

Molynor AS

Case study report on

MMI (Mobile Metal Ions) Orientation Survey. Nordli Porphyry Molybdenite Deposit , Hurdal, Norway

Work conducted in 2011

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Preface

The Nordli molybdenum porphyry deposit in Hurdal was selected for testing the MMITM (Mobile Metal Ions) method because this deposit is covered by 1-5 meter moraine and results from previous soil sampling surveys are available for comparison.

The purpose of conducting a MMITM Orientation Survey prior to adapting the method to regional areas is to determine the sample spacing for each deposit type and to establish the appropriate depth below the organic layer at which to collect a sample. To do so, the practice of the orientation survey is to collect 4 samples from each hole at different intervals. When results from the orientation survey reveals which depth interval returns the highest response ratio, only this interval will be sampled in more regional surveys.

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1. Geology and mineralisation

1.1 The Nordli deposit

The Nordli molybdenum porphyry deposit is classified as a batholith related epigenetic deposit with an extreme degree of regional structural control of the mineralisation. The mineralisation is related to the emplacement of a large alkali granitic intrusion that constitutes the Nordli stock. The magmatic evolution of the Nordli stock involves several phases of intrusion and molybdenum mineralisation (Olerud & Ihlen, 1986).

The first phase in the evolution of the Nordli stock involved intrusions of a volatile laden, highly alkalic and silica-rich stock consisting of quartz eye granite. This was superseded

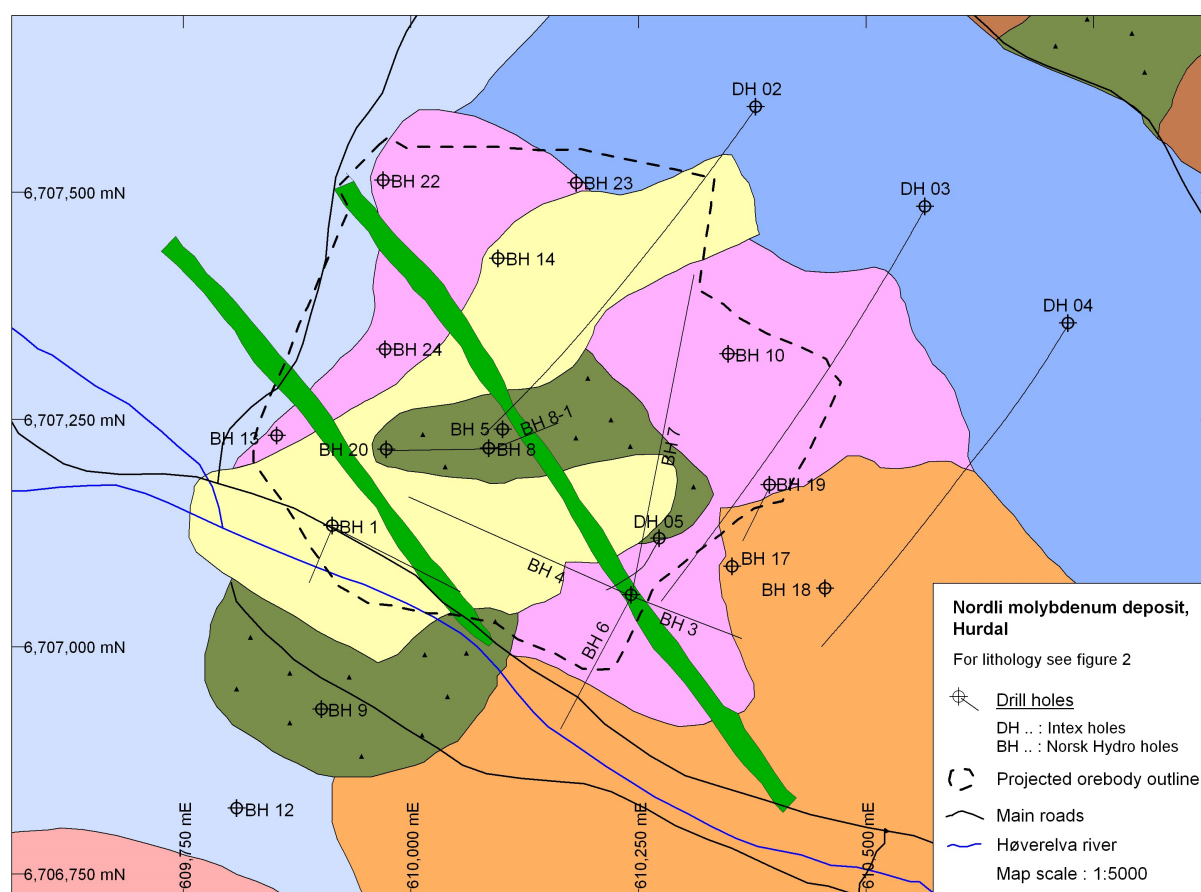


Figure 1 . Geological map and drill hole locations, Nordli area.

by the formation of a diatreme consisting of granite porphyry and intrusive breccias that partly obliterated the early intrusion phase. Soon afterwards, the Nordli stock intruded the diatreme forming a composite body of highly differentiated granite. The first granophyric phase (figure 1) reached a shallow level and spread out towards the south to form an overhang over the deep parts of the diatreme. A water-rich supercritical vapour released during the crystallisation of the granophyre formed an upper low-grade molybdenite enriched shell composed of numerous steeply dipping and flat lying quartz

veinlets with pyrite, hematite, magnetite, sericite and molybdenite. The second aplogranitic phase transected the granophyre 150 m below the present surface and gave rise to a middle molybdenite enriched shell composed of steeply dipping, ribbon-type veinlets consisting of molybdenite, quartz, pyrite, sericite, biotite and alkali feldspar. Following the emplacement of the aplogranite, the third phase consisting of micro granite intruded to a level of about 600 metres below the present surface. The granite gave rise to a lower, rather flat-lying molybdenite shell composed of a stockwork of cavernous veinlets with molybdenite, quartz, calcite, K-feldspar, magnetite and pyrite. Finally, a late phase of volatile-depleted porphyritic microgranite intruded the deepest parts of the system and transected parts of the richest molybdenite mineralisation in the deposit (Olerud & Ihlen, 1986).

Nordli orebody, Hurdal

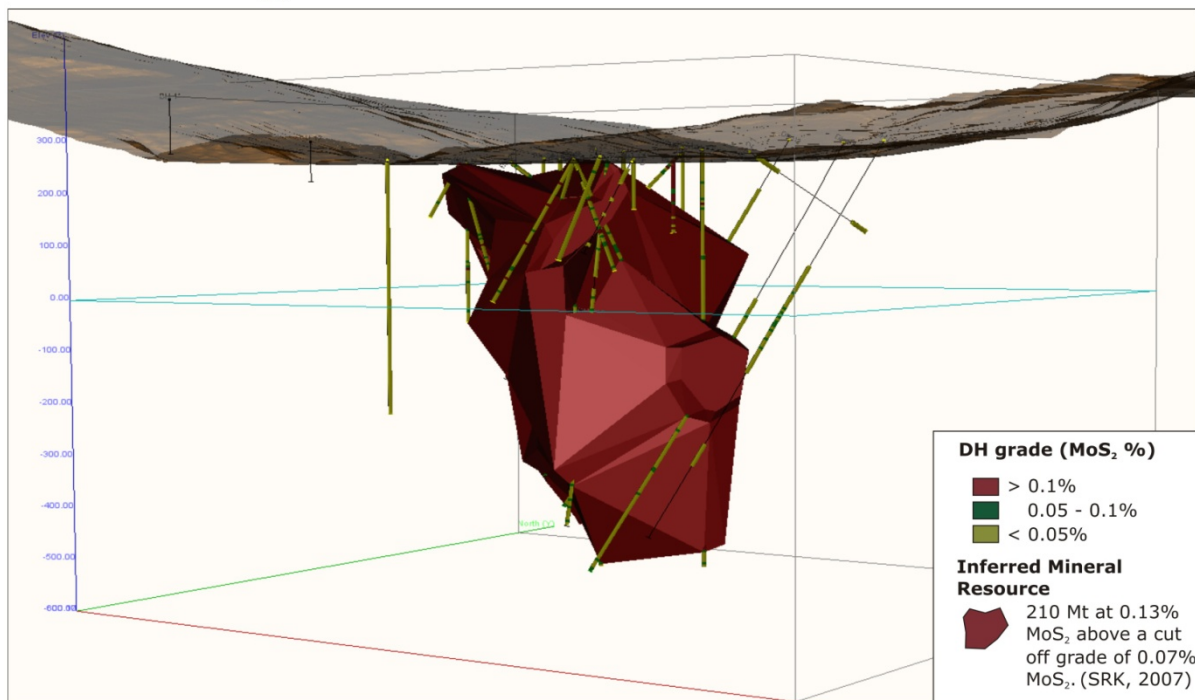


Figure 2. Surface, drill holes and modelled orebody, Hurdal molybdenum deposit, SRK 2007.

