CZECH GEOLOGICAL SURVEY SPECIAL PAPERS
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CHEMICAL COMPOSITION OF YOUNG VOLCANITES OF THE CZECH REPUBLIC

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Czech Geological Survey
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Comments of the reviewer

I consider the paper to be an essential, long-time awaited work that contributes formidably to the solution of genesis of young alkaline volcanites of the Bohemian Massif. This alkaline province that provided a basis for F. Becke (1906) to define the alkaline Atlantic family (Sippe) of volcanism, deserves an extraordinary attention. In the Anglo-Saxon literature, priority of this term (as well as of the Pacific province) is, nevertheless, attributed to A. Harker (1909).

Czech specialists are at present confronted with an invasion of foreign researchers who have duely grasped the unique character of this young alkaline volcanic province of the Bohemian Massif on a global scale. Therefore I consider this Czech contribution as remarkably appropriate, because it is a monography presenting on a larger scale an evaluation of the geochemistry and petrology of our young alkaline volcanites based on 1000 samples dealt with by a single author, by the same methodology and in the same chemical laboratory. Moreover, if we consider the meticulously rigorous and critical approach of the author toward the solution of this task, we cannot but appreciate the robust basis of this work's construction. At present and in the given field, there is, besides special studies, a collection of papers available from the same author that deals with the chemical and mineral composition of volcanites of only some areas of the Bohemian Massif in English in Czech journals. I consider the fact that no complete analytical data of this set (particularly of trace elements) have been published until now, as thoroughly detrimental. The presented complete evaluation of chemistry of this collection, author's "Gesamtkunstwerk", even though highly praiseworthy, cannot entirely fill this gap.

Paralleling the chemistry of volcanites of the Bohemian Massif with other important global volcanic provinces is also entirely original. One only feels sorry that the genetic aspects of evolution of the volcanic series of young volcanism of the Bohemian Massif were not aimed at in this work, despite, or probably because of author's remarkable knowledge of this field. I also consider author's approach in preferentially designating the rock types on the basis of quantitatively mineralogical system as positive in contrast with the current boom of chemical classifications and original in the chemical classification that enables paralleling his own system elaborated solely for young alkaline volcanites of the Bohemian Massif with the international classification of the IUGS.

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Position of young volcanism of the Bohemian Massif in Europe

Young volcanites of the Bohemian Massif are a part of the alkaline-rock association of the West European platform on the territories of France, Germany, the Czech Republic and Poland; geotectonically, they are situated at the contact of the West European platform, the East European platform and the Alpine-Carpathian system (Shrbený 1987). Maximum manifestations of volcanism in the Bohemian Massif are bound to a 250 km long and 30 km wide, W.S.W.-N.E.N.-trending zone („rift"), which in its middle (Czech) portion (Fig. 1) mainly includes volcanites of the České středohoří and the Doupovské hory Mts. with a scatter in the surrounding areas, on the S.W. edge the occurrences in Upper Palatinate (Oberpfalz) in Germany and on the N. E. margin in the Neisse river area near the German-Polish border and S.W. of the Polish Jawor. Weaker manifestations of volcanism outside this zone and its vicinity can be found in the north-eastern part of the Bohemian Massif: in the Bohemian Cretaceous Basin area, in the Czech-Polish frontier region, in the Nízké Jeseníky Mts. and in Polish Silesia.

Characteristic features of young volcanism of the Czech Republic

The volcanites are mostly of Tertiary, much less of Late Cretaceous and Pleistocene ages (Table 1). Both the Doupovské hory and the České středohoří Mts. volcanologically represent complexes of subhorizontal effusions of solid to highly altered (autohydrothermally metamorphosed–autometamorphosed) basaltoids alternating with pyroclastic layers, locally even with tuffites and nonvolcanic sediments. The maximum inferred present-day thickness of the products reaches 500 m and 400 m in the Doupovské hory and České středohoří Mts., respectively. Larger, but in contrast to the two complexes volumetrically negligible, basaltoid effusions are in the Nízký Jeseník Mts., in the Železný Brod area and occasionally also elsewhere. The total present-day volume of surficial volcanic products on territory of the Czech Republic is c. 180 km^3 (Table 2). Besides the surficial volcanic forms of basaltoids s.l. and their pyroclastics, also subvolcanic bodies are known (dykes, sheet veins and necks of basaltoid and trachytoid rocks and laccoliths or eruption laccoliths of trachytoids).

Principal petrological types of the volcanites and their estimated mutual relative proportion are shown in Fig. 2. The diverse composition of the unaltered volcanites reflected in the variability of mineralogical and chemical types is the subject of this paper.

History of investigations of the young volcanites dates back to the 18th century, an important stage being the period of J. E. Hibsch and his contemporaries, particularly from the turn of the 19th and 20th centuries and the first decades of the 20th century. The studies of L. Kopecký, who has provided the newest syntheses of the young volcanism on territory of the Czech Republic (Kopecký 1964 and 1987–1988), go up to the present times.

Data for chemistry evaluation

The evaluation of chemical composition of young volcanites of the Czech Republic (highly altered volcanites and pyro- clastics – Fig. 2 – are excluded) is based on investigations conducted by author of this paper in the Czech Geological Survey from 1960 to 1990. Calculations of the averages and correlations from the sets compiled by the author were carried out by Igor Hron in the computer center of the Survey mostly in 1992. The calculations were partly supplemented by other authors' analyses, mainly of those rock types not sufficiently represented in author's data set. The summary of data used for this paper is given in Tables 3 and 4. The total quantity of volcanites of all the genetic types analysed to date is shown in Table 5. A considerable part of other authors' analyses has analytical shortcomings, samples lack adequate petrological determination, they have secondarily altered chemistry, inadequate location etc., so that they are unusable for chemistry evaluation. A more comprehensive information on the analyses listed in Table 3 as author's own, or on the chemistry of young volcanites of the Czech Republic in general, can be found in the papers by Shrbený (1966, 1967, 1968a, b, 1969, 1971, 1974, 1979, 1980, 1982, 1986, 1987, 1989a, b, 1990a, b, c, 1991, 1992a, b), by Macháček-Shrbený (1970a, b, c, 1971), by Shrbený-Macháček (1973, 1974) and by Shrbený-Macoun (1976). It can be said in general that the elements As through Zr (see tables) were determined by the XRF method, Ce through Yb by the INAA method, Be mostly by spectral analysis with replicate chemical analysis and the major elements (oxides) predominantly by conventional silicate analysis.

Rock-type chemistry

Rocks of the association are linked together by gradual chemical and mineralogical transitions. The whole set was subdivided into a certain number of rock types for reason of evaluation of the material composition and these types are in turn characterised by their average composition. Three vari-ants of rock classification were chosen for establishment of the rock types: 1) mineralogical classification based on the rock determination from thin sections, 2) chemical classification defined by the IUGS proposal (Le Bas et al. 1986) based on the alkalis vs. SiO_2 relation in the large volcanic groups from all over the world and 3) analogous to that under 2) (Shrbený 1990a, b), with fields defined in the alkalis vs. SiO_2 diagram into which fall certain microscopically determined mineralogical types from territory of the Czech Republic (see below).

In tables of the average values (Tables 7, 10, 12, 13), the data given in the *det.ratio* (determination ratio) column indicate in percentage how many of the analytical values

used for calculation of the averages were above the limits (i. e. above the detection limit of a given analytical method). If the numerical data are not stated, then 100 % of the values were above this limit. If the above-limit values are less than 33 %, the mean was not calculated. If they are 33 % or exceed 33 %, the mean is calculated from these values; from those below the limit (listed in the analyses as less than 1, less than 10, etc.) the mean is calculated by multiplying the below-limit value (1 or 10, etc.) by a coefficient of 0.3. The means calculated from 50 % and lesser percentage of the above-limit values are not entirely credible and the minimum and maximum contents are not given in the tables. Data in column *n* of the tables indicate the quantity of analyses, *s.d.* indicates standard deviation. The arithmetic average is understood under the notion of *mean*. The SiO_2 to BaO contents are given in per cents, those of As to Yb are in ppm.

Average composition according to the mineralogical classification

Summary of the rock types listed in tables of the averages defined by the mineralogical classification (Tables 7/1 to 7/50) is given in Table 6, which also shows 936 analyses from 42 types of young alkaline volcanites of the Czech Republic being used in total for the calculation of the averages. The classification principles can be inferred from Table 8, where the rock-type numbers are equal to those stated in the tables of the averages (Tables 7/1 through 7/50). The tables include all the principal types of the rock association, except for rocks not microscopically determinable because of their considerably fine grain size, or presence of microlites in the mesostasis etc. These rocks are usually denoted e. g. as olivine basaltic rocks. Number of the samples (936 – see Table 6) used for chemistry evaluation is according to the mineralogical classification lower than in the chemical classifications (1026 and 1018 – Tables 9 and 11), where textural and structural evolution of the matrix and the mesostasis does not influence their ability of being classified. Volcanites containing more than one foid (or zeolite, melilite, glass) were assigned to the individual types according to the dominant mineral, or glass (e. g. nepheline-analcime basanite to analcime basanites etc.). Summary in Table 6 shows the set of basaltoids s. l. (No. 1– 26) with 537 analyses dominating over trachytoids s. l. (32– 35) with 173 analyses. Trachybasaltoids (28–31, including trachyandesites – 27) with 54 analyses, the coarse-grained subvolcanic rocks (36–38) with 78 analyses and lamprophyres and semilamprophyres (39–42) with 54 analyses are considerably less represented in the set. Mainly olivine foidites (out of which in turn olivine nephelinites) and basanites (out of which nepheline basanites), further olivine-free foidites and tephrites dominate among basaltoids s. l. and trachytes and sodalite trachytes predominating over phonolites clearly dominate among the trachytoids s. l. The rocks enumerated here are also the dominating mineralogical types of the Czech young volcanic regions. The strongly olivinic to picritic foidites (assigned to Table 7/6) differ chemically from the common olivine foidites particularly in their higher MgO content – over 15 % (isolated types denominated as picritic have more than 20 % of MgO). Empirical boundary between the olivine- and olivine-free feldspar basaltoids of the Czech Republic fluctuates around 7.25 % of MgO and that drawn between the olivine- and olivine-free foidites is mostly at 9 % of MgO (all values after recalculation to 100 % on a H_2O^+, H_2O^- and CO_2-free basis).

Figure 3 clearly shows position of the rock-type averages according to the classification discussed here (after recalculation free of water and CO_2) in the Na_2O+K_2O/Si_2O diagram which enables a comparison with the averages defined by the other classifications (Figs. 4 and 5).

Average composition according to the classification recommended by the IUGS

The rock types for which the average composition was calculated in this case (Tables 10/1 to 10/15) are defined by the IUGS classification (Le Bas et al. 1986) based on the Na_2O+K_2O/SiO_2 relationship (Fig. 4). They are listed in Table 9. This table also shows numerical proportion of the rock groups. The total number of 1026 analyses considered for the calculations is highest of all the three used classifications. Meeting the requirement for the content of H_2O^+ less than 2 mass % and CO_2 less than 0.5 mass % for an exact classification after the IUGS principles (Le Bas et al. 1986) would markedly reduce the quantity of analyses available for the calculations; therefore, to assign a rock analysis to the tables of averages in this paper, the criterion of c. 5 % of H_2O^+, H_2O^- and CO_2 as a maximum was used, in some cases even more (higher content of H_2O^+ and CO_2 is at some types primary – presence of primary analcime, carbonate etc.). The distortion in the classification (plotting in the $Na_2O+ +K_2O/SiO_2$ classification diagram) after recalculation to 100 %, free of water and CO_2, is small. Based on an overall experience, "fresh" rocks were taken to be those young alkaline volcanites of the Czech Republic with the total water and CO_2 content below 5 %, as slightly altered those with 5 to 7 %, as altered with 7 to 10 %, and as highly altered (mostly strongly autometamorphosed) those with the volatiles content exceeding 10 %. The dominant rock type in the discussed classification is the volcanites from the "tephrite" field, next the "basanite", "phonolite", "foidite", "alkali basalt" and the "trachyte" fields, "hawaiites", "mugearites" and "benmoreites" being the least represented. There is a lack of agreement in rock names between the conventional mineralogical classification (see above) and the chemical IUGS classification in the case of our volcanites. The latter is unsuitable for the Czech young volcanite association, since it separates the association and thus also rocks of the same type in lengthwise direction, i. e. in that of the natural "evolution" of the association, into two artificially created parts (by the boundary between the $S_1 - U_1$, $S_2 - U_2$, $S_3 - U_3$, T – Ph fields, as seen from Figs.

3, 4 and particularly from Fig. 5). This appears to be explicit by plotting all the single rocks of the association into the IUGS diagram (see e. g. Shrbený 1987 and Figs. 3 and 4). The divide between the olivine- and olivine-free basaltoids ("basanites" and "tephrites") at 10 % content of normative olivine (Table 9) also appears unsuitable, since it causes tephrites to predominate markedly over basanites, thus disregarding the "mineralogical reality". Of particular interest is the IUGS classification and the rock types defined therein for a mere comparison of the various associations regardless of the actual mineralogical rock character and genetic affinity or even identity.

Average composition according to the classification of Shrbený

The average rock composition of the individual fields (groups) defined in the alkalis/silica diagram (Shrbený 1990a, b) is shown in Tables 12/1 to 12/12. The fields in the diagram (Fig. 5, Table 11) are only valid for young alkaline volcanites of the Bohemian Massif. The boundaries separating the fields resulted from plotting analytical data from a wealth of accurately microscopically determined volcanites (the analyses were recalculated to 100 %, free of water and CO_2 – the classification is relatively exact if the content of these components does not exceed 5 %). The diagram enables to determine a mineralogical rock type even if there are no thin sections or optically identifiable rocks available. On the contrary, chemistry can check the accuracy of microscopic determination or classification of the boundary types. The average chemical values of the twelve basic fields characterise the chemistry of the rock association better than do the other classifications. Rock types contained in the fields are listed in Table 11. In tables of the averages (Tables 12/1 to 12/12), the rocks of groups 5 B (including tephrites and other olivine-free feldspar basaltoids) are the most abundant, being followed by group 3 A (olivine foidites and basanites closer to foidites), 5 A (basanites closer to olivine alkali basalts and these basalts), 3 B (mainly olivine-free foidites), 8 (mainly trachytes) and 9 (mainly "nepheline" phonolites). In Figure 5, chemical affinity (in the alkali-silica relationship) of all olivine-basaltic rocks of the Czech Republic is striking (the proximity of projections of fields 3 A, B, 4, 5 A, B).

"Average rock"

Chemical composition of the "average rock" (Table 13) was calculated from analyses of a set of 1066 fresh volcanites of the Czech Republic. The somewhat larger number of analyses compared to the set used e. g. for calculation of the rock-types composition according to the IUGS classification (Table 9) is caused by the fact that analyses of several samples from one locality were added as separate (not as average) in order to obtain a larger number of data for the calculation of correlations (see below). The data on the minimum and maximum contents of oxides and elements (Table 13) indicate a wide range of compositions and therefore a considerable degree of differentiation of the association, reflected in the diversity of mineralogical types (Table 6).

Distribution of oxides and elements in the rock association

Figures 6/1 and 6/2 show the distribution of selected major and trace elements in the mineralogical types of the rock association (according to Table 7) in relation to the silica content. The diagrams and tables of average composition (Tables 7/1 to 7/50) indicate an overall increasing content mainly of Al_2O_3, Na_2O, K_2O, Rb, Zr, Hf and Th and decreasing content of TiO_2, Fe_2O_3 + Feo, MgO, CaO, P_2O_5, Cr, Ni, Co, Sc, Sm and Eu from the more basic towards the more acid rocks. Nb, Sr, Y, Ce, La, Lu, Ta, Tb and Yb exhibit a slightly dependent, ambiguous or independent distribution in relation to the silica content. The contents of some elements and oxides on one side of the rock series, particularly in polzenites (or the other melilitic rocks), or in phonolites on the other side, are a relatively persistent anomaly within the whole trend (Shrbený 1969). Both these types seem to represent a partial, more alkaline association (Shrbený 1987) within a relatively less ("normally") alkaline one, dominant on territory of the Bohemian Massif. The anomaly for polzenites is manifested e. g. in the case of TiO_2, Fe_2O_3 + FeO, Cr, Tb (lower contents than expected at given basicity), or K_2O and Sr (mostly higher contents), for phonolites mainly at Na_2O, Nb, Zr, Hf, Lu and Th (mostly higher contents). The Sr anomaly (higher content) at 50 % SiO_2 is typical for trachybasalts (the content decreases towards the more basic and more acid types), the anomaly of MgO, Cr, Ni and Co (higher content) at 42 % SiO_2 corre-sponds to highly olivinic foidites.

Pair correlations of oxides and elements

From a set of 1 066 analyses, correlation coefficients for all pairs of oxides and elements represented in these analyses (except for H_2O^+, H_2O^- and CO_2) were calculated, as illustrated in Table 14. Number of the pairs from which the calculations were made can be inferred from Table 13, compiled from the set of analyses used for the calculation of correlations. The number of pairs is then given by the less represented oxide or element in the pair (*n* in Table 13). The highest correlations (0.8 and higher), positive and negative, are listed according to the degree of dependence in Table 15. While there is essentially an absolute dependence (0.9 and more) in the case of positive correlations at trace elements (Cr–Ni, Zr–Th, Zr–Hf, Eu–Sm), in the case of negative correlations it exists at major elements (SiO_2 – CaO, Al_2O_3–MgO, Al_2O_3–CaO, CaO–K_2O). Even in correlations lower than 0.9, there is an obvious dominance in the representation of trace elements over major elements at

positive correlation and on the contrary, of major elements over trace elements at negative one; positive higher-degree dependences are, nevertheless, more numerous than the negative ones.

Chemical position of young volcanites of the Czech Republic among other rock associations

The chemistry of the association of young volcanites of the Bohemian Massif in relation to other associations can be estimated on the basis of the diagrams (Figs. 7/1 to 7/8) illustrating the relationship of major oxides (TiO_2, Al_2O_3, Fe_2O_3+FeO, MgO, CaO, Na_2O, K_2O and P_2O_5) to silica. Larger associations in the near vicinity have been selected for comparison: associations of young volcanites on the territories of Germany (without the Bohemian Massif) and France (both situated, just as the Czech association, on the West European platform), young volcanites of Slovakia (in the Alpine-Carpathian system) as well as areas of global importance, representing a wide range of the main rock-association types: the W. and E. African Rifts, Ethiopia and Yemen, Hawaii, Chile and Japan. The overall position of the rock association of the Bohemian Massif (i. e., essentially of the Czech Republic) among the other associations of young volcanites was studied by Shrbený (1987).

Figures 7/1 to 7/8 show the Bohemian Massif to be chemically closest to the association on the territory of Germany and our association to be possibly a part of that of the African Rifts (of the eastern, in particular). The markedly subalkaline associations of Japan and Slovakia, which are close to each other, largely differ from that of the Bohemian Massif. The Hawaiian association is distinguished from the others by its low degree of differentiation.

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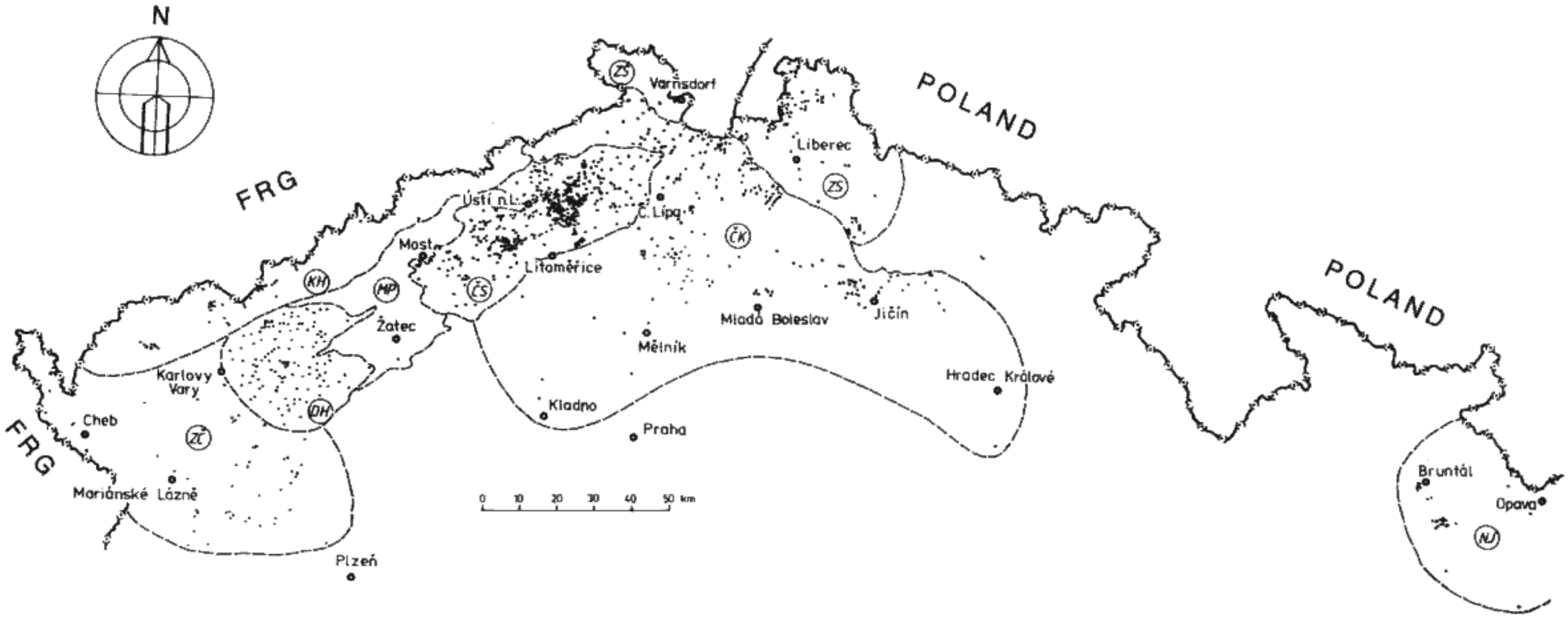

Fig. 1. Outline of areas with occurrence of young volcanites in the Czech Republic. Ticked line denotes the boundaries of the individual areas: ZČ – western Bohemian area, KH– Krušné hory Mts., DH – Doupovské hory Mts., MP – Most Basin, ČS – České středohoří Mts., ČK – area of Bohemian Cretaceous Basin, ZS – West Sudetes area, NJ – Nízký Jeseník Mts. The areas have been delimited with regard to the orographic division of the Czech lands (Balatka-Czudek-Demek-Sládek 1973). Dots denote the location of analysed samples included in the tables of average rock types (Tables 7, 10, 12).

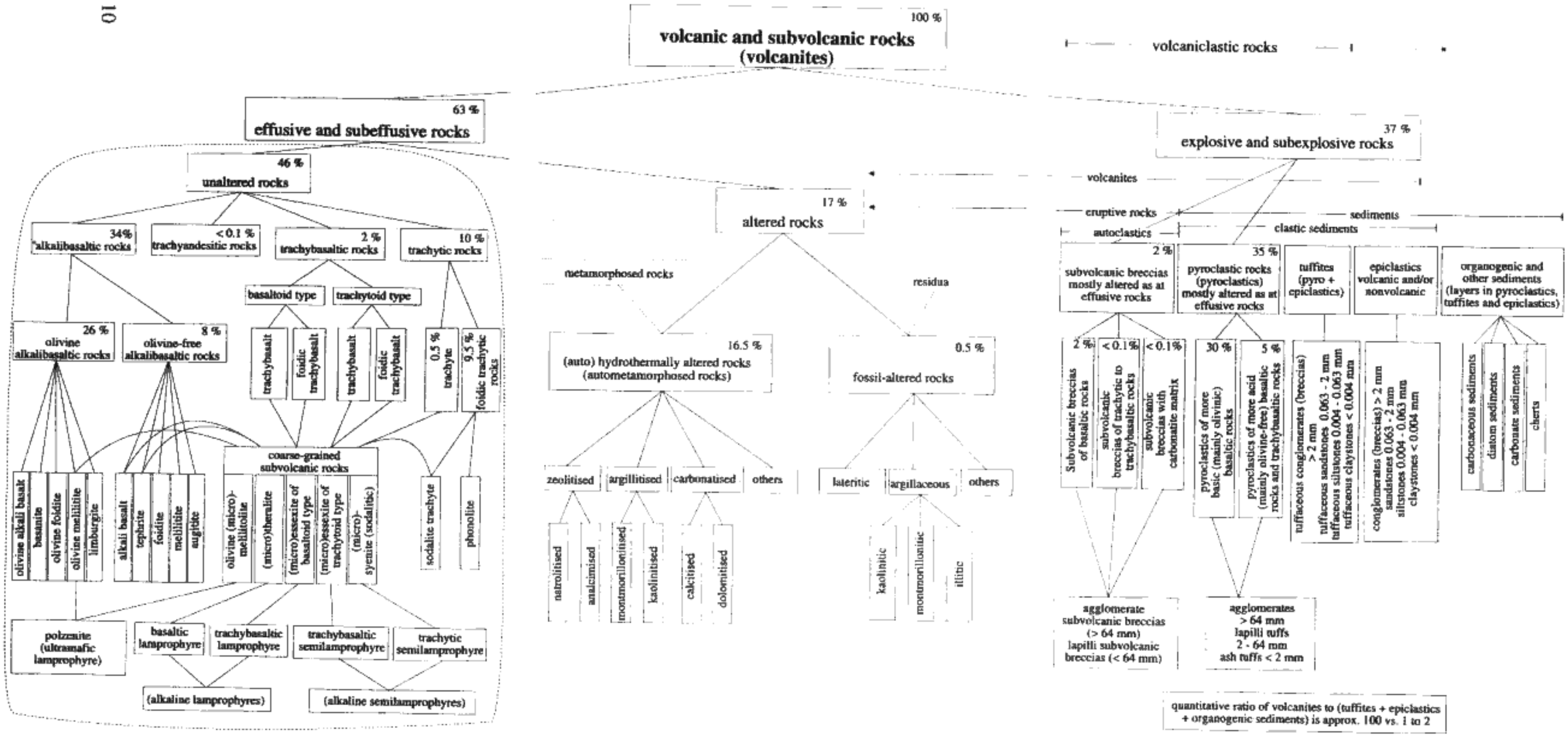

Fig. 2. Subdivision scheme of young volcanites of the Czech Republic. Unaltered eruptive rocks evaluated chemically in this paper fall within she dashed line.

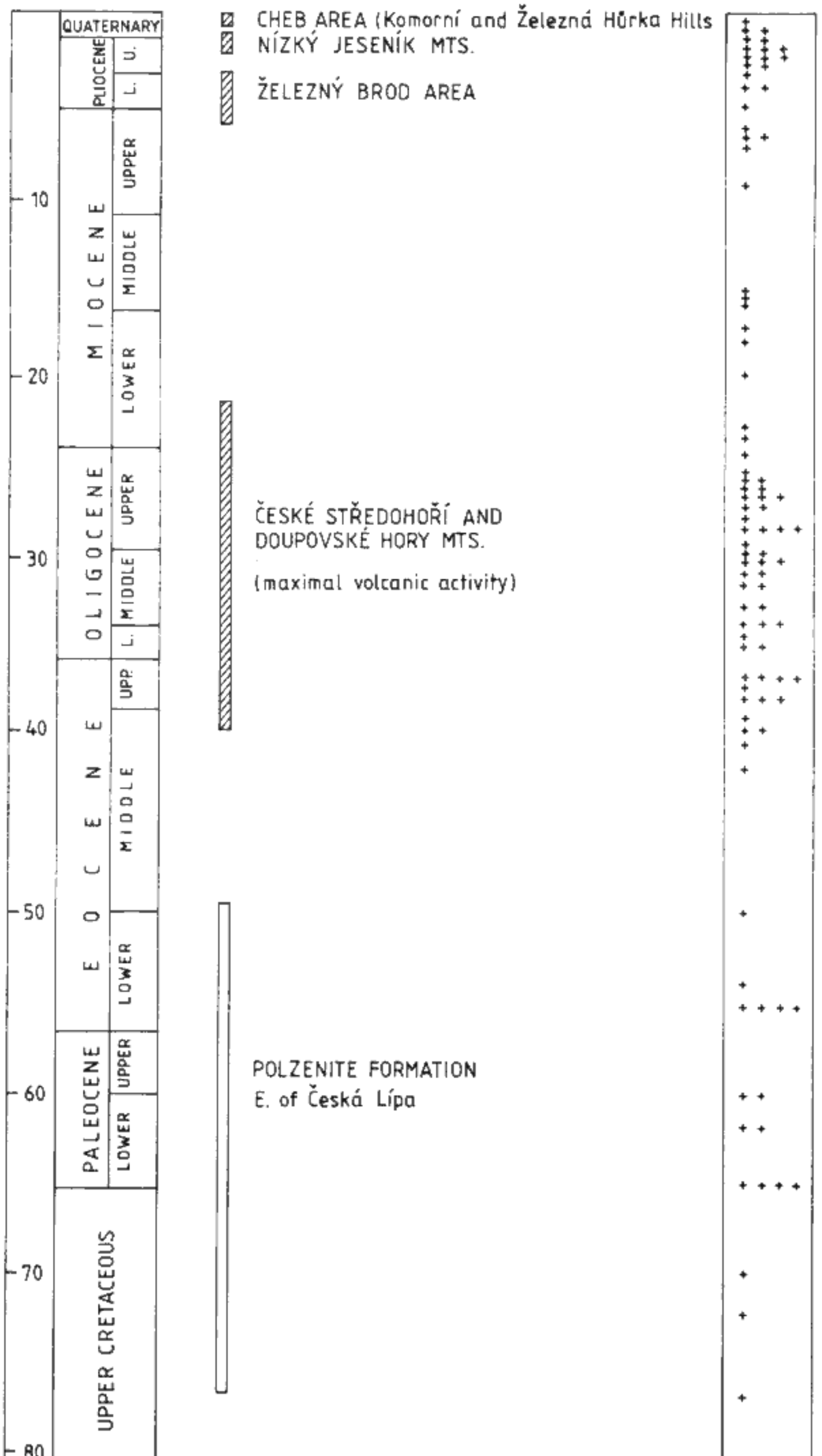

Table 1. Approximate K/Ar age of the main areas of young volcanism in the Czech Republic. Hatched rectangulars: prevailingly subaerial volcanism, empty rectangular: dyke volcanism, crosses: individual analyses (mean values irrespective of accuracy dispersal).

