

SVERIGES GEOLOGISKA UNDERSÖKNING

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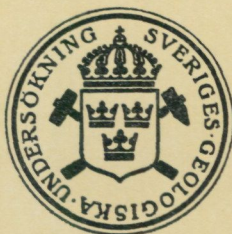
ÅRSBOK 61 NR 2

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O. BROTZEN

GEOCHEMICAL RANKING  
OF ROCKS

WITH TABLES CONTAINING 600 ROCK COMPOSITIONS



STOCKHOLM 1966

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C. DAVIDSONS BOKTRYCKERI AB, VAXJÖ 1967

## ABSTRACT

In geochemical ranking, rocks are ordered according to the concentration-coefficients of their major elements. This strictly objective, non-genetical and descriptive approach forms a suitable basis for the filing of chemical data of rocks. It makes possible rapid coordination of rocks of similar composition, and aids in their identification and geochemical interpretation. The simple procedure is fully described, and tables of 600 rocks are given with an alphabetical index.

## INTRODUCTION

A standard chemical analysis produces about ten numerical and highly objective parameters for most rocks. These parameters usually represent the same ten major elements or their oxides. The wide coverage and inherent simplicity of this information together with the relative ease and economy with which it may be obtained by modern techniques, make chemical data a suitable basis for the characterization of rocks. Certainly a full description of rocks also includes mineralogical, textural, structural and geological parameters, but these, by their inherent complexity, do not lend themselves as readily to simple systematic and quantitative treatment. Considering especially the normal descriptions of rock-compositions in terms of minerals, it is seen that these, although they are often highly informative and specific, require more than 40 different minerals to cover even a moderate range of rocks. Furthermore they suffer, quite generally, from the compositional variations which are possible in each mineral. Therefore the common two-dimensional systems of rock-classification by mineral composition are necessarily inaccurate and inadequate beyond an elementary grouping within a restricted range of non-metamorphic igneous rocks. This is probably also the reason why a number of different classification systems are in current, and often confusing, use. Other difficulties of the mineralogical approach arise when glassy or finegrained rocks are involved. Also the strong mineralogical changes characteristic of metamorphism often effectively obscure the original nature of a rock, although, at the same time, they illuminate the conditions of metamorphism.

A number of systems already exist which help to define the nature of a rock by means of its chemical composition. In addition to these wellknown systems, full use of the information contained in a standard analysis together with the accumulated knowledge on the chemistry of other rocks, also seems to call for a procedure, whereby it is possible to group a rock together with others of similar composition, regardless of any preliminary genetical assumptions. Such a grouping,

independent of initial decisions on the igneous, sedimentary, metamorphic or metasomatic nature of the rock under consideration might provide a strictly objective, quantitative basis for chemical petrology. It should be of special value in systematic compilation and documentation regarding chemical data of rocks and make such work amenable to mechanization, since no petrological judgement is required in the process. Finally it may be helpful in work where genetical interpretation is difficult.

It is obvious that such a grouping of rocks makes necessary a multidirectional system of reference as no single chemical variable is a satisfactory key to all rocks. Also a reduction in the number of variables by combining several individual components into a smaller number of functional groups, e. g. the alkalis or the femic group, is undesirable because information is lost in this way. Effective use of a procedure of grouping and comparison finally requires that a sufficient number of rocks are included in the system of reference for comparisons to be made. The present work therefore tries to outline a technique for the indicated purpose by simple geochemical ranking. A selection of rock analyses is also provided to act as an illustration of the method and a nucleus for the system of reference.

### Principles

The basic principle of the suggested technique is that the composition of each rock is compared with a nominal average crustal composition, which therefore serves both as a reference point and as a scale for each component. Comparing the composition of a sedimentary rock with such an average composition appears quite logical. The deviations found obviously reflect the combined effects of particular compositional features inherited from the original source rocks and of later modifications during sediment formation. Regarding igneous rocks, however, such a comparison at first sight appears less meaningful. Conventionally, igneous rocks are thought of as resulting from differentiation from some parental magma, and a description in terms of degree and direction of this differentiation would seem much more appropriate. Unfortunately little precise information is usually available regarding the composition of parental magmas, and the existence of a universal parental magma which could serve as a generally applicable starting point in such descriptions still appears somewhat hypothetical. Therefore it is more practical to compare igneous rocks with a specific central composition, which is somewhere midway between basalt and granite. This, in a way, may be likened to reading temperature from a convenient nominal zero point before the true starting-point of the absolute scale of temperature was known.

Once a nominal starting-point and scale have been defined it is easy to arrange the major components of a rock according to their relative quantitative importance.

This provides a simple yet multidirectional structure wherein each rock-composition can be accurately located. The details of the procedure are described below. Here it may be noted, however, that this ordering principle emphasises the dominant constituents of the rock and to a certain extent duplicates the principles underlying the conventional petrographic systems. From a geochemical point of view, however, components that are low or missing in a rock are also highly significant and must be taken into account in any attempt at interpretation.

Among existing estimates of average crustal compositions the average igneous rock proposed by Mead (1914) seems to be the most pertinent in the present context, because it actually represents a balance-calculation of the predominant types of igneous and sedimentary rocks. A revised version of Mead's calculations using modern data has recently been given, Brotzen (1966). The results, which strongly confirm those originally given by Mead, may, for easy handling and memorizing, be rounded off to the following values:  $\text{SiO}_2$  60;  $\text{TiO}_2$  1.0;  $\text{Al}_2\text{O}_3$  15;  $\text{Fe}_2\text{O}_3$  3.0;  $\text{FeO}$  3.0;  $\text{MnO}$  0.15;  $\text{MgO}$  3.0;  $\text{CaO}$  5.0;  $\text{Na}_2\text{O}$  3.0;  $\text{K}_2\text{O}$  3.0;  $\text{H}_2\text{O}$  1.0; and  $\text{P}_2\text{O}_5$  0.3; all in weight percent. These figures, for the major oxides, are used as a basis of calculation in the following tables.

### Procedures

The actual procedures of calculation and ordering are extremely simple and rapid. The content of each major oxide in a rock is divided by the corresponding figure of the nominal average, giving for each oxide a coefficient of concentration. (The same coefficients are obtained if the composition of the rock and the average are stated in some other fashion, such that the weight percentages of the elements or their atomic percentages are compared instead of the oxides.) For iron the coefficient is taken as half of the sum of the coefficients for ferric and ferrous iron respectively, which is equal to the sum of the oxides divided by 6.0. To avoid decimal points all coefficients are multiplied by 100. Finally the coefficients are arranged in order of decreasing magnitude and indicated by the chemical symbol of the corresponding element. If two or more elements have identical coefficients they are arranged in the order indicated by the following series: Mg, Fe, Ca, Na, K, Al and Si, cf. below. Only the seven major oxides of the crustal average are considered in this ranking. In order to indicate the oxidation state of iron in a rock, the content of ferric oxide divided by the total content of iron oxides, and multiplied by 100 is given as a separate coefficient — Ox. All calculations are conveniently carried out by an ordinary slide-rule, which gives a perfectly satisfactory degree of accuracy. Minor constituents such as C,  $\text{CO}_2$ , S and  $\text{P}_2\text{O}_5$ , which occasionally become important, are noted separately and  $\text{H}_2\text{O}$  and  $\text{TiO}_2$  are also given without any calculation. To illustrate this procedure an example is given in table 1.

TABLE 1

	1	2	3
SiO <sub>2</sub>	63.75	60	106
TiO <sub>2</sub>	0.66	1.0	
Al <sub>2</sub> O <sub>3</sub>	15.32	15	102
Fe <sub>2</sub> O <sub>3</sub>	4.11	3.0	137
FeO	1.53	3.0	51
MnO	0.17	0.15	
MgO	0.36	3.0	12
CaO	1.52	5.0	30
Na <sub>2</sub> O	7.28	3.0	243
K <sub>2</sub> O	4.62	3.0	154
H <sub>2</sub> O <sup>+</sup>	0.53	1.0	

4. Na 243, K 154, Si 106, Al 102, Fe 94, Ca 30, Mg 12, Ox 73, H<sub>2</sub>O<sup>+</sup> 0.53 %, TiO<sub>2</sub> 0.66 %.

1. Composition of aegirine syenite, Nockolds (1954, p. 1016).
2. Composition of nominal average.
3. Coefficients of concentration x 100.
4. Geochemical ranking.

In this way all normal rock compositions can be arranged into seven first-order groups, each characterized by a predominant element. In order to simulate the conventional petrographic classifications these groups are taken in the following order: Mg, Fe, Ca, Na, K, Al and Si; which tends to place ultrabasic and basic rocks in the beginning, intermediate-, leucocratic alkaline- and acid rocks next, and hydrolysate rocks and resistate sediments towards the end.

For further subdivision each first-order group may be split into six second-order groups according to the second-greatest component. Thus the first-order group comprising all Mg-dominant rocks can be divided into six second-order groups characterized by the following pairs of predominant constituents: Mg Fe; Mg Ca; Mg Na; Mg K; Mg Al; and Mg Si; and each of these may in turn be subdivided into five groups of the third order and so on.

This grouping, which reflects the association of predominant elements, carries a certain qualitative notion and may be taken to indicate, at least formally, the direction of the total fractionation which the rock has experienced, with the average composition as origo. The degree of fractionation therefore is given by the magnitude of the coefficients, and this provides a second ordering principle of a more quantitative nature. Thus within each qualitative group compositions are listed in order of decreasing fractionation as indicated by the greatest concentration coefficient. If two compositions have identical coefficients for this element the coefficients of the second element will decide their order.

### Notes on the tables

The following tables are based solely on these two ordering principles. All rocks are first grouped according to the three elements with the highest coefficients, and within each of the resulting groups of the third order (of which, theoretically, there are 210), they are listed in order of decreasing fractionation, as indicated by the concentration coefficient of the first element. In using the tables the significance of this ordering must constantly be kept in mind. In particular it must be pointed out that the first division into third-order groups is a purely practical step. Within many of the larger of these groups petrologic affinities are clearly marked between rocks that would fall in the same fourth-order group disregarding the degree of fractionation. Therefore both the qualitative aspect of element association and the quantitative aspect of the concentration coefficients must be considered in each case. Furthermore even the low or nearly absent constituents are geochemically significant, as, of course, is the varying degree of oxidation. Finally, it is obvious that *alternative groups must be considered when in a particular rock-composition any two of the four first elements show nearly the same coefficients.*

Regarding the selection of rock-compositions in the tables it appeared desirable that it should correspond to common petrological needs and also that the data can be related to some generally available context. The tables therefore contain rock-compositions given in three authoritative petrological texts, namely Niggli (1952), Pettijohn (1957) and Turner and Verhoogen (1960). In addition the average compositions of igneous rocks, as compiled by Nockolds (1954) have also been included.

Even so the material remains incomplete and unbalanced. Thus in a major treatise on igneous and metamorphic rocks one third of the quoted compositions refer to basaltic rocks, and only about 5 percent represent granitic and rhyolitic rocks. No chemical data are given for a single example of metamorphic or metasomatic rocks. Indeed, no chemical compilation of such rocks in accordance with modern facies-classifications seems to exist, and it appears to the writer that this disregard of detailed bulk-composition marks a major weakness in current approaches to the petrology of metamorphic and metasomatic rocks. Also the present tables contain, with the exception of a few gneisses, only igneous and sedimentary rocks. It can only be hoped that prolonged work will provide a more adequate selection in the future.

An inspection of the present tables shows that, in a general way, related rocks also occur together in the tables. This coordination applies in the normal case when different varieties of the same rock type are considered. It also applies to other relationships as shown by the pairs granite — arkose and diorite — greywacke. On the other hand the more frequently represented rock types, e. g. basalts or greywackes, are definitely split into several different groups representing different associations of elements and varying degrees of fractionation. This splitting primarily reflects a lack of chemical precision in current rock-terms based on mineralo-

gical and textural criteria, as discussed above, and also some minor differences in classification among the authorities from whom the data have been compiled. Whether this splitting into sub-groups has also some truly petrological significance remains to be seen. At present the fact that such variations can be made apparent is in itself an interesting feature of the geochemical ranking of rocks.

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## TABLES

## Explanations

Order of elements: Mg, Fe, Ca, Na, K, Al, Si;

Concentration coefficient =  $\frac{100 C}{A}$ ; where C is the content of an element in the rock and A is the content of the same element in the nominal average.

To calculate the coefficients from weight percentages of the different oxides A is as follows: Si 60; Al 15; Fe 6.0; Mg 3.0; Ca 5.0; Na 3.0; K 3.0.

Ox-coefficient =  $\frac{\text{Fe}_2\text{O}_3}{\text{FeO} + \text{Fe}_2\text{O}_3}$ ; (weight percent).

Rock compositions are taken from:

Niggli 1952: indicated by Ni

Nockolds 1954: „ „ N

Pettijohn 1957: „ „ P

Turner & Verhoogen 1960: indicated by TV

## Index of second-order groups

—	MgFe p. 10	MgCa p. 12	MgNa p. —	MgK p. 16	MgAl p. 16	MgSi p. 17
FeMg p. 17	—	FeCa p. 18	FeNa p. 19	FeK p. 20	FeAl p. 21	FeSi p. 22
CaMg p. 23	CaFe p. 25	—	CaNa p. 26	CaK p. 27	CaAl p. 27	CaSi p. 28
NaMg p. 29	NaFe p. 29	NaCa p. 31	—	NaK p. 31	NaAl p. 33	NaSi p. 34
KMg p. 35	KFe p. 35	KCa p. 35	KNa p. 36	—	KAl p. 37	KSi p. 38
AlMg p. 39	AlFe p. 39	AlCa p. 40	AlNa p. —	AlK p. 40	—	AlSi p. 40
SiMg p. 41	SiFe p. 41	SiCa p. 42	SiNa p. 43	SiK p. 43	SiAl p. 44	—

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others	Type of Rock and Reference
<b>Mg-groups</b>								
	<b>Mg</b>	<b>Fe</b>	<b>Ca</b>					
1045	155	136	si59 k35 al26 na11	56	1.22	7.43	2.73	Kimberlite, basaltic. N9:6 p. 1023.
1030	209	96	si76 al37 na27 k15	21	0.96	1.69		Peridotite, hornblende-. N9:5 p. 1023.
890	226	116	si70 al61 na47 k7	4	0.8			Picrite. TV7:3 p. 178.
889	181	136	k81 si60 al35 na12	69	1.89	7.25	1.64	Kimberlite, micaceous. N9:7 p. 1023.
810	223	143	si67 al49 na35 k21	32	1.30	3.67	0.34	Peridotite, alkali-. aver. N9:II p. 1023.
785	221	129	si77 na50 al40 k14	44	1.75	0.64		Basalt, picrite. TV18:4 p. 220 (7:4 p. 178).
760	197	130	si83 al47 na23 k4	22	0.67	0.42		Hypersthenite, hornblende. N8:7 p. 1022.
657	191	162	al90 si73 na45 k19	19	0.67	0.50		Troctolite. N7:VI p. 1020.
655	215	184	si72 al60 na50 k23	27	2.12	0.74		Basalt, alkali-, olivine-rich. N7:XII p. 1021.
582	228	140	si81 al62 na53 k14	16	0.82	0.99		Diabase, olivine. TV16:1 p. 215.
548	239	236	na103 si68 al59 k40	42	2.7			Basalt, picrite. TV9:7 p. 183.
467	201	186	si80 al79 na55 k19	19	1.65	0.59		Basalt, olivine-, tholeiitic. N7:VIII p. 1021.
410	260	226	al76 si70 na60 k28	34	2.86	1.31		Hornblendite. N8:8.
400	265	206	na143 si74 al51 k50	40	2.7			Picrite, calc. waterfree. TV9:5 p. 183; 22:2 p. 245.
389	175	172	k91 al88 si78 na73	25	2.47	0.57	0.03	Basanite, leucite-; Murambite. TV20:6 p. 238.
370	221	216	na88 al83 si77 k14	4	1.62	0.60	Trace	Basalt, olivine. TV13:1 p. 190.
363	221	182	al90 k82 na78 si73	31	1.61	1.22	0.05	S 0.01 Limburgite. TV13:2 p. 190.
338	196	195	si84 al77 na70 k14	23	2.97			Basalt, tholeiitic, aver. of 24. TV18:3 p. 220.
323	215	199	si68 k66 al60 na53	35	5.81	4.16	0.64	Limburgite. TV23:2 p. 253.
319	222	163	na110 al94 si75 k59	31	2.49	2.05		Teschenite, 20 ft. from lower contact. TV6:1 p. 176.
290	208	204	na103 al98 si78 k30	28	2.3			Basalt, olivine, aver. of. 8, water free. TV3:1 p. 168.

