SOME OCCURRECES IN TELEMARKEN & BAMBLE, SE-NORWAY NORRBOTTEN EXPLORATION AB, 2011

Rørholt, sample 563339: textbook example of ball texture.

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CONTENT

1.1 INTRODUCTION

This report deals with the results of about two weeks of fieldwork in SE-Norway – an historical Norwegian mining district in Proterozoic rocks hosting e.g. the Kongsberg Silver Mines. There are several hundred occurrences and deposits in the area but none would be profitable today. Twenty occurrences were selected from a database provided by the Norwegian Geological Survey (NGU). The database contains 576 samples from c. 200 occurrences and the selection criteria were the presence of samples with relatively high contents of gold, silver and/or base-metals. Highest gold content in the database is 7.2 ppm (Skyttemyr) and five per cent of the samples have more than 1 ppm gold. Six per cent of the 576 samples have more than 10% base-metals but half of them come from the Sauda area which is outside Telemark and Bamble. Some of the twenty occurrences were included because of their nearness to occurrences of relatively high grades. The occurrences at Gunhildskås had not been sampled by NGU.

A brief historical and geological description of each site is given – heavily inspired by NGU's recent investigations. In most cases also a basic map has been drawn and representative specimens have been photographed. Almost all the visited occurrences have during the last 10 years been sampled by NGU (86 samples) and in addition 38 more samples were taken by NEAB. Both sample sets are shown and in most cases there is little difference.

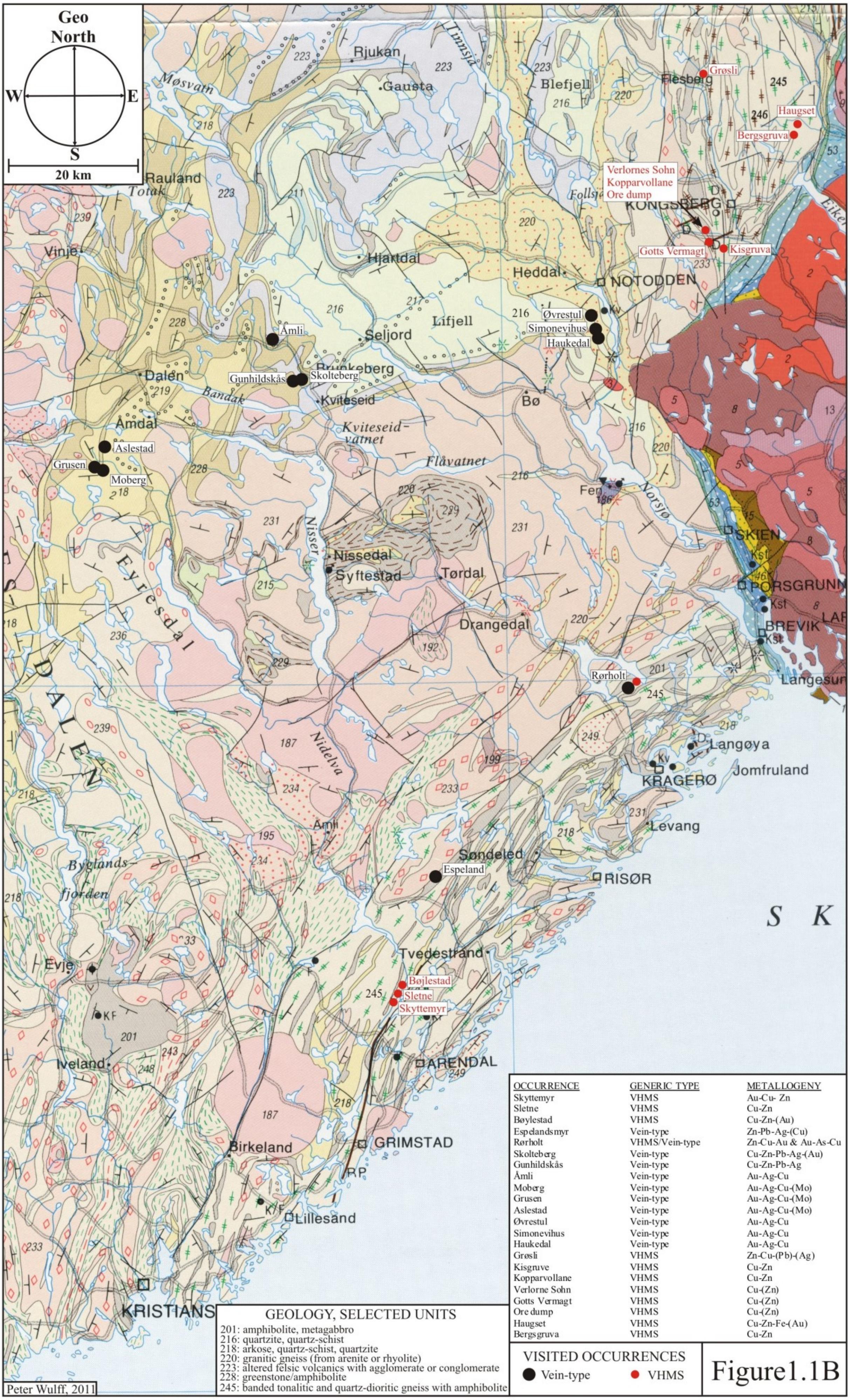
Many of the larger occurrences, or deposits, rather, have been investigated again and again during the last hundred years or more but despite extensive drilling and geophysics none of them were ever reopened.

The 20 occurrences are VHMS or vein-types but one occurrence, Rørholt, is probably both. In the cases where actual mining took place, the commodities mined were pyrite (for sulphur), silver and base-metals, mainly copper.

The CD at the back of this report contains a copy of this report, table 1, table 2, figure 1.1A, figure 1.1B, JPEGs of all cut samples and the geochemical data from Als Chemex.

OCCURRENCE	GENERIC TYPE	METALLOGENY
Skyttemyr	VHMS	Au-Cu- Zn
Sletne	VHMS	Cu-Zn
Bøylestad	VHMS	Cu-Zn-(Au)
Espelandsmyr	Vein-type	Zn-Pb-Ag-(Cu)
Rørholt	VHMS/Vein-type	Zn-Cu-Au & Au-As-Cu
Skolteberg	Vein-type	Cu-Zn-Pb-Ag-(Au)
Gunhildskås	Vein-type	Cu-Zn-Pb-Ag
Åmli	Vein-type	Au-Ag-Cu
Moberg	Vein-type	Au-Ag-Cu-(Mo)
Grusen	Vein-type	Au-Ag-Cu-(Mo)
Aslestad	Vein-type	Au-Ag-Cu-(Mo)
Øvrestul	Vein-type	Au-Ag-Cu
Simonevihus	Vein-type	Au-Ag-Cu
Haukedal	Vein-type	Au-Ag-Cu
Grøsli	VHMS	Zn-Cu-(Pb)-(Ag)
Kisgruve	VHMS	Cu-Zn
Kopparvollane	VHMS	Cu-Zn
Verlorne Sohn	VHMS	Cu-(Zn)
Gotts Vermagt	VHMS	Cu-(Zn)
Ore dump	VHMS	Cu-(Zn)
Haugset	VHMS	Cu-Zn-Fe-(Au)
Bergsgruva	VHMS	Cu-Zn

Figure1.1A



OCCURRENCE	GENERIC TYPE	METALLOGENY
Skyttemyr	VHMS	Au-Cu- Zn
Sletne	VHMS	Cu-Zn
Bøylestad	VHMS	Cu-Zn-(Au)
Espelandsmyr	Vein-type	Zn-Pb-Ag-(Cu)
Rørholt	VHMS/Vein-type	Zn-Cu-Au & Au-As-Cu
Skolteberg	Vein-type	Cu-Zn-Pb-Ag-(Au)
Gunhildskås	Vein-type	Cu-Zn-Pb-Ag
Åmli	Vein-type	Au-Ag-Cu
Moberg	Vein-type	Au-Ag-Cu-(Mo)
Grusen	Vein-type	Au-Ag-Cu-(Mo)
Aslestad	Vein-type	Au-Ag-Cu-(Mo)
Øvrestul	Vein-type	Au-Ag-Cu
Simonevihus	Vein-type	Au-Ag-Cu
Haukedal	Vein-type	Au-Ag-Cu
Grøsli	VHMS	Zn-Cu-(Pb)-(Ag)
Kisgruve	VHMS	Cu-Zn
Kopparvollane	VHMS	Cu-Zn
Verlorne Sohn	VHMS	Cu-(Zn)
Gotts Vermagt	VHMS	Cu-(Zn)
Ore dump	VHMS	Cu-(Zn)
Haugset	VHMS	Cu-Zn-Fe-(Au)
Bergsgruva	VHMS	Cu-Zn

Figure1.1B

2.1 SKYTTEMYR

The Skyttemyr Au-Cu-Zn deposit is on the 15 km long *Skyttemyr sulphide zone* (fig. 2.3.4). The deposit is said to have been mined to a depth of 200 m and 300 m along strike. At least 10000 tons of ore were produced. The occurrence was in 1985 investigated in some detail by the company Arco A/S.

Old workings and rusty outcrops can at Skyttemyr be followed for about 160 m and the whole zone was followed for about 450 m (fig. 2.1.1). Strike is 26° and dip is 60-70° W. The mineralization is in surface outcrop up to 1 m thick of which massive sulphides constitute less than 50%. Along the old workings lie dumps of which massive sulphides (mostly pyrrhotite) constitute less than 1% while low-grade material makes up 10%. There is more gold in the low-grade material (like sample 563330) than in the massive sulphides. The latter are deformed and ball-texture is omnipresent. Quartz is common and may have been mobilized from the mineralization during metamorphism. The metamorphism is in amphibolite facies so it's difficult to say much about the origin of the country rocks. Silicification, calc-silicate and sericitization are the dominant alteration types.

I found no specimens of massive sulphide with significant contents of chalcopyrite or sphalerite. Such samples are reported by NGU, however, so either the hand-sorting was very effective or this kind of rich ore is uncommon. The average grade of gold in NEAB's and NGU's samples is 2.3 ppm which is probably higher than the grade of the whole deposit as the samples with the most gold also have higher grades of base-metals than the deposit as a whole.

Susceptibility was measured on mineralization and country rocks. Maximum susceptibility of massive pyrrhotite was 22×10^{-3} S.I. units while country rocks are unmagnetic. So the mineralization is magnetic but probably not enough to be detected in e.g. a SkyTEM survey. Its conductivity (plenty of pyrrhotite) would reveal it, however.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563330	Skyttemyr	3.2	35	3.5	0.7	0.0	3900	100	6	9.5	5.8	51	2
563331	Skyttemyr	0.9	8	0.3	4.6	0.0	46	32	9	37.4	>10.0	174	7

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
AA0160.01	Skyttemyr	4.0	78	>10.0	1.5	0.0	416	101	2	23.3	12.6	64	3
AA0160.02	Skyttemyr	4.0	23	2.2	>10.0	0.0	3	43	3	6.6	9.8	438	8
AA0160.03	Skyttemyr	7.2	23	2.7	>10.0	0.0	66	100	2	8.5	9.6	530	5
AA0160.04	Skyttemyr	1.2	6	1.1	2.1	0.0	477	32	2	32.1	19.9	82	7
AA0160.05	Skyttemyr	0.8	14	1.4	4.2	0.0	27	44	5	7.1	5.1	226	3
AA0160.06	Skyttemyr	0.8	103	8.4	0.2	0.0	222	89	7	11.7	9.7	18	3
AA0160.07	Skyttemyr	1.1	15	0.8	0.1	0.0	900	74	8	6.5	2.2	7	4
AA0160.08	Skyttemyr	0.3	4	1.0	0.7	0.0	83	23	2	24.3	12.2	30	5

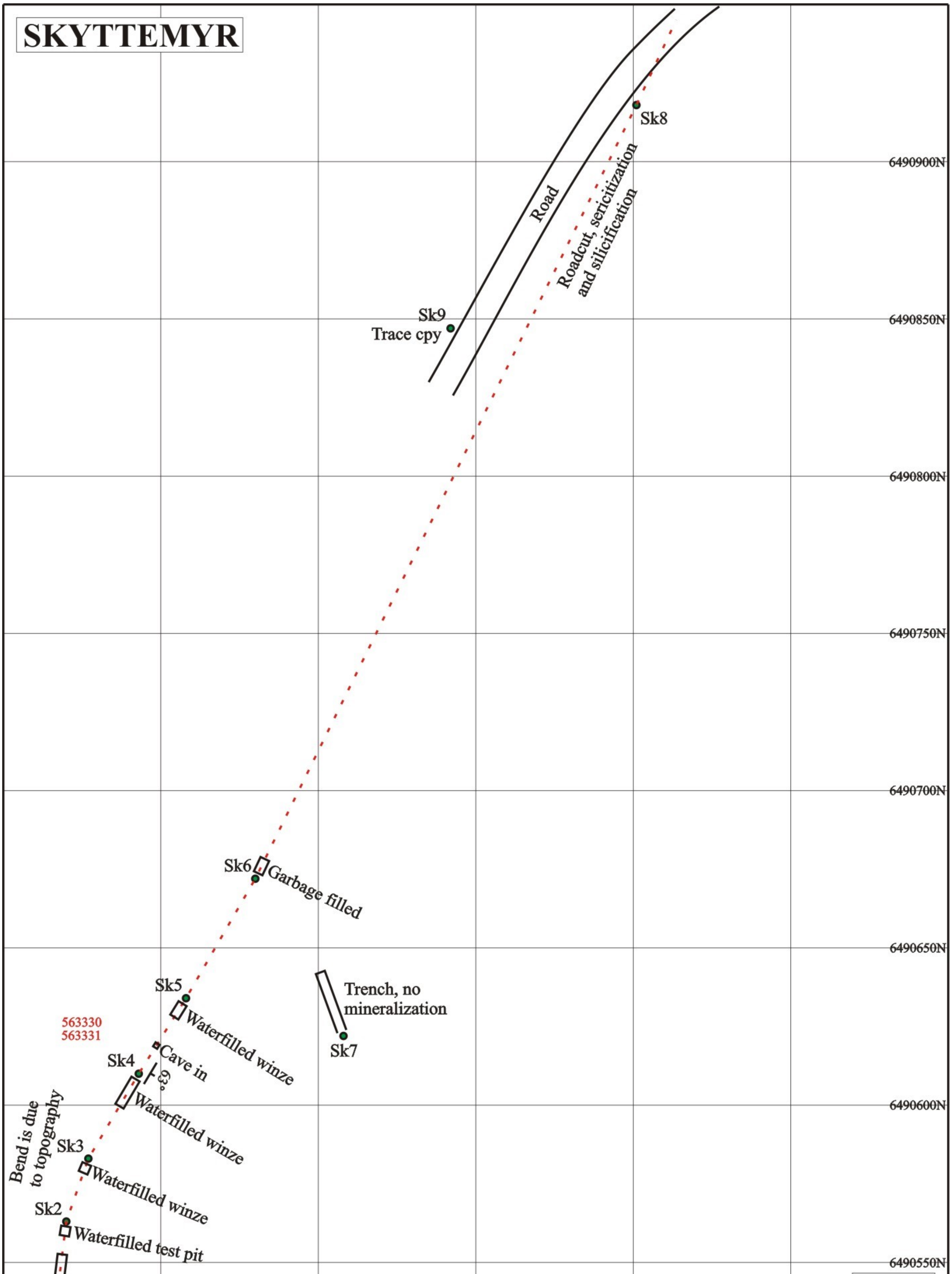


Fig. 2.1.1: The Skyttemyr deposit and its old workings.

Fig. 2.1.2: Skyttemyr, sample 563330. Quartz and calc-silicates with chalcopyrite, sphalerite, pyrrhotite and löllingite and/or arsenopyrite.

Fig. 2.1.3: Skyttemyr, sample 563331. Pyrrhotite with rounded silicate clasts, i.e. ball-texture. Only traces of chalcopyrite and löllingite and/or arsenopyrite.

