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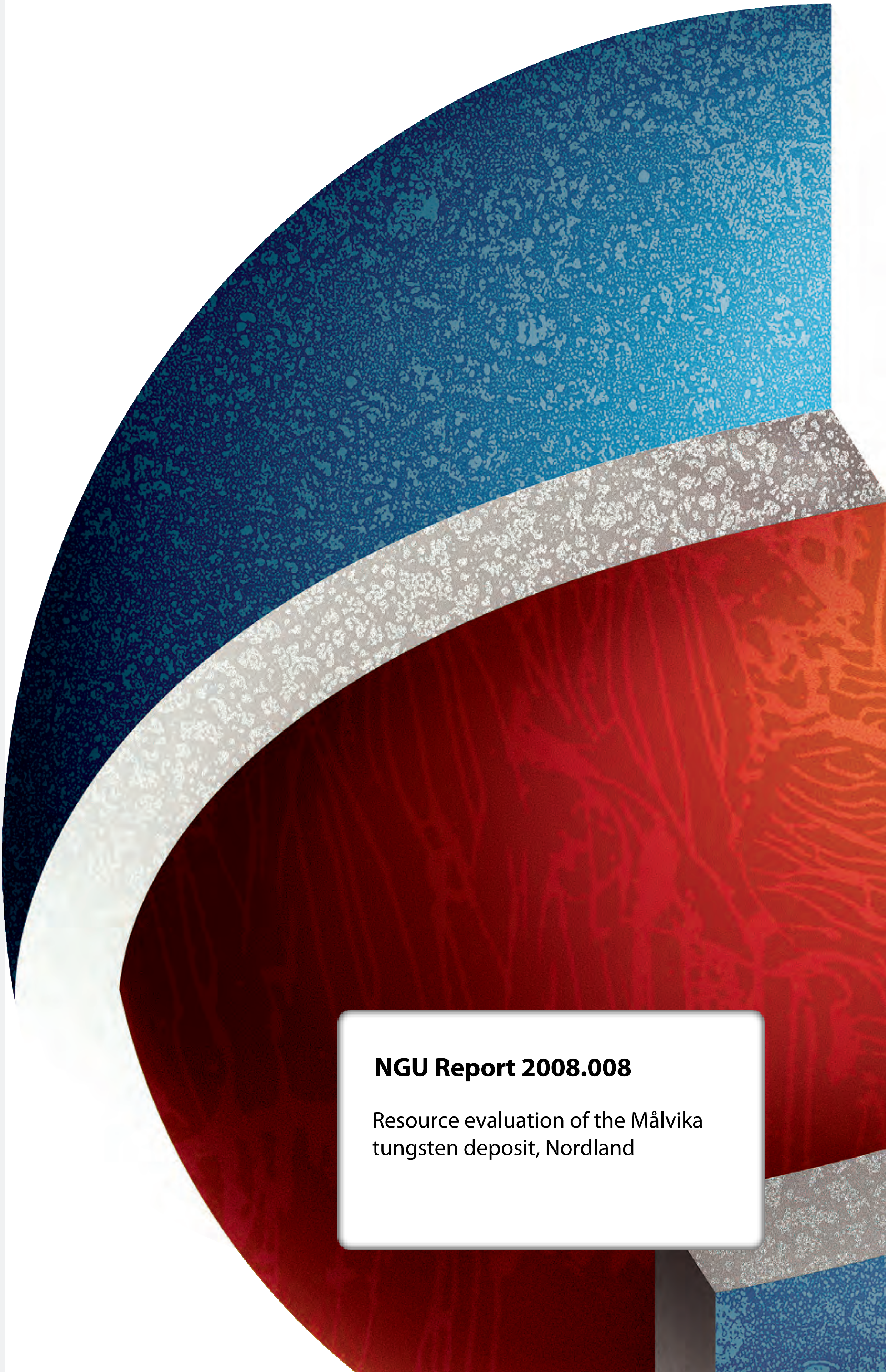

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Resource evaluation of the Målvika tungsten deposit, Nordland

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REPORT

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Title:
Resource evaluation of the Målvika tungsten deposit, Nordland

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Summary:
Nordic Mining contacted NGU in spring 2007 in order to re-evaluate the resource and grade of the Målvika tungsten deposit in Tosbotn municipality in Nordland, Norway.

The Målvika tungsten deposit is a tungsten skarn mineralisation which extends 900 m NNW-ward from the northern coastline of Tosenfjord towards mountain Landnubben and ends at an altitude of about 500 m a.s.l.. The skarn zone comprises marbles, metasomatic calc-silicate rocks (skarn *sensu strictu*), skarn-altered gneisses and granites. The ore-bearing diopside and garnet-diopside skarns form individual boudins (lenses) usually smaller than 5 m in length and 2 m in width, aligned in vein-like structures commonly 2 m wide and up to two hundred metres long. Scheelite ore is accumulated in 1-20 cm large batches distributed very heterogeneously within complexly folded and boudinaged skarns.

The deposit has previously been the target of three exploration phases with contrasting results since its discovery in 1972 by P. Skaarup. Some results indicate that the Målvika skarn is a world-class tungsten resource having an ore tonnage of 2 509 000 t with a grade of 0.7 to 0.9 wt.% WO_3 while a drilling project performed in 1983 by Sulfidmalm AS indicated only traces of tungsten.

Fieldwork was carried out during two campaigns in July and October 2007. The first campaign included 393 *in situ* analyses of the tungsten concentration of different rock types in the mineralised zone using a portable X-ray fluorescence diffraction spectrometer. During the second campaign, 66 bulk rock trench samples were taken, transecting nine different skarn layers.

The results indicate that the Målvika skarn zone is a minor tungsten deposit with a possible mineable ore tonnage of 750 000 t diopside and garnet-diopside skarn with an ore grade of about 0.44 wt.% WO_3. The granites of the Visttindane massif sampled 0.5 to 1 km E of Målvika have a high average tungsten content of 121 ppm reflecting an extreme enrichment of tungsten in the granite magmas. Thus, these granites are the most likely source of the tungsten and the Målvika deposit is an intrusion-related skarn. The mineralisation was presumably formed 430-440 Ma years ago. This result suggests that there is the possibility of finding more tungsten deposits within a radius of 5 km around the Visttindane granite massif , or within the pluton.

Keywords: ore	Målvika	scheelite
tungsten	skarn	calc-silicate
Tosbotn	Mosjøen	Nordic Mining

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1. Introduction

Nordic Mining contacted NGU in spring 2007 in order to re-evaluate the resource and grade of the Målvika tungsten deposit located in Tosbotn municipality in Nordland, Norway (Figures 1 and 2).

Figure 1. *Northern shore of Tosenfjord with the Målvika skarn zone (yellow dashed line).*

The Målvika tungsten deposit is a tungsten skarn containing the mineral scheelite ($CaWO_3$), which serves as an ore mineral for the production of tungsten (Figure 3). Scheelite shows a strong blue fluorescence if it is exposed to ultra-violet (UV) light (Figure 4). The feature is used to identify scheelite in the field. Skarns are calc-silicate rocks that result from metamorphism of impure carbonate rocks (e.g., Bowman 1998). Interaction of hydrothermal fluids with the highly reactive carbonates and calc-silicates can result in various types of mineralisations such as scheelite.

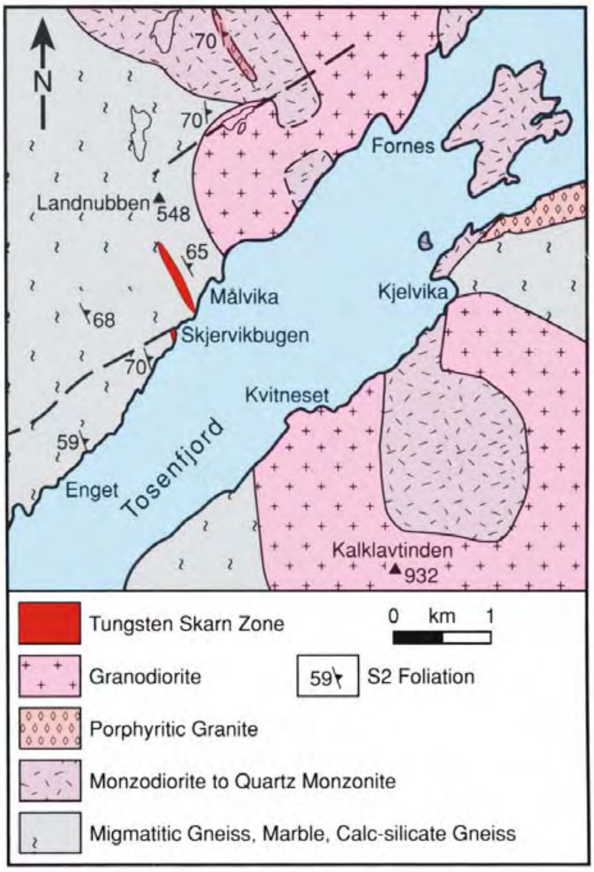

Figure 2. *Geological map of the area surrounding the scheelite skarn of Målvika (modified after James et al. 1993). The skarn is hosted by migmatitic gneisses (grey). The magmatic rocks (pinkish colours) are part of the Bindal batholith.*

The deposit, situated on the northern shore of the Tosenfjord, has been target of several exploration phases with contrasting results since its discovery in 1972 by P. Skaarup. Some results indicate the Målvika skarn as world-class tungsten resource having the ore tonnage of 2 509 000 t with a grade of 0.7 to 0.9 wt.% WO_3 (Nixon & Kjærsrud 1983; Skaarup & Lande 1998) while a drilling project performed in 1983 by Sulfidmalm AS indicated only traces of tungsten (Mjelde et al. 1983).

Fieldwork was carried out by Leif Furuhaug and Axel Müller during two campaigns between 17th and 20th July and 20th and 23rd October 2007. The first campaign included mapping of the mineralised skarn zone, 393 *in situ* (in place) analyses of the tungsten concentration of different rock types in the Målvika ore zone using a portable X-ray fluorescence diffraction (XRF) spectrometer, and collection of 15 grab samples. The grab samples were analysed by neutron activation analyses (INAA) of trace elements (ACME laboratories Vancouver) and XRF analyses of major elements (NGU laboratories) in order to compare the results achieved with the portable XRF spectrometer. During the second campaign, 9 sampling trenches between 1.6 and 5.5 m long transecting the mineralised skarn layers were cut out with a rock saw. 66 bulk rock samples were taken, each covering 50 cm of the trench length. These samples were sent to Actlabs in Ancaster, Canada, for major and trace element analysis.

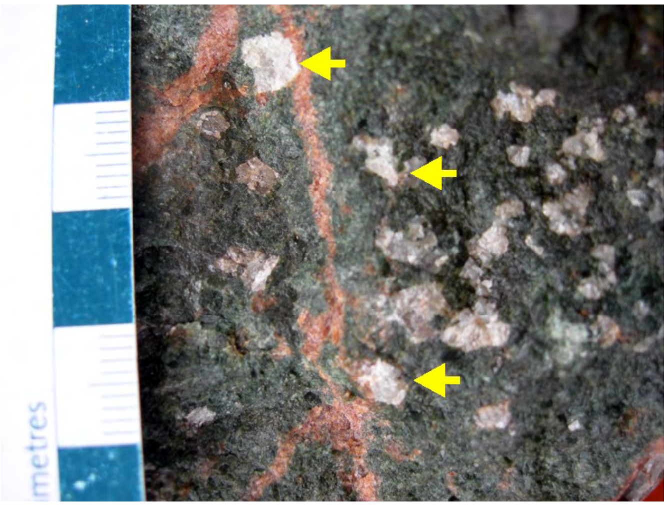

Figure 3. *High-grade tungsten ore from Målvika: Garnet (red brown)-diopside (olive-green) skarn with scheelite crystals (white, yellow arrows). The* WO_3*-content of this rock (sample 45462) is 6.96 wt.% - the sample with the highest* WO_3*-content found. Scale on the left is in centimetres.*

Figure 4. *UV-light image of a garnet-diopside skarn with fluorescing scheelite crystals. The sample is 12 cm in length. Same sample (45462) as in Figure 3.*

2. Regional geology

The Målvika skarn is situated in the uppermost allochthon (“Upper Nappe”) of the Helgeland Nappe Complex which is the structurally highest nappe complex in the central Norwegian Caledonides (e.g., Gee et al. 1985, Barnes et al. 2007). The Upper Nappe is composed of strongly deformed, high-metamorphic grade pelitic to semi-pelitic gneisses (partially migmatitic) and calcareous metasedimentary rocks (marble, skarn rocks). These rocks are typical of deposition in continental shelf environments. Barnes et al. (2007) proposed that the deposition of the Upper Nappe sedimentary protoliths was Cambrian-Ordovician (Figure 5). However, Sr and C isotopes indicate a Neoproterozoic age for the sea water from which the carbonates precipitated (Ihlen 2008, pers. comm.).

The Målvika skarn is situated 500 m east of the western contact of the Visttindane massif of the Bindal Batholith which intruded the rocks of the Upper Nappe (Nordgulen 1992). The batholith consists of plutons that span the compositional range from gabbro to granite. The western part of the batholith near Målvika consists of peraluminous two-mica granites with emplacement ages from 424 to 437 (Nissen et al. 2006, Nordgulen & Sundvoll 1992, Nordgulen et al. 1993, Birkeland et al. 1993, Barnes et al. 2007). Isotopic studies showed that batholith magmas arose by partial melting of a range of crustal sources, with or without mantle-derived contributions (Nordgulen & Sundvoll 1992, Birkeland et al. 1993). Slightly deformed mafic and granite dykes at Storvika, 8 km W of Målvika were emplaced at 442.2 ± 3.4 Ma and 431.2 ± 3.6 Ma, respectively (Barnes et al. 2007).

Sturt (1982) identified three major episodes of deformation, D1-D3, producing folds and fabrics in the area (Figure 5). The earliest identifiable deformation (D1) caused the strong foliation of the sedimentary sequence. The penetrative D1 foliation is parallel or sub-parallel to the lithologic banding. The D2 structures fold the D1 foliation. The D2 folds are relatively small structures and do not appear to have significant influence on the overall disposition of the metasedimentary units. The regional peak metamorphism – high amphibolite facies with partial anatexis (melting) - is probably related to the D2 event or older. During D2 deformation extensive boudinage (stretching of a competent strata into sausages and lenses = boudins) of the more competent horizons, such as skarn rocks, is a characteristic structural style. The supposed age of the regional peak metamorphism is ca. 480 Ma (Barnes et al. 2007).

The folding related to D3 is responsible for large-scale structures and hence controls the major distribution of the rock units and deposit. According to Sturt (1982) the Målvika skarn lies in the core of medium-scale (decametre) D3 antiform and on the eastern flank of the large-scale (several hundred metres) Målvika Antiform. The skarn boudin bands developed at D2, are folded by D3. As the result of steep disposition during D3 folding, the D2 boudins have steeply plunging long axes. This may be one of the reasons for the apparently steeply plunging lensoidal form of the scheelite-bearing skarns at Målvika. The plunge of the D3 Målvika Antiform is probably gentle to the north. However, the folds are non-cylindrical and thus the plunge of the D3 fold axis is variable (Sturt 1982). The emplacement of the Bindal batholith and associated dykes is syn-genetic in respect to D3. According to Sturt (1982), the Bindal granites near Målvika are younger than the main scheelite mineralisation. The latter is assumed to be related to the D2 peak metamorphism around 480 Ma (Sturt 1982).

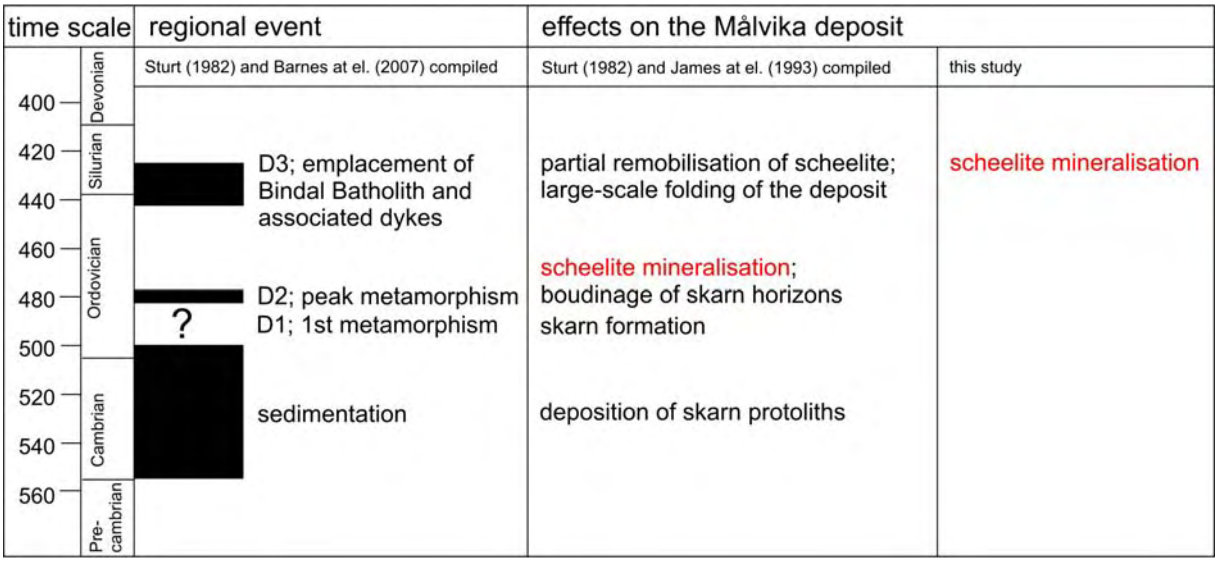

Figure 5. *Chronology of regional events and interpretations, as to how these events affected the Målvika skarn deposit.*

3. Deposit geology and petrography

The skarn zone at Målvika extends 900 m NNW-ward from the northern coastline of Tosenfjord, where it is freshly exposed in a new road cut (national road 76), towards the mountain Landnubben and ends at an altitude of about 500 m a.s.l. (Figures 1 and 2; Map I). The skarn zone is defined here as zone comprising marbles, calc-silicate rocks (skarn *sensu strictu*), skarn-altered gneisses and granites. The skarn forms individual boudins (lenses) usually smaller than 5 m in length and 2 m in width. Diopside-bearing marbles are preserved within the core of the larger skarn horizons (thicker than 2 meters) and in folds. The marble can be up to 10 meters in thickness. The skarn zone is best exposed in the road cut as a 15 m wide zone dipping 60° NNE. One to five parallel skarn horizons - each 0.5 to 4 m in thickness - are exposed within the Målvika zone probably due to repetition by folding. The skarn horizons having an average thickness of 1.5 m, are enveloped by partially skarn-altered leucocratic biotite gneiss or amphibole-biotite gneiss. The area is crosscut by granodioritic to granitic dykes, of which three generations have been identified (Sturt 1982). The western contact of the large Bindal Batholith is located some 500 m to the east of Målvika.

Figure 6. *Skarn boudins (dashed yellow lines) of the Målvike skarn zone exposed in the road cut of Tosenveien.*

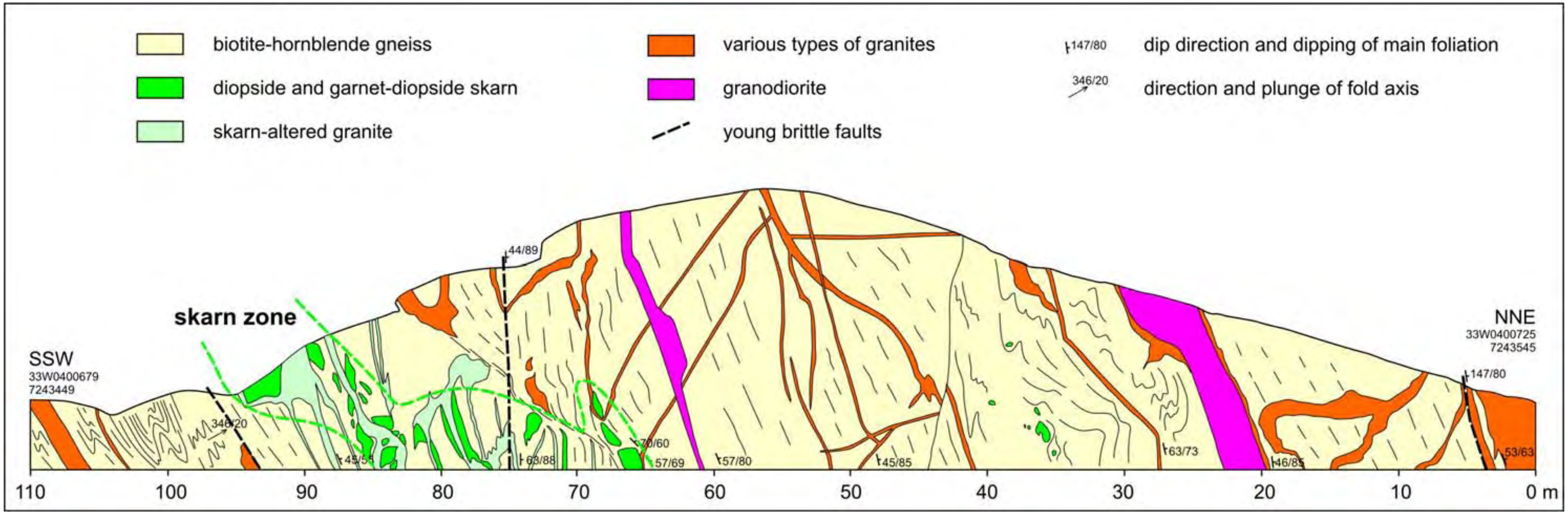

Figure 7. *Road cut along Tosenveien at Målvika exposing a ca. 15 m wide skarn zone. The minor folds plunge 20° northward.*

The most voluminous and abundant skarn bodies are exposed between 40 and 90 m a.s.l. above the road cut. This lower skarn zone – in the following named zone I - has here a maximum thickness of 80 m, containing at least five major skarn layers alternating with gneiss, granite dykes and marble (Map I). The root of this zone is exposed in the road cut where it is ca. 15 m wide (Figures 6 and 7). Weathering of the marbles has resulted in a karst landscape with small caves and depressions covered by dense vegetation.