Table 2
Approximate volume and extent of young volcanites of the Czech Republic (calculated from geological maps +)

volcanites	volume (km^3)	areal extent (km^2)
Doupovské hory Mts.	123	594
České středohoří Mts.	52	472
Železný Brod, Frýdlant and Varnsdorf areas	< 0.5	–
Nízký Jeseník Mts.	0.4	12
Czech Republic total	c. 180	c. 1100

+ effusive and explosive bodies overlying the basement of the volcanites, subvolcanic bodies above the present-day surface of surrounding rocks

Table 3
Numerical proportion of analyses of individual areas used for calculation of average composition of rock types (corresponding to the IUGS classification – tables 10/1 to 10/15)

	silicate analyses		RFA (As to Zr)		INAA (Ce to Yb)	
	this author's	borrowed[1)]	this author's	borrowed[1)]	this author's	borrowed[1)]
České středohoří Mts. (ČS)	288	214	239	52	199	13
Bohemian Cretaceous Basin area (ČK)	166	42	167	11	85	
Doupovské hory Mts. (DH)	119	18	117	4	116	
West Sudetes area (ZS)	59	4	59	4	51	
West Bohemia area (ZČ)	48	3	46	3	46	
Krušné hory Mts. (KH)	39	4	38	4	37	
Nízký Jeseník Mts. (NJ)	5	16				
Most Basin (MP)	1		1		1	
Czech Republic	725	301[1)]	667	78[1)]	535	13[1)]
	1026		745		548	

[1)] see Table 4

Table 4
List of analyses of other authors used for calculation of the average rock-type composition (see Table 3)

Author	Number of borrowed analyses (Czech Republic)		
	sil. an.	RFA	INAA
Krutský 1989	71	71	
Žežulková 1985	22		
Kopecký (from author's files)	22		
Tvrdý 1983	18		4
Kratochvíl 1984	14		
Ulrych – Novák 1988	14	1	9
Barth – Zapletal 1970	13		
Ulrych et al. 1983	11		
Holečková 1960	10		
Kavka 1968	9		
Holečková 1963	8		
Mag 1984	8		
Scheumann 1913	8		
Voldán 1952	7		
Kopecký 1968	7		
Knorr 1932	6		
Voldán 1953	6		
Hibsch 1894	5		
Pacák 1952	4		
Dubánek 1982	4		
Hibsch 1903	3		
Fediuk – Fediuková 1985	3		
Pivec et al. 1986	3	3	
Fediuk 1988	3		
Jelínek et al. 1989	3	3	
Hibsch 1899	2		
Hibsch 1911	2		
Hibsch 1915	2		
Hibsch 1921	2		
Arendárik – Štěpánková 1982	2		
Hibsch 1897	1		
Hibsch 1904	1		
Hibsch 1905	1		
Hibsch et al. 1917	1		
Hibsch 1920	1		
Hibsch – Senger 1923	1		
Kopecký 1959	1		
Kočandrle 1973	1		
Kopecký 1983	1		

Table 5
Indicative number of all young volcanites of the Czech Republic analysed to date
(silicate analyses [1)] in publications and reports approximately until 1990)

volcanites c. 2000				
eruptive rocks c. 1900				pyroclastics c. 100
± fresh c. 1600		strongly altered c. 150	subvolcanic breccias c. 100	
used in the report 1026 (see Table 3)	others c. 500			

[1)] total number of XRF and INAA analyses differs from that given in Table 3 only by additional several tens

Table 6
Summary of rock types defined by the mineralogical classification and represented in tables of average composition (Tables 7/1 to 7/50).
See Table 8 also

		n
1	polzenites and ± pyroxene-free olivine (micro)melilitolites	18[+)]
2	olivine-nepheline melilitites	2
3	olivine-melilite nephelinites	24
4	olivine nephelinite with melilite	1
2–4 (A)	olivine-melilitic rocks (except for polzenites and melilitolites)	27
5	strongly olivinic to picritic foidites	5
6	olivine nephelinites	115
7	olivine analcimites	8
8	olivine apoleucitites	21
6–8 (B)	olivine foidites except for strongly olivinic ad 5)	144
9	melilite nephelinites	2
10	nephelinite with melilite	1
9–10 (C)	olivine-free melilitic rocks	3
11	nephelinites	38
12	analcimites	14
13	apoleucitites	16
11–13 (D)	olivine-free foidites	68
14	nepheline basanites	103
15	analcime and zeolite basanites	13
16	apoleucite basanites	9
14–16 (E)	basanites	125
17	olivine alkali basalts	38
18	nepheline tephrites	16
19	analcime and zeolite tephrites	28
20	apoleucite tephrites	11
21	sodalite tephrites	9
18–21 (F)	tephrites	64
22	alkali basalts	23
23	limburgites	8
24	plagioclase limburgites	9
25	augitites	9
26	plagioclase augitites	1
27	trachyandesites	2
28	nepheline trachybasalt	1
29	apoleucite trachybasalt	1
30	sodalite trachybasalts	33
31	foid-free trachybasalts	17
28–31 (G)	trachybasalts	52
32	sodalite trachytes	63
33	foid-free trachytes	44
34	sodalite trachytes and trachytes with nepheline	27
32–34 (H)	trachytes	134
35	sodalite phonolites and phonolites	39
36	(micro)theralites and nepheline (micro)theralites	28
37	(micro)essexites and sodalite (micro)essexites	42
38	(micro)syenites and sodalite (micro)syenites	8
39	basaltic lamprophyres	29
40	trachybasaltic lamprophyres	10
41	trachybasaltic semilamprophyres	10
42	trachytic semilamprophyres	5
		936

[+)] several mean values taken over from more than one analysis are also included (actually n equals 49)

Tables 7/1 to 7/50. Average composition of rock types according to the mineralogical classification. See text for denomination of the columns

Table 7/1

1 – POLZENITES AND ± PYROXENE-FREE OLIVINE (MICRO)MELILITOLITES						
mass %	n+)	det. ratio	mean	s. d.	min.	max.
SiO2	18		33.15	1.95	30.19	37.55
TiO2	18		2.38	0.27	1.85	3.20
Al2O3	18		7.92	0.45	7.05	8.97
Fe2O3	18		5.18	0.81	4.30	7.04
FeO	18		5.79	0.82	3.66	7.02
MnO	18		0.21	0.01	0.19	0.23
MgO	18		16.59	2.19	9.83	19.63
CaO	18		16.41	2.15	11.85	20.93
Na2O	18		1.95	0.59	0.51	2.90
K2O	18		1.93	0.39	1.28	2.77
H2O+	18		4.33	1.19	1.13	6.59
H2O-	17		0.37	0.26	0.05	1.04
P2O5	18		1.51	0.85	0.86	4.41
CO2	18		1.58	0.82	0.22	3.76
Li2O	2	0				
S	18		0.20	0.06	0.12	0.33
F	5		0.14	0.02	0.12	0.18
BaO	18		0.16	0.04	0.10	0.26
ppm						
As	13	8				
Cr	18		611	165.42	72	814
Cu	18		92	26.45	52	156
Mo	13	77	19	13.78	2	54
Nb	18		148	34.27	96	245
Ni	18		343	93.25	98	462
Pb	18	28				
Rb	18		50	18.48	16	86
Sr	18		1502	924.56	912	5090
Y	17	94	32	9.79	3	49
Zn	13		103	14.86	67	118
Zr	18		258	65.46	166	456
Be	13	85	1.39	0.56	0.30	2.20
Ce	12		196.50	29.73	160.00	247.00
Co	12		52.74	3.83	46.90	60.50
Cs	12	17				
Eu	12		4.11	0.49	3.54	5.19
Hf	12		7.36	1.80	5.49	11.40
La	12		120.15	36.80	64.40	189.00
Lu	12	92	0.24	0.10	0.03	0.42
Sb	12	33	0.75	0.75		
Sc	12		28.14	4.37	20.80	33.20
Sm	12		11.76	2.10	9.22	15.90
Ta	12		6.54	0.97	4.51	8.03
Tb	12	50	0.95	0.69		
Th	12		11.63	2.57	7.98	15.70
U	12	58	3.41	2.29	0.90	6.07
Yb	12	83	3.42	1.87	0.30	6.01

+) See note to Tab. 6

Table 7/2

2 – OLIVINE-NEPHELINE MELILITITES						
mass %	n	det. ratio	mean	s. d.	min	max.
SiO2	2		37.77	1.27	36.87	38.67
TiO2	2		2.47	0.23	2.30	2.63
Al2O3	2		9.46	0.45	9.14	9.77
Fe2O3	2		5.32	0.52	4.95	5.68
FeO	2		6.04	1.15	5.22	6.85
MnO	2		0.21	0.02	0.19	0.22
MgO	2		15.38	3.30	13.04	17.71
CaO	2		13.76	2.03	12.32	15.19
Na2O	2		2.26	0.35	2.01	2.50
K2O	2		1.37	0.19	1.23	1.50
H2O+	2		2.35	0.36	2.09	2.60
H2O-	2		0.42	0.04	0.39	0.45
P2O5	2		1.09	0.11	1.01	1.17
CO2	2		1.77	0.67	1.30	2.24
Li2O	1		0.004			
S	2		0.08	0.05	0.04	0.11
F	1		0.12			
BaO	2		0.13	0.10	0.06	0.20
ppm						
As	2	0				
Cr	2		775	49.50	740	810
Cu	2		86	38.89	58	113
Mo	1		21			
Nb	2		96	18.38	83	109
Ni	2		339	101.12	267	410
Pb	2	0				
Rb	2		52	12.73	43	61
Sr	2		844	38.18	817	871
Y	2		29	0.00	29	29
Zn	2		86	24.75	68	103
Zr	2		261	77.07	206	315
Be	2		1.75	0.35	1.50	2.00
Ce	1		155.00			
Co	1		56.00			
Cs	1		1.83			
Eu	1		3.74			
Hf	1		8.60			
La	1		91.00			
Lu	1		0.32			
Sb	1		<1			
Sc	1		33.40			
Sm	1		10.60			
Ta	1		5.96			
Tb	1		1.29			
Th	1		9.92			
U	1		<3			
Yb	1		1.23			

Table 7/3

3 – OLIVINE-MELILITE-NEPHELINITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	24		38.30	1.02	35.69	40.38
TiO2	24		2.66	0.25	2.23	3.27
Al2O3	24		10.07	1.67	8.43	14.99
Fe2O3	24		4.53	1.25	3.25	7.89
FeO	24		7.43	0.98	4.92	9.70
MnO	24		0.23	0.11	0.13	0.60
MgO	24		15.72	3.20	9.03	19.45
CaO	24		12.58	1.42	9.41	15.63
Na2O	24		2.87	0.71	2.00	4.68
K2O	24		1.35	0.39	0.22	2.04
H2O+	24		2.11	0.79	0.02	3.66
H2O-	24		0.42	0.32	0.10	1.38
P2O5	24		0.95	0.21	0.75	1.52
CO2	21		0.55	0.57	0.08	2.22
Li2O	6	50	0.002	0.0006		
S	21		0.05	0.04	0.02	0.21
F	6		0.11	0.02	0.09	0.14
BaO	19		0.17	0.22	0.07	1.06
ppm						
As	19	0				
Cr	19		858	298.69	356	1245
Cu	19		111	22.28	63	155
Mo	19	79	19	14.08	2	62
Nb	19		103	17.35	73	136
Ni	19		415	120.88	205	576
Pb	19	6				
Rb	19		38	11.32	20	67
Sr	19		829	152.52	681	1237
Y	19		25	6.15	13	37
Zn	19		111	13.50	67	128
Zr	19		203	29.10	154	289
Be	19		1.51	0.58	0.17	3.00
Ce	12		104.03	13.09	85.30	130.00
Co	12		60.28	3.31	55.80	65.20
Cs	12	8				
Eu	12		2.65	0.20	2.35	3.02
Hf	12		7.21	1.10	4.78	9.06
La	12		55.00	8.89	37.20	66.40
Lu	12	83	0.18	0.09	0.03	0.30
Sb	12	17				
Sc	12		30.05	1.40	27.40	32.60
Sm	12		7.36	0.61	6.36	8.31
Ta	12		4.77	0.39	4.01	5.44
Tb	12	17				
Th	12		6.08	1.02	4.30	7.43
U	12	17				
Yb	12	83	2.76	1.60	0.30	5.28

Table 7/4

4 – OLIVINE NEPHELINITE WITH MELILITE						
mass %	n	det. ratio	mean	s. d.	min	max.
SiO2	1		40.23			
TiO2	1		2.46			
Al2O3	1		11.46			
Fe2O3	1		5.30			
FeO	1		6.75			
MnO	1		0.19			
MgO	1		11.91			
CaO	1		13.18			
Na2O	1		2.88			
K2O	1		1.17			
H2O+	1		1.82			
H2O-	1		0.82			
P2O5	1		0.77			
CO2	1		0.35			
Li2O	1		<0.005			
S	1		0.04			
F	1		0.11			
BaO	1		0.14			
ppm						
As	1		<10			
Cr	1		368			
Cu	1		89			
Mo	1		27			
Nb	1		115			
Ni	1		228			
Pb	1		<10			
Rb	1		50			
Sr	1		891			
Y	1		23			
Zn	1		114			
Zr	1		163			
Be	1		1.00			
Ce	1		126.00			
Co	1		54.90			
Cs	1		<0.20			
Eu	1		2.71			
Hf	1		5.20			
La	1		85.20			
Lu	1		0.20			
Sb	1		0.60			
Sc	1		28.65			
Sm	1		11.80			
Ta	1		6.30			
Tb	1		1.10			
Th	1		8.20			
U	1		<0.60			
Yb	1		3.20			

Table 7/5

2–4 (A) – OLIVINE MELILITIC ROCKS (except for polzenites and melilitolites ad 1)						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	27		38.33	1.07	35.69	40.38
TiO2	27		2.64	0.25	2.23	3.27
Al2O3	27		10.07	1.60	8.43	14.99
Fe2O3	27		4.62	1.21	3.25	7.89
FeO	27		7.30	1.02	4.92	9.70
MnO	27		0.23	0.10	0.13	0.60
MgO	27		15.55	3.16	9.03	19.45
CaO	27		12.69	1.43	9.41	15.63
Na2O	27		2.82	0.69	2.00	4.68
K2O	27		1.34	0.37	0.22	2.04
H2O+	27		2.12	0.75	0.02	3.66
H2O-	27		0.44	0.31	0.10	1.38
P2O5	27		0.95	0.20	0.75	1.52
CO2	24		0.64	0.65	0.08	2.24
Li2O	8	50	0.002	0.0009		
S	24		0.05	0.04	0.02	0.21
F	8		0.11	0.02	0.09	0.14
BaO	22		0.16	0.20	0.06	1.06
ppm						
As	22	0				
Cr	22		828	296.22	356	1245
Cu	22		108	23.90	58	155
Mo	22	77	20	14.38	2	62
Nb	22		103	16.90	73	136
Ni	22		400	122.45	205	576
Pb	22	5				
Rb	22		40	11.82	20	67
Sr	22		833	142.12	681	1237
Y	22		25	5.85	13	37
Zn	22		109	15.60	67	128
Zr	22		207	37.24	154	315
Be	22		1.51	0.56	0.17	3.00
Ce	13		107.95	18.89	85.30	155.00
Co	13		59.95	3.38	55.80	65.20
Cs	13	15				
Eu	13		2.73	0.36	2.35	3.74
Hf	13		7.31	1.12	4.78	9.06
La	13		57.77	13.12	37.20	91.00
Lu	13	85	0.19	0.09	0.03	0.32
Sb	13	15				
Sc	13		30.31	1.63	27.40	33.40
Sm	13		7.61	1.07	6.36	10.60
Ta	13		4.87	0.50	4.01	5.96
Tb	13	23				
Th	13		6.37	1.45	4.30	9.92
U	13	15				
Yb	13	85	2.64	1.59	0.30	5.28

Table 7/6

5 – STRONGLY OLIVINIC TO PICRITIC FOIDITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	5		42.08	0.44	41.51	42.72
TiO2	5		1.87	0.52	1.15	2.49
Al2O3	5		7.40	1.68	5.86	9.68
Fe2O3	5		4.12	1.27	3.20	6.36
FeO	5		7.21	1.33	5.60	8.74
MnO	5		0.22	0.12	0.14	0.43
MgO	5		20.35	2.55	16.62	23.69
CaO	5		10.44	1.44	9.02	12.61
Na2O	5		1.83	0.69	1.14	2.84
K2O	5		0.65	0.39	0.24	1.24
H2O+	5		1.73	0.47	1.22	2.35
H2O-	5		0.47	0.24	0.18	0.76
P2O5	5		0.76	0.65	0.34	1.90
CO2	5		0.45	0.63	0.03	1.45
Li2O	3		0.0009	0.0001	0.0008	0.001
S	4		0.05	0.05	0.02	0.12
F	3		0.07	0.01	0.06	0.08
BaO	4		0.07	0.02	0.05	0.09
ppm						
As	4	0				
Cr	4		1008	382.61	777	1580
Cu	4		88	68.16	44	189
Mo	4	50	44	72.46		
Nb	4		54	19.41	42	83
Ni	4		585	211.53	272	733
Pb	4	0				
Rb	4		38	20.63	14	64
Sr	4		628	158.77	441	789
Y	4		16	7.33	9	26
Zn	4		92	33.90	53	123
Zr	4		161	36.19	111	198
Be	4	75	1.20	0.73	0.30	2.00
Ce	2		95.30	13.72	85.60	105.00
Co	2		74.15	0.50	73.80	74.50
Cs	2	50	1.97	2.36		
Eu	2		2.12	0.47	1.79	2.45
Hf	2		5.04	0.41	4.75	5.33
La	2		50.85	24.54	33.50	68.20
Lu	2	50	0.10	0.09		
Sb	2	0				
Sc	2		37.65	23.12	21.30	54.00
Sm	2		6.92	1.01	6.20	7.63
Ta	2		3.12	0.02	3.10	3.13
Tb	2	0				
Th	2		5.63	1.34	4.68	6.58
U	2	0				
Yb	2	50	1.53	1.74		

Table 7/7

6 – OLIVINE NEPHELINITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	115		40.91	1.33	38.31	44.94
TiO2	115		2.99	0.56	1.70	4.62
Al2O3	115		11.70	1.43	6.65	14.66
Fe2O3	115		5.12	1.01	3.40	8.86
FeO	115		6.90	0.96	4.36	10.45
MnO	114		0.20	0.03	0.16	0.40
MgO	115		11.12	2.00	7.08	17.94
CaO	115		12.45	1.23	9.24	16.00
Na2O	115		3.06	0.62	1.14	4.64
K2O	115		1.09	0.43	0.36	3.68
H2O+	115		2.27	0.83	0.20	5.72
H2O-	112		0.58	0.31	0.08	1.58
P2O5	115		0.83	0.25	0.03	1.46
CO2	107	99	0.50	0.69	0.003	4.27
Li2O	93	84	0.002	0.002	0.0003	0.01
S	100	96	0.04	0.04	0.003	0.19
F	95		0.10	0.03	0.01	0.16
BaO	87		0.09	0.03	0.05	0.19
ppm						
As	92	2				
Cr	96		377	200.94	41	1138
Cu	96		80	34.05	40	210
Mo	92	28				
Nb	96		95	19.14	41	158
Ni	96		218	96.62	21	559
Pb	93	11				
Rb	96	96	42	37.01	2	322
Sr	96		956	221.86	373	1600
Y	93		25	5.26	13	39
Zn	95		87	15.35	49	149
Zr	96		271	68.65	79	460
Be	85	71	1.61	1.19	0.30	5.00
Ce	67		134.20	34.14	63.00	271.00
Co	65		59.09	11.05	30.50	113.00
Cs	68	35	1.12	1.76		
Eu	66		2.89	0.46	1.72	4.29
Hf	68		6.52	1.59	3.25	10.40
La	67		77.83	25.30	31.30	154.00
Lu	67	93	0.27	0.12	0.03	0.61
Sb	68	21				
Sc	68		30.98	8.99	16.90	59.60
Sm	66		8.94	1.63	5.35	15.50
Ta	67		4.88	1.22	2.13	8.98
Th	66	67	0.95	0.50	0.30	2.12
Th	65		8.43	3.28	1.80	20.30
U	64	47	2.73	2.24		
Yb	67	99	2.60	0.96	0.30	5.27

Table 7/8

7 – OLIVINE ANALCIMITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	8		40.96	1.27	39.34	42.82
TiO2	8		3.78	0.33	3.46	4.33
Al2O3	8		11.53	0.72	10.25	12.33
Fe2O3	8		5.22	0.61	4.64	6.41
FeO	8		6.78	0.81	5.75	7.78
MnO	8		0.18	0.01	0.16	0.19
MgO	8		9.41	1.11	7.64	11.42
CaO	8		12.92	1.25	11.36	15.12
Na2O	8		3.01	0.75	1.94	4.20
K2O	8		0.96	0.51	0.51	2.08
H2O+	8		2.22	0.72	0.97	3.42
H2O-	8		0.83	0.31	0.34	1.36
P2O5	8		0.60	0.11	0.50	0.79
CO2	8		1.11	1.05	0.02	3.42
Li2O	8	88	0.001	0.0004	0.001	0.002
S	8		0.03	0.01	0.02	0.05
F	8		0.13	0.03	0.10	0.19
BaO	8		0.07	0.02	0.05	0.11
ppm						
As	8	13				
Cr	8		245	84.94	117	334
Cu	8		106	35.87	77	174
Mo	8	33	8.30	7.46		
Nb	8		80	11.14	63	95
Ni	8		108	63.67	34	209
Pb	8	0				
Rb	8		50	9.45	40	63
Sr	8		705	70.96	603	828
Y	8		22	1.20	20	23
Zn	8		89	32.16	47	124
Zr	8		284	56.21	187	365
Be	8		1.25	0.46	1.00	2.00
Ce	7		111.16	17.49	92.90	139.00
Co	7		49.44	3.55	42.30	52.80
Cs	7	29				
Eu	7		2.49	0.22	2.08	2.71
Hf	7		8.00	2.06	5.29	10.20
La	7		54.23	10.23	36.70	70.00
Lu	7	71	0.18	0.14	0.03	0.41
Sb	7	29				
Sc	7		38.71	9.37	31.00	58.10
Sm	7		8.45	0.71	7.58	9.42
Ta	7		4.64	0.84	3.32	5.82
Tb	7	29				
Th	7		4.84	1.33	3.49	7.27
U	7	0				
Yb	7	86	1.82	1.02	0.30	3.50

Table 7/9

8 – OLIVINE APOLEUCITITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	21		41.57	1.58	39.38	44.68
TiO2	21		3.61	0.62	2.39	4.44
Al2O3	21		11.21	1.79	7.50	13.71
Fe2O3	21		5.45	1.35	3.43	9.29
FeO	21		6.40	1.41	3.73	9.83
MnO	21		0.18	0.02	0.14	0.22
MgO	21		9.82	2.42	6.61	15.18
CaO	21		13.50	1.46	11.73	15.90
Na2O	21		2.72	0.80	1.37	4.35
K2O	21		0.87	0.41	0.35	1.80
H2O+	21		2.35	0.63	0.93	3.87
H2O-	21		0.79	0.40	0.06	1.57
P2O5	21		0.53	0.15	0.28	0.87
CO2	20		0.57	0.62	0.03	2.81
Li2O	15	87	0.002	0.001	0.0003	0.005
S	19		0.03	0.02	0.01	0.11
F	15		0.13	0.04	0.08	0.25
BaO	17		0.09	0.03	0.05	0.16
ppm						
As	13	15				
Cr	18		318	240.60	80	903
Cu	18		142	48.68	55	240
Mo	13	23				
Nb	18		74	21.38	33	114
Ni	18		114	69.03	40	262
Pb	18	23				
Rb	18	94	57	42.04	3	172
Sr	18		801	206.37	490	1200
Y	13		23	4.50	15	31
Zn	18		84	22.28	47	119
Zr	18		290	133.89	114	726
Be	17	74	1.48	1.04	0.30	4.00
Ce	12		110.58	30.28	63.00	168.00
Co	12		53.29	5.60	41.00	61.30
Cs	13	31				
Eu	13		2.46	0.57	1.60	3.51
Hf	13		6.88	1.48	4.90	9.40
La	13		48.32	14.66	26.00	77.20
Lu	13	85	0.19	0.09	0.03	0.32
Sb	13	31				
Sc	13		45.96	8.88	30.55	61.10
Sm	11		8.45	2.03	5.75	12.00
Ta	11		4.15	1.40	2.36	7.00
Tb	13	46	0.84	0.62		
Th	13		5.28	1.57	2.00	7.27
U	11	45	2.72	2.37		
Yb	13	77	1.64	1.04	0.30	4.08

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6–8 (B) – OLIVINE FOIDITES (except for strongly olivinic types AD 5)						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	144		41.01	1.37	38.31	44.94
TiO2	144		3.13	0.62	1.70	4.62
Al2O3	144		11.62	1.46	6.65	14.66
Fe2O3	144		5.18	1.05	3.40	9.29
FeO	144		6.82	1.04	3.73	10.45
MnO	143		0.19	0.03	0.14	0.40
MgO	144		10.84	2.10	6.61	17.94
CaO	144		12.63	1.31	9.24	16.00
Na2O	144		3.01	0.67	1.14	4.64
K2O	144		1.05	0.43	0.35	3.68
H2O+	144		2.28	0.80	0.20	5.72
H2O-	141		0.63	0.34	0.06	1.58
P2O5	144		0.77	0.26	0.03	1.46
CO2	135	99	0.55	0.71	0.003	4.27
Li2O	116	84	0.002	0.002	0.0003	0.01
S	127	97	0.04	0.03	0.003	0.19
F	118		0.10	0.03	0.01	0.25
BaO	112		0.09	0.03	0.05	0.19
ppm						
As	113	4				
Cr	122		359	203.97	41	1138
Cu	122		91	42.68	40	240
Mo	113	28				
Nb	122		91	20.70	33	158
Ni	122		196	100.68	21	559
Pb	114	11				
Rb	122	96	45	36.89	2	322
Sr	122		916	225.98	373	1600
Y	114		25	5.09	13	39
Zn	121		87	17.81	47	149
Zr	122		274	80.35	79	726
Be	110	74	1.56	1.13	0.30	5.00
Ce	59		125.19	32.08	63.00	211.00
Co	56		58.88	12.13	28.00	113.00
Cs	60	40	1.05	1.41		
Eu	59		2.76	0.55	1.60	5.10
Hf	59		6.41	1.65	3.25	10.20
La	60		67.96	26.12	26.00	154.00
Lu	59	90	0.23	0.10	0.03	0.42
Sb	59	24				
Sc	60		33.61	9.68	19.60	61.10
Sm	57		8.85	1.65	5.35	13.50
Ta	56		4.54	1.08	2.36	7.02
Tb	58	62	0.92	0.53	0.30	2.12
Th	57		7.36	3.32	2.00	20.30
U	53	42	2.69	2.43		
Yb	60	92	2.07	0.92	0.30	5.25

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9 – MELILITE NEPHELINITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	2		37.01	0.69	36.52	37.50
TiO2	2		4.79	0.47	4.46	5.12
Al2O3	2		10.83	0.16	10.71	10.94
Fe2O3	2		7.68	0.007	7.67	7.68
FeO	2		7.13	0.13	7.04	7.22
MnO	2		0.25	0.03	0.23	0.27
MgO	2		7.28	0.16	7.16	7.39
CaO	2		16.42	0.85	15.82	17.02
Na2O	2		3.17	0.40	2.89	3.45
K2O	2		1.54	0.23	1.38	1.70
H2O+	2		1.98	0.33	1.75	2.21
H2O-	2		0.25	0.09	0.18	0.31
P2O5	2		1.03	0.31	0.81	1.25
CO2	2		0.08	0.007	0.07	0.08
Li2O	2		0.002	0.000	0.002	0.002
S	2		0.06	0.01	0.05	0.07
F	2		0.13	0.01	0.12	0.14
BaO	2		0.09	0.003	0.09	0.09
ppm						
As	2	0				
Cr	2		101	15.56	90	112
Cu	2		241	28.99	220	261
Mo	2	0				
Nb	2		139	8.49	133	145
Ni	2		50	8.49	44	56
Pb	2	0				
Rb	2		37	0.71	36	37
Sr	2		1148	102.53	1075	1220
Y	2		32	2.83	30	34
Zn	2		123	2.83	121	125
Zr	2		320	40.31	291	348
Be	2		2.50	0.71	2.00	3.00
Ce	2		213.00	24.04	196.00	230.00
Co	2		59.30	6.51	54.70	63.90
Cs	2	0				
Eu	2		4.26	0.36	4.00	4.51
Hf	2		11.45	1.20	10.60	12.30
La	2		131.00	12.73	122.00	140.00
Lu	2		0.47	0.13	0.37	0.56
Sb	2	0				
Sc	2		37.30	3.54	34.80	39.80
Sm	2		14.45	1.06	13.70	15.20
Ta	2		8.02	1.49	6.96	9.07
Tb	2	50	0.96	0.93		
Th	2		12.00	0.42	11.70	12.30
U	2	0				
Yb	2		4.43	1.93	3.06	5.79