286	210	184	na130	al92	si72	k71	29	2.66	2.37	Trace	S 0.04	Basalt, alkaline (atlantite) w. biotite and anorthoclase. TV3:2 p. 168.
284	192	170	na100	al100	si83	k40						Basalt, olivine, aver. of 23. TV15:11 p. 208.
282	183	177	na175	si80	al78	k77	37	1.94		0.21		Basalt; cf. Fe 130 Na K; Fe 142 Na Si. Ni3:10:A p. 57.
274	205	155	na116	al88	si81	k52	33	4.29				Basalt, aver. of 5 flows. TV11:2 p. 188, 15:10 p. 208, 14:7 p. 192.
270	231	174	al100	na87	si76	k13	25	3.1	1.7	0.1		Basalt, plateau-, aver. of 3. TV19:A:2 p. 226.
269	202	200	na104	al99	si79	k40	21	2.48				Basalt, olivine-, continental. TV14:2 p. 192, 5:2 p. 174.
250	189	174	al103	na100	si84	k47	39	1.5				Basalt, olivine, aver. of 27. TV14:3 p.192.
248	207	167	na127	al98	si75	k60	25	2.62	2.88			Teschenite, 270 ft. from lower contact. TV6:3 p. 176.
247	205	188	al105	na103	si79	k43	32	2.9				Basalt, olivine, aver. of 27. TV14:4 p. 192.
242	197	190	na125	al103	si79	k40	33	2.84	0.78			Andesite, alkali, aver. N6:IV p. 1019.
237	213	127	na105	al85	si75	k55	78	4.54	2.29			Basalt, weath., cf Mg 252 Ca Fe. Ni3:12:B p. 58.
237	181	178	na92	al92	si84	k28	43	1.15	2.35			Basalt. TV15:6 p. 208.
232	200	172	na97	al95	si84	k24	29	1.30	2.28			Basalt, aver. of 8 New Jersey. TV15:5 p. 208.
224	166	163	na112	al101	si88	k33	24					Basalts, weighted aver. of 5. TV5:3 p. 174.
220	207	174	na109	al109	si74	k7	35	2.51	1.69	0.06		Diabase, analcite-olivine; Crinanite. TV19:A:3 p. 226.
212	180	177	al110	na103	si77	k51	37	2.25	3.40			Teschenite, aver. of 4. TV8:4 p. 179.
211	201	173	na127	al108	si79	k38	32	3.57				Basalt, aver. of 4 flows. TV11:1 p. 188.
205	180	176	na132	al106	si80	k64	31	2.87	0.66			Mangerite, alk. Hurum type, volc. equi. N5:9 p. 1018.
204	186	177	na132	al109	si77	k45	34	2.13	3.55			Teschenite, aver. N11:VI p. 1027.
201	197	167	na123	al105	si82	k46	31					Basalt, aver. of 14. TV5:4 p. 174, 8:5 p. 179.
185	173	169	k136	al105	na82	si81	21	3.17	0.41			Trachybasalt. TV20:7 p. 238.
180	177	163	na148	al105	k82	si78	36	2.43	3.59			Glenmuirite, aver. N11:II p. 1027.

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others		Type of Rock and Reference		
<b>Mg</b>	<b>Fe</b>	<b>Na</b>									
373	200	197	ca172	al98	si71	k40	28	2.6	P <sub>2</sub> O <sub>5</sub> 1.1	Theralite, aver. TV9:3 p. 183.	
285	170	142	ca118	al94	si84	k5	16	1.55	4.49	Spilite, border of pillow. TV24:2 p. 259.	
<b>Mg</b>	<b>Fe</b>	<b>Al</b>									
558	377	112	si50	ca38	na9	k1	18	0.58	10.18	0.08	Spilite, matrix. TV24:3 p. 259.
538	346	113	ca59	si49	na28	k18	25	3.01	9.64		Spilite, matrix. TV24:4 p. 259.
226	189	114	si83	ca66	k32	na22	92		3.95	0.75	Clay, red. Ni49:31 p. 312.
<b>Mg</b>	<b>Fe</b>	<b>Si</b>									
1440	229	67	ca15	na10	al5	k5	14	0.20	0.44		Dunite. N9:1 p. 1023.
1220	193	72	ca60	al28	na13	k5	19	0.25	0.64		Peridotite, pyroxene-. N9:4 p. 1023.
1150	204	69	ca27	k10	al8	na7	33	0.25	5.20	Cr <sub>2</sub> O <sub>3</sub> 3.20	Harzburgite. TV31:4 p. 299.
1037	159	91	ca32	al14	na5	k3	9	0.17	0.31		Pyroxenite with rhombic pyroxene. N8:2.
1030	161	92	al16	ca13			0	0.10	Nil		Pyroxenite. TV31:3 p. 299.
735	636	59	ca29	al10	na9	k0	0	0.03	0.35		Hortonolite dunite. N9:2 p. 1023.
730	698	44	al15	ca11	na11	k5	31	5.97	0.32		Dunite,-ore-. N9:3 p. 1023.
<b>Mg</b>	<b>Ca</b>	<b>Fe</b>									
715	220	160	si87	al30	na19	k6	23	0.32	0.49		Pyroxenite w. two pyroxenes. N8:3 p. 1022.
690	619	13	si1				8		0.27	46.27	Dolomite. Ni58:3 p. 448.
683	619	17	al1	si1	na0	k0	0			47.51	Dolomite. P81 F p. 418.
635	247	208	si72	al56	na45	k18	39	2.27			Ankaramite, aver. TV10:2 p. 187.
634	338	208	si75	al29	na12	k9	36	1.00	0.42		Pyroxenite, olivine-. N8:4 p. 1022.
622	526	36	k41	na15	si14	al8	100		0.24	41.41	Dolomite. Ni58:1 p. 448.
560	241	213	si76	al56	na36	k13	40	1.83	0.94		Hornblendite, olivine-. N8:9 p. 1022.
540	326	206	na77	si62	al54	k45	42	3.31	1.89		Melilitite, olivine-, aver. N12:XV p. 1029.
510	435	113	si82	al30	na18	k11	28	0.89	0.63		Pyroxenite, with augite. N8:1 p. 1022.

505	276	156	al100 si71 na28 k12	44	1.54	0.95				Ariegite. N8:6 p. 1022.
496	242	233	al70 si70 na52 k14	30	2.41	0.87				Basalt, picrite-. TV18:5 p. 220.
490	250	216	si74 al63 na60 k17	25	2.8					Basalt, picrite. TV9:6 p. 183.
487	304	181	k137 si64 al63 na45	59	2.81	2.95				Leucitite, olivine, melilite-. N13:15 p. 1031.
476	192	183	k83 al79 si74 na72	36	2.10	0.40	0.21			Murambite. TV21:7 p. 242.
473	310	187	k92 si73 al51 na23	49	2.51	0.77				Pyroxenite, biotite-. N8:5 p. 1022.
462	213	183	k136 si73 na72 al68	46	2.54	0.72				Leucitite, olivine-. N13:11 p. 1031.
454	225	206	na101 al76 si71 k31	27	2.94	0.44				Basanite, nepheline-. TV18:10 p. 220.
449	295	200	na121 al74 si63 k44	43	3.40	1.45				Nephelinite, olivine, melilite, aver. N12:XIV p. 1029.
443	260	209	na105 al75 si68 k48	39	2.90	1.08				Nephelinite, olivine-; aver. N12:VII p. 1028.
442	203	182	k97 na84 al78 si74	19	2.55	0.44	0.05			Basalt, leucite-; Ugandite. TV20:1 p. 238.
435	338	243	si69 al48 na46 k23	47	3.31	0.50				Pyroxenite, alkali-; aver. N8:II p. 1022.
433	180	135	k109 si79 na65 al64	42	1.85	3.90		P <sub>2</sub> O <sub>5</sub> 1.05		Basalt, leucite. TV21:6 p. 242.
431	231	180	k153 si76 al60 na47	34	0.76	0.95		P <sub>2</sub> O <sub>5</sub> 1.52		Shonkinite. TV22:1 p. 245.
408	236	205	na101 al78 si65 k14	33	3.60	3.30				Monchiquite. TV23:1 p. 253.
402	276	225	na158 al80 si61 k30	45	2.41	1.61				Basalt, nepheline-melilite-. TV18:9 p. 220.
396	395	272	si59 k33 al27 na20	58	7.4 ± 1.3	0.2		P <sub>2</sub> O <sub>5</sub> 1.3		Pyroxenite, biotite-, aver. TV35:8 p. 391.
390	320	206	k110 si59 na52 al46	78	4.88	3.11	1.47	P <sub>2</sub> O <sub>5</sub> 1.18		Katungite. TV21:9 p. 242.
377	305	181	k74 si63 al63 na57	52	3.05	2.20	1.70	P <sub>2</sub> O <sub>5</sub> 1.68		Monchiquite, nepheline-. TV21:8 p. 242.
364	240	132	al124 na78 si78 kTr.	0	0.90	0.10				Basalt, olivine-. TV28:1 p. 285.
340	170	167	al91 na85 si85 k20	24	2.14	0.61				Basalt, hypersthene-. TV18:2 p. 220.
335	227	168	al116 si78 na68 k13	19	0.97	0.63				Gabbro, olivine-. N7:3 p. 1020.
320	226	200	al112 na82 si80 k7	13	0.79	0.29				Gabbro, olivine-, noritic. TV30:2 p. 293.
318	233	201	na103 al83 si78 k35	25	1.74	1.11				Limburgite. TV20:10 p. 238.
312	215	199	al97 na88 si77 k32	26	2.63	0.76				Basalt & dolerite, normal alkali. N7:IX p. 1021.
310	247	203	al99 na77 si73 k31	36	2.83	0.66				Gabbro, alkali, aver. N7:III p. 1020.
310	194	146	al117 si84 na65 k21	15	0.89	0.47				Norite, aver. N7:II p. 1020.

				Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others	Type of Rock and Reference
<b>Mg</b>	<b>Ca</b>	<b>Fe</b>	<b>(Continued)</b>						
305	245	161	al113 si95 na27 k23	9	0.60	0.21			Diabase, pyroxene-enriched. TV16:3 p. 215.
302	263	213	na112 k105 al89 si67	42	3.14	0.90			Etindite, olivine-. N13:13 p. 1031.
299	227	122	al115 si87 na61 k13	9	0.21	0.52			Norite, aver. of 5. TV31:2 p. 299.
290	236	229	na143 al99 si70 k53	36	1.6	1.3			Nephelinite, olivine-. TV9:4 p. 183.
287	208	202	na137 al99 si74 k57	25	3.2				Basalt, alkaline (atlantite, zeolitized). TV9:2 p. 183.
284	232	224	na137 al98 si68 k52	36	1.42	1.34	0.04	S 0.05	Nephelinite, olivine-. TV3:3 p. 168.
279	187	170	k145 na95 al80 si77	73	1.80	2.17	0.24		Lamprophyre, biotite-augite. TV23:5 p. 253.
278	266	230	na102 al91 si68 k55	48	3.99	0.50			Melteigite w. Ti-augite. N12:V p. 1028.
278	225	207	na116 al96 si74 k53	37	3.46				Basanitoid, aver. TV14:8 p. 192.
278	217	161	al104 si86 na71 k19	23	1.13	0.48			Gabbro, pyroxene-. N7:2 p. 1020.
277	214	199	al88 si83 na75 k18	20	3.17				Basalt, aver. of 11 Hawaiian. TV7:2 p. 178.
275	245	197	al110 si81 na40 k8	28	0.63				Basalt, olivine-. TV27:1 p. 281.
267	196	175	na155 al90 si75 k40	52	3.51	2.80			Analcitite, olivine-; aver. N:12:IX p. 1028.
265	189	162	na131 al85 si81 k3	33	1.21	6.14			Spilite, center of pillow. TV 24:1 p. 259.
262	209	164	al126 na81 si80 k6	12	1.40	0.41	0.06		Gabbro, olivine-. TV30:1 p. 293.
258	205	199	na105 al104 si82 k33	42					Basalt, aver. of 14. TV5:5 p. 174.
255	183	182	al99 na95 si84 k12	29	2.33	0.73			Basalt, aver. of 10. TV18:1 p. 220.
254	194	143	al121 na90 si84 k23	19	1.30				Basalt, olivine-. TV28:2 p. 285.
250	194	172	al102 si86 na77 k26	10	1.25	0.93			Diabase, undif. aver. TV16:6 p. 215.
250	185	171	na138 al99 si77 k64	52	3.06	1.29			Basalt; cf. Mg 237 Fe Ca; Fe 214 Mg Ca; Fe207 Mg Al. Ni3:12:A p. 58.
249	216	176	al15 si80 na76 k18	28	1.55	1.10			Gabbro, hornblende-. N7:1 p. 1020.
244	168	147	k131 al99 na89 si86	21	1.14	0.52			Monzonite, augite-biotite-olivine-. N4:3 p. 1017.

242	206	182	na177 al103 si75 k42	39	2.65	1.56			Nepheline tephrite, aver. N11:V p. 1027.
240	200	175	al101 si85 na67 k27	29	1.0	1.3	Trace		Basalt, aver. Drakensberg. TV16:11 p. 215.
235	220	160	al107 si87 na79 k17	29					Basalt, aver of. 3. TV5:6 p. 174.
232	194	179	a197 si88 na73 k32	8	1.10	0.71			Diabase, aver. Karroo. TV16:8 p. 215.
229	173	154	na105 al104 si88 k47	25	1.29	0.56			Diorite, pyroxene-mica-. N6:3 p. 1019.
228	218	155	al125 si86 na53 k5	6	0.34	0.34			Gabbro, hypersthene-; Norite. TV31:1 p. 299.
225	176	137	al117 na111 si86 k26	18	1.12	0.49			Basalt, olivine-. TV28:3 p. 285.
224	190	186	al110 na103 si81 k32	27	1.91	1.11			Diorite, hornblende & hbl, augite-. N6:2 p. 1019.
220	217	189	k135 na125 al100 si74	33	2.31	0.36	0.02		Leucitite, olivine-. TV20:2 p. 238.
212	208	199	al94 si85 na74 k27	24	2.03	0.91			Basalt & dolerite, normal tholeiitic. N7:VII p. 1021.
158	152	138	al121 na117 si88 k55	24	1.60	1.00			Diorite, hornblende, biotite-. N6:1 p. 1019.
<b>Mg</b>	<b>Ca</b>	<b>Na</b>							
648	534	14	al13 si13 fe12 k4	21	0.12	0.33	41.13		Dolomite. P81 C p. 418.
212	193	166	fe159 al114 si76 k42	57	2.36	2.48			Tephrite, analcite-, aver. N11:VII p. 1027.
186	176	165	fe164 al99 si80 k15	6	2.68	2.54	1.40		Spilite. TV25:2 p. 262.
172	148	122	al120 fe112 si93 k41	30	0.84	0.72			Andesite, basaltic-. TV28:4 p. 285.
<b>Mg</b>	<b>Ca</b>	<b>K</b>							
508	356	81	fe41 al41 si30 na15		0.26	2.54	24.90	SO <sub>3</sub> 6.54 org.	Marl, dolomitic, w.anhydrite and carbon. Ni49:33 p. 312; 58:5 p. 448.
444	295	181	fe106 si78 al69 na30	40	1.19	0.53			Missourite, melanocratic. N13:9 p. 1031.
415	310	80	al72 si44 fe36 na17	76	0.76	3.34	23.62		Marl, dolomitic, red. Ni49:35 p. 312, 58:7 p. 448.
326	192	174	fe152 si83 na73 al73	37	0.84	1.34			Shonkinite, augite-biotite-olivine-. N3:3 p. 1016.
266	186	176	fe132 al88 si84 na73	41	1.22	1.81			Trachyte, alkali; lavas corresp. shonkinite-. N3:4 p. 1016.

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others		Type of Rock and Reference
<b>Mg</b>	<b>Ca</b>	<b>Al</b>							
238	181	97	k78 si71 fe48 na17	1.01	4.88	13.65			Marl, dolomitic-. Ni48:22 p. 311; 58:4 p. 448.
<b>Mg</b>	<b>Ca</b>	<b>Si</b>							
695	591	5	fe4 al1 na- k-	75		0.30	45.54		Dolomite P81 D p. 418.
490	446	41	fe17 al12 na1 k1	65	0.18	0.42	33.82		Dolomite, cherty. P81 E p. 418.
421	364	56	fe21			0.64	29.72	MnO <sub>2</sub> 4.05	Marl-, radiolaritic-. Ni57:8 p. 367.
325	212	81	k67 al42 na31 fe23	55	0.80	2.01	16.80		Marl, dolomitic, green. Ni49:34 p. 312, 58:6 p. 448.
123	108	108	al71 k68 fe52 na45	84	0.40	2.05	6.31		Loess. Ni27:1 p. 233. P 73 A p. 378.
<b>Mg</b>	<b>K</b>	<b>Fe</b>							
364	294	134	ca94 si76 al46 na28	75	7.34	0.75	0.08	P <sub>2</sub> O <sub>5</sub> 1.83	Wolgidite. TV21:1 p. 242.
121	117	115	al108 si102 na88 ca27	4	1.09	3.11			Gneiss, sericite-biotite; cf. K129 Si Na. Ni3:5:A p. 55.
<b>Mg</b>	<b>K</b>	<b>Ca</b>							
344	331	97	si85 fe66 al66 na27	69	2.13	2.19		P <sub>2</sub> O <sub>5</sub> 1.53	Orendite. TV21:3 p. 242.
272	270	223	fe117 al94 si78 na59	50	1.65	0.71			Missourite, mesotype. N13:8 p. 1030.
272	199	159	fe116 si86 na75 al74	51	1.80	1.90			Lamprophyre, mica-. TV21:5 p. 242.
263	188	182	fe118 si86 na85 al77	33	1.85	1.10			Minette. TV23:6 p. 253.
238	179	174	fe158 na97 al87 si84	45	1.20	0.75			Shonkinite, augite-biotite-. N3:2 p. 1016.
215	126	102	si94 fe82 al77 na17	71	0.48	2.82	7.42		Slate, red. Ni50:42 p. 313.
162	158	154	fe123 na115 al109 si89	37	1.07	0.73			Monzonite, augite-biotite-. N4:2 p. 1017.
<b>Mg</b>	<b>Al</b>	<b>Ca</b>							
500	202	78	si56 fe33 k32 na20			10.76		P <sub>2</sub> O <sub>5</sub> 2.54	Soil, residual on limestone; cf. Ca 895 Mg Fe. Ni4:3:B p. 60.

Mg	Al	K					1.23	6.22	1.42			
141	118	104	si89	fe85	ca33	na21					Clay, Ni48:18 p. 311.	
Mg	Si	Al					94	0.81	1.93	1.57		
172	106	95	ca87	na82	fe68	k68					Clay, glacio-limnic. Ni46:7 p. 309.	
117	104	101	ca92	na89	fe86	k86	11	0.50	1.56	1.30	Graywacke. P51 C p. 306.	

