Minerals of the axinite group from Norwegian localities

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Introduction

The mineral known today as axinite was first described by Schreiber in 1781, but thought to be a variety of schorl. During the next two decades the mineral was referred to under different names: *violet schorl*, *yanolite*, *thumerstein*, *thumite* and *glasschorl*. The name axinite was first applied by Haüy in 1799, in reference to the common axe-like shape of the crystals.

The axinite group minerals are complex cyclosilicates. The three Ca-dominant end-members are *ferroaxinite, manganaxinite* and *magnesio-axinite*, named after the second most abundant cations, and with the general formula $Ca_4(Fe,Mn,Mg)_2Al_4B_2Si_8O_{30}(OH)_2$. *Tinzenite* has a Ca deficiency, compensated by an excess of Mn, and with the formula $Ca_2Mn_4Al_4B_2Si_8O_{30}(OH)_2$. The definition of ferroaxinite, manganaxinite and tinzenite was established by Sanero & Gottardi (1968), while magnesio-axinite was described by Jobbins et al. (1975).

Axinite from Norway was first described by Schumacher (1801) who reported the mineral both from the silver deposits at Kongsberg and from Torbjørnsbo iron mine at Arendal. Keilhau (1838) mentioned axinite from Nikkerud iron mine near Drammen. Goldschmidt (1911) thoroughly described axinite from Årvoll near Oslo, and his chemical analysis showed that the mineral was close to the manganaxinite end member. He also mentioned another axinite locality at Årvoll, as well as Nikkerud (Åserud) near Drammen. Münster (1883) mentioned axinite from the Kongsberg silver deposits, while Neumann (1944) described axinite from several localities within the Kongsberg silver deposits, and published the chemical composition of an axinite from Gottes Hülfe in der Noth mine (358 m level). An axinite from an unspecified locality at Kongsberg was analysed by Lumpkin & Ribbe (1979). Axinite from localities within the Norwegian Caledonides was first reported by Chadwick et al. (1963), and later described in more detail by Carstens (1965). An overview of Norwegian axinite localities was given by Neumann (1985). Ferroaxinite from an unspecified locality within the Trondheim region was investigated by Fuchs et al. (1997, 2001). The chemical composition of Norwegian axinites reported in the literature is shown in Table 1.

During the last decades many new occurrences of axinite group minerals have been discovered in Norway. In order to establish the correct nomenclature of these axinites, the minerals have been analysed, and the results are published in this paper.

Types of occurrence

The Norwegian axinite occurrences analysed in this study are tentatively grouped into three types of occurrence.

1. Alpine type occurrences within the Caledonides

The largest number of the axinite occurrences are defined as alpine type and found in Caledonian rocks. They have been found in three regions: Western Norway, Sør-Trøndelag (Trondheim region) and Troms.

Western Norway

Around the Hardangerfiord axinite has been found in cavities in metadacite in Bergsdalen, Samnanger, Fusa, Utne, Bruravik and Fresvik (2 finds), and along fissures in quartzite at Nå

(Nordrum & Kleivane 2005). In the cavities chlorite, adularia, albite, palygorskite, apophyllite, fluorite, byssolite, titanite, smoky quartz, calcite, prehnite, datolite, analcime, laumontite, apatite, stilbite, pyrite, chalcopyrite, sphalerite, and pyrrhotite have been found. At Nå the axinite has a violet colour, similar to the one commonly found in fluorite.

Axinite has also been found in Suldal (quartz veins in granite), Bømlo (albite, calcite, quartz, chlorite, tourmaline, epidote veins in gabbro) (Carstens 1965, p. 406), Naustdal (with prehnite in cavity in amphibolite), Vågsøy (Allmenningen) (cavities with albite, quartz, calcite, laumontite, chlorite), Tafjord (cavities with datolite, quartz, apophyllite, laumontite, microcline, albite, babingtonite, julgoldite, prehnite) and Molde (cavities with epidote, prehnite, apophyllite, babingtonite, laumontite, quartz, calcite, chalcopyrite). Axinite from all these occurrences has been analysed in this study.