2.2 SLETNE

The occurrence (fig. 2.2.1) can be followed for about 100 m and its thickness is most likely less than half a meter. The absence of long open pits (as at Skyttemyr and Bøylestad) suggests that the occurrence is inconsistent with regard to sulfide content.

The ore types at Sletne are identical to those at Skyttemyr but there may be relatively less of massive sulphides at Sletne. Specimens with several per cents of copper are common in the semi-massive part of the mineralization, however. Overall, contents of gold and base-metals are insignificant.

Susceptibility was measured on mineralization and country rocks. Maximum susceptibility of massive pyrrhotite was 47×10^{-3} S.I. units while country rocks are practically unmagnetic. So the mineralization is weakly magnetic.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563332	Sletne S	0.3	30	3.4	0.9	0.0	66	26	<5	26.0	>10.0	11	1

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
AA0159.06	Sletne N	0.0	2	0.3	0.0	0.0	742	4	2	14.0	8.2	1	4
AA0159.07	Sletne S	0.0	2	0.2	4.6	0.0	169	5	2	31.6	14.5	308	4

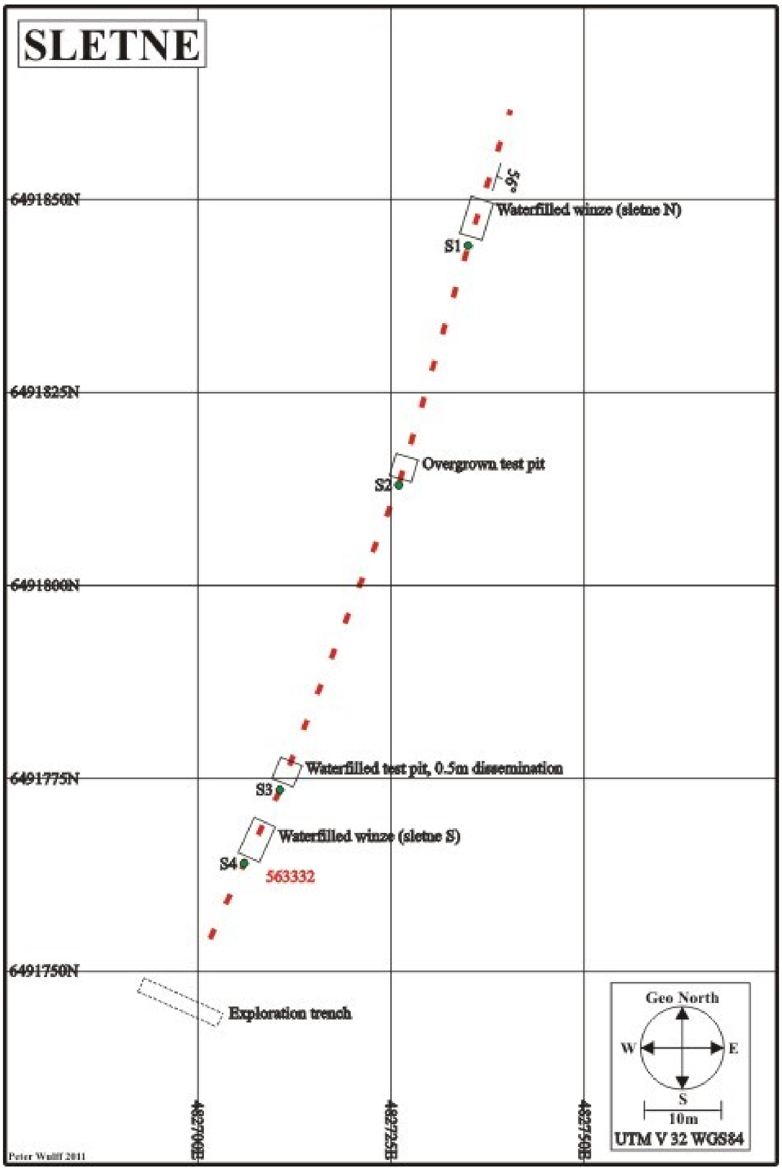


Fig. 2.2.1: The Sletne occurrence and its old workings.

2.3 BØYLESTAD

With regard to strikelength, strike, dip, thickness, ore types and alteration, Bøylestad is quite similar to Skyttemyr. It can be followed intermittently for about 470 m (fig. 2.3.1) but much is a rustzone only. The zone probably enters the Nidelven to the north. Maximum thickness of the mineralization as seen in the old workings' mostly inaccessible outcrops, is about 1 meter of which most seems to be low-grade material only. This is also reflected by the sparsity of massive sulphides in the large dumps.

Old sources state that the deposit during 70 years was mined to at depth of 120 m. At least 6000 tons of ore were produced during the years 1866- 82. Contents of gold and base-metals are on average low.

Susceptibility was measured on mineralization and country rocks. Susceptibility of massive pyrrhotite was up to 40×10^{-3} S.I. units. As at Sletne and Skyttemyr, the country rocks are practically unmagnetic.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563333	Bøylestad	0.1	7	1.2	0.1	0.0	5	14	7	23.4	>10.0	4	3
563334	Bøylestad	0.2	27	1.9	0.3	0.1	31	34	8	30.8	>10.0	13	9

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
AA0159.01	Bøylestad	0.3	9	1.3	0.5	0.0	346	35	2	23.0	16.1	26	7
AA0159.02	Bøylestad	0.1	6	1.1	0.1	0.0	49	17	5	7.5	2.25	5	4
AA0159.03	Bøylestad	0.0	3	0.7	1.7	0.0	699	13	2	28.9	17.7	57	2
AA0159.04	Bøylestad	0.0	1	0.1	4.4	0.0	27	2	2	35.4	26.3	147	2
AA0159.05	Bøylestad	2.0	25	2.2	0.5	0.0	107	38	2	12.1	7.5	18	3

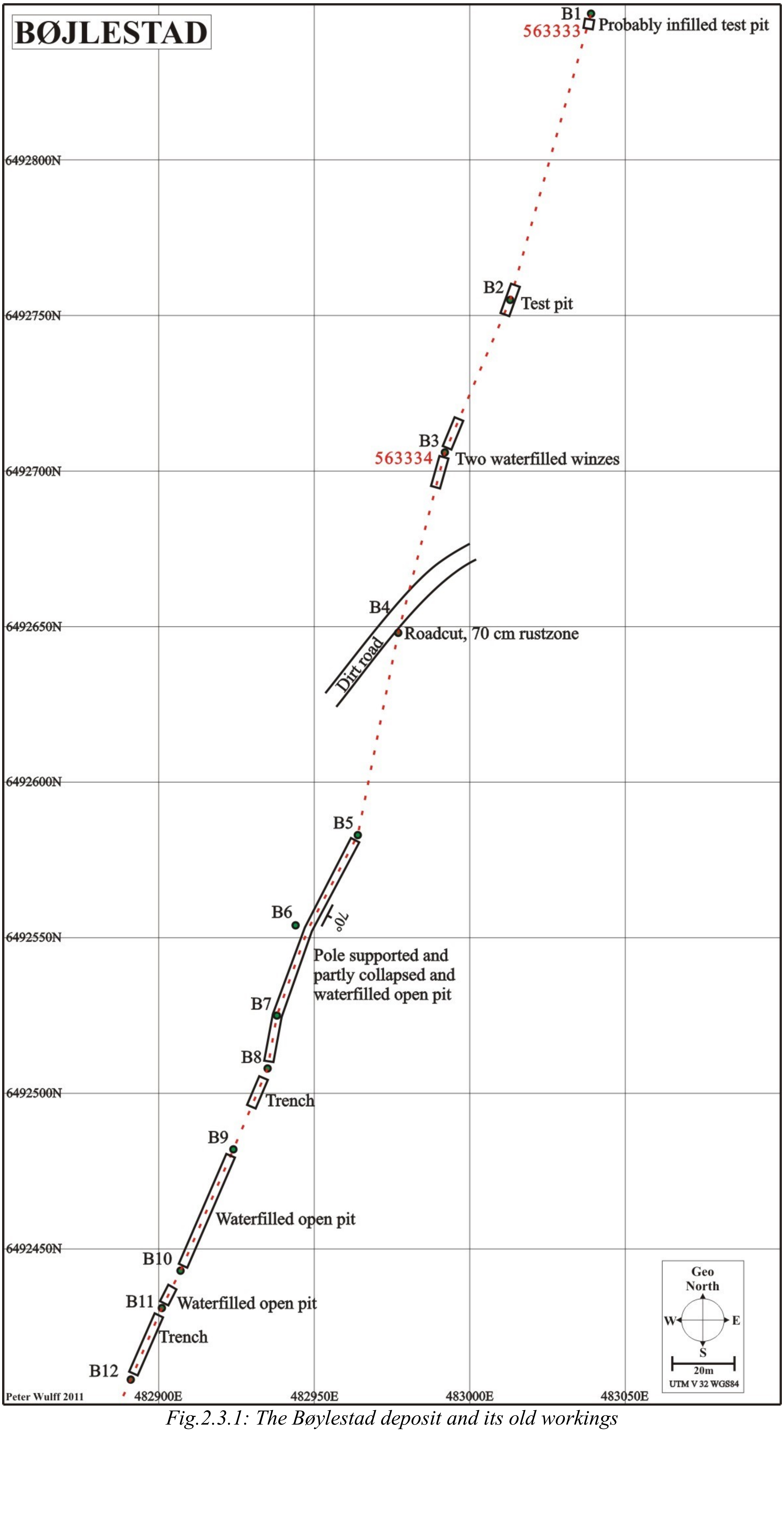


Fig.2.3.1: The Bøylestad deposit and its old workings

Fig. 2.3.2: Bøylestad, sample 563334. Pyrrhotite with rounded quartz and calc-silicate clasts. Only traces of chalcopyrite which mostly occurs as fracture-filling in silicate clasts.

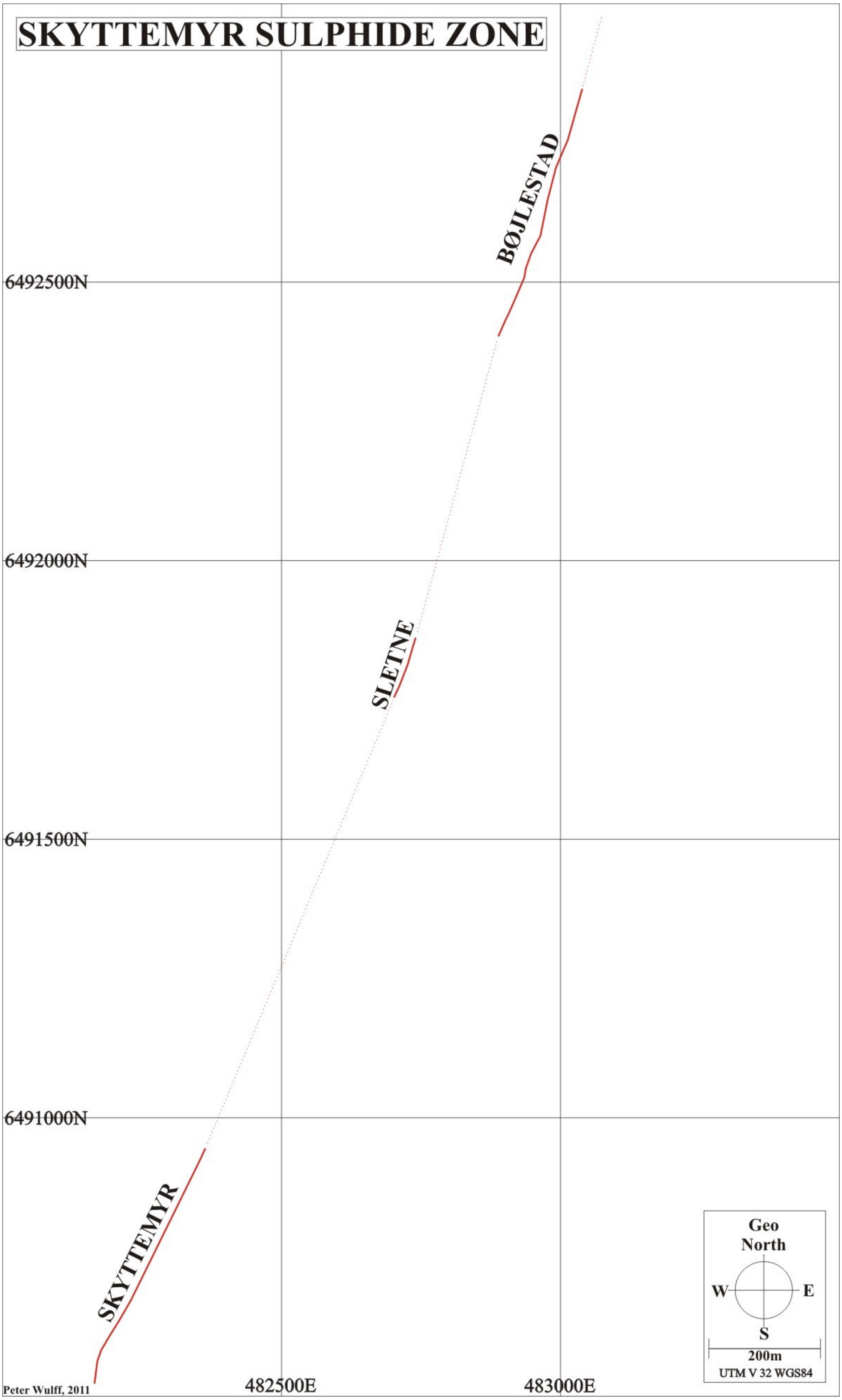


Fig. 2.3.4: Overview map showing mineralization in part of the Skyttemyr Sulphide Zone. The strike length of this part of the zone is 2.5 km. This is not insignificant but the low average grades and inconsistency of the individual deposits and occurrences detracts from the zone's exploration potential.

2.4 ESPELANDSMYR

During years 1879-84 elleven thousand tons (of which 500 tonnes was ore in the economic sense) is said to have been mined at Espelandsmyr. Today there are few signs of this activity which included two 65 m deep shafts (now probably under the newer road) and 240 m strike length of underground workings. Two test pits and a possible scheideplats are all that remain (fig. 2.4.1).

The mineralization can be followed for about 420 m and is at Es3 up to 1.5 m thick. The sulphides in this outcrop comprise sphalerite and galena in a fine-grained, silicified, carbonatized and biotized rock. The unevenly distributed sulphides occur as dissemination and mm-thick veinlets (sample 563335). This type is also common at the scheideplats and seems to be the main type of ore. At the scheideplatz also occurs vein-quartz with pyrrhotite and in one case chalcopyrite (sample 563336).

The ore has attracted some academic interest because of the presence of less common minerals like boulangerite, stephanite, pyrargyrite, hessite and silver-rich tetrahedrite (freibergite).

