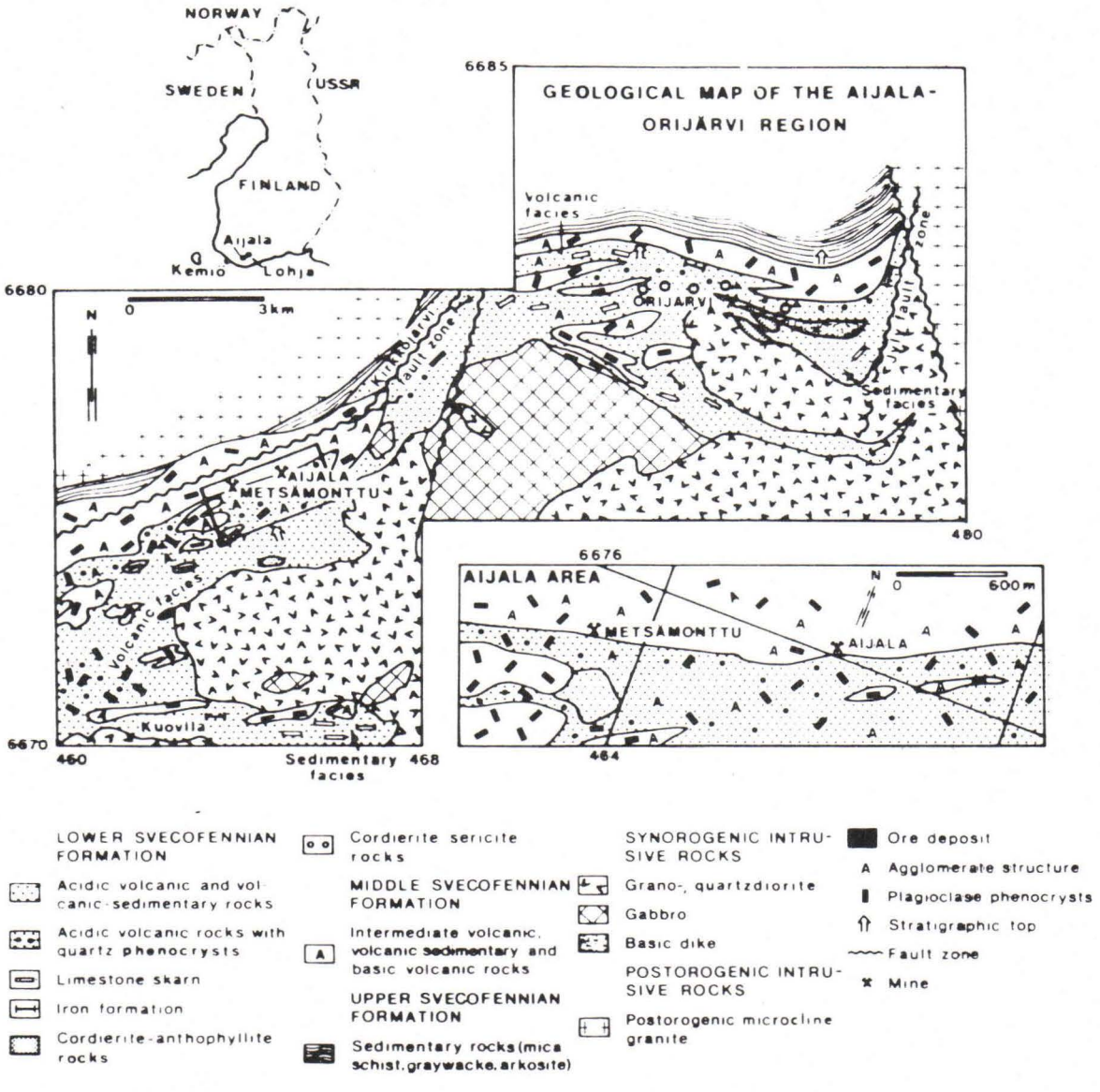


Fig. 8.1. General geological map of the Aijala-Orijärvi area, and detailed map of the environment of the Aijala area (lower right-hand corner).

General geology

The leptite zone, of which the Aijala-Orijärvi area is a part, belongs to the Svecofennian schist zone of the Svecokarelian orogeny, which reached its culmination

1800-1950 Ma ago. Rocks of volcanic origin display a marked concentration in the area compared with the rest of the leptite zone within Finland, while forwards Lohja in the east and Perniö and Kemiö in the west the proportions of rocks of sedimentary origin clearly increase. The primary structures in the metavolcanic rocks and the existence of chemical sediments in the area (limestones, cherts and iron formations) indicate that these rocks were deposited in a relatively shallow, oxidizing water.