Sør-Trøndelag (Trondheim region)
Carstens (1965) described a number of vein occurrences in Sør-Trøndelag, occurring in rocks from the Støren group, Hovin group and Gula group, mainly in greenstones and amphibolites. Associated minerals are quartz, calcite, albite, epidote/clinozoisite, byssolite, tourmaline, prehnite and apophyllite (Carstens 1965, p. 407). In this study axinite from Kyrkseterøra, Meldal (4 occurrences), and Malvik (Mostadmarka) has been analysed.

Troms
Two occurrences, Grovfjord in Skånland (cavities with actinolite, byssolite, apophyllite, clinozoisite, albite, prehnite, calcite) and Gierdduidvárri in Kvænangen (in vein in greenstone), are probably of alpine type. Axinite from the two occurrences has been analysed.

2. Skarn deposits
Axinite has been found in skarns in a) the Oslo region (by permian contact metamorphose), b) the Bamble region (Arendal area) (by Precambrian regional metamorphose), and c) the Trondheim region and d) Nordland and Troms (by Caledonian regional metamorphose).

Oslo region
Goldschmidt (1911) described three occurrences of axinite in the Oslo region. Two of the occurrences were found at the eastern and western slopes of the Årvoll valley. The eastern location has axinite in two colour varities, yellow and yellowish green. An analysis by Goldschmidt verified manganaxinite. The third axinite occurrence at Nikkerud (Åserud) iron mine, mentioned by Keilhau (1838), has not been localised in modern time. It was described as fissures in a diabase dike. The Nikkerud iron mine is a skarn deposit situated in the contact zone of the Drammen granite. However, an axinite sample in the collection at Geological Museum (GM), Oslo (marked Åserud, catalogue no. 26166) shows brownish violet axinite crystals embedded in calcite and black tourmaline. This may be Keilhau's axinite. In this study both yellow and green axinite from Årvoll and axinite from Nikkerud have been analysed.

Bamble region
Schumacher (1801) described axinite from Torbjørnsbo iron mine in Arendal. Axinite from Nødebro iron mine was identified by X-ray diffraction at GM in 1965, and similar material has been collected by Hans Chr. Olsen from a nearby mine. The Nødebro axinite is yellow, and in the specimen it occurs in cracks in coarsegrained microcline together with quartz and calcite. Agder naturmuseum (ANM) has an old sample from Vestre Kjenli mine, Klodeborg, Øyestad. Vogt (1918) reported diopside, calcite, spinel, garnet, hornblende, mica etc. from Klodeborg. A large number of minerals have been reported from skarns in the area (Bugge 1943, p. 130). In this study axinite from Nødebro and Klodeborg has been analysed.

Trondheim region
Axinite from Vinstradalen, Oppdal, occurs in skarn, and among other andradite/grossular, clinozoisite/epidote, diopside, scapolite and vesuvianite are reported (Witsø 2005).

Nordland and Troms
Axinite in northern Norway was not mentioned by Neumann (1985). Collectors have, however, found the mineral in several occurrences. Most of the occurrences are skarns. Grossular, vesuvianite, epidote, diopside, calcite, quartz, tourmaline, titanite and scapolite have been reported as associated minerals. Vogt (1910) reported "hornblende, pyroxene, garnet etc." from Bjarkøy. Nordrum et al. (2003) reported grossular, vesuvianite, diopside, clinozoisite and calcite from Sandnessjøen. In this study axinite from Sandnessjøen, Dønna, Beiarn (Gråtådalen), Bjarkøy (Nergård iron mine) and Kvæfjord (Skår iron mine) have been analysed.

3. Hydrothermal, silver-bearing calcite veins in the Kongsberg ore district
Axinite has been reported from a number of deposits within the Kongsberg ore district, the very first by Schumacher (1801). Neumann (1944) mentioned Gottes Hülfe in der Noth mine, Morgenstjerne mine, Stadsmyr mine, Askebekk mine and Rosengangen mine. In recent years collectors have also found the mineral in Knutehove mine, Samuel mine, Bratteskjerpet mine, Krag's mine and Deildok prospect.

Neumann (1944) presented an analysis of axinite from Nordlige gang nr. 1, level 358 m, Gottes Hülfe in der Noth mine. He stated that axinite was typically found in the paragenesis epidote-pyrite-fluorite-calcite-bitumen, and that it was among the earliest minerals to crystallize. Quartz, armenite, apophyllite, and datolite are also reported in association with axinite at Kongsberg.