In 2007, SRK Consulting was engaged to conduct a resource estimate of the ore body and produced a geological model of the mineralisation which is shown in figure 2. SRK concluded that the mineralisation is not controlled by lithology and the deposit was modelled on a grade shell. A cut off grade of 0.05 % MoS₂ (300 ppm Mo) was used to define a three dimensional wireframe for the mineralisation. The wireframe seems to form a vertical, cylinder shaped ore body with a channel-like zone in the middle representing areas with less than 0.05 % MoS₂ (300 ppm Mo). The main centre of the cylinder is defined by drill holes BH 14, 23, 24, 8, 8-1 and has a full extent from the surface to about 8-900 m depth. The channel shaped zone in the middle divides the ore body in two along a vertical plane and the eastern part of the ore body has a lesser vertical extent than the western part of the geological model.

1.2 Alteration pattern

Most of the typical alteration phases seen in porphyry deposits are also associated with the Nordli molybdenum deposit, and hydrothermal alteration in connection with the different mineralising phases at Nordli can be seen within a diameter of 1800 m surrounding the Nordli stock.

The bulk of the mineralisation at Nordli occurs in K-feldspar stable rocks and a more or less total alkali feldspar replacement of the parent magmatic rocks are seen together with abundant alkali feldspar rich veins cutting parent magmatic rocks and a growth of secondary biotite and/or biotite-carrying fissures. Other than alkali feldspar alteration only minor vein-bounded hydrothermal alteration, represented by sericite, quartz-sericite and argillic alterations are seen.

Elevated Fe values surround the stock and partly overlap with Mo values and reflect the Fe content in pyrite within the pyrite-sericite alteration halo. The Fe values can therefore be used to outline the alteration halo surrounding the Nordli stock. Pb, Zn and Cu show a uniform distribution and anomalous values are embracing the Nordli stock on the outside of the central Fe-Mo circle (Pedersen, 1982).

2. MMI Orientation Survey at Nordli

The Nordli molybdenum deposit in Hurdal was selected as the project site for testing the MMI method. Nordli is covered by a glacial moraine with thicknesses between 1-5 meters and surface geochemistry data exists for comparison.

In 2008, Intex conducted a deep soil sampling program (DOB) over the Nordli molybdenum porphyry deposit and the results from this survey will be compared with the results obtained from the MMI orientation survey conducted in June 2011. Samples in the DOB program were collected using a portable gas-driven Cobra percussion drill. Sample spacing was 50 meters with an increase of spacing up to 80 meters in the SW part of the sampling area. Soil samples were sent to ALS Chemex Laboratories in Pitea, Luleå for assaying using method ME-MS61 Ultra-trace Level Method with ICP-MS and ICP-AES. (see Wilberg & Blomsterberg, 2008 for more info)

When applying MMI to narrow deposits, a sample spacing of 15-25 meters in non-mineralised areas (background value) is recommended with decreasing spacing to less than 15 meters over the mineralised area. Due to the porphyry type deposit at Nordli and the magnitude of the mineralised area outlined by existing soil geochemistry a spacing of 50 meters were chosen throughout the MMI orientation survey profile. The survey sample line runs E-W at

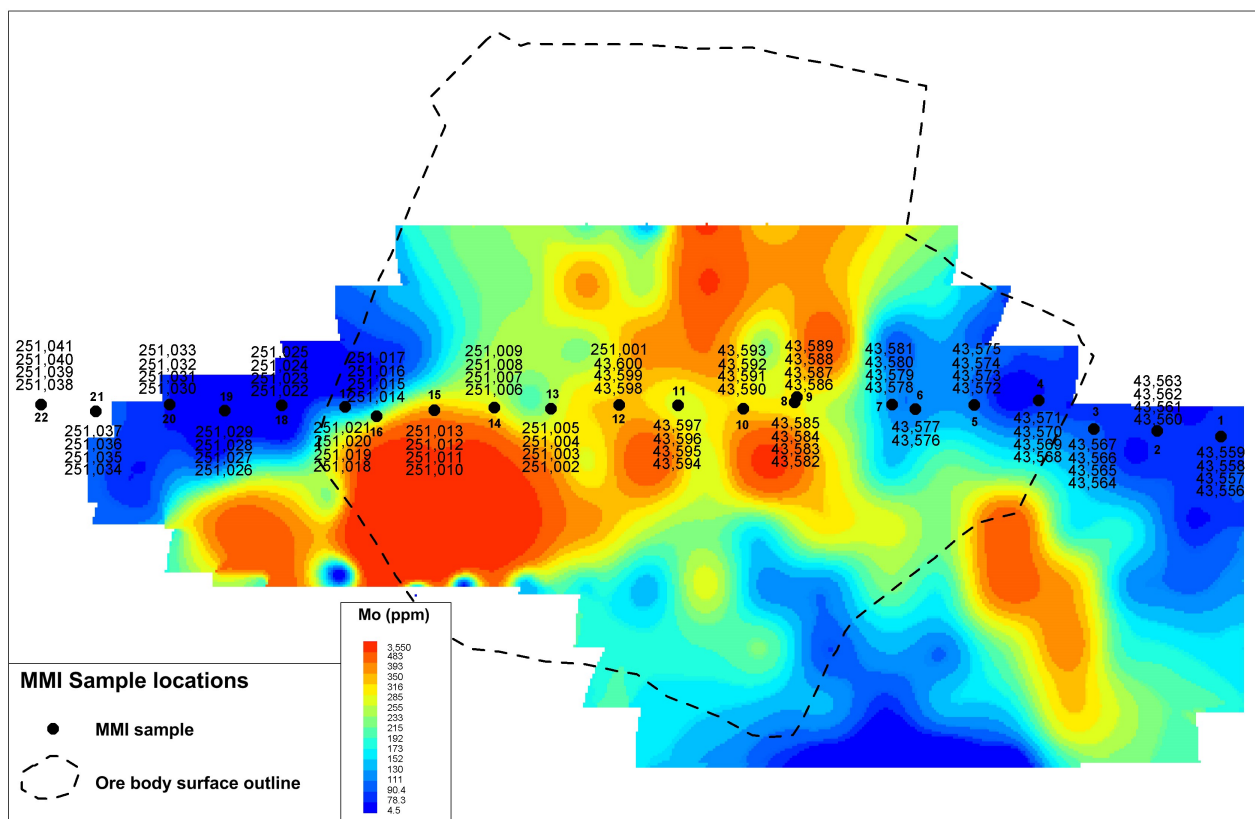


Figure 3. Map showing sample locations and numbers for the MMI orientation survey. Coloured grid is Mo values from a deep soil sampling program conducted in 2008.

N 9707250m (WGS84, Zone 32N) and has a length of 980 meters. The mineralised area at this grid line is approximately 360 meters wide. A total of 22 samples were collected, 13 representing background MMI levels and 9 samples representing the mineralised zone (figure 3).

Equipment used for MMI sampling consisted of a spade, a plastic scoop for sample collection, a white plastic sieve, 4 white plastic bowls for sample handling, a 50 cm wooden ruler, zip plastic bags for sample containment and a brush for cleaning (figures 4 and 5). A problem occurred when it turned out to be impossible to purchase a non-paint coated spade except for aluminium spades. Aluminium spades would quickly be destroyed when digging 50 cm deep holes and it was decided to use the painted spade. In trying to avoid potential Mo contamination from the paint, the plastic scoop was used to scrape the sample profile “clean” before taking the samples from the different depth intervals.



Figure 4. Equipment used for MMI sampling.



Figure 5. Measuring sample intervals.