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10 – NEPHELINITE WITH MELILITE						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	1		35.73			
TiO2	1		4.75			
Al2O3	1		10.82			
Fe2O3	1		6.69			
FeO	1		9.52			
MnO	1		0.29			
MgO	1		5.97			
CaO	1		16.09			
Na2O	1		3.68			
K2O	1		1.68			
H2O+	1		2.75			
H2O-	1		0.49			
P2O5	1		1.51			
CO2	1		0.09			
Li2O	1		0.002			
S	1		0.04			
F	1		0.21			
BaO	1		0.10			
ppm						
As	1		<10			
Cr	1		48			
Cu	1		173			
Mo	1		<10			
Nb	1		168			
Ni	1		15			
Pb	1		27			
Rb	1		33			
Sr	1		1244			
Y	1		46			
Zn	1		171			
Zr	1		426			
Be	1		2.00			
Ce	1		286.00			
Co	1		53.20			
Cs	1		<1			
Eu	1		5.23			
Hf	1		12.60			
La	1		143.00			
Lu	1		0.29			
Sb	1		<1			
Sc	1		29.60			
Sm	1		18.40			
Ta	1		11.80			
Tb	1		1.83			
Th	1		14.40			
U	1		7.05			
Yb	1		5.87			

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9–10 (C) – OLIVINE-FREE MELILITIC ROCKS						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	3		36.58	0.89	35.73	37.50
TiO2	3		4.78	0.33	4.46	5.12
Al2O3	3		10.82	0.12	10.71	10.94
Fe2O3	3		7.35	0.57	6.69	7.68
FeO	3		7.93	1.38	7.04	9.52
MnO	3		0.26	0.03	0.23	0.29
MgO	3		6.84	0.76	5.97	7.39
CaO	3		16.31	0.63	15.82	17.02
Na2O	3		3.34	0.41	2.89	3.68
K2O	3		1.59	0.18	1.38	1.70
H2O+	3		2.24	0.50	1.75	2.75
H2O-	3		0.33	0.16	0.18	0.49
P2O5	3		1.19	0.35	0.81	1.51
CO2	3		0.08	0.01	0.07	0.09
Li2O	3		0.002	0.000	0.002	0.002
S	3		0.05	0.02	0.04	0.07
F	3		0.16	0.05	0.12	0.21
BaO	3		0.09	0.008	0.09	0.10
ppm						
As	3	0				
Cr	3		84	17.95	48	112
Cu	3		218	26.08	173	261
Mo	3	0				
Nb	3		150	20.95	133	168
Ni	3		38	14.73	15	56
Pb	3	0				
Rb	3		35	2.52	33	37
Sr	3		1180	80.18	1075	1244
Y	3		37	8.33	30	46
Zn	3		139	50.72	121	171
Zr	3		355	28.50	291	426
Be	3		2.33	0.58	2.00	3.00
Ce	3		237.33	45.45	196.00	286.00
Co	3		57.27	5.79	53.20	63.90
Cs	3	0				
Eu	3		4.58	0.62	4.00	5.23
Hf	3		11.83	1.08	10.60	12.60
La	3		135.00	11.36	122.00	143.00
Lu	3		0.41	0.14	0.29	0.56
Sb	3	0				
Sc	3		34.73	5.10	29.60	39.80
Sm	3		15.77	2.40	13.70	18.40
Ta	3		9.28	2.43	6.96	11.80
Tb	3	67	1.25	0.83	0.30	1.83
Th	3		12.80	1.42	11.70	14.40
U	3	33	2.95	3.55		
Yb	3		4.91	1.60	3.06	5.87

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11 – NEPHELINITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	38		38.48	2.15	32.70	41.48
TiO2	38		4.36	0.76	2.51	5.83
Al2O3	38		11.41	1.33	8.23	14.38
Fe2O3	38		7.30	1.04	4.93	8.87
FeO	38		7.10	0.94	4.49	8.83
MnO	38		0.25	0.04	0.18	0.37
MgO	38		7.04	0.96	3.97	8.60
CaO	38		14.50	1.39	11.50	16.72
Na2O	38		2.96	0.69	1.72	4.84
K2O	38		1.21	0.33	0.29	1.92
H2O+	38		2.24	0.48	1.32	3.26
H2O-	37		0.76	0.37	0.30	1.91
P2O5	38		1.26	0.89	0.54	4.30
CO2	37		0.65	0.72	0.02	2.56
Li2O	37	95	0.002	0.001	0.0003	0.006
S	38		0.07	0.04	0.01	0.22
F	37		0.13	0.04	0.02	0.22
BaO	25		0.09	0.03	0.06	0.20
ppm						
As	36	11				
Cr	36		54	39.70	5	175
Cu	36		131	78.59	45	329
Mo	36	22				
Nb	36		131	36.83	78	214
Ni	36	94	36	20.57	2	90
Pb	35	17				
Rb	36		41	16.24	12	84
Sr	36		1094	351.81	475	1845
Y	36		33	8.64	21	55
Zn	36		95	30.75	51	161
Zr	36		468	169.84	265	926
Be	25	92	2.12	1.34	0.30	5.30
Ce	25		186.48	38.31	115.00	288.00
Co	25		53.86	10.33	32.30	74.40
Cs	25	32				
Eu	25		4.12	1.10	2.87	7.36
Hf	25		10.99	2.39	6.96	17.60
La	25		104.95	28.20	59.40	173.00
Lu	25		0.33	0.12	0.19	0.69
Sb	25	16				
Sc	25		30.67	9.71	9.77	49.50
Sm	25		13.46	2.43	9.34	19.60
Ta	25		7.38	1.88	4.34	12.60
Tb	25	88	1.64	1.55	0.30	8.77
Th	25		10.23	2.50	6.61	18.00
U	25	52	3.16	2.71	0.90	9.98
Yb	25		3.92	1.13	1.70	6.26

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12 – ANALCIMITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	14		41.16	1.53	38.12	43.98
TiO2	14		3.88	0.47	2.79	4.58
Al2O3	14		12.40	0.85	10.45	13.44
Fe2O3	14		6.35	0.95	4.16	7.75
FeO	14		5.73	0.97	3.63	7.30
MnO	14		0.19	0.05	0.01	0.25
MgO	14		7.18	1.31	5.60	10.78
CaO	14		13.54	1.17	11.38	15.65
Na2O	14		2.52	0.68	1.42	3.69
K2O	14		1.36	0.40	0.67	2.02
H2O+	14		2.56	0.86	0.32	3.93
H2O-	14		1.72	0.80	0.36	3.37
P2O5	14		0.74	0.21	0.47	1.12
CO2	14		0.68	0.75	0.03	2.66
Li2O	13		0.003	0.003	0.001	0.01
S	13		0.06	0.04	0.02	0.11
F	13		0.14	0.03	0.10	0.21
BaO	9		0.08	0.02	0.05	0.10
ppm						
As	13	8				
Cr	13	92	61	40.12	2	136
Cu	13		141	88.61	45	412
Mo	13	31				
Nb	13		96	20.43	58	139
Ni	13		40	21.75	16	81
Pb	13	8				
Rb	13		63	57.63	16	202
Sr	13		951	204.19	645	1446
Y	13		29	5.03	21	41
Zn	13		78	20.56	55	124
Zr	13		378	76.21	274	578
Be	9		1.56	0.53	1.00	2.00
Ce	11		154.82	23.18	125.00	201.00
Co	11		48.10	5.22	40.80	59.50
Cs	11	73	1.54	0.94	0.30	3.17
Eu	11		3.40	0.83	2.75	5.73
Hf	11		10.06	2.16	7.96	15.90
La	11		69.18	15.09	48.30	103.00
Lu	11		0.28	0.13	0.14	0.59
Sb	11	9				
Sc	11		34.65	7.81	18.30	47.60
Sm	11		10.17	1.95	5.30	11.90
Ta	11		6.38	1.27	4.53	8.11
Tb	11	55	0.94	0.70	0.30	2.39
Th	11		8.11	0.97	6.45	10.20
U	11	55	3.03	2.30	0.90	6.47
Yb	11		3.21	1.04	1.45	4.85

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13 – APOLEUCITITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	16		40.74	1.48	38.37	43.23
TiO2	16		4.16	0.52	2.74	4.94
Al2O3	16		11.92	1.14	9.81	14.53
Fe2O3	16		6.54	1.69	2.23	8.79
FeO	16		6.60	1.35	4.33	9.63
MnO	16		0.21	0.02	0.17	0.24
MgO	16		7.16	1.39	5.15	10.75
CaO	16		13.69	1.37	10.33	16.63
Na2O	16		2.99	0.70	1.19	3.84
K2O	16		0.86	0.34	0.38	1.78
H2O+	16		2.41	0.64	1.65	3.67
H2O-	16		1.09	0.36	0.61	1.82
P2O5	16		0.74	0.15	0.48	1.01
CO2	15		0.45	0.59	0.02	2.05
Li2O	14		0.003	0.003	0.001	0.01
S	15		0.03	0.02	0.01	0.09
F	14		0.16	0.02	0.12	0.20
BaO	15		0.08	0.02	0.05	0.15
ppm						
As	14	21				
Cr	15		69	47.04	7	152
Cu	15		182	67.62	93	357
Mo	14	7				
Nb	15		98	11.24	80	114
Ni	15		40	18.89	11	77
Pb	14	14				
Rb	15		70	41.26	7	173
Sr	15		902	226.01	617	1483
Y	14		29	5.86	21	41
Zn	15		92	28.20	57	136
Zr	15		347	70.32	244	510
Be	15	87	2.15	1.33	0.30	4.00
Ce	14		150.29	18.90	121.00	192.00
Co	15		49.25	7.40	31.00	62.30
Cs	15	60	1.34	1.25	0.30	4.91
Eu	15		3.13	0.37	2.56	3.81
Hf	15		8.94	1.54	6.02	11.50
La	14		69.91	15.83	47.60	112.00
Lu	15	87	0.22	0.13	0.03	0.42
Sb	15	20				
Sc	15		36.39	8.44	21.00	49.10
Sm	14		10.90	1.32	8.37	13.60
Ta	14		5.94	1.08	4.41	7.54
Tb	15	60	0.98	0.65	0.30	2.30
Th	15		7.54	1.16	5.11	9.33
U	14	43	3.68	3.73		
Yb	15	93	3.01	1.37	0.30	5.25

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11–13 (D) – OLIVINE-FREE FOIDITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	68		39.56	2.39	32.70	43.98
TiO2	68		4.21	0.94	2.51	5.83
Al2O3	68		11.73	1.49	8.23	14.53
Fe2O3	68		6.93	1.29	2.23	8.87
FeO	68		6.70	1.14	3.63	9.63
MnO	68		0.23	0.05	0.01	0.37
MgO	68		7.10	1.11	3.97	10.78
CaO	68		14.11	1.61	10.33	16.72
Na2O	68		2.88	0.71	1.19	4.84
K2O	68		1.16	0.49	0.29	2.02
H2O+	68		2.35	0.61	0.32	3.93
H2O-	67		0.93	0.51	0.30	3.37
P2O5	68		1.02	0.71	0.47	4.30
CO2	68		0.61	0.68	0.02	2.66
Li2O	64	97	0.003	0.002	0.0003	0.012
S	66		0.06	0.04	0.01	0.22
F	64		0.14	0.04	0.02	0.22
BaO	49		0.09	0.03	0.05	0.20
ppm						
As	63	13				
Cr	64	98	59	41.44	2	175
Cu	64		145	79.97	45	412
Mo	63	21				
Nb	64		116	33.56	58	214
Ni	64	97	38	20.25	2	90
Pb	62	15				
Rb	64		52	36.39	7	202
Sr	64		1020	308.92	475	1845
Y	63		31	7.68	21	55
Zn	64		91	28.80	51	161
Zr	64		421	145.46	244	926
Be	49	92	2.02	1.23	0.30	5.30
Ce	48		169.35	35.72	115.00	288.00
Co	49		51.29	9.05	31.00	74.40
Cs	49	49	1.27	1.20		
Eu	49		3.68	1.00	2.56	7.36
Hf	49		10.25	2.29	6.02	17.60
La	48		87.76	29.16	47.60	173.00
Lu	49	96	0.29	0.13	0.03	0.69
Sb	49	16				
Sc	49		33.07	9.30	9.77	49.50
Sm	48		12.03	2.56	5.30	19.60
Ta	48		6.74	1.70	4.34	12.60
Tb	49	76	1.33	1.23	0.30	8.77
Th	49		9.03	2.30	5.11	18.00
U	48	50	3.27	2.91		
Yb	49	98	3.48	1.25	0.30	6.26

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14 – NEPHELINE BASANITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	103		42.82	1.50	38.45	47.09
TiO2	103		2.84	0.52	1.12	4.18
Al2O3	103		12.86	1.05	9.91	17.78
Fe2O3	103		4.95	1.46	2.06	11.81
FeO	102		6.97	1.01	3.47	9.70
MnO	102		0.20	0.02	0.15	0.28
MgO	103		9.63	2.08	5.76	15.43
CaO	103		11.33	0.86	9.59	13.50
Na2O	103		3.20	0.52	1.69	4.28
K2O	103		1.30	0.41	0.32	2.14
H2O+	100		2.05	0.95	0.15	5.15
H2O-	100		0.60	0.40	0.12	3.15
P2O5	102		0.73	0.21	0.04	1.56
CO2	92	99	0.33	0.45	0.003	2.60
Li2O	80	73	0.002	0.005	0.0003	0.04
S	88	98	0.03	0.03	0.003	0.19
F	81		0.08	0.03	0.01	0.14
BaO	69		0.09	0.02	0.04	0.16
ppm						
As	85	2				
Cr	90		285	142.67	9	719
Cu	90		72	30.96	29	199
Mo	85	34	7.50	9.00		
Nb	90		87	15.57	57	120
Ni	90		184	112.86	19	506
Pb	85	7				
Rb	90	99	35	19.74	2	147
Sr	90		922	221.31	339	2126
Y	85		24	5.87	13	43
Zn	90		89	17.36	62	153
Zr	90		273	51.53	140	419
Be	72	81	1.92	1.22	0.30	5.50
Ce	48		113.81	20.19	78.00	150.00
Co	46		55.51	8.74	33.00	73.00
Cs	48	13				
Eu	48		2.61	0.30	1.70	3.16
Hf	48		6.34	1.01	4.14	9.00
La	48		64.14	17.04	40.00	110.00
Lu	48	96	0.28	0.11	0.03	0.57
Sb	46	20				
Sc	48		28.69	5.66	18.20	46.80
Sm	43		8.09	1.00	5.75	9.96
Ta	43		4.25	0.68	2.29	5.54
Tb	48	52	0.79	0.48	0.30	1.61
Th	46		7.00	2.05	3.85	11.90
U	41	32				
Yb	48	96	2.43	1.05	0.30	4.99

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15 – ANALCIME AND ZEOLITE BASANITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	13		42.25	1.21	40.24	44.35
TiO2	13		3.18	0.49	2.10	3.95
Al2O3	13		12.77	1.94	8.56	15.53
Fe2O3	13		5.82	1.99	2.23	10.35
FeO	13		6.55	1.78	1.65	9.08
MnO	13		0.20	0.02	0.18	0.24
MgO	13		8.90	2.55	6.18	14.88
CaO	13		12.40	1.44	10.20	16.03
Na2O	13		2.79	0.44	2.12	3.50
K2O	13		1.08	0.39	0.54	1.98
H2O+	13		2.40	0.79	1.70	4.54
H2O-	13		0.75	0.39	0.26	1.30
P2O5	13		0.72	0.24	0.40	1.40
CO2	12		0.11	0.07	0.01	0.31
Li2O	11	64	0.001	0.001	0.0003	0.005
S	12		0.02	0.01	0.01	0.05
F	11		0.11	0.04	0.04	0.15
BaO	10		0.09	0.02	0.06	0.13
ppm						
As	12	17				
Cr	12		194	156.03	35	494
Cu	12		84	30.56	49	133
Mo	12	17				
Nb	12		81	15.64	54	105
Ni	12		115	125.32	14	442
Pb	12	33	6.10	6.14		
Rb	12		46	28.05	15	115
Sr	12		867	210.98	645	1437
Y	12	92	23	7.42	3	31
Zn	12		89	21.09	51	128
Zr	12		237	34.51	179	280
Be	10	70	1.62	1.23	0.30	4.00
Ce	8		118.00	8.23	107.00	133.00
Co	8		55.68	5.73	49.10	67.80
Cs	8	28				
Eu	8		2.59	0.16	2.33	2.82
Hf	8		6.75	1.15	5.37	8.64
La	8		57.53	9.03	47.70	76.90
Lu	8		0.30	0.08	0.16	0.41
Sb	8	13				
Sc	8		36.89	6.76	27.80	46.60
Sm	8		8.64	0.95	6.96	9.90
Ta	8		4.21	0.62	2.92	4.72
Tb	8	63	0.99	0.58	0.30	1.67
Th	8		6.41	1.41	4.07	7.85
U	8	50	3.47	2.93		
Yb	8		2.85	0.59	2.06	3.73

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16 – APOLEUCITE BASANITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	9		42.43	1.44	39.54	44.55
TiO2	9		3.14	0.78	1.78	4.48
Al2O3	9		11.31	2.59	6.88	14.56
Fe2O3	9		4.80	0.86	3.48	5.91
FeO	9		6.12	1.05	3.94	8.09
MnO	9		0.17	0.02	0.14	0.20
MgO	9		10.72	4.36	6.18	18.27
CaO	9		12.64	1.37	10.81	14.86
Na2O	9		2.71	0.94	1.46	4.65
K2O	9		0.93	0.54	0.34	1.87
H2O+	9		2.34	0.78	1.30	3.37
H2O-	9		0.68	0.32	0.25	1.16
P2O5	9		0.48	0.25	0.19	0.80
CO2	8		1.18	1.00	0.02	2.88
Li2O	4		0.004	0.004	0.001	0.01
S	9		0.07	0.15	0.01	0.46
F	6		0.10	0.06	0.04	0.18
BaO	4		0.09	0.03	0.06	0.12
ppm						
As	1		<7			
Cr	4		337	178.43	160	500
Cu	4		157	67.69	96	250
Mo	1		<7			
Nb	4		57	9.50	50	70
Ni	4		92	29.82	66	130
Pb	1		<7			
Rb	4		51	17.19	33	70
Sr	4		974	203.66	750	1244
Y	1		20			
Zn	4		100	47.40	70	171
Zr	4		272	107.12	190	426
Be	4		1.83	0.51	1.10	2.30
Ce	2		81.50	43.13	51.00	112.00
Co	2		48.80	1.70	47.60	50.00
Cs	2	50	3.58	4.63		
Eu	2		2.02	0.59	1.60	2.44
Hf	2		4.99	1.39	4.00	5.97
La	2		34.90	14.00	25.00	44.80
Lu	2	50	0.15	0.17		
Sb	2	0				
Sc	2		41.85	8.70	35.70	48.00
Sm	1		8.30			
Ta	1		4.07			
Th	2	0				
Th	2		10.02	4.21	7.04	13.00
U	1		5.15			
Yb	2		2.56	2.20	1.00	4.11

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14–16 (E) – BASANITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	125		42.73	1.47	38.45	47.09
TiO2	125		2.90	0.55	1.12	4.48
Al2O3	125		12.74	1.36	6.88	15.53
Fe2O3	125		5.03	1.50	2.06	11.81
FeO	124		6.86	1.13	1.65	9.70
MnO	124		0.20	0.02	0.14	0.28
MgO	125		9.63	2.36	5.76	18.27
CaO	125		11.53	1.07	9.59	16.03
Na2O	125		3.12	0.57	1.46	4.65
K2O	125		1.25	0.43	0.32	2.14
H2O+	122		2.11	0.92	0.15	5.15
H2O-	122		0.62	0.39	0.12	3.15
P2O5	124		0.71	0.22	0.04	1.56
CO2	112	99	0.37	0.53	0.003	2.88
Li2O	95	73	0.002	0.004	0.0003	0.04
S	109	98	0.04	0.05	0.003	0.46
F	98		0.09	0.03	0.01	0.18
BaO	83		0.09	0.02	0.04	0.16
ppm						
As	98	4				
Cr	106		276	147.27	9	719
Cu	106		77	36.17	29	250
Mo	98	32				
Nb	106		85	16.36	50	120
Ni	106		173	114.97	14	506
Pb	98	10				
Rb	106	99	36	21.11	2	147
Sr	106		913	217.27	339	2126
Y	98	99	24	6.04	3	43
Zn	106		88	17.74	51	153
Zr	106		267	51.15	140	419
Be	86	80	1.87	1.20	0.30	5.50
Ce	59		112.93	20.38	51.00	150.00
Co	57		55.38	8.22	33.00	73.00
Cs	59	15				
Eu	59		2.58	0.31	1.60	3.16
Hf	59		6.30	1.13	3.30	9.00
La	59		61.98	16.85	25.00	110.00
Lu	59	95	0.28	0.11	0.03	0.57
Sb	57	19				
Sc	59		30.38	6.79	18.20	48.00
Sm	53		8.15	1.01	5.75	9.96
Ta	53		4.23	0.66	2.29	5.54
Tb	59	51	0.79	0.50	0.30	1.67
Th	57		6.98	2.09	3.85	13.00
U	51	35	2.25	2.03		
Yb	59	97	2.47	1.04	0.30	4.99

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17 – OLIVINE ALKALI BASALTS						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	38		43.83	1.43	41.23	46.79
TiO2	38		2.81	0.48	1.11	3.75
Al2O3	38		13.22	1.21	10.32	15.99
Fe2O3	38		4.98	1.54	2.23	8.95
FeO	38		6.79	1.76	2.96	12.50
MnO	38		0.21	0.08	0.17	0.64
MgO	38		9.04	2.08	5.70	13.28
CaO	38		10.87	0.82	8.96	12.58
Na2O	38		3.08	0.59	1.80	4.12
K2O	38		1.37	0.46	0.75	2.33
H2O+	38		1.85	0.79	0.58	4.12
H2O-	35		0.56	0.45	0.12	2.37
P2O5	38		0.73	0.22	0.26	1.42
CO2	30		0.39	0.71	0.01	3.16
Li2O	18	94	0.001	0.0008	0.0003	0.004
S	26	92	0.03	0.04	0.003	0.20
F	18		0.09	0.02	0.06	0.13
BaO	18		0.13	0.15	0.06	0.70
ppm						
As	17	18				
Cr	19		245	142.29	60	550
Cu	19		80	44.44	39	200
Mo	17	47	8.00	6.96		
Nb	19		84	17.14	56	120
Ni	19		147	108.46	38	413
Pb	17	12				
Rb	19		42	23.74	13	90
Sr	19		872	230.83	647	1700
Y	17		28	5.11	18	35
Zn	19		99	25.41	63	150
Zr	19		256	90.95	148	550
Be	17	94	2.44	1.47	0.30	6.00
Ce	14		97.14	23.68	50.00	130.00
Co	12		47.44	6.40	39.00	59.40
Cs	14	21				
Eu	14		2.48	0.37	1.60	3.10
Hf	14		5.95	1.40	3.09	7.70
La	14		56.39	16.58	27.00	86.40
Lu	14		0.31	0.11	0.19	0.51
Sb	14	14				
Sc	14		26.52	5.54	20.70	41.00
Sm	12		7.25	1.10	5.25	8.79
Ta	12		3.94	0.70	2.63	5.03
Tb	13	62	0.82	0.44	0.30	1.42
Th	13		6.35	1.66	3.92	9.98
U	10	40	2.67	2.96		
Yb	14	93	2.50	0.88	0.30	3.69

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18 – NEPHELINE TEPHRITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	16		43.50	1.61	41.08	46.13
TiO2	16		3.19	0.39	2.68	4.02
Al2O3	16		14.16	0.98	12.36	15.42
Fe2O3	16		5.52	1.07	3.28	6.97
FeO	16		6.34	1.60	3.58	10.11
MnO	16		0.24	0.03	0.19	0.31
MgO	16		5.34	1.38	2.75	7.63
CaO	16		11.18	0.72	10.16	12.31
Na2O	16		3.26	0.71	2.24	5.05
K2O	16		1.98	0.52	0.90	2.95
H2O+	16		2.83	1.10	1.63	5.35
H2O-	16		0.72	0.34	0.20	1.35
P2O5	16		0.82	0.25	0.55	1.39
CO2	15	93	0.47	0.81	0.003	2.40
Li2O	13	92	0.003	0.002	0.0003	0.006
S	16		0.07	0.04	0.01	0.16
F	13		0.12	0.03	0.07	0.17
BaO	8		0.11	0.02	0.08	0.15
ppm						
As	13	8				
Cr	13	92	63	65.90	2	187
Cu	13		41	19.49	11	74
Mo	13	62	8.60	7.06	2	27
Nb	13		129	45.85	74	220
Ni	13	85	46	47.39	2	132
Pb	13	15				
Rb	13		72	68.51	22	285
Sr	13		1267	381.25	872	2021
Y	13	92	33	11.49	2	49
Zn	13		102	10.74	82	121
Zr	13		446	144.57	301	687
Be	8	88	1.58	0.89	0.30	3.00
Ce	5		218.60	74.71	139.00	297.00
Co	5		39.64	6.70	29.60	46.70
Cs	5	20				
Eu	5		4.24	1.00	2.84	5.22
Hf	5		11.31	3.24	7.33	14.70
La	5		129.70	63.19	68.20	202.00
Lu	5		0.50	0.16	0.33	0.67
Sb	5	0				
Sc	5		13.40	5.82	6.73	19.00
Sm	5		13.80	3.34	10.10	17.10
Ta	5		8.62	3.08	4.37	11.80
Tb	5	80	1.31	0.60	0.30	1.90
Th	5		13.55	5.91	7.91	20.40
U	5	80	3.28	1.36	0.90	4.30
Yb	5		5.54	2.25	2.38	7.62

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19 – ANALCIME TEPHRITES AND ZEOLITE TEPHRITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	28		44.44	1.96	41.39	48.16
TiO2	28		3.19	0.41	2.30	4.02
Al2O3	28		14.64	1.15	12.32	17.39
Fe2O3	28		5.89	0.83	3.89	8.08
FeO	28		5.45	1.15	2.80	7.07
MnO	28		0.21	0.03	0.14	0.28
MgO	28		5.17	0.97	3.33	6.62
CaO	28		10.73	1.10	8.85	12.84
Na2O	28		3.37	0.74	1.55	4.60
K2O	28		1.65	0.63	0.66	3.16
H2O+	28		2.80	0.92	1.66	5.03
H2O-	28		1.05	0.45	0.34	2.07
P2O5	28		0.79	0.15	0.42	1.03
CO2	26		0.29	0.48	0.01	1.64
Li2O	21		0.003	0.001	0.001	0.008
S	28		0.03	0.02	0.01	0.08
F	25		0.14	0.02	0.10	0.19
BaO	22		0.11	0.05	0.05	0.24
ppm						
As	21	33	5.70	5.12		
Cr	23	91	48	33.34	2	127
Cu	23		65	25.48	9	105
Mo	21	5				
Nb	23		105	27.56	63	176
Ni	23	91	25	13.63	2	53
Pb	21	43	6.50	5.23		
Rb	23	96	65	31.47	3	135
Sr	23		1134	422.68	628	2300
Y	21		32	6.18	24	48
Zn	23		103	31.68	52	172
Zr	23		362	101.26	211	590
Be	21	95	1.97	1.09	0.30	5.00
Ce	17		162.29	33.05	110.00	249.00
Co	17		40.16	7.67	23.70	49.00
Cs	17	59	1.31	1.10	0.30	3.73
Eu	17		3.29	0.55	2.40	4.70
Hf	17		8.69	1.75	5.64	11.90
La	17		75.30	17.44	49.80	127.00
Lu	17		0.37	0.13	0.12	0.55
Sb	17	12				
Sc	17		23.44	7.21	8.43	33.90
Sm	17		10.93	1.68	7.81	14.50
Ta	17		6.00	1.72	3.99	11.00
Tb	17	71	1.29	0.69	0.30	2.07
Th	17		9.98	2.34	6.91	16.20
U	17	35	2.07	1.75		
Yb	17		3.42	1.11	1.20	5.11

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20 – APOLEUCITE TEPHRITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	11		43.95	1.63	41.40	46.52
TiO2	11		3.35	0.85	1.45	4.40
Al2O3	11		14.66	1.37	11.49	16.48
Fe2O3	11		5.78	1.53	4.49	9.85
FeO	11		5.42	1.97	0.46	8.53
MnO	11		0.21	0.06	0.15	0.32
MgO	11		5.41	0.92	3.25	6.85
CaO	11		11.28	1.27	9.37	13.74
Na2O	11		3.36	0.72	2.45	4.84
K2O	11		1.84	0.53	1.08	2.85
H2O+	11		2.87	0.71	1.31	3.66
H2O-	10		0.80	0.36	0.10	1.25
P2O5	11		0.65	0.22	0.34	1.10
CO2	11		0.35	0.50	0.03	1.72
Li2O	5		0.003	0.0005	0.002	0.005
S	9		0.05	0.05	0.01	0.17
F	6		0.13	0.03	0.10	0.18
BaO	7		0.09	0.02	0.07	0.11
ppm						
As	5	40	5.70	5.32		
Cr	7	86	40	18.79	2	63
Cu	7		102	52.70	58	210
Mo	5	0				
Nb	7		95	26.08	75	150
Ni	7		24	6.52	17	35
Pb	5	20				
Rb	7		78	31.62	27	110
Sr	7		1255	887.32	692	3200
Y	5		27	4.39	22	33
Zn	7		87	21.11	71	133
Zr	6		367	67.99	278	460
Be	7	71	1.83	1.20	0.30	4.00
Ce	4		131.50	22.52	112.00	161.00
Co	5		42.50	7.86	32.00	51.80
Cs	5	60	1.58	1.76	0.30	4.57
Eu	5		2.70	0.49	2.00	3.34
Hf	5		8.61	1.98	6.00	10.90
La	4		62.63	8.87	52.20	73.50
Lu	5		0.26	0.08	0.16	0.36
Sb	5	20				
Sc	5		26.84	3.75	22.50	30.90
Sm	4		9.35	1.11	8.26	10.80
Ta	4		5.30	1.10	4.14	6.80
Tb	5	40	0.91	0.83		
Th	5		8.00	1.98	5.00	9.52
U	4	25				
Yb	5		2.29	0.82	1.00	3.26