Between 90 and 140 m a.s.l. the zone is poorly exposed in three lumps revealing a 0.5 m wide skarn zone. The most massive skarn rocks occur between 140 and 210 m a.s.l. – zone II (Map I). Here the skarn lenses are up to 12 m long and 2.5 m wide.

The skarn continues as two, poorly exposed, max. 1 m wide horizons between 210 and 290 m a.s.l.. A massive skarn - 10 m in length and 4.5 m in width - occurs at 290 m a.s.l.. A 1.5 m wide skarn horizon is sporadically exposed between 295 and 340 m a.s.l. The NNW end of the Målvik zone is exposed at an altitude of 480 to 500 m a.s.l. where two parallel, 1.5 m wide skarn horizons crop out over a length of 50 m. The skarn zones between 210 and 500 m a.s.l. are named zone III.

A much smaller skarn zone occurs at Skjervikbugen, 300 m SW of the main Målvika deposit, which is on the supposed western flank of a large D3-fold. This 3 m wide Skjervikbugen zone extends for 30 m northwards, where it terminates against a prominent ENE-WSW-trending fault (James et al. 1993). It contains only minor scheelite mineralisation (James et al. 1993).

Minerals forming the skarn at Målvika are predominantly garnet, pyroxene (diopside), and plagioclase. The major type is diopside-plagioclase skarn, which constitutes 75 % of the skarns in the deposit (Figure 8). Garnet-diopside skarn occurs as disparate schlieren within the diopside skarn commonly measuring <50 cm in section and forming 20 % of the skarns. The garnet schlieren are parallel to the foliation of the adjacent gneisses. The skarn is cut by a reticulate system of quartz-plagioclase veins rimmed by needles of recrystallised actinolite and garnet. Minor amounts of epidote, pyrrhotite, chalcopyrite, apatite, and late calcite indicate the multiphase interaction of the skarn with mineralised fluids.

Scheelite at Målvika occurs as strata-bound 1 to 20 cm large segregations or as finely dispersed crystals within boudinaged skarn lenses and preferentially in, or adjacent to zones of garnet-diopside skarn. Traces of disseminated scheelite have been detected by UV light also in marbles and gneisses adjacent to the skarns (Skaarup & Lande 1998).

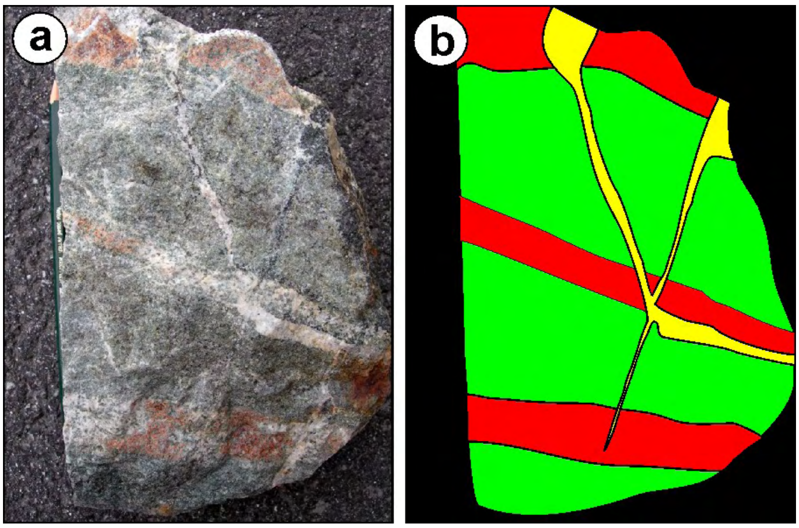

Figure 8. *Typical skarn (a) consisting of diopside-plagioclase skarn (green in b), garnet-diopside-plagioclase skarn (red in b), and quartz-plagioclase veins rimmed by actinolite and occasionally garnet (yellow in b).*

4. History of exploration

The Målvika skarn was discovered in 1973 by P. Skaarup while carrying out a reconnaissance survey with ultra-violet (UV) lamps (Skaarup 1973, 1974). He mapped the deposit, made a regional model for its formation and provided a petrographic description of the scheelite mineralisation and its host rocks. Sturt (1982) described the lithology along a 4-km profile crossing the Målvika skarn zone. The report gives a good introduction to the regional geology and deformation events effecting the Målvika skarn zone.

Nixon & Kjærsrud (1983) collected 39 scheelite-bearing chip and grab samples identified by UV light, on behalf of Sulfidmalm AS. The sampling covered the entire skarn zone. WO_3 concentrations in these samples vary between 0.2 and 16.8 wt.% (Table 1). Where more continuous sections could be sampled, assays yielded 1.48 wt.% over 3.4 m, 2.14 wt.% over 1.9 m, 3.48 wt.% over 1.65 m, 1.58 wt.% over 5 m, and 1.27 wt.% over 5.1 m. Nixon & Kjærsrud (1983) concluded that the scheelite-bearing skarns at Målvika represent a potentially economic deposit with good grades over appreciable widths.

On the basis of Nixon & Kjærsrud's report, Sulfidmalm AS started a drilling project in 1983 (Mjelde et al. 1983). Nine holes, 70 to 200 in length, were drilled. Locations of the drill holes are not given in the report by Mjelde et al. (1983). However, Skaarup & Lande (1998) mentioned that drilling was carried out at four different places. Three drill locations were located in the upper part of the Målvika zone probably between 215 and 250 m a.s.l. ("Helikopterlandingsplass" and "Borestedet" in Map I). These holes drilled in different directions did not meet any skarn horizons. The fourth location was down at the road where the hole intersected the 10 m wide skarn zone (drill hole 1 and 2). Drill holes 3 and 4 intersect a 3-4 m wide skarn zone. Core log for hole 5 is missing. Scheelite mineralisation was identified by UV light in hole 1 at 51.6 to 52 m depth. Disseminated scheelite occurs between 45.6 and 55.6 m in hole 2, and a 1-cm wide scheelite band was detected at 55.4 m depth in hole 8. WO_3 concentrations of 37 skarn samples from hole 1-4 were determined (Table 1). 30 of these analyses are below detection limit, 2 analyses gave 0.1 wt.% WO_3, 3 analyses 0.7 wt.% WO_3 and 1 analysis 0.11 wt.% WO_3.

The comparison of data from Nixon & Kjærsrud (1983) and Mjelde et al. (1983) in Table 1 shows how selective chip sampling with UV light can easily increase the proposed average tungsten concentration in the skarn zone. Sulfidmalm AS stopped the exploration activity because of the disappointing results from the drilling campaign. The company was also in the process of being bought by Terra Mining A/S owned 50% by Norsk Hydro A/S and 50 % by Terra Swede AB.

At the beginning of 1990s the PhD student D. Wyn James worked on the deposit. He describes the small skarn at Skjervikbugen and argued that the age of regional metamorphism and mineralisation was 472 Ma (James et al. 1993). The 402 Ma K/Ar ages of the Bindal granites by James et al. (1993) are in contrast to the 424-437 Ma U/Pb ages by Nissen et al. (2006), Nordgulen & Sundvoll (1992), Nordgulen et al. (1993), Birkeland et al. (1993), and Barnes et al. (2007). Other conclusions by James et al. (1993), e.g., that the skarn formation overprints D2 structures, are not in agreement with previous works.

In 1986 Kåre M. Lade and Peter Skaarup analysed marble with blue fluorescent minerals samples found in river beds in the surrounding area. The blue fluorescent minerals in the marble were diopside and not scheelite (Skaarup & Lande 1998). This finding has been confirmed by Ø. Nordgulen (2008, pers. comm.) who found diopside in the Tosbotn area with fluorescence similar to scheelite.

In 1995 Peter Skaarup and Kåre M. Lade took the initiative and mapped the Målvika skarn zone in detail (Skaarup & Lande 1998). They produced a very detailed geological map indicating all outcrops of skarn in the Målvika zone (Map I). Each skarn outcrop got a name and was mapped with UV light. The field drawings by Skaarup & Lande (1998) are attached in Appendix II for identification of the outcrops in the field. 42 samples were taken by

Skaarup & Lande (1998) from mineralised skarn identified by UV light and adjacent granites and gneisses, which are partially skarn-altered (Table 1). They found an average of 1.18 wt.% WO_3 for garnet-diopside skarn (8 analyses), 0.94 wt.% for diopside skarn (14 analyses), 0.08 wt.% for gneiss (15 analyses), and 0.31 wt.% for granite (5 analyses). Skaarup & Lande (1998) estimated the ore reserves of the Målvika deposit to 2 509 000 t with 0.7 to 0.9 wt.% WO_3. The tonnage corresponds to 22 572 t WO_3 when the grade is 0.9 wt.% and 17 556 t WO_3 applying an ore grade of 0.7 wt.% WO_3. This deposit size would classify the Målvika zone as one of the 100 largest tungsten deposits in the world. The calculations based on the assumptions that (1) the mineralised skarn extends vertically with consistent thickness from 577 m above sea level down to 115 m below sea level, and (2) that the mineralisation occurs in vein-like structures with an average thickness of 2.1 m and a total length of 900 m.

Table 1. *WO_3 analyses of skarn and associated wall rocks in the Målvika deposit. Nixon & Kjærsrud (1983) collected grab and chip skarn samples with UV lamp from the entire skarn zone. Mjelde et al. (1983) analysed drill core samples covering the whole thickness of the skarn horizons of drill hole 1-4. Skaarup & Lande (1998) collected samples along profiles of skarn where scheelite mineralisation was identified with UV light. dp – diopside, gt – garnet.*

Nixon & Kjærsrud (1983)		**Mjelde et al. (1983)**		**Skaarup & Lande (1998)**			
sample nr.	**WO_3 wt.%**	**sample nr.**	**WO_3 wt.%**	**sample nr.**	**rock type**	**outcrop name**	**WO_3 wt.%**
35/82/200	1.42	DH1 35-36m	<0.01	1l.38	dp gt skarn	Hellezonen A	1.58
35/82/201	0.7	DH1 36-37m	<0.01	5a.05	granite	Hellezonen B	0.0008
35/82/202	0.55	DH1 37-38m	<0.01	4a.04	gneiss	Hellezonen B	0.0016
35/82/203	3.04	DH1 38-39m	<0.01	3a.03	dp skarn	Hellezonen B	0.026
35/82/204	1.25	DH1 39-40m	<0.01	2a.02	dp gt skarn	Hellezonen B	0.24
35/82/206	1.71	DH1 40-41m	<0.01	1a.01	gneiss	Hellezonen B	<0.0005
35/82/207	0.57	DH1 41-42m	<0.01	4b.09	dp skarn	Ihlenzonen A	0.46
35/82/208	0.06	DH1 42-43m	<0.01	3b.08	dp gt skarn	Ihlenzonen A	0.51
35/82/209	1.48	DH1 43-44m	<0.01	2b.07	granite	Ihlenzonen A	0.0034
35/82/210	0.40	DH1 44-45m	<0.01	1b.06	gneiss	Ihlenzonen A	<0.0005
35/82/211	0.41	DH1 45-46m	<0.01	3h.27	granite	Korstræet A	1.49
35/82/212	0.82	DH1 51-52m	<0.01	2h.26	gneiss	Korstræet A	0.46
35/82/213	2.92	DH1 52-53m	0.01	1h.25	granite	Korstræet A	0.06
35/82/214	2.12	DH2 45-46m	<0.01	5j.36	granite	Cobra A	<0.0005
35/82/216	0.95	DH2 46-47m	<0.01	4j.35	gneiss	Cobra A	0.0037
35/82/217	2.34	DH2 47-48m	0.01	3j.34	dp skarn	Cobra A	<0.0005
35/82/218	0.21	DH2 48-49m	<0.01	2j.33	dp skarn	Cobra A	1.54
35/82/219	1.60	DH2 49-50m	0.07	1j.32	gneiss	Cobra A	0.0014
35/82/220	1.91	DH2 50-51m	<0.01	4i.31	gneiss	Det sorte hul D	0.0065
35/82/221	2.48	DH2 51-52m	<0.01	3i.46	dp skarn	Det sorte hul D	0.0118
35/82/222	1.45	DH2 52-53m	<0.01	3i.30	dp skarn	Det sorte hul D	0.0141
35/82/223	3.20	DH2 53-54m	<0.01	2i.29	dp gt skarn	Det sorte hul D	0.39
35/82/224	2.66	DH2 54-55m	<0.01	1i.28	gneiss	Det sorte hul D	<0.0076
35/82/225	4.32	DH2 55-56m	<0.01	3c.12	dp skarn	Grantræet	0.30
35/82/226	16.80	DH2 61-62m	<0.01	2c.11	dp gt skarn	Grantræet	1.31
35/82/227	14.00	DH2 62-63m	0.07	1c.44	dp skarn	Grantræet	0.0074
35/82/228	3.96	DH3 61-62m	<0.01	1c.10	dp skarn	Grantræet	0.0025
35/82/229	3.48	DH3 62-63m	<0.01	5d.17	gneiss	Højspændten	0.0142
35/82/230	9.23	DH3 63-64m	0.11	4d.16	gneiss	Højspændten	0.0491
35/82/231	3.32	DH3 64-65m	0.07	3d.15	dp skarn	Højspændten	2.80
35/82/232	2.12	DH3 69-70m	<0.01	2d.14	dp skarn	Højspændten	1.60
35/82/233	2.56	DH3 70-71m	<0.01	1d.13	gneiss	Højspændten	0.0069
35/82/234	1.61	DH3 71-72m	<0.01	3e.45	gneiss	Lindahl A	0.11
35/82/235	1.22	DH4 37-38m	<0.01	3e.20	gneiss	Lindahl A	0.044
35/82/236	0.85	DH4 38-39m	<0.01	2e.18	gneiss	Lindahl A	0.018
35/82/237	3.04	DH4 39-40m	<0.01	1e.19	dp gt skarn	Lindahl A	0.29
35/82/238	1.24	DH4 40-41m	<0.01	1g.24	dp skarn	Hollander B	0.36
35/82/239	1.96			3f.23	gneiss	Peterzonen A	0.55
35/82/240	0.8			2f.22	dp gt skarn	Peterzonen A	2.81
				1f.21	dp gt skarn	Peterzonen A	2.33
				1n.47	dp skarn	Allanzonen A	2.818
				1n.40	dp skarn	Allanzonen A	3.266

5. Results

5.1 *In situ* field analyses of tungsten with portable XRF

393 *in situ* field analyses of the W concentration in different rock types in the Målvika zone were carried out with a portable X-ray fluorescence spectrometer (Table 2). Sampling points were chosen at and around the mineralised skarn zones mapped by Skaarup & Lande (1998). The XRF results show that the garnet-diopside skarns carry the scheelite ore. The average W concentration (78 analyses) in the garnet-diopside skarn is 1220 ppm (0.154 wt.% WO_3) if one analysis (nr. 79) yielding a highly anomalous value of 18.16 wt.% WO_3 is excluded. The average W content in the garnet-diopside skarn would be 3010 ppm (0.380 wt.% WO_3) if this spike is included in the calculation (Table 2). However, from the view of analytical statistics this measurement has to be ignored. A 5-cm wide sulphide vein contains 2.263 wt.% WO_3.

Table 2. *Average tungsten concentrations of different rock types within the Målvika skarn zone. Detection limit is 0.01 wt.%* WO_3.

	skarn rocks			**host rocks**			**sulphide vein**
rock type	garnet-diopside skarn	diopside skarn	marble	biotite gneiss	granite dykes	grano-diorite dykes	5-cm vein
number of analyses	78 (79)	100	22	124	58	9	1
average WO_3 concentration (wt.%)	0.154 (0.380)	<0.01 (0.006)	<0.01 (0.005)	<0.01 (0.003)	<0.01 (0.001)	<0.01 (0)	2.263

The disadvantage of the portable XRF is the small sample area that is analysed (ca. 1x1.5 cm). This causes large statistical errors in the analyses if the rock is heterogeneous and medium- to coarse-grained, as in the case of the Målvika rocks. Therefore, 15 grab samples (size ca. 12x6x6 cm) including all rock types occurring in the Målvika skarn zone and with different tungsten content were measured by another independent method.

First, the 15 samples were analysed 5-10 times each with the portable XRF at different positions on the sample. The W (and Ca, Fe, Zr, Mn, Ti, and Zn) concentrations and averages are listed in Appendix III. Then, the same samples were sent to ACME laboratories in Vancouver to determine the W concentration by INAA (Appendix IV). In Figure 9 the averages determined by the portable XRF are plotted against the W concentration determined by INAA. The concentrations do not plot along the 1:1 ratio line, in particular samples containing >10 000 ppm W. However, all samples with elevated tungsten content were identified with the portable XRF.

However, the average W concentrations determined for the different rock types in the field by the portable XRF (Table 2) cannot be used to define the W grade of the rocks. However, the portable XRF clearly detected all samples with elevated W contents and thus it represents a helpful guide to ore.

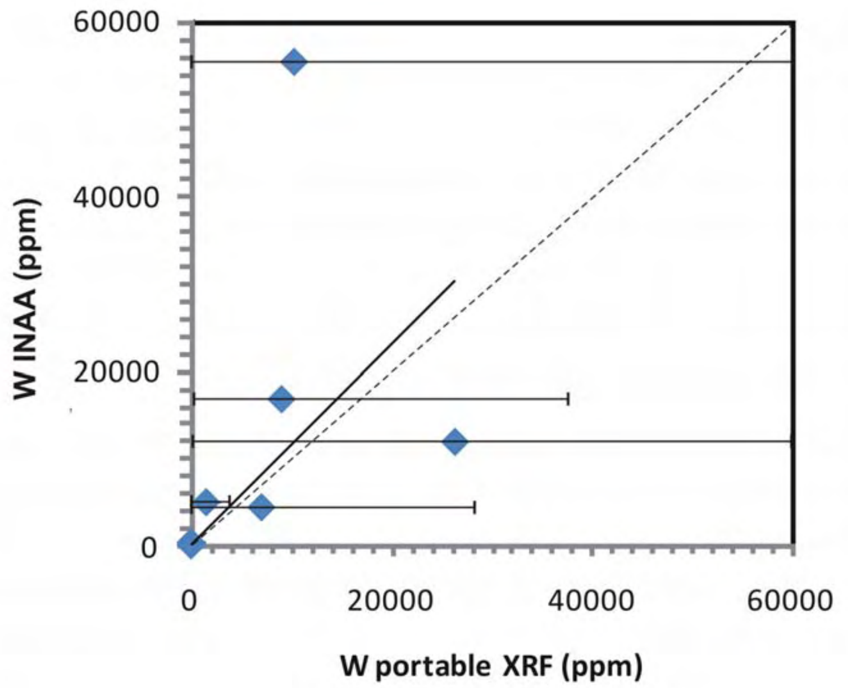

Figure 9. *Average of 5-10 tungsten measurements by the portable XRF plotted against the tungsten concentration determined on the same samples by INAA at ACME laboratories Vancouver. In an ideal case the tungsten concentrations of the 15 samples would plot along the thin dashed line. The sloping solid line represents the linear regression of the measurements. The horizontal lines are standard deviations (1σ) of the 5-10 measurements with the portable XRF.*

5.2 Analytical results of trench sampling

Nine sampling trenches across the mineralised skarn horizons, 1.6 and 5.5 m in length and 5 to 10 in width, were cut out with a rock saw at different places on the deposit (Figures 10 to 12). The locations of the trenches are indicated in Map I. All together 66 bulk rock samples were taken each covering a length of 50 cm. Two of the 66 samples contained blue fluorescent scheelite crystals (samples 58934(2/8) and 57668(7/4)).

The samples were analysed at Actlabs in Ancaster, Canada and the results are listed in Appendices V and VI. One sample of gneiss, four diopside skarns, and two garnet-diopside skarns contain more than 10 000 ppm W, which is the upper detection limit of the INAA analyses. The minimum average WO_3 concentrations are given in Table 3 assuming 10 000 ppm W for the 7 samples. The maximum average WO_3 concentration is based on the assumption that the W content in the 7 samples is 50 000 ppm which corresponds to the highest detected concentration in the Målvika skarn zone (sample 45462; Figures 3 and 4). The standard deviations of the average WO_3 concentrations are high because of the seven concentration spikes (Figure 13). This confirms the field observation that scheelite is very irregularly distributed and concentrated in small segregations 1-20 cm in size. The heterogeneous scheelite distribution is also the reason why the average tungsten concentration determined with portable XRF is lower than that of the trench samples.

