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Distribution of Fe-Ti oxide minerals in the Ørsland, Bakka-Krune and Einebakka area of the Bjerkreim-Sokndal layered norite, Rogaland

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REPORT

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Title:
Distribution of Fe-Ti oxide minerals in the Ørsland, Bakka-Krune and Einebakka area of the Bjerkreim-Sokndal layered norite, Rogaland

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Summary:
Geological mapping in scale 1:5000 in the Sokndal Lobe of the Bjerkreim-Sokndal layered norite intrusion has confirmed that cyclic unit no. IV of the magmatic stratigraphy comprise a high density of Fe-Ti oxide rich layers. The area naturally divides in the Ørsland, Bakka-Krune and Einebakka areas which individually are shaped as mega-lenses connected to each other via more narrow zones. However, seen together they comprise an open synfom dipping 40° to the West. Zones with a high density of Fe-Ti oxide rich layers has a patchy distribution exhibiting thicknesses from 1 to 120 meters and a limited extent along strike. The Bakka-Krune area has the largest size but the most patchy appearance of Fe-Ti oxides which makes it very difficult to evaluate the total resources. The Einebakka area comprise the largest continuous zone of Fe-Ti oxide rich layers with a documented strike length of 450 meters and thicknesses between 20 and 120 meters.

Keywords: Industrimineraler	Ilmenitt	Titan
Dypbergart	Berggrunn	Fagrapport

APPENDIX

App. 1: Geological map of the Ørsland-Bakka area

App. 2: Geological map of the Krune area

App. 3: Description of localities (strike/dip, susceptibility, comments)

INTRODUCTION

This communication reports the results of geological bed rock mapping in the Ørsland, Bakka-Krune and Einebakka areas in the Sokndal lobe of the Bjerkreim-Sokndal layered norite intrusion. Geological mapping aimed at estimating the distribution and geometry of Fe-Ti oxide minerals in cyclic unit number IV in the above-mentioned area. A geological overview of the Sokndal lobe can be obtained from Schiellerup (1995).

The term Fe-Ti oxide rich layers, used in this report, refer to mafic layers with high proportions of both Fe-Ti oxides and pyroxene and characterised by more than 2.5 times the average susceptibility of the generic norites. Strike and dip measurements follows the right-hand rule.

Fieldwork was conducted in the last two weeks of June '96 using 'Økonomisk Kartverk' maps in scale 1:5000 (App. 1 and 2).

DISTRIBUTION OF FE-TI OXIDES

By far the highest density of Fe-Ti oxide rich layers was recognised in the exposed lower third of unit IV in the Ørsland, Bakka-Krune and Einebakka areas. The upper two thirds of Unit IV is characterised by poorly layered to unlayered isotropic norite with less than c. 40 vol. % mafic minerals whereas massive layers rich in Fe-Ti oxides, except for a few widely scattered localities (see App. 1 and 2), are absent. The Fe-Ti oxide rich zone was followed over a distance of c. 4000 meters along strike and has the general geometry of an open synform dipping 40^o toward the West. The northern limb (coinciding with Ørsland) is oriented $160^o/48^o$, the central portion (coinciding with Bakka-Krune) $180^o/40^o$ and the southern limb (equivalent to the Einebakka area) is oriented $205^o/40^o$ although the dip in the south part gradually increase toward the south west to 68^o (loc. 45).

Bakka--Krune

The economically interesting part of the Bakka-Krune area can be described as a mega-lens extending for 1100 meters along strike with a maximum stratigraphic thickness in the central part of c. 250 meters and tapering toward c. 50 meters to the North and the South (App. 1). Earlier recognisance studies in the Bakka-Krune area had already documented several localities at road sections with Fe-Ti oxides rich layers covering several meters of the magmatic stratigraphy. Closer inspection of these localities and mapping elsewhere in the area confirmed that the oxide rich layers continued for some distance along strike (App. 1). In addition to the previously known road localities, a total of seven new localities (no. 6, 10, 12, 13, 14, 15, 18) were discovered. Each of these localities comprise centimetre to decimetre thick Fe-Ti oxide rich layers covering more than 1 meter of the stratigraphy (App. 3). Highest density occurs at locality 7 and 13 where strong enrichment of Fe-Ti oxides appeared over 5 and 4 meters respectively. Typical average susceptibility of Fe-Ti oxide rich layers was c. 0.145 whereas the generic isotropic norite would yield a value around 0.060 (App. 3).