Sampling procedures from SGS Lakefield on MMI Orientation Survey sampling were followed. Four samples were collected from the same hole at each sample locality. The “zero” point which is right under the organic top layer was defined at every locality and four samples were collected at 40-30 cm, 30-20 cm, 20-10 cm and 10-0 cm depths (figure 6). For each interval, 200-300 grams was collected and sieved if containing larger rock fragments. No further sample preparation is necessary for MMI sampling. Samples were put in zip lock plastic bags, labelled and shipped to SGS Lakefield for assaying. In this case, samples were assayed for Mo, Cu, Zn, Mn, Fe, W, Ag, Ba in a minimum 8 element package. Unfortunately, sample 251041, interval 10-0 cm was lost from site to the lab and has not been assayed. MMI also use ICP-MS for assaying but the difference is in the extraction of the elements where a weak solution of organic and inorganic compounds are used rather than conventional aggressive acid or cyanide-based digests (www.sgs.com).

At sample locality 6 it was not possible to obtain samples from the two deepest intervals and therefore only interval 20-10 cm and 10-0 cm are represented. MMI assay results are reported in ppb/ppm and for interpretation of results a Response Ratio (RR) needs to be calculated. This is done by calculating the lower 25% quartile, take the mean of the lower 25% quartile (background value) and then divide the assay value with the mean and round up. Assay results and calculated RR are seen in table 1.

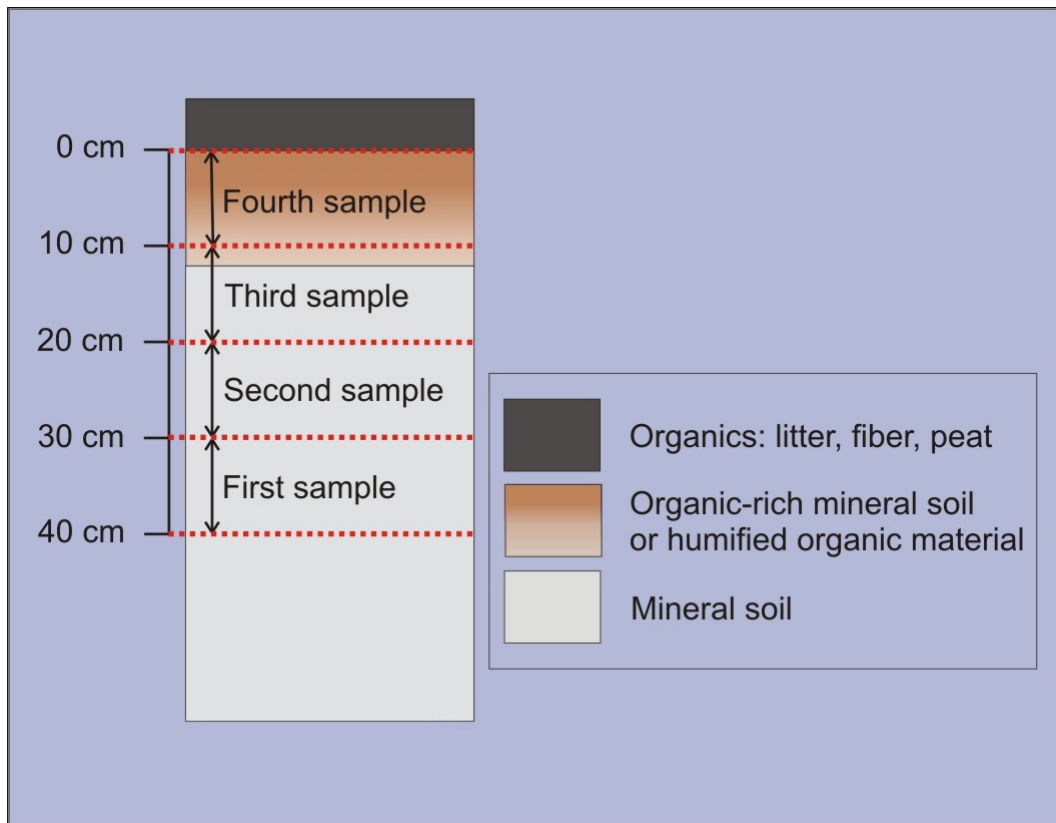


Figure 6. Sampling specifications for MMI method outlined by SGS Lakefield.

Sample no	Interval (cm)	Way point	Easting	Northing	Zone	Elevation (m)	Date	Organic layer (cm)	Color	Size class	Terrain type	Moisture	Comments
43556	40-30	1	610578.5	6707224	32	283	04/06/2011 10:55	14	Dark brown	Silty clay	Grass field	Semi wet	
43557	30-20	1	610578.5	6707224	32	283	04/06/2011 10:55	14	Dark brown	Silty clay	Grass field	Semi wet	
43558	20-10	1	610578.5	6707224	32	283	04/06/2011 10:55	14	Dark brown	Silty clay	Grass field	Semi wet	
43559	10-0	1	610578.5	6707224	32	283	04/06/2011 10:55	14	Dark brown	Silty clay	Grass field	Semi wet	
43560	40-30	2	610525.3	6707229	32	289	04/06/2011 11:59	14	Dark brown	Silty clay	Grass field	Semi wet	
43561	30-20	2	610525.3	6707229	32	289	04/06/2011 11:59	14	Dark brown	Silty clay	Grass field	Semi wet	
43562	20-10	2	610525.3	6707229	32	289	04/06/2011 11:59	14	Dark brown	Silty clay	Grass field	Semi wet	
43563	10-0	2	610525.3	6707229	32	289	04/06/2011 11:59	14	Dark brown	Silty clay	Grass field	Semi wet	
43564	40-30	3	610472.6	6707230	32	292	04/06/2011 12:25	9	Rusty orange brown	Silty sand	Pine tree forest	Dry	Almost direct regolith soil
43565	30-20	3	610472.6	6707230	32	292	04/06/2011 12:25	9	Rusty orange brown	Silty sand	Pine tree forest	Dry	Almost direct regolith soil
43566	20-10	3	610472.6	6707230	32	292	04/06/2011 12:25	9	Rusty orange/light grey	Sand	Pine tree forest	Dry	Almost direct regolith soil
43567	10-0	3	610472.6	6707230	32	292	04/06/2011 12:25	9	Light grey/light brown	Sandy gravel	Pine tree forest	Dry	Almost direct regolith soil
43568	40-30	4	610426.6	6707254	32	289	04/06/2011 13:19	9	Dark brown	Silty clay	Grass field	Semi wet	
43569	30-20	4	610426.6	6707254	32	289	04/06/2011 13:19	9	Dark brown	Silty clay	Grass field	Semi wet	
43570	20-10	4	610426.6	6707254	32	289	04/06/2011 13:19	9	Dark brown	Silty clay	Grass field	Semi wet	
43571	10-0	4	610426.6	6707254	32	289	04/06/2011 13:19	9	Dark brown	Silty clay	Grass field	Semi wet	
43572	40-30	5	610373	6707251	32	294	04/06/2011 13:39	15	Rusty orange brown	Silty sand	Forest hilltop, lots of boulders	Dry	Possible Mo rock in hole, clay alt., sample maybe not up to standard
43573	30-20	5	610373	6707251	32	294	04/06/2011 13:39	15	Rusty orange brown	Silty sand	Forest hilltop, lots of boulders	Dry	Possible Mo rock in hole, clay alt., sample maybe not up to standard
43574	20-10	5	610373	6707251	32	294	04/06/2011 13:39	15	Brown	Silty sand	Forest hilltop, lots of boulders	Dry	Possible Mo rock in hole, clay alt., sample maybe not up to standard
43575	10-0	5	610373	6707251	32	294	04/06/2011 13:39	15	Brown	Silty sand	Forest hilltop, lots of boulders	Dry	Possible Mo rock in hole, clay alt., sample maybe not up to standard
43576	20-10	6	610323.8	6707247	32	293	04/06/2011 15:00	7	Dark brown	Fine silt	Grass field	Semi dry	
43577	10-0	6	610323.8	6707247	32	293	04/06/2011 15:00	7	Dark brown	Fine silt	Grass field	Semi dry	
43578	40-30	7	610304.5	6707251	32	291	04/06/2011 15:41	12	Greyish brown	Sandy gravel	Mixed forest	Semi dry	
43579	30-20	7	610304.5	6707251	32	291	04/06/2011 15:41	12	light grey brown	Sandy gravel	Mixed forest	Semi dry	
43580	20-10	7	610304.5	6707251	32	291	04/06/2011 15:41	12	Dark brown	Silty sand	Mixed forest	Semi dry	
43581	10-0	7	610304.5	6707251	32	291	04/06/2011 15:41	12	Dark brown	Silty sand	Mixed forest	Semi dry	
43582	40-30	8	610223.3	6707253	32	287	04/06/2011 17:40	12	Dark brown	Silty sand	Pine tree forest	Dry	
43583	30-20	8	610223.3	6707253	32	287	04/06/2011 17:40	12	Dark brown	Silty sand	Pine tree forest	Dry	
43584	20-10	8	610223.3	6707253	32	287	04/06/2011 17:40	12	Dark brown	Silty sand	Pine tree forest	Dry	
43585	10-0	8	610223.3	6707253	32	287	04/06/2011 17:40	12	Dark brown	Silty sand	Pine tree forest	Dry	
43586	40-30	9	610225.4	6707257	32	285	04/06/2011 17:43	7	Orange brown	Silty sand	Grass field	Dry	
43587	30-20	9	610225.4	6707257	32	285	04/06/2011 17:43	7	Orange brown	Silty sand	Grass field	Dry	
43588	20-10	9	610225.4	6707257	32	285	04/06/2011 17:43	7	Orange brown	Silty sand	Grass field	Dry	
43589	10-0	9	610225.4	6707257	32	285	04/06/2011 17:43	7	Orange brown	Silty sand	Grass field	Dry	
43590	40-30	10	610180.4	6707247	32	281	05/06/2011 10:28	10	Orange brown	Sand	Grass field	Dry	
43591	30-20	10	610180.4	6707247	32	281	05/06/2011 10:28	10	Orange brown	Sand	Grass field	Dry	
43592	20-10	10	610180.4	6707247	32	281	05/06/2011 10:28	10	Orange brown	Sand	Grass field	Dry	
43593	10-0	10	610180.4	6707247	32	281	05/06/2011 10:28	10	Orange brown	Silty sand	Grass field	Dry	
43594	40-30	11	610126.2	6707250	32	283	05/06/2011 11:10	8	Dark orange brown	Coarse sand	Birch dom forest	Dry	
43595	30-20	11	610126.2	6707250	32	283	05/06/2011 11:10	8	Orange brown	Sand	Birch dom forest	Dry	
43596	20-10	11	610126.2	6707250	32	283	05/06/2011 11:10	8	Orange brown	Silty sand	Birch dom forest	Dry	
43597	10-0	11	610126.2	6707250	32	283	05/06/2011 11:10	8	Brown	Silty sand	Birch dom forest	Dry	
43598	40-30	12	610077.1	6707250	32	287	05/06/2011 11:33	12	Orange brown	Coarse sand	Light forest, pine trees	Dry	
43599	30-20	12	610077.1	6707250	32	287	05/06/2011 11:33	12	Orange brown	Coarse sand	Light forest, pine trees	Dry	
43600	20-10	12	610077.1	6707250	32	287	05/06/2011 11:33	12	Orange brown	Silty sand	Light forest, pine trees	Dry	
251001	10-0	12	610077.1	6707250	32	287	05/06/2011 11:33	12	Orange brown	Silty sand	Light forest, pine trees	Dry	