The mineralization is epigenetic. Grades of zinc are significant but Espelandsmyr as a whole is unimpressive in comparison to e.g. Skolteberg and Gunhildskås. Sample 563335 has 149 ppm antimony – the highest content of antimony of all the samples listed in this report. Sample 563336 differs from the others in being quartz with minor copper but still with more silver than the other samples.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563335	Espelandsmyr	0.1	135	0.0	5.1	2.6	241	10	149	3.6	4.7	401	<1
563336	Espelandsmyr	0.1	222	0.6	0.3	0.3	7	25	45	11.9	5.3	22	4

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
AA0144.01	Espelandsmyr	0.1	71	0.0	8.5	1.3	107	6	69	4.4	5	521	5
AA0144.02	Espelandsmyr	0.0	69	0.0	>10.0	1.3	301	6	55	4.5	6.5	665	5
AA0144.03	Espelandsmyr	0.0	12	0.0	8.9	0.1	153	2	9	5.8	5.8	360	5
AA0144.04	Espelandsmyr	0.0	71	0.1	0.4	0.5	41	36	78	23.9	13.9	21	9
AA0144.05	Espelandsmyr	0.1	157	0.0	>10.0	2.1	2850	30	125	5.7	8.19	733	8

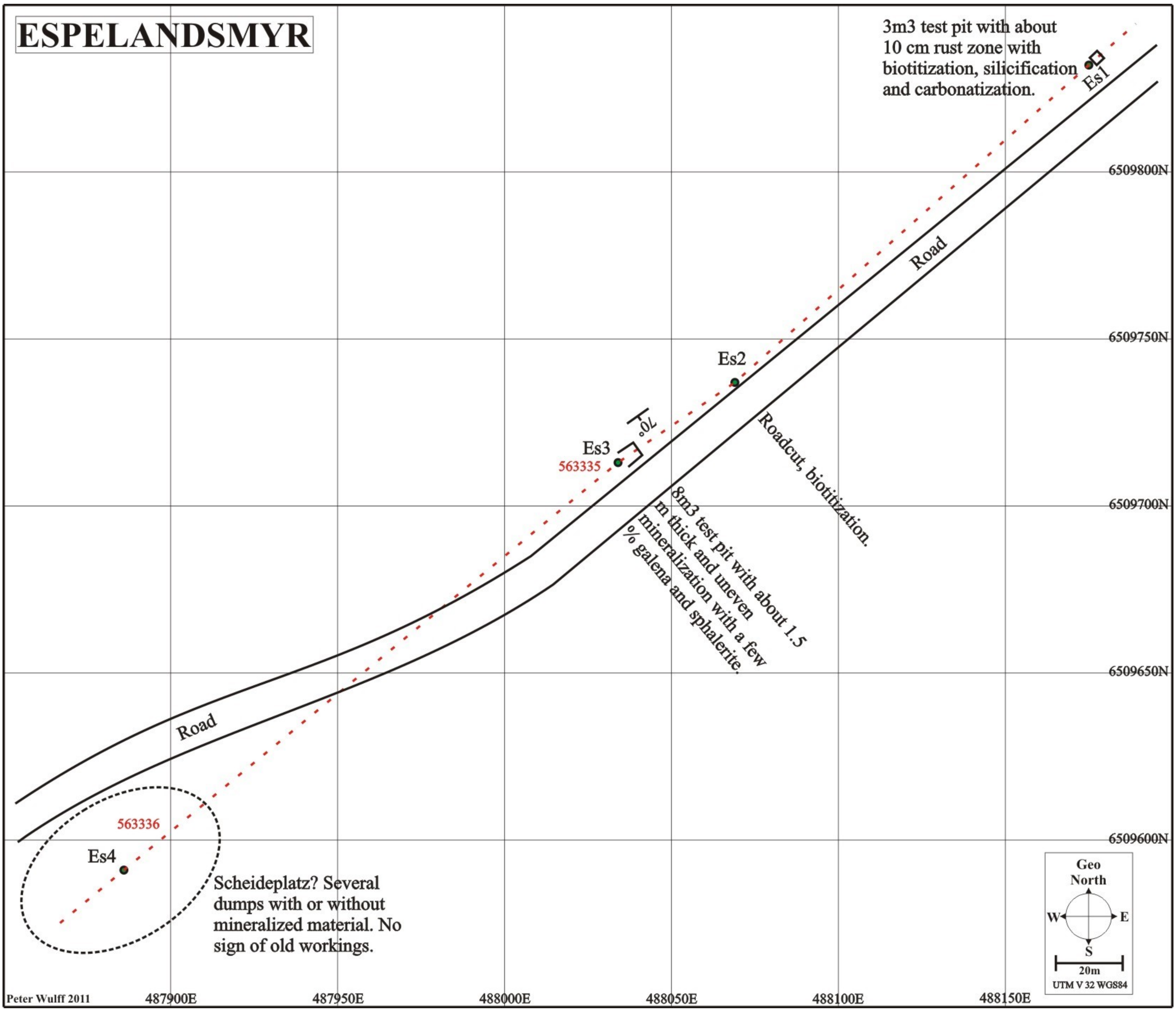


Fig. 2.4.1: Overview map of the Espelandsmyr occurrence.

Fig. 2.4.2: Espelandsmyr, sample 563335. Lower part is fine-grained quartz and biotite with weak dissemination of galena and sphalerite. Upper part is quartz with galena, sphalerite and possibly traces of pyrrhotite.

Fig. 2.4.3: Espelandsmyr, sample 563336. Quartz with pyrrhotit, chalcopyrite and traces of galena and sphalerite as fracture-filling.

2.5 RØRHOLT

There was test mining at Rørholt around 1880 and again during WW1. Handsorting resulted in around 110 tonnes of export ore with 5-10% Cu, most of it coming from a winze which has since been infilled and is no longer seen.

There are at least three mineralized horizons (fig. 2.5.1) of which the southernmost is the largest. Its maximum thickness is said to be 1 m. The appearance and geochemistry of the massive sulphides in the dumps at the winze resemble massive sulphide from nearby VHMS deposits (e.g. Bøylestad) so the southernmost of the mineralized horizons at Rørholt is a VHMS. The country rock lying in the dumps at the winze is intensely silicified and the ore is strongly deformed as evidenced by the omnipresent ball-texture in the massive ore (fig. 2.5.3). In the less massive mineralization at the strike drive, the sulphides occur as fracture-filling/mobilisates and as dissemination. The susceptibility of the massive ore from the winze is up to $80x10^{-3}$ S.I. units while the country rock is practically unmagnetic.

The Au-As-Au mineralized quartz vein in the westernmost test pit is clearly epigenetic. The quartz vein is up to 80 cm thick and averages a few per cents of unevenly distributed arsenopyrite and chalcopyrite.

The mineralized horizons, whether syn- or epigenitic are parallel to the schistosity of the finegrained gneiss which is most likely of supracrustal origin, and margins are sharp and tectonic

So, there are two different kinds of mineralization at Rørholt: VHMS with Au-Cu-Zn and vein type with Au-As-Cu. In the tables below, the samples with zinc are from the VHMS horizon while those without zinc are from the vein-type occurrences.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563337	Rørholt strike d.	0.3	9	0.8	2.7	0.0	8	2	7	10.5	5.7	72	1
563338	Rørholt test pit	0.0	1	0.0	0.0	0.0	10	<2	9	7.2	2.5	1	12
563339	Rørholt winze	1.1	9	1.5	2.7	0.0	36	<2	9	33.2	>10.0	77	7

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
TE0249.01	Rørholt strike d.	0.4	20	2.1	7.3	0.0	4	21	3	5.3	7.3	186	3
TE0249.02	Rørholt strike d.	0.8	23	2.5	4.3	0.0	6	2	3	5.2	6.0	111	2
TE0249.03	Rørholt strike d.	0.7	8	1.0	1.2	0.0	5	6	3	2.3	5.9	33	3
TE0249.04	Rørholt strike d.	2.5	22	2.6	1.4	0.0	4	2	5	7.7	4.4	37	4
TE0249.05	Rørholt test pit	0.0	1	0.0	0.0	0.0	156	2	17	8.1	1.8	0	17
TE0249.06	Rørholt test pit	0.6	0	0.0	0.0	0.0	72	2	3	11.3	3.7	0	16
TE0249.07	Rørholt winze	4.5	32	3.8	0.3	0.0	3	37	8	10.4	4.7	9	3
TE0249.08	Rørholt winze	2.0	17	2.5	4.4	0.0	9	4	2	18.2	10.6	125	4
TE0249.09	Rørholt winze	0.4	3	0.5	2.6	0.0	43	8	2	35.5	24.9	72	4
JS02.28	Rørholt Au-As-Cu	1.4	18	1.2	0.0	0.0	>99999	11	10	8.7	n.a.	1	3

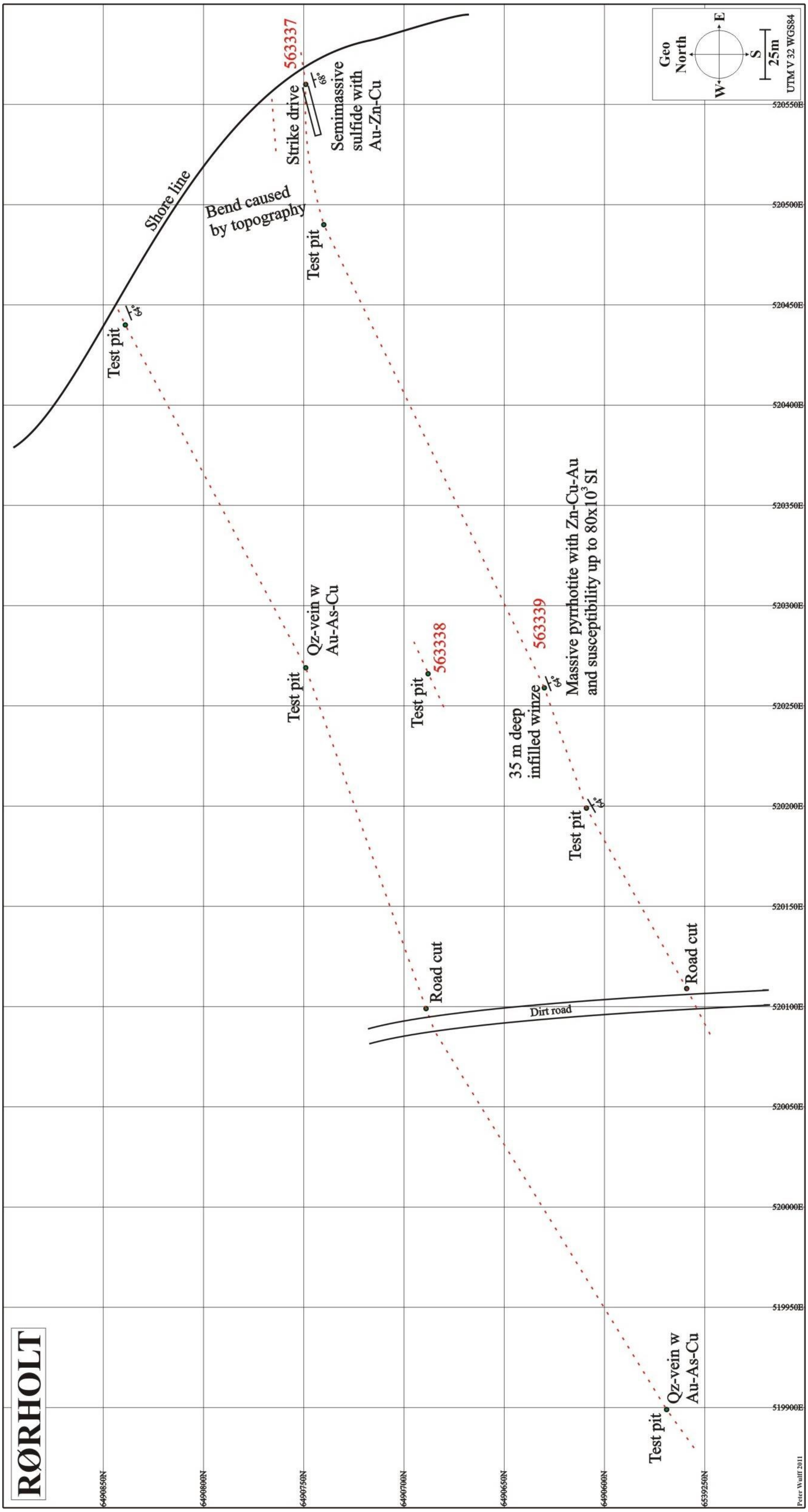


Fig. 2.5.1: Overview map of the Rørholt occurrences.

Fig. 2.5.2: Rørholt, sample 563337. Strongly tectonized quartz and chlorite with pyrrhotite and chalcopyrite.

Fig. 2.5.3: Rørholt, sample 563339. Textbook example of ball-texture. Rounded quartz clasts in matrix of pyrrhotite and chalcopyrite.

2.6 SKOLTEBERG

It is said that the Skolteberg occurrence was worked in 1889, 1899 and 1935. The presence of fairly high-grade material in the dump suggests that nothing was ever sold. NGU did a VHF-survey in 1979 and may have traced the occurrence for 300 m. Within the surveyed area were 3-4 other and stronger anomalies. Fig. 2.6.1 shows an uncertain interpretation of the mineralization that is not easily followed in and between the old working. The host rock is mafic and may be a dolerite dike. The country rock is also mafic, however. The mineralization is associated with a system of mm-cm thick quartz-veinlets. The primary ore minerals are galena and sphalerite which occur in amounts exceeding 10%. Else there is magnetite and minor amounts of chalcopyrite. The ore minerals occur as dissemination, as fracture filling and as cm-thick massive bands.

Susceptibility of the magnetite bands is up to $400x10^{-3}$ S.I. units, i.e. it can be traced with a magnetometer. Such a survey is simple.

The contents of zinc, lead and silver are rather high. The samples with the highest copper content are also the ones with the most gold and silver. The relatively high contents of antimony and bismuth indicate the presence of less common sulfosalts.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563340	Skolteberg	0.3	233	0.5	23.7	19.3	7	140	147	6.1	>10.0	>1000	<1
563341	Skolteberg	0.4	154	0.4	6.6	12.2	5	84	77	10.8	5.6	576	<1
563342	Skolteberg	1.2	1010	1.0	0.2	10.1	9	429	12	26.3	3.1	22	119

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
TE0083.01	Skolteberg	0.0	9	0.3	0.0	0.1	n.a.	n.a.	0	1.1	n.a.	0	10
TE0083.02	Skolteberg	0.1	20	0.4	0.3	1.7	n.a.	n.a.	10	9.6	n.a.	40	520
TE0083.03	Skolteberg	0.2	112	0.1	7.3	5.8	n.a.	n.a.	70	7.6	n.a.	440	0
TE0083.04	Skolteberg	0.9	347	0.8	13.2	9.5	n.a.	n.a.	80	8.4	n.a.	880	20

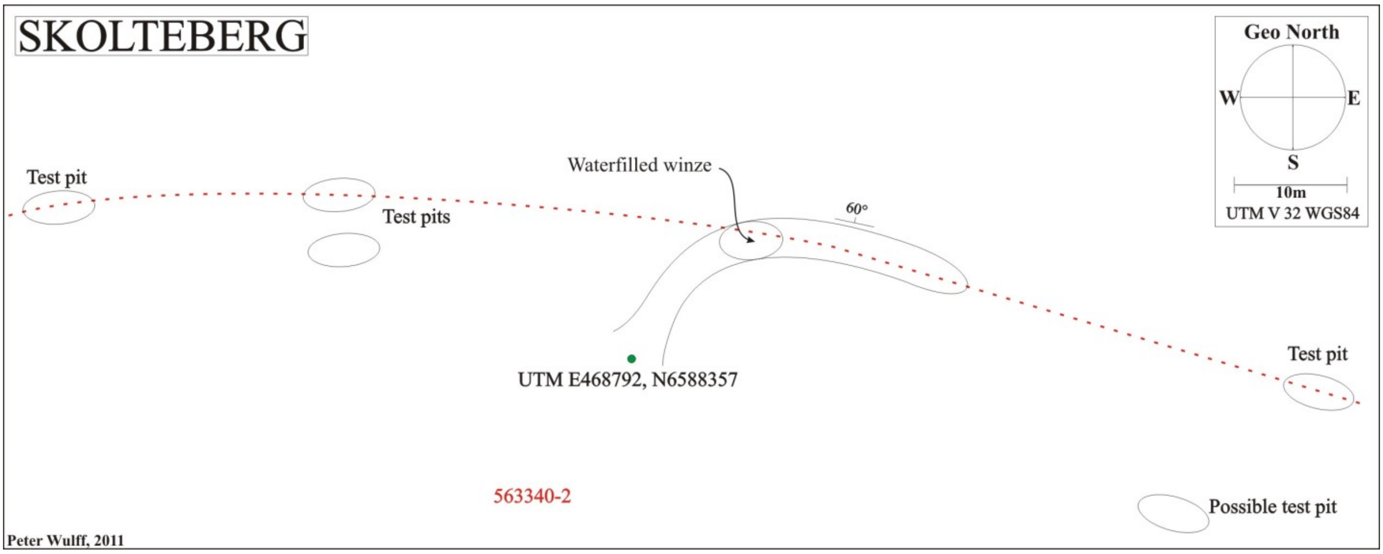


Fig. 2.6.1: Sketch of the Skolteberg occurrence.