In this study axinite from Gottes Hülfe in der Noth mine, Bratteskjerpet mine, Krag's mine and Deildok prospect has been analysed by electron microprobe (Table 2).

Analysing conditions
The chemical analyses were conducted on a CAMECA SX-100 electron microprobe using an operating voltage of 15 kV, a beam current of 10 nA, and and a beam spot of 5 μm. The instrument was operating in wave-length dispersive mode. The following standards were used: Wollastonite (SiKα, CaKα), synthetic Al_2O_3 (AlKα), MgO (MgKα), Fe_2O_3 (FeKα), $MnTiO_3$ (MnKα, TiKα), albite (NaKα) and orthoclase (KKα). Back-scattered electron imaging was used to investigate compositional zonation of crystals.

The concentrations of boron and hydrogen have been calculated assuming 2 B and 2 (OH) in the chemical formula. This is justified by the fact that Andreozzi et al. (2000) showed that the boron and hydrogen contents in axinites are rather close to stoichiometry. Boron ranges from 1.88 to 2.07 apfu, while hydrogen ranges from 1.7 to 2.1 apfu. The same investigation showed that for all samples most of the iron is Fe^{2+}.

The table contents
Tables 1 and 2 give the chemical composition (in weight %), structural formula based on 20 cations, and mol-% of ferroaxinite, manganaxinite and magnesio-axinite. Table 1 gives the result of previous analyses, while Table 2 gives the results of the electron micro probe analyses in this study. Each result is the mean of three or more spot analyses.

Results
Axinites from 36 occurrences was analysed. Most axinites were ferroaxinites with a content ranging from 44 to 73 mol-%. Six axinites were manganaxinites: Årvoll (Oslo) (both the yellow and the yellowish green crystals), Krag's mine (Kongsberg), Nødebro mine (Arendal),