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21 – SODALITE TEPHRITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	9		45.90	1.10	43.79	46.73
TiO2	9		2.65	0.68	1.15	3.32
Al2O3	9		14.47	1.17	12.62	17.00
Fe2O3	9		5.49	1.02	4.40	7.15
FeO	9		5.13	1.01	3.56	6.08
MnO	9		0.24	0.02	0.22	0.30
MgO	9		4.35	0.88	2.82	5.79
CaO	9		10.51	0.77	9.58	11.82
Na2O	9		3.57	0.70	2.41	4.36
K2O	9		2.53	0.39	1.99	3.29
H2O+	9		2.73	0.36	2.08	3.32
H2O-	5		1.24	1.10	0.29	3.05
P2O5	9		0.94	0.14	0.75	1.11
CO2	8	88	0.09	0.06	0.003	0.20
Li2O	2		0.003	0.0003	0.003	0.003
S	3		0.07	0.03	0.04	0.09
F	2		0.13	0.04	0.10	0.16
BaO	7		0.12	0.03	0.07	0.16
ppm						
As	3	33	5.70	6.29		
Cr	4		20	10.41	11	34
Cu	3		61	52.16	11	115
Mo	3	33	5.40	4.90		
Nb	3		158	42.03	112	194
Ni	3	67	15	10.12	3	21
Pb	3	33	5.10	5.14		
Rb	7		73	21.42	46	100
Sr	7		1322	85.76	1201	1440
Y	7		36	5.28	30	44
Zn	5		102	15.90	88	125
Zr	7		446	61.57	362	550
Be	3		3.00	1.00	2.00	4.00
Ce	3		184.67	64.47	144.00	259.00
Co	3		20.23	8.33	14.00	29.70
Cs	3		2.31	0.88	1.45	3.20
Eu	3		2.90	0.83	2.40	3.86
Hf	3		9.33	1.54	8.30	11.10
La	3		100.83	30.69	79.50	136.00
Lu	3		0.35	0.11	0.23	0.43
Sb	1		<1			
Sc	3		10.83	7.34	6.20	19.30
Sm	3		10.87	3.49	8.80	14.90
Ta	3		5.33	2.39	3.90	8.09
Tb	3		1.16	0.42	0.91	1.65
Th	3		14.63	3.82	11.90	19.00
U	3		2.99	0.63	2.35	3.61
Yb	3		2.88	1.17	2.15	4.23

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18–21 (F) – TEPHRITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	64		44.33	1.84	41.08	48.16
TiO2	64		3.14	0.57	1.15	4.40
Al2O3	64		14.50	1.15	11.49	17.39
Fe2O3	64		5.72	1.05	3.28	9.85
FeO	64		5.62	1.45	0.46	10.11
MnO	64		0.22	0.04	0.14	0.32
MgO	64		5.14	1.10	2.75	7.63
CaO	64		10.91	1.03	8.85	13.74
Na2O	64		3.37	0.71	1.55	5.05
K2O	64		1.89	0.62	0.66	3.29
H2O+	64		2.81	0.87	1.31	5.35
H2O-	59		0.93	0.50	0.10	3.05
P2O5	64		0.79	0.21	0.34	1.39
CO2	60	97	0.32	0.55	0.003	2.40
Li2O	41	98	0.003	0.001	0.0003	0.008
S	56		0.05	0.03	0.01	0.17
F	46		0.13	0.03	0.06	0.19
BaO	44		0.11	0.04	0.05	0.24
ppm						
As	42	26				
Cr	47	91	49	43.09	2	187
Cu	46		63	35.86	9	210
Mo	42	24				
Nb	46		114	37.47	63	220
Ni	46	89	30	28.43	2	132
Pb	42	31				
Rb	50	98	70	42.36	3	285
Sr	50		1212	467.78	628	3200
Y	46	98	33	7.93	2	49
Zn	48		100	24.62	52	172
Zr	49		397	112.13	211	687
Be	39	90	1.94	1.08	0.30	5.00
Ce	29		169.52	50.10	110.00	297.00
Co	30		38.17	9.42	14.00	51.80
Cs	30	57	1.32	1.19	0.30	4.57
Eu	30		3.33	0.78	2.00	5.22
Hf	30		9.18	2.19	5.64	14.70
La	29		85.72	36.43	49.80	202.00
Lu	30		0.37	0.14	0.12	0.67
Sb	28	11				
Sc	30		21.17	8.30	6.20	33.90
Sm	29		11.20	2.44	7.81	17.10
Ta	29		6.29	2.20	3.90	11.80
Tb	30	73	1.27	0.66	0.30	2.07
Th	30		10.62	3.84	5.00	20.40
U	29	52	2.43	1.62	0.90	6.26
Yb	30		3.56	1.59	1.00	7.62

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22 – ALKALI BASALTS

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	23		44.92	2.19	39.77	47.44
TiO2	23		3.01	0.43	2.39	4.24
Al2O3	23		14.90	0.86	12.74	16.21
Fe2O3	23		5.77	1.16	4.12	8.71
FeO	23		5.40	1.17	2.49	7.39
MnO	23		0.21	0.03	0.17	0.29
MgO	23		5.05	1.10	3.62	7.08
CaO	23		10.59	1.16	8.59	13.38
Na2O	23		3.40	0.49	2.51	4.26
K2O	23		1.91	0.64	0.89	3.36
H2O+	23		2.68	1.22	1.03	5.66
H2O-	23		0.85	0.46	0.26	2.12
P2O5	23		0.81	0.21	0.40	1.20
CO2	23	95	0.18	0.28	0.003	1.17
Li2O	15	80	0.002	0.001	0.001	0.005
S	20	95	0.03	0.01	0.003	0.06
F	17		0.12	0.04	0.07	0.25
BaO	16		0.11	0.02	0.07	0.14
ppm						
As	15	20				
Cr	16	94	53	59.32	2	243
Cu	16		50	17.83	18	90
Mn	15	27				
Nb	16		103	25.14	64	167
Ni	16	88	25	21.19	2	87
Pb	15	33	6.10	5.84		
Rb	16		77	77.54	29	359
Sr	16		1157	373.95	759	2200
Y	15		34	9.31	22	55
Zn	16		105	23.77	68	140
Zr	16		362	92.86	201	577
Be	16	88	1.92	1.05	0.30	4.00
Ce	10		139.70	32.40	99.00	188.00
Co	11		38.55	10.15	19.00	52.30
Cs	11	55	1.85	2.79	0.30	9.93
Eu	11		2.93	0.40	2.53	3.72
Hf	11		8.50	0.94	6.83	9.85
La	10		70.00	22.19	40.70	119.00
Lu	11		0.33	0.13	0.14	0.51
Sb	11	27				
Sc	11		21.42	4.52	13.00	26.10
Sm	10		9.52	1.50	7.47	11.80
Ta	10		5.50	1.21	4.10	7.34
Tb	11	64	0.91	0.50	0.30	1.51
Th	11		9.29	2.86	4.76	14.80
U	10	60	2.93	1.86	0.90	5.61
Yb	11		3.16	1.16	1.86	5.18

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23 – LIMBURGITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	8		41.27	1.87	39.60	44.00
TiO2	8		3.33	0.74	2.47	4.24
Al2O3	8		11.32	1.97	8.15	13.47
Fe2O3	8		5.00	1.17	3.76	6.99
FeO	8		6.93	1.52	5.53	9.75
MnO	8		0.20	0.06	0.15	0.32
MgO	8		9.68	2.51	6.50	13.80
CaO	8		12.89	1.34	11.04	14.51
Na2O	8		2.00	0.58	1.36	3.18
K2O	8		1.63	0.51	0.67	2.09
H2O+	8		2.83	0.82	1.82	4.55
H2O-	8		0.81	0.35	0.43	1.50
P2O5	8		0.63	0.13	0.42	0.74
CO2	7		1.21	0.67	0.05	2.09
Li2O	6	83	0.002	0.0009	0.0003	0.003
S	8		0.05	0.03	0.02	0.10
F	6		0.10	0.02	0.07	0.13
BaO	6		0.10	0.03	0.07	0.16
ppm						
As	5	20				
Cr	7		314	203.61	100	666
Cu	7		143	91.12	45	320
Mo	5	40	7.40	7.76		
Nb	7		86	23.04	54	120
Ni	7		131	62.65	60	240
Pb	5	20				
Rb	7		50	26.94	35	110
Sr	7		1076	379.86	578	1700
Y	5		20	4.18	14	24
Zn	7		91	27.91	57	127
Zr	7		272	36.44	222	330
Be	5		0.92	0.70	0.30	2.00
Ce	4		98.25	20.65	85.00	129.00
Co	4		50.38	7.76	43.00	59.60
Cs	4	50	0.96	0.82		
Eu	4		2.75	0.43	2.28	3.20
Hf	4		7.43	1.66	6.00	9.02
La	4		49.40	7.89	40.20	59.40
Lu	4	75	0.15	0.08	0.03	0.20
Sb	4	50	15.15	21.07		
Sc	4		39.10	13.03	27.00	52.90
Sm	2		8.52	2.38	6.84	10.20
Ta	2		4.40	1.32	3.46	5.33
Tb	4	75	1.09	0.54	0.30	1.49
Th	4		5.26	1.44	3.51	7.00
U	2	0				
Yb	4	75	1.93	1.50	0.30	3.90

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24 – PLAGIOCLASE LIMBURGITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	9		42.31	1.77	40.49	45.50
TiO2	9		3.09	0.52	2.41	3.65
Al2O3	9		13.50	1.43	10.03	14.85
Fe2O3	9		4.40	0.84	2.69	5.60
FeO	9		7.72	0.73	6.63	8.62
MnO	9		0.21	0.03	0.18	0.27
MgO	9		9.16	2.39	7.28	14.87
CaO	9		10.87	0.57	9.88	11.66
Na2O	9		2.83	0.40	2.03	3.45
K2O	9		1.78	0.26	1.26	2.11
H2O+	9		2.46	0.60	1.57	3.45
H2O-	9		0.43	0.13	0.29	0.61
P2O5	9		0.73	0.11	0.54	0.89
CO2	9	89	0.25	0.19	0.003	0.56
Li2O	7	71	0.001	0.0007	0.0003	0.002
S	8		0.03	0.01	0.02	0.05
F	7		0.09	0.03	0.03	0.13
BaO	7		0.07	0.05	0.04	0.18
ppm						
As	9	0				
Cr	9		251	224.94	29	763
Cu	9		71	26.26	52	138
Mo	9	11				
Nb	9		89	16.91	61	111
Ni	9		163	125.25	41	418
Pb	9	0				
Rb	9		38	11.30	19	47
Sr	9		973	132.83	733	1138
Y	9		26	6.52	17	33
Zn	9		94	16.20	71	128
Zr	9		316	85.81	209	493
Be	8	75	1.41	0.78	0.60	2.80
Ce	4		126.00	18.07	105.00	143.00
Co	5		59.14	7.30	48.10	68.60
Cs	5	40	0.66	0.50		
Eu	5		2.97	0.48	2.43	3.73
Hf	5		7.88	1.46	5.36	15.80
La	5		58.64	16.56	32.00	77.70
Lu	5		0.27	0.09	0.13	0.37
Sb	5	0				
Sc	5		26.50	4.28	19.60	30.30
Sm	5		7.71	2.63	3.20	9.58
Ta	5		5.20	1.41	3.04	6.50
Tb	5	60	0.77	0.43	0.30	1.12
Th	5		7.40	1.22	5.57	8.70
U	5	40	2.26	1.87		
Yb	5		2.86	0.94	1.79	4.27

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25 – AUGITITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	9		42.15	2.22	38.95	45.99
TiO2	9		3.46	0.48	2.50	4.06
Al2O3	9		14.03	1.44	12.18	15.78
Fe2O3	9		6.25	2.95	4.22	13.88
FeO	9		6.80	2.52	0.27	9.80
MnO	9		0.22	0.04	0.18	0.32
MgO	9		6.07	0.85	4.96	7.81
CaO	9		11.70	1.12	10.37	13.25
Na2O	9		3.09	0.63	2.00	3.90
K2O	9		2.07	0.51	1.24	2.90
H2O+	8		2.38	0.64	1.32	3.23
H2O-	7		0.71	0.51	0.25	1.75
P2O5	9		0.89	0.30	0.59	1.42
CO2	8	88	0.23	0.25	0.003	0.64
Li2O	4		0.003	0.0006	0.002	0.003
S	7		0.05	0.01	0.04	0.08
F	6		0.12	0.03	0.08	0.15
BaO	5		0.10	0.02	0.08	0.14
ppm						
As	4	50	7.10	5.72		
Cr	5		61	28.83	30	97
Cu	5		115	67.14	40	187
Mo	2	50	5.10	1.17		
Nb	5		103	11.98	90	121
Ni	5		42	13.83	29	57
Pb	4	50	8.60	7.02		
Rb	5		52	6.80	45	60
Sr	5		1116	301.02	992	1200
Y	4		32	12.50	20	47
Zn	5		117	33.04	75	151
Zr	5		353	63.75	268	416
Be	5		2.48	0.50	2.00	3.00
Ce	2		184.50	14.85	174.00	195.00
Co	2		50.05	0.35	49.80	50.30
Cs	2	50	1.16	1.22		
Eu	2		3.79	0.24	3.62	3.96
Hf	2		9.52	0.06	9.48	9.56
La	2		82.65	8.56	76.60	88.70
Lu	2		0.32	0.02	0.30	0.33
Sb	2	50	0.85	0.78		
Sc	2		28.10	3.39	25.70	30.50
Sm	2		13.05	1.77	11.80	14.30
Ta	2		5.57	0.45	5.25	5.89
Tb	2	50	1.11	1.15		
Th	2		9.61	0.04	9.58	9.63
U	2	50	4.70	5.37		
Yb	2		3.06	0.28	2.86	3.25

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26 – PLAGIOCLASE AUGITITE

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	1		42.73			
TiO2	1		2.77			
Al2O3	1		13.98			
Fe2O3	1		4.18			
FeO	1		7.66			
MnO	1		0.21			
MgO	1		6.10			
CaO	1		11.07			
Na2O	1		2.76			
K2O	1		2.12			
H2O+	1		2.88			
H2O-	1		0.70			
P2O5	1		0.78			
CO2	1		1.25			
Li2O	1		0.001			
S	1		0.04			
F	1		0.03			
BaO	1		0.11			
ppm						
As	1		<7			
Cr	1		118			
Cu	1		47			
Mo	1		11			
Nb	1		118			
Ni	1		101			
Pb	1		<7			
Rb	1		50			
Sr	1		1269			
Y	1		33			
Zn	1		105			
Zr	1		369			
Be	1		3.80			
Ce						
Co						
Cs						
Eu						
Hf						
La						
Lu						
Sb						
Sc						
Sm						
Ta						
Tb						
Th						
U						
Yb						

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27 – TRACHYANDESITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	2		54.41	1.65	53.24	55.77
TiO2	2		1.75	0.02	1.73	1.76
Al2O3	2		17.74	0.01	17.73	17.75
Fe2O3	2		5.00	0.14	4.90	5.10
FeO	2		2.02	0.65	1.56	2.48
MnO	2		0.20	0.04	0.17	0.22
MgO	2		1.74	0.15	1.63	1.84
CaO	2		6.40	0.43	6.09	6.70
Na2O	2		4.67	0.44	4.36	4.98
K2O	2		3.34	0.23	3.18	3.50
H2O+	2		1.34	0.68	0.86	1.82
H2O-	2		0.58	0.42	0.28	0.88
P2O5	2		0.58	0.11	0.50	0.65
CO2	2		0.02	0.003	0.02	0.02
Li2O	2		0.004	0.0007	0.003	0.004
S	2		0.01	0.00	0.01	0.01
F	1		0.02			
BaO	2		0.17	0.01	0.16	0.17
ppm						
As	2	0				
Cr	2		18	4.95	14	21
Cu	2		20	13.44	10	29
Mo	2		29	1.41	28	30
Nb	2		135	16.97	123	147
Ni	2	50	10	9.90		
Pb	2	0				
Rb	2		89	19.09	75	102
Sr	2		1331	412.24	1040	1623
Y	2		38	4.95	34	41
Zn	2		141	3.54	138	143
Zr	2		377	19.09	363	390
Be	2		5.50	4.95	2.00	9.00
Ce						
Co						
Cs						
Eu						
Hf						
La						
Lu						
Sb						
Sc						
Sm						
Ta						
Tb						
Th						
U						
Yb						

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28 – NEPHELINE TRACHYBASALT

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	1		48.49			
TiO2	1		3.07			
Al2O3	1		16.08			
Fe2O3	1		4.30			
FeO	1		5.03			
MnO	1		0.16			
MgO	1		3.74			
CaO	1		8.19			
Na2O	1		4.73			
K2O	1		2.69			
H2O+	1		2.58			
H2O-	1		0.76			
P2O5	1		0.60			
CO2	1		<0.01			
Li2O	1		0.002			
S	1		0.04			
F	1		0.11			
BaO	1		0.09			
ppm						
As	1		<7			
Cr	1		13			
Cu	1		29			
Mo	1		<7			
Nb	1		87			
Ni	1		8.00			
Pb	1		<7			
Rb	1		69			
Sr	1		843			
Y	1		25			
Zn	1		83			
Zr	1		412			
Be	1		2.00			
Ce	1		129.00			
Co	1		33.80			
Cs	1		<1			
Eu	1		2.56			
Hf	1		9.95			
La	1		65.30			
Lu	1		0.28			
Sb	1		1.06			
Sc	1		17.20			
Sm	1		8.40			
Ta	1		4.91			
Tb	1		1.40			
Th	1		9.96			
U	1		<3			
Yb	1		2.75			

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29 – APOLEUCITE TRACHYBASALT

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	1		47.60			
TiO2	1		1.15			
Al2O3	1		16.07			
Fe2O3	1		5.32			
FeO	1		3.28			
MnO	1		0.13			
MgO	1		4.23			
CaO	1		8.36			
Na2O	1		4.24			
K2O	1		2.51			
H2O+	1		3.44			
H2O-	1		2.09			
P2O5	1		0.51			
CO2	1		0.44			
Li2O						
S	1		tr.			
F						
BaO						
ppm						
As						
Cr						
Cu						
Mo						
Nb						
Ni						
Pb						
Rb						
Sr						
Y						
Zn						
Zr						
Be						
Ce						
Co						
Cs						
Eu						
Hf						
La						
Lu						
Sb						
Sc						
Sm						
Ta						
Tb						
Th						
U						
Yb						

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30 – SODALITE TRACHYBASALTS

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	33		50.23	2.34	46.11	54.57
TiO2	33		1.61	0.78	0.15	2.95
Al2O3	33		17.78	1.43	15.17	20.41
Fe2O3	33		3.91	1.04	2.04	6.31
FeO	33		3.35	1.07	1.50	6.15
MnO	33		0.25	0.12	0.17	0.70
MgO	33		2.43	0.94	1.05	4.80
CaO	33		7.03	1.47	4.86	9.67
Na2O	33		4.86	0.76	3.44	6.01
K2O	33		3.63	0.70	2.32	4.97
H2O+	31		3.00	0.88	1.01	4.56
H2O-	29		0.79	0.41	0.21	1.66
P2O5	32		0.49	0.23	0.13	1.06
CO2	26		0.35	0.29	0.03	0.95
Li2O	15	93	0.004	0.002	0.0003	0.008
S	26		0.10	0.13	0.01	0.69
F	17		0.10	0.04	0.05	0.21
BaO	20		0.14	0.05	0.08	0.25
ppm						
As	16	13				
Cr	22	59	20	20.61	2	75
Cu	22	82	38	47.94	2	170
Mo	17	35	5.70	5.07		
Nb	22		171	38.20	111	231
Ni	22	50	9.20	8.41		
Pb	17	24				
Rb	22		82	25.06	39	129
Sr	22		1883	749.48	950	3900
Y	17		41	10.70	23	60
Zn	22		105	23.16	73	171
Zr	22		631	105.41	425	815
Be	18	94	4.01	2.62	0.60	13.00
Ce	12		229.50	54.37	153.00	298.00
Co	13		24.59	12.00	10.00	46.00
Cs	13	54	1.72	3.07	0.30	11.70
Eu	13		3.85	1.03	2.40	5.24
Hf	13		12.76	1.83	9.50	16.30
La	12		139.87	46.76	78.40	198.00
Lu	13		0.42	0.10	0.29	0.58
Sb	13	23				
Sc	13		7.65	5.04	2.19	22.90
Sm	12		12.49	3.84	7.56	18.20
Ta	12		8.34	1.89	5.70	10.80
Tb	13	92	1.27	0.38	0.30	1.93
Th	13		16.61	4.39	6.00	23.00
U	12	50	3.34	3.22		
Yb	13		4.86	2.02	2.37	9.04

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31 – FOID-FREE TRACHYBASALTS						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	17		50.30	2.82	44.73	55.17
TiO2	17		2.02	0.55	1.18	3.06
Al2O3	17		17.17	0.71	16.11	18.23
Fe2O3	17		3.97	0.94	2.72	5.93
FeO	17		3.68	0.68	2.39	4.59
MnO	17		0.19	0.04	0.14	0.28
MgO	17		2.48	0.76	1.53	4.20
CaO	17		7.23	1.21	5.60	9.27
Na2O	17		4.51	0.61	3.15	5.70
K2O	17		3.65	0.89	2.19	5.20
H2O+	17		2.67	0.86	1.05	4.53
H2O-	16		0.61	0.44	0.07	1.73
P2O5	17		0.50	0.19	0.17	0.89
CO2	14	93	0.52	1.17	0.003	4.48
Li2O	11		0.004	0.001	0.002	0.005
S	17		0.05	0.05	0.01	0.22
F	11		0.11	0.04	0.05	0.16
BaO	15		0.13	0.04	0.06	0.19
ppm						
As	12	25				
Cr	15	80	20	12.86	2	44
Cu	15		48	43.84	12	140
Mo	12	33	7.70	8.35		
Nb	14		127	34.55	81	206
Ni	15	60	13	9.98	2	30
Pb	12	50	11	12.62		
Rb	15		91	39.00	29	180
Sr	15		1435	674.56	702	3400
Y	12		34	6.13	25	46
Zn	15		112	21.54	86	149
Zr	15		485	97.13	335	730
Be	14		2.86	1.51	1.00	6.00
Ce	5		200.80	49.84	171.00	289.00
Co	5		27.78	9.62	16.00	39.80
Cs	5	80	1.15	0.53	0.30	1.73
Eu	5		3.51	0.69	2.89	4.64
Hf	5		11.66	1.67	9.92	14.20
La	5		106.00	50.63	75.40	196.00
Lu	5		0.42	0.09	0.32	0.55
Sb	5	0				
Sc	5		10.58	5.58	6.07	19.60
Sm	5		11.91	2.63	9.05	16.10
Ta	5		6.56	2.13	5.17	10.30
Tb	5	80	1.24	0.63	0.30	2.00
Th	5		14.28	3.82	11.30	20.90
U	5	40	3.41	3.58		
Yb	5		4.22	1.29	2.96	6.17

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28–31 (O) – TRACHYBASALTS						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	52		50.17	2.47	44.73	55.17
TiO2	52		1.76	0.74	0.15	3.07
Al2O3	52		17.51	1.27	15.17	20.41
Fe2O3	52		3.96	1.00	2.04	6.31
FeO	52		3.49	0.97	1.50	6.15
MnO	52		0.23	0.10	0.13	0.70
MgO	52		2.51	0.91	1.05	4.80
CaO	52		7.14	1.37	4.86	9.67
Na2O	52		4.73	0.71	3.15	6.01
K2O	52		3.60	0.77	2.19	5.20
H2O+	50		2.89	0.86	1.01	4.56
H2O-	47		0.76	0.46	0.07	2.09
P2O5	51		0.50	0.21	0.13	1.06
CO2	42	95	0.40	0.70	0.003	4.48
Li2O	27	96	0.004	0.002	0.0003	0.008
S	44		0.08	0.11	0.01	0.69
F	29		0.10	0.04	0.05	0.21
BaO	36		0.13	0.05	0.06	0.25
ppm						
As	29	14				
Cr	38	68	20	17.54	2	75
Cu	38	89	41	45.52	2	170
Mo	30	30				
Nb	37		152	43.21	81	231
Ni	38	55	11	9.02	2	30
Pb	30	30				
Rb	38		85	30.94	29	180
Sr	38		1680	474.49	702	3900
Y	30		37	9.83	23	60
Zn	38		106	21.68	73	171
Zr	38		572	125.47	335	815
Be	33	97	3.46	2.23	0.60	13.00
Ce	18		215.94	56.03	129.00	298.00
Co	19		25.92	11.06	10.00	46.00
Cs	19	58	1.50	2.55	0.30	11.70
Eu	19		3.69	0.96	2.40	5.24
Hf	19		12.33	1.85	9.50	16.30
La	18		126.32	49.88	65.30	198.00
Lu	19		0.41	0.10	0.28	0.58
Sb	19	21				
Sc	19		8.92	5.44	2.19	22.90
Sm	18		12.10	3.48	7.56	18.20
Ta	18		7.65	2.12	4.91	10.80
Tb	19	89	1.27	0.43	0.30	2.00
Th	19		15.65	4.37	6.00	23.00
U	18	44	3.22	3.17		
Yb	19		4.58	1.83	2.37	9.04

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32 – SODALITE TRACHYTES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	63		55.98	2.45	51.28	61.91
TiO2	63		0.69	0.47	0.17	3.48
Al2O3	63		19.51	0.92	15.86	21.26
Fe2O3	63		2.21	0.67	1.20	4.60
FeO	63		1.51	0.93	0.31	4.24
MnO	63		0.20	0.06	0.13	0.44
MgO	63	98	0.76	0.51	0.03	2.39
CaO	63		3.53	1.31	1.21	6.50
Na2O	63		6.20	0.87	3.88	8.26
K2O	63		5.23	0.75	3.78	6.93
H2O+	60		2.63	0.92	1.12	4.90
H2O-	59		0.65	0.41	0.06	1.65
P2O5	63		0.13	0.10	0.01	0.50
CO2	58		0.42	0.46	0.01	2.23
Li2O	12		0.008	0.02	0.001	0.06
S	58		0.03	0.04	0.01	0.17
F	41		0.07	0.04	0.02	0.16
BaO	50		0.16	0.05	0.03	0.26
ppm						
As	27	11				
Cr	40	65	9.20	8.74	1	37
Cu	53	81	55	49.88	1	242
Mo	25	20				
Nb	53		135	27.01	87	195
Ni	53	53	5.30	5.30	2	27
Pb	27	74	22	15.46	2	55
Rb	53		145	36.27	77	277
Sr	53		1379	659.04	211	2550
Y	27		32	5.32	16	43
Zn	53		101	26.57	62	195
Zr	53		674	130.03	333	1012
Be	26	96	4.62	1.16	0.60	6.80
Ce	26		161.03	32.89	90.50	227.00
Co	25	96	8.64	11.15	0.30	41.50
Cs	25	92	2.76	3.68	0.30	19.90
Eu	26		1.64	0.60	0.56	2.92
Hf	26		12.77	2.32	8.10	17.60
La	26		113.17	26.62	33.20	176.00
Lu	26		0.39	0.09	0.23	0.56
Sb	26	42	0.77	0.58		
Sc	26	96	1.34	1.18	0.03	4.82
Sm	26		4.97	1.89	1.58	8.89
Ta	26		4.57	1.77	1.51	8.42
Tb	26	23				
Th	26		19.07	4.11	13.60	31.30
U	26	58	3.31	2.53	0.30	9.76
Yb	26		3.90	1.10	1.62	5.73

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33 – FOID-FREE TRACHYTES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	44		59.75	2.98	54.80	66.87
TiO2	43		0.60	0.31	0.11	1.58
Al2O3	44		18.77	0.93	16.93	21.84
Fe2O3	44		2.35	1.12	0.25	6.68
FeO	44		1.19	0.92	0.11	4.62
MnO	44		0.18	0.10	0.01	0.53
MgO	44		0.59	0.45	0.06	2.07
CaO	44		2.27	1.29	0.75	5.98
Na2O	44		6.12	1.14	3.29	8.94
K2O	44		5.42	0.86	3.62	6.97
H2O+	44		1.37	0.84	0.12	3.02
H2O-	43		0.65	0.81	0.07	4.17
P2O5	41		0.13	0.11	0.02	0.50
CO2	39		0.40	0.59	0.01	2.41
Li2O	9		0.007	0.003	0.003	0.01
S	24	96	0.03	0.04	0.01	0.18
F	18		0.07	0.06	0.02	0.26
BaO	37		0.12	0.07	0.008	0.24
ppm						
As	27	26				
Cr	32	72	13	9.55	2	33
Cu	36	83	53	41.82	2	148
Mo	18	22				
Nb	37		153	54.45	77	321
Ni	37	57	7.70	6.46	2	21
Pb	28	61	23	22.86	2	86
Rb	37		173	55.16	73	361
Sr	37		620	503.40	27	1900
Y	28		37	12.50	20	67
Zn	37		108	32.98	63	192
Zr	37		674	201.97	287	1344
Be	28		4.83	1.85	3.00	10.00
Ce	23		163.84	46.25	95.40	280.00
Co	23	91	3.09	3.15	0.30	12.90
Cs	23	91	2.72	3.51	0.30	18.00
Eu	23		1.55	0.95	0.26	5.00
Hf	23		14.48	3.47	7.68	23.20
La	23		116.42	36.31	38.40	184.00
Lu	23		0.41	0.09	0.27	0.63
Sb	23	35	0.81	0.78		
Sc	23	96	1.27	1.21	0.03	6.28
Sm	22		4.87	2.60	1.50	13.20
Ta	22		6.60	3.48	1.69	15.20
Tb	23	39	0.77	0.66		
Th	23		21.39	6.97	14.00	46.80
U	22	50	3.68	3.22		
Yb	23		4.33	1.34	1.52	5.88