Fig. 2.6.2: Skolteberg, sample 563340. Fine-grained ore breccia with galena, sphalerite and minor chalcopyrite and magnetite. Rounded clasts (ball texture) are quartz and chloritized metabasalt.

Fig. 2.6.3: Skolteberg, sample 563341. Chloritized metabasalt (?) with bands of galena, sphalerite and minor chalcopyrite.

Fig. 2.6.4: Skolteberg, sample 563342. The most copper- and gold-rich specimen found. Tectonized quartz and chlorite with magnetite (left half) and chalcopyrite, sphalerite and pyrite.

2.7 GUNHILDSKÅS AND UDDARÅSEN

The test pits at Gunhildskås 1 & 2 (fig. 2.7.1) are 55 m apart and targeted the same 15-40 cm thick quartz vein. The quartz-vein in the lower test pit strikes 75° and dips 64°N. In the upper test pit the quartz-vein strikes 78° and dips 70°N. There are plenty of mineralized floats between the two test pits. The quartz vein is banded by both chlorite and sulphides, and mediumgrained in the lower test pit while finegrained in the upper. Quartz with more than 10% chalcopyrite has been extracted but apparently not sold. The quartz also has minor galena and magnetite. 5-10 cm of the chloritized mafic country rock is mineralized with galena, sphalerite and magnetite on both sides of the quartz vein, and there are still traces of chalcopyrite 50 cm from the vein. Susceptibility of the vein and nearest surroundings is up to $400x10^{-3}$ S.I. units so the host structure will respond to a magnetometer survey.

The zinc and lead contents of some of the samples are unexpectedly high, as was also the case with the samples from nearby Skolteberg. Relative to Skolteberg however, the samples from Gunhildskås have much higher copper content but still only traces of gold. There is only little antimony but probably enough to form less common sulfosalts of the kind occurring in Espelandsmyr. The cadmium contents of sample 563364 and 563398 are above detection limit but the commonly linear correlation between zinc and cadmium suggests a content of 1400 ppm and 1900 ppm cadmium, respectively.

Gunhildskås 1 & 2 is about 820 m from Skolteberg, and since mineralization is fairly similar they may be related to the same structure which may therefore be of considerable extent,

Dons (1963) writes that there are two inches of massive galena carrying 0.066% silver in a test pit on Uddaråsen. The test pit is supposed to lie between Gunhildskås and Skolteberg but it was not relocated in 1961. I Searched for the test pit for more than 5 hours and found a test pit here called Gunhildskås 3, a >200 kg quartz-vein float, and a quartz vein. Neither the quartz-vein or Gunhildskås 3 seems to be the test pit mentioned by Dons.

Gunhildskås 3lies above the two test pits of Gunhildskås. It is 4 m^3 and targeted a c. 50 cm thick quartz-vein that can be followed for 8-10 m, part of which most is probably a semi-outcrop only. Its orientation is approximately 80°/60°N. The quartz has chalcopyrite and galena but much less than in Gunhildskås 1& 2, and I found no mineralization in the basaltic country rock.

The quartz-vein float (sample 563399) is mostly buried but it is edgy (so local) and composed of schist-banded quartz with weak chalcopyrite dissemination. On top of the quartz-vein is 5 cm of basaltic, chloritized country rock impregnated with some galena, chalcopyrite and sphalerite – similar to the mineralization at Gunhildskås 1-2 and quite possibly coming from the same structure.

The quartz-vein (sample 563400) is 30 cm thick, strikes 156° and dips 50°E and has basalt in the footwall and either a rhyolite or intensely silicified rock in its hanging wall. The vein has weak dissemination of chalcopyrite and seemingly has not been worked. The vein can only be followed for a few meters before it gets covered by overburden or becomes inaccessible. Being on Uddaråsen's steep hillface it is not easily accessed.

Dons (1963) mentions an occurrence called Nøsterud but his site description is very unclear and I failed to locate the occurrence. A trench and a winze are reported and the mineralization is said to be a quartz-vein with bornite, chalcopyrite and galena. Sphalerite is not reported but it wasn't reported from Gunhildskås either. Dons (1963) also descripes an occurrence called Lundevassdalen (fig. 2.7.2), but due to dense vegetation neither this one was located. "Intimately intergrown" chalcopyrite and galena is reported and there should be a 12 m long trench. Sphalerite is not mentioned.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563364	Gunhildskås 1	0.2	188	0.2	9.7	>20.0	7	324	19	7.7	9.0	>1000	<1
563365	Gunhildskås 1	0.3	109	0.1	3.8	5.2	10	165	13	9.7	3.2	549	1
563366	Gunhildskås 1	0.0	213	9.1	0.6	0.5	9	14	<5	9.8	6.0	108	3
563367	Gunhildskås 2	0.2	163	4.7	0.4	2.8	18	107	<5	5.7	3.8	113	1
563398	Gunhildskås 2	0.5	190	0.4	12.9	8.5	6	202	18	10.3	8.2	>1000	<1
563401	Gunhildskås 3	0.0	6	0.3	0.0	0.0	6	<2	<5	1.1	0.3	1	84
563402	Gunhildskås 3	0.0	22	0.3	0.0	1.5	<5	24	<5	2.6	0.6	1	149
563399	Qz-vein float	0.1	10	0.1	0.2	0.4	<5	9	<5	11.5	0.2	13	6
563400	Qz-vein	0.0	4	0.1	0.0	0.1	<5	2	<5	1.7	0.1	1	94

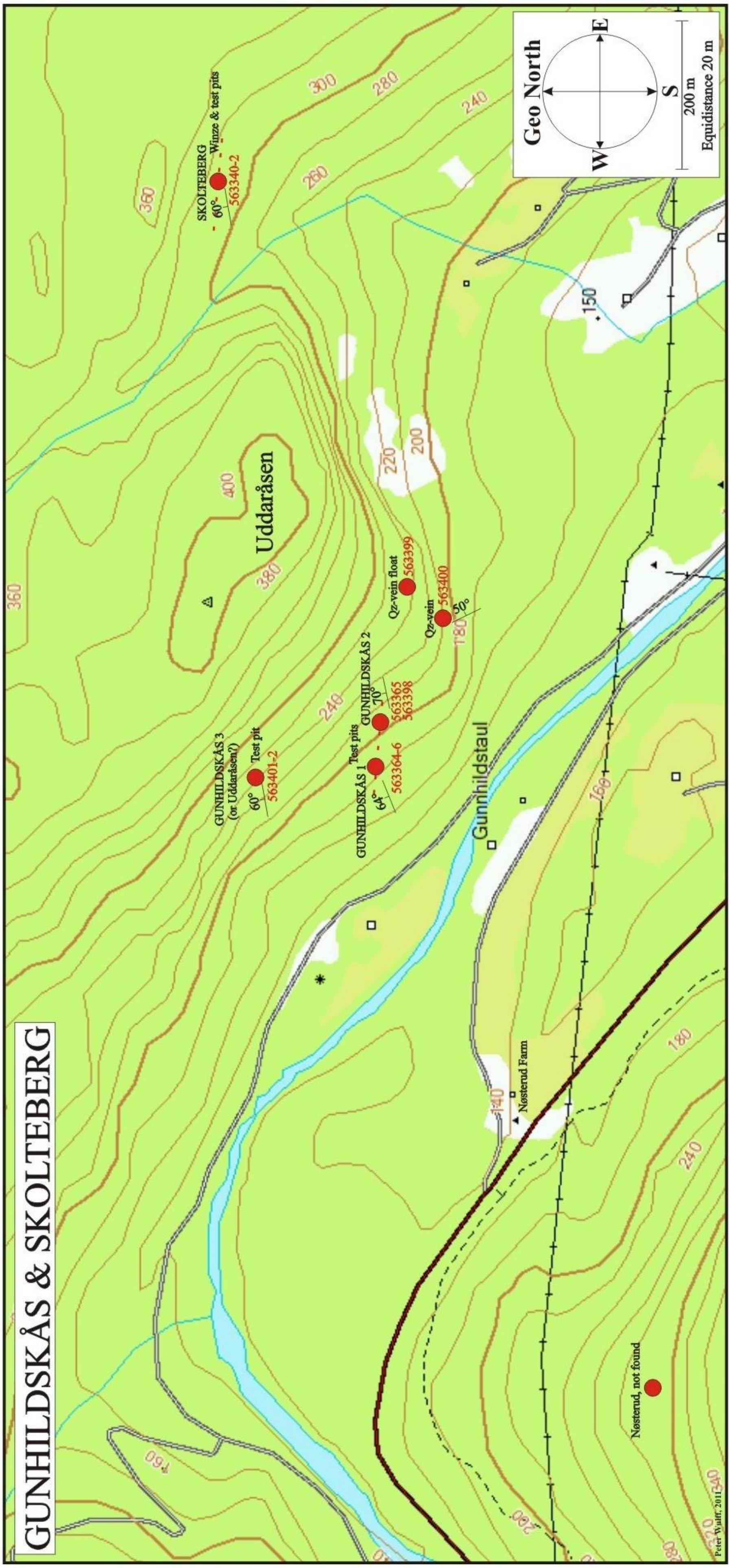


Fig. 2.7.1: map showing the Gunhildskås and Skolteberg occurrences. A test pit called Uddaråsen is reported to lie somewhere between them. To the west is marked an occurrence called Nøsterud which was not found.

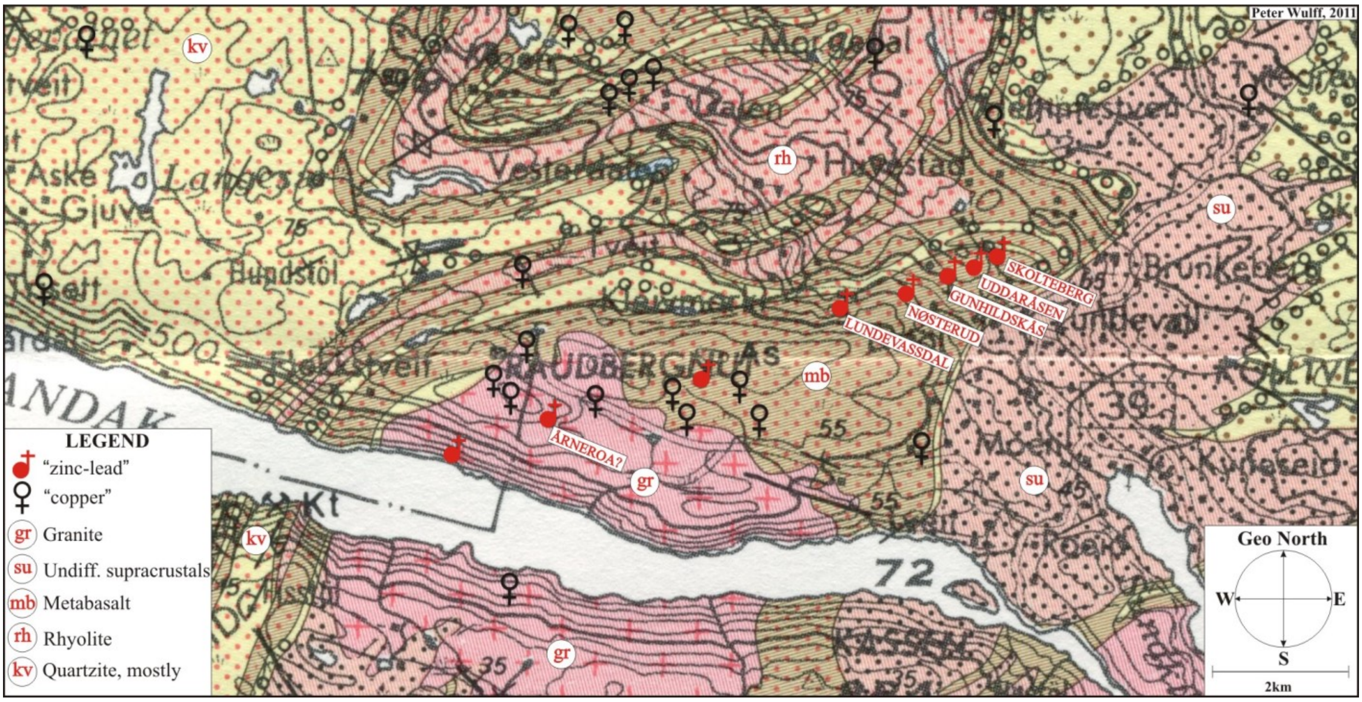


Fig. 2.7.2: Modified geological map showing Skolteberg, Uddaråsen, Gunhildskås and 4-5 other occurrences which are marked (or NEAB have estimated) as "zinc-lead" occurrences. They seem to line up along a common, 8-9 km long structure. The data from the geological map are uncertain as e.g. Gunhildskås is marked as a "copper" occurrence although it is a Cu-Pb-Zn occurrence.

Fig. 2.7.3: Gunhildskås 1, sample 563364. Fine-grained ore breccia with galena, sphalerite and minor chalcopyrite and magnetite. Rounded clasts (ball texture) are quartz and chloritized metabasalt.

Fig. 2.7.4: Gunhildskås 1, sample 563365. Chloritized metabasalt above ore breccia of quartz and chlorite clasts and magnetite, galena and sphalerite.

Fig. 2.7.5: Gunhildskås 1, sample 563366. Finegrained quartz with bands of chlorite and tourmaline. Chalcopyrite and traces of magnetite occur as fracture filling. This sample also has minor galena and sphalerite but not in this section.

2.8 ÅMLI

This quartz-vein outcrops on a steep hill face and was mined in 1860. Test mining was carried out later, in years 1871, 1887-88 and maybe again during 1890-1907. There are no data on the amount of copper produced.

The quartz-vein is from 1 to 50 cm thick and carries a few percents of unevenly distributed chalcopyrite, bornite and possibly chalcosite. Country rock is a felsic supracrustal which is unaffected by the mineralization. NGU's copper-rich (but iron-poor?) sample has 3.6 ppm gold whereas NEAB's similarly copper-rich sample only has traces of gold.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563343	Åmli	0.1	66	9.1	0.0	0.0	15	13	28	5.3	4.01	2	8

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
TE0103.01	Åmli	0.1	13	0.7	0.0	0.0	0	0	10	1.0	n.a.	0	0
TE0103.02	Åmli	0.1	12	0.9	0.0	0.0	0	0	0	1.0	n.a.	0	0
TE0326.01	Åmli	3.6	759	10.4	0.0	0.0	0	800	0	0.6	n.a.	0	730

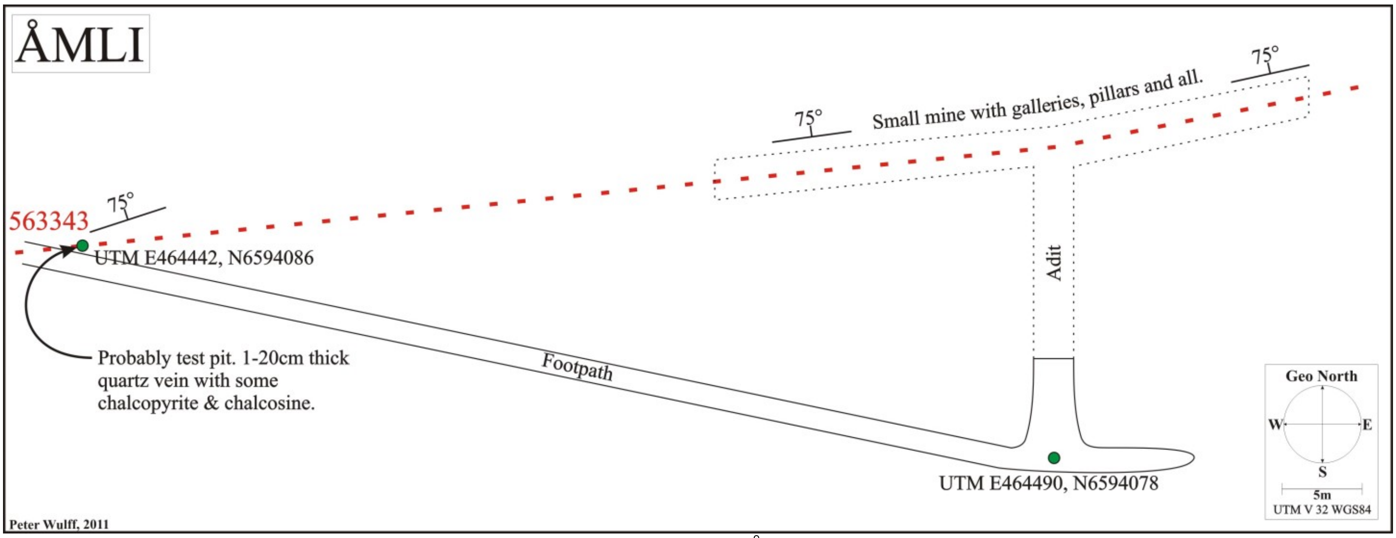


Fig. 2.8.1: Sketch of the Åmli occurrence.