Table 1. Sample and result list for MMI samples.

Sample no	Interval (cm)	Way point	Easting	Northing	Zone	Elevation (m)	Date	Organic layer (cm)	Color	Size class	Terrain type	Moisture	Comments
251002	40-30	13	610020.3	6707248	32	286	05/06/2011 12:23	10	Orange brown	Coarse sand	Mixed forest	Dry	
251003	30-20	13	610020.3	6707248	32	286	05/06/2011 12:23	10	Orange brown	Coarse sand	Mixed forest	Dry	
251004	20-10	13	610020.3	6707248	32	286	05/06/2011 12:23	10	Orange brown	Sand	Mixed forest	Dry	
251005	10-0	13	610020.3	6707248	32	286	05/06/2011 12:23	10	Orange brown	Sand	Mixed forest	Dry	
251006	40-30	14	609973.2	6707248	32	289	05/06/2011 12:51	12	Coffee brown	Silt	Wet area in forest , waterfilled 5cm bottom	Wet	
251007	30-20	14	609973.2	6707248	32	289	05/06/2011 12:51	12	Coffee brown	Silt	Wet area in forest , waterfilled 5cm bottom	Wet	
251008	20-10	14	609973.2	6707248	32	289	05/06/2011 12:51	12	Coffee brown	Silt	Wet area in forest , waterfilled 5cm bottom	Wet	
251009	10-0	14	609973.2	6707248	32	289	05/06/2011 12:51	12	Coffee brown	Silt	Wet area in forest , waterfilled 5cm bottom	Wet	
251010	40-30	15	609923.1	6707246	32	290	05/06/2011 13:48	11	Coffee brown	Silt	Pine tree forest	Wet	
251011	30-20	15	609923.1	6707246	32	290	05/06/2011 13:48	11	Coffee brown	Silt	Pine tree forest	Wet	
251012	20-10	15	609923.1	6707246	32	290	05/06/2011 13:48	11	Coffee brown	Silt	Pine tree forest	Wet	
251013	10-0	15	609923.1	6707246	32	290	05/06/2011 13:48	11	Coffee brown	Silt	Pine tree forest	Wet	
251014	40-30	16	609875	6707241	32	291	05/06/2011 14:07	13	Dark brown	Silt	Birch tree forest	Semi wet	
251015	30-20	16	609875	6707241	32	291	05/06/2011 14:07	13	Dark brown	Silt	Birch tree forest	Semi wet	
251016	20-10	16	609875	6707241	32	291	05/06/2011 14:07	13	Dark brown	Silt	Birch tree forest	Semi wet	
251017	10-0	16	609875	6707241	32	291	05/06/2011 14:07	13	Dark brown	Silt	Birch tree forest	Semi wet	
251018	40-30	17	609848.8	6707249	32	289	05/06/2011 14:23	15	Dark orange brown	Silty sand	Pine tree forest	Dry	Probably old blasting area for historic assessment.
251019	30-20	17	609848.8	6707249	32	289	05/06/2011 14:23	15	Orange brown	Silty sand	Pine tree forest	Dry	Samples taken in cross section of the depression.
251020	20-10	17	609848.8	6707249	32	289	05/06/2011 14:23	15	Orange brown	Sand	Pine tree forest	Dry	
251021	10-0	17	609848.8	6707249	32	289	05/06/2011 14:23	15	Orange brown	Sand	Pine tree forest	Dry	
251022	40-30	18	609796.2	6707250	32	285	05/06/2011 15:00	10	Brown	Sand	Forest	Dry	
251023	30-20	18	609796.2	6707250	32	285	05/06/2011 15:00	10	Brown	Sand	Forest	Dry	
251024	20-10	18	609796.2	6707250	32	285	05/06/2011 15:00	10	Brown	Sand	Forest	Dry	
251025	10-0	18	609796.2	6707250	32	285	05/06/2011 15:00	10	Light brown	Sand	Forest	Dry	
251026	40-30	19	609748.5	6707246	32	287	05/06/2011 15:18	5	Light brown	Coarse sand	Wet area in forest	Very wet	
251027	30-20	19	609748.5	6707246	32	287	05/06/2011 15:18	5	Light brown	Coarse sand	Wet area in forest	Very wet	
251028	20-10	19	609748.5	6707246	32	287	05/06/2011 15:18	5	Brown	Coarse sand	Wet area in forest	Very wet	
251029	10-0	19	609748.5	6707246	32	287	05/06/2011 15:18	5	Dark brown	Coarse sand	Wet area in forest	Very wet	
251030	40-30	20	609702.5	6707251	32	281	05/06/2011 15:52	6	Brown	Silty sand	Forest next to river	Dry	
251031	30-20	20	609702.5	6707251	32	281	05/06/2011 15:52	6	Brown	Silty sand	Forest next to river	Dry	
251032	20-10	20	609702.5	6707251	32	281	05/06/2011 15:52	6	Brown	Silty sand	Forest next to river	Dry	
251033	10-0	20	609702.5	6707251	32	281	05/06/2011 15:52	6	Brown	Silty sand	Forest next to river	Dry	
251034	40-30	21	609641.2	6707245	32	278	05/06/2011 16:48	6	Coffee brown	Sand	Open forest, lots of boulders	Dry	
251035	30-20	21	609641.2	6707245	32	278	05/06/2011 16:48	6	Coffee brown	Sand	Open forest, lots of boulders	Dry	
251036	20-10	21	609641.2	6707245	32	278	05/06/2011 16:48	6	Coffee brown	Sand	Open forest, lots of boulders	Dry	
251037	10-0	21	609641.2	6707245	32	278	05/06/2011 16:48	6	Coffee brown	Sand	Open forest, lots of boulders	Dry	
251038	40-30	22	609595.7	6707251	32	279	05/06/2011 17:39	10	Dark brown	Coarse sand	Open area, low bushes and grass	Dry	
251039	30-20	22	609595.7	6707251	32	279	05/06/2011 17:39	10	Brown	Coarse sand	Open area, low bushes and grass	Dry	
251040	20-10	22	609595.7	6707251	32	279	05/06/2011 17:39	10	Brown	Coarse sand	Open area, low bushes and grass	Dry	
251041	10-0	22	609595.7	6707251	32	279	05/06/2011 17:39	10	Orange brown	Coarse sand	Open area, low bushes and grass	Dry	

Table 1. continued...