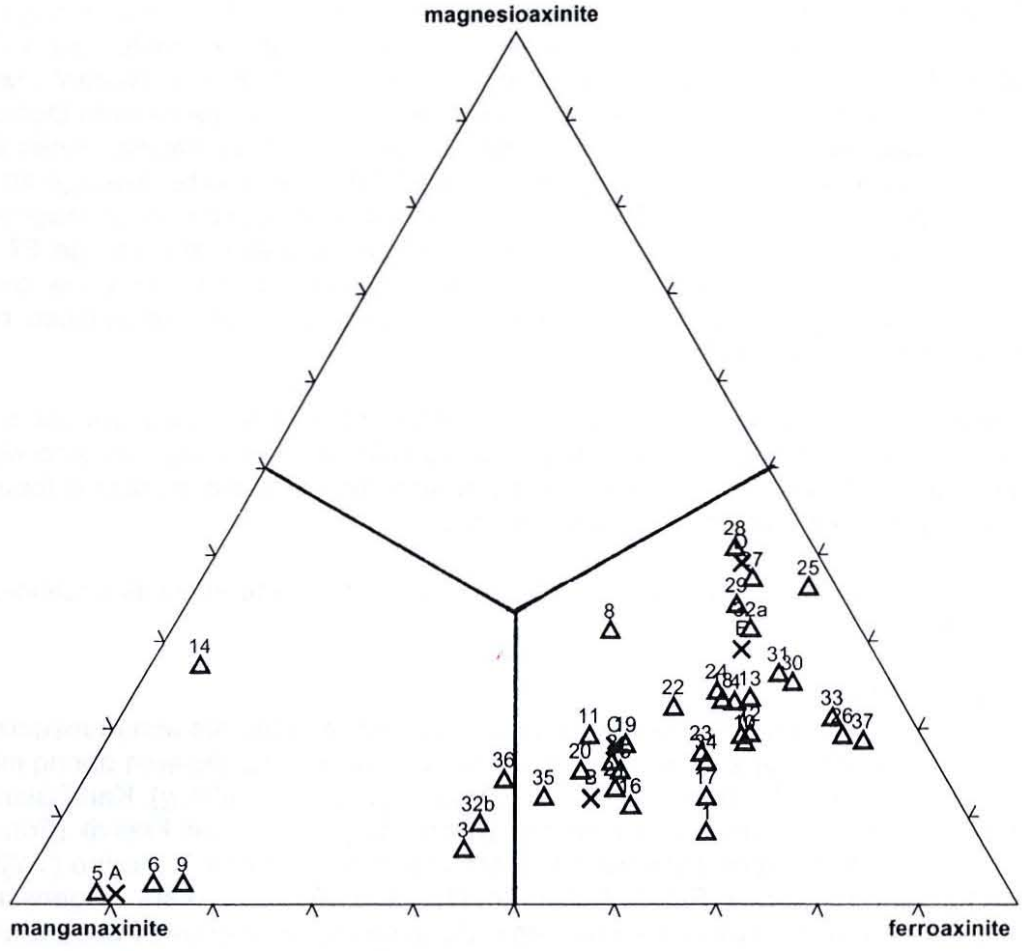

Fig. 1. Ternary diagram of Norwegian axinites. Crosses refer to axinites in Table 1, while triangles refer to axinites in Table 2.

Nå (Ullensvang), Dønna, and Nergård mine (Bjarkøy), with a content ranging from 44 to 91 mol-%. The analytical results of the axinites are plottet in a ternary diagram (Fig. 1).

No magnesio-axinite was identified. The highest content of magnesio-axinite (in mol-%) was found in Meldal at Moshaugen (41), steinbrudd Løkken Verk (37) and Granmoen (34) and in Vinstradalen, Oppdal (36).

Most ferroaxinites had a content around 60 mol-% ferroaxinite. Highest values (in mol-%) were found in axinites from Prestbuvatnet (73), Gierdduidvárri (73) and Beiarn (71). They had all very low Mn-content (8, 6 and 8 mol-% manganaxinite, respectively).

The yellow axinite from Årvoll is among the purest manganaxinites ever recorded, with 91 mol-% manganaxinite. The yellowish green axinite from Årvoll and the yellow axinite from Nødebro by Arendal also have a very high mol-% content of manganaxinite (85 and 82 mol-%, respectively). The violet axinite from Nå was also manganaxinite with a fairly high manganese content (68 mol-%). All other analysed axinites had similar shades of the typical axinite colour (reddish brown), also the manganaxinites from Kongsberg, Dønna and Bjarkøy. They had a Mn-content only slightly higher than the Fe-content.

In addition to the very manganese-rich axinites from Årvoll and Nødebro, two other axinites showed chemical patterns very different from the other axinites. The violet manganaxinite from Nå had a rather high magnesium content (27 mol-% magnesioaxinite) but a very low iron content (5 mol-% ferroaxinite). It was the only axinite with an iron content lower than both manganese and magnesium. All analysed axinites, except the axinite from Dønna, were fairly homogenous. The sample from Dønna was strongly zoned, containing zones with two very different chemical contents. One type of zones with manganaxinite (average 49 mol-%) with a high content of iron (42 mol-% ferroaxinite) and a very low content of magnesium (9 mol-% magnesio-axinite) and another type of zones with ferroaxinite (average 57 mol-%) with a high content of magnesium (31 mol-% magnesio-axinite) and a very low content of manganese (11 mol-% manganaxinite). Hence the manganese and magnesium contents showed very significant variations.

Distinct differences in chemical content between different modes of occurrences have not been revealed. In all three types there is a great variation in chemistry, and also within the different regions great variation is found. A relative high content of magnesium is found in the southwestern Trondheim region (Meldal-Oppdal area).

A sample from Storlidalen (Oppdal), which has previously been identified as tinzenite, turned out to be titanite.

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Table 1. Chemical composition (in wt.%) of Norwegian axinites reported in the literature, the structural formula, and mol-% of ferroaxinite, manganaxinite and magnesioaxinite. A: Årvoll, Oslo (Goldschmidt 1911). B: Gottes Hülfe in der Noth mine (358 m level), Kongsberg (Neumann 1944). C: Unspecified locality at Kongsberg (Lumpkin & Ribbe 1979). D: Nævermoen, Trondheim (Carstens 1965). E: Unspecified locality in the Trondheim region (Fuchs et al. 1997).