2.9 MOBERG, GRUSEN & ASLESTAD

A number of quartz veins have been mined or test-mined for copper and silver at Moberg, Grusen and Aslestad. The mining at Moberg dates back to at least 1541 so is one of Norway's oldest mines. About 15-20 tons of copper and 50 kilo of silver were won from Moberg and Grusen while Aslestad is too small to ever having produced anything. The area was investigated in 2006 by the Norwegian geologist Berg.

The Moberg quartz vein is by far the largest and is probably almost 1 km long. Its maximum thickness is minimum 4-5 m. Unfortunately, much of the vein is unmineralized. The quartz-vein at Grusen was not seen due to the mine's collapsed roof and snow and ice. Judging from the dump, it is much smaller than the Moberg quartz-vein. The quartz-vein at Aslestad is even smaller. The quartz-veins at these three occurrences have lots of coarse-grained muscovite and the quartz is locally rose quartz, i.e. the veins are close to being pegmatites. Locally in the foot- and hanging walls a Moberg's open pit occur copper-bearing quartz veinlets. Farther away from the main-vein, the quartz veinlets grade into unmineralized carbonate veins. The mineralization at Moberg and Aslestad only occurs in association with the quartz-veins, but at Grusen there is also mineralization in the country rocks. Bornite and traces of molybdenite occur at both Moberg and Grusen but at Aslestad only bornite was noticed.

The samples from Moberg, Grusen and Aslestad are enriched in the same metals but ratios vary. NEAB's two samples from Moberg are quartz with and without copper-sulphides. Evidently, the gold, silver and bismuth are associated with copper-sulphides.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	Ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563344	Moberg	0.0	6	0.0	0.0	0.0	5	51	<5	0.3	0.0	1	67
563345	Moberg	2.2	635	10.1	0.0	0.0	5	1515	<5	2.4	2.7	<0.5	225

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	Ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
TE0174.01	Moberg	0.1	12	1.3	0.0	0.0	n.a.	100	10	0.6	n.a.	0	2930
TE0174.02	Moberg	0.8	100	3.9	0.0	0.0	n.a.	400	0	0.8	n.a.	0	50
TE0174.03	Moberg	3.1	425	8.2	0.0	0.0	n.a.	800	0	1.6	n.a.	0	490
TE0174.04	Moberg	0.3	60	1.3	0.0	0.0	n.a.	500	10	0.9	n.a.	0	410
TE0174.05	Moberg	5.4	531	13.5	0.0	0.0	n.a.	1700	10	2.8	n.a.	0	50

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	Ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563346	Grusen (Loc. 349)	0.0	95	3.1	0.0	0.0	<5	294	<5	1.7	1.03	<0.5	13

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
TE0175.01	Grusen	2.3	454	13.4	0.0	0.0	n.a.	1000	0	1.9	n.a.	0	940
TE0175.02	Grusen	0.1	30	0.8	0.0	0.0	n.a.	100	0	0.6	n.a.	0	10520
TE0175.03	Grusen	1.2	192	6.6	0.0	0.0	0	600	0	1.2	n.a.	0	630

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563347	Aslestad	0.2	93	2.7	0.0	0.0	<5	316	<5	0.8	1.0	<0.5	1200
563348	Aslestad	0.7	412	14.0	0.0	0.0	<5	895	<5	5.7	3.0	<0.5	142

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
TE0173.01	Aslestad	1.0	60	2.3	0.0	0.0	n.a	200	0	1.1	n.a.	0	90
TE0173.02	Aslestad	1.1	56	1.2	0.0	0.0	n.a.	100	0	0.5	n.a.	0	120

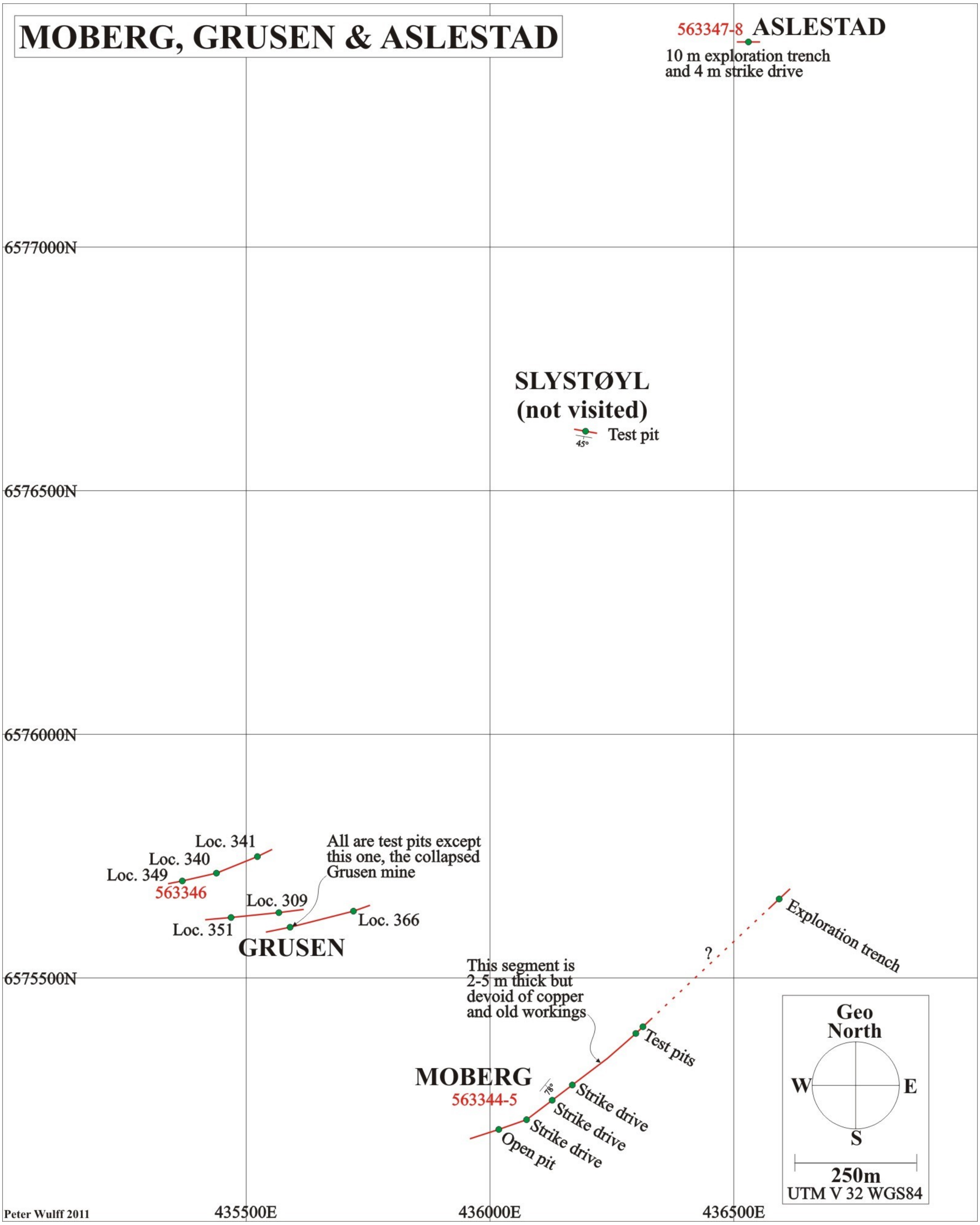


Fig. 2.9.1: The Moberg, Grusen and Aslestad quartz veins.

Fig. 2.9.2: Grusen. Completely sericitized arenite with chalcosite (bluish) replacing bornite (brown). Not analyzed.

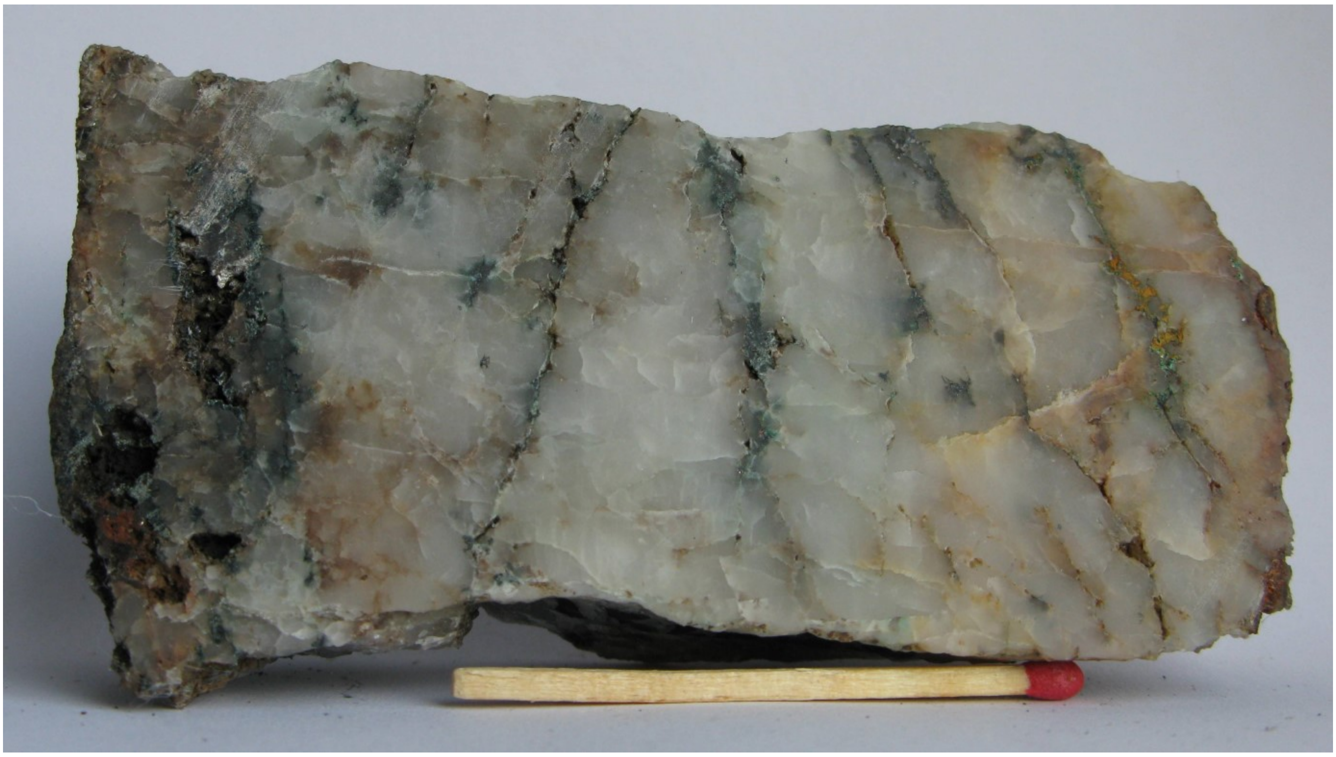


Fig. 2.9.3: Aslestad, sample 563347. Mediumgrained quartz with bornite as fracture filling.

2.10 ØVRESTUL, SIMONEVIHUS & HAUKEDAL

Haukedal was test mined in 1888 and further investigated in the early twentieth century. Simonevihus was discovered and test mined in 1909. If there was ever any production from these two occurrences, it must have been a few kilos of copper only. At Øvrestul there are only test pits.

The mineralization at Øvrestul, Simonevihus and Haukedal is largely identical: mediumgrained quartz veins with muscovite and less than 1% chalcopyrite and bornite occurring as dissemination and along the contacts to the country rock. Almost all quartz specimens have at least traces of copper minerals. The country rock at the two quartz veins at Øvrestul is amphibolite (supracrustal origin, most likely) that is biotized along the contact to the veins. At Simonevihus the country rock is a felsite (supracrustal origin, most likely) that is sericitized along the contacts to the quartz veins. The country rock at Haukedal is sericitized quartzite. The quartz veins are 60-80 cm thick and concordant with bedding/schistosity of their country rocks. The quartz vein at Haukedal can with certainty be followed for about 110 m but is perhaps 200 m long if a possible test pit to the SE is counted in despite there are no signs of copper in it. The quartz veins at Øvrestul and Simonevihus have only been test mined for 10-15 m of strike lengths.