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34 – SODALITE TRACHYTES WITH NEPHELINE AND TRACHYTES WITH NEPHELINE						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	27		56.30	2.88	50.10	61.30
TiO2	27		0.42	0.28	0.14	1.14
Al2O3	27		20.03	0.81	18.36	21.20
Fe2O3	27		1.78	0.66	1.09	4.02
FeO	27		1.59	1.10	0.10	4.20
MnO	27		0.24	0.06	0.16	0.38
MgO	27	93	0.34	0.24	0.03	0.90
CaO	27		2.28	1.00	0.72	4.04
Na2O	27		7.87	1.04	6.12	9.60
K2O	27		5.67	0.56	4.75	6.45
H2O+	25		2.20	0.74	0.88	3.75
H2O-	23		0.48	0.26	0.11	1.13
P2O5	27		0.13	0.14	0.02	0.63
CO2	23	96	0.24	0.21	0.003	0.80
Li2O	3		0.007	0.002	0.005	0.009
S	23		0.07	0.08	0.01	0.34
F	12		0.11	0.04	0.05	0.19
BaO	23	87	0.11	0.11	0.00	0.52
ppm						
As	16	44	8.90	7.86		
Cr	22	68	16	13.87	2	53
Cu	23	70	50	40.51	2	128
Mo	11	64	10	6.47	2	19
Nb	25		175	93.53	79	415
Ni	24	50	6.90	5.98		
Pb	16	69	19	14.23	2	43
Rb	25		194	52.61	116	303
Sr	25	92	877	836.30	2	2550
Y	16		32	9.84	13	52
Zn	25		133	45.16	77	237
Zr	25		868	192.26	599	1330
Be	16		5.69	1.96	3.00	10.00
Ce	14		163.46	48.43	84.80	240.00
Co	14	79	2.21	1.60	0.30	6.09
Cs	14		3.21	2.14	1.64	9.40
Eu	14		1.20	0.54	0.50	2.24
Hf	14		16.66	4.30	9.27	26.10
La	14		131.72	34.88	52.20	179.00
Lu	14		0.44	0.18	0.21	0.83
Sb	14	79	1.85	1.77	0.30	7.12
Sc	14	93	0.63	0.47	0.03	1.45
Sm	14		3.71	1.58	1.49	6.69
Ta	14		5.11	3.89	1.56	14.00
Tb	14	29				
Th	14		23.22	7.60	14.00	38.70
U	14	86	5.74	2.62	0.90	10.20
Yb	14		4.38	1.33	1.85	6.43

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32–34 (H) – TRACHYTES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	134		57.29	3.21	50.10	66.87
TiO2	133		0.61	0.40	0.11	3.48
Al2O3	134		19.37	1.01	15.86	21.84
Fe2O3	134		2.17	0.86	0.25	6.68
FeO	134		1.42	0.97	0.10	4.62
MnO	134		0.20	0.08	0.01	0.53
MgO	133	98	0.62	0.47	0.03	2.39
CaO	134		2.86	1.39	0.72	6.50
Na2O	134		6.51	1.21	3.29	9.60
K2O	134		5.38	0.77	3.62	6.97
H2O+	129		2.12	1.02	0.12	4.90
H2O-	125		0.62	0.56	0.06	4.17
P2O5	131		0.13	0.01	0.01	0.63
CO2	120		0.38	0.47	0.003	2.41
Li2O	24		0.007	0.01	0.001	0.06
S	105	99	0.04	0.05	0.01	0.34
F	71		0.07	0.04	0.02	0.26
BaO	110	97	0.14	0.08	0.00	0.52
ppm						
As	70	24				
Cr	94	68	12	10.64	1	53
Cu	112	79	54	45.24	1	242
Mo	54	30				
Nb	115		150	57.89	77	415
Ni	114	54	6.00	5.89	2	27
Pb	71	68	22	18.34	2	86
Rb	115		165	50.33	73	361
Sr	115	98	1026	735.97	2	2550
Y	71		34	9.87	13	67
Zn	115		110	35.29	62	237
Zr	115		716	186.59	287	1344
Be	70	99	4.95	1.69	0.60	10.00
Ce	62		162.24	41.33	84.80	280.00
Co	61	92	5.21	7.89	0.30	41.50
Cs	61	93	2.86	3.31	0.30	19.90
Eu	62		1.50	0.75	0.26	5.00
Hf	62		14.26	3.57	7.68	26.10
La	62		118.53	32.84	33.20	184.00
Lu	62		0.41	0.12	0.21	0.83
Sb	62	48	1.04	1.10		
Sc	62	95	1.16	1.11	0.03	6.28
Sm	62		4.65	2.14	1.49	13.20
Ta	62		5.41	3.08	1.51	15.20
Tb	62	31				
Th	62		20.82	6.28	13.60	46.80
U	62	61	3.99	2.93	0.30	11.30
Yb	62		4.15	1.25	1.52	6.43

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35 – SODALITE PHONOLITES AND PHONOLITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	76		56.19	1.42	53.58	60.12
TiO2	75		0.24	0.07	0.10	0.43
Al2O3	76		21.08	1.11	18.32	23.14
Fe2O3	76		1.58	0.39	0.41	2.71
FeO	76		1.22	1.18	0.02	4.64
MnO	76		0.28	0.22	0.04	1.91
MgO	75	92	0.21	0.18	0.01	0.88
CaO	76		1.13	0.53	0.50	2.87
Na2O	76		9.36	1.21	5.80	11.01
K2O	76		5.50	0.54	3.83	7.49
H2O+	74		2.08	1.10	0.02	5.21
H2O-	69		0.44	0.34	0.02	2.26
P2O5	70		0.06	0.09	0.004	0.70
CO2	69	99	0.27	0.25	0.003	1.47
Li2O	13		0.02	0.02	0.002	0.07
S	59		0.04	0.04	0.01	0.21
F	35		0.11	0.07	0.03	0.31
BaO	53	87	0.03	0.04	0.00	0.20
ppm						
As	38	39	7.50	6.52		
Cr	49	73	22	29.20	2	165
Cu	60	83	60	53.55	1	156
Mo	31	26				
Nb	64		237	176.93	13	920
Ni	60	53	8.30	12.45	1	84
Pb	39	97	30	12.82	2	54
Rb	63		259	69.25	160	439
Sr	63	89	197	267.67	2	1293
Y	39	97	45	35.46	3	163
Zn	64		179	65.10	82	420
Zr	64		1332	477.25	247	2600
Be	40		9.49	4.12	3.50	22.00
Ce	40		155.12	64.31	70.90	329.00
Co	40	88	5.17	9.45	0.30	40.90
Cs	40	98	4.69	2.68	0.30	9.21
Eu	40		0.78	0.47	0.21	1.81
Hf	40		23.87	13.96	8.57	69.30
La	40		124.56	40.93	32.20	210.00
Lu	40	98	0.60	0.48	0.03	2.16
Sb	40	82	1.80	1.13	0.30	5.38
Sc	40	80	0.72	0.71	0.03	2.84
Sm	40	98	3.19	1.81	0.30	7.40
Ta	40	98	7.50	10.40	0.30	40.50
Tb	40	28				
Th	40		38.23	15.00	17.30	82.30
U	40	82	9.93	6.56	0.90	30.50
Yb	40	90	5.38	4.66	0.30	20.50

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36 – (MICRO)THERALITES AND NEPHELINE (MICRO)THERALITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	28		44.43	2.03	40.54	46.94
TiO2	28		3.28	0.63	1.70	4.12
Al2O3	28		14.40	1.72	11.34	17.15
Fe2O3	28		6.01	1.19	3.68	8.80
FeO	28		5.78	1.06	3.29	7.72
MnO	28		0.22	0.06	0.08	0.32
MgO	28		5.22	1.03	3.20	7.34
CaO	28		10.38	1.49	7.76	13.42
Na2O	28		3.44	0.59	2.16	4.50
K2O	28		2.85	0.63	1.65	3.84
H2O+	28		1.91	1.10	0.23	4.62
H2O-	27		0.46	0.31	0.02	1.42
P2O5	28		0.83	0.31	0.47	1.90
CO2	18		0.66	0.83	0.05	3.49
Li2O	5		0.002	0.0006	0.001	0.003
S	14		0.18	0.23	0.02	0.87
F	6		0.13	0.02	0.09	0.16
BaO	9		0.09	0.03	0.05	0.14
ppm						
As	5	0				
Cr	10	90	50	74.99	2	210
Cu	10		102	68.14	30	270
Mo	5	0				
Nb	8		100	36.61	60	159
Ni	10		28	17.60	9	60
Pb	7	29				
Rb	10		105	101.24	40	296
Sr	10		1171	520.69	792	2500
Y	5		30	2.77	26	33
Zn	8		81	21.70	66	130
Zr	8		384	99.67	270	560
Be	8		2.93	1.76	1.80	7.00
Ce	5		161.80	29.88	130.00	209.00
Co	6		43.07	3.32	40.00	49.10
Cs	6	17				
Eu	6		3.09	0.43	2.40	3.55
Hf	6		8.36	1.68	5.29	10.20
La	5		72.04	24.13	50.00	113.00
Lu	6	83	0.30	0.18	0.03	0.48
Sb	6	17				
Sc	6		25.35	10.43	5.20	35.00
Sm	5		10.37	0.78	9.04	11.10
Ta	5		5.00	2.04	3.14	8.15
Tb	6	50	0.82	0.58		
Th	6		8.87	2.96	6.00	14.30
U	5	60	4.03	3.02	0.90	6.93
Yb	6		2.93	0.95	2.00	4.16

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37 – (MICRO)ESSEXITES AND SODALITE (MICRO)ESSEXITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	42		50.7	1.47	46.54	52.85
TiO2	42		1.97	0.51	0.81	3.46
Al2O3	42		16.93	1.21	13.80	20.04
Fe2O3	42		4.58	1.29	1.32	7.92
FeO	42		3.13	1.10	0.85	6.07
MnO	39		0.24	0.14	0.14	0.98
MgO	42		2.68	0.96	1.17	5.82
CaO	42		7.21	1.09	5.54	10.82
Na2O	42		4.79	0.71	3.38	6.93
K2O	42		3.78	0.42	2.85	4.88
H2O +	40		2.60	1.15	0.24	4.84
H2O -	26		0.68	0.49	0.07	1.87
P2O5	38		0.55	0.19	0.11	1.11
CO2	30		1.30	0.94	0.06	3.86
Li2O	3		0.004	0.003	0.001	0.006
S	6		0.08	0.06	0.02	0.19
F	3		0.09	0.06	0.03	0.15
BaO	15		0.14	0.05	0.01	0.21
ppm						
As	2	0				
Cr	11	91	15	9.26	2	30
Cu	7		33	23.72	9	70
Mo	2	0				
Nb	14		152	48.08	75	212
Ni	6	83	7.90	3.09	2	10
Pb	4	50	7.30	7.04		
Rb	14		110	7.08	93	120
Sr	14		1503	496.06	844	2400
Y	11		26	6.88	19	41
Zn	12		86	10.93	70	103
Zr	14		436	164.22	291	810
Be	5		3.24	1.04	2.00	4.50
Ce	8		144.13	38.92	52.00	176.00
Co	7		9.77	6.67	5.00	20.90
Cs	8		2.51	0.68	1.70	3.70
Eu	8		2.68	0.35	2.24	3.23
Hf	8		9.15	1.41	8.30	12.60
La	8		81.78	9.87	58.00	87.00
Lu	8	88	0.44	0.19	0.33	0.90
Sb	2	0				
Sc	8		7.21	2.72	2.06	10.80
Sm	8		9.64	2.20	6.94	14.30
Ta	8		4.63	1.00	3.90	6.44
Tb	8		1.06	0.15	0.94	1.36
Th	8		12.35	2.16	8.50	16.40
U	7	86	3.83	3.54	0.90	11.50
Yb	8		2.58	0.46	1.95	3.60

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38 – (MICRO)SYENITES AND SODALITE (MICRO)SYENITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	8		53.42	1.55	50.39	55.13
TiO2	8		1.23	0.23	0.93	1.68
Al2O3	8		18.04	0.65	17.33	19.10
Fe2O3	8		3.45	0.87	1.86	4.74
FeO	8		1.85	1.04	0.59	3.82
MnO	8		0.17	0.08	0.04	0.31
MgO	8		1.55	0.76	0.68	2.69
CaO	8		4.30	0.86	2.89	5.92
Na2O	8		6.00	0.77	4.94	7.02
K2O	8		5.14	0.69	4.25	6.20
H2O+	8		3.01	1.12	1.17	4.62
H2O-	8		0.51	0.33	0.11	1.00
P2O5	8		0.25	0.11	0.04	0.41
CO2	6		1.34	1.39	0.17	3.89
Li2O	0					
S	4		0.20	0.11	0.06	0.31
F	0					
BaO	2		0.14	0.02	0.12	0.15
ppm						
As	0					
Cr	2		26	33.94	2	50
Cu	2		39	43.84	8	70
Mo	0					
Nb	2		146	22.63	130	162
Ni	2		12	11.31	4	20
Pb	0					
Rb	2		149	72.12	98	200
Sr	2		1321	750.24	790	1851
Y	0					
Zn	2		105	35.36	80	130
Zr	2		498	96.17	430	566
Be	1		3.80			
Ce						
Co						
Cs						
Eu						
Hf						
La						
Lu						
Sb						
Sc						
Sm						
Ta						
Tb						
Th						
U						
Yb						

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39 – BASALTIC LAMPROPHYRES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	29		44.03	1.44	40.95	46.78
TiO2	29		2.81	0.53	1.63	3.59
Al2O3	29		15.76	1.50	11.72	18.69
Fe2O3	29		5.52	0.99	3.52	7.63
FeO	29		5.15	0.61	3.43	6.24
MnO	29		0.24	0.19	0.02	1.18
MgO	29		5.20	1.12	3.62	9.45
CaO	29		10.05	1.23	7.55	14.24
Na2O	29		3.30	0.74	2.05	5.19
K2O	29		3.15	0.70	1.34	4.50
H2O+	28		2.58	0.77	0.20	4.08
H2O-	24		0.89	0.64	0.08	3.51
P2O5	29		0.67	0.18	0.43	1.30
CO2	25		0.63	0.60	0.08	2.60
Li2O	5		0.003	0.003	0.001	0.008
S	9		0.06	0.04	0.02	0.13
F	5		0.11	0.05	0.03	0.17
BaO	7		0.08	0.03	0.04	0.13
ppm						
As	4	25				
Cr	5		49	39.63	15	115
Cu	5		65	21.95	38	88
Mo	4	25				
Nb	5		108	53.07	64	200
Ni	5		31	23.94	15	72
Pb	6	33	5.70	6.17		
Rb	8		82	75.60	25	263
Sr	8		941	258.80	550	1308
Y	8		28	9.70	20	50
Zn	5		65	25.43	30	79
Zr	5		340	50.48	276	393
Be	4	50	1.23	0.90		
Ce	5		129.00	17.61	118.00	160.00
Co	5		42.36	13.66	20.00	56.80
Cs	5	80	6.20	12.14	0.30	27.90
Eu	5		2.86	0.31	2.47	3.27
Hf	5		8.25	1.34	6.32	10.00
La	6		57.68	11.69	49.60	80.50
Lu	5		0.34	0.10	0.19	0.48
Sb	4	0				
Sc	6		28.60	8.29	20.70	44.10
Sm	5		9.58	1.13	8.36	10.80
Ta	5		4.87	0.87	3.46	5.70
Tb	5	60	0.81	0.48	0.30	1.36
Th	5		7.83	1.96	5.70	9.94
U	5		3.74	2.37	0.90	7.47
Yb	5		2.28	0.68	1.70	3.36

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40 – TRACHYBASALTIC LAMPROPHYRES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	10		47.15	1.55	45.53	51.07
TiO2	10		2.36	0.66	1.45	3.37
Al2O3	10		16.94	0.91	15.75	18.37
Fe2O3	10		4.25	0.92	2.01	5.47
FeO	10		4.57	1.58	2.99	8.57
MnO	10		0.22	0.18	0.10	0.72
MgO	10		3.59	0.51	2.92	4.35
CaO	10		7.75	0.61	6.17	8.22
Na2O	10		4.08	0.82	2.22	5.25
K2O	10		4.15	0.68	3.06	5.36
H2O+	7		2.36	1.03	1.27	4.34
H2O-	4		0.97	0.52	0.54	1.68
P2O5	9		0.55	0.13	0.40	0.86
CO2	8		0.63	0.49	0.03	1.54
Li2O	1		0.003			
S	1		0.09			
F	1		0.19			
BaO	4		0.12	0.06	0.08	0.20
ppm						
As	1		<7			
Cr	2		51	51.62	14	87
Cu	1		34			
Mo	1		<7			
Nb	1		121			
Ni	1		45			
Pb	1		<7			
Rb	1		75			
Sr	1		1337			
Y	1		26			
Zn	1		83			
Zr	1		500			
Be	1		2.00			
Ce	3		145.67	14.19	133.00	161.00
Co	1		33.60			
Cs	3	67	9.20	12.82	1.50	24.00
Eu	3		2.40	0.11	2.30	2.51
Hf	3		7.08	2.05	5.90	9.45
La	3		62.27	24.27	44.00	89.80
Lu	3	67	0.48	0.37	0.23	0.90
Sb	0					
Sc	3		14.63	1.47	13.50	16.30
Sm	3		10.23	2.43	7.68	12.50
Ta	3		4.95	0.43	4.50	5.36
Tb	3	67	0.57	0.23	0.30	0.71
Th	4		10.25	2.04	8.80	13.20
U	1		<3			
Yb	3		2.08	0.47	1.76	2.62

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41 –TRACHYBASALTIC SEMILAMPROPHYRES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	10		50.57	1.45	49.14	53.33
TiO2	10		1.98	0.30	1.45	2.30
Al2O3	10		17.63	0.75	16.84	19.20
Fe2O3	10		4.06	0.95	1.76	5.19
FeO	10		3.21	0.78	2.10	4.90
MnO	10		0.17	0.08	0.01	0.28
MgO	10		2.55	0.29	2.26	3.10
CaO	10		5.74	0.97	4.57	7.17
Na2O	10		4.91	1.43	2.80	7.77
K2O	10		4.47	0.88	3.10	6.45
H2O+	8		2.60	1.03	0.30	3.79
H2O-	3		2.22	1.57	0.75	3.87
P2O5	10		0.46	0.09	0.32	0.60
CO2	7		0.57	0.26	0.20	0.88
Li2O	0					
S	0					
F	0					
BaO	2		0.15	0.07	0.10	0.20
ppm						
As						
Cr						
Cu						
Mo						
Nb						
Ni						
Pb						
Rb						
Sr						
Y						
Zn						
Zr						
Be						
Ce						
Co						
Cs						
Eu						
Hf						
La						
Lu						
Sb						
Sc						
Sm						
Ta						
Tb						
Th						
U						
Yb						

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42 – TRACHYTIC SEMILAMPROPHYRES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	5		54.84	1.58	53.23	56.85
TiO2	4		1.43	0.52	0.84	2.10
Al2O3	5		17.92	1.06	16.11	18.92
Fe2O3	5		2.92	0.42	2.49	3.62
FeO	5		2.22	1.08	1.30	3.99
MnO	4		0.19	0.12	0.11	0.37
MgO	5		1.64	0.76	0.73	2.56
CaO	5		4.18	1.17	2.41	5.34
Na2O	5		5.09	0.89	4.19	6.35
K2O	5		5.84	1.53	3.80	7.93
H2O+	4		2.69	0.72	2.03	3.69
H2O-	2		0.36	0.12	0.27	0.44
P2O5	5		0.36	0.25	0.14	0.76
CO2	3		0.83	0.64	0.24	1.51
Li2O	2	50	0.001	0.001		
S	2		0.015	0.007	0.01	0.02
F	2		0.04	0.00	0.04	0.04
BaO						
ppm						
As						
Cr						
Cu						
Mo						
Nb						
Ni						
Pb						
Rb						
Sr						
Y						
Zn						
Zr						
Be						
Ce						
Co						
Cs						
Eu						
Hf						
La						
Lu						
Sb						
Sc						
Sm						
Ta						
Tb						
Th						
U						
Yb						

Table 8
Position of analysed volcanites in the mineralogical classification
(numbers and letters correspond to denomination of rock types in Tables of average composition 7/1 to 7/50 and in synoptic Table 6)

	alkali feldspar or alkali feldspar >plagioclase	alkali feldspar or alkali feldspar >plagioclase + mineral of sodalite group	alkali feldspar + nepheline (± mineral of sodalite group)	plagioclase > alkali feldspar	plagioclase > alkali feldspar + foid	plagioclase		plagioclase + foid, zeolite		foid, zeolite		melilite + nepheline		glass (+ plagioclase)	
	trachytic rocks			trachybasaltic and trachyandesitic rocks		olivine-free and olivine basaltic rocks						melilitic rocks		partly glassy rocks	
olivine	–			–		–	+	–	+	–	+	–	+	–	+
volcanites s.s.	trachyte 33	sodalite trachyte 32	sodalite phonolite and phonolite 35	trachybasalt 31	nepheline, apoleucite[1], sodalite trachybasalt 28-30	alkali basalt 22	olivine alkali basalt 17	nepheline, analcime, zeolite, apoleucite, sodalite tephrite 18-21 (F)	nepheline, analcime, zeolite, apoleucitite basanite 14-16 (E)	nephelinite, analcimite, apoleucitite 11-13 (D)	olivine nephelinite, ol. analcimite, ol. apoleucitite 6-8 (B)	melilite nephelinite, nephelinite with melilite 9-10 (C)	olivine nepheline melilitite, ol. melilite nephelinite, ol. nephelinite with melilite 2-4 (A)	augitite (plagioclase augitite) 25-26	limburgite (plagioclase limburgite) 23-24
	sodalite trachytes and trachytes with nepheline 34			trachyandesite 27							strongly olivinic to picritic foidites				
coarse-grained subvolcanic rocks	(micro)-syenite 38	sodalite (micro)-syenite 38		(micro)-essexite 37	sodalite (micro)-essexite 37	(micro)-theralite 36		nepheline (micro)-theralite 36					olivine (micro)-melilitolite 1		
lamprophyres and semilamprophyres (+ hornblende and/or biotite)	trachytic lamprophyre 42			trachybasaltic semi-lamprophyre 41 / lamprophyre 40		basaltic lamprophyre 39							polzenite 1		

[1] apoleucite = leucite altered to analcime or to analcime-like mineral

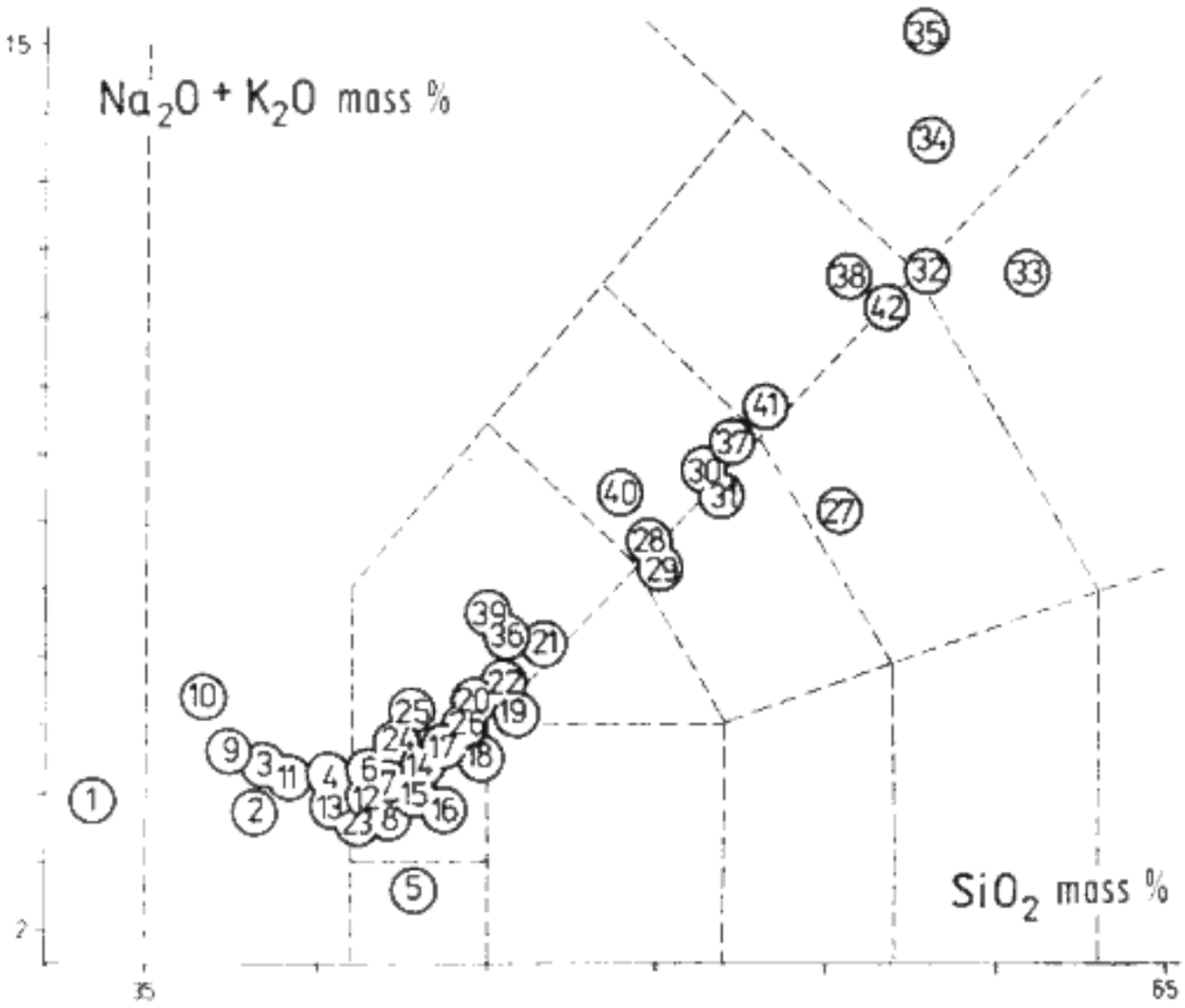

Fig. 3 Position of rock types according to the mineralogical classification in the $Na_2O + K_2O/SiO_2$ diagram. Plotted from data in Table 7. The fields defined by the IUGS classification (LeBas et al. 1986) are shown for comparison.

