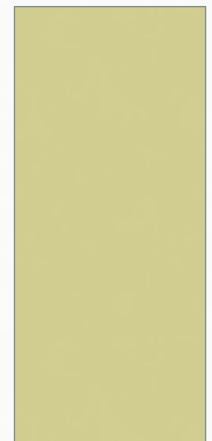


ROGALAND COMPLEX, NORWAY

BY: CHRISTINA LAMMERS AND ANDREW VAN SICKLE
NDSU PETROLOGY GEOL 422 MAY 6, 2014



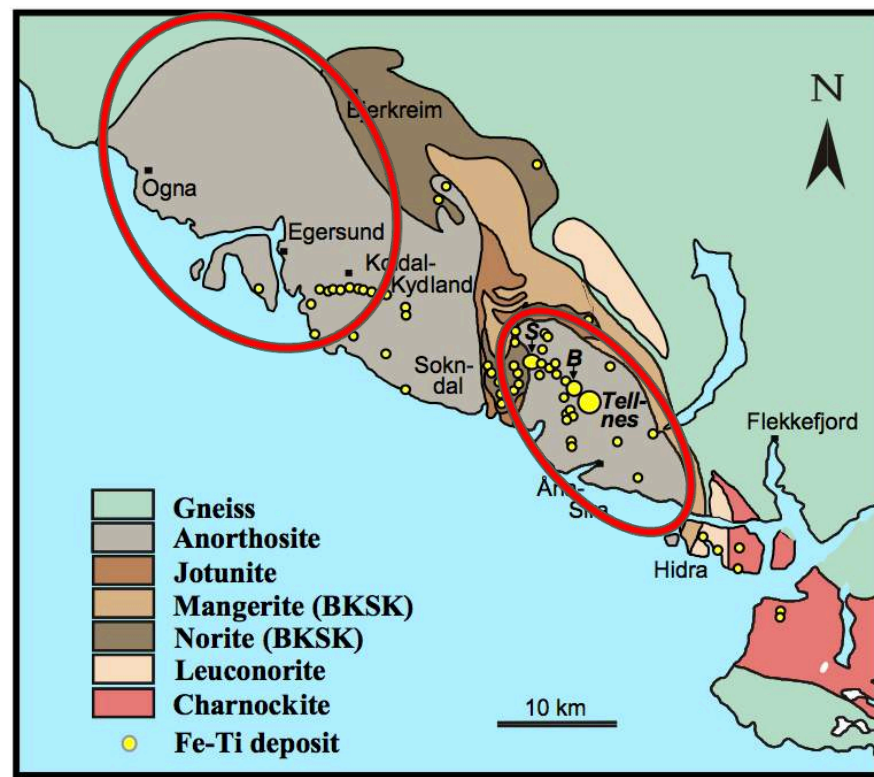
CONTENTS:

- Background
- Objectives
- Methods
- Results
- Comparison

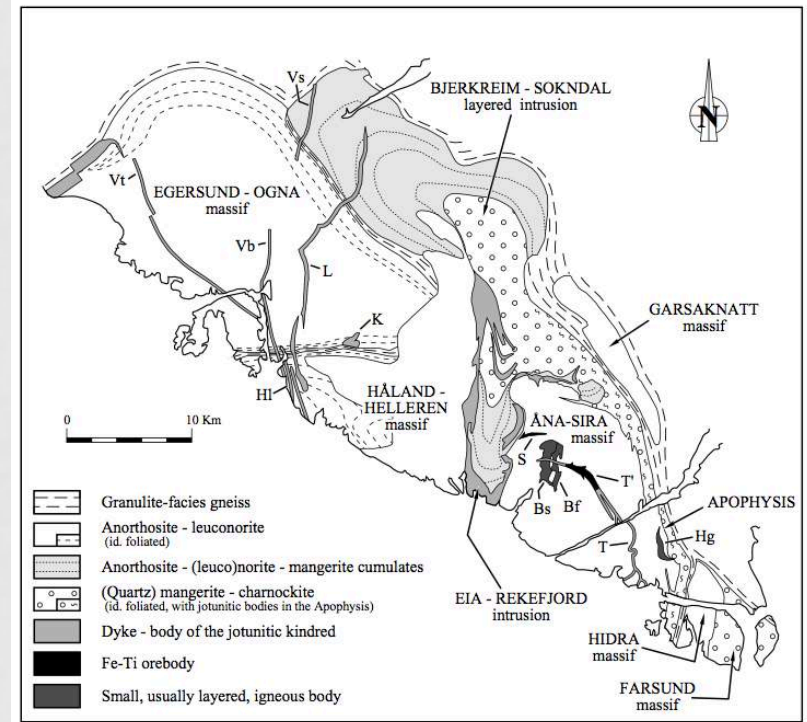
LOCATION:



ROGALAND COMPLEX:



(Korneliussen, et al., 2000)



(Duchesne, 2001)

ROGALAND IGNEOUS PROVINCE

- Origin: Sveconorwegian Orogenic belt
- Age: 1.25-0.9 Ga
- Depth: over 20 km thick
- Massif:
 - “A block of the earth’s crust bounded by faults or flexures and displace as a unit without internal charge” (Webster’s Dictionary, 2014)

ROGALAND ANORTHOSITE

- 3 massifs:
 - • Egersund- Oгна
 - Håland-Helleren
 - • Åna-Sira
- Layered intrusion
 - Bjerkreim-Sokndal
- 2 smaller bodies of leuconorite
 - Hidra
 - Garsaknatt
- 3 acidic intrusions to the south:
 - Farsund charnockite
 - Lyndal
 - Kleivian

(Duchesne, 2001)

OBJECTIVE:

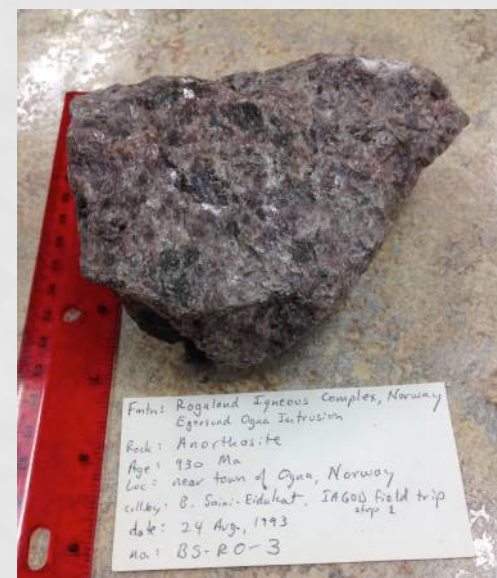
Answer questions:

- Do are samples fit the descriptions of the area as stated by previous studies?
- What are the composition of our samples? Are they similar? If not, how do they differ?