The lateral distribution of Fe-Ti oxide rich layers is strongly irregular. Layers at individual localities in Bakka-Krune fades out over a lateral distance of 50 to 150 meters. In conclusion, the distribution of Fe-Ti oxides can best be described as patchy.

Ørsland

Similar to Bakka, the economically interesting part of the Ørsland area describe a rhombohedral mega-lens extending for 700 meters along strike with maximum stratigraphic thickness in the central part of 200 meters and tapering to 50 meters in North and South.

Localities with abundant Fe-Ti oxide rich layers were identified at locality 19, 20, 21 and 22 (App. 1 and 3). Highest density was observed at locality 19 and 20 where c. 25 meters with Fe-Ti oxide rich layers could be followed over a total distance (loc. 19 + 20) of 250 meters. Susceptibility measurements yielded average values from 0.152 to 0.178 (App. 3). The extend of the Fe-Ti oxide rich layers seems more persistent compared to Bakka and the stratigraphic thickness is indeed much higher. However, the area as a whole has a smaller areal extend compared to Bakka.

Einebakka

The Einebakka area also has the geometry of a mega-lens tapering toward relatively narrow zones in NNE and SW. Maximum thickness is 150 meters and the length is 800 meters. Locality 33, 34, 42, 43 an 45 comprise a high abundance of Fe-Ti oxide rich layers extending over 20 to 120 meters of the magmatic stratigraphy. Fe-Ti oxides rich layers were recognised at almost every inspected exposure in the area. Given this fact, it is implicated that Fe-Ti oxide rich layers are continuos for minimum 450 and perhaps the entire 800 meters of the Einebakka area, only interrupted by narrow zones of isotropic Fe-Ti oxide poor norite. The average susceptibility is higher than anywhere else in the mapped area yielding values between 0.162 and 0.221.

CONCLUSION

1) The distribution of Fe-Ti oxides rich norite can naturally be divided in three areas each having the geometry of a mega-lens tapering toward narrow zones toward the bordering lens(es). These areas (from N to S) are Ørsland, Bakka-Krune and Einebakka.

2) Bakka-Krune has the largest size but both Ørsland and Einebakka are characterised by thick zones with Fe-Ti oxide rich layers which can be followed for a longer distance along strike compared to Bakka-Krune.