In addition to the supracrustal rocks, the Orijärvi batholith is an essential part of the Aijala-Orijärvi area. It is a synorogenic intrusive ranging in composition from hornblendite to granodiorite. The complex also features a small layered intrusion.

Fig. 8.1 gives a general geological map of the Aijala-Orijärvi area.

Structure and metamorphism

Evidence of three separate folding phases is found in the Aijala-Orijärvi area. The oldest, F_1, has caused an isoclinal folding which is 5-10° overturned to the south in the Orijärvi area. The axial plane schistosity of F_1 parallels the primary bedding. The second phase, F_2, abounds in the Orijärvi area. Its axial plane schistosity is at a 10-20° angle to the bedding. These two fold axes are flat-lying. The phase F_3 is typically shearing in the Aijala area; and the lineation connected with it is vertical.

The diapirically raised Orijärvi batholith (Eskola 1914) is in an antiform structural position in the Aijala and Orijärvi areas. A triangular geosynclinal basin bordered by NE and NW-striking faults and shear zones exists north of Orijärvi.

The degree of regional metamorphism is that of a low-pressure amphibolite facies and is associated with the peaks of the deformation phases F_2 and F_3. Typical of the mineral parageneses are coexisting muscovite, quartz, potassic feldspar, and sillimanite.

Stratigraphy

The leptite zone is divided stratigraphically into three groups: the lower, middle and the upper Svecofennian supracrustal groups.

The lower group is composed of mainly acidic supracrustal rocks that are either of volcanic origin or are weathering sediments, depending on their original location within the paleo-basin. Both types include chemical sediments, limestones, cherts and intercalated iron formations.

The overlying middle group contains mostly intermediate and/or basic metavolcanites. Narrow skarn and limestone intercalations (0.1-0.5 m) occur in the basal part.

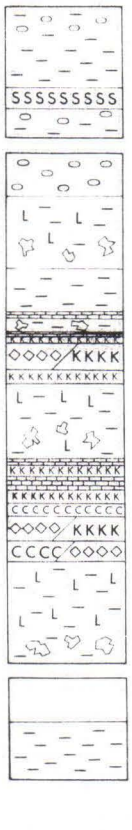
The upper group consists of weathering sediments mixed with material of volcanic origin. As a whole, it represents the vaining stage of volcanic activity.

Fig. 8.2 gives the stratigraphy of the leptite zone in the Aijala-Orijärvi area.

The stratigraphic sequence in the Aijala area begins with acidic metavolcanites, which are overlain by intermediate and basic metavolcanites. Metasediments occur at the top.

The stratigraphy of the Orijärvi area is basically similar, with acidic metavolcanites at the bottom that are overlain by a volcanic conglomerate formation 200-300 m thick. The overlying basic metavolcanite formation is composed of several agglomerate and lapilli beds.

STRATIGRAPHY OF THE LEPTITE BELT.



TOP	GRYTHYTTAN	LJUSNARSBERG	AMMEBERG	UTÖ	AIJALA-ORIJÄRVI
	CGL META-ARGILLITE, GRF-SLATE, SPILITES	MICA SCHIST		PARAGNEISS GRW, SUBGRW DACITIC TUFFITES	TUFFITES ARENITES VOLCANIC CGL GRW, MICA SCHISTS
	GRW, CGL	GRW			BASIC VOLCANIC ROCKS (PYROCL. +LAVAS)
	K-HALLEFLINTA, LIMESTONE, Mn-RICH IRON ORE	LEPTITE SCHIST, SPILITES, LEPTITE, Mn-RICH IRON ORE, LIMESTONE	SKARN, LIMESTONE, LEPTITE (EPI-CLASTIC SEDIMENTS + TUFFS + LAVAS)		
	Na-HALLEFLINTA, LIMESTONE, Mn-POOR IRON ORE, CHERT	LEPTITE, Mn-POOR IRON ORE, LIMESTONE	LEPTITE (EPICLASTIC SEDIMENTS + TUFFS + LAVAS) SKARN CHEMICAL SEDIMENTS (LIMESTONE, QZT)	HALLEFLINTA LEPTITE, LIMESTONE, IRON ORE	CGL, LIMESTONE, IRONFORM., CHERT, ACID VOLCANIC ROCKS (PYROCLASTIC)
			LEPTITE - HALLE-FLINT (LAVAS + TUFFS)	GRV, SUBGRW	
	SUNDIUS (1923)	MAGNUSSON (1940)	HENRIQUES (1964)	GAVELIN et al. (1976)	

Fig. 8.2. Stratigraphic sections across the leptite belt, and the Aijala-Orijärvi area.

Petrology

Plutonic rocks

The synorogenic plutonic rocks of the Orijärvi batholith are located in the central part of the area. The supracrustal rocks, now surrounding the batholith, were deposited directly on the roof of the batholith in the north and northwest. In this case an acidic plutonic rock gradually grades to an acidic metavolcanic rock. In the Orijärvi area the batholith is surrounded by a quartz porphyritic border facies.