It can be concluded that the minimum average WO_3 concentration of 50 skarn samples (diopside and garnet-diopside skarn) is 0.166±0.394 wt.% and the maximum average 0.712±1.977 wt.% WO_3. Thus, the ore grade is in the range 0.17 to 0.71 wt.% WO_3. We suggest an average ore grade of 0.44 wt.% WO_3 of the diopside and garnet-diopside skarns at Målvika, representing the mean of the minimum and maximum average WO_3.

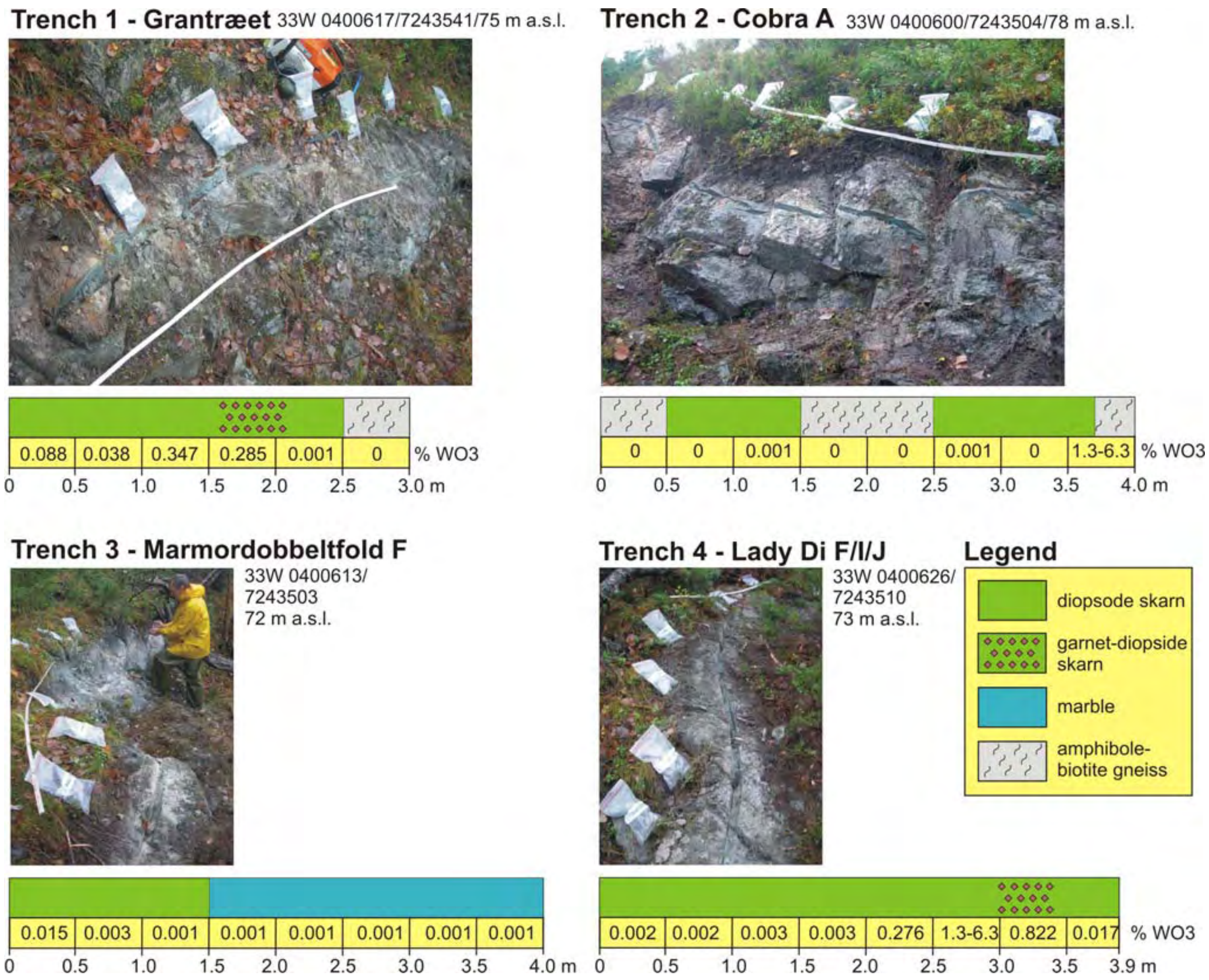

Figure 10. *Sampling trenches 1 to 4 with photograph and indicated trench length, rock types and* WO_3 *concentrations in the boxes below the photographs.*

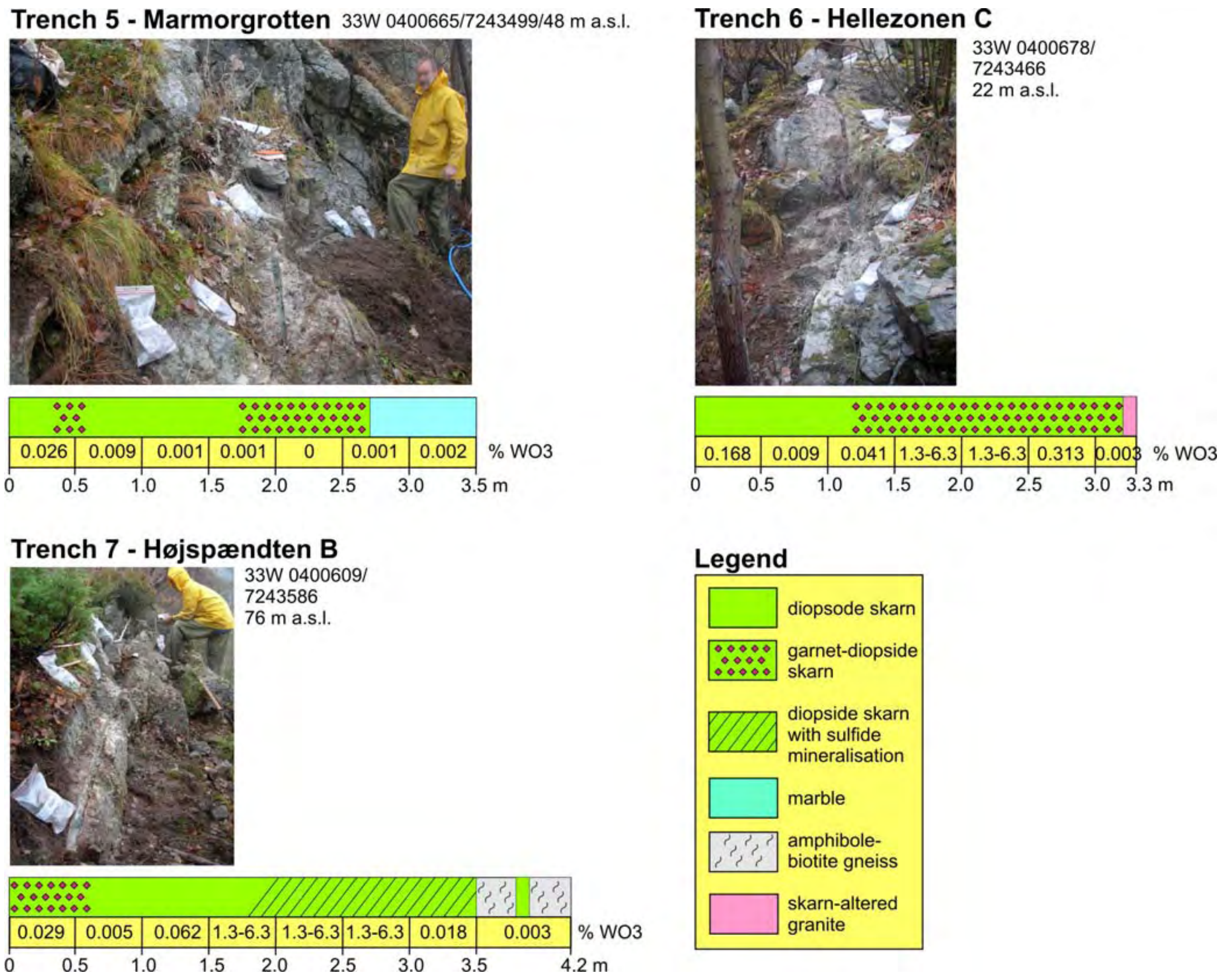

***Figure 11**. Sampling trenches 5 to 7 with photograph and indicated trench length, rock types and WO_3 concentrations in the boxes below the photographs.*

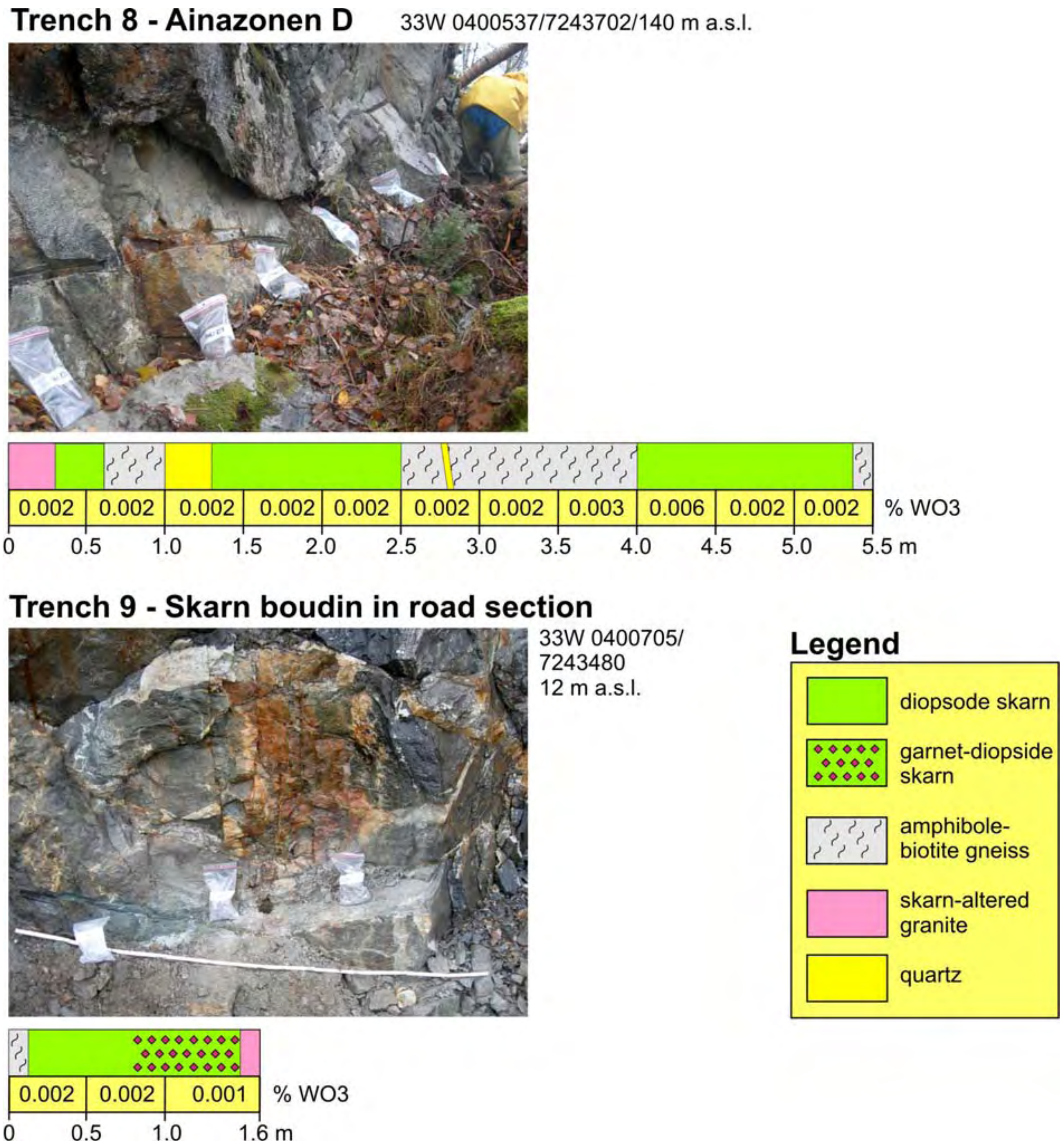

Figure 12. *Sampling trenches 1 to 4 with photograph and indicated trench length, rock types and WO_3 concentrations in the boxes below the photographs.*

Table 3. *Average WO_3 concentrations of trench samples in the Målvika skarn zone. The analysed amphibole-biotite gneisses are max. 0.5 m away from the contact.*

rock type	garnet-diopside skarn	diopside skarn	diopside-bearing marble	amphibole-biotite gneiss
number of analyses	13	37	6	10
minimum average WO_3 (wt.%)	0.312±0.481	0.165±0.394	0.001±0.001	0.127±0.398
maximum average WO_3 (wt%)	0.632±1.995	0.712±1.977	0.001±0.001	1.090±2.329

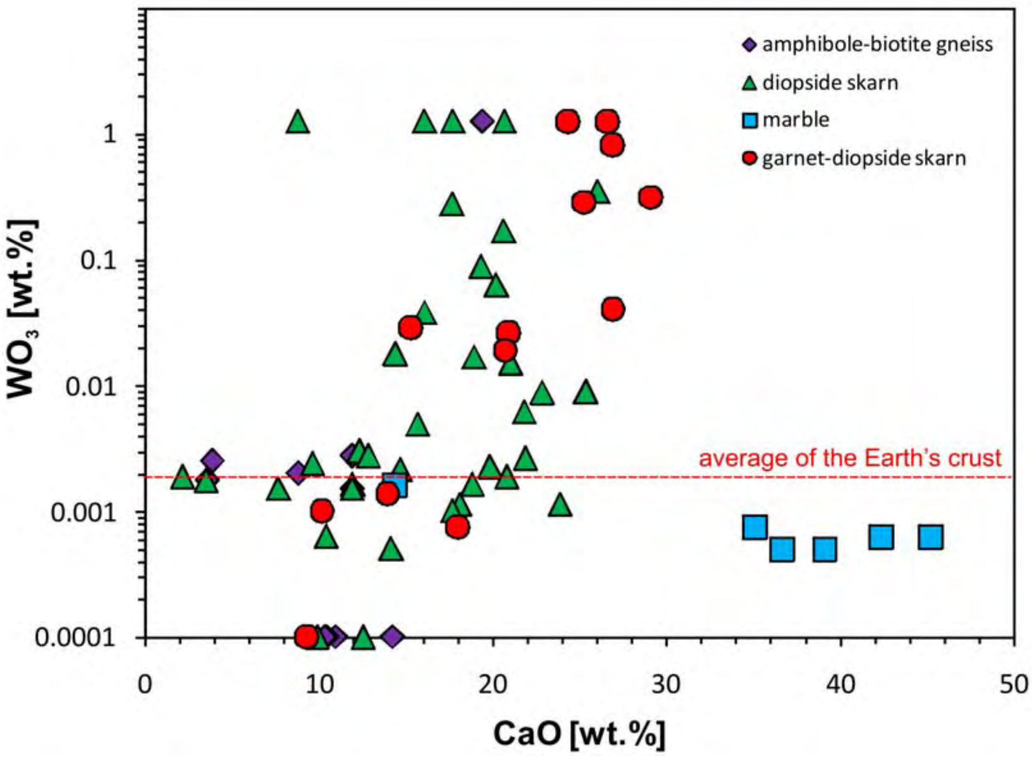

Figure 13. *CaO versus WO_3 plot illustrating the distribution of tungsten in different rock types of the Målvika skarn zone. Rocks with 10 to 30 wt.% CaO may contain elevated tungsten.*

5.3 Estimation of the deposit ore tonnage

The Målvikå skarn zone is exposed over a length of 1025 m which corresponds to a vertical distance of 505 m and a horizontal distance of 900 m. The mountain has a slope of ca. 30º. However, the zone is not continuously exposed. This is not just caused by the lack of outcrops, but also by discontinuous and boudinaged skarn horizons, e.g., indicated by the lack of skarn horizons in 5 of 9 drill cores (Mjelde et al. 1983). The skarn zones consist of skarn lenses embedded in partially skarn-altered granites and gneisses (Figures 6 and 7). Moreover, the skarn zones are intersected by vertical, SW-NE striking faults (Map I), which separate the skarn zones into a number of different blocks. The individual blocks show vertical displacement of several 10's of metres. Thus, each block exposes different levels of the skarn zone. This leads to the conclusion that the skarn zone is discontinuous and irregular in both vertical and horizontal extension. To provide an example: The isoclinally folded skarn layers at 70 m a.s.l. form a ca. 80 m wide zone in an E-W direction. 100 m south in the road cut (15 m a.s.l.) the entire zone is about 15 m wide and down at the shoreline just 0.5 m. Thus, the zone of 80 m width thinned down to 0.5 m over a vertical distance of 70 m.

It is important to note that the fold axis plunges ca. 10-20º NNW. Therefore, the exposed width of the zones extends horizontally into the hill side rather than vertically. We assume for the possible ore tonnage calculation that the exposed skarn horizons continue with constant thickness 300 m horizontally into the mountain (Table 4). Skaarup & Lande (1998) assumed that the skarn horizons continue with constant width over a vertical distance of 692 m (Table 4). However, this is not supported by the observed field relationships discussed above.

Table 4. *Extension of skarn zones with visually (Skaarup & Lande 1998) and analytically (this study) determined WO_3 grade. The locality names were introduced by Skaarup & Lande (1998; Appendix II and Map I). The volume of individual zones was determined for this study by multiplying cos 30º of the exposed length (x * 0.866), width y and horizontal length z.*

	Skaarup & Lande (1998)				this study	
locality name	**exposed length x**	**thickness y**	**vertical length**	**visually evaluated WO_3**	**horizontal length z**	**volume of zone**
	m	**m**	**m**	**wt.%**	**m**	**m^3**
Hellezonen	20	2	692	1.5	300	10392
Ihlenzonen	10	2	692	0.5	300	5196
Korstræ, nedre zone	45	2	692	1.5	300	23382
Korstræ, øvre zone	45	1	692	0.5	300	11691
Lady Di fra A til E	35	3	692	1.0	300	27279
Lady Di fra F til J	20	3	692	3.0	300	15588
Marmorfolde område	14	2	692	0.5	300	7274.4
Sorte Hul, Cobra, Cafeteriet	115	1	692	1.0	300	29877
Gl. Røske 3, Grantræet, Dalblotning, Sulfidmalm	55	2	692	1.0	300	28578
Ø-Dalen	45	1	692	0.5	300	11691
Højspændten A - B	15	2	692	3.0	300	7794
Højspændten C - G	15	2	692	1.0	300	7794
Ainazone D - K	118	(1?)	692	0.5	300	30656
Ainazone D - K	57	3	692	2.0	300	44426
Kårezone A - K	18	3	692	4.0	300	14029
Lindahl Øst-zone A-B-G	40	2	692	0.5	300	20784
Lindahl Vest-Zone H-A-C	16	3	692	2.0	300	12470
Lindahl Vest-Zone D-F	16	3	692	4.0	300	12470
Hollanderzonen	90	(1?)	692	0.5	300	23382
Peterzonen A-B	50	3	692	5.0	300	38970
Peterzonen C	20	2	692	1.0	300	10392
Skråningen	25	2	692	3.0	300	12990
Allanzonen	65	3	692	2.0	300	50661
	total: 949 m	**average: 2.1 m**		**weighted average: 1.4**		**tot. volume: 457768 m^3**

The volume of each skarn zone was determined by multiplying cos 30º (0.866) of the exposed length x, thickness y and horizontal length z (Table 4). We used the data of Skaarup & Lande (1998) for the exposed length x and the zone width y of the skarn zones. As mentioned above the mapping of Skaarup & Lande (1998) is very accurate and reproducible (Map I). The presently determined total volume of the Målvika skarn is 457 768 m^3. The scheelite-bearing skarn boudins comprise maximum 50 % of the individual skarn zones (Figures 6 and 7) which corresponds to 228 884 m^3. The skarn rocks are in turn composed of 25 % garnet-diopside skarn and 75 % diopside skarn, which corresponds a density of about 3.29 t/m^3 (Skaarup & Lande 1998). Thus, the Målvika skarn zone hosts a possible mineable ore tonnage of about 753 000 t diopside and garnet-diopside skarns with an ore grade of 0.44 wt.% WO_3 corresponding to 3300 t WO_3. The ore tonnage corresponds to the size of a minor deposit.

Skaarup & Lande (1998) overestimated the ore tonnage of the Målvika zone because they assumed that the mineralisation occurs in strike-continuous vein-like structures over a vertical distance of 692 m and a horizontal distance of 900 m which is not the case according to our data. The skarns form lenses which occur aligned as strata-bound units.

Due to the present high tungsten price on the world market (235-240 U$ per MTU = 23-24 U$ per kg, January 2008) ore grades down to 0.10 % WO_3 are currently mined, e.g. at Batistau, Kazakhstan. However, these low-grade deposits have an ore tonnage of >200 million metric tons (Table 5, Figure 14). The ore tonnage and ore grade of the Målvika skarn zone plots in the (currently) non-economic field if the suggested ore grade of 0.44 wt.% WO_3 is applied. However, the deposit plots near the border between currently economic and non-economic deposits if the maximum ore grade of 0.7 wt.% WO_3 is applied (Figure 14).