Table 9
Summary of rock types defined by the IUGS classification (Le Bas et al. 1986) represented in tables of average composition (Tables 10/1–10/15)

			n
F		foidites	86
Pc		picrobasalts	18
B		alkali basalts	73
U_1	a	basanites (Oln CIPW more then 10 %)	146
	b	tephrites (Oln CIPW less then 10 %)	294
U_2		phonotephrites	44
U_3		tephriphonolites	46
S_1	a	hawaiites (mass % $Na_2O - 2$) more then K_2O	11
	b	potassic trachybasalts (mass % $Na_2O - 2$) less then K_2O	38
S_2	a	mugearites (mass % $Na_2O - 2$) more then K_2O	4
	b	shoshonites (mass % $Na_2O - 2$) less then K_2O	25
S_3	a	benmoreites (mass % $Na_2O - 2$) more then K_2O	6
	b	latites (mass % $Na_2O - 2$) less then K_2O	45
T		trachytes	65
Ph		phonolites	125
			Σ 1026

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U1b – TEPHRITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	294		42.34	1.88	39.02	47.49
TiO2	294		3.41	0.60	1.00	4.94
Al2O3	294		13.63	1.69	8.57	18.69
Fe2O3	294		5.83	1.28	2.23	13.88
FeO	294		6.18	1.21	0.77	10.11
MnO	294		0.21	0.08	0.01	1.18
MgO	294		6.80	1.80	2.75	11.60
CaO	294		11.84	1.55	7.55	15.72
Na2O	294		3.23	0.66	1.42	5.19
K2O	294		1.73	0.89	0.29	4.50
H2O+	293		2.44	0.92	0.20	6.38
H2O-	282		0.77	0.47	0.02	3.51
P2O5	294		0.77	0.24	0.25	1.90
CO2	270	99	0.54	0.68	0.003	3.49
Li2O	181	86	0.002	0.003	0.0003	0.04
S	235		0.05	0.06	0.01	0.50
F	199		0.12	0.03	0.01	0.25
BaO	197		0.10	0.06	0.04	0.70
ppm						
As	183	14				
Cr	212	97	137	134.65	2	795
Cu	211		100	53.72	2	329
Mo	184	27				
Nb	209		100	32.09	50	300
Ni	211	97	67	53.61	2	257
Pb	188	19				
Rb	216	99	60	51.00	3	378
Sr	216		1057	522.43	339	6500
Y	190	99	28	7.72	2	62
Zn	211		93	25.71	20	171
Zr	213		332	103.38	174	812
Be	192	85	2.01	1.28	0.30	7.00
Ce	135		137.44	40.66	50.00	297.00
Co	135		47.31	9.67	14.00	74.40
Cs	141	38	1.38	3.33		
Eu	138		3.02	0.69	1.60	7.11
Hf	141		8.18	2.14	4.14	17.60
La	136		68.98	26.76	27.00	202.00
Lu	139	94	0.29	0.14	0.03	0.69
Sb	137	19				
Sc	142		30.52	10.22	5.20	59.60
Sm	127		9.87	2.27	4.56	19.60
Ta	129		5.47	1.77	2.85	12.60
Tb	137	61	0.95	0.57	0.30	2.39
Th	138		7.76	2.84	3.49	20.40
U	124	52	3.19	3.25	0.30	27.60
Yb	139	96	2.80	1.27	0.30	7.62

Table 10/6

U2 – PHONOTEPHRITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	44		47.99	1.76	43.98	51.14
TiO2	44		2.23	0.62	0.81	3.46
Al2O3	44		16.90	1.06	14.60	18.93
Fe2O3	44		4.47	1.14	1.32	7.92
FeO	44		3.95	1.13	2.20	8.57
MnO	43		0.26	0.15	0.10	0.98
MgO	44		3.12	0.90	1.23	5.82
CaO	44		7.86	1.08	5.82	10.82
Na2O	44		4.72	0.77	2.22	6.93
K2O	44		3.73	0.64	2.32	5.36
H2O+	41		2.56	1.07	0.24	4.53
H2O-	31		0.67	0.45	0.07	1.73
P2O5	42		0.59	0.17	0.32	1.11
CO2	37	97	0.75	0.90	0.003	4.48
Li2O	12		0.003	0.0008	0.002	0.005
S	17		0.10	0.09	0.01	0.34
F	13		0.12	0.04	0.06	0.21
BaO	23		0.13	0.05	0.01	0.24
ppm						
As	13	0				
Cr	20	80	26	24.87	2	87
Cu	19		29	24.12	11	90
Mo	14	36	6.00	5.76		
Nb	19		157	45.98	84	218
Ni	18	72	13	11.57	2	45
Pb	16	19				
Rb	20		78	26.76	20	122
Sr	20		1510	455.98	843	2500
Y	17		36	10.68	23	53
Zn	20		98	17.62	70	135
Zr	20		545	106.03	293	720
Be	14		3.89	2.82	2.00	13.00
Ce	14		205.93	80.12	52.00	298.00
Co	12		27.68	11.48	5.00	46.00
Cs	14	50	2.65	6.19		
Eu	14		3.57	1.15	2.30	5.24
Hf	14		11.00	2.86	5.90	14.20
La	14		129.81	64.90	44.00	232.00
Lu	14	93	0.43	0.17	0.23	0.90
Sb	10	40	0.69	0.54		
Sc	14		10.44	5.58	4.09	22.90
Sm	14		12.70	3.82	7.68	18.20
Ta	14		7.41	2.58	3.90	10.80
Tb	14	93	1.27	0.48	0.30	2.00
Th	17		15.25	4.72	8.80	23.10
U	12	50	3.24	3.17		
Yb	14		4.00	1.75	1.76	7.10

Table 10/7

U3 – TEPHRIPHONOLITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	46		52.16	1.91	47.75	55.32
TiO2	45		1.25	0.58	0.50	3.48
Al2O3	46		18.70	1.22	16.11	21.21
Fe2O3	46		3.19	1.02	1.76	6.00
FeO	46		2.38	1.03	0.31	4.90
MnO	44		0.23	0.09	0.01	0.57
MgO	45		1.48	0.65	0.48	2.69
CaO	46		5.23	1.15	3.00	7.40
Na2O	46		5.95	0.78	4.43	7.77
K2O	46		4.56	0.69	3.10	6.56
H2O+	45		3.03	1.19	0.30	7.28
H2O-	36		0.84	0.70	0.06	3.87
P2O5	45		0.30	0.16	0.04	0.76
CO2	37		0.65	0.78	0.06	3.86
Li2O	11		0.004	0.002	0.001	0.007
S	28		0.09	0.13	0.01	0.69
F	16		0.08	0.03	0.03	0.13
BaO	24		0.17	0.09	0.06	0.52
ppm						
As	18	28				
Cr	25	72	12	9.59	1	30
Cu	25	80	40	34.58	2	106
Mo	16	31				
Nb	25		151	33.17	103	247
Ni	25	48	7.00	6.93		
Pb	19	68	15	13.37	2	43
Rb	26		124	40.52	76	277
Sr	26		1868	583.42	1003	3500
Y	20		30	6.86	16	43
Zn	26		109	32.26	70	195
Zr	26		624	127.73	291	850
Be	18	94	4.23	1.56	0.60	6.80
Ce	18		170.78	19.77	133.00	205.00
Co	18		12.84	11.46	2.51	38.60
Cs	18	94	2.98	4.37	0.30	19.90
Eu	18		2.03	0.53	0.77	2.98
Hf	18		11.88	2.98	5.81	17.60
La	18		116.76	27.02	86.90	195.00
Lu	18		0.38	0.09	0.21	0.56
Sb	17	41	0.79	0.61		
Sc	18		2.58	1.85	0.15	7.00
Sm	18		6.15	1.67	2.51	8.90
Ta	18		4.97	1.43	2.39	8.30
Tb	18	28				
Th	19		18.84	5.58	12.60	31.30
U	18	67	4.54	3.34	0.90	11.50
Yb	18	94	3.88	1.68	0.30	6.77

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S1a – HAWAIITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	11		46.15	1.19	44.87	48.16
TiO2	11		2.56	0.43	1.45	3.10
Al2O3	11		14.87	1.59	12.44	16.48
Fe2O3	11		5.40	1.83	2.76	9.85
FeO	11		5.16	2.13	0.46	8.58
MnO	11		0.21	0.05	0.15	0.32
MgO	11		5.88	2.66	3.25	9.93
CaO	11		10.06	1.09	8.59	12.30
Na2O	11		4.05	0.22	3.76	4.45
K2O	11		1.49	0.32	0.96	2.09
H2O+	10		2.26	0.86	0.88	3.81
H2O-	9		0.86	0.48	0.12	1.83
P2O5	11		0.80	0.18	0.52	1.16
CO2	10		0.19	0.26	0.01	0.82
Li2O	6	83	0.003	0.003	0.001	0.008
S	7	86	0.02	0.01	0.003	0.04
F	6		0.10	0.05	0.03	0.17
BaO	4		0.11	0.03	0.07	0.13
ppm						
As	6	0				
Cr	6	83	147	176.30	2	417
Cu	6		40	14.46	18	57
Mo	6	67	12	10.10	2	25
Nb	6		124	22.46	102	167
Ni	6	67	114	157.10	2	382
Pb	6	0				
Rb	6		50	22.88	12	76
Sr	6		1099	158.13	929	1380
Y	6		34	8.64	19	43
Zn	6		105	14.76	89	130
Zr	6		377	54.69	324	474
Be	4		2.95	0.82	2.00	4.00
Ce	2		196.50	12.02	188.00	205.00
Co	2		27.00	4.67	23.70	30.30
Cs	2		1.97	0.42	1.67	2.27
Eu	2		3.82	0.14	3.72	3.92
Hf	2		10.74	1.65	9.57	11.90
La	2		107.10	16.83	95.20	119.00
Lu	2		0.49	0.04	0.46	0.51
Sb	2	0				
Sc	2		13.45	3.46	11.00	15.90
Sm	2		11.80	1.27	10.90	12.70
Ta	2		7.16	0.25	6.98	7.34
Tb	2		1.58	0.33	1.34	1.81
Th	2		14.15	0.92	13.50	14.80
U	2	50	2.50	2.26		
Yb	2		4.77	0.40	4.49	5.05

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S1b – POTASSIC TRACHYBASALTS

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	38		46.03	1.02	43.79	48.04
TiO2	38		2.92	0.50	1.15	3.83
Al2O3	38		14.43	1.20	11.34	17.00
Fe2O3	38		5.29	1.39	2.06	8.08
FeO	38		5.30	1.46	2.49	9.15
MnO	38		0.20	0.04	0.14	0.31
MgO	38		5.31	1.71	2.82	11.04
CaO	38		10.18	0.81	8.90	12.23
Na2O	38		3.12	0.46	2.24	4.02
K2O	38		2.31	0.50	1.52	3.29
H2O+	37		2.50	1.01	0.71	5.66
H2O-	35		0.92	0.58	0.28	3.05
P2O5	38		0.73	0.17	0.48	1.23
CO2	34	94	0.45	0.82	0.003	3.64
Li2O	26	96	0.003	0.001	0.001	0.006
S	31		0.07	0.15	0.01	0.87
F	27		0.12	0.04	0.04	0.25
BaO	25		0.11	0.04	0.07	0.24
ppm						
As	26	27				
Cr	27	93	97	130.43	2	430
Cu	27		51	21.89	11	115
Mo	26	19				
Nb	27		105	31.24	68	194
Ni	27	93	54	82.63	2	368
Pb	26	23				
Rb	28		76	63.84	28	359
Sr	28		1033	280.49	628	1979
Y	27		32	9.45	19	55
Zn	27		100	25.22	68	172
Zr	27		372	104.62	211	687
Be	21	95	2.24	1.20	0.30	5.00
Ce	18		145.78	41.95	92.00	259.00
Co	17		39.56	7.25	24.30	52.30
Cs	18	67	2.20	2.79	0.30	9.93
Eu	18		3.02	0.55	2.40	4.30
Hf	18		9.01	1.50	5.88	11.50
La	18		71.63	20.84	45.40	136.00
Lu	18		0.34	0.11	0.14	0.51
Sb	17	18				
Sc	18		22.26	4.35	16.70	33.30
Sm	18		10.16	2.19	7.27	14.90
Ta	18		5.57	1.44	3.99	8.81
Tb	18	78	1.08	0.48	0.30	1.77
Th	18		9.94	3.06	5.21	19.00
U	18	50	2.43	1.69		
Yb	18		2.96	0.90	1.20	4.23

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S2a – MUGEARITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	4		50.25	0.91	49.05	51.19
TiO2	4		1.85	1.13	0.19	2.64
Al2O3	4		17.50	1.29	16.39	19.36
Fe2O3	4		4.79	1.13	3.27	5.93
FeO	4		3.69	0.47	3.07	4.13
MnO	4		0.29	0.22	0.14	0.61
MgO	4		2.64	0.39	2.29	3.11
CaO	4		6.76	0.36	6.39	7.23
Na2O	4		5.10	0.36	4.78	5.46
K2O	4		2.57	0.31	2.19	2.91
H2O+	4		2.86	0.42	2.45	3.30
H2O-	3		0.51	0.22	0.29	0.72
P2O5	4		0.78	0.24	0.56	1.06
CO2	4	75	0.22	0.38	0.003	0.78
Li2O	3		0.003	0.002	0.002	0.005
S	3		0.03	0.006	0.03	0.04
F	3		0.13	0.02	0.12	0.15
BaO	3		0.10	0.04	0.06	0.14
ppm						
As	3	33	7.00	9.18		
Cr	3	33	11	14.95		
Cu	3		26	7.23	21	34
Mo	3	0				
Nb	3		85	4.04	81	89
Ni	3	33	4.70	3.75		
Pb	3		12	0.58	11	12
Rb	3		85	41.58	40	122
Sr	3		809	104.13	702	910
Y	3		30	5.03	25	35
Zn	3		115	30.07	93	149
Zr	3		413	68.37	335	461
Be	3		1.67	0.58	1.00	2.00
Ce						
Co						
Cs						
Eu						
Hf						
La						
Lu						
Sb						
Sc						
Sm						
Ta						
Tb						
Th						
U						
Yb						

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S2b – SHOSHONITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	25		49.95	1.32	47.29	52.08
TiO2	25		2.00	0.6	0.15	3.13
Al2O3	25		16.88	1.28	13.8	20.41
Fe2O3	25		4.45	1.04	2.18	6.31
FeO	25		3.75	0.99	1.97	6.15
MnO	24		0.22	0.11	0.13	0.7
MgO	25		3.03	0.73	1.76	4.23
CaO	25		7.69	1.11	4.57	9.39
Na2O	25		4.11	0.49	2.8	5.03
K2O	25		3.41	0.52	2.51	4.88
H2O+	21		2.56	1.01	1.05	4.44
H2O-	14		0.76	0.65	0.07	2.09
P2O5	22		0.57	0.12	0.39	0.87
CO2	16		1.01	1.00	0.05	3.00
Li2O	4	75	0.003	0.002	0.0003	0.005
S	10		0.05	0.02	0.01	0.08
F	4		0.11	0.03	0.08	0.15
BaO	14		0.15	0.05	0.06	0.21
ppm						
As	4	25				
Cr	12		20	9.17	9	40
Cu	10		57	54.87	10	170
Mo	4	0				
Nb	12		132	39.31	75	200
Ni	10	80	13	9.50	2	30
Pb	5	40	6.90	7.78		
Rb	13		94	34.45	29	150
Sr	13		1458	585.57	620	2800
Y	8		29	8.53	19	41
Zn	12		100	20.50	73	140
Zr	13		468	149.32	318	800
Be	9		2.59	1.27	1.00	5.00
Ce	7		170.86	16.27	145.00	190.00
Co	7		16.24	11.36	5.00	39.80
Cs	8	88	1.88	1.12	0.30	3.70
Eu	8		3.29	0.62	2.55	4.40
Hf	8		10.21	1.76	8.30	13.00
La	7		83.8	14.06	58.00	105.00
Lu	8	88	0.42	0.20	0.30	0.90
Sb	5	20				
Sc	8		9.43	4.51	6.00	19.60
Sm	7		11.13	1.97	8.50	14.30
Ta	7		5.54	1.39	3.90	7.93
Tb	8	88	1.03	0.34	0.30	1.40
Th	8		12.14	4.08	6.00	20.00
U	6	33	1.82	1.48		
Yb	8		3.47	1.20	1.95	5.40

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S3a – BENMOREITES

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	6		54.55	2.02	52.09	57.17
TiO2	6		1.21	0.11	1.07	1.35
Al2O3	6		18.42	0.58	18.23	19.64
Fe2O3	6		2.80	0.42	2.06	3.15
FeO	6		2.71	1.12	1.41	4.62
MnO	6		0.23	0.06	0.15	0.30
MgO	6		1.49	0.49	0.75	2.06
CaO	6		4.96	0.84	3.91	5.82
Na2O	6		6.17	0.69	5.47	6.87
K2O	6		3.44	0.50	2.65	4.00
H2O+	6		1.80	1.03	0.60	3.22
H2O-	6		0.56	0.46	0.09	1.41
P2O5	6		0.24	0.07	0.13	0.34
CO2	6		0.37	0.31	0.10	0.92
Li2O	1		0.003			
S	4		0.03	0.02	0.01	0.06
F	2		0.05	0.00	0.05	0.05
BaO	5		0.13	0.08	0.03	0.25
ppm						
As	3	0				
Cr	5		16	8.97	1	24
Cu	5		63	48.42	12	140
Mo	2	0				
Nb	5		200	48.45	143	250
Ni	5	60	8.80	7.92	3	22
Pb	3	33	8.70	10.66		
Rb	5		93	18.03	73	113
Sr	5		2329	892.43	1743	3900
Y	3		50	10.60	39	60
Zn	5		115	32.16	76	150
Zr	5		515	142.18	287	630
Be	4		4.23	1.19	3.50	6.00
Ce						
Co						
Cs						
Eu						
Hf						
La						
Lu						
Sb						
Sc						
Sm						
Ta						
Tb						
Th						
U						
Yb						

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S3b – LATITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	45		53.55	1.58	50.37	56.40
TiO2	45		1.34	0.49	0.37	2.13
Al2O3	45		18.23	1.24	14.95	20.91
Fe2O3	45		3.47	1.06	1.32	6.06
FeO	45		2.17	0.76	0.72	3.55
MnO	45		0.17	0.03	0.11	0.26
MgO	45		1.70	0.66	0.26	3.48
CaO	45		5.31	0.96	3.62	7.45
Na2O	45		4.72	0.66	2.94	6.09
K2O	45		4.48	0.68	3.18	6.45
H2O+	40		2.65	1.03	0.22	4.56
H2O-	38		0.98	0.47	0.19	2.05
P2O5	45		0.32	0.14	0.09	0.65
CO2	35	97	0.67	0.98	0.003	3.89
Li2O	18		0.004	0.003	0.001	0.02
S	30		0.05	0.07	0.007	0.31
F	24		0.07	0.03	0.02	0.16
BaO	25		0.15	0.03	0.08	0.20
ppm						
As	14	14				
Cr	24	54	11	12.30	2	50
Cu	24	83	33	40.27	2	140
Mo	14	43	11	11.35		
Nb	26		146	27.62	87	216
Ni	24	63	7.90	6.40	2	20
Pb	14	7				
Rb	26		117	30.96	75	200
Sr	26		1574	560.86	790	3400
Y	16		34	8.37	21	49
Zn	25		102	24.41	67	143
Zr	26		585	167.35	311	992
Be	15	93	3.57	2.00	0.60	9.00
Ce	8		189.00	49.01	140.00	297.00
Co	7		18.59	9.15	6.00	30.70
Cs	8	88	3.28	3.61	0.30	11.70
Eu	8		2.99	0.73	2.33	4.72
Hf	8		11.64	2.52	8.70	16.30
La	8		103.95	40.79	63.00	198.00
Lu	8		0.50	0.12	0.38	0.77
Sb	6	0				
Sc	8		6.51	2.66	2.68	11.70
Sm	8		9.97	1.91	7.97	13.60
Ta	8		6.84	1.92	3.90	9.23
Tb	8	88	1.05	0.34	0.30	1.36
Th	8		15.85	3.42	12.00	23.00
U	7	86	4.44	2.63	0.90	7.74
Yb	8		3.74	2.21	2.30	9.04

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T – TRACHYTES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	65		59.53	2.52	55.70	66.87
TiO2	64		0.50	0.20	0.17	1.00
Al2O3	65		19.00	0.95	15.86	21.84
Fe2O3	65		2.05	0.89	0.25	6.68
FeO	65		1.12	0.80	0.11	3.81
MnO	65		0.18	0.09	0.01	0.53
MgO	65	97	0.51	0.37	0.03	2.37
CaO	65		2.15	1.07	0.15	4.98
Na2O	65		6.17	1.01	3.29	7.87
K2O	65		5.59	0.62	4.12	6.97
H2O+	64		1.85	0.98	0.12	4.54
H2O-	63		0.57	0.54	0.07	2.60
P2O5	62		0.08	0.07	0.01	0.45
CO2	59		0.38	0.52	0.01	2.41
Li2O	13	92	0.009	0.016	0.0003	0.06
S	45	98	0.03	0.05	0.01	0.28
F	33		0.07	0.05	0.02	0.26
BaO	56	95	0.12	0.07	0.00	0.26
ppm						
As	35	20				
Cr	43	70	12	9.21	2	37
Cu	56	77	55	48.92	1	242
Mo	25	12				
Nb	57		161	78.35	77	415
Ni	57	51	6.30	6.07	2	21
Pb	36	69	25	21.28	2	86
Rb	57		181	48.82	121	361
Sr	57	98	684	567.05	3	2268
Y	36		37	12.51	16	67
Zn	57		108	43.90	16	292
Zr	57		733	222.60	440	1460
Be	36		4.96	2.00	3.00	12.00
Ce	33		159.13	43.95	53.00	237.00
Co	33	91	4.72	7.89	0.30	41.50
Cs	33	94	2.78	2.95	0.30	18.00
Eu	33		1.34	0.55	0.26	2.57
Hf	33		14.94	4.65	7.68	31.60
La	33		116.14	36.72	30.10	187.00
Lu	33		0.44	0.16	0.23	1.05
Sb	33	42	0.84	0.71		
Sc	33	97	1.15	1.08	0.03	6.28
Sm	32		4.31	1.74	1.36	8.60
Ta	32		6.19	3.55	1.51	15.50
Tb	33	33	0.68	0.59		
Th	33		22.35	7.78	14.20	46.80
U	32	53	4.08	3.73	0.30	12.60
Yb	33		4.37	1.67	1.52	10.10

Table 10/15

Ph–PHONOLITES						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	125		56.04	1.83	50.10	61.12
TiO2	122		0.34	0.24	0.10	1.37
Al2O3	125		20.61	1.25	16.47	23.14
Fe2O3	125		1.77	0.74	0.41	5.32
FeO	125		1.34	1.10	0.02	4.64
MnO	125		0.25	0.18	0.01	1.91
MgO	124	94	0.30	0.25	0.01	1.12
CaO	125		1.75	1.06	0.50	5.14
Na2O	125		8.59	1.57	3.43	11.01
K2O	125		5.59	0.71	3.83	8.72
H2O+	120		2.17	1.04	0.02	5.21
H2O-	112		0.48	0.46	0.02	4.17
P2O5	117		0.09	0.11	0.00	0.70
CO2	113	98	0.40	0.54	0.003	3.22
Li2O	23		0.01	0.01	0.002	0.07
S	99		0.05	0.06	0.01	0.34
F	59		0.10	0.06	0.03	0.31
BaO	87	92	0.07	0.07	0.001	0.25
ppm						
As	62	39	7.40	6.49		
Cr	79	70	19	24.53	2	165
Cu	93	80	58	50.80	1	156
Mo	51	33	7.30	7.20		
Nb	99		200	150.58	13	920
Ni	94	51	7.50	10.51	1	84
Pb	63	89	28	18.17	2	117
Rb	98		227	74.53	95	439
Sr	98	92	498	627.49	2	2550
Y	63	98	39	28.72	3	163
Zn	99		156	62.48	66	420
Zr	99		1133	473.00	247	2600
Be	64		7.96	3.88	3.00	22.00
Ce	62		154.93	56.92	70.90	329.00
Co	59	86	5.34	9.55	0.30	40.90
Cs	61	98	4.21	2.70	0.30	10.30
Eu	62		0.97	0.55	0.21	2.50
Hf	62		20.17	12.26	8.10	69.30
La	62		120.07	38.93	32.20	210.00
Lu	62	95	0.54	0.40	0.03	2.16
Sb	60	73	1.65	1.32	0.30	7.12
Sc	62	84	0.78	0.76	0.03	2.84
Sm	62	98	3.59	2.35	0.30	15.60
Ta	62	98	6.11	8.52	0.30	40.50
Tb	62	27				
Th	62		31.71	14.95	14.00	82.30
U	60	80	8.29	6.21	0.90	30.50
Yb	62	94	4.67	3.83	0.30	20.50

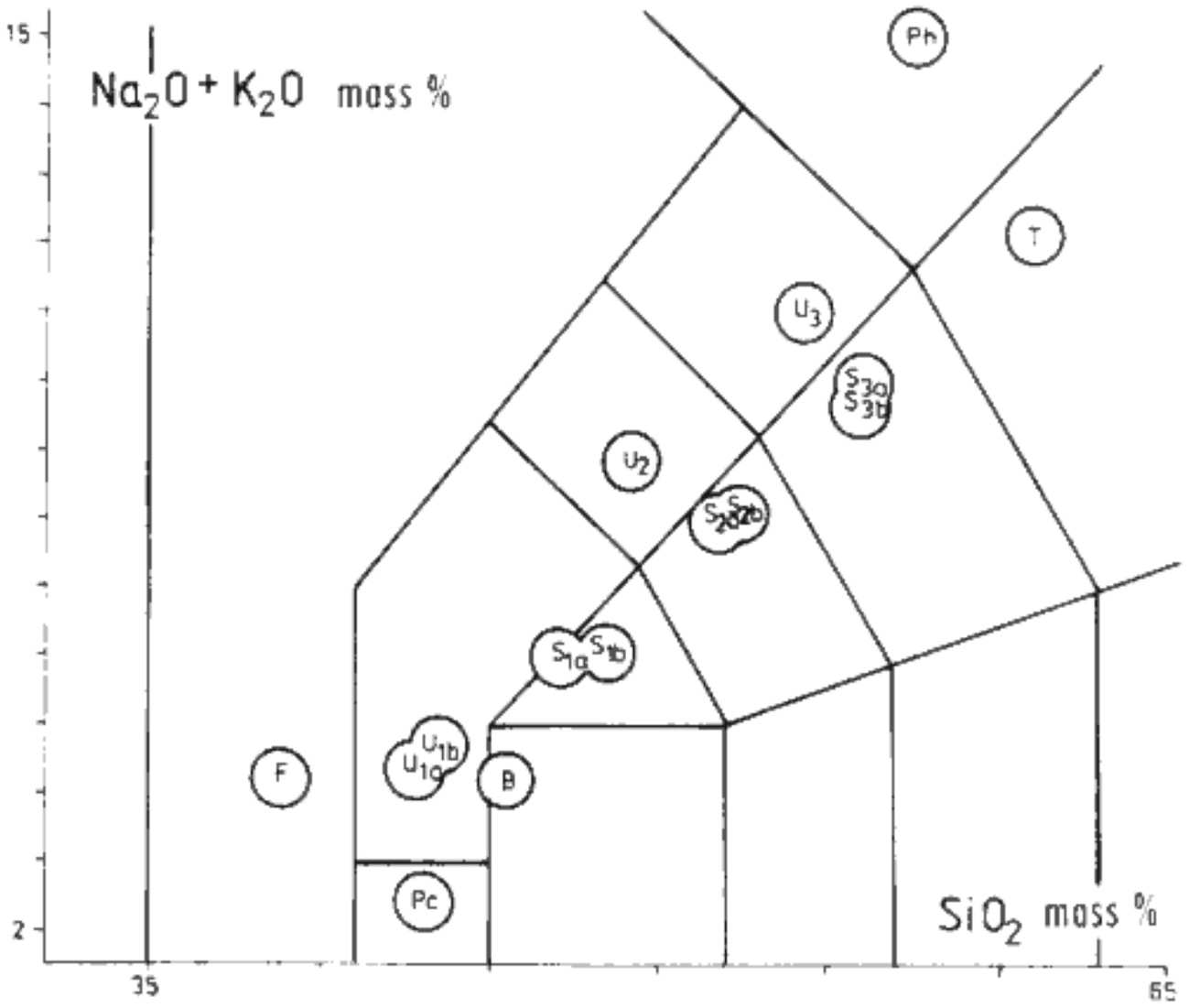


Fig. 4. Position of rock types according to the IUGS classification in the $Na_2O + K_2O/SiO_2$ diagram (LeBas et al. 1986). Plotted from data in Tables 10/1 to 10/15.