Except for molybdenum, the samples from Øvrestul, Simonevihus and Haukedal are enriched in the same elements as the samples from Moberg, Grusen and Aslestad. Contents are on average lower, however. NEAB's samples from Øvrestul 1 & 2 are quartz with and without copper-sulphides, and it is demonstrated that the gold, silver and bismuth follows the copper-sulphides, i.e. no copper no gold.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563349	Øvrestul 1	0.0	2	0.1	0.0	0.0	7	8	<5	0.3	0.0	<0.5	3
563350	Øvrestul 1	0.7	34	1.1	0.0	0.0	6	72	5	1.1	0.4	1	46
563351	Øvrestul 2	1.6	222	3.7	0.0	0.0	7	317	<5	1.8	1.6	1	2
563352	Øvrestul 2	0.0	6	0.2	0.0	0.0	<5	2	6	10.2	0.2	<0.5	2

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
TE0024.03	Øvrestul	0.3	22	0.4	0.0	0.0	0	30	0	1.0	n.a.	0	4
TE0024.04	Øvrestul	0.7	27	0.2	0.0	0.0	0	25	0	1.0	n.a.	0	1

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
TE0024.01	Simonesvihus	3.4	100	1.0	0.0	0.0	4	522	3	1.8	n.a.	0	3
TE0024.02	Simonesvihus	2.4	99	1.0	0.0	0.0	4	178	4	2.8	n.a.	1	6

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563353	Haukedal	0.9	26	0.7	0.0	0.0	5	233	<5	7.5	0.11	<0.5	1

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
TE0025.01	Haukedal	1.8	94	1.0	0.0	0.0	-2	532	0	1.8	n.a.	0	1
TE0025.02	Haukedal	0.8	79	1.0	0.0	0.0	2	285	0	1.2	n.a.	0	1

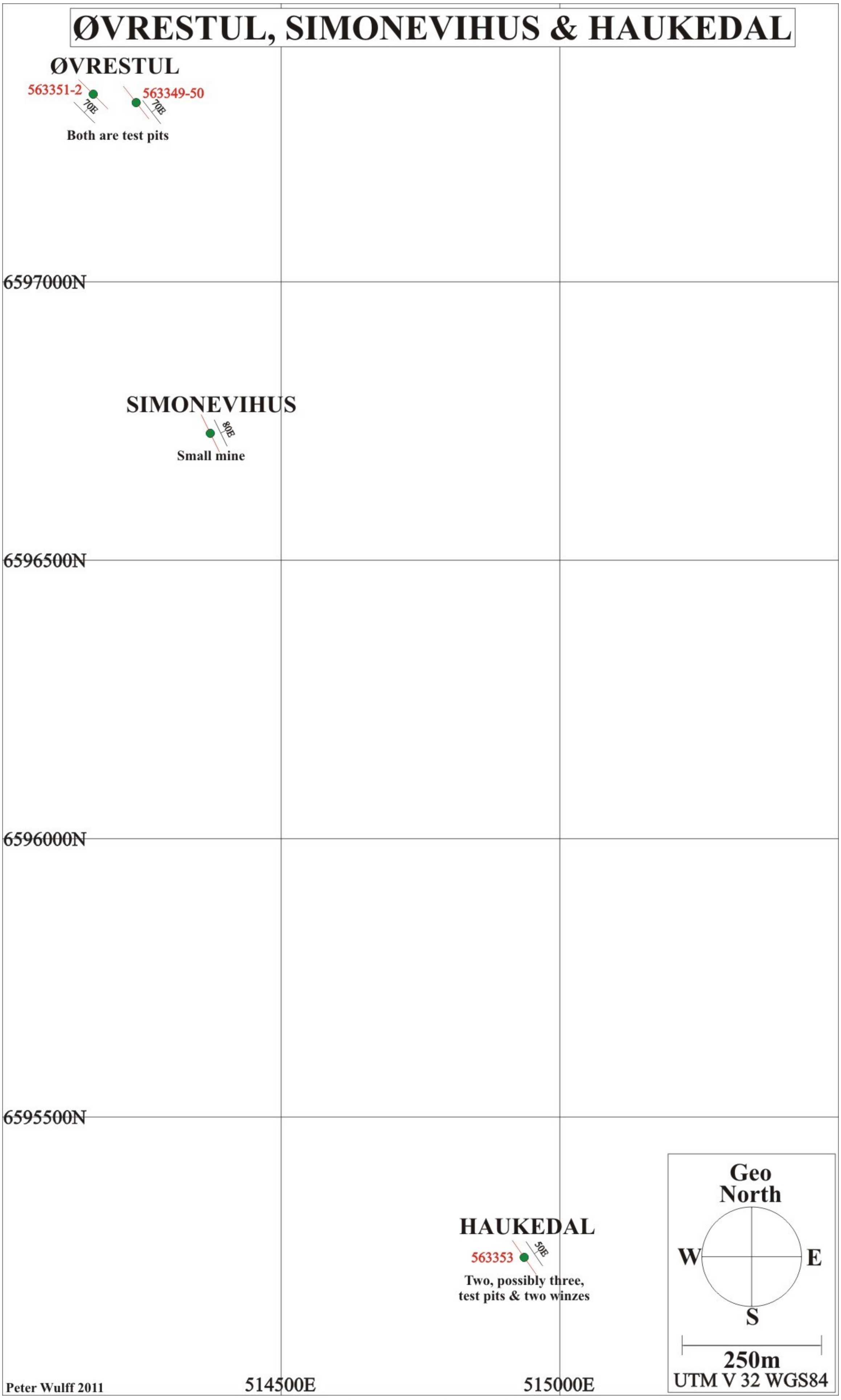


Fig. 2.10.1: The Øvrestul, Simonevihus and Haukedal quartz veins.

Fig. 2.10.2: Øvrestul 1. Specimen equal to sample 563350. Medium-grained quartz with disseminated chalcopyrite and bornite.

2.11 GRØSLI

Grøsli was mined for zinc from 1805 to 1815. Geophysical surveys were subsequently carried out in 1937, during WW2 and in 1974. A soil sampling programme was carried out in 1955. All the surveys indicate that the orebody rapidly wedges out from its maximum thickness of 10 m in the open pit, and that it is between 100 and 200 m long. Sampling by Kongsberg silvermines shows the average grade to be 0.85 Cu, 7.5% Zn and 20 ppm Ag.

The ore was mined in an up to 6-7 m deep open pit which at its entrance has a waterfilled shaft said to be 30 m deep. Strike and dip are about 10°/70°E. Outside the open pit is a sizeable dump much of which is massive ore which is very weathered and rusty due to its high content of pyrrhotite. There is an exploration trench to the south but no mineralization was noticed there.

The ore is very massive, medium-grained and consists of pyrrhotite and lesser amounts of sphalerite, chalcopyrite and pyrite. Pyrite megacrysts up to 6 cm were notice in the dump. Maximum susceptibility of the ore is only $60x10^{-3}$ S.I. units but its high content of pyrrhotite must have made it an easily surveyed object, geophysically.

Country rocks are gneisses with varying appearance – definitely some kind of volcanics as Grøsli is a VHMS-deposit.

NEAB's sample 563354 has 17.4% zinc and 445 ppm cadmium while one of NGU's samples has >10% Zn associated with 580 ppm cadmium. As zinc and cadmium commonly correlate, NGU's sample has 22-23% zinc. NEAB's sample 563355 is the one with the most lead and consequently also the one with the most silver. Bismuth also seems to be associated with lead.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563354	Grøsli	0.0	11	1.0	17.4	0.0	7	2	14	38.6	>10.0	445	1
563355	Grøsli	0.0	193	0.3	12.5	1.1	34	803	11	14.7	>10.0	354	15

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
BU0173.01	Grøsli	0.0	7	0.8	>10.0	0.0	12	0	0	26.3	29.2	580	7
BU0173.02	Grøsli	0.0	0	0.0	0.0	0.0	5	0	0	2.5	0.5	0	2
BU0173.03	Grøsli	0.0	13	1.7	1.2	0.0	121	21	0	48.7	30.1	30	3
BU0173.04	Grøsli	0.0	1	0.0	0.2	0.0	35	0	4	6.2	0.3	1	2
BU0173.05	Grøsli	0.2	18	0.2	1.6	0.4	51	33	0	12.9	8.8	38	2
BU0173.06	Grøsli	0.0	7	0.8	7.9	0.0	320	12	0	44.0	31.9	221	2

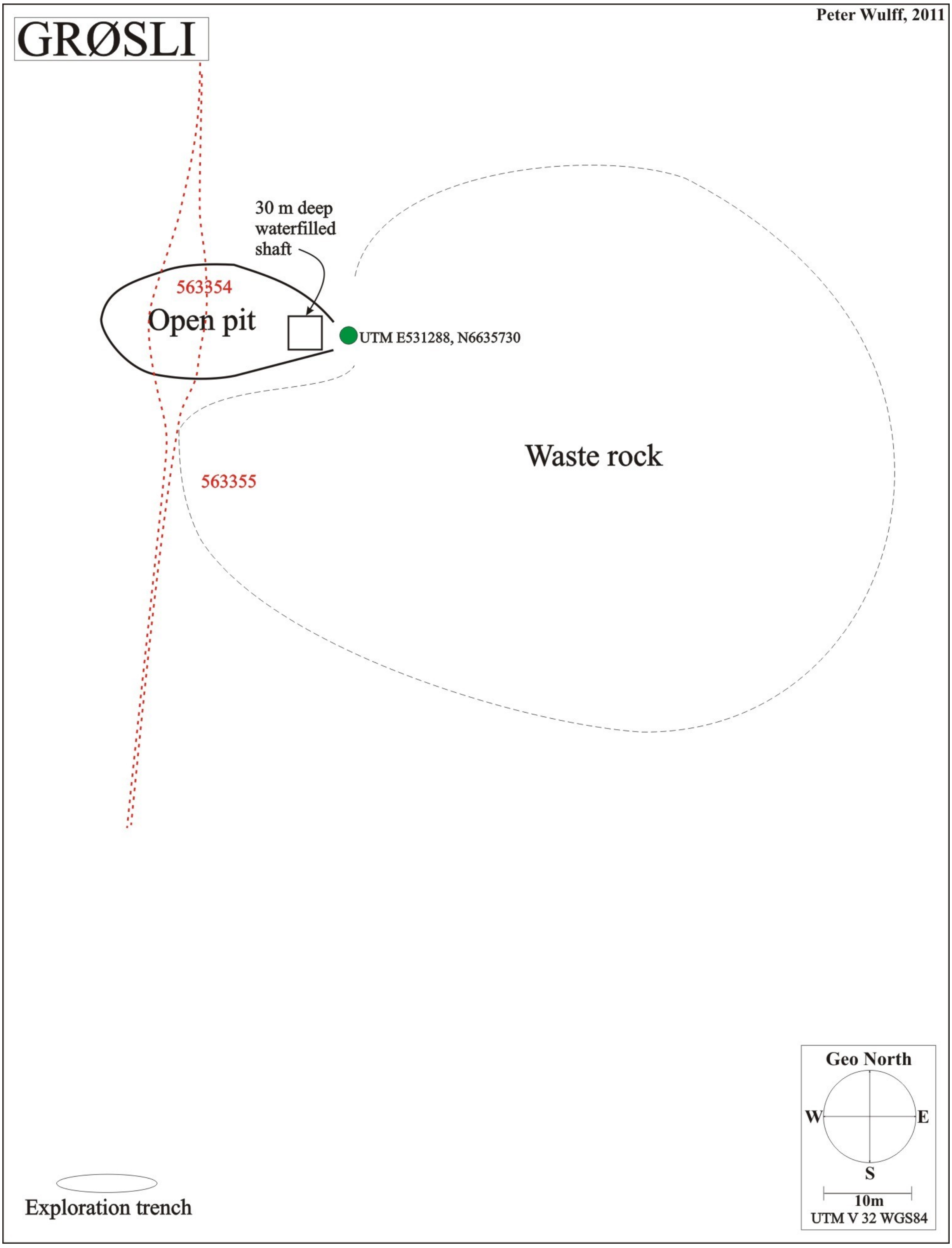


Fig. 2.11.1: The Grøsli deposit.

Fig. 2.11.2: Grøsli, sample 563354. Massive pyrrhotite with sphalerite, chalcopyrite and minor pyrite.

2.12 KISGRUVA

Kisgruva is said to have been mined already during the 16th century. Kongsberg Silver Mines intermittently worked the deposit for sulphur (from pyrite) and copper (35-40% & 1%, resp.) from 1650 to 1902. In total about 50.000 tons of ore have been extracted. A geophysical survey was carried out during 1944-45. Drilling in the mid-fifties indicated a resource of 581.000 tons grading 1.1% Cu, 1.2% Zn, 430 ppm Se, 25 ppm Ag and 2.5 ppm Au. Later sampling (three samples by NGU in 1976) failed to reproduce the relatively high gold-content. Seven holes were drilled in 1978 and indicated a total resource of 2-3 Mt grading 0.5-1% Cu, 0.5-1% Zn, 10 ppm Ag and 0.1-0.2 ppm Au. A CP-survey in 1978 showed that the deposit consists of three separate ore bodies – the southernmost of which is the one with the aforementioned 581.000 tons.

Old workings occur along almost 800 m of strikelength but actual mining has probably only taken place in the northernmost third of them. According to NGU, the low-grade mineralization in a trench to the west of the deposit and almost perpendicular to it, may be a feederzone. Outcropping massive sulphides were only seen in one of the southern test pits while massive sulphides in dumps were only found in the northern part of the deposit. The massive sulphides mostly consist of rounded and annealed pyrite metablasts with interstitial chalcopyrite and pyrrhotite. Compared to e.g. Bergsgruva, there is little massive sulphide at Kisgruva and the general impression is that the deposit as a whole is only semi-massive. The alteration of the felsic country rock is dominated by sericitization (quite extensive) and silicification which is minimum 10 m thick at the largest of the waterfilled pits. The above feederzone seems to be hosted in a chloritized mafic rock - metabasalt.

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
BU0289.01	Kisgruva	0.0	1	0.1	0.1	0.0	50	4	2	11.9	0.6	2	1
BU0289.02	Kisgruva	0.1	2	0.2	0.5	0.0	245	2	2	24.7	22.6	5	3
BU0289.03	Kisgruva	0.0	1	0.1	0.0	0.0	45	4	2	4.9	3.5	0	3
BU0289.04	Kisgruva	0.0	1	0.1	0.1	0.0	48	4	2	10.9	1.63	1	3
BU0289.05	Kisgruva	0.1	3	0.3	0.9	0.0	95	8	2	19.0	14.1	11	6
BU0289.06	Kisgruva	0.2	20	1.6	0.9	0.1	358	97	2	35.3	35.3	23	2
BU0289.07	Kisgruva	0.1	2	0.1	0.1	0.0	108	14	2	21.4	14.5	1	2

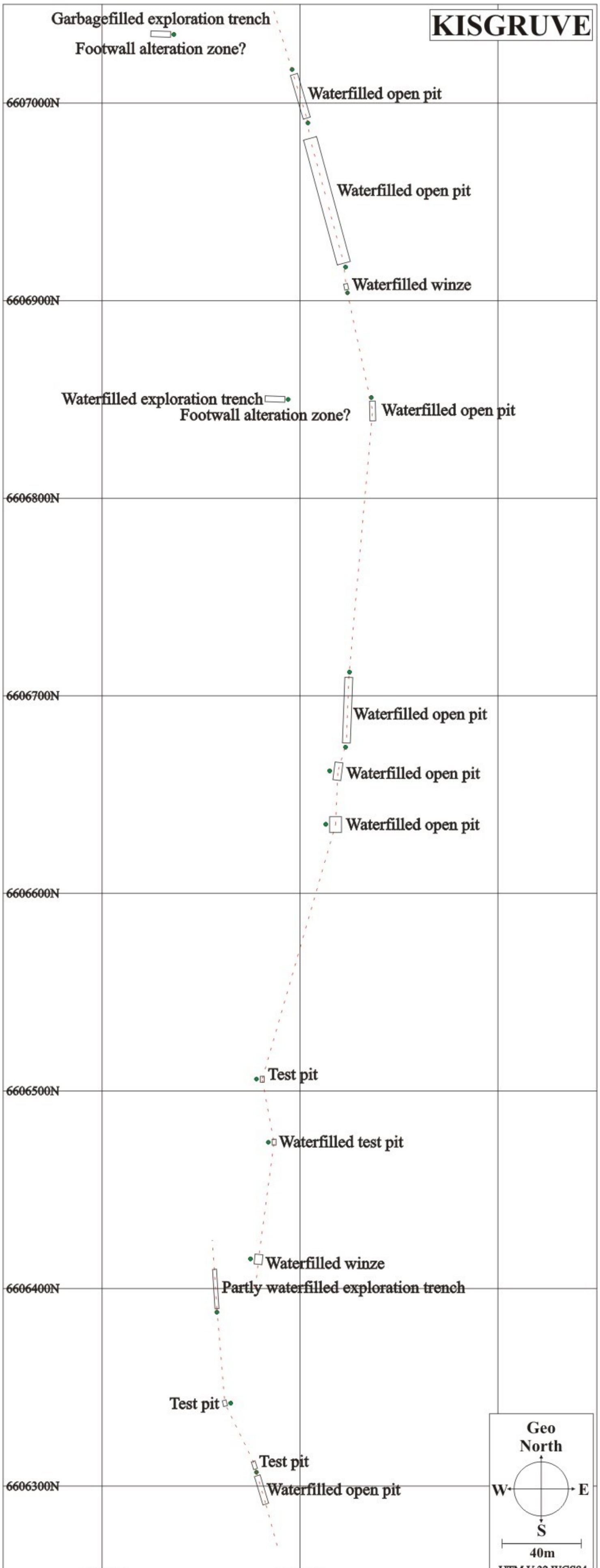


Fig. 2.12.1: Kisgruva.