Table 5. *The major tungsten deposits of the world. Sources: Mutschler (2007) and Playfair Mining LTD (2007).*

deposit name	deposit type	ore tonnage (mill t)	WO_3 (mt)	grade WO_3 (%)
Kairakty, Kazakhstan	Greisen W-Mo	815	871 000	0.11
Shizhuyan, China	Skarn W-Sn-Mo	270	598 750	0.22
Mactung, Canada	Skarn W (Cu, Bi)	63	479 000	0.76
Kara-Oba, Kazakhstan	Greisen W-Mo (Sn, Bi)	200	400 000	0.20
Lianhuashan, China	Porphyry W	40	320 000	0.8
Yogodzir, Mongolia	Greisen W-Mo	90	270 000	0.3
Tyrnyauz, Russia	Skarn W	51	241 300	0.48
Northern Dancer, Yukon	porphyry Mo-W	242	230 500	0.10
Batistau, Kazakhstan	Greisen W-Mo	213	213 400	0.10
Logtung, Canada	Porphyry W-Mo	162	166 320	0.10
Sangdong, South Korea	Skarn W	20	158 400	0.79
Xingluokeng, China	Porphyry W	78	140 400	0.18
King Island, Australia	Skarn W (Mo)	17	115 770	0.68
Vostok-2, Russia	Skarn/Greisen W	22	100 980	0.46
Mount Pleasant, Canada	Greisen W-Mo-Sn	45	94 584	0.21
Risby, Canada	Skarn W	6.38	29 500	0.46
Lened, Canada*	Skarn W	0.74	8 400	1.14
Grey River, Newfoundland	Greisen W	0.85	7 300	0.86
Clea, Canada*	Skarn W	0.26	2 400	0.93

* two examples of historical mines

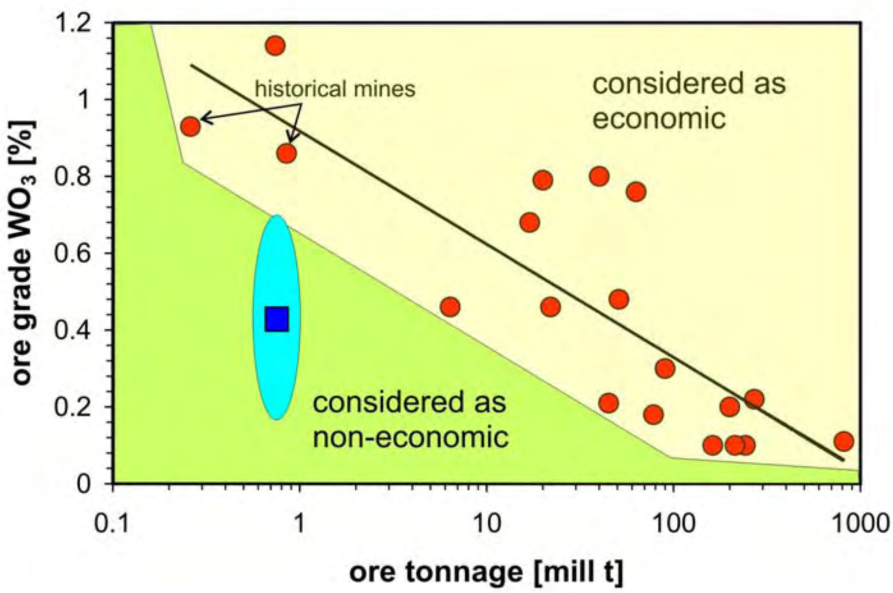

Figure 14. *Plot of ore tonnage versus ore grade for the world's tungsten major deposits (red circles; same data as in Table 5) and the Målvika deposit (blue ellipse and square). The blue squares represents the suggested ore grade of 0.44 wt.% WO_3.*

6. Remarks on the deposit genesis

Two models have been suggested to explain the tungsten mineralisation of the Målvika skarn zone:

Theory 1 – reaction skarn.

Skaarup (1974) concluded from his results that the scheelite-bearing skarns in the Bindal area are reaction skarns in the sense of Eskola (1939), formed at the contact between marbles and gneisses at a late stage of regional metamorphism without tungsten input from an external source and significant element transfer. The tungsten may have been derived from evaporitic horizons sedimented together with the carbonates. These evaporites have not survived the regional metamorphism and just their immobile elements (including tungsten) remained and reacted with the associated carbonate horizons. Recent continental evaporitic sequences can contain 0.07 to 0.12 % WO_3 (Smith 1979; Smith et al. 1983). During regional metamorphism tungsten is further enriched due to the desolution and deposition of the salts and other easy dissolved phases. Such type of skarn deposits are typically small, averaging about 1.1 Mt and grading 0.7 WO_3, with most lying in the range of 0.05 to 22 Mt and grading from 0.34 to 1.4 WO_3 (USGS 2007). However, the former carbonate(evaporate) sequence at Målvika was presumably not thick enough to enrich noticeable amounts of tungsten by *in situ* metamorphic-hydrothermal processes.

Theory II – intrusion-related skarn.

Nissen (1969) and Bowitz-Ihlen (1973) stressed epigenetic relationships between the scheelite mineralisation and the host rocks elsewhere in the contact zone of the Bindal batholith. They regarded the mineralisation as hydrothermal, with granite as the most probable source for the tungsten-bearing solutions. Sturt (1982) suggested that the likely candidates for the scheelite mineralisation are older, D2-related muscovite-tourmaline granite veins occurring in the area.

The granites in the area – the Visttindane massif as part of the Bindal batholith and the granitic dyke suite exposed in the road cut and elsewhere in the Målvika skarn zone - are moderately fractionated in respect to granite differentiation (Figure 15). This is important to note, because tungsten is an incompatible element and becomes increasingly enriched in granitic magmas with increasing melt fractionation. The granitic dykes exposed in the road cut and elsewhere in the Målvika skarn zone contain less <1 ppm W (Appendix IV) and thus, they are unlikely to be the source of tungsten. However, the granites of the Visttindane massif sampled ca. 0.5 to 1 km east from the Målvika skarn zoned are extremely enriched in tungsten. Four grab samples show an average W content of 121 ppm (Appendix IV). The concentration reflects a tungsten enrichment of 8 times compared to the average WO_3 value of the Earth's crust (0.002 % WO_3; Mason & Moore 1982). Granites containing more than 50 ppm W are considered as tungsten-enriched granites.

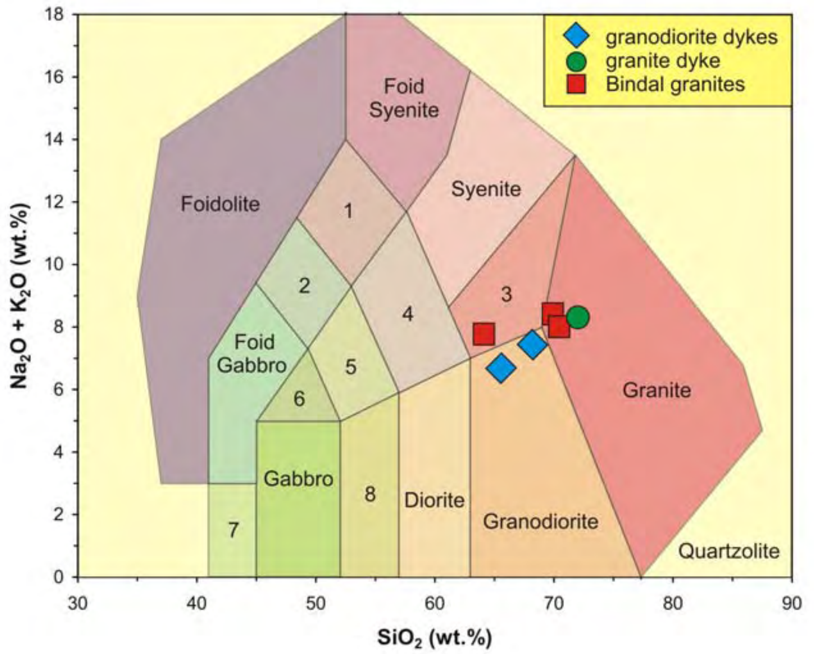

Figure 15. *Chemistry of Bindal granites 0.5-1 km east of Målvika (samples 45465-7), and granite (sample 45456) and granodiorite dykes (samples 45457-8) exposed in the road cut at Målvika plotted on the total alkali-silica (TAS) diagram. Names for the numbered fields are: 1 – foid monzosyenite, 2 – foid monzodiorite, 3 – quartz monzonite, 4 – monzonite, 5 - monzdiorite, 6 - monzogabbro, 7 – peridotgabbro, and 8 – gabbroic diorite.*

As a conclusion, the Bindal granites are the most likely source of the tungsten in the Målvika deposit and thus the deposit is an intrusion-related skarn. Tungsten-enriched hydrothermal fluids escaped from the crystallising granites and reacted with the nearby carbonate sequence at Målvika, where scheelite, as a consequence, precipitated. Because the granites near Målvika are between 424-437 Ma in age, the scheelite mineralisation should have a corresponding age, which is in contrast to former assumptions by Sturt (1982) and James et al. (1993; Figure 5).

7. Summary and outlook

The skarn zone at Målvika extending 900 m NNW-ward from the northern coastline of the Tosenfjord hosts a minor tungsten deposit with a possible mineable ore tonnage of ca. 750 000 t diopside and garnet-diopside skarn with an ore grade of about 0.44 wt.% WO_3. The deposit contains ca. 3300 t WO_3. The ore mineral is scheelite.

Scheelite is very heterogeneously distributed within the skarn zone. It is accumulated in small segregations measuring 1 to 20 cm in garnet-diopside and diopside skarn. In addition scheelite grains occur very finely dispersed in the skarns and occasionally in the wall rock gneiss at the skarn contact in the form of foliation-parallel schlieren up to 1 m in length. The ore-bearing skarns form 0.5 to 5 m long lenses aligned along vein-like structures commonly 2 m wide and up to two hundred metres long. The fact that the scheelite ore is accumulated in small segregations distributed unevenly within the complexly folded and boudinaged skarn horizons makes the identification of ore-rich zones very challenging. This was also the reason why the drilling project carried out by Sulfidmalm AS in 1983 (Mjelde et al. 1983) was not successful.

The fold axis of the foliated rocks in the Målvika skarn zone plunges ca. 10-20º NNW. Therefore, the exposed width of the skarn zones continues horizontally into the hill side rather than vertically. This suggests that the exposed skarn horizons continue horizontally with a constant thickness of 300 m into the hill side.

This study shows that the results of the ore tonnage calculation and ore grade estimation given by Skaarup & Lande (1998) are not reproducible. The overestimation of the ore tonnage (2 509 000 t) and ore grade (0.7 to 0.9 wt.%) by Skaarup & Lande (1998) was caused by (1) the assumption that the ore-bearing skarns form continuous veins with constant thickness over a vertical distance of 692 m and horizontal distance of 900 m and (2) the visual evaluation of the ore grade by the intensity of the UV fluorescence. Tungsten grade overestimation is a common phenomenon if scheelite is explored visually by UV light due to its very bright fluorescence (e.g. Plimer 1994; Figure 4).

Four samples of granites from the Visttindane granite massif east of Målvika reveal an average content of 121 ppm W. The value reflects an extreme enrichment of tungsten in the granite magmas of the massif. Thus, these granites are the most likely source of the tungsten and the Målvika deposit is assumed to represent an intrusion-related skarn. Tungsten-enriched hydrothermal fluids escaped from the crystallising granites and reacted with the nearby carbonate sequence at Målvika forming the scheelite mineralisation around 430-440 Ma years ago. This result suggests that there is the possibility of finding other and potentially larger and richer tungsten deposits within a radius of 5 km around the Visttindane granite massif or within the massif itself.

For future work it is suggested to do raster sampling of granites from the Visttindane massif in order to verify if the high tungsten concentration is a common phenomenon of the Visttindane granites. If the high tungsten values can be confirmed for other parts of the massif, than further exploration of scheelite mineralisation related to carbonate and calc-silicate horizons within a radius of 5 km around the massif is recommended. There is also a potential of wolframite mineralisation within the Visttindane granite massif.

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Appendix I. *Sample list.*

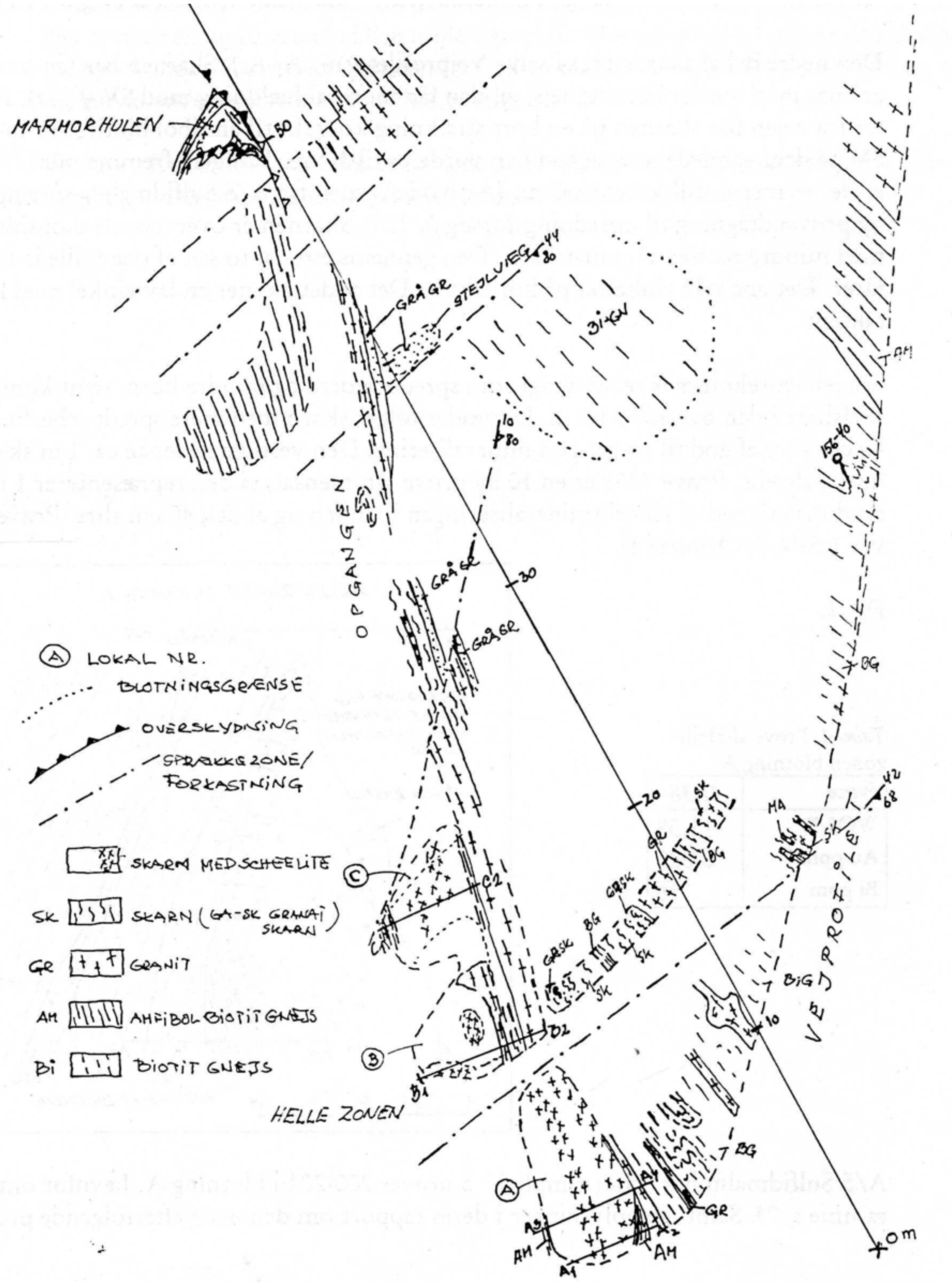
NGU number	field number	WGS 84			
		zone	easting	northing	rock type
45456	AX01-07	33 W	400725	7243525	fine-grained granite
45457	AX02-07	33 W	400718	7243545	fine-grained foliated granodiorite
45458	AX03-07	33 W	400703	7243497	fine-grained foliated granodiorite
45459	AX17-07	33 W	400646	7243510	garnet-diopside skarn
45460	AX20-07	33 W	400614	7243505	diopside skarn
45461	AX21-07	33 W	400614	7243505	diopside-bearing marble
45462	AX22-07	33 W	400623	7243503	garnet-diopside skarn
45463	AX23-07	33 W	400632	7243499	garnet-diopside skarn
45464	AX24-07	33 W	400626	7243494	garnet-diopside skarn
45465	AX25a-07	33 W	402235	7245064	porphyritic Bindal quartz monzonite
45466	AX25b-07	33 W	402235	7245064	Bindal granite
45467	AX26-07	33 W	401066	7244137	Bindal granite
45468	AX28-07	33 W	400699	7243481	garnet-diopside skarn
45469	AX29-07	33 W	400622	7243503	garnet-diopside skarn
45470	AX30-07	33 W	400101	7246543	Bindal syenite
58921	trench 1/1	33 W	400617	7243541	diopside skarn
58922	trench 1/2	33 W	400617	7243541	diopside skarn
58923	trench 1/3	33 W	400617	7243541	diopside skarn
58924	trench 1/4	33 W	400617	7243541	garnet-diopside skarn
58925	trench 1/5	33 W	400617	7243541	diopside skarn
58926	trench 1/6	33 W	400617	7243541	amphibole-biotite gneiss
58927	trench 2/1	33 W	400600	7243504	amphibole-biotite gneiss
58928	trench 2/2	33 W	400600	7243504	diopside skarn
58929	trench 2/3	33 W	400600	7243504	diopside skarn
58930	trench 2/4	33 W	400600	7243504	amphibole-biotite gneiss
58931	trench 2/5	33 W	400600	7243504	amphibole-biotite gneiss
58932	trench 2/6	33 W	400600	7243504	diopside skarn
58933	trench 2/7	33 W	400600	7243504	diopside skarn
58934	trench 2/8	33 W	400600	7243504	amphibole-biotite gneiss
58935	trench 3/1	33 W	400613	7243503	diopside skarn
58936	trench 3/2	33 W	400613	7243503	diopside skarn
58937	trench 3/3	33 W	400613	7243503	diopside skarn
58938	trench 3/4	33 W	400613	7243503	diopside-bearing marble
58939	trench 3/5	33 W	400613	7243503	diopside-bearing marble
58940	trench 3/6	33 W	400613	7243503	diopside-bearing marble
58941	trench 3/7	33 W	400613	7243503	diopside-bearing marble
58942	trench 3/8	33 W	400613	7243503	diopside-bearing marble
58943	trench 4/1	33 W	400626	7243510	diopside skarn
58944	trench 4/2	33 W	400626	7243510	diopside skarn
58945	trench 4/3	33 W	400626	7243510	diopside skarn
58946	trench 4/4	33 W	400626	7243510	diopside skarn
58947	trench 4/5	33 W	400626	7243510	diopside skarn