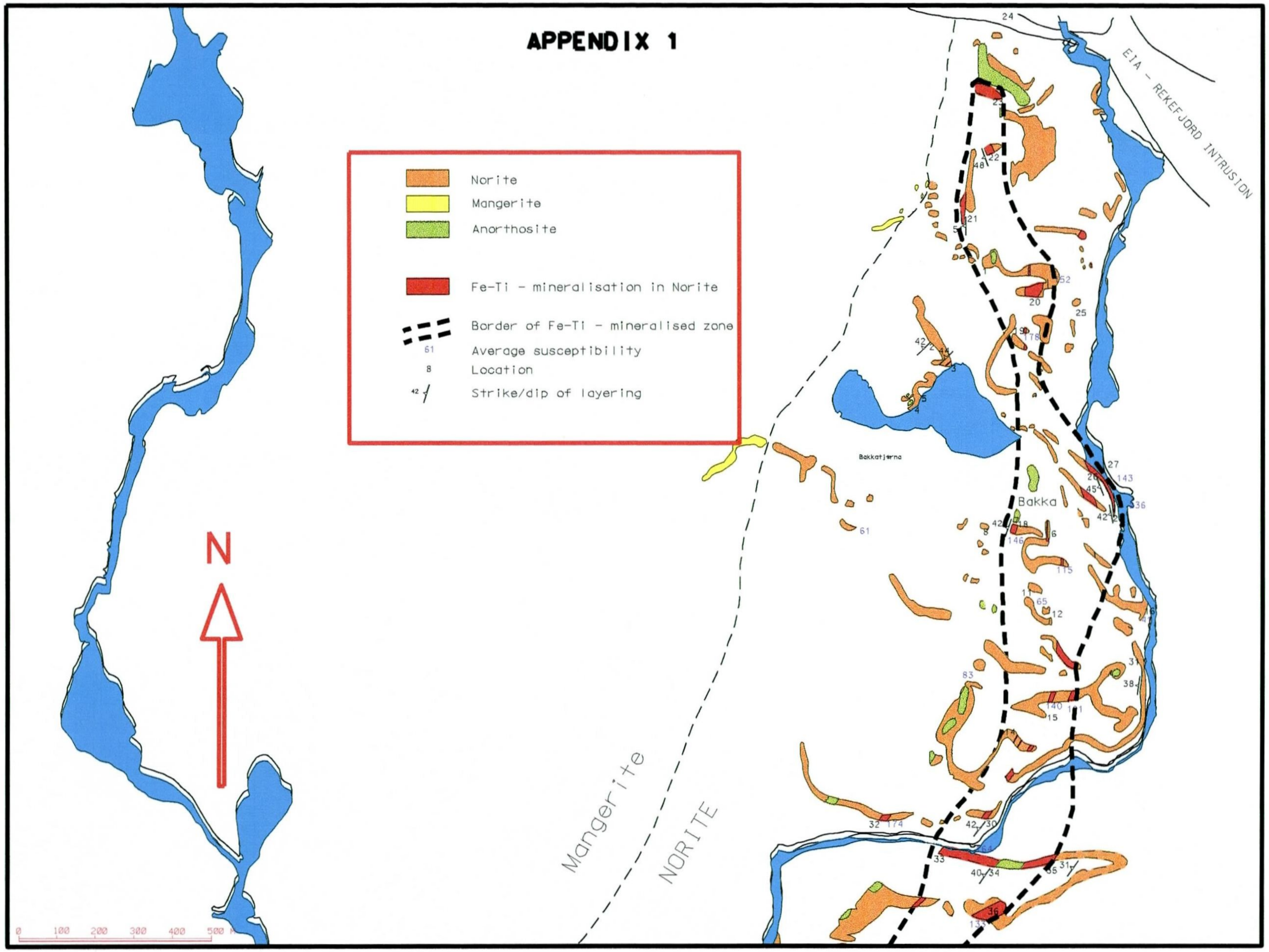
3) The Einebakka area comprise the most continuos Fe-Ti oxide rich zone found anywhere in the examined area. Mapping could document a 20 to 120 meters thick zone which could be followed for 450 meters along strike. Possibly, this zone is continuous for the entire 800 meters of the Krune area.

4) The upper two thirds of cyclic unit IV is generally devoid of major zones with extensive Fe-Ti oxide rich layers.