Sample no	Interval (cm)	Mo_ppb_M MI-M5	Cu_ppb_M MI-M5	Fe_ppm_M MI-M5	Mn_ppb_M MI-M5	Zn_ppb_M MI-M5	Mo_RR	Cu_RR	Fe_RR	Mn_RR	Zn_RR
43556	40-30	58	780	0.5	3610	690	2	31	1	30	11
43557	30-20	48	310	2	4830	780	2	12	1	40	12
43558	20-10	52	140	21	710	560	2	6	1	6	9
43559	10-0	481	290	84	3190	1530	15	12	2	26	24
43560	40-30	1770	90	71	430	170	56	4	1	4	3
43561	30-20	1650	40	137	240	90	52	2	3	2	1
43562	20-10	1150	40	176	220	200	36	2	3	2	3
43563	10-0	810	120	205	420	410	26	5	4	3	6
43564	40-30	105	20	10	90	60	3	1	1	1	1
43565	30-20	101	20	16	100	120	3	1	1	1	2
43566	20-10	264	40	66	150	60	8	2	1	1	1
43567	10-0	126	80	96	70	200	4	3	2	1	3
43568	40-30	56	0.5	88	2220	1030	2	1	2	18	16
43569	30-20	21	0.5	106	650	870	1	1	2	5	14
43570	20-10	342	40	96	1290	1720	11	2	2	11	27
43571	10-0	401	220	131	1540	1890	13	9	3	13	30
43572	40-30	527	110	75	980	760	17	4	1	8	12
43573	30-20	315	130	72	1440	1020	10	5	1	12	16
43574	20-10	259	110	117	1460	970	8	4	2	12	15
43575	10-0	199	100	168	1060	700	6	4	3	9	11
43576	20-10	1660	20	184	700	630	53	1	4	6	10
43577	10-0	1060	270	148	4080	3460	34	11	3	34	54
43578	40-30	991	350	152	250	80	31	14	3	2	1
43579	30-20	1230	180	98	100	30	39	7	2	1	1
43580	20-10	558	40	114	20	10	18	2	2	1	1
43581	10-0	99	30	137	40	10	3	1	3	1	1
43582	40-30	1720	90	514	5610	170	54	4	10	46	3
43583	30-20	1720	80	544	4130	150	54	3	11	34	2
43584	20-10	598	80	269	1240	110	19	3	5	10	2
43585	10-0	233	50	208	420	80	7	2	4	3	1
43586	40-30	1740	240	78	1150	450	55	10	2	10	7
43587	30-20	1790	240	82	880	570	57	10	2	7	9
43588	20-10	279	30	221	540	40	9	1	4	4	1
43589	10-0	601	190	40	2560	510	19	8	1	21	8
43590	40-30	589	120	130	1530	240	19	5	3	13	4
43591	30-20	507	110	105	1460	260	16	4	2	12	4
43592	20-10	435	200	85	1410	330	14	8	2	12	5
43593	10-0	362	280	73	2630	560	11	11	1	22	9
43594	40-30	388	160	107	990	230	12	6	2	8	4
43595	30-20	203	150	70	810	270	6	6	1	7	4
43596	20-10	240	110	61	1500	210	8	4	1	12	3
43597	10-0	236	130	105	2240	270	7	5	2	19	4
43598	40-30	1640	80	329	16500	220	52	3	6	136	3
43599	30-20	1420	90	312	11400	190	45	4	6	94	3
43600	20-10	759	90	225	10500	140	24	4	4	87	2
251001	10-0	163	90	217	950	250	5	4	4	8	4

Table 1. continued...

Sample no	Interval (cm)	Mo_ppb_M MI-M5	Cu_ppb_M MI-M5	Fe_ppm_M MI-M5	Mn_ppb_M MI-M5	Zn_ppb_M MI-M5	Mo_RR	Cu_RR	Fe_RR	Mn_RR	Zn_RR
251002	40-30	648	180	70	1280	80	21	7	1	11	1
251003	30-20	699	200	83	2210	80	22	8	2	18	1
251004	20-10	153	160	45	930	80	5	6	1	8	1
251005	10-0	69	110	101	460	180	2	4	2	4	3
251006	40-30	1260	20	106	90	70	40	1	2	1	1
251007	30-20	1110	10	101	110	120	35	1	2	1	2
251008	20-10	826	20	126	200	80	26	1	2	2	1
251009	10-0	653	10	125	200	110	21	1	2	2	2
251010	40-30	1080	30	105	30	40	34	1	2	1	1
251011	30-20	1110	80	112	50	230	35	3	2	1	4
251012	20-10	487	40	137	50	40	15	2	3	1	1
251013	10-0	89	30	99	50	30	3	1	2	1	1
251014	40-30	61	20	114	80	40	2	1	2	1	1
251015	30-20	60	60	58	190	360	2	2	1	2	6
251016	20-10	35	30	174	210	100	1	1	3	2	2
251017	10-0	21	20	95	120	80	1	2	2	1	1
251018	40-30	20	150	44	3790	180	1	6	1	31	3
251019	30-20	12	120	48	3540	240	1	5	1	29	4
251020	20-10	11	140	56	3090	310	1	6	1	26	5
251021	10-0	11	110	84	3640	250	1	4	2	30	4
251022	40-30	25	420	70	3680	740	1	17	1	30	12
251023	30-20	31	440	78	7140	900	1	18	2	59	14
251024	20-10	34	700	117	10200	1230	1	28	2	84	19
251025	10-0	38	670	97	11000	1000	1	27	2	91	16
251026	40-30	309	290	286	3690	410	10	12	6	31	6
251027	30-20	512	220	407	4590	670	16	9	8	38	11
251028	20-10	334	210	323	5870	550	11	8	6	49	9
251029	10-0	193	180	271	7460	650	6	7	5	62	10
251030	40-30	33	150	110	5820	280	1	6	2	48	4
251031	30-20	46	180	81	5720	130	1	7	2	47	2
251032	20-10	52	250	105	6290	180	2	10	2	52	3
251033	10-0	43	220	144	4970	370	1	9	3	41	6
251034	40-30	30	380	64	7020	1200	1	15	1	58	19
251035	30-20	29	410	94	8070	1220	1	16	2	67	19
251036	20-10	34	290	114	11200	1240	1	12	2	93	19
251037	10-0	14	210	281	14600	2300	1	8	5	121	36
251038	40-30	132	180	147	20100	1840	4	7	3	166	29
251039	30-20	157	140	158	24100	2530	5	6	3	199	40
251040	20-10	148	130	165	21800	2190	5	5	3	180	34
251041	10-0	L.N.R.	L.N.R.	L.N.R.	L.N.R.	L.N.R.					

Table 1. Continued...

2.1 Results and discussion

The main exercise for conducting an MMI orientation survey is to define the ideal depth interval for a more regional survey. When looking at the response ratio per depth interval for Mo in table 2, the two deepest intervals (40-30 cm and 30-20 cm) dominate in regards to returning the highest response ratio for Mo. The values at these two intervals are at the same level with minor variations in response ratios. The recommendation for further MMI sampling in the Nordli area must therefore be to sample from the 40-30 cm or 30-20 cm interval. Digging holes of up to 50 cm depth is time consuming and can be exhausting, and since the response ratio is very similar for the two intervals, it is recommended to apply interval 30-20 cm as a standard MMI sample interval for Nordli. Alternatively, if applying MMI sampling to a larger area the two deep sample intervals could be sampled until a better statistical basis for a decision is obtained.