METHODS:

- Create thin sections
- Form hand and microscopic description
- Use XRD to compare results
- Use compare and contrast knowledge

SAMPLE: BS-RO-3



EGERSUND-OGNA



(Duchesne, 2001)



(Korneliussen, et al., 2000)

INITIAL OBSERVATIONS:

- Aphanitic grain size
- Can scratch glass
- Pink with green and dark areas
- Vitreous

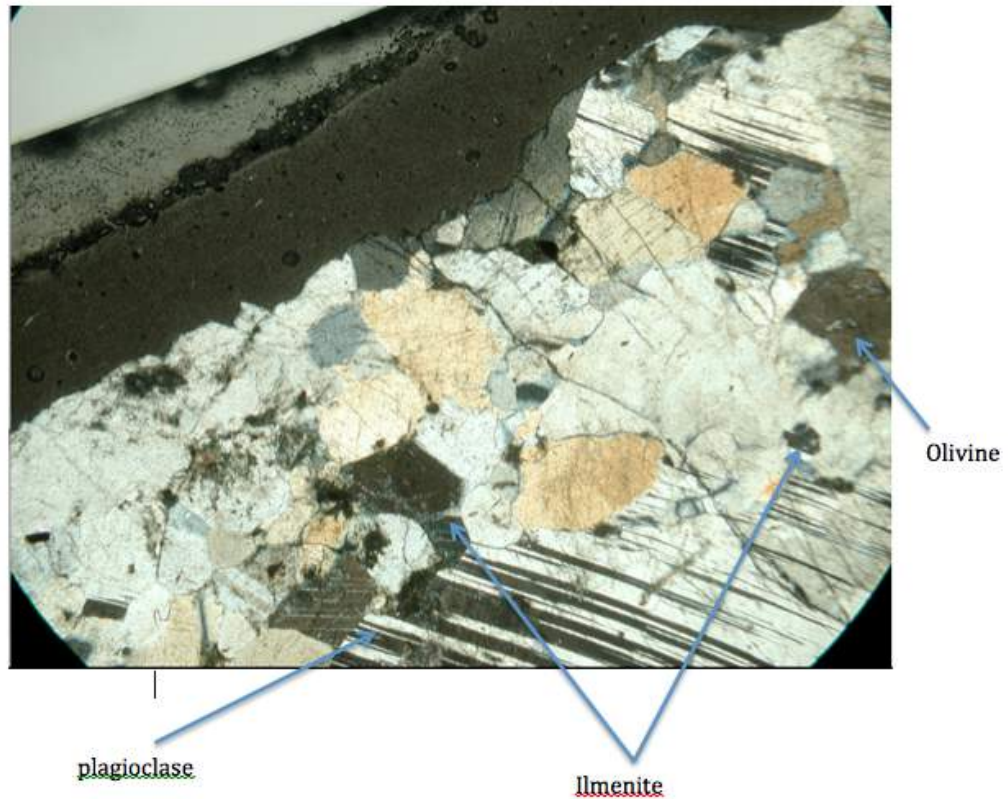


CREATING THIN SECTIONS:



FINDINGS ON BS-RO-3

- Granoblastic
- Minerals:
 - Plagioclase
 - Ilmenite
 - Olivine
 - Iron/garnet



16mm

EXTINCTION ANGLES:

- Michel-Lévy's method
- Avg: 57°
- 96% Anorthite

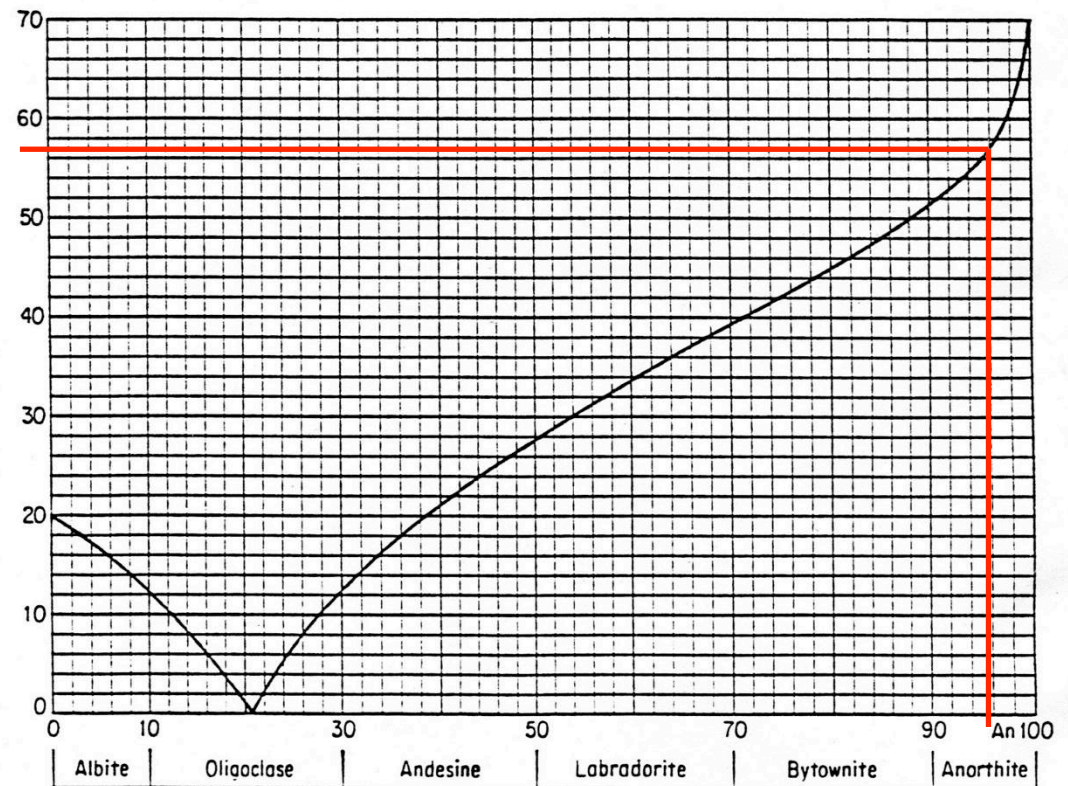


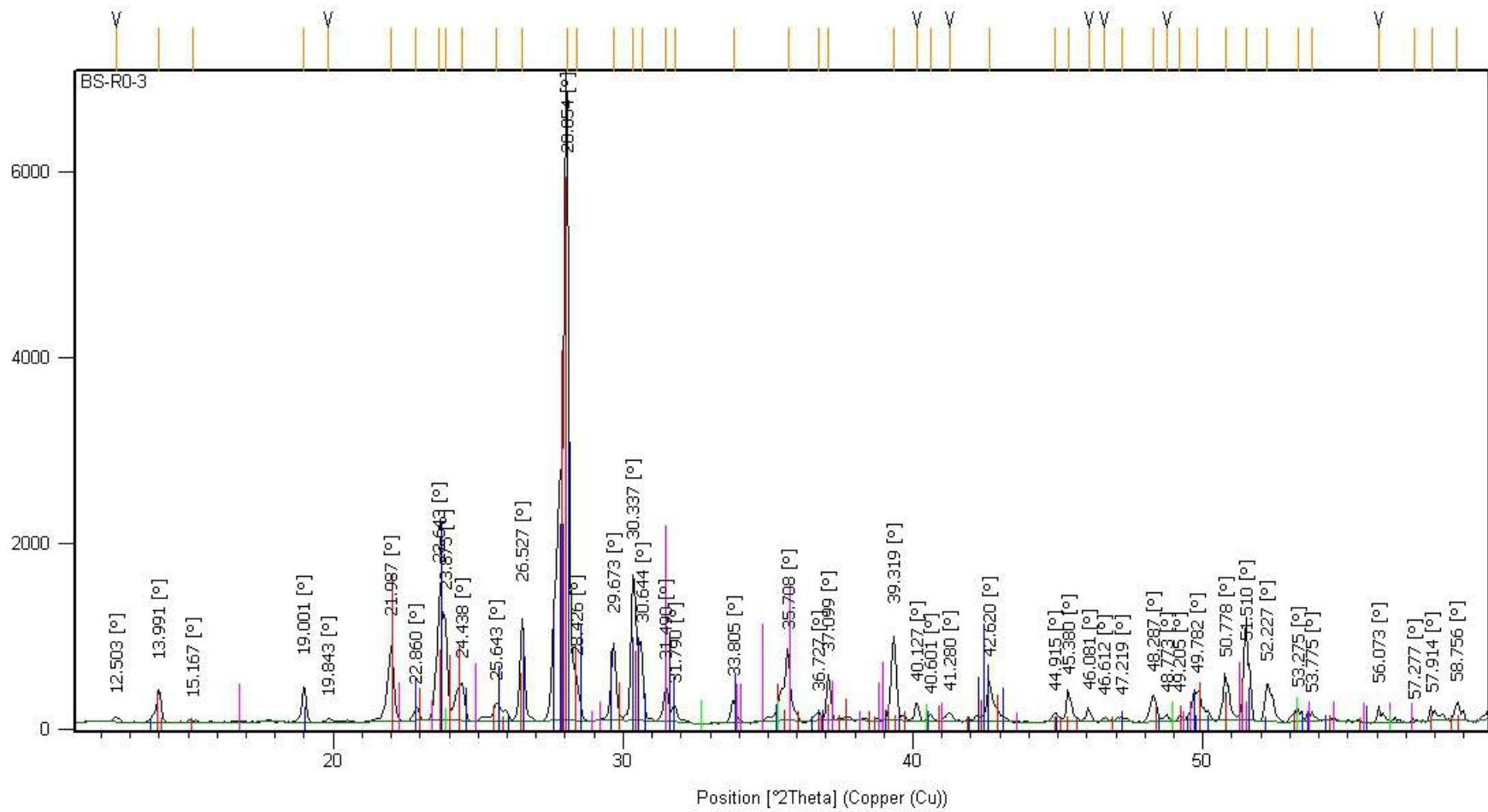
FIG. 13-26. Curve showing the maximum extinction angle of albite twins cut normal to (010) for the plagioclase feldspars (Michel-Lévy's method).

XRD:

- X-ray Defraction machine
- Reflects x-rays off of mineral



Photograph by: Hamid



2	<input checked="" type="checkbox"/>	00-041-
3	<input checked="" type="checkbox"/>	00-007-
4	<input checked="" type="checkbox"/>	00-003-

RESULTS:

- Chemical formula:
 $(\text{Ca}, \text{Na})(\text{Si}, \text{Al})_4\text{O}_8$
- Lake County, Oregon

Date: 5/1/2014 Time: 5:20:04 PM

File: BS-R0-3

User: Angel

Name and formula

Reference code: 00-018-1202
Mineral name: Anorthite, sodian, intermediate
PDF index name: Sodium Calcium Aluminum Silicate
Empirical formula: CaO_8Si_4 ← typo?
Chemical formula: $(\text{Ca}, \text{Na})(\text{Si}, \text{Al})_4\text{O}_8$

Crystallographic parameters

Crystal system: Anorthic
Space group: C-1
a (Å): 8.1760
b (Å): 12.8650
c (Å): 7.1020
Alpha (°): 93.4500
Beta (°): 116.1000
Gamma (°): 90.5000
Calculated density (g/cm³): 2.71
Measured density (g/cm³): 2.72
Volume of cell (10⁶ pm³): 334.56
Z: 4.00