The supracrustal rocks are altered to varying degrees at the gradually changing contacts of the batholith. The strongest degrees of alteration are encountered at Björknäs (appr. 1.5 km S of Aijala) and Venetkorpi (appr. 2.5 km SW of Aijala). The composition of the batholith ranges from hornblendite to granodiorite. Silicification is encountered in places, as indicated by quartz eyes in the grano and quartz diorites.

Genetically associated with the batholith are frequently encountered acidic subvolcanic dykes. These dykes, in which large quartz eyes are typical, occur both conformably with, and cutting across the supracrustal rocks.

It is evident that the batholith was originally an acidic dome in the earth's crust, originating from volcanic activity. Present erosion exhibits a deeper level in the southern part of the batholith than in the north.

Table 8.1 gives the chemical compositions of the Orijärvi batholith and an acidic dyke.

Supracrustal rocks

The metavolcanic rocks of the area are tholeiitic and calc-alkalic in composition. Fig. 8.3 shows the chemical compositions of the metavolcanic rocks of the area plotted on an AFM diagram.

Volcanic activity in the area was subaquatic, and took place on, or close to, a sea bed at a depth of 200-300 m.

The metavolcanic rocks in the Aijala and Orijärvi areas display marked differences despite the fact that they may represent same stratigraphic formations. The primary structures and textures of the rocks in the Orijärvi area are better preserved than those in the Aijala area.

Table 8.1. Chemical compositions of rock types in the Orijärvi batholith.

	1	2	3	4	5	6
SiO_2	66.9	72.8	71.36	71.50	50.99	49.15
TiO_2	0.27	0.23	0.34	0.34	0.65	1.52
Al_2O_3	13.7	14.2	13.31	13.79	15.18	17.73
Fe_2O_3	-	-	0.99	0.76	1.87	2.76
FeO	4.1	3.03	3.36	2.07	8.09	7.20
MnO	0.06	0.03	0.10	0.06	0.18	0.14
MgO	1.25	0.47	0.87	1.47	10.0	6.91
CaO	2.80	1.99	2.85	3.54	8.60	9.91
Na_2O	4.31	4.65	3.58	4.48	2.67	2.88
K_2O	2.52	2.34	2.26	1.11	0.38	0.72

1. Acidic dyke with quartz eyes. Kisko, Aikonlahti (x = 6676.05, y = 466.92).
2. Even-grained granodiorite. Kisko, Aikonlahti (x = 6676.05, y = 466.92).
3. Granodiorite. Orijärvi (Eskola 1914).
4. Quartz porphyry, a contact variant of the Orijärvi granodiorite (Eskola 1914).
5. Basic sill. Orijärvi (Eskola 1914).
6. Hornblende gabbro. Appr. 6 km S from Kisko (Eskola 1914).

1-2. XRF analyses, Outokumpu Oy.

Mafic pyroclastic rocks are dominant in the Orijärvi area. These were originally mainly tuffs, lapilli tuffs and agglomerates. Metalavas are also encountered, but metatuffites are rare. Quartz and plagioclase phenocrysts are seldom found in the acidic metavolcanites.

The majority of the rocks in the Aijala area are acidic pyroclastic metavolcanites. These are overlain by intermediate-basic metavolcanites containing moderate amounts of weathering sediments in places.