	A	B	C	D	E**
SiO_2	41.99	42.40	42.61	40.93	42.38
B_2O_3	5.13	6.95	6.17	n.a.	n.a.
Al_2O_3	16.32	18.22	18.01	19.64	18.09
Fe_2O_3	1.62	0.53	n.a.	0.12	n.a.
FeO	n.a.	5.83	6.70	6.54	7.42
MnO	12.86	4.42	3.98	1.02	1.71
MgO	0.07	0.83	1.34	2.68	2.10
CaO	20.14	19.72	19.88	19.65	19.89
Na_2O	n.a.	0.14	n.a.	n.a.	0.02
K_2O	n.a.	0.03	n.a.	n.a.	0.01
H_2O	1.87	1.60	1.60	n.a.	n.a.
Total	100.00	99.77	100.29	90.58*	91.64***
Si	8.085	7.884	7.983	7.711	7.959
B	1.705	2.231	1.995	-	-
Al	3.703	3.993	3.976	4.361	4.004
Fe^{3+}	0.235	0.074	-	0.017	-
Fe^{2+}	-	0.907	1.050	1.030	1.165
Mn	2.097	0.696	0.632	0.163	0.272
Mg	0.020	0.230	0.374	0.753	0.588
Ca	4.155	3.929	3.990	3.966	4.002
Na	-	0.050	-	-	0.007
K	-	0.007	-	-	0.002
OH	2.402	1.984	1.999	-	-
Ferroaxinite	10	51	51	53	58
Manganaxinite	89	36	31	8	13
Magnesioaxinite	1	12	18	39	29

n.a. = not analysed
* = including 0.06 wt.% TiO_2
** = mean of 14 EMP analysis points
*** = including 0.02 wt.% TiO_2

Table 2. Chemical composition (in wt.%), structural formula based on 20 cations, and mol-% of ferroaxinite (Fe-axn), manganaxinite (Mn-axn) and magnesioaxinite (Mg-axn). The proportions of H_2O and B_2O_3 were calculated assuming 2 B and 2 (OH) in the chemical formula. Each result is the mean of three or more spot analyses.

	1 Gottes Hülfe Kongsberg	2 Bratteskj., Kongsberg	3 Krags mine, Kongsberg	4 Deildokk pr., Kongsberg	5 Årvoll, Oslo (gul)	6 Årvoll, Oslo (grønn)	7 Nikkerud, Drammen
SiO_2	42.35	42.20	41.73	42.21	41.40	42.16	41.67
B_2O_3	6.15	6.11	6.08	6.15	6.02	6.09	6.12
Al_2O_3	17.88	17.74	17.08	17.95	16.95	16.55	17.88
FeO	8.45	6.56	5.72	7.68	1.13	1.98	8.41
MnO	3.54	4.09	6.98	2.07	12.41	13.03	2.38
MgO	0.57	1.18	0.52	1.63	0.04	0.20	1.45
CaO	19.74	19.91	19.76	20.13	19.47	18.72	19.83
Na_2O	0.03	0.02	0.02	0.03	0.01	0.07	0.02
K_2O	0.01	0.00	0.00	0.01	0.00	0.01	0.02
H_2O	1.59	1.58	1.58	1.59	1.56	1.58	1.58
Total	100.61	99.39	99.47	99.45	98.99	100.39	99.46
Si	7.977	7.982	7.946	7.947	7.948	8.001	7.875
B	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Al	3.969	3.955	3.833	3.983	3.835	3.702	3.983
Fe^{2+}	1.331	1.038	0.911	1.209	0.181	0.314	1.329
Mn	0.565	0.655	1.126	0.330	2.018	2.095	0.381
Mg	0.160	0.333	0.148	0.458	0.011	0.057	0.409
Ca	3.984	4.034	4.031	4.061	4.005	3.807	4.015
Na	0.011	0.007	0.007	0.011	0.004	0.026	0.007
K	0.002	0.000	0.000	0.002	0.000	0.002	0.005
OH	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Fe-axn	65	51	42	61	8	13	63
Mn-axn	27	32	52	17	91	85	18
Mg-axn	8	16	6	23	1	2	19