RIR: -

Subfiles and Quality

Subfiles: Inorganic
Mineral
Common Phase
Educational pattern
Forensic
Quality: Indexed (I)

Comments

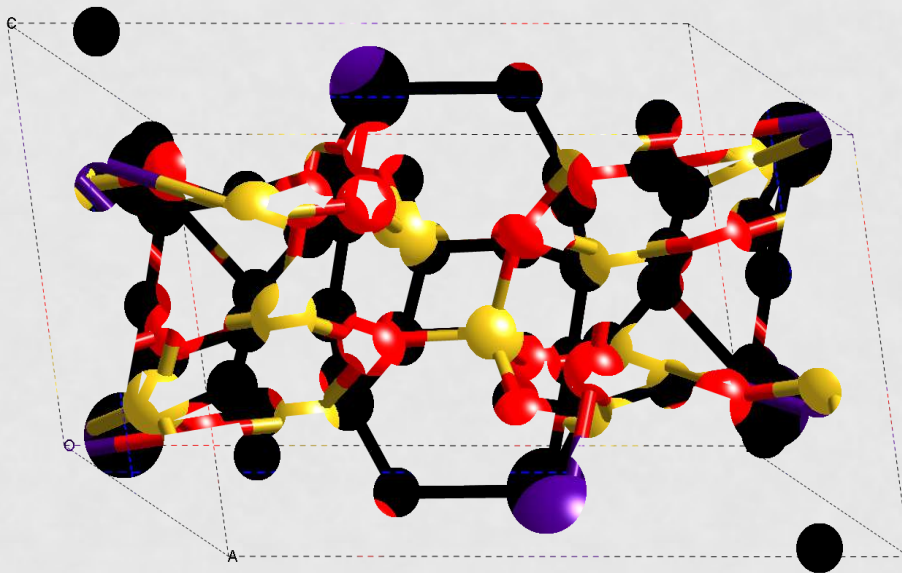
Color: Colorless, light yellow
General comments: Pattern obtained at 26 C using CaF_2 standard with $a=5.4622$, average of 3 patterns.
Sample source: Specimen from Lake County, Oregon, USA.
Structure: Structural state intermediate between high and low but more similar to high.
Analysis: Chemical analysis reports anorthite 67.2, albite 31.5, orthoclase 1.3.
Optical data: $A=1.5625$, $B=1.5668$, $Q=1.5718$, Sign=+, $2V=85^\circ$
Unit cell: Unit cell sub-cell indexes all powder reflections. True cell is $a=8.17$, $b=12.87$, $c=14.19$, $a=93.29$, $b=116.0$, $g=90.77$.

References

Primary reference: Stewart, Walker, Wright, Fahey., *Am. Mineral.* **51**, 177, (1966)