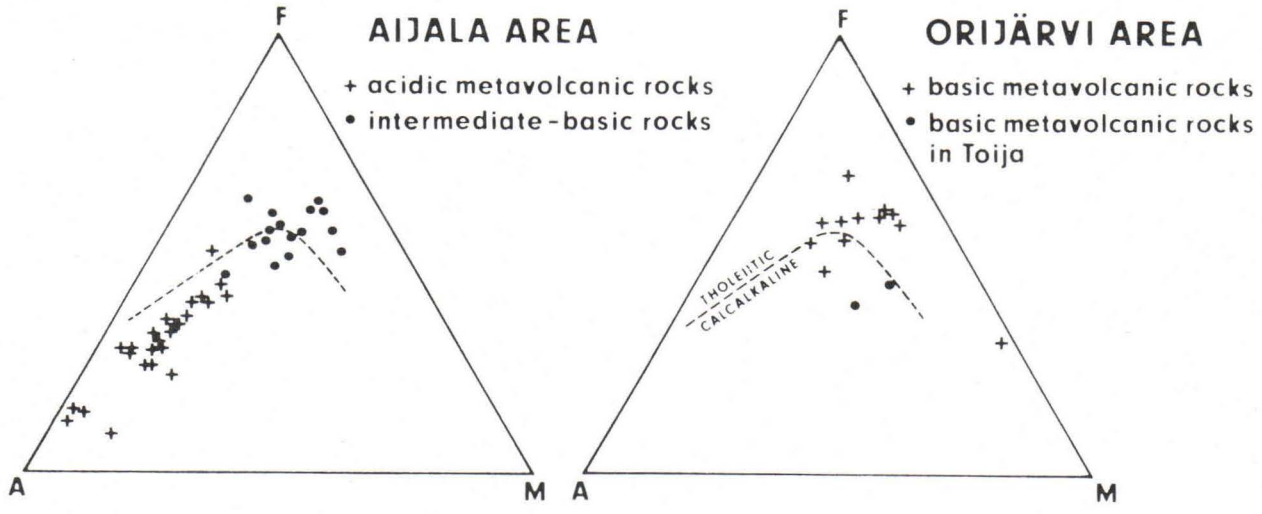


Fig. 8.3. AFM diagram for metavolcanites from the Aijala-Orijärvi area. The broken dividing line between the tholeiitic and calc-alkaline fields is after Irvine and Baragar (1971).

The basic metavolcanite formation is repeated in the Orijärvi area due to isoclinal folding, but the primary volcanic textures are well preserved. The metalavas contain plagioclase phenocrysts, and locally spherules filled with quartz and epidote. The composition of the fragments in the agglomerates and lapilli tuffs ranges from acidic to basic.

Acidic metavolcanic rocks

There are two main types of acidic metavolcanite encountered in the Aijala area. The lower one in the stratigraphy is an even-grained, homogeneous tuff. This is overlain by phenocrystal pyroclastic metavolcanites, which can be classified according to the size, quality and quantity of the phenocrysts, which are composed of quartz and plagioclase (diameter 1-4 mm). It is difficult to differentiate between the quartz phenocrysts and the

Table 8.2. Chemical compositions of acidic metavolcanites.

	1	2	3	4	5	6
SiO_2	70.75	73.85	72.35	74.25	76.20	66.35
TiO_2	0.33	0.20	0.25	0.38	0.34	0.39
Al_2O_3	13.50	12.93	13.96	13.00	12.31	13.84
Fe_2O_3	3.18	3.31	3.04	2.57	0.64	5.86
MnO	0.03	0.04	0.03	0.03	0.02	0.09
MgO	0.94	1.61	1.19	1.14	0.14	2.20
CaO	3.57	3.65	2.85	1.95	2.80	2.54
Na_2O	4.72	2.14	3.08	3.35	3.63	4.92
K_2O	1.80	1.11	2.12	1.89	1.03	1.72
Total	98.1	98.84	98.89	98.56	97.11	97.91

1. Even-grained metavolcanite. Aijala (x = 6675.420, y = 463.810).
2. Acidic metavolcanite with phenocrysts. Aijala (x = 6675.496, y = 464.456).
3. Acidic metavolcanite with quartz eyes. Aijala (x = 6675.256, y = 465.568).
4. Acidic metavolcanite with quartz eyes. Aijala (x = 6675.532, y = 463.866).
5. Quartz-eyed fragment in quartz-eyed metavolcanites. Aijala (x = 6675.530, y = 463.808).
6. Hornblende and biotite bearing fragment in quartz-eyed metavolcanite. Aijala (x = 6675.684, y = 465.318).

1-6. Wet chemical analyses (Lukkarinen 1979).

quartz eyes, since both are deformed and partly recrystallized. The quartz aggregates are 2-10 mm in diameters. The quartz eyes originate from the precipitation of quartz in the pores of acidic pumice from heated, circulating sea-water.

The altered acidic metavolcanites in the Orijärvi area are massive and locally brecciated by skarned

fissures. A few acidic agglomerate beds are encountered. The acidic metavolcanites are overlain by beds of chert, limestone, iron formations and a volcanic conglomerate. These mainly chemical sediments indicate a quiet period in the volcanic activity.

Table 8.2 gives the chemical compositions of the acidic metavolcanites.

Intermediate-basic metavolcanites

The intermediate-basic metavolcanites in the Aijala area are heterogenic in composition and habit. The majority are made up of thin, layered (1-10 cm) tuffite beds containing diopside-skarn intercalations. The strongly developed shear-schistosity gives this rock type a banded structure. In addition to tuffites, the intermediate-basic metavolcanites contain agglomerate and tuff beds of a more mafic composition.

There is a basic metavolcanite located at Toija (NW corner of the Orijärvi area) that differs in chemical composition from the rest of the E-W-oriented volcanites in the area. This appears to represent another phase in volcanic activity and may be connected with the emplacement of ultramafic rocks and associated basic volcanites in the area.

Table 8.3 gives the chemical compositions of the intermediate and basic metavolcanites.