### Fe-groups

Fe	Mg	Ca					5	0.36	4.05	20.70	P <sub>2</sub> O <sub>5</sub>	1.30		
645	125	111	al41	si14	na2	k1								Ironstone, sideritic-chamositic, mudstone. P84 F p. 451.
341	185	171	na112	al93	si75	k11	18	2.55	0.34					Gabbro, ferro-; hortonolite-. TV30:4 p. 293.
262	214	205	al79	si75	na71	k16	10	6.88	0.14	0.26				Gabbro, pyroxene-. TV32:4 p. 325.
218	176	176	na106	al88	si86	k35	26	2.60	0.87					Andesite, tholeiitic, aver. N6:III p. 1019.
214	178	120	al85	na78	si75	k34	78	5.56	3.90					Basalt, weathered; cf. Mg 252 Ca Fe. Ni3:12:C p. 58.
194	190	166	na117	al111	si82	k57	37	2.9						Basalt, olivine-, continental. TV14:5 p. 192.
134	117	112	al88	si77	na60	k59	0	0.75	7.45	3.64	S, SO <sub>3</sub>	2.23		Clay, calcic, dark gray. Ni48:20 p. 311.
Fe	Mg	Na					12	1.50	2.02	0.10				
177	158	153	ca141	al96	si89	k34								Spilite. TV25:5 p. 262.
Fe	Mg	Al					89	Tr.	0.77	Tr.				
1598	10	9	k8	na3	si2									Iron ore, hematitic. Ni56:2 p. 361.
207	195	114	si65	na36	ca31	k19	92	5.59	7.16					Basalt, weathered; cf. Mg 252 Ca Fe Ni3:12:D p. 58.
159	110	106	k95	si91	na68	ca39	91	0.98	7.04		org. S + rest 0.60			Clay, red deep sea; aver. Ni47:13 p. 310.
140	113	102	si101	na83	k56	ca43	9	0.87	3.38	1.01				Graywacke. P51 F p. 306.

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others		Type of Rock and Reference
<b>Fe</b>	<b>Mg</b>	<b>Si</b>							
637	121	48	ca15 al9 na-	k-	3	0.20	0.68	25.21	Ironstone, carbonate, cherty. P84 B p. 451.
600	105	40	ca36 al11 k7 na1		2		0.21	27.60	P <sub>2</sub> O <sub>5</sub> 0.91 C 1.96 Ironstone, carbonate, cherty. P84 C p. 451.
592	127	53	ca30 al14 na-	k-	42	0.12	1.80	19.40	P <sub>2</sub> O <sub>5</sub> 0.83 Ironstone, carbonate, cherty. P84 D p. 451.
<b>Fe</b>	<b>Ca</b>	<b>Mg</b>							
870	132	79	al52 si22 na9 k6			0.52	6.22	10.01	S 0.09 Ironstone, oolitic. Ni55:2 p. 352.
800	120	103	al65 si22 na8 k4			0.54	6.77	10.32	S 0.07 Ironstone, oolitic. Ni55:1 p. 352.
584	250	120	al80 si28 na25 k7		8	0.46	5.97	8.58	P <sub>2</sub> O <sub>5</sub> 1.27 MnO 0.25 S 0.38 Shaly bed in ironstone. Ni56:7 p. 361.
504	413	262	al24 si15 na-	k-	100			24.78	P <sub>2</sub> O <sub>5</sub> 0.75 Ironstone, hematite-. P84 H p. 451.
378	250	172	na22 k7 al5 si3		38	Tr.	1.12	35.48	MnO 19.11 Iron-Mn-ore. Ni56:4 p. 361.
246	197	130	na116 al107 si80 k52		41	2.31			Basalt -olivine, aver. of 19. TV4:1 p. 171; 5:1 p. 174; 14:1 p. 192.
239	203	191	al87 si83 na75 k17		27	2.34	1.99		Basalt, aver. of 4 low Deccan. TV15:2 p. 208.
237	213	193	al94 si82 na72 k12		11	2.46	0.32		Basalt, tholeiitic. TV19:B:8 p. 226.
234	224	203	na140 al115 k83 si71		58	2.1			Basalt, feldspar-. TV14:6 p. 192.
233	164	158	na97 al91 si83 k43		17	2.87	1.22		Basalt, aver. of 6 Oregon. TV15:4 p. 208.
229	164	139	na108 al98 si86 k31		21	0.63	2.01		Basalt, aver. of 3 high Deccan. TV15:3 p. 208.
225	188	180	al96 si82 na67 k33		25	2.9	1.6		Diabase, tholeiitic, aver. of 4. TV19:B:5 p. 226.
222	193	160	na128 al94 si74 k61		29	4.07	3.26		Teschenite, 500 ft. from lower contact. TV6:5 p. 176.

219	189	182	al90 na87 si84 k24	24	1.91	2.13			Basalt, aver. of. 11 Deccan. TV15:1 p. 208, 16:10 p. 215.
217	200	167	na93 al87 si83 k40						Basalt, tholeiitic magma type. TV15:8 p. 208.
217	194	174	na93 si92 al91 k37	29	1.8	2.2			Tholeiite, aver. of 8. TV19:B:7 p. 226.
206	182	181	al92 si84 na81 k32	31	2.39	1.51	0.58		Diabase, aver. Whin sill. TV16:7 p. 215.
202	195	179	k141 al104 na98 si74	25	3.75	0.54			Basanite, leucite-, Kivite. TV20:5 p. 238.
195	183	150	na142 al109 si78 k60	54	2.59	3.62			Teschenite. TV8:1 p. 179.
178	155	111	al106 na104 si94 k25	28	1.24	0.36			Andesite, pigeonitic ser. TV27:3 p. 281.
148	136	134	na115 al111 si92 k91	38	1.30	0.51			Mangerite, pyroxene-biotite-. N5:3 p. 1018.
<b>Fe</b>	<b>Ca</b>	<b>Na</b>							
449	149	88	si81 al57 mg40 k11	15	2.20	1.13			Gabbro, ferro-, faylite-. TV30:5 p. 293.
229	163	135	al106 mg99 k80 si73	30	3.53	4.04		P <sub>2</sub> O <sub>5</sub> 1.21	Teschenite, roof of intrusion. TV6:6 p. 176.
220	189	172	mg167 al102 si70 k6	25	4.15	3.29	2.47		Camptonite. TV23:3 p. 253.
184	133	121	al108 mg107 si90 k76	36	1.63	0.98	Trace	S Nil, P <sub>2</sub> O <sub>5</sub> 1.01, MnO 1.10	Basalt, oligoclase. TV13:3 p. 190.
<b>Fe</b>	<b>Ca</b>	<b>Al</b>							
614	332	57	mg39 si24 na n.d. k n.d.	91	n.d.	7.80	11.80	P <sub>2</sub> O <sub>5</sub> 2.49	Ironstone, oolitic. Ni55:4 p. 352.
188	172	113	si95 na70 mg59 k52	23	0.75	0.12			Diabase, dioritic affinities. TV16:4 p. 215.
<b>Fe</b>	<b>Ca</b>	<b>Si</b>							
1554	14	8		75	0.25	0.55	0.67		Iron ore, hematitic. Ni56:1 p. 361.
178	109	86	al84 na78 mg36 k33	30	5.12	5.05	3.70		Slate, ferruginous. Ni50:41 p. 313.
<b>Fe</b>	<b>Na</b>	<b>Mg</b>							
201	164	152	ca138 al91 si86 k25	24	3.32	1.88	0.94		Spilite, aver. of 19. TV25:1 p. 262; 26:1 p. 271.
188	185	138	al101 si89 ca59 k11	23	2.41	3.14	Nil		Diabase, albite-. TV25:4 p. 262.
162	159	143	ca143 al110 si86 k78	33	2.29	0.63			Doreite, alkali-; aver. N5:IV p. 1018.

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others		Type of Rock and Reference	
<b>Fe</b>	<b>Na</b>	<b>Ca</b>								
253	130	101	si98 k80 al80 mg24	38	1.26	0.21			Granophyre, hedenbergite-. TV30:6 p. 293.	
222	174	105	mg101 al99 si82 k70	46	1.84	1.61	P <sub>2</sub> O <sub>5</sub> 1.47		Mugearite. TV19:A:4 p. 226.	
221	175	131	al107 mg105 si80 k67	26	2.20	0.77	0.17	S 0.04	Mugearite, (basalt, oligoclase-andesine-) TV3:5 p. 168.	
218	175	125	mg122 si88 al85 k6	29	2.54	2.33	Nil		Spilite. TV25:3 p. 262.	
193	150	124	mg120 al107 si81 k59	66	1.94	2.9	1.45		Spilite. TV26:3 p. 271.	
184	160	135	al122 mg108 si83 k67	38	1.82				Basalt, trachydoleritic. TV11:3 p. 188.	
181	167	132	mg124 al109 si86 k64	43	2.74		P <sub>2</sub> O <sub>5</sub> 1.00		Mugearite, aver. TV26:2 p. 271.	
150	137	129	mg112 al110 k100 si93	34	0.83	0.56			Mangerite, pyroxene, hornblende, biotite. N5:2 p. 1018.	
<b>Fe</b>	<b>Na</b>	<b>K</b>								
184	123	106	si101 ca89 al87 mg13	29	1.06	1.42			Syenite, quartz-; aver. of 5. TV31:5 p. 299.	
130	115	115	mg105 si104 ca67 al63	85	1.42	0.17		S 0.37	Soil; from basalt; cf. Mg 282 Fe Ca. Ni3:10:B p. 57.	
<b>Fe</b>	<b>Na</b>	<b>Si</b>								
142	118	113	k105 al54 mg20 ca17	81	1.20	0.18		S 0.43	Soil from basalt; cf. Mg 282 Fe Ca. Ni3:10:C p. 57.	
<b>Fe</b>	<b>K</b>	<b>Na</b>								
159	120	117	al100 si97 mg55 ca5	38	0.64	3.46	0.03	S 0.04, C 3.27	Slate, black. P70 D p. 362.	
<b>Fe</b>	<b>K</b>	<b>Al</b>								
353	133	75	si73 mg46 na40 ca14	1	0.50		15.76		Porcellanite, sideritic. P82 F p. 435.	
191	185	110	mg103 si92 na50 ca4	0.81		5.69			Clay (blue). Ni42:1 p. 283; 49:37 p. 312.	
135	105	90	si85 mg38 ca19 na14	0.81		5.79, C 13.11			Shale, carbonaceous. P70 A p. 362.	
108	108	103	si97 mg81 ca62 na43	62	0.65	3.66	2.63		Pelitic rocks, aver. Clarke; Ni50:39 p. 313.	

Fe	K	Si							
385	237	86	mg67	al55	ca10		6.7		Sand, glauconite-. Ni22:5 p. 228.

Fe	Al	Mg								
1183	45	37	ca17	si10		n.d.	n.d.	P <sub>2</sub> O <sub>5</sub> 1.3	Ironstone, oolitic grains. Ni55:5 p. 352.	
1040	54	50	ca40	si19	na10 k5	0.54	7.75	2.96	S 0.09 P <sub>2</sub> O <sub>5</sub> 1.24	Ironstone, oolitic. Ni55:3 p. 352.
316	122	115	si79	ca77	na- k-	2.20	6.49		Lateritic weathering; cf. Na 155 Al Si. Ni6:C p. 70.	
156	145	138	ca122	si81	na80 k26	56	0.90	3.92		Amphibolite, weathered; cf. Ca 197 Mg Fe. Ni3:4:B p. 55.
104	92	84	k73	si70	na59 ca39	0.58	8.36	0.67	S, SO <sub>3</sub> 3.05, C org. S 12.72	Clay, black. Ni48:19 p. 311.
Fe	Al	Ca								
1252	38	30	si21	mg14	na- k-	0.27	2.17		P <sub>2</sub> O <sub>5</sub> 1.63	Ironstone, hematite, chamosite-. P84 G p. 451.
933	175	13	mg7	si2	na- k-	1.59			Rest (water) 14.39	Laterite. Ni5:3 p. 68.
256	191	159	mg101	na51	si43 k27	72	0.18	15.17	0.12	Gabbro, hornblende-; weathered; cf. Ca 350 Fe Mg. Ni3:9:B p. 57.
Fe	Al	K								
363	218	40	si39	mg19	ca15 na13	0.15	15.05	0.52		Gabbro, hornblende-; weathered, earthy; cf. Ca 350 Fe Mg. Ni3:9:C p. 57.
126	119	110	si96	mg93	na92 ca45	43	1.14	4.33		Gneiss, biotite, weathered; cf. K 182 Fe Al. Ni3:2:B p. 54.
Fe	Al	Si								
1067	73	18	mg2	ca2	na- k-		12.5		S 0.1	Limonitic concretions. Ni8:6 p. 75.
573	236	18	ca8	mg-	na- k-	0.10			Rest (water) 19.00	Laterite. Ni5:2 p. 68.

				Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others	Type of Rock and Reference
<b>Fe</b>	<b>Al</b>	<b>Si</b>	<b>(Continued)</b>						
496	245	24	ca14 mg9 na- k-		2.27	16.43			Lateritic weathering; cf. Na 155 Al Si. Ni6:F p. 70.
339	177	57	kTr. naTr. mg- ca-	97	1.23	17.01			Lateritic weathering; cf. Fe 136 Al Si. Ni6:6 p. 70.
327	107	81	k8 na3 mg- ca-	96	0.88	11.94			Lateritic weathering; cf. Fe 136 Al Si. Ni6:4 p. 70.
235	164	73	mg10 na6 k4 ca-		0.80				Soil, andesite, weathered, completely earthy; cf. Ca 135 Fe Mg. Ni3:8:C p. 56.
223	193	70	na31 ca13 k12 mg9		2.60	11.13			Clay (bole). Ni8:4 p. 75.
210	149	72	k52 mg44 ca43 na13		1.00	8.55	0.73		Clay, with limonitic concretions. Ni8:5 p. 75.
205	143	85	mg14 na6 k4 ca1		0.48				Soil, andesite, weathered, almost earthy; cf. Ca 135 Fe Mg. Ni3:8:B p. 56.
151	130	84	k53 mg46 ca30 na22		0.21	7.68	0.27	Org. 1.74	Terra rossa; cf. Ca 1110 Mg Fe. Ni9:1B p. 77.
136	115	107	k100 na81 ca42 mg16	51	0.88	0.87			Gneiss. Ni6:1 p. 70.
123	115	95	k75 mg72 ca41 na35	69	1.27	7.17		Org. S + rest 2.07	Mud, blue; aver. Ni47:9 p. 310.

<b>Fe</b>	<b>Si</b>	<b>Mg</b>							
422	103	78	ca6 al2 na- k-	59		4.17	2.04		Ironstone, greenalite-. P84 E p. 451.
<b>Fe</b>	<b>Si</b>	<b>Ca</b>							
492	83	49	al34 mg32 na28 k16	99		6.56			Sandstone, limonitic. Ni26:4 p. 232.
<b>Fe</b>	<b>Si</b>	<b>K</b>							
420	61	60	al46 mg22 na9 ca3		0.39	1.25		S 10.3, C 7.28	Slate, pyritic, graphitic. P70 C p. 362.

Fe	Si	Al								
250	94	70	ca70 mg32					2.49	MnO <sub>2</sub> 3.23	Mud, radiolaritic. Ni57:9 p. 367.
112	109	92	mg62 k53 na49 ca14	19	0.90	3.94	tr.			Graywacke, P51 L p. 306.

### Ca-groups

Ca	Mg	Fe									
1110	10	1	al0 si0 na- k-				0.002			43.78	Limestone. Ni9:1:A p. 77.
1075	19	4	al3 si2 na1 k1							0.69 42.69	Limestone, lithographic. P74 E p. 384.
978	127	14	al6 si6 k4 na2				0.04			0.27 40.75	Limestone, weathered. Ni9:2:A p. 77.
909	90	31	si12 al10 k8 na5	37			0.14			0.38 39.27	Limestone, crinoidal. P74 C p. 384.
895	144	39	al28 k12 si7 na5							2.26 34.10	Limestone; cf. Mg 500 Al Ca. Ni4:3:A p. 60.
580	271	193	na75 si64 al40 k9	60	1.85	0.55	0.79		P <sub>2</sub> O <sub>5</sub> 3.04		Uncompahgrite, aver. N12:XII p. 1029.
417	202	199	k81 si53 al30 na2				0.41			3.31 18.12	Marl, glauconitic. Ni50:44 p. 313; 57:6 p. 429.
415	212	170	na147 k93 al90 si56	58	2.85	2.25	0.93		P <sub>2</sub> O <sub>5</sub> 1.68		Turjaite, aver. N12:XI p. 1029.
402	287	154	k85 al76 si75 na25	53	2.17	0.20					Gabbro, leucite-; (Puglianite). N13:3 p. 1030.
399	258	91	k44 si44 na26 al9				0.23			4.44 21.70	Terra rossa; cf. Ca 978 Mg Fe. Ni9:2:B p. 77.
332	182	179	na170 k89 al82 si70	60	2.21	0.87	0.82		P <sub>2</sub> O <sub>5</sub> 1.24		Melteigite, aver. N12:III p. 1028.
316	275	189	na119 al90 k83 si65	69	3.10	2.06					Nephelinite, melilite-. aver. N12:XIII p. 1029.
252	173	168	na137 al106 k83 si77	29	2.5						Teschenite. TV9:1 p. 183.
250	224	175	al103 na83 si81 k13	11	2.9						Teschenite. TV7:1 p. 178.
248	227	195	al97 na87 si78 k36	32	3.00	0.51					Basalt, alkali, without olivine. N7:X p. 1021.
246	168	147	al132 si80 na73 k10	51	1.3	1.8					Basalt, porphyritic, aver. of 3. TV19:C:9 p. 226.
236	221	188	na156 al98 si72 k49	31	2.59	5.34					Bekinkite, aver. N12:VIII p. 1028.
226	221	146	al108 si88 na53 k30	6	0.58	0.48					Diabase, undifferentiated. TV16:5 p. 215.
226	218	178	al101 si90 na76 k27	25	1.30	1.01	0.07				Tholeiite, olivine-. TV19:B:6 p. 226.
221	200	180	al109 si77 na71 k10	33	3.05	1.10					Basalt, feldspar-porphyritic. TV19:C:10 p. 226.
218	201	195	al99 na98 si84 k19	29	0.96	0.28					Tholeiite, aver. of 3. TV15:7 p. 208.
209	191	187	na169 al111 si77 k46	26	2.34	0.66					Theralite, aver. N11:IV p. 1027.