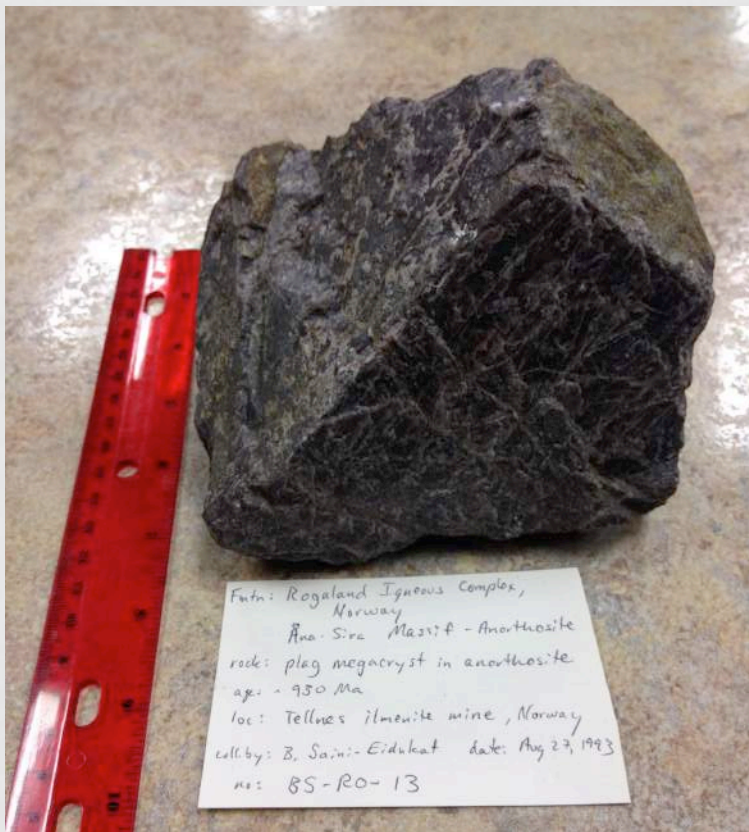
Peak list

ANORTHITE STRUCTURE



Purple: Calcium
Yellow: Silicon
Red: Oxygen

SAMPLE: BS-RO-13

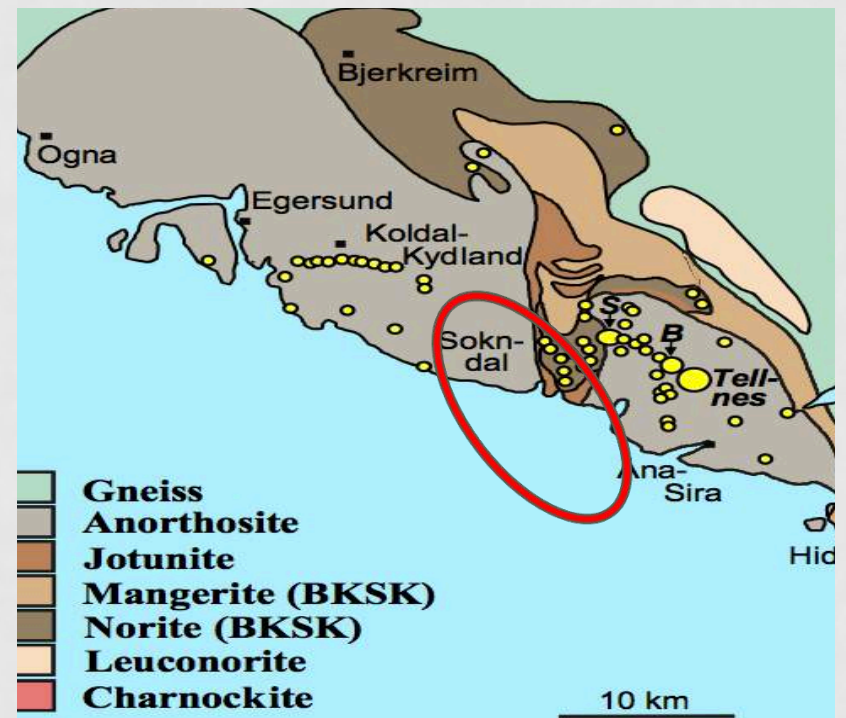


ÅNA-SIRA MASSIF



Photo 0.1. In the Åna-Sira anorthosite massif

(Duchesne, 2001)

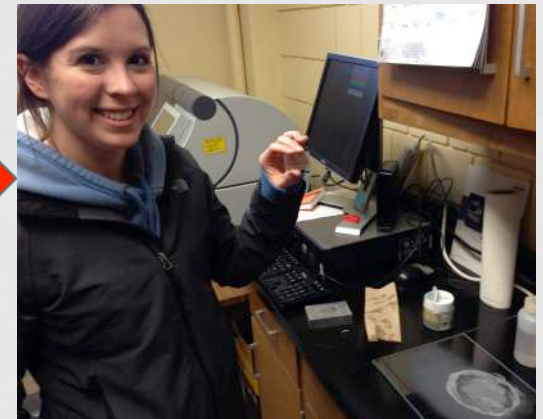
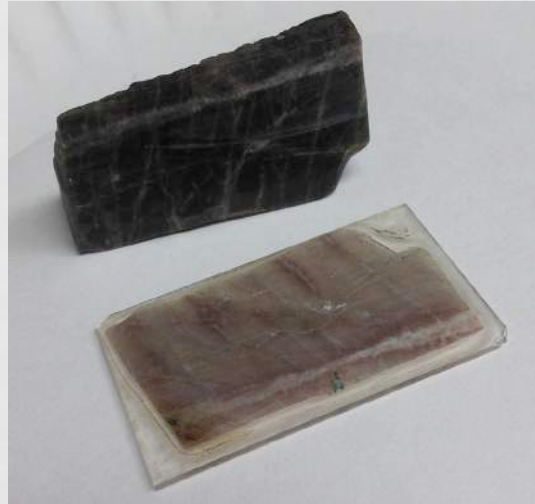


(Korneliussen, et al., 2000)

INITIAL OBSERVATIONS:

- Aphanitic grain size
- Very dark purple with brown and green areas
- Vitreous
- Can scratch glass
- Columnar structure

CREATING THIN SECTIONS:



Photograph by: Dr. Eidukat

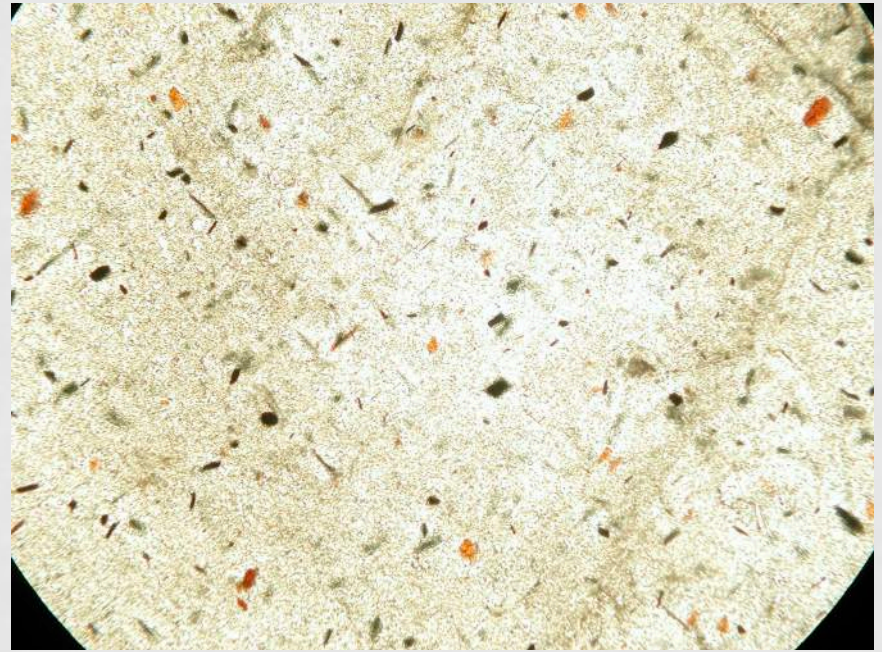


FINDINGS ON BS-RO-13

- Plagioclase
- Iron oxides or magnetite
- Twinning



16mm



4mm

XRD



Photograph by: Hamid

Name and formula

Reference code: 60-041-1460
 Mineral name: Albite, calcic, ordered
 PDF index name:
 Empirical formula: $Al_1.2Ca_{0.2}Na_{0.8}O_8Si_{2.8}$
 Chemical formula: $(Na, Ca)Al(Si, Al)_3O_8$

Crystallographic parameters

Crystal system: Anorthic
 Space group: C-1

a (Å): 8.1610
 b (Å): 12.8580
 c (Å): 7.1120
 Alpha (°): 93.6000
 Beta (°): 116.4200
 Gamma (°): 89.3900

Calculated density (g/cm³): 2.64
 Measured density (g/cm³): 2.61
 Volume of cell (10⁻⁶ cm³): 333.42
 Z: 4.00

PIR: 1.06

Subfiles and Quality

Subfiles: Inorganic
 Mineral
 Common Phase
 Educational pattern
 Forensic
 Indexed (I)