Sample location	RR Mo (0-10 cm)	RR Mo (10-20 cm)	RR Mo (20-30 cm)	RR Mo (30-40 cm)
1	15	2	2	2
2	26	36	52	56
3	4	8	3	3
4	13	11	1	2
5	6	8	10	17
6	34	53		
7	3	18	39	31
8	7	19	54	54
9	19	9	57	55
10	11	14	16	19
11	7	8	6	12
12	5	24	45	52
13	2	5	22	21
14	21	26	35	40
15	3	15	35	34
16	1	1	2	2
17	1	1	1	1
18	1	1	1	1
19	6	11	16	10
20	1	2	1	1
21	1	1	1	1
22		5	5	4

Table 2. Molybdenum response ratios (RR) for the 4 sample intervals.

In figures 7-14 the response ratio is compared with the DOB results from the soil program conducted in 2008. The background coloured grid represents the DOB results and the bars represent the MMI response ratio. The response ratio is given for all 4 depth intervals. The comparison between the two sets of data will not be based on statistical methods but more on a comparison of actual levels of metal content.

The response ratio for Mo is shown in figure 7. When comparing the response ratio with the deep soil sampling results in figure 7, there is an overall correlation between high response ratios and high Mo content, especially in the central area of the Nordli deposit outline. A good correlation is also seen in the

low Mo area west of the area of the Nordli deposit outline. A discrepancy between the two methods is clearly seen east of the central high Mo area. In this low Mo area, high response ratios are seen from three sample locations. The two sample locations 6 and 7 are borderline being close to the central Mo anomaly, but the very high response ratio from location 2 cannot be explained. Only additional sampling could exclude contamination and only trenching or drilling can verify an unknown mineralisation so far east of the main mineralisation. Another possible explanation to the discrepancy could be that although the deep soil sampling survey in 2008 aimed at taking the samples at the rock/cover surface it is possible that some holes did not reach the rock surface but a large boulder and this could be a reason for a “false” negative anomaly.

The response ratio for Cu (figure 8) reflects the generally low levels of Cu in the Nordli porphyry system. The central area of the Nordli outline has very low response ratios with somewhat higher Cu ratios in the eastern and especially western more distal flanks. This pattern is also seen for Zn (figure 9) and Mn (figure 10) but in a much more pronounced contrast. The distal zoning of Zn is known from other porphyry deposits. The correlation between two soil surveys for Cu and Zn is good except for the 5 western most samples for Zn where the response ratios are high in a low Mo area (DOB).

Often Ag follows the pattern for Zn with a distal zoning from Mo (- Cu) mineralisation but at Nordli it seems that Ag (figure 11) is also associated with Mo. In comparing the two soil surveys for Ag there is an overall good correlation except that the central high response ratio from the MMI survey is not quite as distinct in the deep soil survey data.

The response ratio for Fe (figure 12), W (figure 13) and Ba (figure 14) reflects the narrow span in content of these elements without any major peaks or distinct patterns.

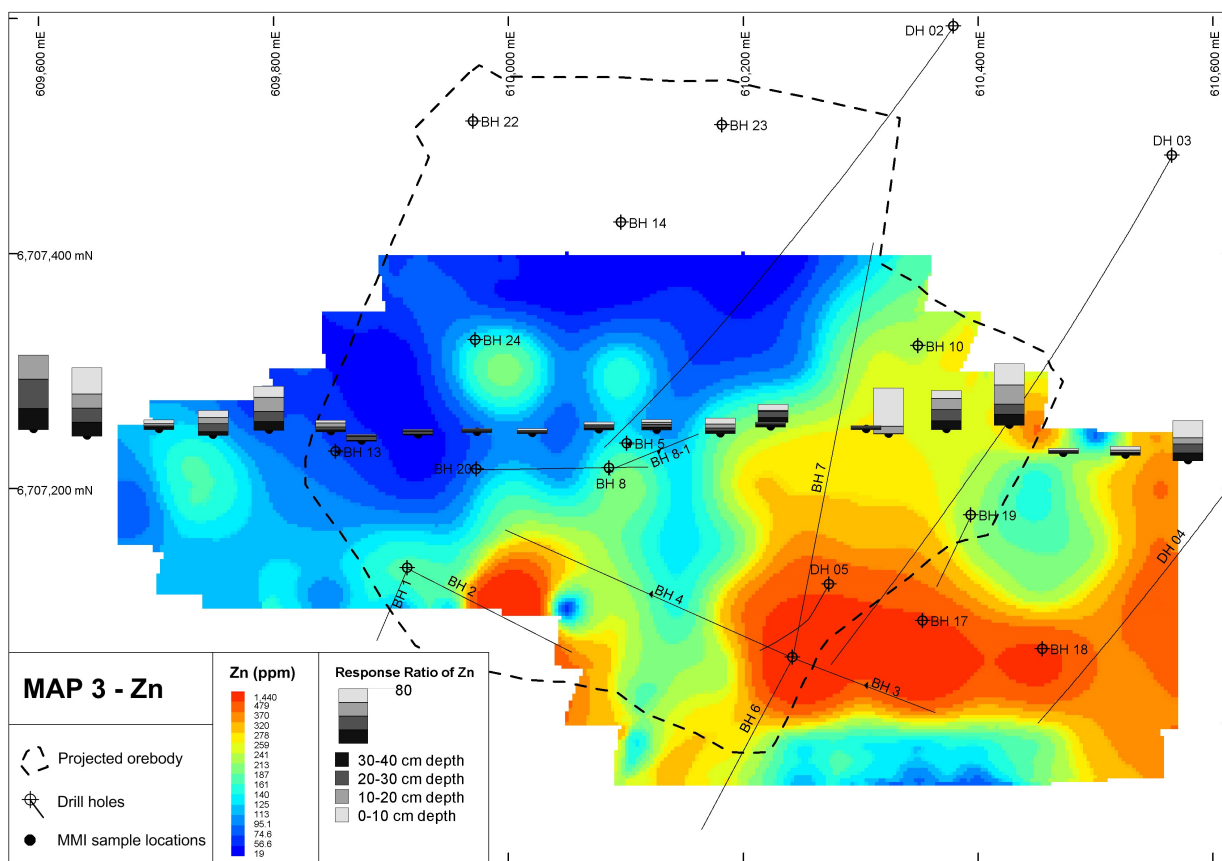


Figure 9. Map showing Zn response ratios and coloured grid of deep soil sampling (DOB) in 2008.