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>			Others	Type of Rock and Reference		
<b>Ca</b>	<b>Mg</b>	<b>Fe</b>	<b>(Continued)</b>									
206	205	189	na119	al102	si80	k36	22	3.53	0.62		Basalt, olivine-. TV18:6 p. 220.	
206	196	185	na107	al107	si77	k73	30	3.4	0.4	0.6	Trachybasalt, aver. of 4. TV19:A:1 p. 226.	
201	200	152	al121	na92	si86	k27	37	1.10	0.45		Basalt, "central". N7:XII p. 1021.	
197	190	174	al125	si84	na83	k19	37	0.83	0.51		Amphibolite; cf. Fe 156 Al Mg. Ni3:4:A p. 55.	
194	181	171	al110	si87	na77	k34	15	0.97	0.84	0.16	Diabase, quartz-. TV16:2 p. 215.	
183	167	122	al118	si96	na53	k24	31	0.28	0.09		Andesite, olivine-; hypersthentic ser. TV27:5 p. 281.	
(120	81	26	na19	k12	al7	si3	0		0.82	37.60	MnO 46.43	Manganese-ore,-carbonatic. Ni56:5 p. 361.)
<b>Ca</b>	<b>Mg</b>	<b>Na</b>										
293	185	112	fe93	al84	si74	k46	45		2.25	7.76		Sandstone, lime-marl-. Ni25:1 p. 231.
<b>Ca</b>	<b>Mg</b>	<b>K</b>										
1108	12	1	fe1	al1	na0	si0			0.34	43.11		Travertine. P74 H p. 384.
852	264	11	fe9	si9	al5	na2		0.06	0.56	41.58		Limestone, composite of 345. P74 A p. 384.
628	148	83	si46	fe26	na26	al24		0.20	0.16	27.32		Limestone, marly. Ni57:2 p. 429; 50:47 p. 313.
596	88	82	si51	fe47	al26	na16		0.47	1.86	24.67		Marl; cf. K 123 Si Mg; Ca 125 K Si; Ni4:5:A p. 61; 48:28 p. 311.
581	558	36	fe22	si14	al11	na2	16		0.42	41.66		Dolomite. Ni58:2 p. 448.
537	75	68	al57	si49	fe38	na10		0.67	3.05	22.91	S Tr.	Marl, calcic. Ni50:46 p. 313.
245	223	184	fe112	al104	si81	na64	25	1.69	0.55			Mangerite, leucite-. N13:2 p. 1030.
236	235	87	si81	fe53	al50	na31	79	0.45	2.02	15.47		Marl, glacial. Ni46:5 p. 309.
216	207	179	fe150	al108	si79	na78	39	1.54	0.62			Tephrite, leucite-. N13:6 p. 1030.
<b>Ca</b>	<b>Mg</b>	<b>Al</b>										
1091	20	5	na5	fe1	si1	k0				42.90		Limestone. P74 B p. 384.
1050	20	11	fe9	si4	na-	k-				41.85		Chalk. P74 G p. 384.

521	223	45	si44 fe43 k40 na14		0.61	2.63	25.46		Marl, calcic-dolomitic. Ni48:27 p. 311.
280	125	82	k74 fe70 si69 na20	54	0.57	4.84	12.40		Marl. Ni48:23 p. 311.
265	131	88	si78 fe74 k33 na25		1.14	7.30	8.61		Clay, glacial-. Ni46:6 p. 309.
246	136	134	na119 si89 fe78 k18	15	0.69	0.73	0.38		Gabbro, anorthositic. TV32:3 p. 325.
<b>Ca</b>	<b>Mg</b>	<b>Si</b>							
911	235	4	fe3 al2 k1 na0	17	0.02	0.05	43.60		Limestone, dolomitic. P74 D p. 384.
740	286	24	fe10 k5 na4 al4	40	0.03	0.58	37.66		Limestone, dolomitic. Ni25:7 p. 231.
452	267	48	fe47 al46 k40 na4		0.35	2.07	24.56		Marl, dolomitic-calcic. Ni48:29 p. 311.
432	242	51	k51 fe48 al44 na38		0.45	3.34	22.69		Marl, dolomitic-. Ni48:25 p. 311.
410	238	62	fe41 al40 k20 na9		0.40	1.95	21.20		Marl-, dolomitic-calcic. Ni48:26 p. 311.
264	99	87	fe76 k71 na52 al43		1.49	10.36		ZrO <sub>2</sub> 2.26	Sand, carbonatic-. Ni22:8 p. 228.
227	195	97	k41 al39 fe33 na12		0.17	14.94			Sand, carbonatic-. Ni22:6 p. 228.
179	152	101	fe54 al53 na39 k36	81	0.52	1.14	9.63		oess. P73 B p. 378.
<b>Ca</b>	<b>Fe</b>	<b>Mg</b>							
990	51	10	si7 al6				38.76	Na, K 0.63	Limestone, limnic. Ni57:9 p. 429.
721	166	53	al22 si22	21	0.17	1.25	32.10		Limestone, ferruginous. Ni57:8 p. 429.
705	429	31	na13 al9 k5 si4	82	Tr.	0.62	32.58		Iron-ore, calcitic. Ni56:3 p. 361.
512	76	69	al61 na54 si53 k44			6.02	17.13	Cl <sub>2</sub> 2.46	Mud, red coastal; Marl. Ni47:10 p. 310.
350	169	155	al117 na80 si75 k46	31	0.31	0.46			Gabbro, hornblende-; cf. Fe 363 Al K; Fe 256 Al Ca. Ni3:9:A p. 57.
284	253	205	na136 al79 k69 si66	58	3.86	1.59			Nephelinite, aver. N12:VI p. 1028.
222	136	110	si66 k63 na47 al9		0.37	5.45	9.16		Terra rossa; cf. Ca 978 Mg Fe. Ni9:2:C p. 77.
205	183	159	na133 al115 si75 k59	23	2.71	2.86			Teschenite, 120 ft. from lower contact. TV6:2 p. 176.
203	201	175	al120 na115 si80 k5	21	2.64	0.20	0.03		Gabbro. TV30:3 p. 293.
202	178	153	na131 al112 si76 k61	25	2.79	2.84			Teschenite, 420 ft. from lower contact. TV6:4 p. 176.
196	195	188	na127 al104 si87 k70	38	2.70	0.94			Mangerite, alk.-, Hurum type. N5:6 p. 1018.

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others		Type of Rock and Reference	
<b>Ca</b>	<b>Fe</b>	<b>Mg</b>	<b>(Continued)</b>							
158	150	146	na122 al114 si84 k37	39	1.31	0.86			Andesite, aver. N6:II p. 1019.	
153	121	118	al103 na102 si91 k86	35	0.91	3.23	1.12		Sandstone, immature. Ni26:8 p. 232.	
135	131	105	si102 al99 na75 k62		0.54				Andesite; cf. Fe 205 (235) Al S. Ni3:8:A p. 56.	
<b>Ca</b>	<b>Fe</b>	<b>Na</b>								
365	174	174	mg144 al93 k80 si66	72	2.9	1.2	0.5	P <sub>2</sub> O <sub>5</sub> 1.2	Ijolite, aver. TV35:9 p. 391.	
200	183	156	mg121 al108 k81 si76	27	3.30	0.85	0.38		Essexite. TV35:7 p. 391.	
144	101	99	al94 si78 mg65 k61	68	1.04	5.86	4.05	S + rest. 1.65 Cl <sub>2</sub> 2.25	Mud, blue and green, marine; aver. Ni47:8 p. 310.	
137	135	119	mg113 al112 si92 k87	46	1.29	0.92			Doreite, aver. N5:II p. 1018.	
136	132	121	mg102 al88 k81 si75	91	0.82	5.93	3.91	Cl <sub>2</sub> 2.77	Clay, red deep sea-; aver. Ni47:11 p. 310.	
135	132	119	al115 mg114 k94 si93	37	1.09	0.79			Mangerite, hornblende-biotite-. N5:1 p. 1018.	
<b>Ca</b>	<b>Fe</b>	<b>K</b>								
330	97	82	al75 si69 mg63 na32	97	1.28	5.54	12.52		Mud, fluviatile. Ni45:2 p. 308.	
170	158	148	al125 na120 mg85 si77	37	1.74	1.05	Nil	S Nil P <sub>2</sub> O <sub>5</sub> 1.88	Tephrite, leucite. TV13:6 p. 190.	
<b>Ca</b>	<b>Fe</b>	<b>Al</b>								
460	118	74	si53 mg22			7.90	17.08	P <sub>2</sub> O <sub>5</sub> 1.28	Ooze, globigerina-; aver. Ni47:14 p. 310.	
240	156	136	mg135 si83 na63 k10	28	0.87	0.39			Basalt, olivine-, pigeonitic. TV27:2 p. 281.	
<b>Ca</b>	<b>Fe</b>	<b>Si</b>								
538	212	52	al27 mg13			3.30	20.68		Mud, green. Ni47:15 p. 310.	
139	122	93	al88 na87 mg63 k63	35	0.76	2.99	4.97		Sandstone, arkosic. Ni24:6 p. 230.	
<b>Ca</b>	<b>Na</b>	<b>Mg</b>								
586	98	78	fe76 si61 al48 k21	35		3.45	11.30		Sandstone, carbonatic. Ni25:2 p. 231.	
190	170	162	fe160 al114 k88 si78	38	2.81	0.97			Essexite, aver. N11:I p. 1027.	

Ca	Na	Fe									
766	87	76	al47	mg41	k29	si23				31.31	Limestone, argillaceous. P74 F p. 384.
214	182	179	k173	mg148	al112	si71	45	2.67	0.52	Etindite. N13:12 p. 1031.	
143	132	129	al120	mg116	k108	si90	40	1.24	0.54	Mangerite, augite-biotite-. N5:4 p. 1018.	
Ca	Na	Al									
114	114	111	si104	fe98	mg90	k53	24	0.7		Tonalite, aver. TV34:1 p. 344.	

Ca	K	Mg													
295	199	110	al95	fe77	si63	na14	64	0.45	2.67	13.94	P <sub>2</sub> O <sub>5</sub> 2.83	Shale, potassic. P72 B p. 370.			
238	232	220	fe109	al100	si82	na51	33	1.15	0.49		Monzonite, leucite- (Sommaite). N13:1 p. 1030.				
(41	21	20	fe12	al8	si3							1.28	2.31	MnO 57.59	Manganese-ore, hausmannite. Ni56:6 p. 361.)
											MnO <sub>2</sub> 30.62				
Ca	K	Na													
1085	12	9	fe7	mg4	al3	si3	0.04		42.76		Limestone; cf. Ca 334 Al Fe. Ni4:2:A p. 59; 57:1 p. 429.				
Ca	K	Al													
248	100	99	fe86	mg83	si75	na42	78	0.80	4.52	8.90		Clay, calcic, yellow. Ni48:21 p. 311.			
Ca	K	Si													
430	103	67	al62	mg57	fe53	na24	0.73		3.49		16.08		Slate, marly; cf. Si 119 Mg K; K 124 Si Fe. Ni4:1:A p. 59; 50:45 p. 313.		
350	80	72	fe65	al62	mg54	na41	64	0.68	3.14	15.40		Sandstone, marly-. Ni25:3 p. 231; 48:24 p. 311.			
125	114	102	fe76	al63	mg62	na51	0.60		3.21		6.65		S Tr. Soil. from marl; cf. Ca 593 Mg K. Ni4:5:C p. 61.		

Ca	Al	Mg											
155	129	107	si83	fe80	k59	na36	0.48		6.36		5.19		Clay, carbonatic. Ni43:1 p. 284.

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others	Type of Rock and Reference
<b>Ca</b>	<b>Al</b>	<b>Fe</b>						
337	78	70	si67 k63 mg51 na13	0.56	5.41	13.67		Limestone, weathered; cf. Ca 1085 K Na. Ni4:2:B p. 59.
292	128	101	mg81 si65 k17 na4	94	4.42	10.00		Clay, carbonatic, red. Ni49:32 p. 312.
<b>Ca</b>	<b>Al</b>	<b>Na</b>						
280	193	91	si83 fe37 mg28 k14	36	0.14	0.55		Anorthosite, localized. N7:V p. 1020.
207	161	144	si87 mg81 fe72 k42	21	0.50	0.60		Kenningite, aver. of 2, recal. TV32:6 p. 325.
202	150	127	fe90 si89 mg73 k40	23	0.72	0.41		Anorthosite, gabbroic; aver. of 7. TV 32:2 p. 325.
199	170	153	si91 fe38 mg34 k34	43	0.67	0.55		Anorthosite, aver. of 4. TV32:1 p. 325.
197	160	139	si89 fe66 mg63 k27	23	0.77	0.69		Anorthosite, gabbroic. TV32:5 p. 325.
193	172	155	si91 fe38 k35 mg28	37	0.52	0.63		Anorthosite, in massifs. N7:IV p. 1020.
<b>Ca</b>	<b>Al</b>	<b>K</b>						
242	88	77	si76 mg71 fe65 na16	0.52	4.16	10.38	C org. + S 3.47	Slate, marly. Ni50:43 p. 313.
208	115	100	si55 fe33 mg33 na33		1.7	9.24	S 2.31, C 9.06	Shale, copperbear. P70 F p. 362.
<b>Ca</b>	<b>Si</b>	<b>Mg</b>						
730	45	41	fe36 na21 al9 k8	53	0.17	0.90	30.30 C 5.10	Limestone, crinoidal, sandy, w. glauconite. Ni26:3 p. 232; 57:3 p. 429.
730	44	17	fe11 al6 naTr. kTr.			2.26	25.84	Loess (Adobe). Ni27:5 p. 233.
688	58	44	fe15 k11 na4 al1		0.13	1.15	26.83	Limestone, siliceous. Ni57:7 p. 429.
660	54	49	al20 fe16 k5 na3		0.15	1.25	27.26	Limestone, cf. Ca 166 Si K; Si 126 Al Fe. Ni4:4:A p. 60.
340	94	46	fe40 k35 al33 na16	13	0.28	1.53	13.96	Marl, radiolaritic. Ni57:7 p. 367.
258	118	63	fe5 al3 na2 k2	10	0.03	0.32	12.04	Chert, calcareous, nodular. P82 E p. 435.

222	113	18	fe7 al4					9.06		Marl, diatomaceous. Ni57:10 p. 367.
196	99	77	al76 k72 fe64 na60	60	0.60	0.96	7.41			Loess. P73 D p. 378.
<b>Ca</b>	<b>Si</b>	<b>Fe</b>								
532	80	29	na15 k15 mg8 al2	47	0.10	0.45	20.98			Limestone, crinoidal, sandy. Ni57:4 p. 429.
420	103	4	na3 k3 al2 mg0				16.1			Sandstone, crystalline. P49 G p. 298.
365	103	29	k20 na17 al10 mg4	38		0.66	14.31			Sandstone, crinoidal, w. glauconite. Ni26:2 p. 232; 57:5 p. 429.
139	103	90	al86 mg78 na72 k47	39	Tr.	3.10	5.05			Sandstone, arkosic. Ni24:5 p. 230.
<b>Ca</b>	<b>Si</b>	<b>Na</b>								
327	80	76	mg74 al74 fe46 k39	46	0.24	1.78	12.73			Sandstone, arkosic Ni24:7 p. 230
278	103	53	k45 al45 fe33 mg21		0.28		11.45		CO <sub>2</sub> +H <sub>2</sub> O±	Sand, carbonatic-. Ni22:7 p. 228.
241	102	88	k55 al52 mg42 fe27	46	0.51	0.84	10.23			Sandstone, flysch-. Ni25:4 p. 231.
202	108	70	al64 k47 fe45 mg13	59		0.8	6.9			Sandstone, calcareous. P54 C p. 319.
112	108	104	al93 fe56 k47 mg41	22	0.46	2.30	2.83			Graywacke. P51 G p. 306.
<b>Ca</b>	<b>Si</b>	<b>K</b>								
339	86	63	na44 fe41 al38 mg32		0.32	2.25	13.34			Sandstone; cf. Ca 235 Si K; Si 106 Fe Ca. Ni4:6:A p. 61; 25:5 p. 231.
235	96	67	fe58 al58 na51 mg44		0.49	2.32	8.17			Sandstone, weathered; cf. Ca 339 Si K. Ni4:6:B p. 61.
166	101	85	al84 fe69 mg28 na26	70	0.65	1.96	6.38			Soil, from limestone; cf. Ca 660 Si Mg. Ni4:4:B p. 60.
138	114	68	mg53 al48 na38 fe37	80	0.79	1.29	6.25			Loess. Ni27:2 p. 233.

### Na-groups

<b>Na</b>	<b>Mg</b>	<b>Fe</b>								
124	113	103	si102 al89 k72 ca71	28	0.62	2.33	3.04			Graywacke. P51 D p. 306.
<b>Na</b>	<b>Fe</b>	<b>Mg</b>								
187	154	132	ca109 si89 al83 k38	27	2.23	3.19	1.59			Sandstone, immature. Ni26:6 p. 232.