Comments

Color: White
 General comments: D₂₅ (131-131) = 1.66, D₂₅ (241-241) = 0.73.
 Sample source: Specimen from Zdanov, Czechoslovakia.
 Analysis: Chemical analysis (wt.%): SiO₂ 60.8, Al₂O₃ 24.7, CaO 5.3, Na₂O 8.6, K₂O 0.4; [Na_{0.75}Ca_{0.15}Al_{1.1}(Si_{2.8}Al_{0.2})O₈]
 Optical data: A=1.527, B=1.531, C=1.538, Sign=+, 2V=77°
 Additional pattern: To replace 9-457 and validated by calculated pattern 2015-48
 Temperature: Pattern taken at 25(1) °C

References

Primary reference: Sano, I., Polytechnic Foreign Trade Corporation, Pansko, Czechoslovakia, *XXIX Internat. (1980)*
 Structure: Colville, A., Rabin, P., *Spec. Pap. Geol. Soc. Am.* 101, 41, (1966)
 Optical data: Deer, W., Howie, R., Zussman, J., *Rock-Forming Minerals* 4, 94, (1963)

1 OF 3

Results:

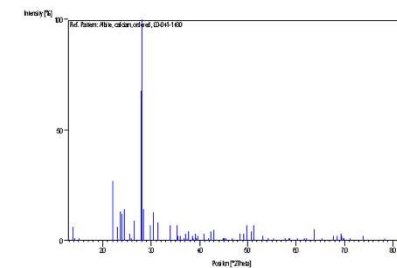
- Empirical Chemical Formula: $Al_{1.2}Ca_{0.2}Na_{0.8}O_8Si_{2.8}$
- Zdanov, Czech Republic

Peak list

No.	h	k	l	d (Å)	2Theta(deg)	I (%)
1	0	2	0	6.36558	13.901	6.0
2	1	1	0	6.28905	14.071	1.0
3	-1	-1	1	5.86616	15.091	1.0
4	-2	0	1	4.03136	22.031	27.0
5	1	-1	1	3.87179	22.951	6.0
6	1	1	1	3.75875	23.651	13.0
7	-1	3	0	3.70624	23.991	12.0
8	2	0	0	3.65374	24.341	14.0
9	-1	3	1	3.49010	25.501	3.0
10	-2	-2	1	3.44232	25.862	1.0
11	-1	1	2	3.36936	26.432	9.0
12	-2	0	2	3.18713	27.882	66.0
13	0	0	2	3.18167	28.022	100.0
14	2	2	0	3.14865	28.322	14.0
15	1	-3	1	2.99359	29.822	7.0
16	0	-4	1	2.95496	30.432	13.0
17	1	3	1	2.84382	31.432	6.0
18	-1	3	2	2.64281	33.892	7.0
19	-2	-4	1	2.53832	35.332	7.0
20	2	-2	1	2.52380	35.542	2.0
21	-2	4	1	2.49193	36.012	2.0
22	2	2	1	2.44536	36.722	1.0
23	-1	5	0	2.43959	36.812	1.0
24	-1	-5	1	2.42496	37.042	3.0
25	-3	1	0	2.39997	37.442	1.0
26	2	4	0	2.38584	37.672	4.0
27	-1	5	1	2.33805	38.472	2.0
28	-1	-1	3	2.32757	38.652	1.0
29	-3	-3	1	2.30012	39.132	3.0
30	-3	3	1	2.28665	39.372	1.0
31	-1	1	3	2.26950	39.682	2.0
32	1	-5	1	2.20664	40.862	3.0
33	-2	2	3	2.15571	41.873	1.0
34	0	6	0	2.13383	42.323	4.0
35	1	5	1	2.10584	42.913	5.0
36	-4	0	2	2.01873	44.863	1.0
37	-4	0	1	2.01066	45.053	1.0
38	2	0	2	1.99930	45.323	1.0
39	3	-1	1	1.98685	45.623	1.0
40	-4	-2	2	1.93751	46.853	1.0
41	2	2	2	1.88012	48.373	3.0
42	-4	0	3	1.85068	49.193	3.0
43	4	0	0	1.82702	49.873	7.0
44	1	1	3	1.79673	50.773	4.0
45	-2	0	4	1.77779	51.353	7.0
46	-4	-4	2	1.72205	53.143	2.0
47	0	4	3	1.71965	53.223	1.0
48	-2	2	4	1.68596	54.373	1.0
49	2	4	2	1.65785	55.374	1.0
50	0	0	4	1.59310	57.804	1.0
51	-4	-2	4	1.57565	58.534	1.0
52	0	-2	4	1.56978	58.774	1.0
53	2	-2	3	1.53425	60.274	1.0
54	-2	-8	1	1.50055	61.774	1.0

2 OF 3

55	3	3	2	1.49077	62.224	1.0
56	2	8	0	1.45740	63.514	5.0
57	-5	1	4	1.42668	65.254	1.0
58	1	-3	4	1.38191	67.755	2.0
59	-4	0	5	1.36948	68.454	2.0
60	-5	5	1	1.35406	69.345	3.0
61	-1	-9	2	1.35252	69.435	2.0
62	-5	-5	1	1.34558	69.845	1.0
63	-1	1	5	1.34390	69.945	1.0
64	-1	-3	5	1.32254	71.245	1.0
65	-6	0	4	1.28107	73.925	2.0
66	2	8	2	1.21935	78.356	1.0
67	-3	1	6	1.17312	82.086	1.0
68	0	-8	4	1.16949	82.396	1.0
69	0	10	2	1.16590	82.966	1.0
70	0	4	5	1.15776	83.416	2.0
71	-5	-7	4	1.15629	83.546	1.0