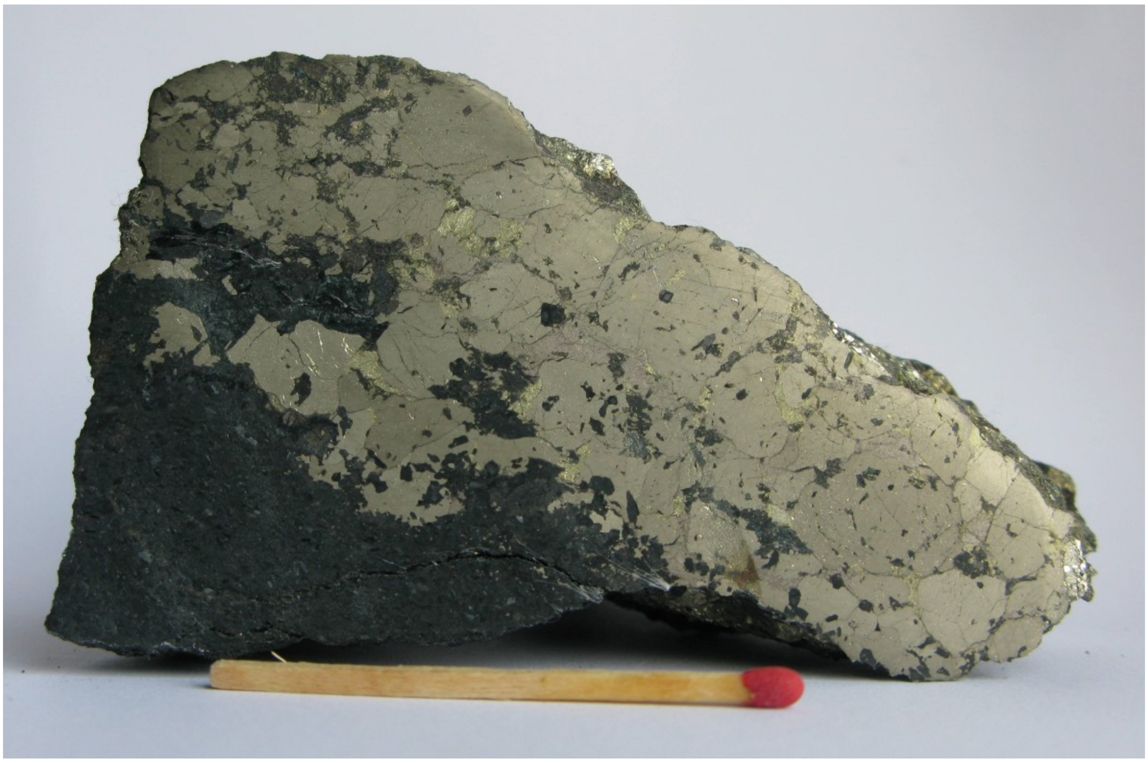


Fig. 2.12.2: Kisgruva. Amphibolite in contact with massive pyrite (as recrystallized metablasts) and minor, interstitial chalcopyrite and pyrrhotite. Not analyzed.

Fig. 2.12.3: Kisgruva. Massive pyrite (as recrystallized metablasts) and minor chalcopyrite and pyrrhotite. Not analyzed.

2.13 KOPPARVOLLANE

There is little information available but the occurrence was probably mined around year 1500 together with Verlorne Sohn and other nearby occurrences and deposits. A discouraging geophysical was carried out in 1944.

There are three sub-parallel rustzones (up to 2 m thick) two of which coalesce in the largest of the old workings – a fenced in,waterfilled pit. There is no massive sulphide in the dump or in outcrop. Sample 563358 was the richest found at the site and is as low-grade as NGU's samples. Pyrrhotite dominates over chalcopyrite and traces of arsenopyrite and magnetite. The ore minerals occur in schlierens in a fine-grained and sheared matrix of chlorite and quartz. Country rock is metabasalt and maximum susceptibility of both country rock and mineralization is $10x10^{-3}$ S.I. units – i.e. practically unmagnetic.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563358	Kopparvollane	0.7	26	1.2	0.0	0.0	6460	68	11	17.25	6.4	2	2

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
BU0281.01	Kopparvollane	0.5	12	0.9	0.0	0.0	3299	43	2	10.4	n.a.	3	2
BU0281.02	Kopparvollane	0.1	28	0.7	0.7	0.1	4783	16	3	11.8	n.a.	41	9
BU0281.03	Kopparvollane	0.3	3	0.2	0.0	0.0	>99999	93	9	14.2	n.a.	2	2

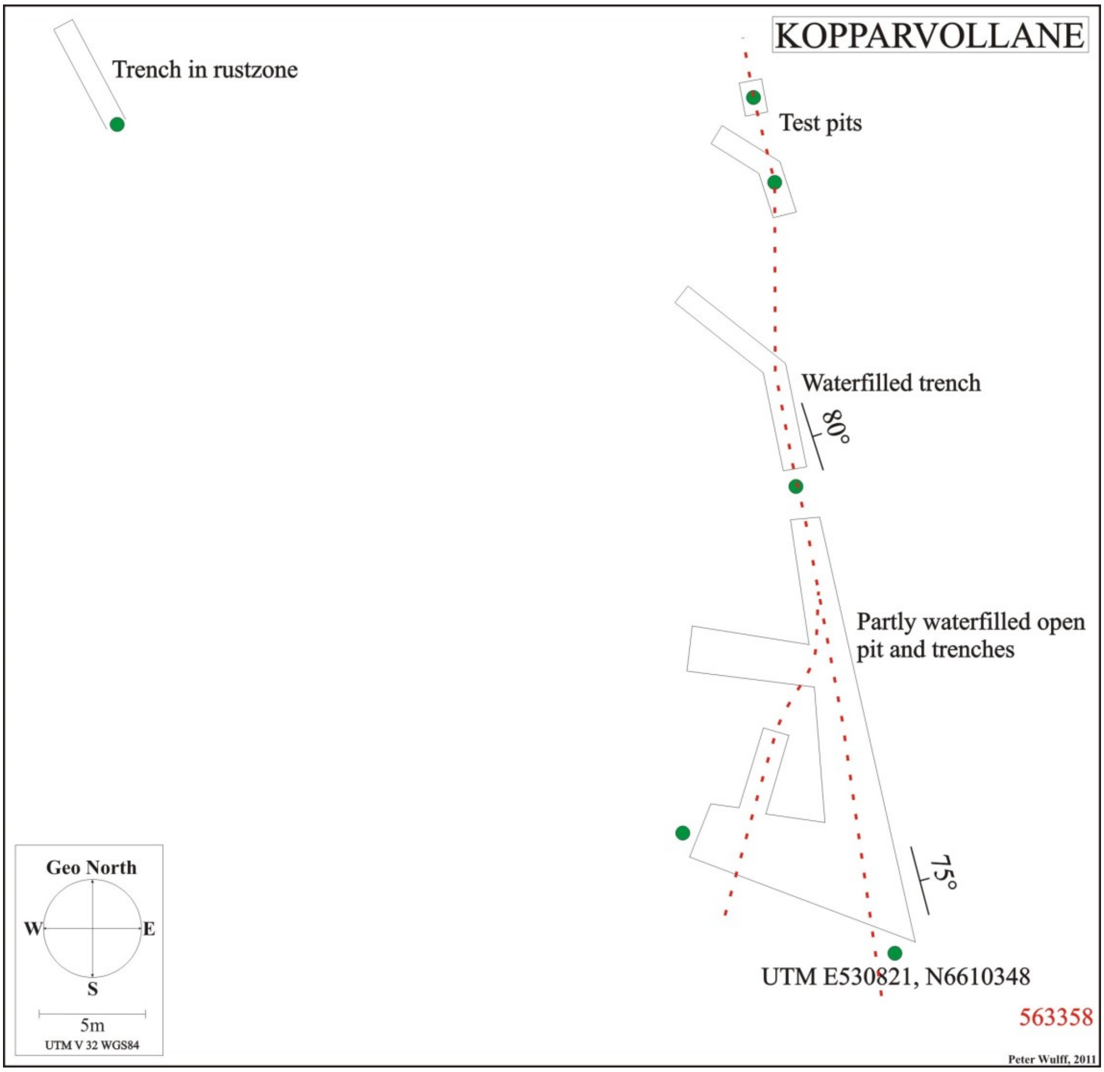


Fig. 2.13.1: The old workings at Kopparvollane.

Fig. 2.13.2: Kopparvollane, sample 563358. Deformed chlorite-quartz schist with pyrrhotite, chalcopyrite and traces of arsenopyrite and magnetite.

2.14 VERLORNE SOHN

Mining dates back to year 1490 and possibly earlier. Since then, the deposit was mined intermittently until mining started in earnest at Kongsberg Silver Mines. In a report (Støren, 1916-17) it is said that the orebody's maximum thickness is 4 m, its strike length 30 m and that it was mined out 41 m below surface. Furthermore, it is said that there in both the foot- and hanging walls are silver rich quartz-calcite veins with sphalerite, galena and minor barite. Geologisk Malmleting carried out a geophysical survey in 1944 and concluded that there are no larger deposits in the vicinity.

The deposit was mined in an open pit which today is waterfilled and surrounded by dumps. The ore is semi-massive, tectonized and composed of pyrrhotite, pyrite and chalcopyrite in descending order. Country rock is metabasalt which has been chloritized, silicified and sericitized. To the east of the open pit is a test pit in which one of the aforementioned argentiferous veins was possibly investigated although I saw nothing but a rustzone there. In the strike direction towards northwest occur two insignificant old workings collectively called Brattåsen where I found only low-grade material. The old workings at Verlorne Sohn and Brattåsen are not necessarily on the same stratigraphic level - as indicated in fig. 2.14.1.

None of NEAB's or NGU's seven have significant grades of valuable metals.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563356	Verlorne Sohn	0.3	7	2.2	0.1	0.0	9	110	10	26.5	9.2	8	2
563357	Verlorne Sohn	0.4	1	0.6	0.2	0.0	9	44	12	40.5	>10.0	6	2

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
BU0282.01	Verlorne Sohn	0.6	6	1.1	0.1	0.0	95	35	5	23.2	8.9	4	1
BU0282.02	Verlorne Sohn	0.3	6	1.8	0.4	0.0	45	59	2	22.1	11.6	8	2
BU0282.03	Verlorne Sohn	0.3	7	1.8	0.1	0.0	24	16	3	6.9	3.7	4	3
BU0282.04	Verlorne Sohn	0.1	2	0.1	0.0	0.0	84	7	2	10.1	10.3	1	3
BU0282.05	Verlorne Sohn	0.7	9	2.1	0.4	0.1	160	24	7	7.9	6.04	20	5

Fig. 2.14.1: Old workings at Verlorne Sohn and Brattåsen.They are not necessarily on the same stratigraphic level.

Fig. 2.14.2: Verlorne Sohn, sample 563356. Semimassive pyrrhotite & chalcopyrite in quartz. Also minor pyrite.

2.15 GOTTS VERMAGT

Gotts Vermagt comprises old workings at two sites. The eastern occurrence is insignificant and seems to have targeted a low-grade iron formation with only little sulphides, pyrite, mostly. Its susceptibility is up to $1000x10^{-3}$ S.I. units – relatively high. The western occurrence looks better and there is plenty of fairly cupriferous material in the dumps. Most of the sulphides (pyrrhotite, pyrite and chalcopyrite) occur in a matrix of chlorite but quartz is matrix in the richest specimens. Susceptibility is less than $10x10^{-3}$ S.I. units, i.e. unmagnetic. Country rock at both sites is chloritized metabasalt.

A discouraging EM-survey was carried out in 1944. The samples have some copper but else nothing of interest.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563360	Gotts Vermags W	0.2	27	4.7	0.3	0.0	90	11	12	25.0	>10.0	3	1

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
BU0283.01	Gott Vermags W	0.0	2	0.2	0.2	0.0	135	7	3	30.3	20.1	4	4
BU0283.02	Gott Vermags W	0.2	23	3.4	0.2	0.0	104	25	3	22.3	21.0	3	3

Fig. 2.15.1: The old workings at Gotts Vermagt W & E.

Fig. 2.15.2: Gotts Vermagt W, sample 563360. Deformed chalcopyrite, pyrite and pyrrhotite. The silicate phase is chlorite.

2.16 ORE DUMP

Just north of the railway is a dump with ore that looks like it's coming from Verlorne Sohn and/or Gotts Vermagt. Some specimens are of higher grade than I managed to find at the old workings and one such sample was taken. It probably came from Verlorne Sohn.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563359	Ore dump	0.5	26	7.1	0.3	0.0	8	8	6	16.3	9.2	14	1

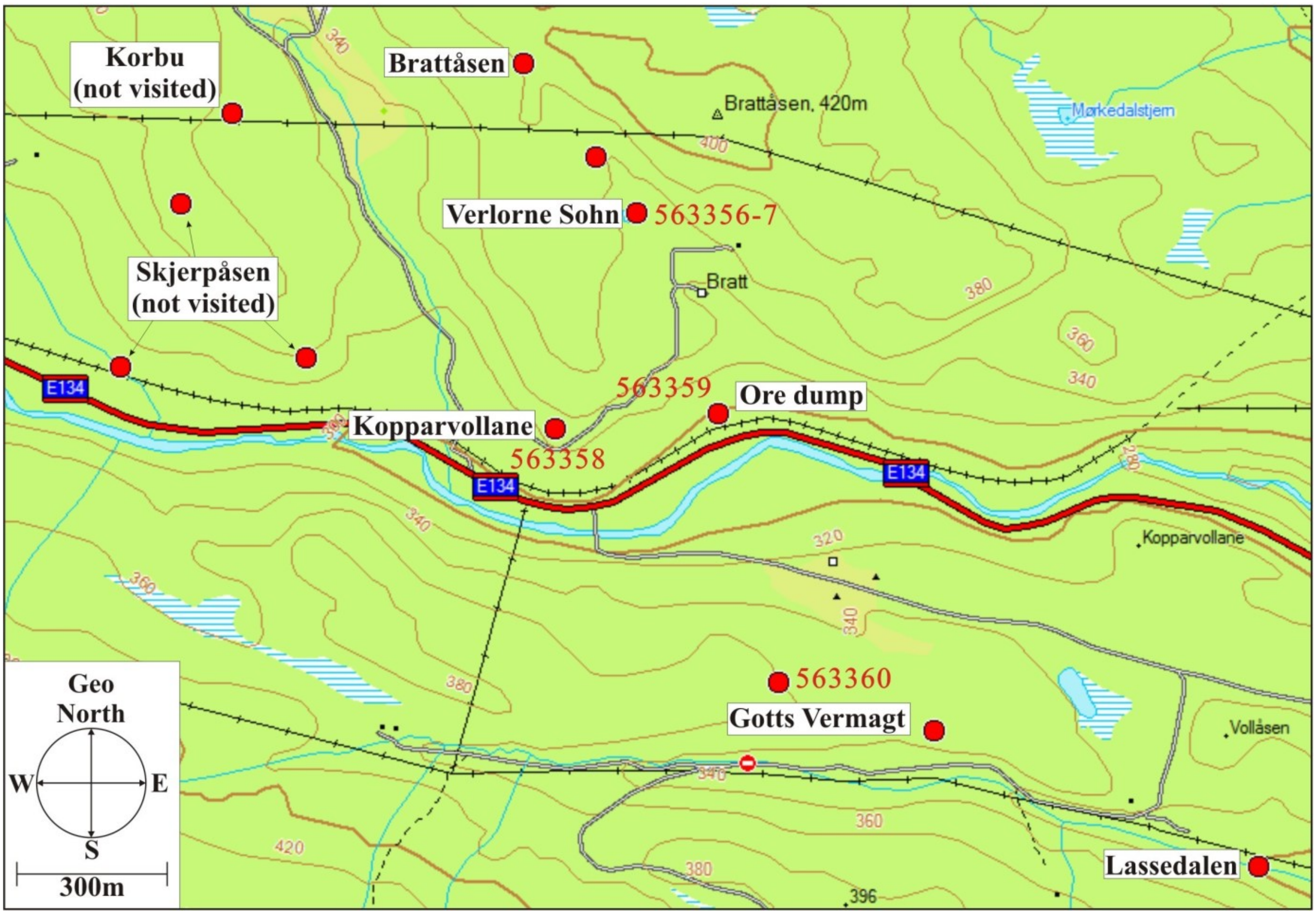


Fig. 2.16.1: The occurrences are all VHMS mineralizations except Lassedalen which is a fluorite deposit with minor zinc.