Table 11
Summary of rock groups (fields) defined by Shrbený (see Fig. 5) represented in tables of average composition (Tables 12/1 to 12/12)

field	rock type within a field	rocks typical for pertinent fields	n
1		polzenites – part, olivine (micro)melilitolites	14
2		polzenites – part, other melilitic rocks, olivine-free foidites	47
3	A	olivine foidites (more than 9 % MgO), basanites - part	162
	B	olivine-free foidites (less than 9 % MgO), (micro)theralites – part, basaltic lamprophyres – part	114
4		more strongly olivinic to picritic foidites	25
5	A	basanites – part, olivine alkali basalts (more than 7.25 % MgO)	125
	B	tephrites, olivine-free alkali basalts (less than 7.25 % MgO), (micro)theralites – part, basaltic lamprophyres – part	181
6a		trachybasalts and (micro)essexites of basaltoid type, trachybasaltic lamprophyres	53
6b		trachybasalts and (micro)essexites of trachytoid type, trachybasaltic semilamprophyres	64
7		trachyandesites	3
8		trachytes, (micro)syenites, trachytic semilamprophyres	123
9		phonolites	107
			Σ 1018

Tables 12/1 to 12/12. Average composition of rocks of individual fields in the Na2O + K2O/SiO2 diagram by Shrbený (see Fig. 5)

Table 12/1

ROCKS OF THE FIELD 1						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	14		32.36	1.11	30.19	34.08
TiO2	14		2.42	0.27	2.22	3.20
Al2O3	14		7.95	0.46	7.05	8.97
Fe2O3	14		5.21	0.78	4.45	7.04
FeO	14		5.84	0.80	3.66	7.02
MnO	14		0.21	0.01	0.19	0.23
MgO	14		16.78	2.38	9.83	19.63
CaO	14		16.81	2.04	13.62	20.93
Na2O	14		2.09	0.57	0.51	2.90
K2O	14		1.94	0.40	1.28	2.77
H2O+	14		4.23	1.18	1.13	5.86
H2O-	13		0.35	0.24	0.05	1.04
P2O5	14		1.66	0.92	0.86	4.41
CO2	14		1.41	0.53	0.22	2.20
Li2O	1		<0.001			
S	14		0.20	0.06	0.12	0.33
F	4		0.13	0.01	0.12	0.14
BaO	14		0.16	0.04	0.10	0.26
ppm						
As	10	10				
Cr	14		609	185.04	72	814
Cu	14		95	25.95	64	156
Mo	10	70	15	9.30	2	26
Nb	14		157	32.89	99	243
Ni	14		338	94.36	98	440
Pb	14	29				
Rb	14		46	15.94	16	71
Sr	14		1626	1019.42	944	5090
Y	13	92	32	10.81	3	49
Zn	10		103	16.23	67	118
Zr	14		270	65.69	205	456
Be	10	90	1.52	0.50	0.30	2.20
Ce	10		198.60	30.72	160.00	247.00
Co	10		53.39	3.83	46.90	60.50
Cs	10	20				
Eu	10		4.20	0.49	3.54	5.19
Hf	10		7.53	1.93	5.49	11.40
La	10		129.14	33.02	87.40	189.00
Lu	10	90	0.23	0.11	0.03	0.42
Sb	10	30				
Sc	10		29.20	3.86	22.40	33.20
Sm	10		12.23	1.99	9.95	15.90
Ta	10		6.49	1.07	4.51	8.03
Tb	10	32				
Th	10		11.35	2.41	7.98	15.60
U	10	70	3.91	2.18	0.90	6.07
Yb	10	80	3.12	1.89	0.30	6.01

Table 12/2

ROCKS OF THE FIELD 2						
mass %	n	det. ratio	mean	s. d.	min	max
SiO2	47		37.45	1.11	34.11	39.07
TiO2	47		3.68	1.19	2.23	5.83
Al2O3	47		10.22	1.40	7.43	14.99
Fe2O3	47		6.05	1.85	3.25	9.16
FeO	47		7.30	0.97	4.39	9.70
MnO	47		0.23	0.06	0.13	0.60
MgO	47		12.02	4.85	5.97	19.45
CaO	47		14.19	1.79	10.12	17.02
Na2O	47		2.69	0.68	0.95	4.29
K2O	47		1.31	0.42	0.22	2.48
H2O+	47		2.31	0.98	0.02	6.59
H2O-	47		0.49	0.28	0.10	1.38
P2O5	47		1.02	0.25	0.56	1.52
CO2	47		0.61	0.74	0.04	3.76
Li2O	27	89	0.002	0.001	0.001	0.006
S	45		0.08	0.06	0.02	0.32
F	28		0.14	0.03	0.09	0.21
BaO	42		0.14	0.15	0.06	1.06
ppm						
As	40	8				
Cr	43		465	434.23	29	1245
Cu	43		148	70.35	52	346
Mo	40	43	12	14.95		
Nb	43		116	20.65	73	168
Ni	43		228	203.04	15	576
Pb	40	13				
Rb	43		44	15.38	20	86
Sr	43		924	252.34	681	2000
Y	42		28	6.26	13	46
Zn	41		104	22.69	66	171
Zr	43		297	102.42	154	540
Be	40	93	1.61	0.71	0.30	3.40
Ce	36		165.69	46.70	85.30	286.00
Co	37		58.64	4.96	48.10	70.80
Cs	37	22				
Eu	37		3.64	0.94	2.35	7.36
Hf	37		9.27	2.30	5.40	14.90
La	36		92.77	30.79	37.20	143.00
Lu	37	92	0.26	0.11	0.03	0.56
Sb	37	16				
Sc	37		32.54	5.25	24.20	45.60
Sm	35		11.75	3.29	6.63	18.40
Ta	36		6.51	1.57	4.01	11.80
Tb	37	73	1.35	1.38	0.30	8.77
Th	37		9.17	2.33	4.58	14.40
U	36	39	2.63	2.77		
Yb	37	92	3.32	1.35	0.30	5.94

Table 12/3

ROCKS OF THE FIELD 3, TYPE A						
mass %	n	det. ratio	mean	s. d	min	max
SiO2	162		40.87	1.21	38.45	43.93
TiO2	162		2.98	0.59	1.40	4.62
Al2O3	162		11.84	1.20	7.11	14.35
Fe2O3	162		5.15	1.18	2.23	11.81
FeO	161		6.92	1.00	4.02	10.45
MnO	161		0.20	0.04	0.14	0.53
MgO	162		11.28	1.93	8.55	18.30
CaO	162		12.21	1.17	9.41	15.67
Na2O	162		3.02	0.56	1.49	4.68
K2O	162		1.07	0.36	0.32	2.22
H2O+	161		2.35	0.87	0.20	6.38
H2O-	159		0.57	0.36	0.06	3.15
P2O5	161		0.79	0.25	0.33	1.46
CO2	150	99	0.52	0.82	0.003	5.41
Li2O	127	81	0.002	0.002	0.0003	0.01
S	143	96	0.03	0.04	0.003	0.19
F	125		0.10	0.03	0.01	0.19
BaO	123		0.09	0.03	0.05	0.19
ppm						
As	127	3				
Cr	135		369	175.93	85	1023
Cu	135		84	39.02	40	329
Mo	127	31				
Nb	135		90	18.92	50	136
Ni	135		219	110.79	34	574
Pb	127	8				
Rb	135	97	39	24.06	2	202
Sr	135		918	211.03	553	1700
Y	127		23	5.08	13	39
Zn	135		87	17.77	47	149
Zr	135		266	69.37	79	726
Be	121	77	1.69	1.17	0.17	5.00
Ce	102		123.98	29.75	51.00	211.00
Co	101		58.41	9.54	41.00	113.00
Cs	105	29				
Eu	103		2.74	0.42	1.60	3.95
Hf	105		6.38	1.73	3.25	15.30
La	104		71.18	24.63	24.50	154.00
Lu	104	89	0.24	0.11	0.03	0.51
Sb	104	18				
Sc	105		31.32	2.56	19.60	39.60
Sm	99		8.71	1.32	2.76	15.90
Ta	100		4.68	1.07	1.53	7.02
Tb	104	63	0.89	0.48	0.30	2.42
Th	102		7.62	2.79	2.00	20.30
U	97	30	2.14	2.08		
Yb	104	92	2.38	1.04	0.30	5.25

Table 12/4

ROCKS OF THE FIELD 3, TYPE B						
mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	114		40.72	1.01	38.12	43.32
TiO2	114		3.83	0.52	2.51	5.09
Al2O3	114		12.71	1.07	10.45	15.53
Fe2O3	114		6.50	1.35	4.01	13.88
FeO	114		6.54	1.38	0.77	9.80
MnO	114		0.22	0.03	0.17	0.36
MgO	114		7.10	0.94	5.08	9.45
CaO	114		13.03	1.07	10.96	15.65
Na2O	114		2.96	0.63	1.42	4.84
K2O	114		1.24	0.48	0.29	2.90
H2O+	114		2.43	0.68	0.52	4.01
H2O-	114		0.93	0.44	0.17	2.21
P2O5	114		0.84	0.25	0.28	1.56
CO2	110	99	0.53	0.65	0.003	3.15
Li2O	92	85	0.003	0.004	0.0003	0.041
S	109		0.05	0.06	0.01	0.50
F	95		0.13	0.04	0.02	0.25
BaO	91		0.10	0.03	0.04	0.19
ppm						
As	93	17				
Cr	104	99	92	71.51	2	311
Cu	104		120	62.76	45	412
Mo	93	25				
Nb	104		103	23.98	64	206
Ni	104	97	52	34.13	2	160
Pb	93	17				
Rb	104	99	59	51.67	3	378
Sr	104		1033	257.01	475	1818
Y	93	99	29	8.25	3	62
Zn	104		95	26.31	51	161
Zr	104		342	103.62	187	812
Be	91	87	1.96	1.16	0.30	5.30
Ce	64		154.19	42.01	81.00	325.00
Co	65		48.58	6.92	32.00	74.40
Cs	65	51	1.35	1.61	0.30	10.20
Eu	65		3.32	0.80	2.00	7.11
Hf	65		8.99	2.32	4.44	17.60
La	64		72.45	24.65	31.40	173.00
Lu	65	95	0.29	0.14	0.03	0.69
Sb	65	25				
Sc	65		32.57	8.69	16.10	52.90
Sm	60		10.82	2.42	4.56	19.60
Ta	60		6.53	1.73	3.14	12.60
Tb	64	64	1.05	0.63	0.30	2.43
Th	65		2.85	2.47	4.00	18.00
U	60	59	3.01	2.42		
Yb	65	98	3.17	1.24	0.30	6.79

Table 12/5

ROCKS OF THE FIELD 4

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	25		42.41	1.66	38.91	44.94
TiO2	25		2.49	0.76	1.15	4.16
Al2O3	25		8.24	1.38	5.86	10.71
Fe2O3	25		4.64	1.12	3.20	7.44
FeO	25		6.30	1.01	3.94	8.74
MnO	25		0.18	0.05	0.14	0.43
MgO	25		14.74	4.03	11.00	23.69
CaO	25		14.18	2.02	9.02	16.91
Na2O	25		1.52	0.44	0.70	2.20
K2O	25		0.66	0.32	0.24	1.54
H2O+	25		2.41	0.90	1.22	4.61
H2O-	25		0.78	0.43	0.18	1.79
P2O5	25		0.60	0.35	0.19	1.90
CO2	24		0.53	0.61	0.02	1.99
Li2O	20		0.002	0.003	0.0008	0.012
S	23		0.05	0.03	0.01	0.12
F	21		0.10	0.03	0.04	0.16
BaO	20		0.08	0.03	0.05	0.15
ppm						
As	20	10				
Cr	20		640	362.45	73	1580
Cu	20		107	71.46	39	357
Mo	20	15				
Nb	20		67	25.81	33	113
Ni	20		285	199.59	41	733
Pb	20	40	7.00	6.31		
Rb	20	95	42	29.43	3	131
Sr	20		702	250.16	373	1266
Y	20		21	5.25	9	31
Zn	20		76	22.08	47	119
Zr	20		210	81.17	102	342
Be	20	65	1.11	0.91	0.30	4.00
Ce	13		114.35	51.16	70.00	271.00
Co	13		56.88	9.79	30.50	73.80
Cs	13	38	1.44	2.67		
Eu	13		2.40	0.72	1.68	4.29
Hf	13		6.04	1.69	3.92	10.40
La	13		54.85	34.36	31.30	145.00
Lu	13	77	0.23	0.16	0.03	0.61
Sb	13	23				
Sc	13		50.82	10.16	20.50	61.10
Sm	13		8.31	2.83	5.42	15.50
Ta	13		3.66	1.78	2.13	8.98
Tb	13	31				
Th	13		5.99	4.53	1.80	20.20
U	13	54	2.89	2.06	0.90	6.09
Yb	13	85	2.02	1.30	0.30	5.27

Table 12/6

ROCKS OF THE FIELD 5, TYPE A

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	125		43.71	1.15	41.50	47.09
TiO2	125		2.72	0.48	0.76	3.81
Al2O3	125		12.51	1.40	8.32	15.97
Fe2O3	125		4.60	1.30	1.88	10.35
FeO	125		6.80	1.39	1.65	12.50
MnO	123		0.20	0.05	0.12	0.64
MgO	125		9.64	1.77	7.06	14.97
CaO	125		11.28	1.24	8.69	16.03
Na2O	125		3.08	0.63	1.34	4.65
K2O	125		1.46	0.44	0.54	3.68
H2O+	122		1.95	0.84	0.15	5.15
H2O-	117		0.57	0.30	0.12	1.53
P2O5	125		0.68	0.19	0.03	1.40
CO2	106	98	0.61	0.86	0.003	4.54
Li2O	83	77	0.002	0.002	0.0003	0.007
S	95	98	0.05	0.06	0.003	0.46
F	84		0.08	0.03	0.01	0.15
BaO	65		0.10	0.08	0.04	0.70
ppm						
As	87	5				
Cr	92		327	158.96	82	942
Cu	92		77	40.79	32	250
Mo	87	34	6.00	6.32		
Nb	92		84	17.15	41	120
Ni	92		196	99.21	50	483
Pb	87	9				
Rb	92		41	36.23	10	322
Sr	92		883	194.64	339	1700
Y	87		25	5.50	13	43
Zn	92		89	21.06	51	153
Zr	92		282	70.79	140	550
Be	68	79	1.66	1.15	0.30	5.50
Ce	53		107.77	22.69	50.00	143.00
Co	50		53.71	9.82	33.00	88.70
Cs	54	22				
Eu	53		2.54	0.37	1.60	3.73
Hf	54		6.50	1.81	3.09	15.80
La	53		60.93	17.37	27.00	102.00
Lu	53	98	0.27	0.10	0.03	0.57
Sb	53	21				
Sc	54		29.16	7.23	18.20	47.50
Sm	49		7.68	1.35	3.20	11.80
Ta	50		4.11	0.80	2.29	6.50
Tb	52	44	0.68	0.45		
Th	51		6.63	1.92	3.51	11.60
U	46	37	2.04	1.74		
Yb	53	95	2.46	1.07	0.30	5.29

Table 12/7

ROCKS OF THE FIELD 5, TYPE B

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	181		44.41	1.74	40.58	48.16
TiO2	181		3.07	0.55	1.00	4.69
Al2O3	181		14.86	1.26	11.34	18.69
Fe2O3	181		5.57	1.08	2.23	8.95
FeO	181		5.63	1.23	2.49	9.63
MnO	181		0.22	0.09	0.014	1.18
MgO	181		5.20	1.03	2.75	7.71
CaO	181		10.53	1.11	7.55	13.74
Na2O	181		3.38	0.66	1.55	5.46
K2O	181		2.30	0.82	0.64	4.50
H2O+	179		2.55	1.02	0.20	5.06
H2O-	169		0.82	0.57	0.02	3.51
P2O5	181		0.77	0.22	0.40	1.00
CO2	161	98	0.46	0.68	0.003	3.64
Li2O	94	90	0.003	0.002	0.0003	0.009
S	132	99	0.06	0.09	0.003	0.87
F	107		0.12	0.03	0.03	0.25
BaO	102		0.12	0.09	0.04	0.87
ppm						
As	93	23				
Cr	106	92	54	51.20	2	243
Cu	105		62	32.27	9	220
Mo	94	28				
Nb	103		108	36.16	60	220
Ni	105	90	30	23.79	2	131
Pb	98	31				
Rb	112	99	70	55.83	3	359
Sr	112		1161	438.43	550	3200
Y	102	99	32	8.39	2	66
Zn	105		100	26.18	20	172
Zr	106		368	107.00	200	687
Be	92	92	2.36	1.36	0.30	7.00
Ce	72		159.43	46.80	74.00	297.00
Co	73		38.00	9.44	14.00	54.10
Cs	75	59	1.60	3.46	0.06	27.90
Eu	75		3.25	0.62	2.40	5.22
Hf	75		8.94	1.78	5.29	14.70
La	73		84.87	36.58	40.70	232.00
Lu	75		0.37	0.12	0.14	0.67
Sb	72	17				
Sc	76		21.92	7.63	4.26	38.00
Sm	72		11.09	2.70	6.90	17.40
Ta	72		5.90	1.79	3.35	11.80
Tb	75	76	1.16	0.56	0.30	2.17
Th	75		9.93	3.84	4.76	23.20
U	70	54	3.05	3.61	0.18	27.60
Yb	75		3.31	1.23	1.00	7.62

Table 12/8

ROCKS OF THE FIELD 6a

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	53		48.32	1.73	44.73	51.69
TiO2	53		2.20	0.73	0.15	3.46
Al2O3	53		16.79	1.16	13.80	20.41
Fe2O3	53		4.68	1.06	1.32	7.92
FeO	53		4.09	1.03	1.97	8.57
MnO	51		0.26	0.16	0.10	0.98
MgO	53		3.31	0.79	1.53	5.82
CaO	53		8.12	0.87	6.17	10.82
Na2O	53		4.35	0.65	2.22	5.87
K2O	53		3.46	0.66	2.19	5.36
H2O+	47		2.48	1.10	0.24	4.53
H2O-	37		0.67	0.46	0.07	2.09
P2O5	48		0.64	0.18	0.34	1.11
CO2	41	95	0.57	0.74	0.003	4.48
Li2O	17	94	0.003	0.001	0.0003	0.005
S	24		0.08	0.06	0.01	0.22
F	18		0.12	0.03	0.06	0.21
BaO	28		0.13	0.04	0.06	0.25
ppm						
As	18	11				
Cr	25	84	27	22.22	2	87
Cu	24		33	31.14	10	140
Mo	19	21				
Nb	23		139	42.84	75	213
Ni	24	71	14	11.28	2	45
Pb	20	25				
Rb	24		76	29.22	29	150
Sr	24		1407	469.76	702	2500
Y	20		36	9.70	24	53
Zn	24		103	19.19	73	149
Zr	24		520	111.26	335	730
Be	21		3.16	2.56	1.00	13.00
Ce	18		201.06	58.59	129.00	298.00
Co	15		28.21	9.70	16.00	46.00
Cs	18	56	2.47	5.46	0.30	24.00
Eu	18		3.56	0.99	2.30	5.24
Hf	18		10.76	2.54	5.90	14.20
La	18		110.88	54.48	44.00	196.00
Lu	18	89	0.44	0.19	0.23	0.90
Sb	14	21				
Sc	18		11.29	5.13	4.09	22.90
Sm	18		12.52	3.25	7.68	18.20
Ta	18		7.13	2.30	4.50	10.80
Tb	18	89	1.21	0.48	0.30	2.00
Th	19		13.32	4.49	6.00	22.00
U	15	40	3.15	3.33		
Yb	18		3.99	1.60	1.76	7.10

Table 12/9

ROCKS OF THE FIELD 6b

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	64		51.23	1.48	47.75	55.17
TiO2	64		1.64	0.45	0.52	2.54
Al2O3	64		17.79	1.12	14.90	21.08
Fe2O3	64		3.78	1.03	1.76	6.06
FeO	64		2.82	0.89	0.85	6.15
MnO	63		0.20	0.06	0.01	0.36
MgO	64		2.06	0.58	0.69	3.48
CaO	64		6.15	0.78	4.57	8.33
Na2O	64		5.06	0.82	2.80	7.77
K2O	64		4.10	0.63	2.65	6.45
H2O+	61		2.99	1.03	0.30	7.28
H2O-	46		0.91	0.70	0.07	3.87
P2O5	63		0.41	0.14	0.09	0.75
CO2	50	98	0.84	0.91	0.003	3.85
Li2O	16		0.004	0.002	0.001	0.008
S	32		0.08	0.12	0.01	0.69
F	18		0.08	0.03	0.03	0.16
BaO	33		0.15	0.05	0.01	0.25
ppm						
As	17	18				
Cr	31	74	14	10.21	2	30
Cu	27	85	44	47.54	2	170
Mo	16	31				
Nb	34		160	43.27	30	247
Ni	26	53	8.00	6.77	2	22
Pb	18	44	10	11.41		
Rb	34		106	23.23	70	180
Sr	34		1760	772.75	620	3900
Y	25		31	10.69	16	60
Zn	32		100	24.24	70	188
Zr	34		545	162.84	291	815
Be	22	95	3.68	1.41	0.60	6.00
Ce	16		173.81	54.56	52.00	297.00
Co	16		14.25	10.59	5.00	38.60
Cs	17	94	2.41	2.52	0.30	11.70
Eu	17		2.70	0.86	0.77	4.72
Hf	17		10.93	2.71	5.81	16.30
La	16		108.82	41.27	63.00	198.00
Lu	17		0.42	0.13	0.21	0.77
Sb	11	27				
Sc	17		5.71	2.67	0.15	11.70
Sm	16		8.95	3.12	2.51	15.70
Ta	16		5.62	2.11	2.39	10.00
Tb	17	76	0.93	0.39	0.30	1.40
Th	20		16.30	4.43	12.00	26.60
U	15	73	4.00	3.16	0.90	11.50
Yb	17	94	3.40	2.04	0.30	9.04

Table 12/10

ROCKS OF THE FIELD 7

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	3		54.54	1.19	53.24	55.57
TiO2	3		1.69	0.10	1.58	1.76
Al2O3	3		17.57	0.30	17.22	17.75
Fe2O3	3		4.84	0.29	4.52	5.10
FeO	3		1.98	0.42	1.56	2.48
MnO	3		0.20	0.03	0.17	0.22
MgO	3		1.85	0.22	1.63	2.07
CaO	3		6.26	0.39	5.98	6.70
Na2O	3		4.55	0.38	4.30	4.98
K2O	3		3.55	0.39	3.18	3.96
H2O+	3		1.35	0.48	0.86	1.82
H2O-	3		0.63	0.31	0.28	0.88
P2O5	3		0.55	0.09	0.50	0.65
CO2	3		0.13	0.20	0.02	0.36
Li2O	2		0.0035	0.0007	0.003	0.004
S	3		0.01	0.00	0.01	0.01
F	2		0.06	0.05	0.02	0.09
BaO	3		0.15	0.02	0.12	0.17
ppm						
As	2	0				
Cr	3	67	12	9.88	2	21
Cu	3		16	11.27	9	29
Mo	2		29	1.41	28	30
Nb	3		134	12.12	123	147
Ni	3	67	10	7.00	3	17
Pb	2	0				
Rb	3		88	13.53	75	102
Sr	3		1407	319.73	1040	1623
Y	2		38	4.95	34	41
Zn	3		119	36.75	77	143
Zr	3		450	128.59	363	598
Be	2		5.50	4.95	2.00	9.00
Ce	2		228.00	5.66	224.00	232.00
Co	2		11.20	1.84	9.90	12.50
Cs	2		0.70	0.42	0.40	1.00
Eu	2		3.76	0.32	3.53	3.98
Hf	2		11.15	0.64	10.70	11.60
La	2		148.25	2.47	146.50	150.00
Lu	2		0.50	0.00	0.50	0.50
Sb	2	0				
Sc	2		7.66	1.73	6.44	8.88
Sm	2		15.25	1.63	14.10	16.40
Ta	2		8.00	0.85	7.40	8.60
Tb	2		1.35	0.07	1.30	1.40
Th	2		13.95	1.48	12.90	15.00
U	2		3.70	2.12	2.20	5.20
Yb	2		4.95	0.07	4.90	5.00

Table 12/11

ROCKS OF THE FIELD 8

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	123		57.25	3.22	51.28	66.87
TiO2	121		0.69	0.44	0.17	3.48
Al2O3	123		19.11	1.04	15.86	21.84
Fe2O3	123		2.30	0.89	0.25	6.68
FeO	123		1.49	0.97	0.11	4.62
MnO	122		0.20	0.09	0.01	0.57
MgO	122	98	0.76	0.57	0.03	2.69
CaO	123		3.08	1.43	0.72	6.50
Na2O	123		6.09	0.95	3.29	8.26
K2O	123		5.34	0.80	3.62	7.93
H2O+	118		2.15	1.05	0.12	4.90
H2O-	112		0.67	0.59	0.06	4.17
P2O5	120		0.14	0.12	0.01	0.76
CO2	108		0.45	0.60	0.01	3.89
Li2O	24	96	0.0068	0.012	0.0003	0.060
S	86	99	0.04	0.05	0.01	0.31
F	60		0.07	0.04	0.02	0.26
BaO	91	97	0.14	0.08	0.00	0.52
ppm						
As	58	19				
Cr	78	69	12	10.43	1	50
Cu	94	82	57	46.78	1	242
Mo	47	23				
Nb	95		155	66.11	77	415
Ni	95	53	6.00	6.06	2	27
Pb	59	69	23	19.03	2	86
Rb	95		163	51.37	73	361
Sr	95	99	1012	706.05	3	2550
Y	59		36	10.71	16	67
Zn	95		111	39.63	62	292
Zr	95		697	202.17	287	1460
Be	60	98	4.80	1.83	0.60	12.00
Ce	56		168.52	42.85	90.50	280.00
Co	56	91	5.82	8.39	0.30	41.50
Cs	56	93	2.81	3.48	0.30	19.90
Eu	56		1.61	0.81	0.26	5.00
Hf	56		14.12	4.19	7.68	31.60
La	56		121.35	34.94	33.20	187.00
Lu	56		0.42	0.14	0.23	1.05
Sb	56	45	1.00	1.19		
Se	56	96	1.30	1.17	0.03	6.28
Sm	56		5.16	2.57	1.42	13.80
Ta	56		5.84	3.23	1.51	15.50
Tb	56	38	0.69	0.55		
Th	56		20.57	6.81	12.60	46.80
U	56	59	3.95	3.15	0.30	11.40
Yb	56		4.28	1.48	1.52	10.10

Table 12/12

ROCKS OF THE FIELD 9

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	107		55.97	1.92	50.10	61.12
TiO2	104		0.31	0.21	0.10	1.25
Al2O3	107		20.73	1.25	16.47	23.14
Fe2O3	107		1.74	0.71	0.41	5.32
FeO	107		1.32	1.15	0.02	4.64
MnO	107		0.26	0.19	0.04	1.91
MgO	106	93	0.26	0.22	0.01	0.96
CaO	107		1.58	1.01	0.50	4.33
Na2O	107		8.99	1.25	5.80	11.01
K2O	107		5.52	0.59	3.83	7.49
H2O+	104		2.15	1.06	0.02	5.21
H2O-	97		0.43	0.30	0.02	2.26
P2O5	100		0.08	0.10	0.004	0.70
CO2	97	98	0.36	0.52	0.003	3.22
Li2O	20		0.013	0.015	0.002	0.070
S	87		0.05	0.06	0.01	0.34
F	52		0.11	0.06	0.03	0.31
BaO	76	91	0.06	0.07	0.00	0.25
ppm						
As	53	43	8.00	6.65		
Cr	68	68	17	18.89	2	134
Cu	81	78	54	49.99	1	156
Mo	40	32				
Nb	87		211	157.73	76	920
Ni	82	51	7.00	7.07	1	45
Pb	53	87	28	19.28	2	117
Rb	86		235	73.36	95	439
Sr	86	91	441	634.80	2	2550
Y	53	98	40	31.16	3	163
Zn	87		160	63.23	66	420
Zr	87		1209	470.55	489	2600
Be	54		8.45	4.01	3.00	22.00
Ce	53		154.63	59.11	70.90	329.00
Co	50	90	5.91	10.25	0.30	40.90
Cs	52	98	4.48	2.65	0.30	10.30
Eu	53		0.94	0.56	0.21	2.50
Hf	53		21.06	12.92	8.50	69.30
La	53		120.05	37.93	32.20	210.00
Lu	53	94	0.56	0.43	0.03	2.16
Sb	51	76	1.61	1.04	0.30	5.38
Sc	53	83	0.80	0.74	0.03	2.84
Sm	53	98	3.61	2.45	0.30	15.60
Ta	53	98	6.51	9.12	0.30	40.50
Tb	53	25				
Th	53		33.87	14.94	14.00	82.30
U	51	84	9.15	6.26	0.90	30.50
Yb	53	92	4.83	4.10	0.30	20.50

Table 13. Average, minimum and maximum content of of oxides (elements) in the young unaltered alkaline rocks of the Czech Republic ("average rocks")

mass %	n	det. ratio	mean	s. d.	min.	max.
SiO2	1066		46.11	6.81	30.19	66.87
TiO2	1061		2.40	1.26	0.10	5.83
Al2O3	1066		14.76	3.69	5.86	23.14
Fe2O3	1066		4.56	1.90	0.25	13.88
FeO	1065		4.93	2.48	0.02	12.50
MnO	1059		0.22	0.10	0.01	1.91
MgO	1064	99	6.30	4.75	0.01	23.69
CaO	1066		9.32	4.41	0.15	20.93
Na2O	1066		4.17	2.12	0.34	11.01
K2O	1066		2.67	1.82	0.15	8.72
H2O+	1043		2.42	1.07	0.00	7.57
H2O-	979		0.69	0.51	0.02	4.75
P2O5	1049		0.63	0.44	0.00	4.41
CO2	950	99	0.59	0.83	0.003	6.10
Li2O	548	86	0.003	0.005	0.0003	0.07
S	827	99	0.06	0.08	0.003	0.87
F	639		0.10	0.04	0.01	0.31
BaO	712	99	0.11	0.07	0.00	1.06
ppm						
As	642	14				
Cr	748	90	193	244.45	1	1580
Cu	771	95	78	53.84	1	346
Mo	619	30				
Nb	780		124	74.68	33	920
Ni	772	84	105	133.21	1	733
Pb	656	29				
Rb	792	99	89	78.72	2	439
Sr	792	99	1005	577.90	2	6500
Y	670	99	30	12.54	2	163
Zn	777		104	39.77	16	420
Zr	787		477	351.34	79	2600
Be	622	88	2.85	2.64	0.17	22.00
Ce	524		150.38	50.53	50.00	335.00
Co	516	98	39.45	21.98	0.30	113.00
Cs	533	53	2.00	4.32	0.06	53.90
Eu	531		2.71	1.08	0.21	7.36
Hf	534		10.04	6.34	3.09	69.30
La	527		89.52	39.85	24.50	240.00
Lu	532	95	0.34	0.20	0.03	2.16
Sb	516	29				
Sc	535	98	22.40	14.71	0.03	61.10
Sm	512		8.91	3.78	0.30	24.10
Ta	515		5.66	3.53	0.30	40.50
Tb	530	59	0.93	0.66	0.30	8.77
Th	532		12.79	10.14	1.80	82.30
U	500	52	3.53	3.82	0.02	30.50
Yb	532	96	3.30	1.95	0.30	20.50

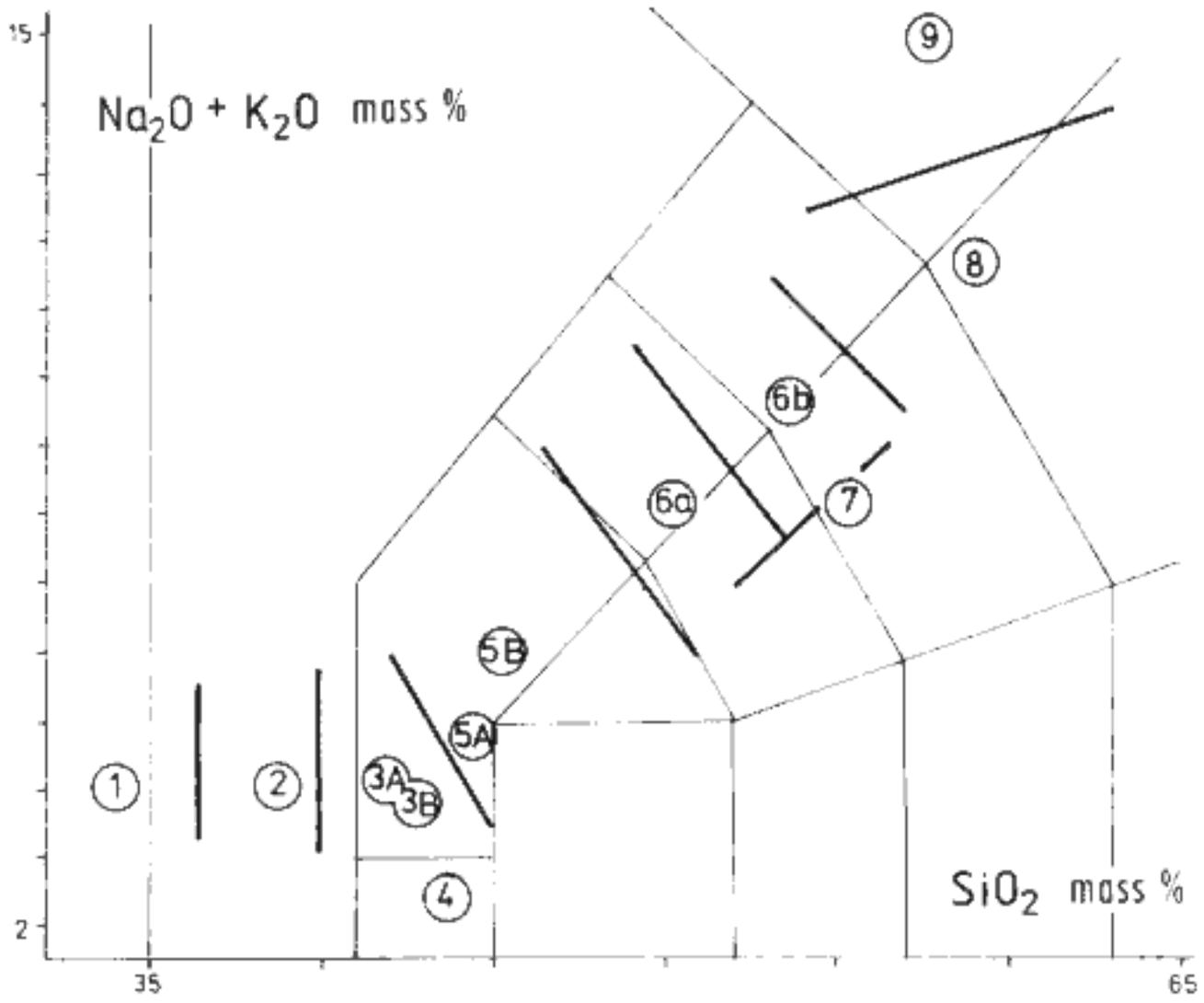


Fig. 5. Position of rocks of individual fields defined by Shrbený (Shrbený 1990a, b) in the $Na_2O + K_2O/SiO_2$ diagram - thick solid lines. Plotted from data in Tables 12/1 to 12/12. The fields defined by the IUGS classification (Le Bas et al. 1986) are shown for comparison also - thin solid lines. Rocks typical for individual fields (1 to 9) are in Table 11.