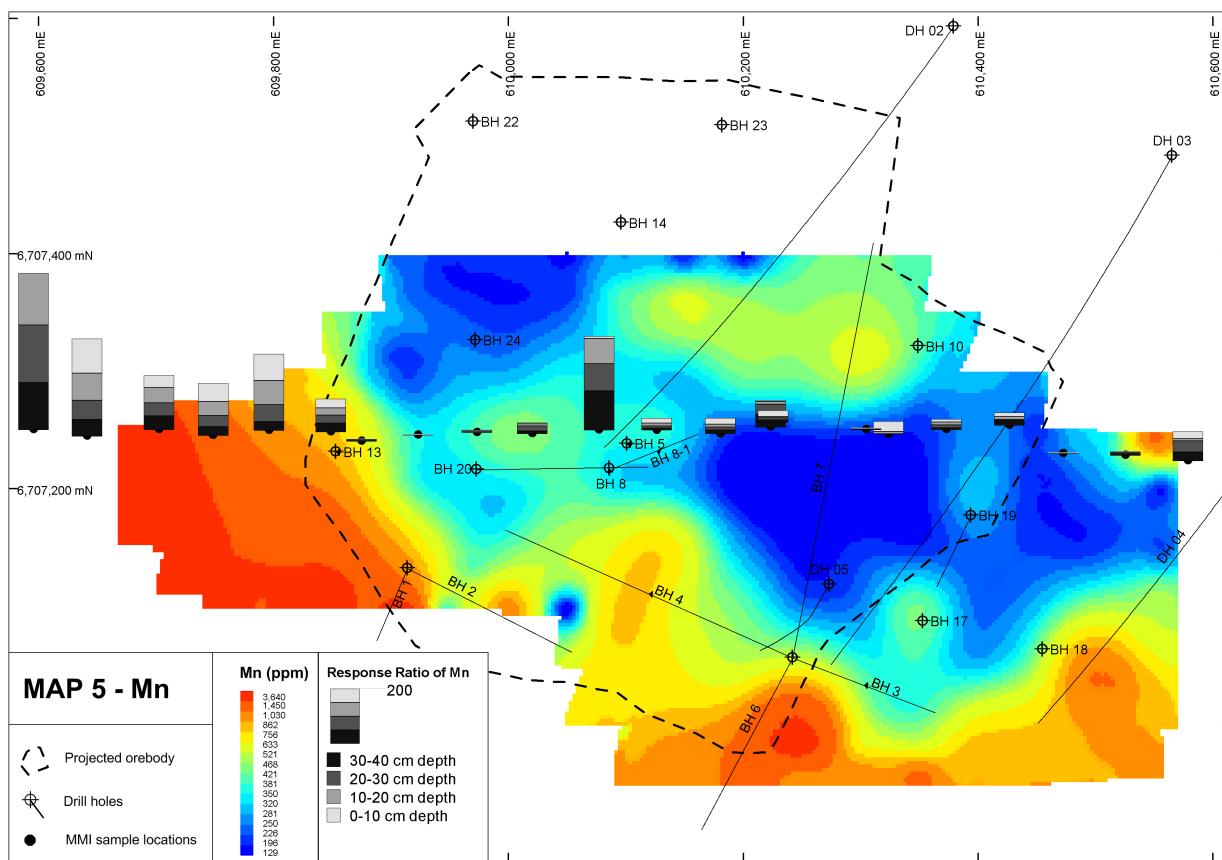


Figure 10. Map showing Mn response ratios and coloured grid of deep soil sampling (DOB) in 2008.

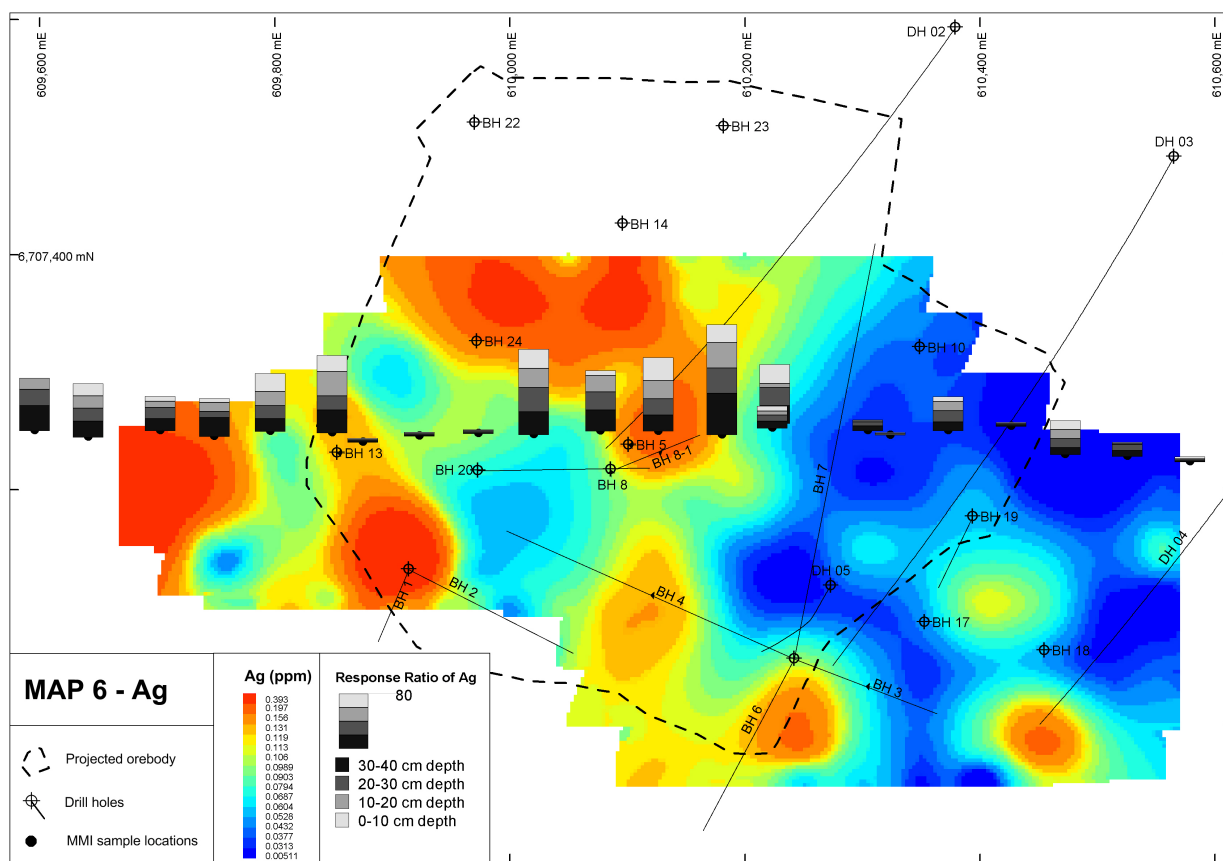


Figure 11. Map showing Ag response ratios and coloured grid of deep soil sampling (DOB) in 2008.

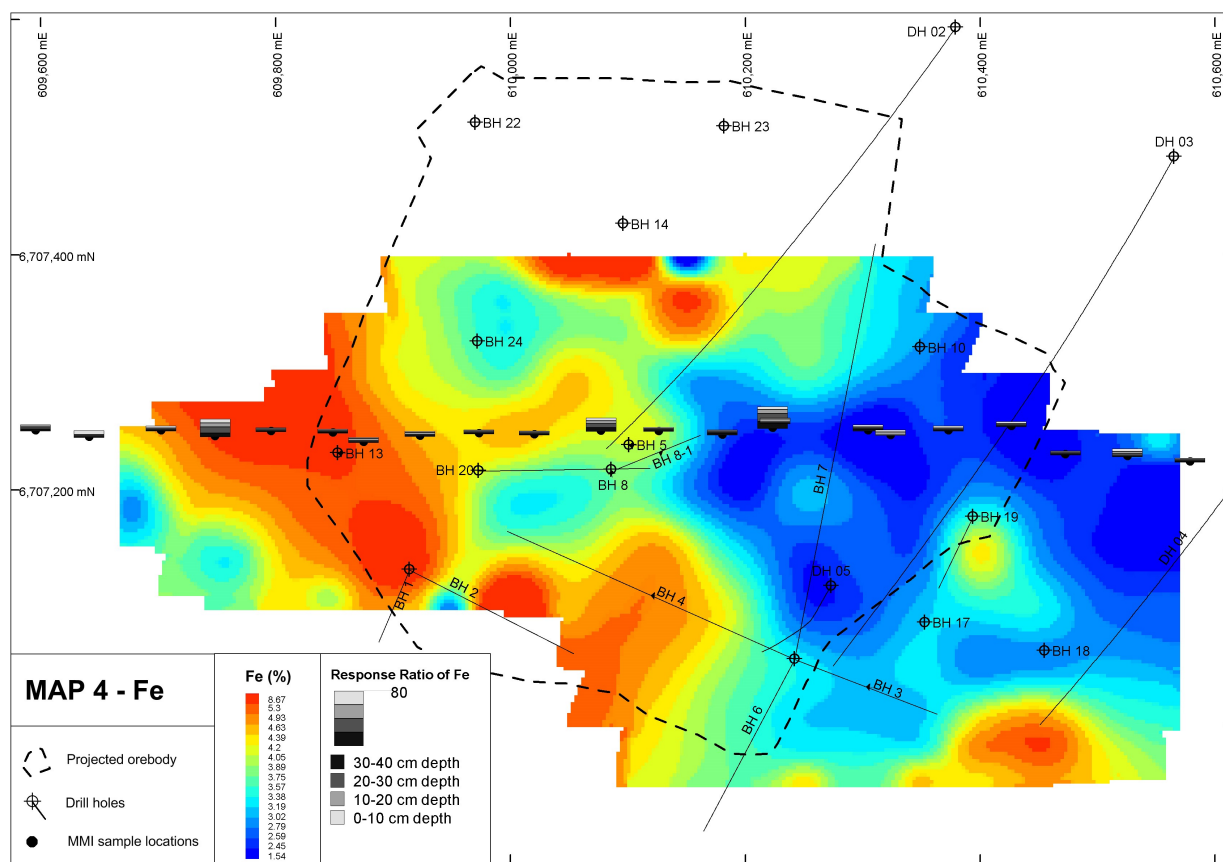


Figure 12. Map showing Fe response ratios and coloured grid of deep soil sampling (DOB) in 2008.