Metasediments

Within the leptite zone metasediments are encountered both on the lateral continuation of the metavolcanites and overlying them. The overlying metasediments are in the majority in the Aijala-Orijärvi area.

Table 8.3. Chemical compositions of intermediate-basic metavolcanites.

	1	2	3	4	5	6	7	8	9
SiO_2	60.20	53.70	48.00	50.8	55.50	47.40	45.80	56.50	48.60
TiO_2	0.51	0.59	0.55	0.60	0.68	0.46	0.49	0.37	1.11
Al_2O_3	14.58	15.05	17.76	17.40	15.50	16.30	18.80	14.50	13.70
Fe_2O_3	7.98	9.59	10.54	-	-	-	-	-	-
FeO	-	-	-	10.60	9.20	12.60	12.60	7.55	10.40
MnO	0.13	0.16	0.20	0.19	0.18	0.25	0.19	0.12	0.14
MgO	3.84	5.26	6.51	3.98	2.86	6.10	6.06	2.44	9.15
CaO	7.77	7.69	11.49	10.90	8.69	8.79	8.24	13.6	7.51
Na_2O	1.79	3.37	2.11	3.32	3.41	2.06	1.57	0.25	3.34
K_2O	1.29	1.15	0.21	0.42	0.50	0.10	0.99	0.10	1.06
Total	98.09	98.56	97.37	98.21	96.52	94.06	94.74	95.43	95.01

1. Intermediate metavolcanite. Aijala (x = 6676.392, y = 465.140).
2. Intermediate tuff containing plagioclase and hornblende phenocrysts. Aijala (x = 6675.180, y = 461.420).
3. Basic metavolcanite. Orijärvi (x = 6676.292, y = 465.552).
4. Basic metavolcanite, pillow lava. Orijärvi (x = 6680.35, y = 470.74).
5. Basic metavolcanite, lava. Orijärvi (x = 6680.36, y = 470.75).
6. Basic metavolcanite, tuff. Orijärvi (x = 6681.27, y = 472.93).
7. Basic metavolcanite, cummingtonite bearing tuff. Orijärvi (x = 6681.25, y = 472.93).
8. Epidote skarn fragment in basic metavolcanite (x = 6681.26, y = 472.93).
9. Basic metavolcanite, pillow lava. Toija, appr. 2.5 km NW from Kisko (x = 6684.95, y = 469.02).

1-3. Wet chemical analyses (Lukkarinen 1979).
4-9. XRF analyses, Outokumpu Oy.

Only a narrow band of metasediments, a mica gneiss, is exposed in the Aijala area, and this is intersected in the west by a postorogenic potassic granite, the Perniö granite.

The metavolcanite beds in the Orijärvi area are overlain by metasediments, and the acidic metavolcanites by cherts, limestones, iron formations and a volcanic conglomerate, as mentioned above. The conglomerate mainly contains fragments of acidic metavolcanite, mica gneiss, mica schist and chert. Some of the fragments resemble underlying formations, e.g. the quartz-eyed metavolcanites. This formation is overlain by basic metavolcanites, which are in turn overlain by mica schists, arkosites and, a little higher in the stratigraphy, intercalated intermediate and acidic tuffites.

The chemical sediments, limestones and iron formations are numerous but small in size as compared with those in the areas distal to the volcanic centres, e.g. the Lohja area (20 km east of Orijärvi), where there are operating limestone quarries and exhausted iron ore mines.

The typical iron formations of the Aijala-Orijärvi area are of the Algoma type. These occur in volcanic environments and typically display small horizontal and vertical dimensions as compared with the Superior-type iron formations in sedimentary environments.

The following iron ore types occur in the Aijala-Orijärvi area:

1. Chert-banded iron formations.
2. Banded and massive types of skarn iron ones.
3. Titanium iron ores associated with plutonic rocks.

Comparing the iron formations of the Aijala-Orijärvi area with those of Central Sweden, the following differences can be noted (Sipilä 1981).

1. There are no apatite iron ores in Southwest Finland.
2. Magnetite and hematite coexist in Central Sweden.
3. The iron formations of Central Sweden are located higher in the stratigraphy, i.e. in the potassic leptites.

4. Oxide facies iron formations predominate in Central Sweden while the silicate facies type is the most common in Southwest Finland. (Oxide and sulphide facies of iron formations are also encountered in the Aijala-Orijärvi area.)

Table 8.4 gives the chemical compositions of the metasediments in the Aijala-Orijärvi area.

Ore deposits

There are three exhausted mines in the Aijala-Orijärvi area, the Aijala Cu-S mine, the Metsämonttu Zn-Cu-Pb mine, and the Orijärvi Zu-Cu mine. The mines were operated by Outokumpu Oy. The Aijala and Metsämonttu deposits are in the same stratigraphic horizon, close to the contact between the basic and acidic metavolcanites, on the acidic side. The whole distance between the mines (1.5 km) is mineralized. The Orijärvi deposit is within an acidic metavolcanite formation, slightly lower in the stratigraphy.

