## 4.3. Geology of the Orijärvi-Aijala area

Markku Väisänen
Geologisk-mineralogiska institutionen
Åbo Akademi, 20500 Åbo Finland

This general description is based largely on the study by Lukkarinen (1986).

The Orijärvi-Aijala area is located in soutwestern Finland, about 100 km west of Helsinki (Fig. 29). The area is part of the leptite zone, the bulk of which is in Central Sweden. The Finnish part of the zone apparently exhibits a deeper erosional level than the Swedish part. The leptite zone is part of the Svecofennian schist belt of the Svecokarelian orogeny, which reached its culmination 1900-1850 Ma ago (Simonen 1980), and has been correlated with an island-arc structure (Hietanen 1975, Latvalahti 1979). Colley and Westra (1987) have interpreted the tectonic setting as a back-arc rifting that may represent an ancient analogue of present day New Zealand. Rocks of volcanic origin are more abundant in the Orijärvi-Aijala area than to the west and east of the area. The synorogenic plutonic rocks of the Orijärvi batholith are surrounded by supracrustal rocks. The aplitic and pegmatitic apophyses of the postorogenic microcline (Perniö) granite represent the youngest rocks in the area. The geology of the Orijärvi-Aijala area has been described by Eskola (1914, 1915), Tuominen (1951, 1957), Latvalahti (1979) and Mäkelä (1983).

The synorogenic rocks of the Orijärvi batholith are located in the central part of the area. The composition of the batholith ranges from granodiorite to gabbro with some hornblenditic portions. Silicification is encountered in places, as indicated by quartz phenocrysts in the granodiorites and quartz diorites. Felsic dykes with large phenocrysts of quartz are genetically associated with the batholith. These dykes both conform with and cut across the supracrustal rocks. In the Orijärvi area the batholith is surrounded by a quartz porphyritic border facies. The supracrustal rocks are altered to varying degrees at the gradual contacts of the batholith. The altered rocks contain sericite, andalusite, cordierite and anthophyllite. Eskola (1914; see also Latvalahti 1979, Mäkelä 1983 and Colley and Westra 1984) assumed that the rocks of the batholith and the volcanic rocks of the supracrustal series had the same magmatic source. The diapirically raised Orijärvi batholith is in an antiform structure in the Orijärvi-Aijala area (Eskola 1914). The present erosion niveau has exposed a deeper level in the southern part of the batholith than in the north.