Appendix I. *Sample list. Continued.*

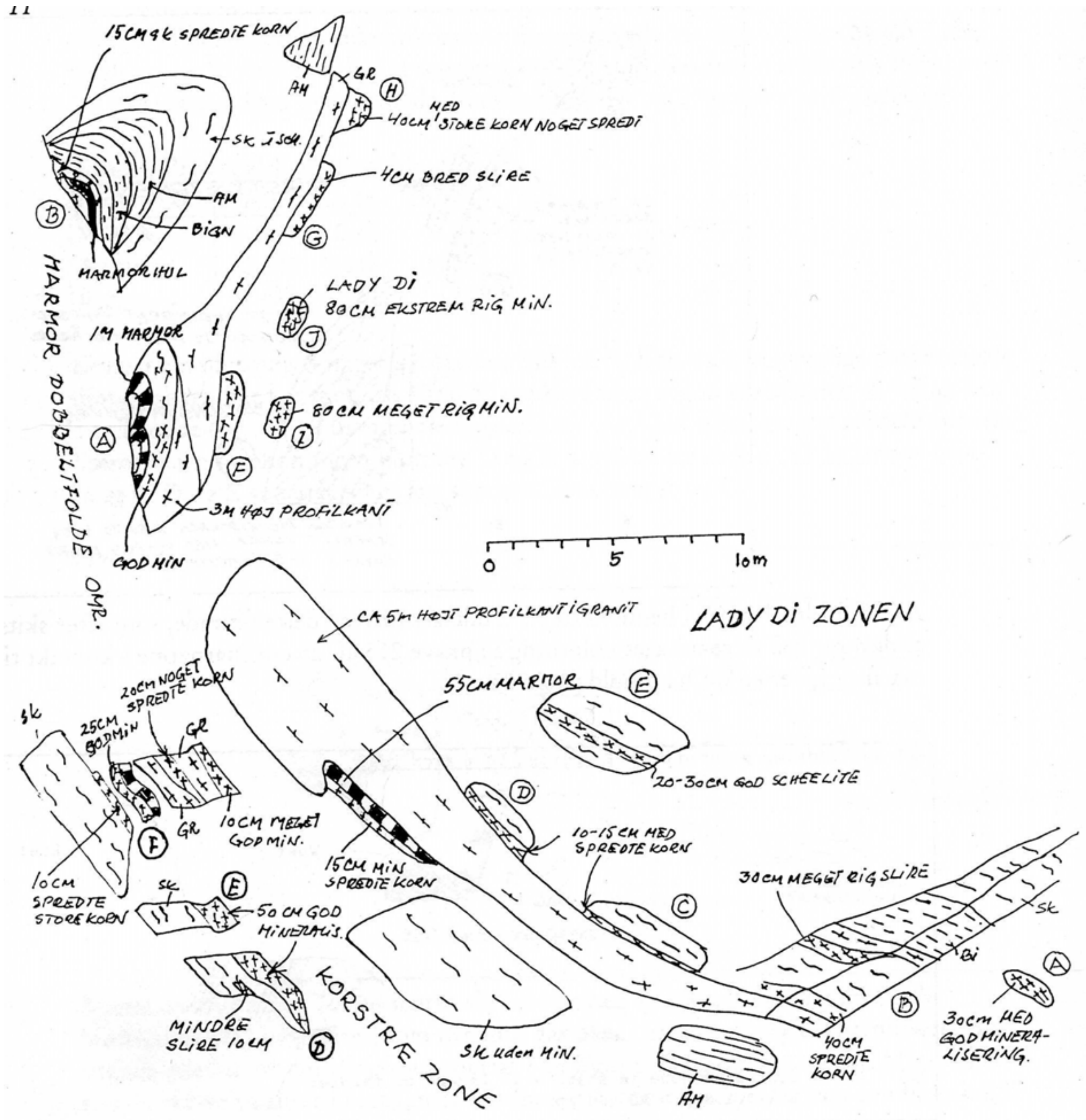
NGU number	field number	WGS 84			
		zone	easting	northing	rock type
58948	trench 4/6	33 W	400626	7243510	diopside skarn
58949	trench 4/7	33 W	400626	7243510	garnet-diopside skarn
58950	trench 4/8	33 W	400626	7243510	diopside skarn
57651	trench 5/1	33 W	400665	7243499	garnet-diopside skarn
57652	trench 5/2	33 W	400665	7243499	diopside skarn
57653	trench 5/3	33 W	400665	7243499	diopside skarn
57654	trench 5/4	33 W	400665	7243499	garnet-diopside skarn
57655	trench 5/5	33 W	400665	7243499	garnet-diopside skarn
57656	trench 5/6	33 W	400665	7243499	garnet-diopside skarn
57657	trench 5/7	33 W	400665	7243499	diopside-bearing marble
57658	trench 6/1	33 W	400678	7243466	diopside skarn
57659	trench 6/2	33 W	400678	7243466	diopside skarn
57660	trench 6/3	33 W	400678	7243466	garnet-diopside skarn
57661	trench 6/4	33 W	400678	7243466	garnet-diopside skarn
57662	trench 6/5	33 W	400678	7243466	garnet-diopside skarn
57663	trench 6/6	33 W	400678	7243466	garnet-diopside skarn
57664	trench 6/7	33 W	400678	7243466	garnet-diopside skarn
57665	trench 7/1	33 W	400609	7243586	garnet-diopside skarn
57666	trench 7/2	33 W	400609	7243586	diopside skarn
57667	trench 7/3	33 W	400609	7243586	diopside skarn
57668	trench 7/4	33 W	400609	7243586	diopside skarn
57669	trench 7/5	33 W	400609	7243586	diopside skarn with sulphides
57670	trench 7/6	33 W	400609	7243586	diopside skarn with sulphides
57671	trench 7/7	33 W	400609	7243586	diopside skarn with sulphides
57672	trench 7/8	33 W	400609	7243586	amphibole-biotite gneiss
57673	trench 8/1	33 W	400537	7243702	diopside skarn
57674	trench 8/2	33 W	400537	7243702	amphibole-biotite gneiss
57675	trench 8/3	33 W	400537	7243702	diopside skarn
57676	trench 8/4	33 W	400537	7243702	diopside skarn
57677	trench 8/5	33 W	400537	7243702	diopside skarn
57678	trench 8/6	33 W	400537	7243702	amphibole-biotite gneiss
57679	trench 8/7	33 W	400537	7243702	amphibole-biotite gneiss
57680	trench 8/8	33 W	400537	7243702	amphibole-biotite gneiss
57681	trench 8/9	33 W	400537	7243702	diopside skarn
57682	trench 8/10	33 W	400537	7243702	diopside skarn
57683	trench 8/11	33 W	400537	7243702	diopside skarn
57684	trench 9/1	33 W	400705	7243480	diopside skarn
57685	trench 9/2	33 W	400705	7243480	diopside skarn
57686	trench 9/3	33 W	400705	7243480	garnet-diopside skarn

Appendix II. *Outcrop drawings and names approximately from south to north according Skaarup & Lande (1998). For location of outcrops on a large scale see Map I.*

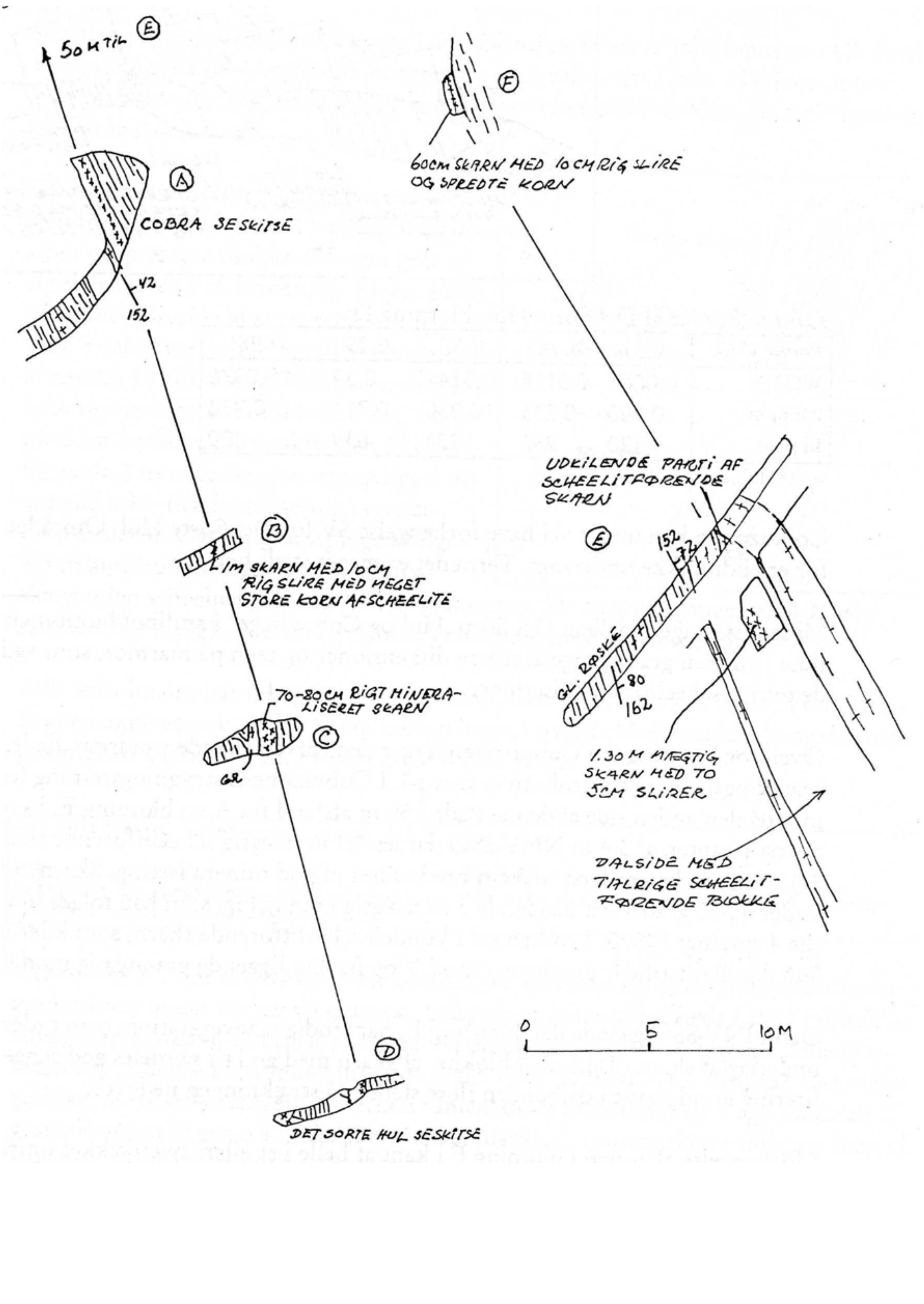
Hellezonen



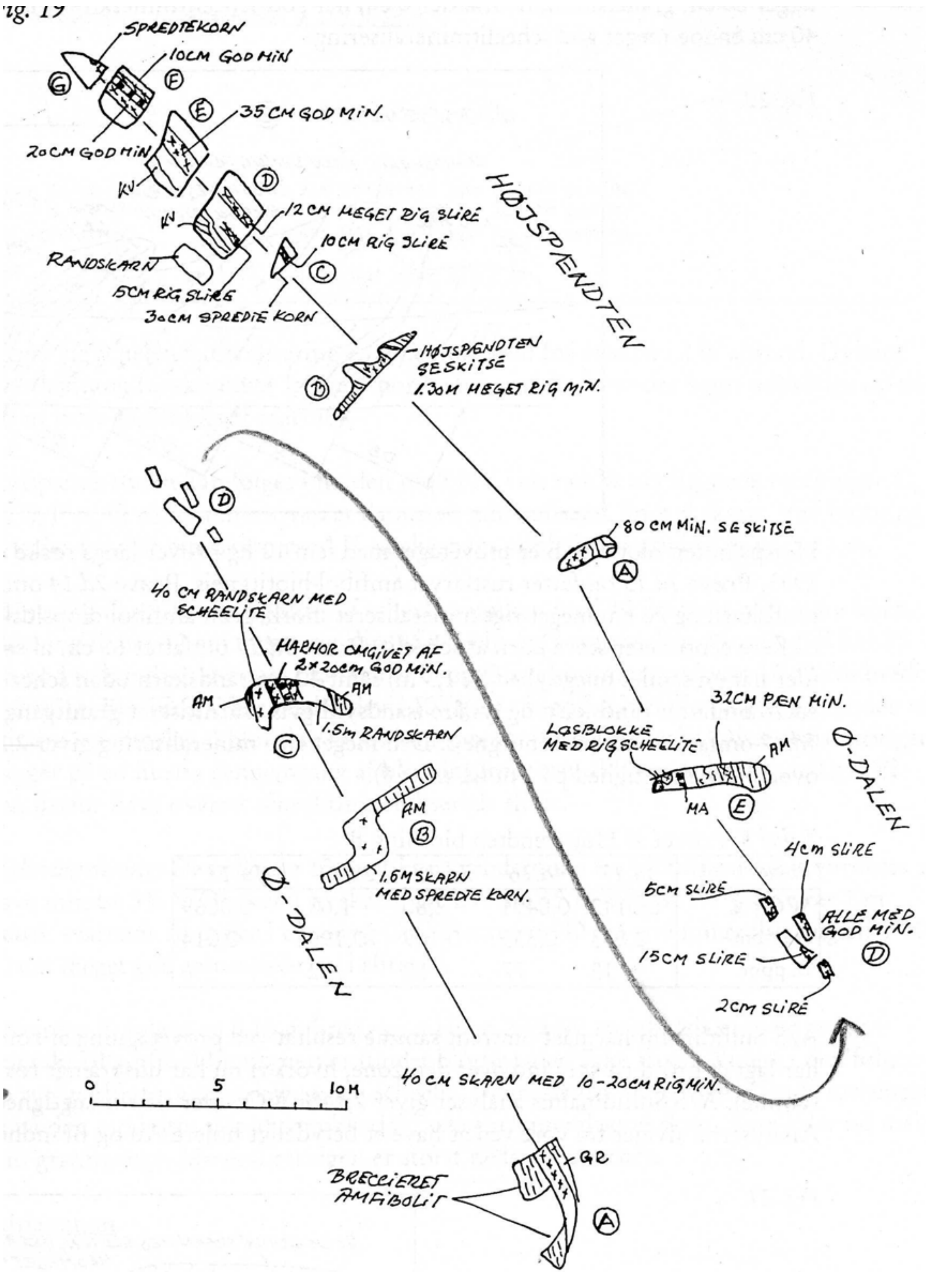
***Appendix II.** Continued.*
Korstræ Zonen - Lady Di Zonen – Marmordobbeltfoldområde



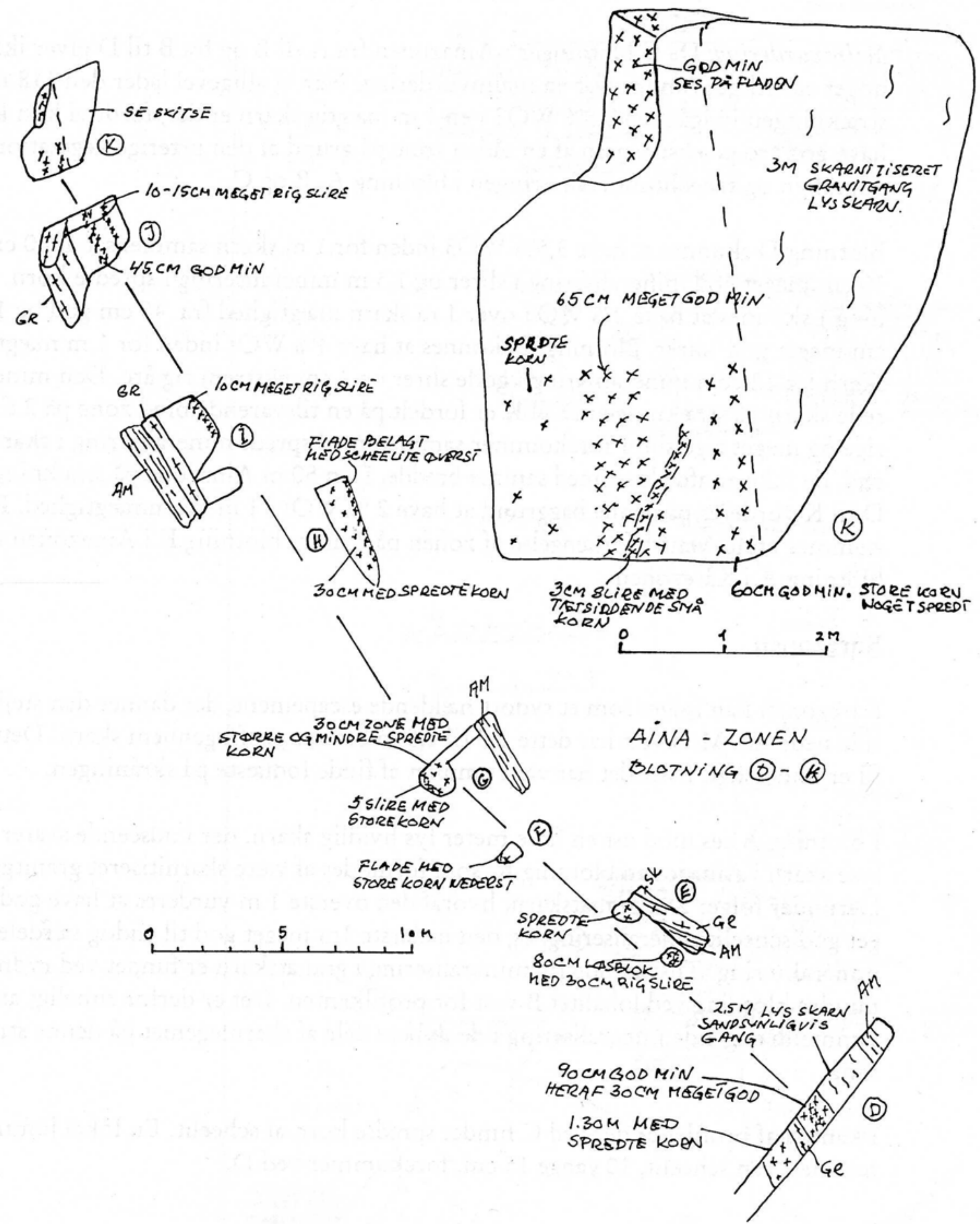
***Appendix II*. Continued.**
Det Store Hul – Cobra



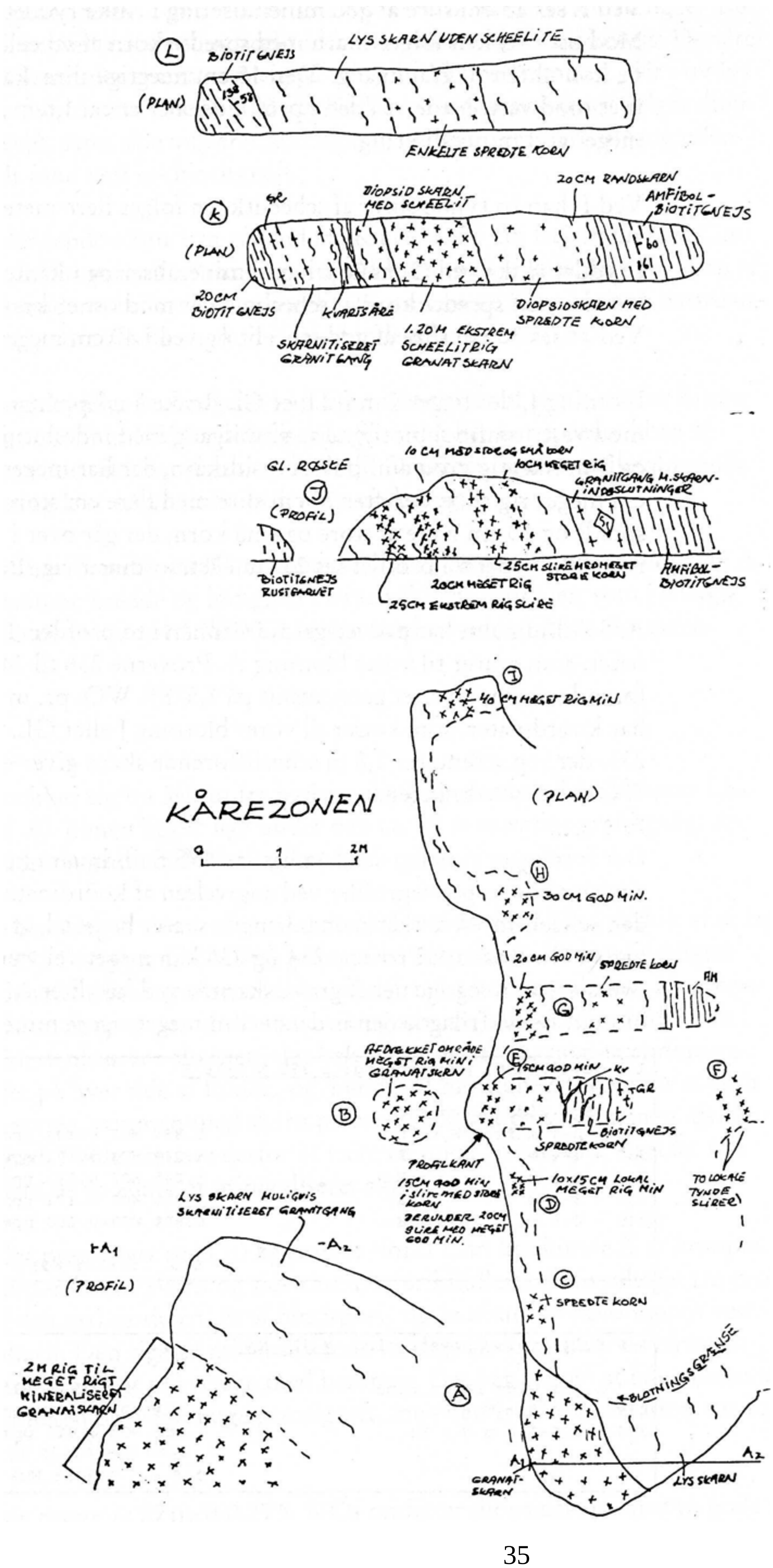
Appendix II. Continued.
Ø-Dalen - Højspændten