The Orijärvi mine is one of the oldest in Finland dating back to 1757. It has yielded appr. 1 million tons of ore containing 0.7 % Cu, and 3.0 % Zn. The ore is locally and genetically associated with an alteration zone. The best quality ore was contained in diopside skarn, and some was also present in sericite schist, quartz rock and cordierite-antophyllite rock. The alteration zone lies appr. 200 m away from the Orijärvi batholith.

The total production of the Aijala mine was 0.8 million tons grading 1.6 % Cu and 14.2 % S, and that of the Metsämonttu mine 1.4 million tons grading 3.5 % Zn, 0.8 % Pb, 25 ppm Ag and 13.3 % S.

All the three ore bodies were relatively small in size and had been badly broken up by tectonic movements and partly remobilized, but they were nevertheless strata-bound. There are distinct hydrothermal alterations associated with the ore deposits producing cordierite-

Table 8.4. Chemical compositions of metasediments.

	1	2	3	4	5	6	7
SiO_2	71.9	24.66	48.89	76.2	75.3	67.3	58.5
TiO_2	-	0.03	0.05	0.20	0.15	0.74	0.54
Al_2O_3	0.40	0.88	0.92	9.58	11.5	12.2	17.5
FeO	19.56	55.98	42.86	4.20	2.28	6.71	8.18
MnO	3.15	0.25	1.32	0.05	0.06	0.08	0.08
MgO	2.36	7.80	2.50	1.48	0.80	2.33	3.15
CaO	4.21	6.41	4.19	0.99	4.62	3.59	2.03
Na_2O	0.01	0.04	0.04	3.09	1.57	1.94	1.18
K_2O	0.12	0.02	0.01	1.39	3.53	2.17	2.78
P_2O_5	0.07	1.72	0.5	0.04	0.05	0.16	0.22
Total	101.5	99.17	102.29	97.22	99.86	97.22	94.16

1. Chert-banded iron formation. Kisko, Marjaniemi (x = 6677.40, y = 467.10).
2. Silicate facies iron formation. Kisko, Marjaniemi (x = 6677.40, y = 467.10).
3. Silicate facies iron formation. Kisko, Marjaniemi (x = 6677.40, y = 467.10).
4. Matrix of a volcanic metaconglomerate (upper). Kisko (x = 6681.16, y = 472.87).
5. Matrix of a volcanic metaconglomerate (lower). Kisko (x = 6680.92, y = 476.75).
6. Graded mica schist. Kisko, Sorvastonlampi (x = 6680.92, y = 476.30).
7. Mica schist with andalusite and cordierite porphyroblasts. Kisko (x = 6681.16, y = 475.00).

1-3. XRF analyses, Rautaruukki Oy (Sipilä 1981).
4-7. XRF analyses, Outokumpu Oy.

antophyllite rocks, sericite and/or cordierite schists, and quartz rocks. The skarns generally hosted high grade ores. The three ore bodies are regarded as proximal volcanic-exhalative, Kuroko-type deposits.

CONCLUSIONS

The mainly calc-alkalic leptite zone is composed largely of supracrustal rocks and extends from Central Sweden into Southwest Finland. This zone is part of a Proterozoic island arc structure. The Finnish side of the zone apparently exhibits a deeper erosional level than the Swedish side. The eastern limits of the leptite zone are found in Southwest Finland.

Metavolcanites make up the majority of the rock types in the Aijala-Orijärvi area. The volcanism in the area is considered to be related to the Orijärvi batholith, which has affected the geological evolution of the area in many ways. After the culmination of the volcanic activity the batholith rose and the contact zone rocks were altered as a consequence of changing PT conditions. Characteristic of the Aijala-Orijärvi area are volcanic-exhalative ore deposits and mineralizations with associated alteration phenomena. This alteration phase probably took place before the next one at the contact zone between the batholith and surrounding supracrustal rocks.

EXCURSION SITES IN THE AIJALA-ORIJÄRVI AREA

Fig. 8.4 gives the excursion route and stops.