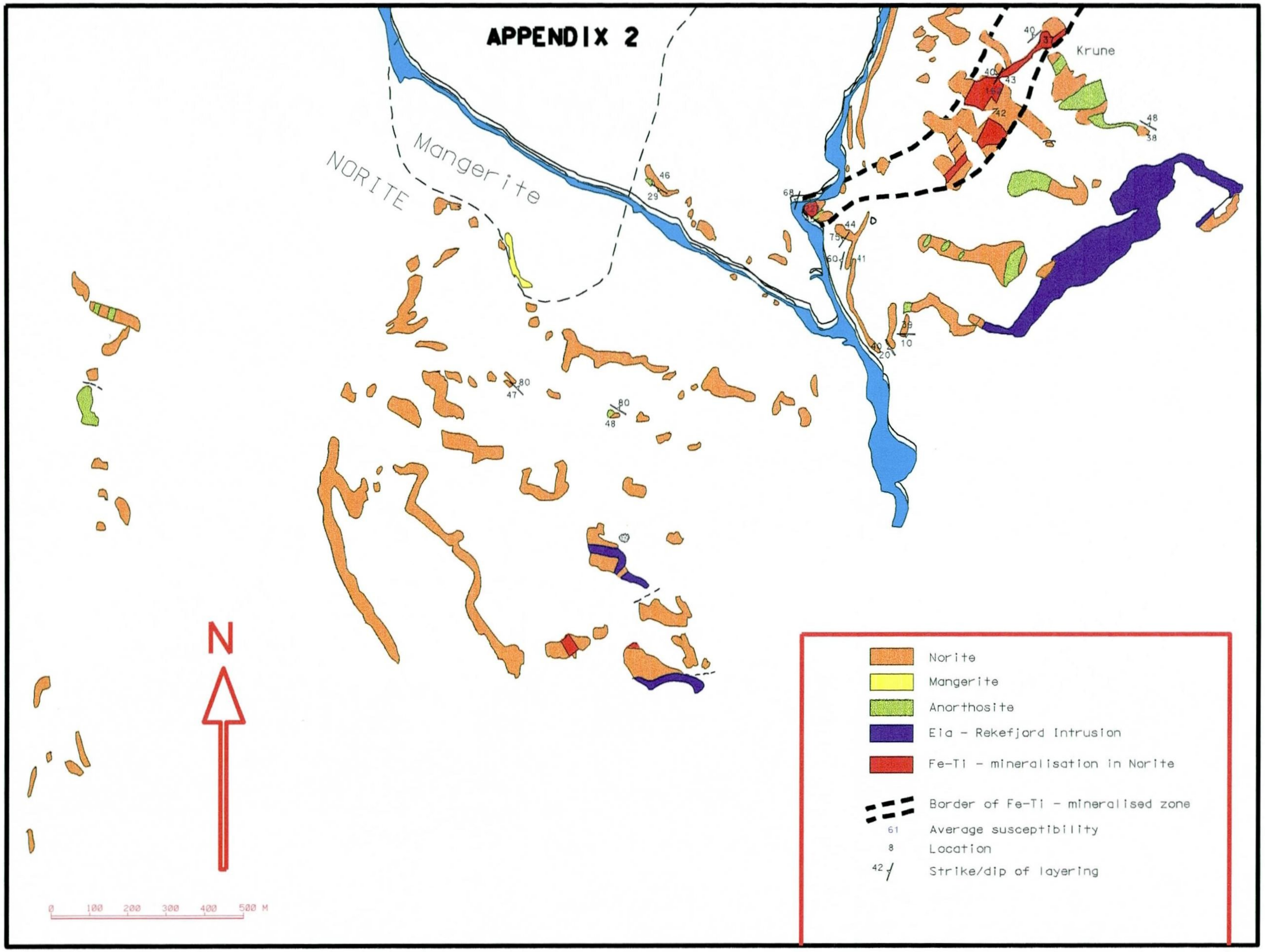
REFERENCES

Schiellerup H. (1995) Fe-Ti mines and prospects in the Egersund area of the South Rogaland Igneous province. NGU-report **96.051**. 1-21 + App.

APPENDIX 1


Norite
Mangerite
Anorthosite
Fe-Ti - mineralisation in Norite
Border of Fe-Ti - mineralised zone
Average susceptibility
Location
Strike/dip of layering
EIA - REKEFJORD INTRUSION
Bakkatjerna
Bakka
Mangerite
NORITE
N
0 100 200 300 400 500

APPENDIX 2



Mangerite
NORITE
Krune
N
0 100 200 300 400 500 M
Norite
Mangerite
Anorthosite
Eia - Rekefjord Intrusion
Fe-Ti - mineralisation in Norite
Border of Fe-Ti - mineralised zone
61 Average susceptibility
8 Location
42 Strike/dip of layering