Fig. 2.16.2: Ore dump, sample 563359. Intensely deformed chalcopyrite and minor pyrite, pyrrhotite and sphalerite in quartz matrix.

2.17 HAUGSET

Mining at Haugset started in 1869 and lasted for a few years during which 190 tons of ore grading 9% copper were produced. The handsorting must have been very effective as such rich specimens do not occur in the dump. Geofysisk Malmleting and NGU carried out geophysics in 1946 and 1979, respectively but failed to indicate any depth or strikelength.

There are two ore types at Haugset. The least common type is massive pyrrhotite with minor chalcopyrite and sphalerite. NGU says it maximum thickness is only 5 cm. The most common type is massive magnetite with bands of disseminated chalcopyrite. Its susceptibility exceeds 3000×10^{-3} S.I. units (higher than I measured on magnetite from Malmberget in Sweden) and the largest specimens are up to 15 cm thick across banding. Some of the specimens of this type are attached to an unmetamorphosed dolerite suggesting that the magnetite with chalcopyrite is the result of the VHMS being contact-metamophosed.

The samples from Haugset are poor, except one of NGU's samples with 1.7 ppm of gold.

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563361	Haugset	0.3	1	0.8	0.6	n.d.	8	<2	7	>50	1.29	5	2

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
BU0182.01	Haugset	0.0	0	0.0	0.0	0.0	1	2	2	1.1	n.d.	0	4
BU0182.02	Haugset	1.7	5	0.9	0.4	0.0	13	18	2	31.5	9.5	4	3
BU0182.03	Haugset	0.2	2	0.3	0.3	0.0	7	2	3	33.1	0.1	1	12
BU0182.04	Haugset	0.1	2	0.3	0.5	0.0	3	2	3	30.5	2.2	2	4
BU0182.05	Haugset	0.2	4	0.8	1.6	0.0	11	9	4	34.0	23.8	39	3

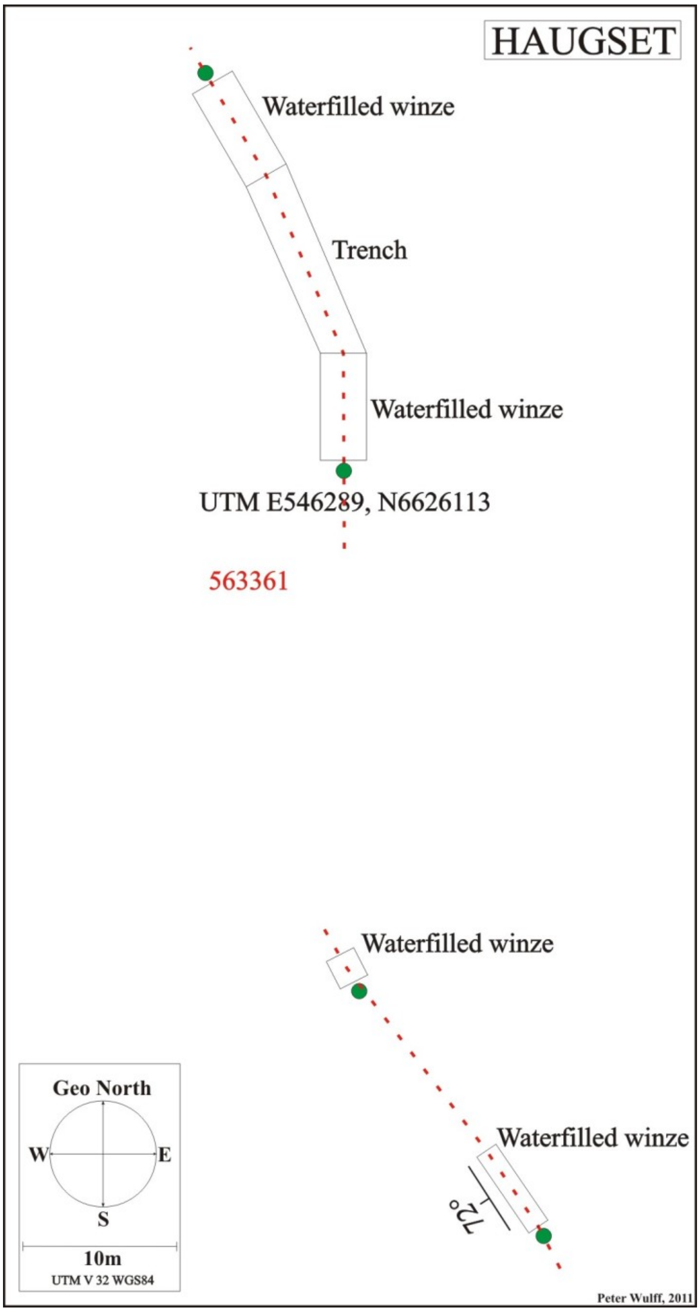


Fig. 2.17.1: Sketch of the Haugset occurrence and its old workings.

Fig. 2.17.2: Haugset, sample 563361. Amphibole and magnetite with chalcopyrite and minor pyrite. Although not evident in this cut, the sulphides occur in bands in this type of ore.

2.18 BERGSGRUVA

About 18200 tons grading 4% Cu was mined during 1874-79 and 1885-89 but there was also mining prior to these periods. This earlier mining must have been significant as the dumps at Bergsgruva almost equal the combined dumps at all the other visited occurrences. In 1980, NGU carried out a VLF-survey including Bergsgruva and other nearby occurrences and deposits. A number of conductors were detected. Bergsgruva was worked to a depth of 138 m downdip. The old workings are waterfilled, more or less collapsed and straddle about 300 m of strikelength. Strike is 27° and dip is 50° W. Maximum thickness in outcrop was about 80 cm of which 25% was semimassive sulphides. Historical sources say that maximum thickness was 2 meter. Maximum susceptibility was $450x10^{-3}$ S.I. units but susceptibility is mostly less than $100x10^{-3}$ S.I. units. The sulphide body is strongly deformed and has rounded, dm-sized host-rock inclusions. Sericitization and silicification are the dominant alteration types, judging from the dumps. Most of the ore in the dumps contain a few per cent of copper and zinc but a few specimens are far richer with respect to zinc. The main sulphides are pyrrhotite followed by pyrite and lesser amount of sphalerite and chalcopyrite. All cracked ore specimens contain numerous inclusions of crystals and host rock inclusions. NEAB's two samples are of reasonable grades with respect to zinc but their copper contents are far from the 4% that reportedly was mined. The same go for NGU's seven samples

NEAB		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
563362	Bergsgruva	0.1	2	0.4	6.2	0.0	14	5	18	39.4	>10.0	135	3
563363	Bergsgruva	0.1	5	0.9	4.6	0.0	16	6	20	41.5	>10.0	105	5

NGU		Au	Ag	Cu	Zn	Pb	As	Bi	Sb	Fe	S	Cd	Mo
		ppm	ppm	%	%	%	ppm	ppm	ppm	%	%	ppm	ppm
BU0183.01	Bergsgruva	0.3	13	2.0	3.9	0.0	15	2	2	34.3	24.5	84	1
BU0183.02	Bergsgruva	0.2	10	1.0	4.7	0.0	37	17	2	32.1	30.8	105	1
BU0183.03	Bergsgruva	0.0	1	0.0	0.0	0.0	62	2	2	11.4	1.4	1	6
BU0183.04	Bergsgruva	0.3	4	0.5	4.5	0.0	60	9	4	33.6	35.2	99	2
BU0183.05	Bergsgruva	0.1	4	0.2	0.4	0.0	11	12	2	16.5	7.8	1	1
BU0183.06	Bergsgruva	0.1	3	0.2	1.9	0.0	11	13	2	15.3	8	28	1
BU0183.07	Bergsgruva	0.1	4	0.5	3.5	0.0	75	6	2	30.4	30.6	69	12

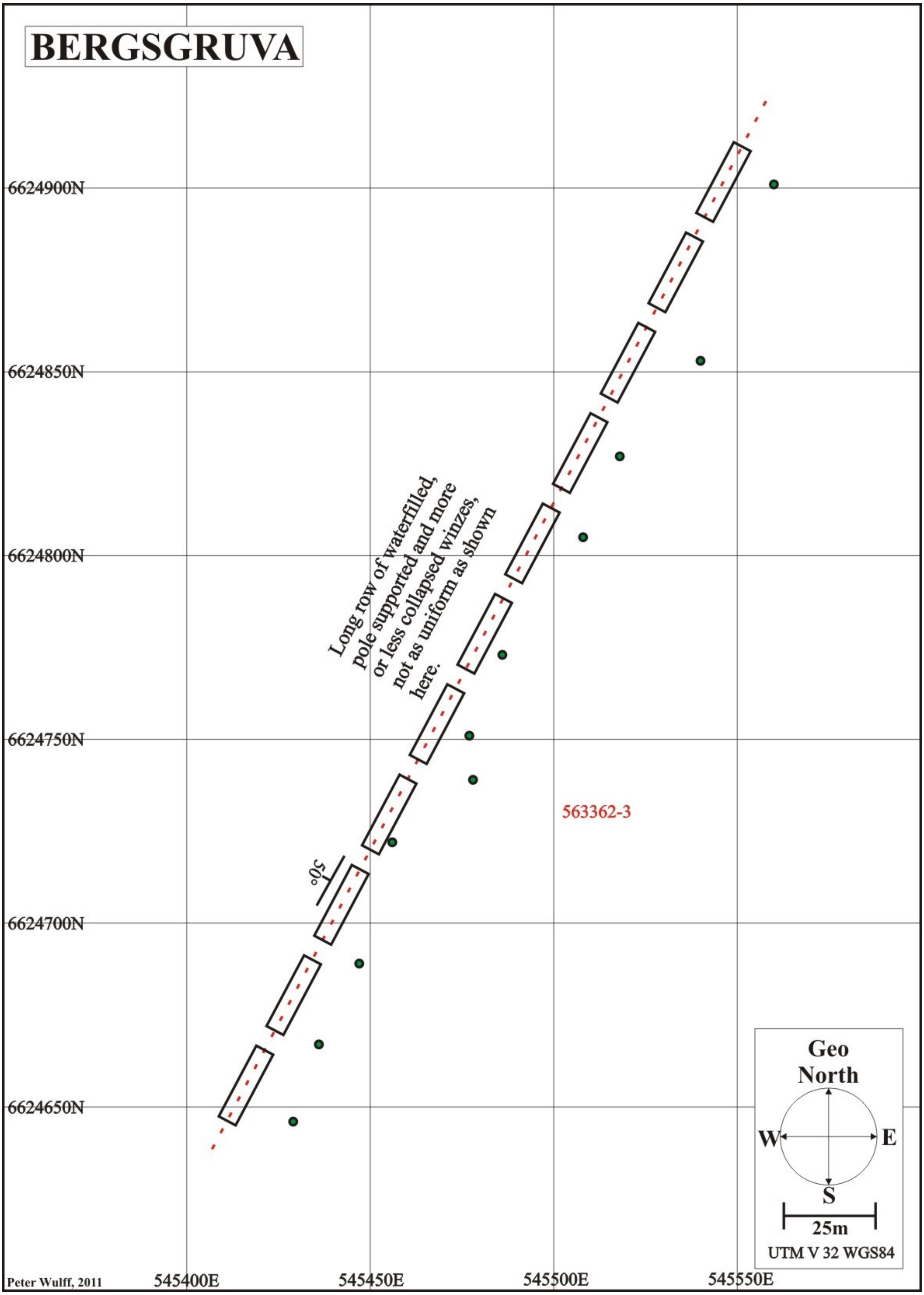


Fig. 2.17.1: Sketch of the Bergsgruva deposit.

Fig. 2.17.2: Bergsgruva, sample 563362. Massive pyrite with sphalerite and minor chalcopyrite. Silicate is needle shaped amphibole.

Fig. 2.17.3: Bergsgruva, sample 563363. Massive pyrrhotite with minor chalcopyrite, sphalerite and pyrite. Silicates are amphibole and quartz.

3.1 CONCLUSION AND FURTHER WORK

The objective of the sampling program was to identify occurrences or deposits with potential for more tonnage or hitherto unknown precious and base-metals. The objective wasn't met and no further work is recommended.

Samples from the vein-type lead-zinc-copper-silver-(gold) occurrences at Skolteberg and Gunhildskås occasionally have attractive grades and are maybe related to an 8-9 km long, common structure but there is little or no tonnage potential.

Investigating known occurrences is inexpensive but if NGU has sampled them within the last 20 years, there is little or no chance of discovering occurrences like Storhidleren, Tjosås or Løkedal - occurrences where NEAB during the last years has established the presence of hitherto unrecognized gold.

APPENDIX 1: Als Laboratory Group's analytical procedures

NEAB´s 38 samples were analyzed by Als Laboratory Group (Alschemex) as shown below.

ME-ICP61: Elements by HF-HNO3-HClO4 Acid Digestion, HCl Leach and ICP-AES.

This package utilises a near total digestion so that data reported for nearly all elements is considered quantitative. It is considered most appropriate for rock characterization as it includes data for all major and minor elements except silicon.

Notes: Digestion For this digestion, the acid mixture must be taken to incipient dryness. This process ensures the best possible dissolution, but also results in the loss of volatile mercury. In addition, this particular acid mixture results in the loss of silicon, an element not normally considered to be volatile.

To assist in the final dissolution of the sample residue, hydrochloric acid is added and then sample analysis is carried out in a dilute hydrochloric acid matrix. This digestion will be "total" for most rock samples. Certain types of highly resistant minerals, for example zircons, may not be totally attacked. In these limited cases, we recommend that the Whole Rock fusion technique be used.

Ag, Al, As, Ba,Be, Bi Ca, Cd, Co, Cr, Cu (<10000 ppm), Fe, Ga, K, La, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sb, Sc, Sr, Th, Ti, Tl, U, V, W and Zn (<10000 ppm).

Fire Assay-Atomic Absorption procedures for Exploration and Low to Medium Grade Ore Samples

Exploration samples (particularly soils) may require a better detection limit than that offered by the above procedures. Method codes Au-AA21 and Au-AA22, which include a fire assay collection followed by cupellation, dissolution of the precious metal prill and a pre-concentration solvent extraction step. The final determination is by flame AAS, providing a detection limit of 1 ppb. It is a more expensive technique than the conventional fire assay /AAS procedure, but for explorers looking for the best resolution of low level gold anomalies, this procedure is excellent.

In recent times, we have turned to ICPMS technology to offer trace level gold. See method codes **Au-ICP21** and Au-ICP22. In addition to a detection limit of 1ppb, the advantage offered by this technique is the ability to determine platinum and palladium together with gold. Many samples arriving at our laboratories have "intermediate" levels of gold; that is in the range of 3-10 g/t (0.1-0.3 oz/ton). These samples are best analyzed using FA-AAS procedures Au-AA23, Au-AA24. If samples contain higher concentrations of gold, procedures **Au-AA25** or Au-AA26 would be a more appropriate technique.

Au-ICP21: Au (<10 ppm) & Au-AA25: Au (>10 ppm)

Ore Grade Analysis

For simple characterisation of ores, recommended procedures include; the aqua regia digestion (OG26) primarily for lead/silver/zinc rich ores and; four acid digestion method **(OG62)** for copper and zinc ores with low lead, and silver and nickel laterite ores. Samples expected to contain significant amounts of sulphides of copper; nickel and/or cobalt are fused with sodium peroxide and then leached with dilute hydrochloric acid using procedure ICP-81.

Cu (>10000 ppm) and Zn (>10000 ppm).