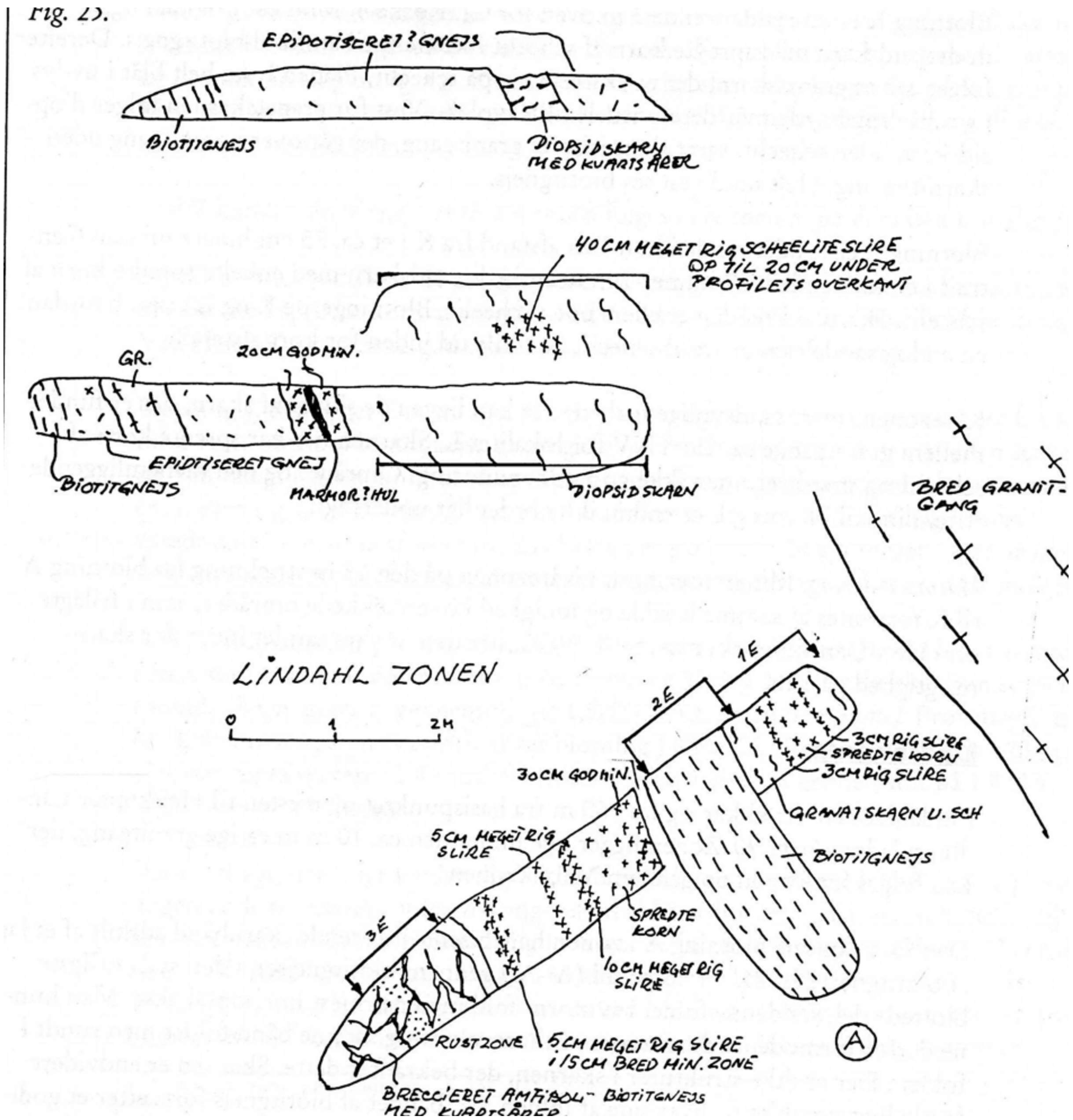
***Appendix II**. Continued.*
Aina Zonen



***Appendix II**. Continued.*
Kårezonen

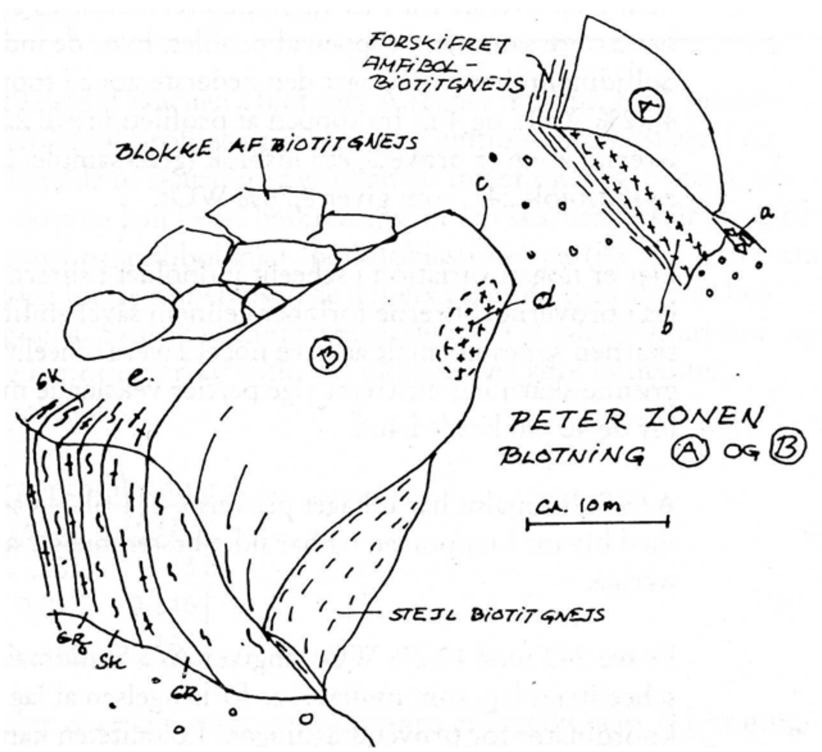


***Appendix II**. Continued.*
Lindahl Zonen



Appendix II. *Continued.*

Peter Zonen



Appendix III. *Portable XRF analyses of 15 grab samples representing different rock types of the Målvika skarn zone with different tungsten content. Each sample was analysed 6-10 times by the portable XRF. The averages of these analyses were used to compare the tungsten concentrations determined by INAA.*

sample	analysis	W	Ca	Fe	Zr	Mn	Ti	Zn
		ppm	%	%	ppm	%	%	ppm
45456	1	<100	1.73	0.63	120	<0.02	0.17	<100
Granite	2	<100	0.89	0.60	110	<0.02	0.20	<100
dyke	3	<100	2.09	0.41	100	<0.02	0.18	<100
	4	<100	2.17	0.52	100	<0.02	0.23	<100
	5	<100	1.55	0.58	100	<0.02	0.17	<100
	average	**<100**	**1.68**	**0.55**	**106**	**<0.02**	**0.19**	**<100**
	stdv		0.51	0.09	9		0.02	
45457	1	<100	6.12	0.86	170	<0.02	0.12	<100
Granodiorite	2	<100	2.43	2.18	220	0.05	0.51	<100
Dyke	3	<100	1.87	2.40	220	0.04	0.45	<100
	4	<100	1.87	2.02	190	0.03	0.45	<100
	5	<100	2.43	3.03	250	<0.02	0.61	130
	average	**<100**	**2.94**	**2.10**	**210**	**0.03**	**0.42**	**<100**
	stdv		1.80	0.79	31	0.01	0.18	
45458	1	<100	2.67	1.76	240	0.03	0.42	<100
Granodiorite	2	<100	3.12	1.63	220	0.04	0.30	<100
Dyke	3	<100	3.38	1.68	240	0.04	0.29	<100
	4	<100	4.33	1.59	230	0.04	0.32	<100
	5	<100	3.13	1.90	240	0.03	0.36	<100
	average	**<100**	**3.33**	**1.71**	**234**	**0.04**	**0.34**	**<100**
	stdv		0.62	0.12	9	0.01	0.05	
45459	1	6540	10.08	5.30	<100	0.37	0.00	1130
Garnet diopside	2	<100	22.02	8.69	<100	0.87	0.15	2210
Skarn	3	<100	31.72	9.07	<100	0.83	0.00	1020
	4	1620	26.30	8.00	<100	0.69	0.05	1550
	5	650	9.98	4.67	<100	0.31	0.00	400
	6	<100	2.36	1.28	<100	0.11	0.01	100
	7	3640	26.74	6.36	<100	0.69	0.08	1470
	8	2290	17.10	7.73	<100	0.59	0.01	870
	9	170	15.77	9.05	<100	0.81	0.01	1770
	average	**1657**	**14.39**	**5.82**	**<100**	**0.50**	**0.02**	**922**
	stdv	2226	9.53	2.58		0.26	0.05	664
45460	1	<100	15.42	7.02	230	0.31	0.40	290
Diopside	2	<100	14.46	5.57	270	0.28	0.34	410
Skarn	3	<100	15.47	7.88	170	0.40	0.76	490
	4	<100	12.86	7.13	260	0.36	0.94	420
	5	<100	9.79	3.12	250	0.13	0.28	110
	6	<100	17.46	8.36	250	0.41	0.74	410
	7	<100	11.12	9.09	240	0.32	0.91	320
	8	<100	11.77	9.94	170	0.48	0.69	400
	9	<100	13.22	8.94	190	0.41	0.35	450
	average	**<100**	**12.67**	**7.89**	**220**	**0.35**	**0.59**	**338**
	stdv		2.43	2.08	39	0.10	0.26	114
45461	1	<100	42.56	0.86	270	0.04	0.14	<100
Marble	2	<100	51.15	0.60	260	<0.02	0.13	<100
	3	<100	48.77	0.48	260	<0.02	0.03	<100
	4	<100	46.86	0.24	260	<0.02	0.01	<100
	5	<100	47.07	0.76	240	<0.02	0.05	<100
	6	<100	48.42	0.41	250	<0.02	0.04	<100
	7	<100	50.05	0.50	250	0.02	0.04	<100
	8	<100	50.17	0.67	260	0.02	0.21	<100
	average	**<100**	**48.51**	**0.51**	**252**	**<0.02**	**0.07**	**<100**
	stdv		2.70	0.20	9	0.01	0.07	

Appendix III. *Continued.*

sample	analysis	W	Ca	Fe	Zr	Mn	Ti	Zn
		ppm	%	%	ppm	%	%	ppm
45462 Garnet diopside Skarn	1	<100	16.92	10.89	<100	0.95	0.05	2080
	2	110	20.00	11.51	<100	0.91	0.14	640
	3	<100	18.21	5.43	<100	0.64	0.12	240
	4	<100	10.41	4.73	130	0.33	0.03	210
	5	<100	19.93	8.46	<100	0.68	0.04	410
	6	530	20.91	7.30	<100	0.80	0.28	300
	7	103570	17.40	7.90	<100	0.64	0.02	<100
	8	<100	13.89	7.71	<100	0.80	0.00	410
	9	<100	30.75	6.00	<100	0.62	0.24	260
	10	<100	17.28	3.59	<100	0.44	0.28	190
	average	**10421**	**20.04**	**6.50**	**<100**	**0.66**	**0.16**	**474**
	stdv	59612	5.29	2.54		0.19	0.11	599
45463 Garnet diopside Skarn	1	<100	22.09	7.19	<100	0.84	0.10	990
	2	32200	19.09	6.47	<100	0.53	0.12	<100
	3	300	26.49	3.96	<100	0.60	0.21	110
	4	<100	29.33	5.20	<100	0.74	0.02	130
	5	<100	31.06	5.67	<100	0.75	0.14	180
	6	<100	21.79	5.37	<100	0.57	0.11	360
	7	<100	25.49	6.81	<100	0.72	0.23	320
	8	<100	20.00	5.38	<100	0.73	0.16	420
	9	39630	19.67	7.43	<100	0.53	0.01	240
	10	<100	23.95	4.44	<100	0.66	0.30	100
	average	**7213**	**22.18**	**5.88**	**<100**	**0.64**	**0.16**	**285**
	stdv	20895	4.14	1.16		0.11	0.09	277
45464 Garnet diopside Skarn	1	18740	12.34	8.18	140	0.54	0.09	440
	2	260	14.80	6.52	120	0.41	0.13	570
	3	72440	11.64	6.48	<100	0.26	0.00	<100
	4	210	15.64	7.89	<100	0.48	0.07	520
	5	<100	16.89	7.21	120	0.38	0.21	790
	6	<100	21.06	5.87	<100	0.46	0.41	460
	7	<100	14.42	5.27	160	0.30	0.26	690
	8	180	18.10	6.62	<100	0.52	0.46	410
	9	110	17.10	6.33	130	0.47	0.08	420
	10	<100	16.25	4.57	140	0.33	0.27	800
	average	**9194**	**17.39**	**5.73**	**<100**	**0.42**	**0.30**	**510**
	stdv	28948	2.75	1.10	15	0.10	0.15	156
45465 Bindal granite	1	<100	2.65	1.77	270	0.04	0.37	<100
	2	<100	2.05	1.66	220	0.04	0.37	<100
	3	<100	2.39	2.53	270	0.05	0.49	<100
	4	<100	6.03	2.89	290	0.03	0.64	<100
	5	100	14.35	1.21	250	0.02	0.22	<100
	6	<100	12.89	1.24	270	0.02	0.11	<100
	7	<100	2.76	2.65	260	0.06	0.49	<100
	8	<100	3.27	3.34	360	0.07	0.61	<100
	9	<100	2.90	2.05	240	0.05	0.42	<100
	average	**<100**	**7.23**	**2.10**	**276**	**0.04**	**0.37**	**<100**
	stdv		4.77	0.75	39	0.02	0.17	
45466 Bindal granite	1	<100	2.58	1.38	160	0.03	0.31	<100
	2	<100	1.13	1.34	160	0.03	0.27	<100
	3	<100	2.27	1.40	170	0.03	0.22	<100
	4	<100	2.22	1.55	180	0.03	0.39	<100
	5	<100	1.16	1.11	130	0.03	0.37	<100
	6	<100	1.37	1.88	160	0.07	0.30	<100
	7	<100	1.08	1.20	150	<0.02	0.27	<100
	8	<100	1.35	1.70	150	0.04	0.18	<100
	average	**<100**	**1.44**	**1.49**	**154**	**0.04**	**0.30**	**<100**
	stdv		0.61	0.26	15	0.02	0.07	
45467 Bindal granite	1	<100	1.67	1.29	200	0.02	0.36	<100
	2	<100	1.27	1.12	190	0.02	0.28	<100
	3	<100	1.36	1.16	180	0.04	0.39	<100
	4	<100	1.67	1.57	210	<0.02	0.25	<100
	5	<100	3.10	0.49	160	<0.02	0.06	<100
	6	<100	2.08	1.76	210	0.03	0.30	<100
	7	<100	2.35	2.48	220	<0.02	0.55	<100
	8	<100	1.44	0.96	170	<0.02	0.28	<100
	average	**<100**	**2.13**	**1.45**	**194**	**<0.02**	**0.29**	**<100**
	stdv		0.62	0.60	21	0.01	0.14	

Appendix III. *Continued.*

sample	analysis	W	Ca	Fe	Zr	Mn	Ti	Zn
		ppm	%	%	ppm	%	%	ppm
45468	1	<100	17.29	5.80	100	0.51	0.35	340
Garnet diopside	2	120	20.92	7.49	<100	0.69	0.26	350
Skarn	3	<100	12.44	5.87	160	0.36	0.04	670
	4	1300	20.96	6.38	<100	0.77	0.17	250
	5	140	16.67	7.02	<100	0.46	0.19	570
	6	120	20.47	4.79	230	0.61	0.21	230
	7	<100	21.26	8.47	<100	0.79	0.27	670
	8	<100	16.70	5.42	<100	0.54	0.23	180
	9	<100	16.57	7.08	<100	0.55	0.33	620
	average	**187**	**18.33**	**6.55**	**<100**	**0.59**	**0.25**	**431**
	stdv	587	2.97	1.14	65	0.14	0.09	200
45469	1	100830	17.60	3.45	<100	0.46	0.00	<100
Garnet diopside	2	27130	16.79	10.36	<100	0.60	0.02	260
Skarn	3	86120	17.27	4.15	<100	0.44	0.04	<100
	4	190	18.44	12.32	<100	1.00	0.04	650
	5	370	19.22	9.81	<100	0.69	0.05	780
	6	640	16.14	13.05	<100	0.92	0.04	690
	7	46400	17.50	10.18	<100	0.65	0.03	<100
	8	370	19.76	11.43	<100	0.90	0.03	880
	9	1310	22.97	6.80	<100	0.90	0.18	220
	10	450	23.30	10.77	<100	0.80	0.08	740
	Average	**26381**	**19.93**	**10.45**	**<100**	**0.84**	**0.07**	**422**
	Stdv	38752	2.48	3.32		0.20	0.05	258
45470	1	<100	3.71	2.79	440	0.07	0.47	<100
Bindal granite	2	<100	3.12	3.94	570	0.07	0.83	<100
	3	<100	3.02	3.45	500	0.07	0.70	<100
	4	<100	3.92	3.42	570	0.08	0.61	<100
	5	<100	2.50	2.71	500	0.05	0.67	<100
	6	<100	2.76	1.84	440	0.06	0.42	<100
	7	<100	3.74	4.70	620	0.08	0.63	<100
	8	<100	3.01	2.33	440	0.05	0.61	<100
	average	**<100**	**3.19**	**3.00**	**514**	**0.06**	**0.59**	**<100**
	stdv		0.51	0.92	70	0.01	0.13	

Appendix IV. *Major (XRF) and trace (INAA) element analyses of grab samples representing different rock types of the Målvika skarn zone with different tungsten contents. These samples were analysed to compare tungsten concentrations determined by the portable XRF and INAA. Note, that high tungsten correlates with high gold.*

		45456 granite dyke	45457 grano-diorite dyke	45458 grano-diorite dyke	45459 garnet diopside skarn	45460 diopside skarn	45461 marble	45462 garnet diopside skarn	45463 garnet diopside skarn	45464 garnet diopside skarn	45465 Bindal granite	45466 Bindal granite	45467 Bindal granite	45468 garnet diopside skarn	45469 garnet diopside skarn	45470 Bindal granite
Major elements																
SiO_2	wt.%	71.9	68.2	65.4	43.2	53.1	n.d.	44.6	n.d.	n.d.	64.1	70.4	70.0	n.d.	n.d.	n.d.
Al_2O_3	wt.%	15.0	15.2	17.5	7.38	9.75	n.d.	5.93	n.d.	n.d.	17.2	15.3	15.8	n.d.	n.d.	n.d.
Fe_2O_3	wt.%	0.96	3.21	3.02	13.8	11.1	n.d.	16.6	n.d.	n.d.	3.76	1.88	1.62	n.d.	n.d.	n.d.
TiO_2	wt.%	0.17	0.55	0.41	0.16	1.07	n.d.	0.21	n.d.	n.d.	0.66	0.25	0.28	n.d.	n.d.	n.d.
MgO	wt.%	0.23	1.28	1.39	3.14	4.63	n.d.	3.19	n.d.	n.d.	1.36	0.65	0.46	n.d.	n.d.	n.d.
CaO	wt.%	1.84	2.65	4.73	26.0	18.2	n.d.	24.3	n.d.	n.d.	3.65	2.26	1.83	n.d.	n.d.	n.d.
Na_2O	wt.%	4.19	3.96	5.24	0.19	1.37	n.d.	0.21	n.d.	n.d.	4.96	4.18	4.29	n.d.	n.d.	n.d.
K_2O	wt.%	4.11	3.37	1.42	0.03	0.24	n.d.	0.03	n.d.	n.d.	2.80	3.80	4.03	n.d.	n.d.	n.d.
MnO	wt.%	0.02	0.04	0.05	1.00	0.36	n.d.	1.10	n.d.	n.d.	0.06	0.04	0.02	n.d.	n.d.	n.d.
P_2O_5	wt.%	0.04	0.17	0.16	0.24	0.17	n.d.	0.22	n.d.	n.d.	0.24	0.10	0.11	n.d.	n.d.	n.d.
LOI	wt.%	0.29	0.35	0.20	3.99	0.03	n.d.	1.38	n.d.	n.d.	0.50	0.37	0.39	n.d.	n.d.	n.d.
total	wt.%	98.7	98.9	99.6	99.1	99.9	n.d.	97.8	n.d.	n.d.	99.2	99.2	98.8	n.d.	n.d.	n.d.
Trace elements																
Sb	ppm	0.3	0.3	0.1	<0.2	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
As	ppm	0.9	0.6	0.5	<1.8	0.9	<0.5	<33	<1.3	<2.4	<0.5	<0.5	<0.5	<0.5	<1.9	<0.5
Ba	ppm	530	480	300	<16	150	220	<50	<120	<50	570	800	520	<50	<50	1900
Br	ppm	<0.5	<0.5	<0.5	<16	<0.5	<0.5	<7	<8.3	<7.8	<0.5	<0.5	<0.5	<0.5	<1.1	<0.5
Ce	ppm	33	70	38	<3	53	17	5	8	6	94	39	70	<3	<3	79
Cs	ppm	4	14	2	<1	3	<1	<1	<1	3	4	2	5	10	<1	1
Cr	ppm	<5	22	15	<15	64	33	10	<5	19	12	12	5	14	15	27
Co	ppm	1	7	6	12	28	3	11	11	22	8	4	2	11	15	6
Eu	ppm	0.9	1.1	0.8	0.7	1.6	0.4	0.7	1.3	0.6	1.6	1.1	0.8	1.3	0.4	2.9
Au	ppb	<2	10	<2	1370	854	8	309	<11	<21	<2	<2	<2	180	338	4
Hf	ppm	3	7	5	<1	5	1	<1	<1	<1	6	<1	5	<1	<1	11
Ir	ppb	<5	<5	<5	<21	<5	<5	<5	<15	<5	<5	<5	<5	<5	<5	<5
La	ppm	19.0	44.0	26.0	4.3	37.0	8.3	5.7	6.9	4.9	54.1	23.0	43.0	1.1	1.2	50.0
Lu	ppm	0.06	0.09	0.11	<0.5	0.48	0.13	<0.2	<0.7	0.26	0.16	0.11	0.08	0.37	0.35	0.22
Hg	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Mo	ppm	<1	<2	<1	<9	38	<1	<5	<7	46	<1	<1	<2	<1	<3	<1
Nd	ppm	10	22	11	<5	19	8	5	8	5	36	15	20	5	<5	31
Ni	ppm	<100	140	160	<100	140	<100	<100	<100	<100	190	<100	<100	<100	<100	130
Rb	ppm	160	170	46	<15	28	21	<15	<15	<15	87	100	150	<15	<15	91
Sm	ppm	2.7	4.9	2.8	1.6	6.0	1.9	1.1	3.3	1.6	8.6	3.2	4.3	2.4	1.0	6.0
Sc	ppm	1.5	4.5	5.2	3.1	16.8	2.9	2.2	2.4	4.3	5.1	2.9	2.3	2.1	2.1	6.0
Se	ppm	<3	<3	<3	<9	58	<3	<3	<6	<3	<3	<3	<3	<3	<3	<3
Ag	ppm	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Sr	ppm	<500	<500	<500	<500	<500	770	<500	<500	<500	<500	<500	<500	<500	<500	<500
Ta	ppm	<0.5	1.0	0.6	<0.5	1.3	<0.5	<0.5	0.8	1.4	1.0	0.5	0.9	<0.5	<0.5	0.6
Tb	ppm	<0.5	<0.5	<0.5	0.8	0.8	<0.5	<0.5	1.2	0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5
Th	ppm	8.7	17.0	6.5	<0.6	8.2	2.3	0.6	<0.4	1.3	11.0	6.2	14.0	<0.2	<0.2	2.7
Sn	ppm	<100	<100	<100	<360	<100	<100	<100	<250	<100	<100	<100	<100	<100	<100	<100
W	ppm	<1	<1	<1	4870	26	57	55200	4160	16600	153	205	37	292	11800	89
U	ppm	2.3	4.4	2.7	<1.9	2.9	1.5	<1.3	<1.1	2.0	1.9	0.7	3.1	1.7	<0.5	1.0
Yb	ppm	0.3	0.4	0.7	1.9	2.9	0.8	1.3	4.7	1.5	1.1	0.7	0.5	2.4	1.6	1.4
Zn	ppm	82	150	180	900	490	55	520	330	600	170	86	81	630	610	160

n.d. – not determined

Appendix V. *Major element concentrations of trench samples analysed by INAA, Actlabs Ancaster, Canada. Limits of detection are given in the third row. dp skarn – diopside skarn, gt-dp skarn – garnet-diopside skarn, skarn + slph – skarn with sulphide mineralisation.*