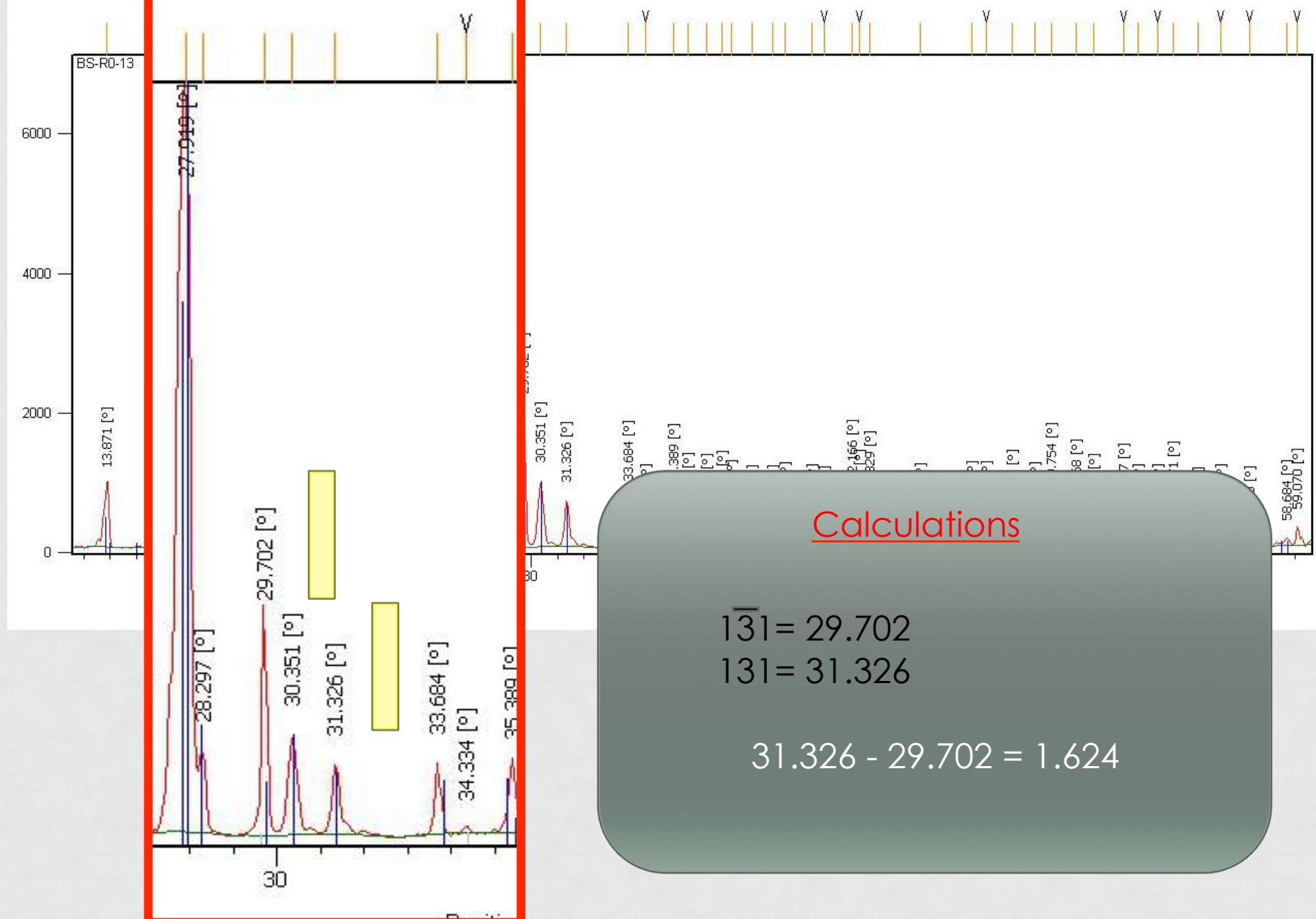
Stick Pattern

Unit cell:

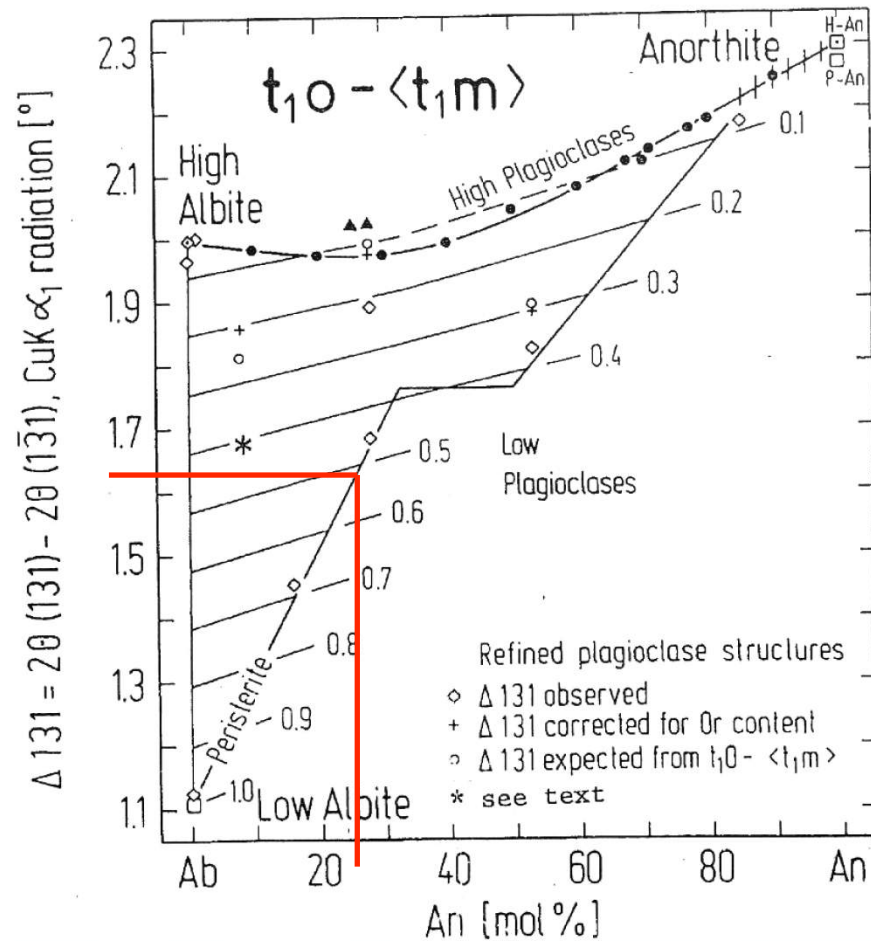
Bayliss, P., University of Calgary, Alberta, Canada., *Private Communication* (1990)**Peak list**