Locality	Strike/dip	Susceptibility x 10^{-3}	Ave. susc.	Comments
1				1-3 cm thick mass. Fe-Ti ox. rich layer.; cross bedding
2	219/42			1 cm thick mass. Fe-Ti ox rich layer.
3	219/44			cm thick mass. Fe-Ti ox. rich layers
4				5-25 cm thick Fe-Ti ox. rich layers
5				anorthosite xenolith wt. qz
6				10 cm thick Fe-Ti ox. rich layers
7	199/42			semi mass. to mass. Fe-Ti ox. rich layers over 5 m
8				leuconorite wt. biotite
9				semi mass. to mass. fe-Ti ox rich layers. over 4 m
10a		101, 134, 95, 93, 152	115	mass. Fe-Ti ox. rich layers
10b		69, 64, 64	66	isotropic norite
11		80, 74, 54, 49	65	isotropic norite
12		93, 142, 117	117	mass. Fe-Ti ox. layers over 1 m
13		120, 120, 160, 105, 100	121	mass. Fe-Ti ox. rich layers over 4 m
14		69, 77, 74, 80, 80, 116, 82	83	isotropic norite
15		161, 158, 144, 103, 141, 131	140	mass. Fe-Ti ox.rich layers over >2 m
16		38, 42, 49, 41, 37, 39, 41, 39	41	isotropic norite right below loc. 15
17		39, 58, 65, 78, 64, 64, 62, 62, 65, 57, 56	61	isotropic norite close to mangerites
18		230, 199, 120, 132, 94, 137, 78, 127, 137, 101	146	mass. Fe-Ti ox. rich layers at loc. 7
19	235/44	281, 267, 172, 200, 229, 157, 200, 131, 187, 245, 160	178	mass. Fe-Ti ox. rich layers over 25 m
20		142, 170, 172, 136, 145, 162, 170, 184, 148, 125, 120	152	mass. Fe-Ti ox. rich layers over 25 m
21	180/51			mass. Fe-Ti ox. rich layers
22	160/48			isotropic norite
23	179/46			isotropic norite
24				anorthosite block wt. patches of qz

Locality	Strike/dip	Susceptibility x 10^{-3}	Ave. susc.	Comments
25	175/45			isotropic norite
26	150/45	160, 139, 139, 129, 142, 188, 96, 153	143	mass. Fe-Ti ox. rich layers
27				mass. Fe-Ti ox. rich layers over 30 m. in road cut
28	166/42	217, 262, 240, 211, 208, 251, 222, 194, 320, 232	236	mass. Fe-Ti ox. layers over 3 m
29		54, 59, 48, 69, 78, 67	63	isotropic norite
30	224/42			mass. Fe-Ti ox. rich layers
31	195/44			isotropic norite
32	225/44	137, 138, 172, 174, 227, 137, 205, 203	174	mass. Fe-Ti ox. rich layers over 10 m
33		193, 115, 115, 136, 183, 192, 216	164	mass. Fe-Ti ox. rich layers
34	222/40			many Fe-Ti ox. rich layers between loc. 33 and 34
35	222/31			isotropic norite
36	240/40	68, 185, 68, 134, 75, 95, 159, 201, 204,	133	semi mass. Fe-Ti ox. rich layers
37	228/40			isotropic norite
38	305/48			isotropic norite, some layering
39	90/10			isotropic norite
40	146/20			isotropic norite, rapid change in orientation
41	195/60			isotropic norite
42		83, 226, 146, 195, 238, 166, 151, 185, 260, 151, 99, 114, 95	162	mass. Fe-Ti ox. rich layers
43	205/40			continuation of mass. Fe-Ti ox. rich layers from loc. 42
44	218/75			isotropic norite, variable orientation
45	201/68	222, 105, 164, 207, 143, 369, 253, 331, 316, 103	221	mass. Fe-Ti ox. rich layers over 20 m, thickest next to river
46	116/29			isotropic norite
47	308/80			isotropic norite
48	288/80			isotropic norite

Locality	Strike/dip	Susceptibility x 10^{-3}	Ave. susc.	Comments
49	160/56			layered norite
50				layered norite
51	340/48			layered norite