NGU #	**trench #**	**rock type**	**SiO_2**	**Al_2O_3**	**Fe_2O_3**	**MnO**	**MgO**	**CaO**	**Na_2O**	**K_2O**	**TiO_2**	**P_2O_5**	**LOI**	**Total**
			wt.%	wt.%	wt.%	wt.%	wt.%	wt.%	wt.%	wt.%	wt.%	wt.%	wt.%	wt.%
			0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.005	0.01	0.01	0.01
58921	1/1	dp skarn	49.44	8.05	12.78	0.57	4.02	19.36	0.67	1.13	1.013	0.37	1.43	98.83
58922	1/2	dp skarn	56.56	12.02	5.28	0.2	2.55	16.1	1.61	0.85	0.853	0.38		96.41
58923	1/3	dp skarn	47.96	10.58	7.23	0.32	4.81	26.06	0.64	0.22	0.754	0.12	2.1	100.8
58924	1/4	gt-dp skarn	47.58	10.01	9.68	0.48	4.58	25.23	0.47	0.19	0.699	0.13	1.93	101
58925	1/5	dp skarn	49.27	10.16	11.73	0.5	4.24	18.13	1.25	0.55	2.453	0.42	0.74	99.44
58926	1/6	gneiss	48.6	14.26	11.99	0.2	6.01	10.95	2.55	0.85	2.103	0.33	1.05	98.91
58927	2/1	gneiss	49.23	14.4	9.92	0.17	9.14	10.45	2.29	1.58	1.387	0.34	1.53	100.4
58928	2/2	dp skarn	57.24	10.86	8.61	0.16	6.78	9.91	2.44	1.51	0.876	0.44	1.76	100.6
58929	2/3	dp skarn	54.11	12.42	8.16	0.26	5.81	14.16	2.31	0.98	0.669	0.43	1.09	100.4
58930	2/4	gneiss	49.76	14.24	9.97	0.2	5.97	14.22	2.28	0.71	1.52	0.43	1.6	100.9
58931	2/5	gneiss	47.3	14.02	10.35	0.15	10.32	10.32	2.07	1.75	1.212	0.19	1.92	99.6
58932	2/6	dp skarn	52.1	10.4	8.46	0.22	12.41	10.44	1.9	2.3	0.558	0.03	1.45	100.3
58933	2/7	dp skarn	48.99	5.78	11.8	0.37	15.45	12.58	0.53	0.67	0.577	0.03	2.38	99.15
58934	2/8	gneiss	50.31	7.57	14.38	0.58	3.65	19.4	0.97	0.23	0.676	0.38	0.56	98.7
58935	3/1	dp skarn	48.82	11.1	10.29	0.21	5.16	21.05	1.23	0.13	1.14	0.46	0.73	100.3
58936	3/2	dp skarn	49.01	10.12	11.47	0.27	4.51	21.91	1.05	0.09	1.101	0.56	0.56	100.7
58937	3/3	dp skarn	47.48	10.77	9.23	0.23	3.96	23.9	0.83	0.14	1.128	0.55	2	100.2
58938	3/4	marble	30.8	7.4	4.24	0.1	3.29	35.06	0.51	0.1	0.697	0.21	15.96	98.36
58939	3/5	marble	20.02	4.97	2.12	0.05	2.73	42.31	0.53	0.16	0.588	0.13	25.85	99.44
58940	3/6	marble	24.9	5.21	2.91	0.07	3.56	39.07	0.55	0.31	0.446	0.16	22.9	100.1
58941	3/7	marble	15.12	3.3	1.81	0.03	2.38	45.17	0.25	0.3	0.296	0.26	31.07	100
58942	3/8	marble	27.06	6.59	2.84	0.05	4.03	36.61	0.61	0.67	0.598	0.15	20.27	99.48
58943	4/1	dp skarn	63.01	13.47	4.46	0.19	1.93	11.95	2.05	0.06	1.23	0.18	0.66	99.2
58944	4/2	dp skarn	60.61	15.27	4.4	0.21	1.78	14.68	0.66	0.08	1.341	0.26		99.29
58945	4/3	dp skarn	55.46	11.17	4.7	0.23	1.74	12.34	0.46	0.01	1.292	0.21		87.61
58946	4/4	dp skarn	66.66	11.85	4.95	0.27	1.57	12.87	0.41	0.04	1.398	0.22	0.69	100.9
58947	4/5	dp skarn	55.21	7.81	13.68	0.67	3.34	17.68	0.43	0.13	0.285	0.38	0.61	100.2
58948	4/6	dp skarn	53.65	4.39	14.17	0.75	3.14	17.73	0.33	0.41	0.121	0.25	0.41	95.35
58949	4/7	gt-dp skarn	42.82	13.96	10.38	0.9	1.69	26.88	0.33	0.1	0.301	0.22	0.85	98.42
58950	4/8	dp skarn	52.64	11.29	9.65	0.48	3.67	18.95	0.67	0.15	0.951	0.2	1.03	99.67
57651	5/1	gt-dp skarn	47.07	14.96	8.32	0.57	2.26	20.87	0.99	0.31	0.346	1.45	1.31	98.46
57652	5/2	dp skarn	47.72	13.1	8.78	0.39	3.01	22.87	0.58	0.2	1.039	0.36	1.43	99.49
57653	5/3	dp skarn	52.46	11.33	9.17	0.27	3.75	17.71	1.34	0.35	1.333	0.3	0.73	98.74
57654	5/4	gt-dp skarn	55.41	13.59	8.32	0.15	3.74	10.2	2.88	1.8	1.502	0.42	1.56	99.58
57655	5/5	gt-dp skarn	54.07	14.2	9.2	0.16	4.28	9.3	2.83	2.62	1.485	0.31	1.09	99.54
57656	5/6	gt-dp skarn	54.22	10.78	8.88	0.28	3.69	17.98	1	0.31	1.24	0.3	0.87	99.56
57657	5/7	marble	58.76	17.52	2.25	0.09	0.66	14.35	1.58	0.68	0.281	0.12	3.17	99.46
57658	6/1	dp skarn	49.13	5.05	17.26	0.96	3.49	20.65	0.45	0.21	0.686	0.33	2.72	100.9
57659	6/2	dp skarn	41.78	5.22	15.14	0.77	3.82	25.38	0.44	0.18	1.013	0.19	4.82	98.75
57660	6/3	gt-dp skarn	41.53	6.44	13.47	0.73	3.72	26.89	0.45	0.14	0.814	0.16	4.99	99.35
57661	6/4	gt-dp skarn	43.78	10.03	11.56	0.68	2.72	24.29	0.32	0.41	0.807	0.18	3.72	98.5
57662	6/5	gt-dp skarn	39.65	10.42	9.6	0.47	2.32	26.56	0.38	0.97	0.86	0.12	7.28	98.62
57663	6/6	gt-dp skarn	40.25	13.02	10.68	0.83	1.63	29.07	0.26	0.14	0.762	0.1	2.83	99.57
57664	6/7	gt-dp skarn	50.11	11.97	8.31	0.42	2.85	20.71	1.09	0.55	1.06	0.29	1.89	99.26

***Appendix V*. Continued.**

NGU #	trench #	rock type	SiO_2 wt.% 0.01	Al_2O_3 wt.% 0.01	Fe_2O_3 wt.% 0.01	MnO wt.% 0.01	MgO wt.% 0.01	CaO wt.% 0.01	Na_2O wt.% 0.01	K_2O wt.% 0.01	TiO_2 wt.% 0.005	P_2O_5 wt.% 0.01	LOI wt.% 0.01	Total wt.% 0.01
57665	7/1	gt-dp skarn	55.3	13.62	8.19	0.54	2.15	15.26	1.26	0.37	0.326	0.38	1.58	98.98
57666	7/2	dp skarn	51.72	8.79	13.74	0.76	3.05	15.7	0.97	0.37	0.077	0.09		95.26
57667	7/3	dp skarn	50.08	4.36	17.59	0.96	5.22	20.23	0.47	0.1	0.117	0.09	0.74	99.96
57668	7/4	dp skarn	44.85	5.91	14.82	0.92	3.76	20.69	0.69	0.18	0.087	0.09	0.47	92.47
57669	7/5	skarn + slph	46.72	11.4	19.47	0.62	3.13	8.8	1.96	0.46	0.202	0.1	6.3	99.17
57670	7/6	skarn + slph	48.43	6.99	18.69	0.72	4.34	16.09	0.99	0.2	0.119	0.06	2.4	99.03
57671	7/7	skarn + slph	53.03	10.67	11.61	0.46	4.5	14.41	1.65	0.61	1.184	0.32	0.94	99.38
57672	7/8	gneiss	49.33	14.55	10.64	0.21	5.93	11.9	2.33	0.95	1.421	0.24	1	98.51
57673	8/1	dp skarn	63.14	13.73	5.95	0.27	1.75	9.66	2.7	0.97	0.711	0.19	0.58	99.67
57674	8/2	gneiss	57.72	12.81	9.05	0.31	3.62	8.82	2.47	1.74	1.037	0.25	1.4	99.23
57675	8/3	dp skarn	87.15	6.62	1.89	0.04	0.15	2.16	1.74	0.21	0.035	0.02	0.97	101
57676	8/4	dp skarn	57.77	13.68	8.25	0.24	2.83	7.68	2.67	1.57	1.063	0.31	1.26	97.3
57677	8/5	dp skarn	48.04	11.23	13.38	0.75	3.53	19.87	0.66	0.11	1.259	0.36	0.97	100.2
57678	8/6	gneiss	58.47	10	9.36	0.52	3.55	11.91	1.53	1.46	0.9	0.34	0.73	98.77
57679	8/7	gneiss	66.87	13.01	4.05	0.33	2.87	3.57	2.56	4.18	0.552	0.63	0.79	99.42
57680	8/8	gneiss	65.31	11.62	6.64	0.16	2.65	3.87	2.17	3.12	0.962	0.27	1.43	98.22
57681	8/9	dp skarn	47.9	6.68	12.3	0.67	7.53	21.85	0.64	0.22	0.398	0.23		98.41
57682	8/10	dp skarn	48.48	11.09	12.2	0.6	4.32	18.86	1.03	0.1	0.957	0.39	1.48	99.52
57683	8/11	dp skarn	66.73	13.06	6.19	0.12	2.6	3.53	2.53	2.86	0.859	0.19	0.71	99.39
57684	9/1	dp skarn	51.85	13.83	7.65	0.22	6.62	11.93	3.06	2.15	1.433	0.69	0.59	100
57685	9/2	dp skarn	49.48	11.14	10.51	0.45	3.75	20.84	0.84	0.2	0.829	1.06	1.54	100.6
57686	9/3	gt-dp skarn	54.43	12.89	9.56	0.46	2.27	13.97	1.49	1.52	0.97	0.33	1.79	99.68

Appendix VIa. *Trace element concentrations (Au to Rb) of trench samples analysed by INAA, Actlabs Ancaster, Canada. Limits of detection are given in the third row. dp skarn – diopside skarn, gt-dp skarn – garnet-diopside skarn, skarn + slph – skarn with sulphide mineralisation.*

NGU #	trench #	rock type	Au	Ag	As	Ba	Be	Bi	Br	Cd	Co	Cr	Cs	Cu	Hf	Hg	Ir	Mo	Ni	Pb	Rb
			ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppm	ppm	ppm	ppm
			5	0.5	2	3	1	2	1	0.5	1	1	0.5	1	0.5	1	5	2	1	5	20
58921	1/1	dp skarn	350	< 0.5	< 2	117	26	129	< 1	0.7	18	47	2.1	6	4.4	< 1	< 5	< 2	34	12	90
58922	1/2	dp skarn	15	< 0.5	< 2	116	33	41	< 1	0.5	11	41	1.3	12	6.1	< 1	< 5	< 2	26	6	50
58923	1/3	dp skarn	< 5	< 0.5	2	23	30	72	< 1	0.8	10	78	< 0.5	1	< 0.5	< 1	< 5	< 2	27	< 5	< 20
58924	1/4	gt-dp skarn	16	< 0.5	2	25	90	58	< 1	0.8	12	71	< 0.5	2	< 0.5	< 1	< 5	< 2	24	9	< 20
58925	1/5	dp skarn	6	< 0.5	< 2	60	26	2	1	0.8	21	22	3.8	69	4.9	< 1	< 5	< 2	20	9	30
58926	1/6	gneiss	< 5	0.7	< 2	84	3	< 2	< 1	0.9	39	172	3.2	90	3.6	< 1	6	< 2	80	16	20
58927	2/1	gneiss	< 5	< 0.5	< 2	193	3	< 2	< 1	0.7	39	365	6.8	42	2.4	< 1	9	2	155	11	50
58928	2/2	dp skarn	8	< 0.5	3	254	6	< 2	1	0.8	21	215	4.9	98	5.7	< 1	< 5	< 2	103	9	40
58929	2/3	dp skarn	< 5	< 0.5	4	126	17	5	2	0.6	19	214	9.6	77	5.5	< 1	< 5	< 2	93	14	30
58930	2/4	gneiss	9	< 0.5	5	64	6	< 2	2	0.6	38	217	2.2	208	2.2	< 1	< 5	< 2	119	10	30
58931	2/5	gneiss	< 5	< 0.5	5	212	3	< 2	1	0.7	48	594	19.1	117	4.1	< 1	< 5	< 2	271	12	90
58932	2/6	dp skarn	7	< 0.5	22	287	7	5	1	0.7	37	698	22.2	20	8.5	< 1	< 5	< 2	348	10	140
58933	2/7	dp skarn	27	< 0.5	15	61	9	22	< 1	0.8	48	1190	1.1	2	3.3	< 1	27	< 2	512	11	30
58934	2/8	gneiss	527	0.8	< 2	34	95	833	< 1	0.8	12	37	< 0.5	16	1.8	< 1	< 5	21	39	13	< 20
58935	3/1	dp skarn	6	0.6	< 2	98	3	16	5	0.7	21	63	< 0.5	38	5.4	< 1	< 5	< 2	38	9	< 20
58936	3/2	dp skarn	6	0.6	< 2	45	4	2	3	0.8	22	50	< 0.5	7	4.3	< 1	< 5	< 2	41	15	< 20
58937	3/3	dp skarn	< 5	0.6	< 2	50	6	12	1	0.8	16	69	< 0.5	2	3.8	< 1	< 5	< 2	33	< 5	< 20
58938	3/4	marble	< 5	0.7	< 2	82	5	13	2	0.5	11	54	< 0.5	2	2.9	< 1	< 5	< 2	21	7	< 20
58939	3/5	marble	< 5	0.9	< 2	267	2	< 2	2	< 0.5	7	41	< 0.5	2	2.4	< 1	< 5	< 2	12	6	< 20
58940	3/6	marble	< 5	1.1	< 2	165	2	< 2	1	< 0.5	7	37	< 0.5	< 1	1.9	< 1	< 5	< 2	9	5	< 20
58941	3/7	marble	< 5	1.9	< 2	167	1	< 2	5	< 0.5	7	30	0.9	28	1.6	< 1	< 5	< 2	14	7	< 20
58942	3/8	marble	< 5	0.8	< 2	424	2	< 2	2	< 0.5	10	54	1.2	3	2.8	< 1	< 5	< 2	17	15	20
58943	4/1	dp skarn	8	< 0.5	< 2	49	18	15	< 1	< 0.5	10	58	< 0.5	21	8.3	< 1	5	< 2	27	7	< 20
58944	4/2	dp skarn	< 5	< 0.5	< 2	17	16	< 2	2	< 0.5	10	66	< 0.5	7	6.8	< 1	10	< 2	26	< 5	< 20
58945	4/3	dp skarn	9	< 0.5	< 2	12	16	17	1	< 0.5	9	56	1.1	4	7.4	< 1	< 5	< 2	32	5	< 20
58946	4/4	dp skarn	16	< 0.5	< 2	9	16	46	2	< 0.5	7	66	< 0.5	6	9	< 1	< 5	< 2	31	7	< 20
58947	4/5	dp skarn	458	0.6	4	13	35	554	4	0.8	15	18	1.6	22	< 0.5	< 1	< 5	3	32	< 5	< 20
58948	4/6	dp skarn	1090	1.3	< 2	13	84	1390	< 1	0.9	13	12	< 0.5	20	0.5	< 1	< 5	26	23	13	< 20

Appendix VIa. *Continued.*

NGU #	trench #	rock type	Au ppb 5	Ag ppm 0.5	As ppm 2	Ba ppm 3	Be ppm 1	Bi ppm 2	Br ppm 1	Cd ppm 0.5	Co ppm 1	Cr ppm 1	Cs ppm 0.5	Cu ppm 1	Hf ppm 0.5	Hg ppm 1	Ir ppb 5	Mo ppm 2	Ni ppm 1	Pb ppm 5	Rb ppm 20
58949	4/7	gt-dp skarn	22	< 0.5	< 2	12	29	44	< 1	1.4	7	20	0.9	7	1	< 1	< 5	6	30	8	< 20
58950	4/8	dp skarn	6	< 0.5	< 2	28	108	6	2	0.7	16	81	1.7	8	3.7	< 1	< 5	< 2	31	12	< 20
57651	5/1	gt-dp skarn	39	< 0.5	< 2	42	28	38	< 1	0.8	9	27	1.9	6	3.2	< 1	< 5	< 2	19	8	30
57652	5/2	dp skarn	5	< 0.5	7	37	53	32	2	0.8	16	40	1.3	7	3	< 1	< 5	< 2	36	11	< 20
57653	5/3	dp skarn	20	< 0.5	4	83	16	27	< 1	0.8	20	72	2	19	5.9	< 1	< 5	< 2	40	10	< 20
57654	5/4	gt-dp skarn	< 5	< 0.5	< 2	455	3	< 2	< 1	0.6	21	73	4.3	111	5.4	< 1	< 5	< 2	38	10	100
57655	5/5	gt-dp skarn	< 5	< 0.5	< 2	424	4	< 2	< 1	0.6	22	75	11.3	122	5.5	< 1	< 5	< 2	43	9	100
57656	5/6	gt-dp skarn	< 5	< 0.5	< 2	71	11	18	1	0.6	17	63	2.8	17	5.1	< 1	< 5	< 2	35	6	30
57657	5/7	marble	< 5	0.7	< 2	41	21	8	< 1	< 0.5	3	14	1.6	7	2.9	< 1	< 5	< 2	14	5	< 20
57658	6/1	dp skarn	120	< 0.5	3	17	37	79	< 1	1	26	85	< 0.5	81	< 0.5	< 1	< 5	< 2	36	12	< 20
57659	6/2	dp skarn	13	< 0.5	< 2	14	13	3	< 1	0.9	26	136	< 0.5	4	3.1	< 1	< 5	< 2	41	11	< 20
57660	6/3	gt-dp skarn	8	< 0.5	10	15	47	9	< 1	0.9	28	95	< 0.5	1	3.1	< 1	< 5	< 2	31	9	< 20
57661	6/4	gt-dp skarn	60	< 0.5	< 2	45	49	64	< 1	0.9	15	69	< 0.5	1	2.5	< 1	< 5	28	37	8	< 20
57662	6/5	gt-dp skarn	158	< 0.5	< 2	107	82	148	< 1	0.8	13	58	< 0.5	2	2.3	< 1	< 5	31	29	7	< 20
57663	6/6	gt-dp skarn	81	< 0.5	< 2	16	14	118	< 1	1.3	12	62	< 0.5	4	< 0.5	< 1	< 5	4	34	7	< 20
57664	6/7	gt-dp skarn	< 5	< 0.5	< 2	57	39	12	< 1	0.7	12	76	1.7	4	3.5	< 1	< 5	< 2	29	7	40
57665	7/1	gt-dp skarn	53	< 0.5	3	29	113	11	< 1	0.8	8	16	2	53	3.2	< 1	< 5	< 2	29	21	< 20
57666	7/2	dp skarn	18	< 0.5	8	28	137	31	< 1	0.6	20	11	< 0.5	18	1.2	< 1	< 5	< 2	19	9	< 20
57667	7/3	dp skarn	46	< 0.5	3	8	154	9	< 1	1.1	21	12	< 0.5	77	1.5	< 1	< 5	< 2	23	16	20
57668	7/4	dp skarn	< 5	< 0.5	< 2	10	141	2	< 1	0.7	11	14	0.6	10	0.8	< 1	< 5	25	13	13	< 20
57669	7/5	skarn + slph	145	< 0.5	< 2	20	66	68	< 1	1	22	18	1	555	1.7	< 1	< 5	21	20	18	< 20
57670	7/6	skarn + slph	121	< 0.5	< 2	14	160	9	< 1	0.9	17	22	0.9	217	0.8	< 1	< 5	27	25	14	< 20
57671	7/7	skarn + slph	< 5	< 0.5	< 2	76	14	< 2	< 1	0.6	20	95	2.4	13	3.7	< 1	< 5	< 2	35	10	< 20
57672	7/8	gneiss	< 5	< 0.5	5	129	4	< 2	< 1	0.6	34	136	1.9	28	2.8	< 1	< 5	< 2	49	12	< 20
57673	8/1	dp skarn	< 5	< 0.5	< 2	98	17	3	< 1	0.5	8	40	2.7	32	6.7	< 1	< 5	< 2	22	16	< 20
57674	8/2	gneiss	< 5	< 0.5	2	352	9	< 2	< 1	0.6	17	68	7	54	8.8	< 1	< 5	< 2	39	10	50
57675	8/3	dp skarn	11	< 0.5	< 2	36	8	3	1	< 0.5	2	< 1	< 0.5	57	0.6	< 1	< 5	< 2	14	5	< 20
57676	8/4	dp skarn	< 5	< 0.5	2	450	9	< 2	< 1	0.5	14	63	10	88	9.4	< 1	< 5	< 2	29	7	70