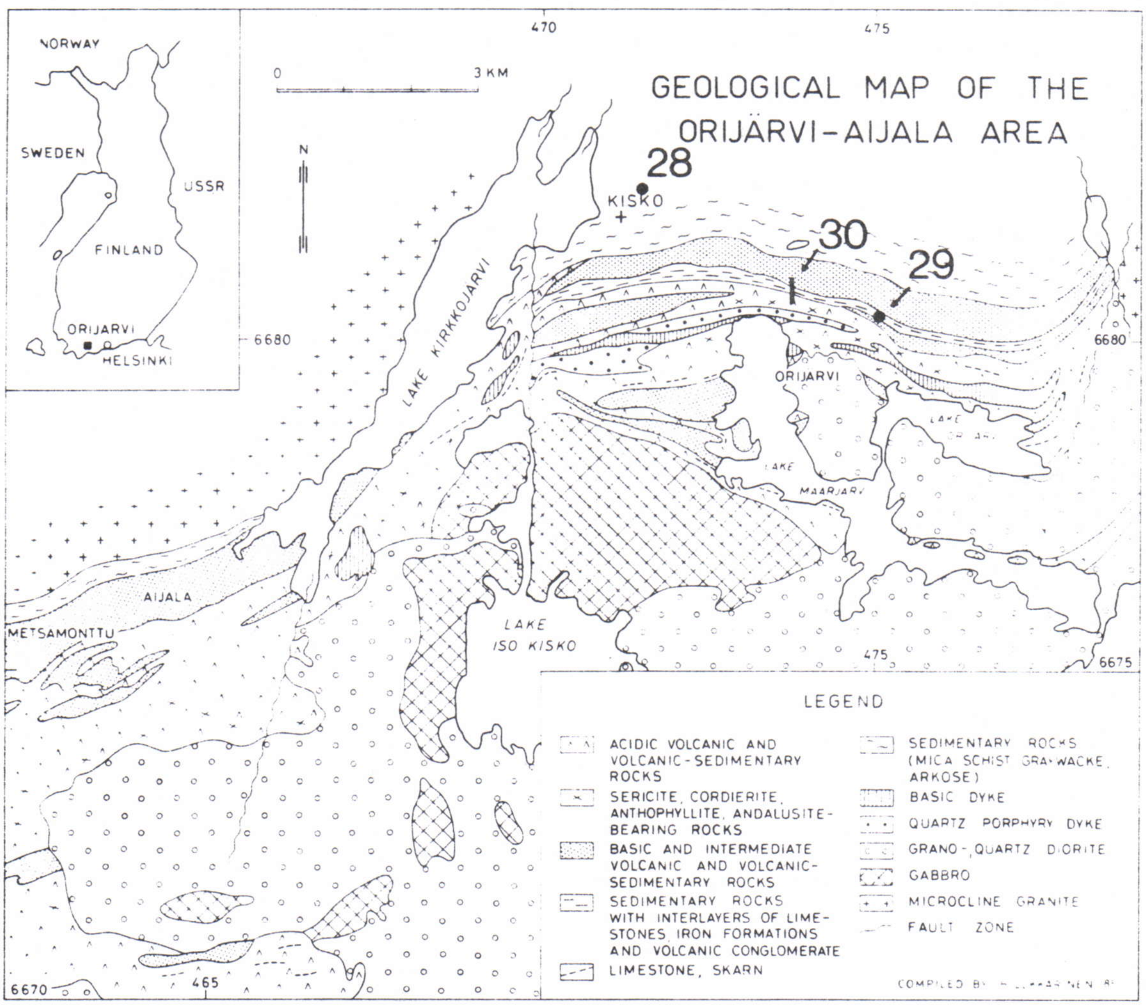


Fig. 29. General geological map of the Orijärvi-Aijala area. Modified after maps compiled by Outokumpu Oy, Exploration, in 1974-1980 (Lukkarinen 1986).

As mentioned above, the rocks of the batholith are surrounded by supracrustal rocks. The apparent stratigraphic sequence begins with felsic metavolcanites and some volcanic-sedimentary rocks, which are overlain by intermediate and basic metavolcanites, and volcanic-sedimentary rocks. Iron formation and turbidite-like metasediments occur at the top of the apparent stratigraphic sequence. In the Orijärvi area there is a horizon of weathering sediments consisting of volcanic conglomerates, arkosites, limestones and iron formations between the acidic and basic-intermediate metavolcanites; this horizon has not been met with in the Aijala area. The end of the felsic volcanism and sedimentation, and the beginning of the mafic volcanism were probably contemporary events, because mafic volcanics are met with both underlying and overlying the sedimentary rocks. In addition, the volcanic conglomerates also contain rare mafic volcanic fragments.

Mafic and intermediate pyroclastic rocks predominate in the Orijärvi area. Metalavas, both massive and pillow structured, are also encountered. The crystal tuffs and metalavas contain phenocrysts of plagioclase and hornblende. Locally, the metalavas have amygdales filled with quartz, epidote and carbonate. The composition of the fragments in the agglomerates and lapilli tuffs varies from felsic to mafic. In the Aijala area the mafic and intermediate metavolcanites are heterogeneous in composition and habit, and the primary structures and textures of the rocks are more deformed than those in the Orijärvi area. The majority of the rocks are made up of thin, layered tuff and tuffite beds (thickness 1-10 cm) containing diopside-skarn intercalations. Besides tuffites and tuffs, the metavolcanites contain interlayers of agglomerate and lapilli tuff. The strongly developed shear schistosity imparts a streaked structure to the rocks of the Aijala area. The mafic-intermediate volcanites of the Orijärvi-Aijala area are tholeiitic and calc-alkalic in composition.

Two main types of felsic metavolcanite are encountered in the Aijala area. The lower one in the stratigraphy is an equigranular homogeneous tuff overlain by phenocrystal tuffs, with quartz and plagioclase phenocrysts varying in size from 1 to 4 mm. Besides true phenocrysts, the felsic volcanites also contain quartz aggregates that formed when silica precipitated in the pores of the felsic tuff from heated circulating seawater. The diameter of the quartz aggregates varies from 2 to 10 mm. Quartz and plagioclase phenocrysts are less common in the acidic volcanite of the Orijärvi area than in the Aijala area. Beds of felsic agglomerates and lapilli tuffs also occur in both areas. The altered felsic metavolcanites in the Orijärvi area are massive and locally brecciated by skarn-filled fissures. The felsic metavolcanites derive from fall-out and ash-flow tuffs.