	8 V. Kjenli m., Arendal	9 Nødebro m., Arendal	10 Suldal	11 Bømlo	12 Fresvik (S), Ullensvang	13 Fresvik (N), Ullensvang	14 Nå, Ullensvang
SiO_2	42.49	42.16	42.06	42.91	42.44	42.37	42.31
B_2O_3	6.16	6.10	6.10	6.20	6.14	6.15	6.17
Al_2O_3	17.34	16.57	17.66	17.79	17.76	17.92	18.16
FeO	5.96	2.34	7.04	6.23	7.97	7.79	0.62
MnO	3.33	11.69	3.40	4.22	2.14	1.94	8.55
MgO	2.33	0.14	1.14	1.34	1.38	1.67	1.95
CaO	20.09	19.50	19.98	19.99	20.09	20.00	20.08
Na_2O	0.02	0.04	0.00	0.03	0.02	0.00	0.02
K_2O	0.00	0.01	0.00	0.00	0.01	0.02	0.00
H_2O	1.59	1.58	1.58	1.60	1.59	1.59	1.60
Total	99.31	100.13	98.96	100.31	99.54	99.45	99.46
Si	7.987	8.010	7.990	8.030	8.001	7.979	7.930
B	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Al	3.841	3.710	3.954	3.925	3.946	3.977	4.017
Fe^{2+}	0.937	0.372	1.118	0.975	1.257	1.227	0.097
Mn	0.530	1.881	0.547	0.669	0.342	0.309	1.359
Mg	0.653	0.040	0.323	0.374	0.388	0.469	0.545
Ca	4.046	3.969	4.067	4.009	4.048	4.035	4.037
Na	0.007	0.015	0.000	0.011	0.007	0.000	0.007
K	0.000	0.002	0.000	0.000	0.002	0.005	0.000
OH	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Fe-axn	44	16	56	48	63	61	5
Mn-axn	25	82	16	33	17	15	68
Mg-axn	31	2	16	19	19	23	27

Table 2 cont.

	15 Utne, Ullensvang	16 Bruravik, Ulvik	17 Bergsdalen, Vaksdal	18 Kvitingen, Samnanger	19 Venjaneset, Fusa	20 Naustdal	21 Allmenning-en, Vågsøy
SiO_2	42.11	42.04	41.85	42.24	42.10	42.57	42.17
B_2O_3	6.12	6.10	6.10	6.15	6.07	6.15	6.12
Al_2O_3	17.77	17.57	17.50	17.97	17.78	17.74	17.62
FeO	6.91	7.20	8.21	7.63	6.73	6.46	6.99
MnO	4.03	4.18	3.22	2.35	3.88	4.61	4.31
MgO	1.09	0.80	0.84	1.68	1.33	1.08	0.97
CaO	19.89	19.95	19.74	19.96	19.98	19.90	19.84
Na_2O	0.03	0.01	0.04	0.01	0.01	0.04	0.01
K_2O	0.02	0.00	0.00	0.01	0.00	0.02	0.00
H_2O	1.59	1.58	1.57	1.60	1.57	1.59	1.58
Total	99.56	99.43	99.07	99.60	99.45	100.16	99.61
Si	7.958	7.975	7.966	7.945	7.839	7.999	7.978
B	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Al	3.958	3.928	3.925	3.983	3.007	3.929	3.929
Fe^{2+}	1.092	1.142	1.307	1.200	1.074	1.015	1.106
Mn	0.645	0.672	0.519	0.374	0.627	0.734	0.691
Mg	0.307	0.226	0.238	0.471	0.378	0.303	0.274
Ca	4.027	4.055	4.026	4.023	4.083	4.006	4.021
Na	0.011	0.004	0.015	0.004	0.004	0.015	0.004
K	0.005	0.000	0.000	0.002	0.000	0.005	0.000
OH	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Fe-axn	53	56	63	59	52	49	53
Mn-axn	32	33	25	18	30	36	33
Mg-axn	15	11	12	23	18	15	13