No.	h	k	l	d [Å]	2Theta[deg]	I [%]
1	0	2	0	6.36558	13.901	6.0
2	1	1	0	6.28905	14.071	1.0
3	-1	-1	1	5.86616	15.091	1.0
4	-2	0	1	4.03136	22.031	27.0
5	1	-1	1	3.87179	22.951	6.0
6	1	1	1	3.75875	23.651	13.0
7	-1	3	0	3.70624	23.991	12.0
8	2	0	0	3.65374	24.341	14.0
9	-1	3	1	3.49010	25.501	3.0
10	-2	-2	1	3.44232	25.862	1.0
11	-1	1	2	3.36936	26.432	9.0
12	-2	0	2	3.19733	27.882	68.0
13	0	0	2	3.18167	28.022	100.0
14	2	2	0	3.14865	28.322	14.0
15	1	-3	1	2.99359	29.822	7.0
16	0	-4	1	2.93496	30.432	13.0
17	1	3	1	2.84382	31.432	8.0
18	-1	3	2	2.64281	33.692	7.0
19	-2	-4	1	2.53832	35.332	7.0
20	2	-2	1	2.52380	35.542	2.0
21	-2	4	1	2.49193	36.012	2.0
22	2	2	1	2.44536	36.722	1.0
23	-1	5	0	2.43959	36.812	1.0
24	-1	-5	1	2.42496	37.042	3.0
25	-3	1	0	2.39997	37.442	1.0
26	2	4	0	2.38584	37.672	4.0
27	-1	5	1	2.33805	38.472	2.0
28	-1	-1	3	2.32757	38.652	1.0
29	-3	-3	1	2.30012	39.132	3.0
30	-3	3	1	2.28665	39.372	1.0
31	-1	1	3	2.26950	39.682	2.0
32	1	-5	1	2.20664	40.862	3.0
33	-2	2	3	2.15571	41.873	1.0
34	0	6	0	2.13383	42.323	4.0
35	1	5	1	2.10584	42.913	5.0
36	-4	0	2	2.01873	44.863	1.0
37	-4	0	1	2.01066	45.053	1.0
38	2	0	2	1.99930	45.323	1.0
39	3	-1	1	1.98685	45.623	1.0
40	-4	-2	2	1.93751	46.853	1.0
41	2	2	2	1.88012	48.373	3.0
42	-4	0	3	1.85068	49.193	3.0
43	4	0	0	1.82702	49.873	7.0
44	1	1	3	1.79673	50.773	4.0
45	-2	0	4	1.77779	51.353	7.0
46	-4	-4	2	1.72205	53.143	2.0
47	0	4	3	1.71965	53.223	1.0
48	-2	2	4	1.68596	54.373	1.0
49	2	4	2	1.65785	55.374	1.0
50	0	0	4	1.59330	57.824	1.0
51	-4	-2	4	1.57565	58.534	1.0
52	0	-2	4	1.56978	58.774	1.0
53	2	-2	3	1.53425	60.274	1.0
54	-2	-8	1	1.50055	61.774	1.0

$$\begin{matrix} 131 & \& \bar{1}\bar{3}1 \\ \bar{2}41 & \& 2\bar{4}1 \end{matrix}$$

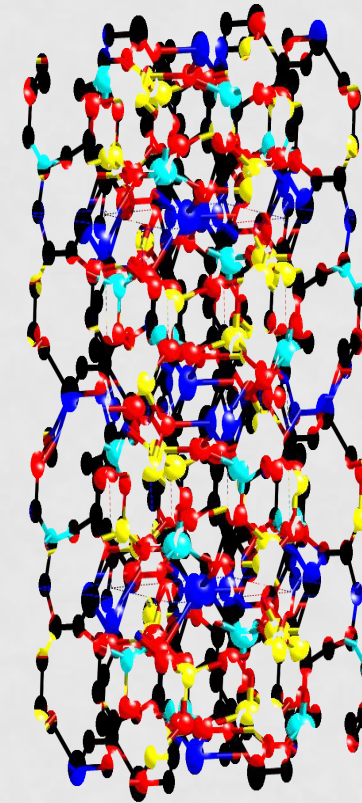
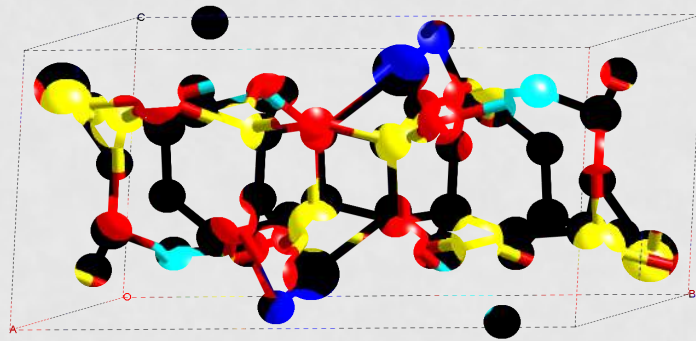


PLAGIOCLASE COMPOSITION



$\Delta 131 = 1.624$
 Low Albite
 75% Albite
 25% Anorthite

ALBITE STRUCTURE



Red: Oxygen
Yellow: Silicon
Blue: Sodium
Light blue: Aluminum

EXPERT GEOLOGISTS

- BS-RO-3 (Egersund- Ognå)
 - All types of plagioclase found
 - Calcium-sodian Anorthite
 - Ilmenite, magnetite, pyroxene, apatite, olivine
 - Ours: fyllite and ilmenite
- BS-RO-13 (Åna-Sira)
 - Megacryst and plagioclase matrix
 - Gray, blue or pink
 - Depth between 30-40km
 - Pressure: excess of 10 kbar
- Both:
 - Granoblastic
 - Large plagioclase megacryst
 - Aphanitic grain size

CONCLUSION

- Samples matched well with others findings
 - Plagioclase megacrysts present
 - Grain size
 - Differences: common minerals that were not found in our samples
 - Pyroxene, apatite
- Both plagioclase but different types
 - Calcium-sodan anorthite with Fylite and ilmenite
 - Albite with magnetite

THANK YOU!