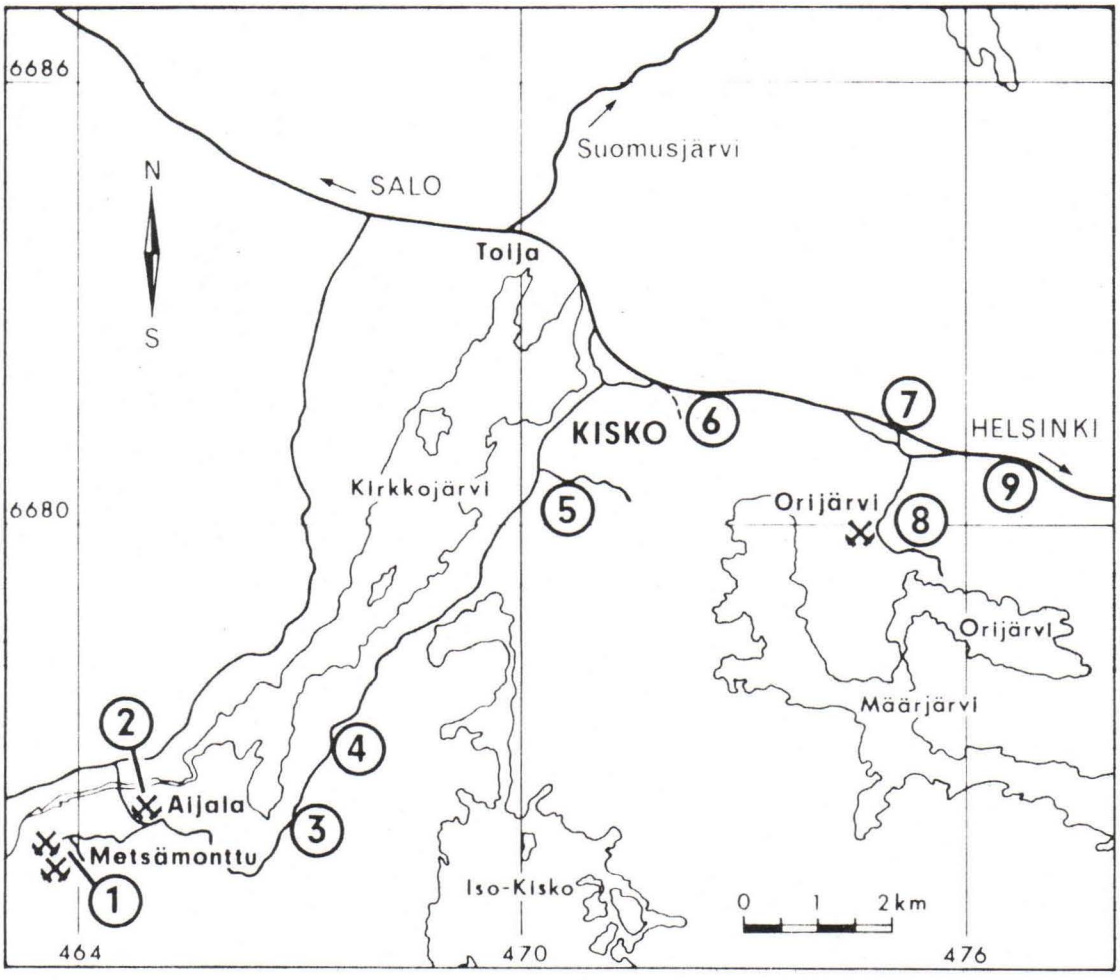


Fig. 8.4. The excursion route and stops in the Aijala-Orijärvi area.

The Aijala area

Stop 1

Metavolcanites at the Metsämonttu mine (x = 6675.78, y = 463.80). 1 km walk.

Intermediate-basic metavolcanites crop out in the vicinity of the Metsämonttu mine, displaying skarn-banded tuffite, lapilli tuff and agglomerate intercalations, and acidic quartz-eyed pyroclastic rocks.

A pronounced shear schistosity and associated vertical lineation are seen.

Two exhausted mines, Metsämonttu and Aijala, are located in the area. These were operated by Outokumpu Oy in 1949-1974. Total production was 2.2 million tons. The mines are in the same stratigraphic horizon, appr. 1.5 km from each other.

Metsämonttu was a Zn-Pb-Ag-Cu mine grading 3.5 % Zn, 0.8 % Pb, 25 ppm Ag, and 0.3 % Cu. Aijala was a Cu-S mine grading 1.6 % Cu, and 14.2 % S.

Stop 2

A micaceous metatuffite at the Aijala sports field (x = 6676.06, y = 465.10).

This metatuffite is stratigraphically between an acidic and an intermediate-basic metavolcanite bed. Primary bedding and a fold are seen in the outcrop.

Stop 3

The contact zone of the Orijärvi batholith at Aikolanlahti, Kisko (x = 6676.05, y = 466.92).

Two acidic rock types of different ages associated with the Orijärvi batholith are seen in the outcrop. The younger one intersects the surrounding older rock, and is an even-grained plutonic rock. It is of a trondhjemitic composition and contains basic inclusions.

The older rock is a coarse-grained, quartz-eyed hypabyssal dyke. These are common in the border zone of the batholith, extending to the metavolcanites. An even-grained

granite also brecciates the quartz-eyed acidic dyke in the outcrop. This is considered younger than the metavolcanites but older than the Orijärvi batholith.