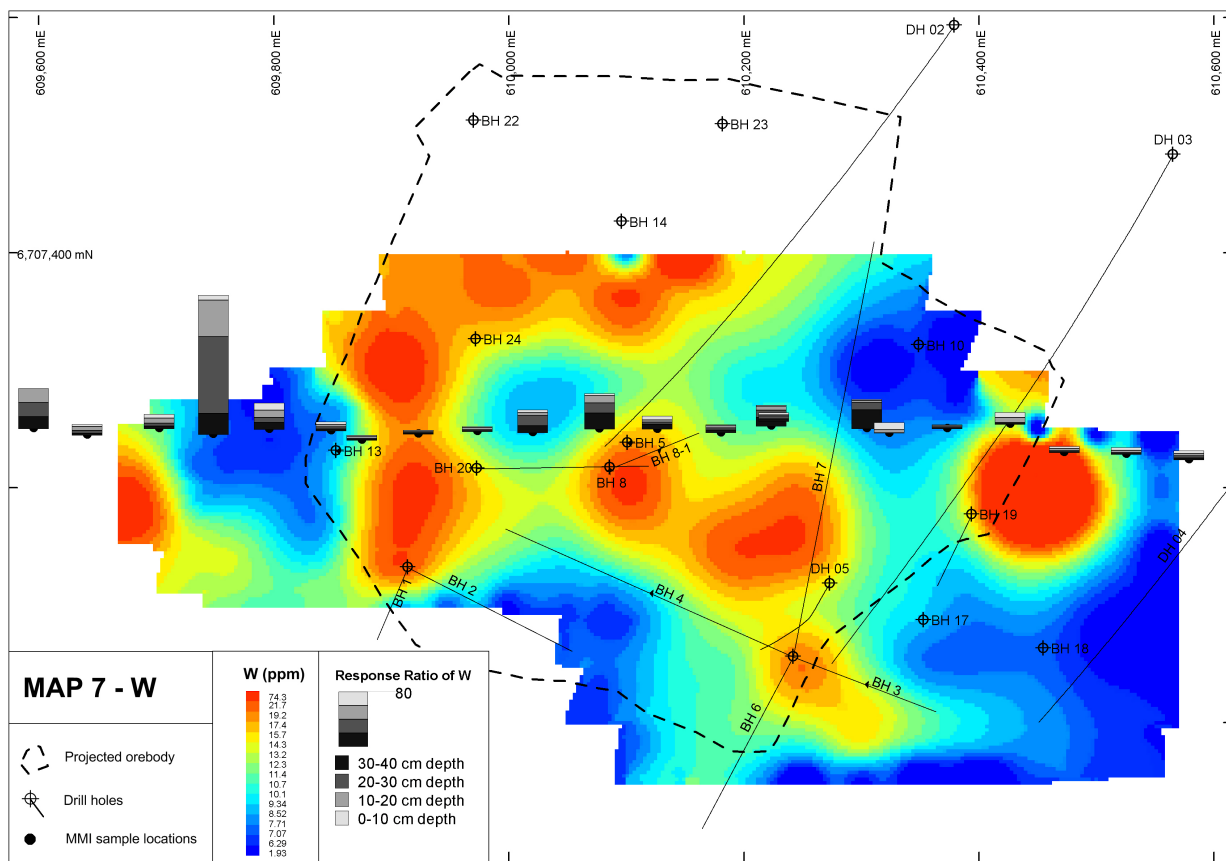


Figure 13. Map showing W response ratios and coloured grid of deep soil sampling (DOB) in 2008.

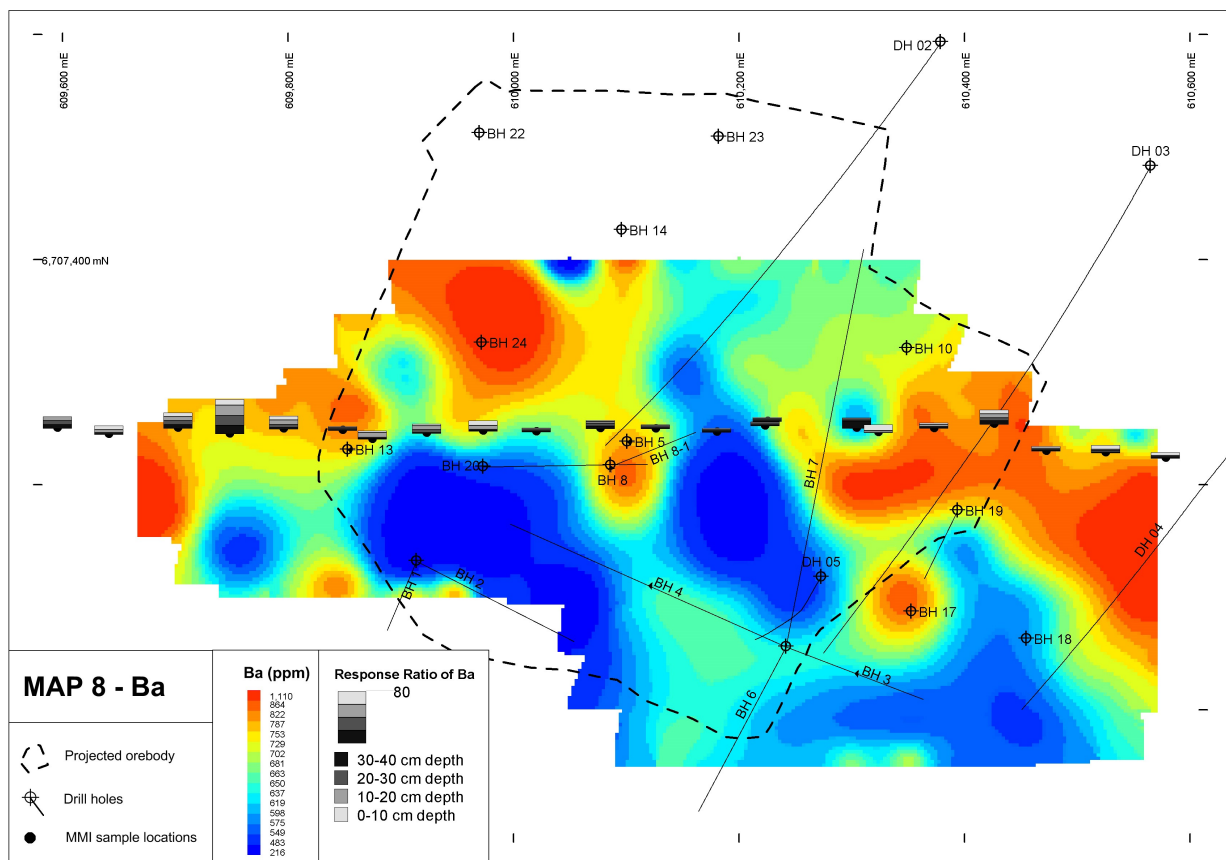


Figure 14. Map showing Ba response ratios and coloured grid of deep soil sampling (DOB) in 2008.

3. Conclusion and recommendations

This first attempt at using the MMI method for mapping the geochemical surface expression of molybdenum at Nordli does look promising. The correlation between MMI response ratios and results from the 2008 deep soil sampling survey is very good with high response ratios across the anomalous central area of the deposit and low response ratios across the more distal parts.

The MMI orientation survey shows that the intervals from 40-30 cm and from 30-20 cm return the highest response ratios for molybdenum and it is recommended to apply the interval from 30-20 cm as a standard MMI sample interval for further MMI sampling programs at Nordli.

Logistically, it may be argued that the MMI method is easier to adapt for extensive soil survey programs. Using the Cobra percussion drill with 10 meters of extra drill pipes for deep soil sampling is effective but physically it is quite challenging and the equipment used for MMI sampling is quite basic and easy to carry.

To obtain more substantial data for a discussion on MMI method contra deep soil sampling it is recommended to carry out a grid survey over a larger area and to collect a deep soil sample and a MMI sample from the exact same location. A grid survey like this would give comparable results and test the two different analytical methods and it should be more evident which method is more successful in mapping the geochemical expression of the Nordli molybdenum deposit. If conducting a grid survey testing various methods it is suggested to also test the Ionic Leach method from ALS Laboratory Group.

4. References

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