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>			Others	Type of Rock and Reference		
<b>Na</b>	<b>Fe</b>	<b>Ca</b>										
256	181	140	k117	mg112	al107	si79	52	1.66	1.36	0.22	Malignite, aver. N10:II p. 1024.	
244	184	169	mg127	k120	al117	si75	33	1.77	0.85		Malignite w. pyroxene & Na-amphibol. N10A:10 p. 1025.	
207	137	122	al121	k110	mg100	si82	47	1.84	1.75	Trace	Basanite, zeolithic-. TV3:6 p. 168.	
188	170	134	al109	mg106	si87	k71	27	3.02	0.29		Mugearite. TV18:7 p. 220.	
180	176	166	mg148	al116	k86	si79	44	3.31			Camptonite, aver.: calc. free of H <sub>2</sub> O and CO <sub>2</sub> . TV23:4 p. 253.	
<b>Na</b>	<b>Fe</b>	<b>K</b>										
353	177	103	al102	si88	ca51	mg19	83	1.13	2.15		Malignite, w. aegirine. N10A:9 p. 1025.	
<b>Na</b>	<b>Fe</b>	<b>Al</b>										
293	175	119	si95	ca46	mg31	k13	57	0.89	0.71	0.91	Keratophyre, magnetite-. TV25:8 p. 262.	
257	127	109	si100	ca42	mg20	k15	65	0.5			Syenitic segregation. TV7:5 p. 178.	
218	134	119	ca91	si89	k73	mg54	38	1.82	2.84		Monzonite. TV8:2 p. 179.	
208	154	119	ca99	k91	si90	mg63	42	1.81	0.24		Mugearite. TV8:6 p. 179.	
190	135	118	ca109	k93	si92	mg73	39	1.55	0.58		Mangerite, alk., volc. equi. of Aker type. N5:7 p. 1018.	
189	162	110	ca101	k92	si90	mg82	30	1.89	0.68		Mugearite. N5:8 p. 1018.	
182	128	123	k107	ca105	si87	mg78	33	1.27	1.06	0.03	S 0.05	Trachy basalt-, hornblende. TV4:2 p. 171.
173	121	118	ca105	k104	si94	mg65	38	1.44	0.61		Mangerite, alkali; Aker type. N5:5 p. 1018.	
<b>Na</b>	<b>Fe</b>	<b>Si</b>										
285	145	108	al94	mg33	ca3	k0	100	0.71	0.39		Radiolarite, red. Ni57:6 p. 367.	
190	189	103	al84	ca81	mg26	k19	36	1.46	0.83		Granophyre, in diabase. TV17:3 p. 216.	
154	151	110	al85	k75	ca53	mg18	27	1.03	0.84		Granophyre, in diabase. TV17:4 p. 216.	

<b>Na</b>	<b>Ca</b>	<b>Fe</b>									
318	228	137	al123 mg107 k85 si71	49	1.41	0.55	0.38	P <sub>2</sub> O <sub>5</sub> 1.52		Ijolite, aver. N12:II p. 1028.	
290	201	149	al137 mg119 k99 si68	43	2.44	0.98	0.40			Ijolite w. Ti-augite. N12:IV p. 1028.	
208	190	172	al118 mg117 si72 k70	23	2.04	2.89	Trace	S 0.07		Theralite, olivine. TV3:4 p. 168.	
204	175	164	mg161 k144 al98 si78	53	2.11	1.09	0.15			Malignite w. pyroxene & biotite. N10A:11 p. 1025.	
185	149	138	k138 al126 mg105 si82	23	1.30	0.60	0.25			Essexite, andesine-. TV35:1 p. 391.	
178	173	171	mg168 al110 k88 si79	44	2.53	0.87				Ordanchite, aver. N11:III p. 1027.	
133	116	115	al105 si96 k88 mg68	57	0.87	3.48	0.52			Sandstone, immature. Ni26:7 p. 232.	
<b>Na</b>	<b>Ca</b>	<b>Al</b>									
180	174	168	si91 fe54 mg33 k23	34	1.3					Anorthosite, aver. of 2. TV32:7 p. 325.	
139	125	119	mg117 si102 fe92 k44	37	0.54	0.26				Andesite, hypersthene-. TV28:5 p. 285.	
116	101	98	si97 fe69 mg63 k47		1.12			S 8.25		Diorite, weathered; cf. K 109, Na Al. Ni3:6:B p. 55.	
<b>Na</b>	<b>Ca</b>	<b>Si</b>									
113	107	107	al106 fe88 mg82 k48	28	0.62	0.80				Tonalite, hornblende-biotite-. N2:11 p. 1015.	
<b>Na</b>	<b>K</b>	<b>Fe</b>									
223	155	138	si103 al98 ca37 mg23	57	0.66	0.58				Syenite, peralkaline, -aver. N3:VI p. 1016.	
194	192	167	al106 si94 ca30 mg7	65						Phonolite, nepheline-rich cossyrite-. TV:4 p. 171.	
194	142	116	al104 si94 ca83 mg58	47	1.16	2.06	0.97			Syenite, analcite-. TV22:4 p. 245.	
181	149	121	si114 al82 ca32 mg11	66	0.68	0.48				Granite, laneite-aegirine-. N1:13 p. 1013.	
148	138	135	si119 al66 ca13 mg11	66	0.36	0.42				Granite, riebeckite-aegirine-. N1:10 p. 1013.	
<b>Na</b>	<b>K</b>	<b>Al</b>									
333	163	143	si93 fe67 ca28 mg11	68	0.37	1.03				Nepheline syenite w. aegirine-augite or aegirine. N10A:1 p. 1025.	
305	175	142	si92 fe76 ca39 mg17	54	0.68	0.87	0.11			Nepheline syenite. Foya type. N10:2 p. 1024.	

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others	Type of Rock and Reference
<b>Na</b>	<b>K</b>	<b>Al</b>	<b>(Continued)</b>					
295	162	138	si95 fe76 ca30 mg24	55	1.13	0.77		Nepheline syenite w. aegir-augite or aeg. and Na-amphib. N10A:2 p. 1025.
290	181	134	si95 fe68 ca38 mg19	55	0.59	0.96		Phonolite, aver. N10:III p. 1024.
289	173	152	si96 fe49 ca19 mg11	22	0.49	0.67	0.31	Nepheline syenite w. biotite. N10A:8 p. 1025.
281	191	141	si92 fe75 ca49 mg14	51	0.79	0.91		Nepheline syenite w. Na-amphibole. N10A:4 p. 1025.
275	168	116	si104 fe72 ca17 mg13	38	0.37	0.39	0.02	Trachyte. TV18:8 p. 220.
270	202	148	si83 fe80 ca77 mg23	53	0.80	1.27	1.88	Foyaite. TV35:3 p. 391.
269	212	143	si91 fe79 ca48 mg18	65	0.82	0.64	0.14	Nepheline syenite w. aegirine augite or aegirine and biotite. N10A:5 p. 1025.
264	191	127	fe90 si90 ca68 mg62	46	0.97	1.24	0.18	Nepheline syenite w. diopsidic augite & biotite. N10A:6 p. 1025.
260	162	126	fe93 si93 ca74 mg56	58	1.34			Phonolite, aver. TV10:4 p. 187.
256	218	144	si90 fe60 ca42 mg4	52	0.40	2.38	Trace	Phonolite, sanidine-. TV13:5 p. 190.
250	178	132	si90 fe75 ca74 mg29	47	1.12	2.09	0.87	Nepheline syenite w. Ti-augite + Na amph. N10A:3 p. 1025.
250	164	118	si101 fe90 ca38 mg6	46	0.42	0.94		Phonolite, aver. of 4. TV11:4 p. 188.
247	146	135	si98 fe84 ca27 mg11	72	0.53	3.29		Syenite. TV8:3 p. 179.
241	170	122	si110 mg23 ca19 fe18					Trachyte, anorthoclase-. TV4:5 p. 171.
235	131	127	fe125 ca115 si81 mg68	32	2.43		Cl 0.16 SO <sub>3</sub> 0.4	Trachyandesite, feldspathoidal; aver. tahitite. TV10:3 p. 187.
233	180	125	si103 fe59 ca32 mg31	57	0.87	0.82		Trachyte, phonolitic-; aver. TV11:5 p. 188; TV10:5 p. 187.
230	193	115	si103 fe82 ca32 mg15	64	0.52	0.58		Trachyte, peralkaline-; aver. N3:VII p. 1016.
226	202	121	fe114 si97 ca45 mg17	48	0.49	0.30	0.17	Tinguaitite. TV35:4 p. 391.

225	168	130	si99 fe59 ca49 mg8	41	1.80	0.82	Trace	P <sub>2</sub> O <sub>5</sub> 1.05	Nordmarkite. TV35:6 p. 391.
218	185	120	si103 fe63 ca38 mg21	61	0.73	0.54			Trachyte, alkali-; aver. N3:V p. 1016.
218	146	128	ca107 fe102 si88 mg67	52	1.43	1.12			Latite, nepheline-; aver. N10:V p. 1024.
215	132	125	si96 fe85 ca74 mg49	31	1.15	0.64	0.10		Larvikite. TV34:9 p. 344.
199	192	129	si99 fe66 ca51 mg37	42	0.70	0.84	0.28		Pulaskite. TV35:2 p. 391.
194	190	114	si107 fe52 ca30 mg11	60	0.70	0.20			Nordmarkite. TV34:8 p. 344.
193	134	119	fe108 si95 ca88 mg51	36	1.67	0.43			Larvikite. N4:5 p. 1017.
193	132	120	si96 fe80 ca79 mg28	46	1.55	1.02	0.43	S 0.02	Trachyandesite, augite-. TV4:3 p. 171.
179	125	121	fe116 si94 ca53 mg40	52	1.24	1.79			Trachyte. TV8:7 p. 179.
<b>Na</b>	<b>K</b>	<b>Si</b>							
243	154	106	al102 fe94 ca30 mg12	73	0.66	0.53			Syenite, aegirine-. N3:5 p. 1016.
188	131	119	al93 fe53 ca13 mg11	60	0.39	0.34			Granite, arfvedsonite-aegirine-. N1:12 p. 1013.
178	138	118	fe116 al73 ca18 mg7	87	0.41	0.29			Granite, aegirine-. N1:11 p. 1013.
172	147	121	fe89 al73 ca14 mg5	55	0.42	0.45			Rhyolite + obsidian, aver. peralkaline. N1:VI p. 1013.
168	131	121	al93 fe40 ca26 mg10	25	0.25	0.05			Rhyolite, obsidian. TV28:9 p. 285.
141	129	125	al88 fe36 ca14 mg5	72	0.31	0.28			Granophyre, acid-. TV30:7 p. 293.
141	117	106	al105 fe50 mg44 ca28		0.65			S 5.74	Syenite, weathered; cf K 148 Na Al. Ni3:3B p. 54.
137	120	118	al104 fe46 ca38 mg22	23	0.30	0.52			Granodiorite, muscovite-biotite-. N2:5 p. 1014.
133	118	118	al98 fe54 ca51 mg18	47	0.50	0.20			Gneiss. Ni3:1:A p. 54.

<b>Na</b>	<b>Al</b>	<b>Fe</b>							
597	149	138	si73 k53 ca19 mg17	76	0.10	1.19			Tawite, aver. N12:X p. 1029.
<b>Na</b>	<b>Al</b>	<b>K</b>							
471	183	127	ca88 fe73 si71 mg23	57	0.35	0.42	1.30		Urtite, aver. N12:I p. 1028.
355	150	138	si91 fe84 ca39 mg Tr	31	0.39	0.18	0.06		Nepheline-syenite. TV35:5 p. 391.
325	141	129	si93 fe86 ca34 mg20	48	0.43	1.02	0.23		Nepheline syenite, Litchfield type. N10:3 p. 1024.

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others	Type of Rock and Reference
<b>Na</b>	<b>Al</b>	<b>K</b>	<b>(Continued)</b>					
289	144	130	fe109 ci90 ca52 mg22	39	0.49	1.20	0.41	Nepheline syenite w. Na-amphibole & biotite. N10A:7 p. 1025.
212	133	132	ca120 fe112 si84 mg72	41	2.49	1.37		Monzonite, nepheline-; aver. N10:IV p. 1024.
<b>Na</b>	<b>Al</b>	<b>Si</b>						
385	142	94	fe80 k74 ca30 mg11	70	0.43	0.77	0.24	Nepheline syenite, Mariupol type. N10:4 p. 1024.
254	119	102	fe90 ca40 k17 mg7	46	0.4			Phonolite, aver. of 5. TV7:6 p. 178.
155	126	108	ca103 fe63 k52 mg30		0.57	0.31		Gneiss. Ni6:A p. 70.
151	124	105	mg89 fe81 ca22 k18	44	0.99	2.69		Shale, carbonaceous. P70 E p. 362.
135	122	105	ca105 fe78 mg77 k39	29	0.54	0.10		Andesite, pyroxene-. TV28:6 p. 285.
112	106	104	fe98 ca95 mg94 k88	27	1.32	0.42		Granodiorite, hypersthene-bear. N2:8 p. 1014.
<b>Na</b>	<b>Si</b>	<b>Mg</b>						
144	114	110	al93 fe77 k59 ca16	60	0.08	2.38	0.52	Graywacke. P51 M p. 306.
<b>Na</b>	<b>Si</b>	<b>Fe</b>						
124	110	102	al90 k67 mg63 ca61	26	0.55	3.13		Graywacke, aver. of 2. TV26:6 p. 271.
118	107	106	ca105 al104 mg85 k41	27	1.03	0.33		Tonalite, hypersthene bear.-. N2:12 p. 1015.
<b>Na</b>	<b>Si</b>	<b>K</b>						
123	115	105	al103 ca60 fe52 mg38	36	0.45	0.70		Granodiorite, biotite-. N2:6 p. 1014.
<b>Na</b>	<b>Si</b>	<b>Al</b>						
213	125	89	fe33 k28 ca8 mg6	82	0.10	1.07	0.10	Keratophyre, quartz-. TV25:7 p. 262.
200	116	112	ca67 k46 mg36 fe26	17	0.23	0.50	0.15	Trondhjemite. TV34:4 p. 344.
171	125	86	k80 fe34 mg10 ca6	34	0.22	0.95	0.03	Keratophyre, quartz-. TV25:6 p. 262.
164	118	104	ca56 k56 fe38 mg28	38	0.37	0.62		Tonalite, muscovite-biotite-. N2:9 p. 1015.
156	116	99	fe71 ca61 k50 mg31	28	0.48	0.64		Tonalite, biotite-. N2:10 p. 1015.

156	112	102	ca89 fe84 mg40 k31	23	0.72	0.14		Andesite, augite-hypersthene, pigeonitic ser. TV27:4 p. 281.
151	114	104	k75 ca61 fe58 mg38	37	0.49	0.54		Dacite. TV28:8 p. 285.
140	116	90	mg67 fe64 k57 ca39	20	0.40	2.08	0.23	Graywacke. P51 E p. 306.
138	111	102	k100 ca74 fe73 mg52	49	0.66	0.68		Rhyodacite + -obsidian, aver. N2:IV p. 1014.
130	113	109	k107 ca67 fe58 mg42	8	0.30	0.22		Dacite, porphyritic. TV28:7 p. 285.
128	109	104	k100 ca82 fe73 mg62	37	0.61	0.69		Granodiorite, hornblende-biotite-. N2:7 p. 1014.
120	119	98	ca70 k68 fe55 mg43	34	0.36	0.27		Dacite, olivine-pyroxene-hornbl. TV27:6 p. 281.

### K-groups

<b>K</b>	<b>Mg</b>	<b>Fe</b>						
301	238	125	ca117 si85 al57 na19	82	4.89	1.99		Cedricite. TV21:2 p. 242.
<b>K</b>	<b>Mg</b>	<b>Ca</b>						
327	326	120	fe87 si84 al75 na46	76	2.27	1.72	P <sub>2</sub> O <sub>5</sub> 1.89 BaO 1.23	Wyomingite. TV21:4 p. 242.
<b>K</b>	<b>Mg</b>	<b>Si</b>						
123	108	108	fe92 al86 na67 ca23		0.72	3.36	1.15	Marl, weathered. Ni4:5:B p. 61.
<b>K</b>	<b>Fe</b>	<b>Na</b>						
154	122	116	ca111 al104 si98 mg84	45	1.40	0.43		Monzonite, hornblende-biotite-. N4:1 p. 1017.
<b>K</b>	<b>Fe</b>	<b>Al</b>						
182	133	129	si94 na88 mg83 ca35	21	1.14	1.66		Gneiss, biotite-, cf. Fe 126 Al K. Ni3:2:A p. 54.
120	116	110	si100 mg77 na34 ca28	58	0.76	3.82	1.46	Shale, aver. of 51. Ni50:38 p. 313.
<b>K</b>	<b>Ca</b>	<b>Mg</b>						
290	217	172	fe139 al112 na80 si77	48	0.73	0.61		Leucitite, melilite-. N13:14 p. 1031.
225	168	148	al123 fe118 na81 si84	30	1.32	0.57		Ordanchite, leucite-. N13:5 p. 1030.
224	220	175	fe151 al105 si79 na67	50	1.25	0.87		Leucitite. N13:10 p. 1031.