Stop 4

Iron formation at Marjaniemi, Kisko (x = 6677.40, y = 467.10).

This stop shows an iron formation with thin intercalating bands of silicate and oxide facies and chert. The formation is plastically deformed and brecciated by a younger plagioclase porphyrite dyke. The iron formations in the Aijala-Orijärvi area occur stratigraphically in several horizons within the acidic metavolcanites.

The Orijärvi area

Stop 5

Basic metavolcanites south of Hyypiänmäki, Kisko (x = 6680.35, y = 470.70). 1 km walk.

The objects of interest are a contact between intermediate and basic metavolcanites, and agglomerate and pillow lava beds in the latter. Typical of the contact zone is a skarned part in the intermediate metavolcanite. Several agglomerate beds are seen, with bombs and sharp-edged fragments of up to 0.2 x 0.3 m^3.

Stop 6

Metavolcanites north of Iilinjärvi, Kisko (x = 6681.24, y = 472.45). 0.5 km walk.

The outcrops display mafic metavolcanite and underlying conglomerate. The two folding phases typical of the Orijärvi area are seen in the conglomerate outcrop.

Stop 7

Mica schist in a cutting in the Salo-Mustio road at Orijärvi (x = 6681.30, y = 475.04).

This site is higher in the stratigraphy than any of the previous ones. At these stratigraphic levels the origin of the weathering material may vary from bed to bed. When it is of volcanic origin the rocks are called intermediate or acidic tuffites. When the material is of sedimentary origin, mica schists result. The road cutting displays a mica schist with alternating andalusite and/or cordierite porphyroblast-bearing beds.

The bedding strikes almost E-W. The outcrop features a drag fold in which the schistosity clearly intersects the bedding.

Stop 8

The Orijärvi mine (x = 6679.76, y = 474.65).

On the north side of the open pit a subvolcanic amphibolite dyke cuts across metavolcanites and ore, while on the south side of the open pit there are altered rock types: skarns, sericite and cordierite-bearing schists and cordierite-antophyllite rocks. Geological observations suggest that there are cordierite-anthophyllite rocks of two different origins in the area:

1. Cordierite-anthophyllite rocks genetically associated with the ore deposits, originally acidic volcanites.

2. Cordierite-anthophyllite rocks originating through alteration from sedimentary rocks. Primary bedding is sometimes seen in these.

Only the open pit, 80 m deep, and the head frame remain of the old Orijärvi mine today.

Stop 9

A metagraywacke in a cutting on the Salo-Mustio road at Sorastonlampi (x = 6680.92, y = 476.30).

Site 9 is stratigraphically at the same level as site 7. The outcrop displays a greywacke schist with bedding, graded bedding, load casts and slumps.

REFERENCES

Eskola, P. 1914, On the petrology of the Orijärvi region in south-western Finland. Bull. Comm. géol. Finlande 40, 279 p.

Eskola, P. 1915, Om sambandet mellan kemisk och mineralogisk sammansättning hos Orijärvi-traktens metamorfa bergarter. Bull. Comm. géol. Finlande 44, 145 p.

Gavelin, S., Lundström, I. & Nordström, S. 1976, Svecofennian stratigraphy on Utö, Stockholm archipelago. Sveriges Geol. Undersökn., Ser. C 719, 44 p.

Henriques, Å. 1964, Geology and Ores of the Åmmeberg Disctrict (Zinkgruvan) Sweden. Ark. Mineral. Geol. 4 (1), 245 p.

Irvine, T.N. & Baragar, W.R.A. 1971, A guide to the chemical classification of the common volcanic rocks. Canadian Journ. Earth Sci. 8, 523-548.

Latvalahti, U. 1979, Cu-Zn-Pb Ores in the Aijala-Orijärvi Area, Southwest Finland. Econ. Geol. 74, 1035-1059.

Lukkarinen, H. 1979, Aijalan ja Metsämontun liuskeista. Unpublished master's thesis, University of Turku, 89 p.

Magnusson, N.H. 1940, Ljusnarsbergs malmtrakt. Beruggrund och malmfyndigheter. Sveriges Geol. Undersökn., Ser. C 30, 188 p.

Sipilä, P. 1981, Lounais-Suomen rautamalmeista. Unpublished master's thesis, University of Turku, 106 p.

Sundius, N. 1923, Grythyttefältets geologi. Sveriges Geol. Undersökn., Ser. C 312.

Tuominen, H.V. 1951, Metamorphic concentration of magnesium and iron in the Orijärvi region. A reply. Bull. Comm. géol. Finlande 154, 234-238.

Tuominen, H.V. 1957, The structure of Archean area, Orijärvi, Finland. Bull. Comm. géol. Finlande 177, 32 p.