The subvolcanic felsic and mafic dykes typical of the Orijärvi-Aijala area are genetically related to the metavolcanic rocks. Phenocrysts of plagioclase and hornblende are encountered in the basic dykes, whereas quartz phenocrysts are typical of the felsic dykes.

Within the leptite zone of southwestern Finland metasediments are encountered both on and overlying the lateral continuation of the metavolcanites. The overlying metasediments, which predominate in the Orijärvi-Aijala area, are mainly turbidite-like clastic rocks: mica schists and mica gneisses. Primary sedimentary structures, such as graded bedding, load casts and slumps, are encountered. Within the metavolcanites in the Orijärvi area there are beds of metasediments consisting of volcanic conglomerates, limestones and iron-formations. The conglomerates contain mainly fragments of felsic metavolcanite, mica gneiss, mica schist and chert. Iron-formation fragments and mafic volcanic fragments are met with, too. Some of the fragments resemble underlying formations, e.g. the quartz-phenocrystal felsic metavolcanites. These sediments indicate a quiet period in the volcanic activity.

The chemical sediments (limestones and iron formations) are numerous albeit small in size. The limestones, which occur as interlayers from a few centimetres to some ten metres thick in the metavolcanites and volcanogenic metasedimentary rocks, are generally composed of pure calcium carbonate but they often contain considerable quantities of calc-silicate minerals as well. The iron-formations typical of the Orijärvi-Aijala area are of the Algoma type. They occur in volcanic environments and typically display small horizontal and vertical dimensions in contrast to the Superior-type iron formations in sedimentary environments. The following iron ore types occur in the

Orijärvi-Aijala area (Mäkelä 1983): 1) chert-banded iron-formations, 2) banded and massive skarn iron ores and 3) titanium iron ore associated with plutonic rocks. Stratigraphically the iron formations may occur in several horizons within the acidic metavolcanites.

The primary structures in the metavolcanites and the existence of chemical sediments (limestones, cherts and iron formations) indicate that subaquatic volcanism and sedimentation took place close to a depth of 200-300 metres (Mäkelä 1983).

There are three exhausted mines in the Orijärvi-Aijala area: the Aijala Cu-S mine, the Metsämonttu Cu-Pb-Ag mine and the Orijärvi Zn-Cu mine. The Aijala and Metsämonttu deposits, which are in the same stratigraphic horizon, are in felsic metavolcanites close to the contact between the mafic and felsic metavolcanites. The Orijärvi deposit is within a felsic metavolcanite unit containing various altered rocks. Latvalahti (1979) considers the three orebodies proximal volcanic-exalative, Kuroko-type deposits.

There is evidence of five deformational phases in the Orijärvi area. D1 produced sharp isoclinal folds parallel to the bedding, but the associated axial-plane foliation has been found only as inclusion trails inside andalusite porphyroblasts. D2 is the main deformation associated with the peak of the metamorphism and the growth of andalusite, sillimanite, cordierite and most probably garnet porphyroblasts, too. D2 folds are generally tight, with thickened fold noses. Associated strong metamorphic axial plane foliation, S2, runs across fold hinges even on a large scale. The D2 fold axis trend subhorizontally E-W where not affected by later deformation. The D2 folding is followed by shearing, roughly along the axial plane. D3 deforms the main foliation (S2) with subvertical dextral open folding trending ENE-WSW where not reorientated. A new crenulation cleavage, S3, has developed only in mica-rich rocks. In some quartz-feldspathic rocks quartz veins intrude fold hinges. D4 crenulates the main foliation with a SE-NW-trending axial plane producing conjugate sets of kink bands. No axial-plane foliation has been reported from the sinistral folding. The N-S-trending postmetamorphic fault zones clearly visible on geophysical and topographic maps are tentatively attributed to D5 deformations. The two main fault zones, the Kirkkojärvi fault zone in the west and the Jyly fault zone in the east, are also tentatively suggested.

A problem arises when structures and stratigraphy are compared: the change in vergency of the main folding (D2) does not change the known stratigraphic way-up directions. That is why a D1-related overthrusting with at least local overturn of strata cannot be ruled out.