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>			Others	Type of Rock and Reference	
<b>K</b>	<b>Ca</b>	<b>Fe</b>									
238	195	129	al122	na115	mg88	si82	60	1.08	0.58	Tephrite, leucite-. Vesuvite. TV20:4 p. 238.	
235	211	195	na191	mg131	al114	si66	49	2.38	0.39	0.36	Nephelinite, melilite-leucite-. TV20:11 p. 238.
160	132	129	mg124	na117	al112	si91	39	0.84	0.82		Monzonite, pyroxene, hornblende, biotite. N4:4 p. 1017.
148	135	130	mg129	al115	na111	si91	49	1.18	0.78		Latite, aver. N4:II p. 1017.
<b>K</b>	<b>Ca</b>	<b>Al</b>									
234	157	128	fe117	na110	mg93	si85	50	0.87	0.61		Latite, leucite-; (incl. vicoite, campanite) N13:4 p. 1030.
<b>K</b>	<b>Na</b>	<b>Fe</b>									
215	178	145	ca143	al114	mg96	si79	40	2.54	0.37	0.02	Basalt, leucite-. Mikenite. TV20:3 p. 238.
<b>K</b>	<b>Na</b>	<b>Al</b>									
308	199	143	si89	fe69	ca58	mg24	62	0.83	0.79	0.26	Nepheline syenite, Juvet type. N10:1 p. 1024.
285	242	129	si90	fe70	ca38	mg-	74	0.29	3.43		Phonolite. Ni7:1 p. 71.
264	205	128	si89	fe70	ca35	mg4	76	0.29	5.26		Phonolite. Ni7:3 p. 71.
262	152	118	fe99	si98	ca42	mg22	41	0.58	1.80		Trachyte. TV20:8 p. 238.
262	144	124	fe113	ca85	si84	mg72	52	0.79	3.43	S 0.04	Syenite, aegirine-. TV22:3 p. 245.
246	128	120	si97	ca85	fe76	mg69	55	0.66	0.53		Trachyte, calc-alkali, aver. N3:III p. 1016.
199	187	116	si103	fe82	ca48	mg25	37	0.59	0.59		Syenite, ferrohastingsite-. N3:1 p. 1016.
197	182	113	si103	fe83	ca51	mg38	47	0.58	0.53		Syenite, alkali-; aver. N3:IV p. 1016.
189	176	110	si104	fe92	ca38	mg2	33	0.42	1.01		Trachyte. TV13:4 p. 190.
177	157	112	si109	fe67	ca34	mg13	32	0.7	0.7		Syenite, quartz-. TV33:7 p. 337.
174	131	112	si108	fe102	ca34	mg7	81	0.25	0.30		Trachyte. TV33:8 p. 337.
167	150	107	si105	fe97	ca66	mg33	46	0.8			Syenite, quartz-. TV34:7 p. 344.
148	140	124	si108	fe59	ca41	mg30	34	0.61	0.46		Syenite; cf. Na 141 K Si. Ni3:3:A p. 54.

109	107	107	si102 fe97 mg92 ca86	43	1.08	1.38	0.62		Diorite; cf. Na 116 Ca Al. Ni3:6:A p. 55.
<b>K</b>	<b>Na</b>	<b>Si</b>							
183	127	123	al85 fe45 ca14 mgNil	48	N.d.	0.4			Porphyry, quartz-. TV33:6 p. 337.
180	119	118	al94 fe55 ca33 mg16	27	0.40	0.50			Granite, biotite-hornblende-. N1:3 p. 1012.
173	140	117	al96 fe59 ca24 mg7	31	0.34	0.37			Granite, ferrohastingsitic-. N1:8 p. 1012.
167	133	121	al91 fe33 ca22 mg7	35	0.4	0.6			Granite, biotite-. TV33:5 p. 337.
163	141	121	al87 fe45 ca21 mg5	61	0.32	0.42			Granite. TV33:3 p. 337.
158	138	124	al84 fe39 ca12 mg4	55	0.17	0.66			Rhyolite & obsidian, aver. alk. N1:IV p. 1012.
155	141	125	al91 fe20 ca12 mgTrace	55	0.15	0.33			Rhyolite. TV33:4 p. 337.
155	118	110	al101 fe74 ca67 mg46	39	0.81	0.52			Adamellite, hornblende-biotite. N2:3 p. 1014.
150	141	122	fe100 al71 ca12 mg3	51	0.24	0.37			Granite, riebeckite-. N1:9 p. 1013.
150	122	117	al96 fe54 ca43 mg21	52	0.42	0.68			Dellenite & -obsidian, aver. N2:II p. 1014.
150	121	121	al92 fe51 ca45 mg4		0.12	0.53	Tr.		Granite; cf. K 160 Si Fe. Ni3:11:A p. 58.
145	134	123	al94 fe31 ca27 mg12	23	0.31	0.12			Rhyolite, obsidian-. TV28:10 p. 285.
140	126	122	al71 fe33 ca15 mg5	48	0.16	4.52			Pitchstone. TV33:2 p. 337.
128	125	116	al96 fe53 ca48 mg18	68	0.46	1.01			Gneiss, weathered; cf Na 133 Si K. Ni3:1:B p. 54.

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<b>K</b>	<b>Al</b>	<b>Fe</b>							
278	133	108	si88 mg54 na20 ca0	64	0.63	3.73		P <sub>2</sub> O <sub>5</sub> 3.95	Shale, potassic, minus carbonate. P72 C p. 370.
<b>K</b>	<b>Al</b>	<b>Si</b>							
620	149	87	na49 ca36 fe28 mg3	73	0.63	0.43			Italite. N13:7 p. 1030.
363	128	94	fe73 mg55 na6 ca2		0.64	2.04		SO <sub>3</sub> 0.72	Shale, potassic. P72 A p. 370.
332	118	116	na14 fe7 ca2 mgTrace			1.45			Sand, feldspar-. Ni22:4 p. 228.
166	102	102	na100 fe99 ca89 mg82	23	1.75	0.29			Trachyandesite. TV20:9 p. 238.
134	114	98	fe96 mg87 na54 ca18	91	1.04	4.48			Clay, red. Ni48:17 p. 311.
128	126	106	fe51 na38 mg12 ca0	76	0.67	7.30			Latoritic weathering, gneiss; cf. Fe 136 Al Si. Ni6:2 p. 70.
120	113	111	na68 fe65 mg32 ca21	78	0.80	3.03			Clay, glacial. Ni45:4 p. 309.

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others		Type of Rock and Reference		
<b>K</b>	<b>Si</b>	<b>Fe</b>									
160	119	79	na77	al75	ca20	mg13	0.08	2.27	0.06	Gravel from granite; cf. K 150 Na Si. Ni3:11:B p. 58.	
159	135	70	al50	na21	mg1	ca1	69	0.40	1.11	Sparagmite. P 56 E p. 324.	
124	116	75	al67	mg48	na30	ca21	0.72	4.10	2.60	S Tr. Marl, flysch-, weathered; cf. Ca 430 K Si. Ni4:1:C p. 59.	
<b>K</b>	<b>Si</b>	<b>Na</b>									
206	122	78	al75	fe71	ca31	mg8	83		0.30	0.92	Arkose. P56 D p. 324.
186	118	112	al87	fe64	ca27	mg17	48	0.41	0.37		Granite, hornblende-. TV34:5 p. 344.
184	122	99	al89	fe32	ca23	mg17	45	0.30	0.50		Granite, biotite-. N1:2 p. 1012.
183	119	99	al97	fe36	ca26	mg18	26	0.31	0.69		Granite, muscovite-biotite-. N1:1 p. 1012.
181	117	110	al88	ca62	fe41	mg0			1.01		Arkose. P56 A p. 324.
178	123	100	al90	fe33	ca33	mg11	64	0.22	0.78		Rhyolite & obsidian, aver. calc-alk. N1:II p. 1012.
174	123	120	al95	fe18	ca14	mg7	31	0.16	0.60		Granite, muscovite-. N1:5 p. 1012.
172	124	102	al91	fe23	mg11	ca11	37	0.14	0.63		Granite, muscovite-biotite, alkali-. N1:6 p. 1012.
168	119	102	al84	fe74	ca35	mg13	20	0.96	0.33		Granite, hypersthene-bearing. N1:4 p. 1012.
167	125	116	al88	fe30	ca11	mg8	52	0.17	0.37		Granite, biotite-, alkali-. N1:7 p. 1012.
157	126	122	al79	fe42	mg10	ca4	49	0.26	0.14	0.06	Alaskite, hornblende-. TV34:6 p. 344.
156	118	111	al96	fe48	ca38	mg25	33	0.39	0.50		Adamellite, biotite-. N2:2 p. 1014.
155	120	106	al98	fe37	ca30	mg22	28	0.30	0.66		Adamellite, muscovite-biotite-. N2:1 p. 1012.
143	127	102	al79	fe31	ca22	mg10	32	0.19	0.22		Granite, leuco-. TV34:3 p. 344.
142	126	115	al79	fe37	ca18	mg5	54	0.28	0.40	0.09	Granite. TV33:1 p. 337.
137	115	100	al89	fe78	ca61	mg34	31	0.76	0.38		Adamellite, hypersthene-bearing. N2:4 p. 1014.

129	111	94	al89 fe75 mg62 ca24	0.54	4.23				Gneiss, sericite-biotite-, weathered; cf. Mg 121 K Fe. Ni3:5:B p. 55.
120	118	87	al77 ca66 mg42 fe33	0.31	0.95	2.80			Sandstone, marly. Ni25:6 p. 231.
<b>K</b>	<b>Si</b>	<b>Al</b>							
176	137	65	fe20 na17 mg6 ca3		0.64	0.19			Arkose. P56 B p. 324.
161	123	93	na92 mg24 fe24 ca18	0.62	0.74				Granite; cf. Al 132 Si Fe. Ni3:7:A p. 56.
140	111	81	na80 ca52 fe41 mg17	39	0.18	5.75		S 0.4	Glass, resid. in tholeiitic diabase-. TV17:1 p. 216.
114	110	97	fe78 mg77 na68 ca20	76	0.76	3.42	0.25		Clay, red. Ni48:16 p. 311.
103	101	78	mg63 ca29 na20 fe6		0.62	3.77	1.65	S 1.7, C 9.20	Shale, carbonaceous. P70 B p. 362.

### Al-groups

<b>Al</b>	<b>Mg</b>	<b>Fe</b>							
158	157	116	si79 k66 ca64 na34	82		5.44	0.50		Clay, green. Ni49:30 p. 312.
<b>Al</b>	<b>Fe</b>	<b>Ca</b>							
365	229	7	si6		0.38			Rest (water) 26.82	Laterite. Ni5:1 p. 68.
<b>Al</b>	<b>Fe</b>	<b>K</b>							
341	185	41	na26 si11 ca7	93	0.50	26.82		ZrO <sub>2</sub> 1.16	Laterite. cf. K 285 Na Al. Ni7:2 p. 71.
324	139	21	na19 si7 mg- ca-	96	0.61	27.69		ZrO <sub>2</sub> 1.19	Laterite. cf. K 264 Na Al. Ni7:4 p. 71.
145	117	110	mg96 si86 na38 ca19	72	1.12	8.03	0.81	S 1.76	Clay. Ni43:8 p. 284.
<b>Al</b>	<b>Fe</b>	<b>Si</b>							
207	145	68	ca20 na13 k10 mg-		7.3	11.0			Clay, residual fr. basalt. P69 A p. 356.
189	121	88	mg6 ca5 na- k-		0.54	10.76			Lateritic weathering; cf. Na 155 Al Si. Ni6:E p. 70.
186	126	83	k43 na26 mg9 ca6	100	1.98	10.17			Clay, (bole) Ni8:3 p. 75.
174	104	92	mg11 k5 ca3 na2	60	1.03	9.75	0.36		Clay, residual fr. gneiss. P69 C p. 356.
172	133	78	k5 na3 ca- mg-	89	0.83	17.80			Lateritic weathering; cf. Fe 136 Al Si. Ni6:5 p. 70.

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others		Type of Rock and Reference
<b>Al</b>	<b>Fe</b>	<b>Si</b>	<b>(Continued)</b>						
168	98	98	ca13	mg5	na-	k-	0.77	9.20	Lateritic weathering; cf. Na 155 Al Si. Ni6:D p. 70.
155	98	87	k77	na74	ca69	mg12	56	0.96 8.34 0.81	Clay, red (Deep sea mud) Ni42:5 p. 283; 47:12 p. 310.
148	138	92	k77	mg48	na6	ca3		tr. 7.76	Clay, residual, fr. dolomite. P69 B p. 356.
129	110	106	na91	ca64	k45	mg28	46	2.29	Graywacke. P51 B p. 306.
<b>Al</b>	<b>Ca</b>	<b>Si</b>							
122	118	89	mg87	fe80	na73	k57	50	0.84 3.14 1.00	Graywacke. P51 K p. 306.
<b>Al</b>	<b>K</b>	<b>Mg</b>							
146	110	96	si86	fe84	na38	ca19		1.12 8.03 0.81	FeS <sub>2</sub> 3.30 Clay. Ni49:36 p. 312.
<b>Al</b>	<b>K</b>	<b>Fe</b>							
465	32	19	si16	na13	ca8	mg5		3.78 13.37	Clay, diaspore-. P69 E p. 356.
141	92	88	si86	mg73	ca56	na20		1.35 8.56 1.64	Clay. Ni50:40 p. 313.
<b>Al</b>	<b>Si</b>	<b>Fe</b>							
236	77	32	na28	ca10	k4	mg4	100	2.70 12.09	Clay (bole). Ni8:2 p. 75.
231	80	26	k20	na17	mg12	ca5		1.00 12.30	Clay P69 F p. 356.
132	113	34	k17	na13	mg4	ca-		0.85 8.52	Granite, weathered; cf. K 161 Si Al. Ni3:7:B p. 56.
126	111	91	na70	ca53	k45	mg22	47	2.13	Graywacke, aver. of 5. TV26:5 p. 271.

Al	Si	Na							
260	75	10	k8 fe6 mg3 ca1		2.44	13.62			Clay, flint-. P69 D p. 356.
121	116	100	ca75 fe38 k36 mg16		0.31	2.08			Lateritic weathering; cf. Na 155 Al Si. Ni6:B p. 70.
Al	Si	K							
192	86	32	fe25 na12 mg8 ca-	70	0.91	14.30			Lateritic weathering product; cf. Fe 136 Al Si. Ni6:3 p. 70.

### Si-groups

Si	Mg	Na							
137	74	61	fe42 ca37 k36 al36	58		0.74			Subgraywacke. P54 D p. 319.
Si	Mg	K							
119	107	93	al78 fe75 na7 ca4		0.72	3.66	0.66		Marl, flysch-, weathered; cf. Ca 430 K Si Ni4:1:B p. 59.
Si	Fe	Mg							
166	20	3	ca3 na3 al2 k1				0.03		Sandstone, orthoquartzitic. P49 H p. 298.
165	2	1	ca1 al1 na- k-	43	0.005	0.17	0.02		Flint. P 82 B p. 435.
131	82	75	ca67 k55 al22 na8		0.24	2.10	2.90		Sandstone, glauconite-. Ni26:1 p. 232.
123	51	49	al48 na40 ca34 k33	86	0.50	6.94			Shale, diatomaceous. P71 B p. 364.
Si	Fe	Ca							
166	5	3	al- mg- na- k-						Sandstone, orthoquartzitic. P49 B p. 298.
148	61	38	mg27 na19 k18 al7	54	0.02	1.05	1.05		Sandstone, glauconitic. Ni23:3 p. 229.
106	83	71	k68 al65 mg50 na49		0.59	3.60	1.22	S abund.	Soil, B-horiz, from sandstone; cf. Ca 339 Si K. Ni4:6:C p. 61.
Si	Fe	Na							
163	14	7	k7 al6 mg5 ca2						Sandstone, orthoquartzitic. P49 D p. 298.
160	25	16	mg12 k7 al6	100	0.08	0.22			Radiolarite-. Ni57:2 p. 367.

			Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others	Type of Rock and Reference	
<b>Si</b>	<b>Fe</b>	<b>K</b>							
144	75	74	al19 mg18 na8 ca2			2.61		Sand. Ni22:2 p. 228.	
139	129	47	na33 al22 mg17 ca8	100	0.40	0.85		Radiolarite. Ni57:3 p. 367.	
131	76	74	al50 mg44 na38 ca26	96		2.75	0.48	Sandstone. Ni23:5 p. 229.	
125	93	85	mg56 al52 ca44 na41	100	0.62	2.15	1.13	Radiolarite, red. Ni57:4 p. 367.	
<b>Si</b>	<b>Fe</b>	<b>Al</b>							
143	83	38	na23 k12 ca10 mg8	58		1.88		Chert. P82 H p. 435.	
141	33	28	ca25 k21 mg17 na15	74	0.35	3.11	C 0.12 (CaCO <sub>3</sub> 5.16)	Shale, cherty, minus carbonate. P71 C p. 364.	
124	78	75	k58 na54 mg43 ca23	17	0.83	2.15	0.48	Subgraywacke. P54 A p. 319.	
119	89	75	mg74 k60 na50 ca40	100	0.63	2.18	1.30	Radiolarite, red. Ni57:5 p. 367.	
116	90	75	k51 na27 ca21 mg7	100	0.81	3.75	0.35	Loess, decalcified. Ni27:4 p. 233.	
<b>Si</b>	<b>Ca</b>	<b>Mg</b>							
165	6	4	al3 fe2			0.44		Sand, glass-. Ni22:1 p. 228.	
<b>Si</b>	<b>Ca</b>	<b>Fe</b>							
166	6	2	al2 mg- na- k-			0.17		Sandstone, orthoquartzitic. P49 E p. 298.	
156	27	24	al18 mg0 na0 k0	100	0.00	0.00	1.00	Chert, bedded. P82 I p. 435.	
<b>Si</b>	<b>Ca</b>	<b>Na</b>							
120	119	75	k70 mg60 al51 fe23	87	0.23	0.78	5.93	Sandstone, arkosic. Ni24:4 p. 230.	
<b>Si</b>	<b>Ca</b>	<b>K</b>							
156	46	21	fe14 mgTr.	100	Tr.	1.29	1.01	Radiolarite. Ni57:1 p. 367.	
129	82	58	fe50 al48 mg40 na29			1.54	3.18	Loess. Ni27:3 p. 233.	
121	107	55	fe49 al47 na35 mg34			5.76		Loess. P73 E p. 378.	