Appendix VIa. *Continued.*

NGU #	trench #	rock type	Au ppb	Ag ppm	As ppm	Ba ppm	Be ppm	Bi ppm	Br ppm	Cd ppm	Co ppm	Cr ppm	Cs ppm	Cu ppm	Hf ppm	Hg ppm	Ir ppb	Mo ppm	Ni ppm	Pb ppm	Rb ppm
			5	0.5	2	3	1	2	1	0.5	1	1	0.5	1	0.5	1	5	2	1	5	20
57677	8/5	dp skarn	14	< 0.5	6	16	14	3	< 1	1	17	65	< 0.5	65	6.1	< 1	< 5	< 2	36	9	< 20
57678	8/6	gneiss	< 5	< 0.5	< 2	187	10	< 2	< 1	0.5	11	65	3.7	26	7.2	< 1	< 5	< 2	26	11	80
57679	8/7	gneiss	< 5	< 0.5	< 2	346	6	7	< 1	< 0.5	10	48	16	12	9	< 1	< 5	< 2	22	10	180
57680	8/8	gneiss	18	< 0.5	< 2	237	5	6	< 1	0.5	11	54	18.5	78	11.6	< 1	< 5	< 2	23	15	160
57681	8/9	dp skarn	27	< 0.5	< 2	32	14		< 1		17	25	< 0.5		1	< 1	< 5				< 20
57682	8/10	dp skarn	45	< 0.5	2	24	17	8	< 1	0.9	14	51	< 0.5	114	4	< 1	< 5	< 2	22	< 5	< 20
57683	8/11	dp skarn	< 5	< 0.5	< 2	400	4	< 2	< 1	< 0.5	15	54	7.7	55	8.6	< 1	< 5	< 2	30	11	120
57684	9/1	dp skarn	< 5	1	< 2	812	8	< 2	< 1	0.6	22	286	6.9	59	5.5	< 1	< 5	< 2	112	14	80
57685	9/2	dp skarn	11	< 0.5	< 2	34	14	18	< 1	0.5	11	74	< 0.5	6	4.2	< 1	< 5	< 2	33	8	< 20
57686	9/3	gt-dp skarn	23	< 0.5	2	163	22	19	< 1	0.8	12	15	4.7	36	3.4	< 1	< 5	< 2	22	8	70

***Appendix VIb**. Trace element concentrations (S to Lu) of trench samples analysed by INAA, Actlabs Ancaster, Canada. Limits of detection are given in the third row. dp skarn – diopside skarn, gt-dp skarn – garnet-diopside skarn, skarn + slph – skarn with sulphide mineralisation.*

NGU	**trench**	**rock**	**S**	**Sb**	**Sc**	**Se**	**Sr**	**Ta**	**Th**	**U**	**V**	**W**	**WO_3**	**Y**	**Zn**	**Zr**	**La**	**Ce**	**Nd**	**Sm**	**Eu**	**Tb**	**Yb**	**Lu**
#	**#**	**type**	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
			0.001	0.2	0.1	3	2	1	0.5	0.5	5	3		1	1	2	0.2	3	5	0.1	0.1	0.5	0.1	0.05
58921	1/1	dp skarn	0.009	0.3	9.7	< 3	202	1	7.5	4.3	91	695	0.088	29	542	175	26.4	53	28	4	1.5	0.8	3.3	0.47
58922	1/2	dp skarn	0.003	1.9	9.1	< 3	168	< 1	16.5	7.5	68	299	0.038	63	281	262	59.1	111	52	7.4	2.3	1.9	5.7	0.82
58923	1/3	dp skarn	0.006	3.3	7	< 3	195	< 1	9.1	2.6	82	2750	0.347	25	587	195	28.3	53	23	3.5	1.3	< 0.5	2.4	0.29
58924	1/4	gt-dp skarn	0.006	2.1	6.4	< 3	297	< 1	9.6	2.3	64	2260	0.285	19	580	191	26.8	48	29	3	0.9	< 0.5	2.1	0.19
58925	1/5	dp skarn	0.095	0.2	26.7	< 3	338	1	6.3	6.6	271	9	0.001	54	365	216	22.4	52	25	5.3	2.7	1.2	5.6	0.8
58926	1/6	gneiss	0.202	< 0.2	32.7	< 3	264	< 1	2.8	1.4	306	< 3	0.000	44	124	159	10.4	29	19	4	1.9	1.2	4.8	0.67
58927	2/1	gneiss	0.033	< 0.2	29.1	< 3	165	< 1	2.8	5.6	263	< 3	0.000	40	95	92	10.7	26	12	3.2	1.5	0.8	4.1	0.58
58928	2/2	dp skarn	0.054	< 0.2	14.1	< 3	243	< 1	10.4	3.6	124	< 3	0.000	42	115	234	22.8	59	25	4.4	1.6	1.1	4.3	0.65
58929	2/3	dp skarn	0.121	0.3	11	< 3	410	< 1	11.8	6.2	108	4	0.001	48	154	208	28.9	61	31	4.6	1.5	1	5.8	0.79
58930	2/4	gneiss	0.664	< 0.2	29.9	< 3	506	< 1	2.3	4.3	256	< 3	0.000	42	146	91	9	24	10	3.2	1.8	0.8	4.2	0.63
58931	2/5	gneiss	0.448	0.3	26.9	< 3	314	< 1	3.5	3.4	235	< 3	0.000	47	163	150	8.4	27	15	3.6	1.5	0.9	5.3	0.79
58932	2/6	dp skarn	0.014	0.6	10.9	< 3	135	1	11.1	3.1	90	5	0.001	97	204	340	16.5	52	28	6.2	2	2.2	10.3	1.37
58933	2/7	dp skarn	0.004	0.3	13.8	< 3	45	< 1	5.7	2.5	120	< 3	0.000	48	379	135	12.2	38	12	3.4	1	1.1	5.3	0.73
58934	2/8	gneiss	0.034	< 0.2	5.8	< 3	275	< 1	< 0.5	< 0.5	93	> 10000	1.260	33	277	124	15.6	23	17	1.7	1.1	0.6	3.3	0.5
58935	3/1	dp skarn	0.033	< 0.2	14.1	< 3	661	2	9.5	2.6	144	119	0.015	33	318	212	30.9	66	29	4.7	1.6	0.9	3.6	0.53
58936	3/2	dp skarn	0.012	< 0.2	13.5	< 3	565	2	10.6	4.2	117	21	0.003	45	515	190	35.9	71	40	5.7	1.9	1.1	4.6	0.62
58937	3/3	dp skarn	0.008	0.5	12.3	< 3	568	2	9	4.2	141	9	0.001	41	479	189	34.1	64	33	4.8	1.8	1	4.2	0.62
58938	3/4	marble	0.007	0.6	6	< 3	754	< 1	6.8	3.1	117	6	0.001	19	209	120	25.7	50	24	3.3	1.1	< 0.5	2	0.29
58939	3/5	marble	0.002	< 0.2	3.4	< 3	883	< 1	7.8	2.2	30	5	0.001	16	92	102	23.7	44	17	2.5	0.9	< 0.5	1.6	0.24
58940	3/6	marble	0.002	< 0.2	3.8	< 3	1031	< 1	7	2.6	57	4	0.001	18	136	97	18.5	35	16	2.3	0.8	< 0.5	1.8	0.26
58941	3/7	marble	0.024	< 0.2	2.9	< 3	1531	< 1	4.6	2.1	28	5	0.001	15	54	83	19.7	38	14	2.2	0.7	< 0.5	1.6	0.25
58942	3/8	marble	0.005	< 0.2	5.3	< 3	818	< 1	9.1	2.2	49	4	0.001	17	96	133	28.4	52	23	2.9	1	0.6	1.7	0.25
58943	4/1	dp skarn	0.013	< 0.2	12.5	< 3	455	< 1	32.7	6.7	85	13	0.002	59	149	383	77.2	143	61	8.9	2.4	1.4	5.9	0.84
58944	4/2	dp skarn	0.008	< 0.2	13.4	< 3	392	3	33	7.9	68	17	0.002	69	150	346	98.8	166	82	9.7	2.8	1.8	7.1	0.97
58945	4/3	dp skarn	0.006	< 0.2	14.1	< 3	255	2	26.1	6.3	74	24	0.003	67	182	352	69.6	131	53	8.1	2.1	1.5	6.4	0.91
58946	4/4	dp skarn	0.005	< 0.2	13	< 3	255	3	36.4	8.3	79	22	0.003	81	184	392	106	175	74	10.5	2.5	1.8	7.3	1.01
58947	4/5	dp skarn	0.034	< 0.2	4.8	< 3	211	< 1	8.6	3.2	74	2190	0.276	13	379	74	21.6	37	17	2.3	0.7	1.4	1.8	0.25
58948	4/6	dp skarn	0.031	< 0.2	2.8	< 3	152	< 1	2.5	< 0.5	37	> 10000	1.261	7	437	15	4.6	9	6	0.6	< 0.1	< 0.5	1.1	0.16

Appendix VIb. *Continued.*

NGU	**trench**	**rock**	**S**	**Sb**	**Sc**	**Se**	**Sr**	**Ta**	**Th**	**U**	**V**	**W**	**WO_3**	**Y**	**Zn**	**Zr**	**La**	**Ce**	**Nd**	**Sm**	**Eu**	**Tb**	**Yb**	**Lu**
#	**#**	**type**	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
			0.001	0.2	0.1	3	2	1	0.5	0.5	5	3		1	1	2	0.2	3	5	0.1	0.1	0.5	0.1	0.05
58949	4/7	gt-dp skarn	0.012	< 0.2	2.8	< 3	165	< 1	2.7	< 0.5	96	6520	0.822	14	300	40	6.8	7	7	1.2	0.9	< 0.5	2.2	0.23
58950	4/8	dp skarn	0.008	0.4	8.1	< 3	318	1	8.2	4.9	96	132	0.017	20	380	127	25.9	49	26	3.1	1.1	< 0.5	2.1	0.3
57651	5/1	gt-dp skarn	0.007	0.5	7.6	< 3	440	< 1	4.9	6	56	209	0.026	63	366	139	16.3	56	37	4.6	1.4	1.6	4.8	0.75
57652	5/2	dp skarn	0.009	1.5	10.5	< 3	394	< 1	8.1	13.2	113	70	0.009	49	310	171	43	99	46	4	2.3	1	4.3	0.32
57653	5/3	dp skarn	0.021	0.7	16.6	< 3	510	< 1	16.2	6.3	122	8	0.001	42	439	208	49.3	120	57	5.3	1.9	1.1	3.8	0.63
57654	5/4	gt-dp skarn	0.143	< 0.2	16.1	< 3	338	< 1	7	3.3	158	8	0.001	44	108	244	30.8	98	42	4.5	2.2	< 0.5	3.5	0.66
57655	5/5	gt-dp skarn	0.159	< 0.2	17.3	< 3	301	< 1	9.2	4.2	176	< 3	0.000	47	112	236	36	96	47	4.5	1.4	1.1	3.9	0.73
57656	5/6	gt-dp skarn	0.013	0.7	17.1	< 3	413	< 1	10.7	6	117	6	0.001	47	414	184	28.4	75	51	4.1	1.8	1.3	3.9	0.28
57657	5/7	marble	0.003	< 0.2	5.6	< 3	606	3	22.5	7.7	34	13	0.002	52	195	100	24	59	23	2.1	0.7	1.2	4.2	0.4
57658	6/1	dp skarn	0.059	< 0.2	5.9	< 3	86	< 1	4.9	4.2	69	1330	0.168	26	577	134	16.7	45	22	3	0.7	1.3	2.4	0.47
57659	6/2	dp skarn	0.006	< 0.2	8.4	< 3	82	1	7.4	2.4	82	71	0.009	19	655	140	16.9	49	29	1.7	1	0.7	1.9	0.35
57660	6/3	gt-dp skarn	0.004	0.5	7.2	< 3	97	< 1	7	3.9	77	322	0.041	21	583	148	22.9	55	24	2.9	1.2	1.1	2	0.39
57661	6/4	gt-dp skarn	0.004	1.4	5.4	< 3	130	2	4.4	< 0.5	78	>10000	1.261	17	470	136	19	22	16	1.4	0.9	0.5	2.7	0.35
57662	6/5	gt-dp skarn	0.003	1.6	4.7	< 3	169	< 1	3	< 0.5	56	> 10000	1.261	13	428	119	35.4	43	< 5	1.6	1.6	< 0.5	1.5	0.21
57663	6/6	gt-dp skarn	< 0.001	0.5	4.5	< 3	66	< 1	3.4	< 0.5	117	2480	0.313	12	315	115	12.2	35	26	3	0.8	1.9	1.3	0.26
57664	6/7	gt-dp skarn	0.004	0.4	8.8	< 3	277	3	6.6	8.4	78	150	0.019	35	374	178	31.2	78	37	3.5	1.9	1	3	0.54
57665	7/1	gt-dp skarn	0.111	0.7	6.9	< 3	317	1	12.1	6.5	72	229	0.029	36	499	156	24.5	60	24	2.9	0.6	0.8	3.9	0.74
57666	7/2	dp skarn	0.022	0.5	2.8	< 3	237	< 1	49.2	12	35	39	0.005	18	339	17	60.5	143	77	4.3	1.1	< 0.5	2	0.49
57667	7/3	dp skarn	0.116	< 0.2	1.7	< 3	112	< 1	7.7	6.5	51	494	0.062	13	765	32	24.6	62	24	2.4	1.1	< 0.5	1.7	0.37
57668	7/4	dp skarn	0.018	2.5	1.8	< 3	188	< 1	2.5	< 0.5	39	> 10000	1.261	9	523	26	4.9	11	6	0.8	0.6	< 0.5	1.1	0.19
57669	7/5	skarn + slph	4.65	< 0.2	7.5	< 3	171	2	7.7	5.3	79	> 10000	1.261	35	245	41	5	22	11	2.2	0.7	< 0.5	4.7	0.65
57670	7/6	skarn + slph	1.33	0.4	2.3	< 3	162	< 1	2.7	7.8	44	> 10000	1.261	14	474	27	5.5	14	10	0.7	0.8	8.1	1.8	0.33
57671	7/7	skarn + slph	0.04	0.4	21	< 3	271	< 1	8.6	6.2	145	141	0.018	44	275	174	19.6	65	23	3.2	1.4	1	4.4	0.74
57672	7/8	gneiss	0.03	0.3	31.1	< 3	298	< 1	3.2	< 0.5	246	22	0.003	39	114	118	12.7	41	25	3.4	1.5	1.3	3.7	0.6
57673	8/1	dp skarn	0.022	< 0.2	10.9	3	293	3	47	11.3	54	19	0.002	50	213	236	60.7	135	77	3.4	1.7	< 0.5	5.3	0.9
57674	8/2	gneiss	0.023	0.5	15.2	< 3	325	3	18.6	7.3	93	16	0.002	62	280	342	45.9	129	63	5.7	2.2	1.6	7	1.15
57675	8/3	dp skarn	0.069	< 0.2	0.6	< 3	149	6	36.9	7.7	20	15	0.002	10	34	6	5	17	< 5	0.7	< 0.1	< 0.5	2.2	0.36
57676	8/4	dp skarn	0.018	0.3	15.5	< 3	224	3	13.2	9	121	12	0.002	63	210	338	24.9	98	49	5.2	2.2	1.3	6.1	1.1
57677	8/5	dp skarn	0.084	0.5	11.4	< 3	301	2	15.2	6.4	82	18	0.002	51	451	227	46.6	111	47	5	1.9	1.6	4.3	0.74

Appendix VIb. *Continued.*

NGU #	trench #	rock type	S %	Sb ppm	Sc ppm	Se ppm	Sr ppm	Ta ppm	Th ppm	U ppm	V ppm	W ppm	WO_3 %	Y ppm	Zn ppm	Zr ppm	La ppm	Ce ppm	Nd ppm	Sm ppm	Eu ppm	Tb ppm	Yb ppm	Lu ppm
			0.001	0.2	0.1	3	2	1	0.5	0.5	5	3		1	1	2	0.2	3	5	0.1	0.1	0.5	0.1	0.05
57678	8/6	gneiss	0.013	0.3	11.4	< 3	146	1	14.2	7.5	75	12	0.002	40	231	282	39	92	46	4.1	1.6	1.2	3.8	0.71
57679	8/7	gneiss	0.005	0.4	8.4	< 3	64	2	12.6	4.3	66	14	0.002	27	78	351	23.1	79	35	3.3	1.2	< 0.5	2.7	0.56
57680	8/8	gneiss	0.074	< 0.2	14.9	< 3	132	2	4.9	5.4	85	20	0.003	29	162	361	11	31	13	2.4	1.6	0.9	3.7	0.58
57681	8/9	dp skarn		< 0.2	6.2	< 3	237	< 1	3.8	3.3	76	49	0.006	19		47	13.8	37	24	1.8	0.6	< 0.5	1.6	0.34
57682	8/10	dp skarn	0.256	0.7	8.4	< 3	345	2	9.5	6.9	87	13	0.002	38	356	157	22.8	66	29	3.5	1.6	0.8	3.5	0.63
57683	8/11	dp skarn	0.131	< 0.2	11.8	< 3	106	< 1	14.9	3.3	88	14	0.002	37	112	373	39.8	98	46	4.2	1.8	< 0.5	3.3	0.7
57684	9/1	dp skarn	0.188	< 0.2	23.7	< 3	1042	5	17.3	7.9	156	12	0.002	130	117	262	82.1	191	101	11.6	4.1	2.9	9.8	1.56
57685	9/2	dp skarn	0.01	0.3	13.1	< 3	349	2	18.6	10.4	97	15	0.002	52	326	152	37.2	87	38	4.1	1.6	1.5	5.3	0.93
57686	9/3	gt-dp skarn	0.061	< 0.2	10.6	< 3	259	2	8.4	9.6	141	11	0.001	86	296	116	26.5	61	39	3.8	1.6	1.5	5.6	0.98


Målvika skarn zone
scale 1 : 1000
modified after Skaarup and Lande (1998)
skarn zone, outcrop/assumed
granite dykes of various age, outcrop/assumed
gneiss undifferentiated, outcrop/assumed
170/54
striking/dipping of main foliation (D1)
fault
sampling trench
Allanzonen
Kaffedalen
Rundingen
Skåringen
Peter-zonen
Zone III
Borestedet
Hollander
Helikopterlandingsplass
Kårezonen
Lindahlzonen
Ainazonen
Zone II
Cafeteriet
Højspændten
Ødalen
Gran-træet
Zone I
Cobra
Marmor-folde
Lady Di
Ihlen
Marmor-grotten
Korstræet
Det Sorte Hul
Hellezonen
Tosenveien
Tosenfjord
100 m
400200
400300
400400
400500
400600
400700
7244200
7244100
7244000
7243900
7243800
7243700
7243600
7243500
7243400