	22 Tafjord, Norddal	23 Sølsnes, Molde	24 Kyrksæter-øra	25 Vinstradalen Oppdal	26 Bogo bru, Prestbuvatn, Meldal	27 Steinbrudd, Løkken Verk, Meldal	28 Moshaugen, Løkken Verk, Meldal
SiO_2	42.42	41.75	42.47	42.85	42.34	43.20	42.97
B_2O_3	6.13	6.07	6.14	6.15	6.13	6.23	6.20
Al_2O_3	17.82	17.30	17.62	17.85	17.91	18.25	17.65
FeO	6.87	7.99	7.58	7.98	9.39	7.19	6.79
MnO	2.92	3.02	2.37	0.34	1.01	1.00	0.98
MgO	1.59	1.26	1.79	2.69	1.38	2.75	3.03
CaO	20.08	19.77	19.91	20.01	19.86	20.18	20.18
Na_2O	0.01	0.02	0.00	0.01	0.00	0.06	0.00
K_2O	0.00	0.00	0.00	0.00	0.00	0.02	0.00
H_2O	1.59	1.57	1.59	1.60	1.59	1.62	1.60
Total	99.43	98.75	99.47	99.48	99.61	100.50	99.40
Si	7.994	7.956	8.000	8.014	7.983	7.986	8.023
B	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Al	3.958	3.885	3.911	3.935	3.980	3.976	3.883
Fe^{2+}	1.083	1.273	1.194	1.248	1.481	1.112	1.060
Mn	0.466	0.487	0.378	0.054	0.161	0.157	0.155
Mg	0.447	0.358	0.503	0.750	0.388	0.758	0.843
Ca	4.054	4.036	4.018	4.010	4.012	3.997	4.037
Na	0.004	0.007	0.000	0.004	0.000	0.022	0.000
K	0.000	0.000	0.000	0.000	0.000	0.005	0.000
OH	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Fe-axn	54	60	58	61	73	55	52
Mn-axn	23	23	18	3	8	8	8
Mg-axn	22	17	24	36	19	37	41

Table 2 cont.

	29 Granmoen, Meldal	30 Mostad-marka, Malvik	31 Storøya, Sandnes-sjøen	32a Dønna	32b Dønna	33 Gråtadalen, Beiarn	34 Marskaret, Grovfjord, Skånland
SiO_2	42.49	42.46	42.87	42.83	42.46	42.15	41.37
B_2O_3	6.14	6.14	6.19	6.18	6.13	6.12	6.05
Al_2O_3	17.50	17.49	18.09	18.07	17.87	17.86	17.46
FeO	7.15	8.72	7.67	7.42	5.30	8.69	7.85
MnO	1.46	1.30	1.31	1.46	6.08	0.95	2.85
MgO	2.49	1.88	1.81	2.27	0.62	1.48	1.16
CaO	20.06	19.90	20.69	20.01	20.01	20.12	19.77
Na_2O	0.01	0.01	0.04	0.00	0.00	0.03	0.00
K_2O	0.04	0.00	0.02	0.00	0.00	0.00	0.00
H_2O	1.59	1.59	1.61	1.60	1.59	1.58	1.56
Total	98.93	99.49	100.30	99.84	100.06	98.98	98.07
Si	8.002	7.996	7.986	8.001	8.008	7.979	7.934
B	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Al	3.884	3.882	3.972	3.979	3.972	3.984	3.947
Fe^{2+}	1.126	1.373	1.195	1.159	0.836	1.376	1.259
Mn	0.233	0.207	0.207	0.231	0.971	0.152	0.463
Mg	0.699	0.528	0.503	0.632	0.174	0.418	0.331
Ca	4.047	4.015	4.130	4.005	4.043	4.081	4.062
Na	0.004	0.004	0.014	0.000	0.000	0.011	0.000
K	0.010	0.000	0.005	0.000	0.000	0.000	0.000
OH	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Fe-axn	55	65	63	57	42	71	61
Mn-axn	11	10	11	11	49	8	23
Mg-axn	34	25	26	31	9	21	16

	35 Skår m., Kvæfjord	36 Nergård m., Bjarkøy	37 Gierdduid-várri, Kvænangen
SiO_2	42.00	42.16	42.26
B_2O_3	6.10	6.10	6.12
Al_2O_3	17.65	17.34	17.68
FeO	6.19	5.74	9.79
MnO	5.26	5.92	0.82
MgO	0.91	1.09	1.34
CaO	19.62	19.35	19.72
Na_2O	0.00	0.01	0.02
K_2O	0.00	0.02	0.00
H_2O	1.58	1.58	1.58
Total	99.31	99.21	99.33
Si	7.974	8.004	7.996
B	2.000	2.000	2.000
Al	3.949	3.880	3.942
Fe^{2+}	0.983	0.911	1.549
Mn	0.846	0.952	0.131
Mg	0.258	0.309	0.378
Ca	3.991	3.936	3.998
Na	0.000	0.004	0.007
K	0.000	0.005	0.000
OH	2.000	2.000	2.000
Fe-axn	47	42	73
Mn-axn	41	44	6
Mg-axn	12	14	18