<b>Si</b>	<b>Na</b>	<b>Mg</b>									
166	5	2	fe2 ca2 k2 al1			0.12					Novaculite. P82 C p. 435.
<b>Si</b>	<b>Na</b>	<b>Fe</b>									
123	116	97	al69 mg54 k33 ca19	67		2.60					Sandstone. Ni23:6 p. 229.
122	119	78	al68 mg48 k46 ca30	12	0.15	2.36	0.84				Graywacke. P51 I p. 306.
115	107	101	al76 mg69 k59 ca23	23	0.60	4.13	0.0				Graywacke. P51 J p. 306.
113	104	86	k83 al76 mg48 ca39	80	0.33	1.17	2.51				Graywacke. P51 H p. 306.
<b>Si</b>	<b>Na</b>	<b>K</b>									
165	27	5	al3 fe3 mg1 ca0	42		0.17					Sandstone, orthoquartzitic. P49 C p. 298.
<b>Si</b>	<b>Na</b>	<b>Al</b>									
128	86	78	fe57 k54 mg46 ca15	16		1.87					Subgraywacke. P54 B. Ni26:5 p. 232.
119	91	88	fe65 mg60 k43 ca36	8	0.35	2.53	0.32				Graywacke. TV26:4 p. 271.
<b>Si</b>	<b>K</b>	<b>Mg</b>									
136	78	46	fe43 al42 ca20 na15		1.00	1.73	0.60	S abund.			Sandstone, glauconitic. Ni23:4 p. 229.
<b>Si</b>	<b>K</b>	<b>Fe</b>									
161	17	14	mg7 al7 na4 ca3			0.04	0.37	S 0.07			Sand. Ni23:1 p. 229.
<b>Si</b>	<b>K</b>	<b>Ca</b>									
138	87	58	mg36 fe21 na17 al12	77		4.75	2.28				Cherty rocks, aver. of. ten. P82 D p. 435.
120	111	77	na77 al71 mg49 fe26	53	0.22	1.46	2.66				Sandstone, arkosic. Ni24:3 p. 230.
<b>Si</b>	<b>K</b>	<b>Na</b>									
126	112	82	al76 fe40 ca34 mg24	33	0.42	1.06	0.51				Arkose. P56 C p. 324.
122	117	114	al94 ca42 fe40 mg13	29	0.2	0.3					Granodiorite, aver. TV34:2 p. 344.
<b>Si</b>	<b>K</b>	<b>Al</b>									
156	17	15	ca13 na12 mg8 fe8			0.72					Chert. P82 A p. 435.
137	64	60	fe49 na32 ca25 mg18			1.01					Sand, fluvialite-. Ni22:3 p. 228.
125	88	82	fe72 na35 ca32 mg2			3.21					Clay, glacial. Ni46:3 p. 309.
116	77	70	fe58 na50 mg47 ca43		0.59	1.96	1.40				Silt, mississippi-. Ni45:1 p. 308.

				Ox	TiO <sub>2</sub>	H <sub>2</sub> O <sup>+</sup>	CO <sub>2</sub>	Others	Type of Rock and Reference
<b>Si</b>	<b>Al</b>	<b>Fe</b>							
155	26	11	mg8 ca4 na0 k0	17		1.43			Sandstone, protoquartzitic. P49 F p. 298.
126	62	61	mg33 k26 ca18 na18	74	0.58	3.95	Tr.		Soil, humus-; from limestone; cf. Ca 660 Si Mg. Ni4:4:C p. 60.
<b>Si</b>	<b>Al</b>	<b>Na</b>							
159	19	5	k5 mg1 fe1 ca0			1.44			Sandstone, orthoquartzitic. P49 Ap.298.
144	27	26	fe21 mg17 k14 ca3						Silica-earth. Ni57:12 p. 367.
140	39	33	fe20 k17 mg14 ca6		0.22	5.56			Shale, siliceous. P71 A p. 364.
134	73	27	k27 fe26 mg6 ca5		0.99	4.58			Sand, quartzrich (Hupper erde); Ni8:1 p. 75.
114	111	81	k78 fe53 ca49 mg43	1	0.31	1.75	0.05		Graywacke. P51 A p. 306.
<b>Si</b>	<b>Al</b>	<b>K</b>							
155	25	20	fe15 na11 ca6 mgTr.	1					Sandstone, protoquartzitic. Ni23:2 p. 229.
124	82	61	fe56 na48 mg37 ca34	4	0.14	2.70	0.49		Loess. P73 C p. 378.

## ALPHABETHICAL LIST OF ROCKS

- Adamellite, biotite-; K156 SiNa  
 „ , hornblende-biotite-; K155 NaSi  
 „ , hypersthene-bearing; K137 SiNa  
 „ , muscovite-biotite-; K155 SiNa  
 Alaskite, hornblende-; K157 SiNa  
 Amphibolite; Ca197 MgFe  
 „ , weathered; Fe156 AlMg  
 Analcitite, olivine-; aver. Mg267 CaFe  
 Andesite; Ca135 FeMg  
 „ , alkali, aver. Mg242 FeCa  
 „ , augite-hypersthene, pigeonitic ser.; Na156 SiAl  
 „ , aver. Ca158 FeMg  
 „ , basaltic-; Mg172 CaNa  
 „ , hypersthene-; Na139 CaAl  
 „ , olivine-; hypersthenitic ser.; Ca183 MgFe  
 „ , pigeonitic ser.; Fe178 CaMg  
 „ , pyroxene-; Na135 AlSi  
 „ , tholeiitic, aver. Fe218 MgCa  
 Ankaramite, aver. Mg635 CaFe  
 Anorthosite, aver. of 4; Ca199 AlNa  
 „ , aver. of 2; Na180 CaAl  
 „ , gabbroic; Ca197 AlNa  
 „ , „ ; aver. of 7; Ca202 AlNa  
 „ , in massifs; Ca193 AlNa  
 „ , localized; Ca280 AlNa  
 Ariegite; Mg505 CaFe  
 Arkose K206 SiNa  
 „ K181 SiNa  
 „ Si126 KNa  
 „ K176 SiAl  
 Atlantite; Mg286 FeCa  
 „ ; Mg287 CaFe  
 „ , zeolitized; Mg287 CaFe  
 Basalt; Mg282 FeCa  
 „ ; Mg237 FeCa  
 „ ; Mg250 CaFe  
 „ , alkali-; olivine-rich; Mg655 FeCa  
 „ , alkaline (atlantite) w. biotite and anorthoclase; Mg286 FeCa  
 „ , alkaline (atlantite, zeolitized) Mg287 CaFe  
 „ , alkali, without olivine Ca248 MgFe  
 „ , aver. Drakensberg Mg240 CaFe  
 „ , aver. of 3; Mg235 CaFe  
 „ , aver. of 3 high Deccan; Fe229 CaMg  
 „ , aver. of 4 flows; Mg211 FeCa  
 „ , aver. of 4 low Deccan; Fe239 CaMg  
 „ , aver. of 5 flows; Mg274 FeCa

- Basalt, aver. of 6 Oregon; Fe233 CaMg  
 ,, , aver. of 8 New Jersey Mg232 FeCa  
 ,, , aver. of 10; Mg255 CaFe  
 ,, , aver. of 11 Deccan; Fe219 CaMg  
 ,, , aver. of 11 Hawaiian Mg277 CaFe  
 ,, , aver. of 14 Mg258 CaFe  
 ,, , aver. of 14 Mg201 FeCa  
 ,, , "central" Ca201 MgFe  
 ,, & dolerite, normal alkali; Mg312 CaFe  
 ,, ,, ,, , normal tholeiitic; Mg212 CaFe  
 ,, , feldspar-; Fe234 CaMg  
 ,, , feldspar-porphyrific; Ca221 MgFe  
 ,, , hypersthene-; Mg340 CaFe  
 ,, , leucite; Mg433 CaFe  
 ,, , leucite-; Mikenite; K215 NaFe  
 ,, , leucite-; Ugandite; Mg442 CaFe  
 ,, , nepheline-melilite-; Mg402 CaFe  
 ,, , oligoclase-; Fe184 CaNa  
 ,, , olivine-; Mg370 FeCa  
 ,, , olivine-; Mg364 CaFe  
 ,, , olivine-; Mg275 CaFe  
 ,, , olivine-; Mg254 CaFe  
 ,, , olivine-; Mg225 CaFe  
 ,, , olivine-; Ca206 MgFe  
 ,, , olivine, aver. of 8, waterfree; Mg290 FeCa  
 ,, , olivine, aver. of 19; Fe246 CaMg  
 ,, , olivine, aver. of 23; Mg284 FeCa  
 ,, , olivine, aver. of 27; Mg247 FeCa  
 ,, , olivine, aver. of 27; Mg250 FeCa  
 ,, , olivine-; continental Mg269 FeCa  
 ,, , olivine-; continental; Fe194 MgCa  
 ,, ,, olivine-; magma type; Mg267 FeCa  
 ,, , olivine-, pigeonitic; Ca240 FeAl  
 ,, , olivine-, tholeiitic; Mg467 FeCa  
 ,, , picrite; Mg785 FeCa  
 ,, , picrite; Mg496 CaFe  
 ,, , picritic; Mg548 FeCa  
 ,, , picritic; Mg490 CaFe  
 ,, , plateau-, aver. of 3. Mg270 FeCa  
 ,, , porphyritic, aver. of 3; Ca246 MgFe  
 ,, , tholeiitic; Fe237 CaMg  
 ,, , tholeiitic, aver. of 24; Mg338 FeCa  
 ,, , tholeiitic, magma type; Fe217 CaMg  
 ,, , trachydoleritic; Fe184 NaCa  
 ,, , weathered; Mg237 FeCa  
 ,, , weathered; Fe214 MgCa  
 ,, , weathered; Fe207 MgAl  
 ,, , weighted aver. of 5; Mg224 FeCa

- Basanite, leucite-; Murambite; Mg389 FeCa  
 „ , leucite-; Kivite; Fe202 CaMg  
 „ , nepheline-; Mg454 CaFe  
 „ , zeolitic-; Na207 FeCa  
 Basanitoid, aver. Mg278 CaFe  
 Bekinkite, aver. Ca236 MgFe  
 Camptonite; Fe220 CaNa  
 „ , aver.; calc. free of H<sub>2</sub>O and CO<sub>2</sub>; Na180 FeCa  
 Cedricite; K301 MgFe  
 Chalk; Ca1050 MgAl  
 Chert; Si143 FeAl  
 „ ; Si156 KAl  
 „ ; bedded Si156 CaFe  
 „ ; calcareous, nodular Ca258 SiMg  
 Cherty rocks, aver. of ten; Si138 KCa  
 Clay; Mg141 AlK  
 „ ; Al145 FeK  
 „ ; Al146 KMg  
 „ ; Al141 KFe  
 „ ; Al231 SiFe  
 „ , black; Fe104 AlMg  
 „ , (blue); Fe191 KAl  
 „ , (bole); Fe223 AlSi  
 „ , (bole); Al186 FeSi  
 „ , (bole); Al236 SiFe  
 „ , calcic, dark gray; Fe134 MgCa  
 „ , calcic, yellow; Ca248 KAl  
 „ , carbonatic; Ca155 AlMg  
 „ , carbonatic, red; Ca292 AlFe  
 „ , diaspore-; Al456 KFe  
 „ , flint-; Al260 SiNa  
 „ , glacial-; Ca265 MgAl  
 „ , glacial; K120 AlSi  
 „ , glacial; Si125 KAl  
 „ , glacio-limnic; Mg172 SiAl  
 „ , green; Al158 MgFe  
 „ , red; Mg226 FeAl  
 „ , red; K134 AlSi  
 „ , red; K114 SiAl  
 „ , red deep sea-; aver. Ca136 FeNa  
 „ , red deep sea; aver. Fe159 MgAl  
 „ , red (Deep sea mud) Al155 FeSi  
 „ , residual fr. basalt Al207 FeSi  
 „ , residual fr. dolomite. Al148 FeSi  
 „ , residual fr. gneiss Al174 FeSi  
 „ , with limonitic concretions; Fe210 AlSi  
 Crinanite; Mg220 FeCa  
 Dacite; Na151 SiAl  
 „ , olivine-pyroxene-hornbl.; Na120 SiAl  
 „ , porphyritic; Na130 SiAl  
 Dellenite & obsidian, aver. K150 NaSi

- Diabase, albite-; Fe188 NaMg  
 „ , analcite-olivine; Crinanite; Mg220 FeCa  
 „ , aver. Karroo; Mg232 CaFe  
 „ , aver. Whin sill; Fe206 CaMg  
 „ , dioritic affinities; Fe188 CaAl  
 „ , olivine-; Mg582 FeCa  
 „ , pyroxene-enriched; Mg305 CaFe  
 „ , quartz-; Ca194 MgFe  
 „ , tholeiitic, aver. of 4; Fe225 CaMg  
 „ , undiff. aver. Mg251 CaFe  
 „ , undifferentiated Ca226 MgFe
- Diorite; K109 NaAl  
 „ , hornblende, biotite-; Mg158 CaFe  
 „ , hornblende & hbl.-augite; Mg224 CaFe  
 „ , pyroxene-mica-; Mg229 CaFe  
 „ , weathered; Na116 CaAl
- Dolomite; Mg690 CaFe  
 „ ; Mg683 CaFe  
 „ ; Mg622 CaFe  
 „ ; Mg648 CaNa  
 „ ; Mg695 CaSi  
 „ ; cherty Mg490 CaSi  
 „ ; Ca581 MgK
- Doreite, alkali-; aver. Fe162NaMg  
 „ , aver. Ca137 FeNa
- Dunite; Mg1440 FeSi  
 „ , hortonolite; Mg735 FeSi  
 „ , ore-; Mg730 FeSi
- Essexite; Ca200 FeNa  
 „ , andesine-; Na185 CaFe  
 „ , aver. Ca190 NaMg
- Etindite Ca214 NaFe  
 „ , olivine-; Mg302 CaFe
- Flint; Si165 FeMg
- Foyaite; Na270 KAl
- Gabbro; Ca203 FeMg  
 „ , alkali, aver. Mg310 CaFe  
 „ , anorthositic; Ca246 MgAl  
 „ , ferro-, fayalite-; Fe449 CaNa  
 „ , ferro-; hortonolite-; Fe341 MgCa  
 „ , hornblende-; Ca350 FeMg  
 „ , hornblende-; Mg249 CaFe  
 „ , hornblende-; weathered; Fe256 AlCa  
 „ , hornblende-; weathered, earthy; Fe363 AlK  
 „ , hypersthene-; Norite; Mg228 CaFe  
 „ , leucite-; (Puglianite) Ca402 MgFe  
 „ , olivine-; Mg335 CaFe  
 „ , olivine-; Mg262 CaFe  
 „ , olivine-, noritic; Mg320 CaFe  
 „ , pyroxene-; Mg278 CaFe  
 „ , pyroxene-; Fe262 MgCa

Glass, resid. in tholeiitic diabase; K140 SiAl

Glenmuirite, aver. Mg180 FeCa

Gneiss; Fe136 AlSi

„ ; Na155 AlSi

„ ; Na133 KSi

„ , biotite-; K182 FeAl

„ , biotite, weathered; Fe126 AlK

„ , sericite-biotite; Mg121 KFe

„ , sericite-biotite-, weathered; K129 SiNa

„ , weathered; K128 NaSi

Granite; K163 NaSi

„ ; K150 NaSi

„ ; K142 SiNa

„ ; K161 SiAl

„ , aegirine-; Na178 KSi

„ , arfvedsonite-aegirine-; Na188 KSi

„ , biotite-; K167 NaSi

„ , biotite-; K184 SiNa

„ , biotite-, alkali-; K167 SiNa

„ , ferrohastingsitic-; K173 NaSi

„ , hornblende-; K180 NaSi

„ , hornblende-; K186 SiNa

„ , hypersthene-bear. K168 SiNa

„ , laneite-aegirine-; Na181 KFe

„ , leuco-; K143 SiNa

„ , muscovite-; K174 SiNa

„ , muscovite-biotite-; K183 SiNa

„ , muscovite-biotite, alkali-; K172 SiNa

„ , riebeckite-; K150 NaSi

„ , riebeckite-aegirine-; Na148 KFe

Granite, weathered; Al132 SiFe

Granodiorite, aver.; Si122 KNa

„ , biotite-; Na123 SiK

„ , hornblende-biotite-; Na128 SiAl

„ , hypersthene-bear. Na112 AlSi

„ , muscovite-biotite-; Na137 KSi

Granophyre, acid-; Na141 KSi

„ , hedenbergite-; Fe253 NaCa

„ , in diabase; Na190 FeSi

„ , in diabase Na154 FeSi

Gravel from granite; K160 SiFe

Graywacke; Mg117 SiAl

„ ; Fe140 MgAl

„ ; Fe112 SiAl

„ ; Ca112 SiNa

„ ; Na124 MgFe

„ ; Na144 SiMg

„ ; Na140 SiAl

„ ; Al129 FeSi

„ ; Al122 CaSi

„ ; Si122 NaFe

- Graywacke; Si115 NaFe  
 „ ; Si113 NaFe  
 „ ; Si119 NaAl  
 „ ; Si114 AlNa  
 „ ; aver. of 2; Na124 FeSi  
 „ ; aver. of 5; Al126 SiFe  
 Harzburgite; Mg1150 FeSi  
 Hornblendite; Mg410 FeCa  
 „ , olivine-; Mg560 CaFe  
 Hortonolite dunite; Mg735 FeSi  
 Hortonolite ferrogabbro; Fe341 MgCa  
 Huppererde; Si141 AlNa  
 Hypersthenite, hornblende-; Mg760 FeCa  
 Ijolite, aver.; Ca365 FeNa  
 „ , aver. Na318 CaFe  
 „ w. Ti-augite Na290 CaFe  
 Iron-Mn-ore; Fe378 CaMg  
 Iron-ore, calcitic; Ca705 FeMg  
 „ , hematitic; Fe1598 MgAl  
 „ , hematitic; Fe1554 CaSi  
 Ironstone, carbonate, cherty Fe637 MgSi  
 „ , carbonate, cherty Fe600 MgSi  
 „ , carbonate, cherty Fe592 MgSi  
 „ , greenalite-; Fe422 SiMg  
 „ , hematite-; Fe504 CaMg  
 „ , hematite, chamosite-; Fe1252 AlCa  
 „ , oolitic; Fe870 CaMg  
 „ , oolitic; Fe1040 AlMg  
 „ , oolitic; Fe800 CaMg  
 „ , oolitic; Fe614 CaAl  
 „ , oolitic grains; Fe1183 AlMg  
 „ , sideritic-chamositic mudstone; Fe645 MgCa  
 Italite; K620 AlSi  
 Katungite; Mg390 CaFe  
 Kenningite, aver. of 2, recalc.; Ca207 AlNa  
 Keratophyre, magnetite-; Na293 FeAl  
 „ , quartz-; Na213 SiAl  
 „ , quartz-; Ni171 SiAl  
 Kimberlite, basaltic; Mg1045 FeCa  
 „ , micaceous; Mg890 FeCa  
 Kivite; Fe202 CaMg  
 Lamprophyre, biotite-augite-; Mg279 CaFe  
 „ , mica-; Mg272 KCa  
 Larvikite; Na215 KAl  
 „ ; Na193 KAl  
 Laterite; Fe933 AlCa  
 „ ; Fe573 AlSi  
 „ ; Al365 FeCa  
 „ ; Al341 FeK  
 „ ; Al324 FeK

- Lateritic weathering; Fe316 AlMg  
 " " ; Fe496 AlSi  
 " " ; Fe339 AlSi  
 " " ; Fe327 AlSi  
 " " ; Al189 FeSi  
 " " ; Al172 FeSi  
 " " ; Al168 FeSi  
 " " ; Al121 SiNa  
 " " ; gneiss; K127 AlSi  
 " " product; Al192 SiK
- Latite, aver. K148 CaFe  
 " , leucite-; (incl. vicoite, campanite) K234 CaAl  
 " , nepheline-; aver. Na218 KAl
- Leucitite; K224 CaMg  
 " ; melilite-; K290 CaMg  
 " ; olivine-; Mg462 CaFe  
 " ; olivine-; Mg220 CaFe  
 " ; olivine, melilite-; Mg487 CaFe
- Limburgite; Mg363 FeCa  
 " ; Mg323 FeCa  
 " ; Mg318 CaFe
- Limestone; Ca1110 MgFe  
 " ; Ca895 MgFe  
 " ; Ca1091 MgAl  
 " ; Ca1085 KNa  
 " ; Ca660 SiMg  
 " , argillaceous; Ca766 NaFe  
 " , composite of 345; Ca852 MgK  
 " , crinoidal; Ca909 MgFe  
 " , crinoidal, sandy; Ca532 SiFe  
 " , crinoidal, sandy w. glauconite; Ca730 SiMg  
 " , dolomitic Ca911 MgSi  
 " , dolomitic; Ca740 MgSi  
 " , ferruginous; Ca721 FeMg  
 " , limnic; Ca990 FeMg  
 " , lithographic; Ca1075 MgFe  
 " , marly; Ca628 MgK  
 " , siliceous; Ca688 SiMg  
 " , weathered; Ca978 MgFe  
 " , weathered; Ca337 AlFe
- Limonitic concretions; Fe1067 AlSi
- Loess; Mg123 CaSi  
 " ; Ca179 MgSi  
 " ; Ca196 SiMg  
 " ; Ca138 SiK  
 " ; Si129 CaK  
 " ; Si121 CaK  
 " Si124 AlK  
 " (Adobe); Ca730 SiMg  
 " , decalcified; Si116 FeAl

- Malignite, aver. Na256 FeCa  
 „ , w aegirine; Na353 FeK  
 „ , w. pyroxene & biotite; Na204 CaFe  
 „ , w. pyroxene & Na-amphibolite; Na244 FeCa  
 Manganese-ore, carbonatic; Ca120 MgFe  
 „ , hausmanite; Ca41 KMg  
 Mangerite, alkali; Aker type Na173 FeAl  
 „ , alkali; Hurum type Ca196 FeMg  
 „ , alk. volc. equi. of Aker type Na190 FeAl  
 „ , alk. volc. equi. Hurum type Mg203 FeCa  
 „ , augite-biotite-; Ca143 NaFe  
 „ , hornblende-biotite-; Ca135 FeNa  
 „ , leucite-; Ca245 MgK  
 Mangerite, pyroxene-biotite-; Fe148 CaMg  
 „ , pyroxene-hornblende, biotite-; Fe150 NaCa  
 Marl; Ca596 MgK  
 „ ; Ca280 MgAl  
 „ , calcic; Ca537 MgK  
 „ , calcic-dolomitic; Ca521 MgAl  
 „ , diatomaceous; Ca222 SiMg  
 „ , dolomitic; Mg238 CaAl  
 „ , dolomitic; Ca432 MgSi  
 „ , dolomitic-calcic; Ca452 MgSi  
 „ , dolomitic-calcic; Ca410 MgSi  
 „ , dolomitic, green; Mg325 CaSi  
 „ , dolomitic, red; Mg415 CaK  
 „ , dolomitic, w. anhydrite and carbon; Mg508 CaK  
 „ , flysch-, weathered; K124 SiFe  
 „ , flysch-, weathered; Si119 MgK  
 „ , glacial; Ca236 MgK  
 „ , glauconitic; Ca417 MgFe  
 „ , radiolaritic; Mg421 CaSi  
 „ , radiolaritic; Ca340 SiMg  
 „ , weathered; K123 MgSi  
 Melilitite, olivine-; aver. Mg540 CaFe  
 Melteigite, aver. Ca332 MgFe  
 „ , w. Ti-augite Mg278 CaFe  
 Mikenite K215 NaFe  
 Minette; Mg263 KCa  
 Missourite, melanocratic; Mg444 CaK  
 „ , mesotype; Mg272 KCa  
 Monchiquite; Mg408 CaFe  
 „ , nepheline-; Mg377 CaFe  
 Monzonite; Na218 FeAl  
 „ , augite-biotite-; Mg162 KCa  
 „ , augite-biotite-olivine; Mg244 CaFe  
 „ , hornblende-biotite; K154 FeNa  
 „ , leucite-; (Sommaite) Ca238 KMg  
 „ , nepheline-; aver. Na212 AlK  
 „ , pyroxene-hornblende, biotite; K160 CaFe

- Mud, blue; aver. Fe123 AlSi  
 „ , blue and green, marine; aver. Ca144 FeNa  
 „ , fluviatile; Ca330 FeK  
 „ , green; Ca538 FeSi  
 „ , radiolaritic; Fe250 SiAl  
 „ , red coastal; Marl; Ca512 FeMg
- Mugearite; Fe222 NaCa  
 „ ; Fe221 NaCa  
 „ ; Na188 FeCa  
 „ ; Na208 FeAl  
 „ ; Na189 FeAl  
 „ , aver. Fe181 NaCa  
 „ , (basalt, oligoclase-andesine-) Fe221 NaCa
- Murambite; Mg388 FeCa  
 „ ; Mg476 CaFe
- Nepheline-syenite; Na355 AlK  
 „ „ , Foya type Na305 KAl  
 „ „ , Juvet type K308 NaAl  
 „ „ , Litchfield type Na325 AlK  
 „ „ , Mariupol type Na385 AlSi  
 „ „ w. aegirite augite/aegirine Na333 KAl  
 „ „ w. aegirine augite/aegirine and biotite Na269 KAl  
 „ „ w. aegir.-augite/aeg. and Na-amphib. Na295 KAl  
 „ „ w. biotite Na289 KAl  
 „ „ w. Na-amphibole & biotite Na289 AlK  
 „ „ w. diopsidic augite & biotite Na264 KAl  
 „ „ w. Na-amphibole Na281 KAl  
 „ „ w. Ti-augite+Na-amph. Na250 KAl
- Nepheline tephrite, aver. Mg242 CaFe
- Nephelinite, aver. Ca284 FeMg  
 „ , melilite-; aver. Ca316 MgFe  
 „ , melilite-leucite-; K235 CaFe  
 „ , olivine-; Mg290 CaFe  
 „ , olivine-; Mg284 CaFe  
 „ , olivine-; aver. Mg443 CaFe  
 „ , olivine, melilite, aver. Mg449 CaFe
- Nordmarkite; Na225 KAl  
 „ ; Na194 KAl
- Norite; Mg228 CaFe  
 „ , aver. Mg310 CaFe  
 „ , aver. of 5; Mg299 CaFe
- Novaculite; Si166 NaFe
- Ooze, globigerina-; aver. Ca460 FeAl
- Ordanchite, aver. Na178 CaFe  
 „ , leucite-; K225 CaMg
- Orendite; Mg344 KCa
- Pelitic rocks, aver; Clarke; Fe108 KAl
- Peridotite, alkali-; aver. Mg810 FeCa  
 „ , hornblende-; Mg1030 FeCa  
 „ , pyroxene-; Mg1220 FeSi

- Phonolite; K285 NaAl  
 „ ; K264 NaAl  
 „ , aver. Na290 KAl  
 „ , aver. Na260 KAl  
 „ , aver. of 4; Na250 KAl  
 „ , aver. of 5; Na254 AlSi  
 „ , nepheline-rich cossyrite-; Na194 KFe  
 „ , sanidine-; Na256 KAl
- Picrite; Mg890 FeCa  
 „ , calc. waterfree-; Mg400 FeCa
- Pitchstone; K140 NaSi
- Porcellanite, sideritic; Fe353 KAl
- Porphyry, quartz-; K183 NaSi
- Puglianite; Ca402 MgFe
- Pulaskite; Na199 KAl
- Pyroxenite; Mg1030 FeSi  
 „ , alkali-; aver. Mg435 CaFe  
 „ , biotite-; Mg473 CaFe  
 „ , biotite-, aver.; Mg396 CaFe  
 „ , olivine-; Mg634 CaFe  
 „ , with augite; Mg510 CaFe  
 „ , with rhombic pyroxene; Mg1037 FeSi  
 „ , w. two pyroxenes; Mg715 CaFe
- Radiolarite; Si160 FeNa  
 „ ; Si139 FeK  
 „ ; Si156 CaK  
 „ , red; Na285 FeSi  
 „ , red; Si125 FeK  
 „ , red; Si119 FeAl
- Rhyolite; K155 NaSi  
 „ , obsidian; Na168 KSi  
 „ , obsidian-; K145 NaSi
- Rhyodacite & obsidian, aver. Na138 SiAl
- Rhyolite & obsidian, aver. alk. K158 NaSi  
 „ & obsidian, aver. calc-alk. K178 SiNa  
 „ & obsidian, aver. peralkaline; Na172 KSi
- Sand; Si144 FeK  
 „ ; Si161 KFe  
 „ , carbonatic-; Ca264 MgSi  
 „ , carbonatic-; Ca227 MgSi  
 „ , carbonatic-; Ca278 SiNa  
 „ , feldspar-; K332 AlSi  
 „ , fluviatile-; Si137 KAl  
 „ , glass-; Si165 CaMg  
 „ , glauconite-; Fe385 KSi  
 „ , quartzrich; (Huppererde); Si134 AlNa
- Sandstone; Ca339 SiK  
 „ ; Si131 FeK  
 „ ; Si123 NaFe  
 „ , arkosic; Ca139 FeSi  
 „ , arkosic; Ca139 SiFe

- Sandstone, arkosic; Ca327 SiNa  
 „ , arkosic; Si120 CaNa  
 „ , arkosic; Si120 KCa  
 „ , calcareous Ca202 SiNa  
 „ , carbonatic; Ca586 NaMg  
 „ , crinoidal, w. glauconite; Ca365 SiFe  
 „ , crystalline Ca420 SiFe  
 „ , flysch-; Ca241 SiNa  
 „ , glauconite-; Si131 FeMg  
 „ , glauconitic; Si148 FeCa  
 „ , glauconitic; Si136 KMg  
 „ , immature; Ca153 FeMg  
 „ , immature; Na187 FeMg  
 „ , immature; Na133 CaFe  
 „ , marly; Ca350 KSi  
 „ , marly; K120 SiNa  
 „ , lime-marl-; Ca293 MgNa  
 „ , limonitic-; Fe492 SiCa  
 „ , orthoquartzitic Si166 FeMg  
 „ , orthoquartzitic Si166 FeCa  
 „ , orthoquartzitic Si163 FeNa  
 „ , orthoquartzitic Si166 CaAl  
 „ , orthoquartzitic Si165 NaK  
 „ , orthoquartzitic Si159 AlNa  
 „ , protoquartzitic Si155 AlFe  
 „ , protoquartzitic; Si155 AlK  
 „ , weathered; Ca235 SiK
- Shale, aver. of 51; K120 FeAl  
 „ , carbonaceous Fe135 KAl  
 „ , carbonaceous Na151 AlSi  
 „ , carbonaceous K103 SiAl  
 „ , cherty, minus carbonate Si141 FeAl  
 „ , copperbear. Ca208 AlK  
 „ , diatomaceous Si123 FeMg  
 „ , potassic Ca295 KMg  
 „ , potassic K 363 AlSi  
 „ , potassic, minus carbonate; K278 AlFe  
 „ , siliceous Si140 AlNa
- Shaly bed in ironstone; Fe584 CaMg
- Shonkinite; Mg431 CaFe  
 „ , augite-biotite; Mg238 KCa  
 „ , augite-biotite-olivine-; Mg326 CaK
- Silica-earth; Si144 AlNa
- Silt, mississippi-; Si116 KAl
- Slate, black Fe159 KNa  
 „ , ferruginous; Fe178 CaSi  
 „ , marly; Ca430 KSi  
 „ , marly; Ca242 AlK  
 „ , pyritic, graphitic Fe420 SiK  
 „ , red; Mg215 KCa

- Soil, andesite, weathered, almost earthy; Fe205 AlSi  
 „ , andesite, weathered, completely earthy; Fe235 AlSi  
 „ , B-horiz., from sandstone; Si106 FeCa  
 „ , from basalt; Fe130 NaK  
 „ , from basalt; Fe142 NaSi  
 „ , from limestone; Ca166 SiK  
 „ , from marl; Ca125 KSi  
 „ , humus-; from limestone; Si126 AlFe  
 „ , residual on limestone; Mg500 AlCa  
 Sommaite; Ca238 KMg  
 Sparagmite; K159 SiFe  
 Spilite; Mg186 CaNa  
 „ ; Fe177 MgNa  
 „ ; Fe218 NaCa  
 „ ; Fe193 NaCa  
 „ , aver. of 19; Fe201 NaMg  
 „ , border of pillow; Mg285 FeNa  
 „ , center of pillow; Mg265 CaFe  
 „ , matrix; Mg558 FeAl  
 „ , matrix; Mg538 FeAl  
 Subgraywacke; Si137 MgNa  
 „ ; Si124 FeAl  
 „ ; Si128 NaAl  
 Syenite; Na247 KAl  
 „ ; K148 NaAl  
 „ , aegirine-; Na243 KSi  
 „ , aegirine-; K262 NaAl  
 „ , alkali-; aver. K197 NaAl  
 „ , analcite-; Na194 KFe  
 „ , ferrohastingsite-; K199 NaAl  
 „ , peralkaline,-aver. Na223 KFe  
 „ , quartz-; aver. of 5; Fe184 NaK  
 „ , quartz-; K177 NaAl  
 „ , quartz-; K167 NaAl  
 „ , weathered; Na141 KSi  
 Syenitic segregation; Na257 FeAl  
 Tahitite Na235; KAl  
 Tawite, aver. Na597 AlFe  
 Tephrite, analcite-; aver. Mg212 CaNa  
 „ , leucite-; Ca216 MgK  
 „ , leucite; Ca170 FeK  
 „ , leucite-; Vesuvite; K238 CaFe  
 „ , nepheline-; aver. Mg242 CaFe  
 Terra rossa; Fe151 AlSi  
 „ „ ; Ca399 MgFe  
 „ „ ; Ca222 FeMg  
 Teschenite; Fe195 CaMg  
 „ ; Ca252 MgFe  
 „ ; Ca250 MgFe  
 „ ; aver. Mg204 FeCa  
 „ , aver. of 4 Mg212 FeCa

- Teschenite, roof of intrusion; Fe229 CaNa  
 „ , 20 ft. from lower contact; Mg319 FeCa  
 „ , 120 ft. from lower contact; Ca205 FeMg  
 „ , 270 ft. from lower contact; Mg248 FeCa  
 „ , 420 ft. from lower contact Ca202 FeMg  
 „ , 500 ft. from lower contact; Fe222 CaMg
- Theralite, aver; Mg373 FeNa  
 „ , aver. Ca209 MgFe  
 „ , olivine Na208 CaFe
- Tholeiite, aver. of 3; Ca218 MgFe  
 „ , aver. of 8; Fe217 CaMg  
 „ , olivine-; Ca226 MgFe
- Tinguaite; Na226 KAl
- Tonalite, aver.; Ca114 NaAl  
 „ , biotite-; Na156 SiAl  
 „ , hornblende-biotite-; Na113 CaSi  
 „ , muscovite-biotite-; Na164 SiAl  
 „ , hypersthene bear.-; Na118 SiFe
- Trachyandesite; K166 AlSi  
 „ , augite-; Na193 KAl  
 „ , feldspathoidal; aver. (Tahitite) Na235 KAl
- Trachybasalt; Mg185 FeCa  
 „ , aver. of 4; Ca206 MgFe  
 „ , hornblende-; Na182 FeAl
- Trachyte; Na275 KAl  
 „ ; Na179 KAl  
 „ ; K262 NaAl  
 „ ; K189 NaAl  
 „ ; K174 NaAl  
 „ , alkali; aver. Na218 KAl  
 „ , alkali; lavas corresp. shonkinite; Mg266 CaK  
 „ , anorthoclase-; Na241 KAl  
 „ , calc-alkali, aver. K246 NaAl  
 „ , peralkaline; aver. Na230 KAl  
 „ , phonolitic; aver. Na233 KAl
- Travertine; Ca1108 MgK
- Troctolite; Mg657 FeCa
- Trondhemite; Na200 SiAl
- Turgaite, aver. Ca415 MgFe
- Ugandite; Mg442 CaFe
- Uncompahgrite, aver. Ca580 MgFe
- Urtite, aver. Na471 AlK
- Vesuvite; K238 CaFe
- Wolgidite; Mg364 KFe
- Wyomingite; K327 MgCa

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Distribution

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