Table 14

Pair correlations (correlation coefficients) of oxides and elements in the young volcanites of the Czech Republic

	SiO2	TiO2	Al2O3	Fe2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	Li2O	S	F	BaO	As	Cr	Cu	Mo	Nb	Ni	Pb	Rb	Sr	Y	Zn	Zr	Be	Ce	Co	Cs	Eu	Hf	La	Lu	Sb	Sc	Sm	Ta	Tb	Th	U	Yb
SiO2		-0.83	0.86	-0.73	-0.83	0.02	-0.81	-0.94	0.79	0.88	-0.74	0.34	-0.16	-0.27	-0.03	0.24	-0.49	-0.38	-0.08	0.39	-0.52	0.50	0.73	-0.20	0.28	0.36	0.67	0.63	0.10	-0.86	0.18	-0.67	0.57	0.35	0.43	0.08	-0.80	-0.58	0.08	-0.20	0.67	0.35	0.33
TiO2			-0.73	0.79	0.77	-0.08	0.53	0.85	-0.75	-0.80	0.59	-0.32	0.04	0.39	-0.04	-0.20	0.13	0.45	-0.08	-0.42	0.16	-0.48	-0.69	0.15	-0.22	-0.41	-0.66	-0.61	-0.07	0.73	-0.17	0.67	-0.49	-0.40	-0.36	-0.11	0.77	0.67	-0.01	0.29	-0.69	-0.35	-0.27
Al2O3				-0.64	-0.79	0.10	-0.91	-0.90	0.84	0.86	-0.65	0.35	-0.10	-0.14	<0.01	0.24	-0.69	-0.39	-0.09	0.43	-0.68	0.45	0.71	-0.05	0.31	0.40	0.72	0.66	0.15	-0.86	0.18	-0.56	0.56	0.40	0.43	0.10	-0.86	-0.48	0.09	-0.17	0.68	0.39	0.31
Fe2O3					0.48	<0.01	0.43	0.76	-0.67	-0.69	0.64	-0.24	0.06	0.39	-0.02	-0.14	0.07	0.34	-0.06	-0.31	0.11	-0.38	-0.59	0.20	-0.09	-0.32	-0.56	-0.51	0.09	0.65	-0.12	0.70	-0.41	-0.26	-0.26	-0.11	0.67	0.70	0.05	0.32	-0.58	-0.31	-0.16
FeO						-0.02	0.75	0.81	-0.73	-0.84	0.59	-0.36	0.03	0.12	-0.02	-0.26	0.47	0.39	0.04	-0.44	0.51	-0.46	-0.73	0.05	-0.33	-0.33	-0.71	-0.61	-0.25	0.81	-0.22	0.52	-0.56	-0.44	-0.39	-0.02	0.75	0.45	-0.11	0.16	-0.68	-0.39	-0.33
MnO							-0.11	-0.06	0.18	0.05	0.12	0.04	0.11	0.15	0.02	0.05	-0.17	-0.01	-0.03	0.49	-0.14	0.17	0.23	0.08	0.43	0.44	0.36	0.34	0.31	-0.21	0.07	-0.01	0.43	0.31	0.39	0.08	-0.22	0.01	0.39	0.05	0.39	0.36	0.42
MgO								0.78	-0.73	-0.80	0.52	-0.32	0.04	-0.04	0.01	-0.24	0.86	0.28	0.18	-0.42	0.88	-0.42	-0.65	-0.02	-0.37	-0.36	-0.66	-0.57	-0.29	0.84	-0.19	0.37	-0.55	-0.41	-0.44	-0.07	0.74	0.26	-0.18	0.04	-0.59	-0.35	-0.36
CaO									-0.87	-0.90	0.71	-0.37	0.12	0.26	0.02	-0.25	0.45	0.41	<-0.01	-0.45	0.45	-0.49	-0.77	0.21	-0.29	-0.45	-0.74	-0.69	-0.08	0.85	-0.18	0.69	-0.59	-0.37	-0.45	-0.12	0.87	0.61	-0.09	0.25	-0.72	-0.39	-0.33
Na2O										0.76	-0.57	0.36	-0.07	-0.12	-0.09	0.22	-0.48	-0.31	-0.02	0.53	-0.48	0.52	0.74	-0.21	0.34	0.56	0.83	0.75	0.17	-0.79	0.15	-0.58	0.66	0.46	0.47	0.11	-0.79	-0.51	0.16	-0.19	0.78	0.49	0.40
K2O											-0.61	0.37	0.03	-0.17	0.04	0.25	-0.48	-0.35	-0.01	0.45	-0.51	0.51	0.77	-0.09	0.31	0.38	0.71	0.64	0.19	-0.87	0.18	-0.59	0.56	0.45	0.39	0.10	-0.85	-0.53	0.08	-0.21	0.70	0.39	0.31
P2O5												-0.16	0.25	0.21	0.09	-0.13	0.25	0.18	0.11	-0.17	0.33	-0.31	-0.54	0.31	-0.02	-0.20	-0.46	-0.48	0.17	0.63	-0.17	0.78	-0.43	-0.08	-0.26	-0.11	0.51	0.69	0.05	0.32	-0.50	-0.26	-0.13
Li2O													0.23	0.12	-0.05	0.09	-0.22	-0.19	-0.03	0.32	-0.22	0.09	0.37	-0.01	0.24	0.27	0.44	0.30	0.17	-0.25	0.19	-0.14	0.32	0.17	0.24	0.04	-0.30	-0.13	0.18	-0.11	0.38	0.26	0.20
S														0.16	0.12	0.16	<-0.01	-0.02	0.11	0.07	0.03	0.06	<-0.01	0.31	0.13	0.06	-0.01	0.05	0.32	-0.08	0.22	0.21	0.06	0.36	0.02	0.09	-0.16	0.17	0.04	0.06	0.16	0.14	0.08
F															-0.09	0.24	-0.26	0.31	-0.06	-0.10	-0.27	0.12	0.04	-0.03	0.07	0.11	-0.03	-0.06	0.21	-0.02	0.12	0.21	0.09	0.06	-0.06	0.09	0.10	0.25	0.01	0.12	0.08	0.11	0.01
BaO																0.03	0.05	0.03	0.14	-0.06	0.05	0.04	-0.14	0.42	-0.01	-0.06	-0.19	-0.14	0.09	-0.06	-0.02	0.15	-0.17	0.10	-0.08	-0.03	-0.10	0.11	-0.06	0.04	-0.13	-0.11	-0.05
As																	-0.16	0.02	-0.05	0.20	-0.19	0.24	0.32	-0.07	0.22	0.34	0.27	0.25	0.04	-0.23	0.14	-0.17	0.26	0.05	0.16	0.22	-0.15	-0.14	0.09	-0.03	0.30	0.22	0.14
Cr																		0.16	0.25	-0.29	0.92	-0.23	-0.40	-0.14	-0.32	-0.20	-0.45	-0.36	-0.31	0.58	-0.14	0.09	-0.38	-0.31	-0.33	-0.05	0.49	<-0.01	-0.18	-0.10	-0.36	-0.21	-0.27
Cu																			0.08	-0.20	0.09	0.07	-0.20	-0.05	-0.11	-0.05	-0.27	-0.21	-0.17	0.23	-0.02	0.07	-0.15	-0.26	-0.31	0.20	0.45	0.10	-0.10	0.07	-0.25	-0.11	-0.19
Mo																				0.01	0.23	-0.02	-0.02	0.01	0.02	0.17	-0.10	0.01	0.11	-0.05	0.06	0.11	-0.04	0.21	0.01	0.04	-0.03	0.20	0.04	0.02	<-0.01	-0.07	0.01
Nb																					-0.28	0.27	0.55	-0.03	0.78	0.71	0.71	0.69	0.56	-0.49	0.15	-0.10	0.85	0.58	0.79	0.10	-0.47	-0.05	0.83	0.10	0.79	0.46	0.80
Ni																						-0.27	-0.43	-0.09	-0.31	-0.21	-0.46	-0.35	-0.29	0.61	-0.15	0.12	-0.40	-0.26	-0.31	-0.05	0.40	0.01	-0.18	-0.07	-0.35	-0.23	-0.26
Pb																							0.49	-0.13	0.26	0.42	0.46	0.46	0.01	-0.59	0.16	-0.50	0.46	0.20	0.23	0.24	-0.45	-0.43	0.04	-0.16	0.51	0.26	0.25
Rb																								-0.29	0.45	0.55	0.80	0.73	0.18	-0.74	0.17	-0.60	0.75	0.40	0.51	0.13	-0.65	-0.51	0.26	-0.16	0.83	0.49	0.43
Sr																									0.05	-0.18	-0.24	-0.21	0.33	0.08	-0.08	0.53	-0.31	0.18	-0.13	0.03	-0.05	0.46	0.01	0.15	-0.27	-0.20	-0.03
Y																										0.60	0.60	0.56	0.59	-0.40	0.17	0.09	0.74	0.53	0.73	0.13	-0.37	0.13	0.81	0.17	0.62	0.34	0.79
Zn																											0.65	0.71	0.38	-0.50	0.21	-0.23	0.76	0.51	0.64	0.16	-0.45	-0.16	0.54	0.05	0.76	0.44	0.61
Zr																												0.85	0.32	-0.70	0.24	-0.46	0.91	0.50	0.67	0.13	-0.68	-0.40	0.47	-0.09	0.92	0.58	0.62
Be																													0.27	-0.66	0.19	-0.45	0.82	0.47	0.65	0.14	-0.63	-0.38	0.41	-0.10	0.87	0.51	0.55
Ce																														-0.27	0.11	0.48	0.43	0.81	0.52	-0.05	-0.33	0.54	0.66	0.37	0.41	0.21	0.61
Co																															-0.18	0.47	-0.61	-0.49	-0.45	-0.13	0.83	0.41	-0.18	0.12	-0.68	-0.34	-0.41
Cs																																-0.15	0.22	0.15	0.18	0.03	-0.15	-0.11	0.07	-0.08	0.27	0.12	0.09
Eu																																	-0.30	0.13	-0.08	-0.11	0.39	0.91	0.29	0.44	-0.44	-0.25	0.09
Hf																																		0.50	0.74	0.10	-0.54	-0.25	0.67	<0.01	0.87	0.50	0.75
La																																			0.49	0.02	-0.56	0.22	0.46	0.18	0.62	0.31	0.57
Lu																																				0.03	-0.46	0.01	0.69	0.11	0.67	0.38	0.70
Sb																																					-0.10	-0.29	0.06	-0.07	0.12	0.23	-0.01
Sc																																						0.38	-0.16	0.12	-0.69	-0.37	-0.40
Sm																																							0.32	0.48	-0.38	-0.21	0.11
Ta																																								0.28	0.46	0.26	0.80
Th																																									-0.05	-0.03	0.17
Th																																										0.58	0.62
U																																											0.34

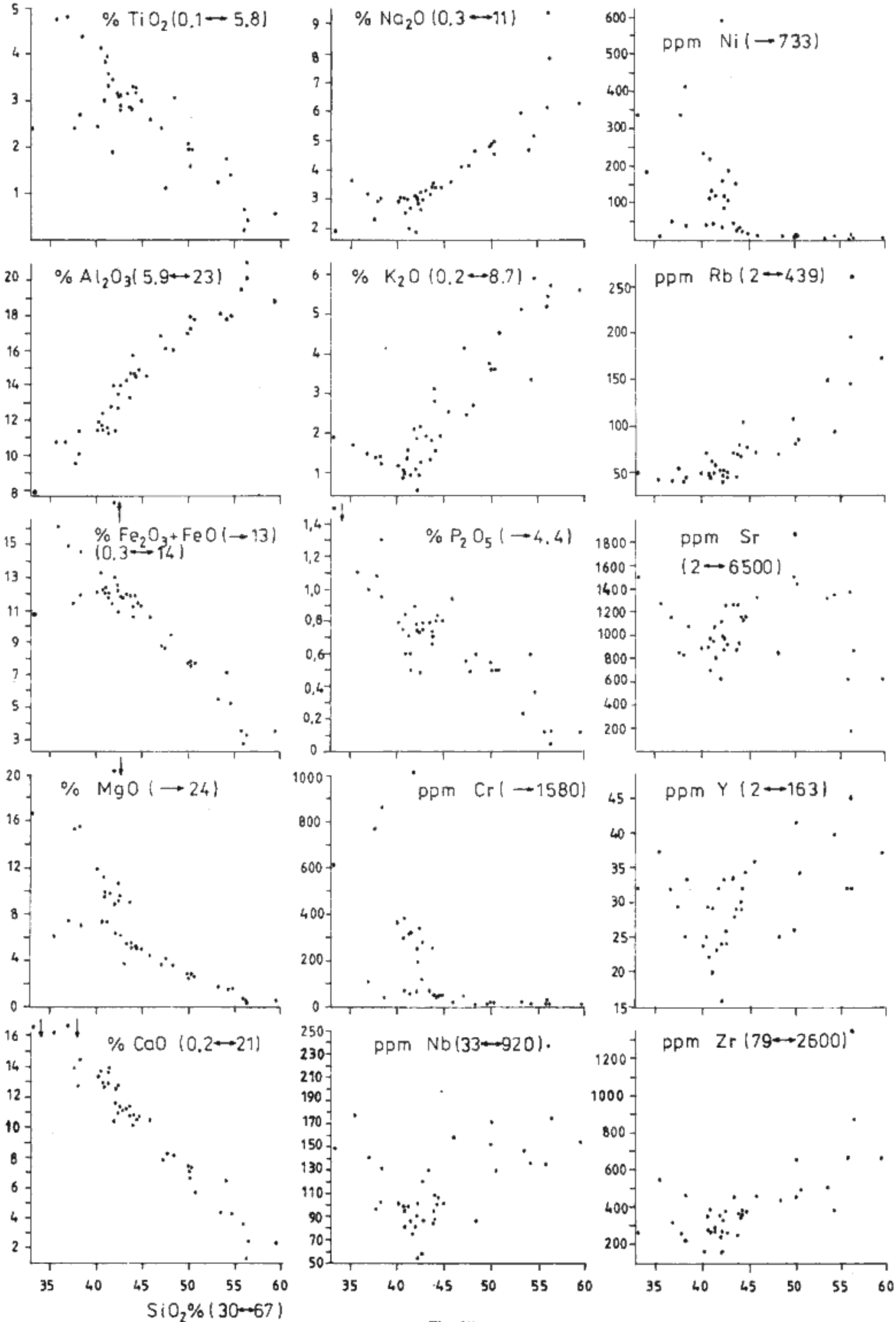

% TiO2 (0.1 → 5.8)
% Na2O (0.3 → 11)
ppm Ni (→ 733)
% Al2O3 (5.9 → 23)
% K2O (0.2 → 8.7)
ppm Rb (2 → 439)
% Fe2O3 + FeO (→ 13)
(0.3 → 14)
% P2O5 (→ 4.4)
ppm Sr
(2 → 6500)
% MgO (→ 24)
ppm Cr (→ 1580)
ppm Y (2 → 163)
% CaO (0.2 → 21)
ppm Nb (33 → 920)
ppm Zr (79 → 2600)
SiO2 % (30 → 67)

Fig. 6/1

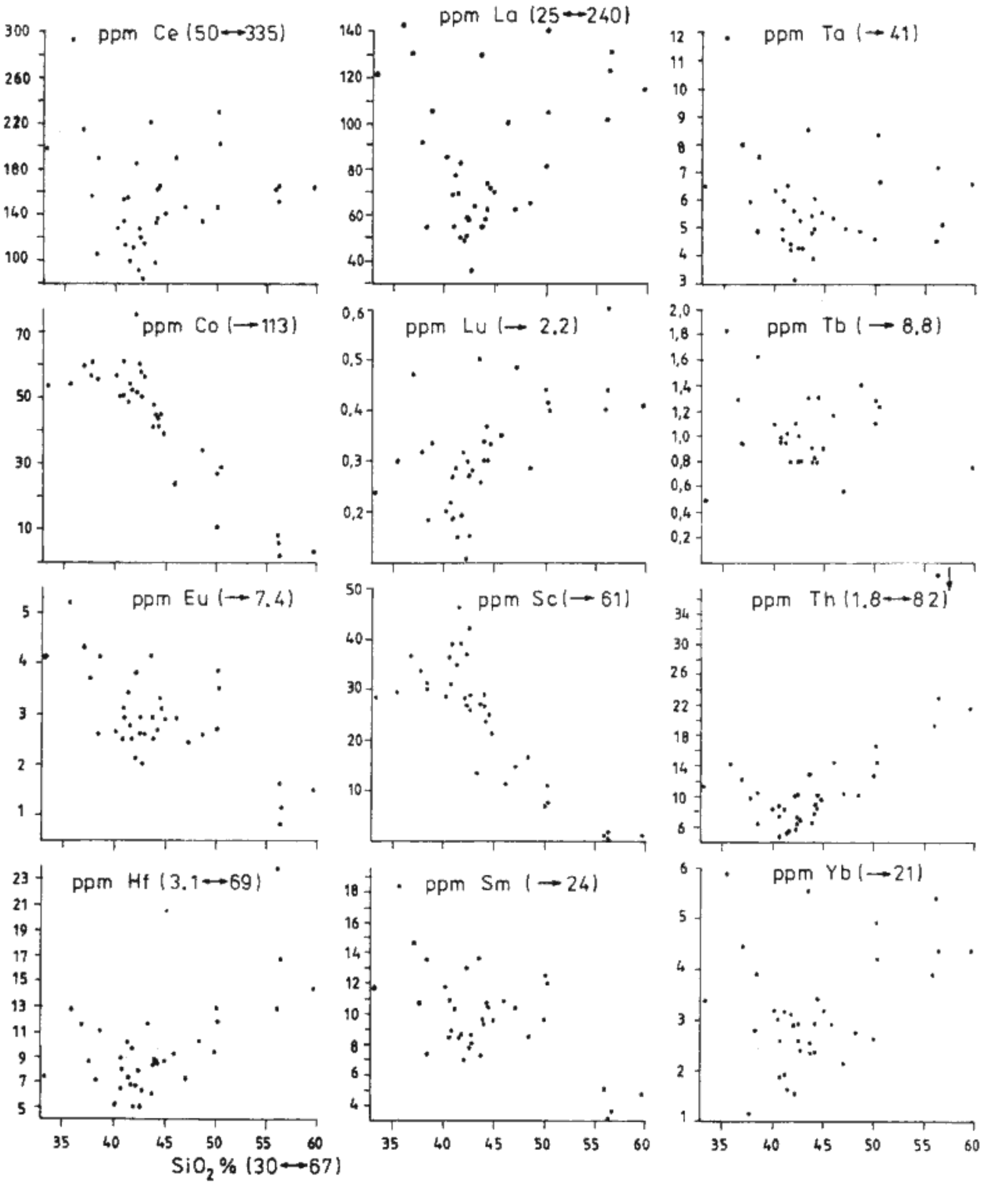


Fig. 6/1 and 6/2. Content of selected oxides (mass %) and elements (ppm) related to SiO_2 content (mass %) in the main types of young volcanites of the Czech Republic. Plotted from table of average composition of the rock types according to the mineralogical classification (Table 7). Numbers in parenthesis indicate the range (or only maximum content) of a given oxide or element in the entire set (according to Table 13).

Table 15
The highest pair correlations of oxides and elements (0.8 and more) in young volcanites of the Czech Republic. (Plotted from data in Table 14)

positive correlation		negative correlation	
Cr – Ni	0.92	SiO_2 – CaO	–0.94
Zr – Th	0.92	Al_2O_3 – MgO	–0.91
Zr – Hf	0.91	Al_2O_3 – CaO	–0.90
Eu – Sm	0.91	CaO – K_2O	–0.90
SiO_2 – K_2O	0.88	CaO – Na_2O	–0.87
MgO – Ni	0.88	K_2O – Co	–0.87
Be – Th	0.87	SiO_2 – Co	–0.86
Hf – Th	0.87	Al_2O_3 – Co	–0.86
SiO_2 – Al_2O_3	0.86	Al_2O_3 – Sc	–0.86
Al_2O_3 – K_2O	0.86	K_2O – Sc	–0.85
MgO – Cr	0.86	FeO – K_2O	–0.84
TiO_2 – CaO	0.85	SiO_2 - TiO_2	–0.83
CaO – Co	0.85	SiO_2 – FeO	–0.83
Nb – Hf	0.85	SiO_2 – MgO	–0.81
Zr – Be	0.85	TiO_2 – K_2O	–0.80
Al_2O_3 – Na_2O	0.84	MgO – K_2O	–0.80
MgO – Co	0.84		
Na_2O – Zr	0.83		
Nb – Ta	0.83		
Rb – Th	0.83		
Co – Sc	0.83		
Be – Hf	0.82		
FeO – CaO	0.81		
FeO – Co	0.81		
Y – Ta	0.81		
Ce – La	0.81		
Nb – Yb	0.80		
Rb – Zr	0.80		
Tb – Yb	0.80		

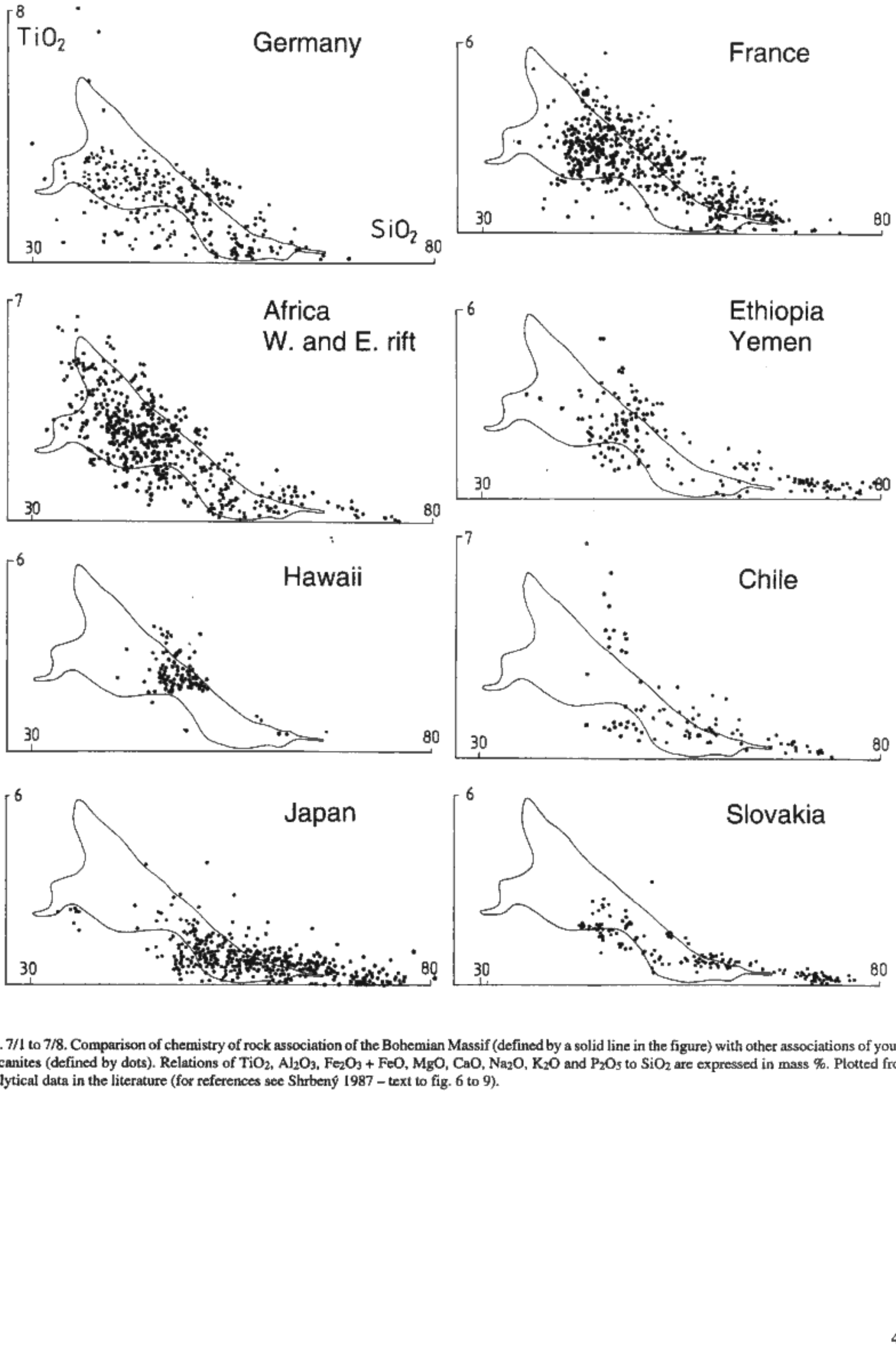


Fig. 7/1 to 7/8. Comparison of chemistry of rock association of the Bohemian Massif (defined by a solid line in the figure) with other associations of young volcanites (defined by dots). Relations of TiO_2, Al_2O_3, Fe_2O_3 + FeO, MgO, CaO, Na_2O, K_2O and P_2O_5 to SiO_2 are expressed in mass %. Plotted from analytical data in the literature (for references see Shrbený 1987 – text to fig. 6 to 9).

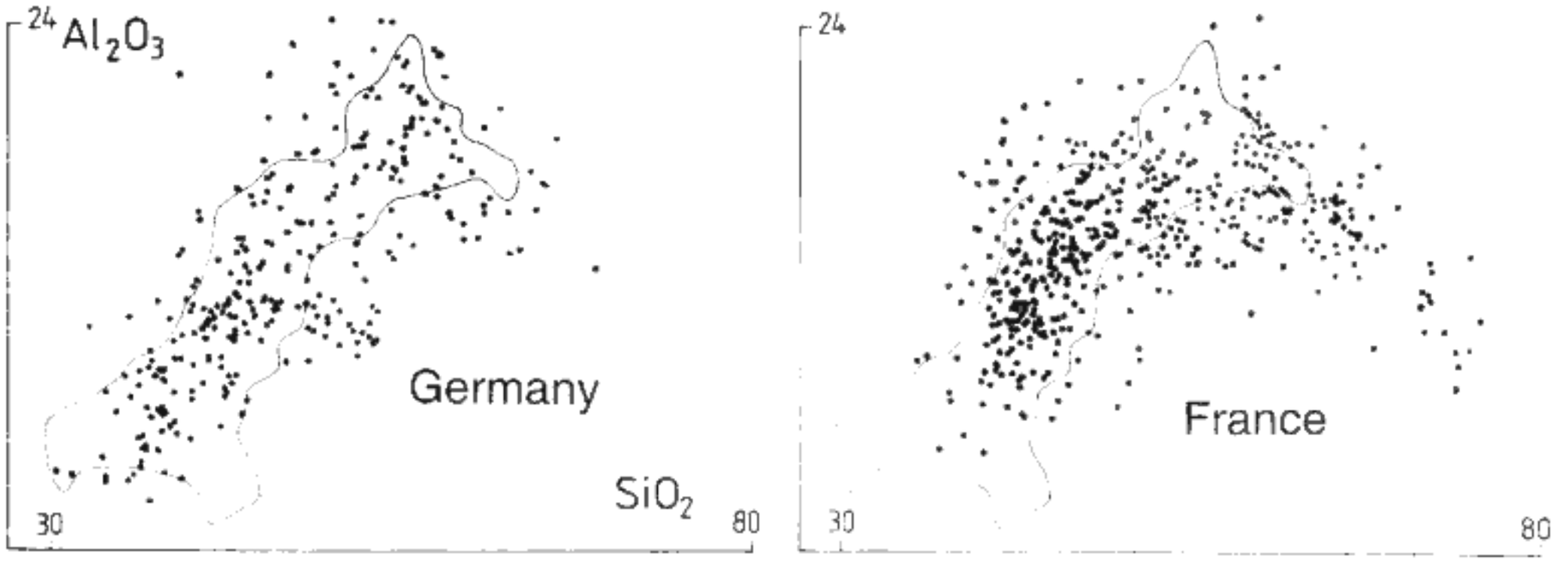

24
Al_2O_3
Germany
SiO_2
30
80
24
France
30
80
24
Africa
W. and E. rift
30
80
24
Ethiopia
Yemen
30
80
24
Hawaii
30
80
24
Chile
30
80
24
Japan
30
80
24
Slovakia
30
80

Fig. 7/2

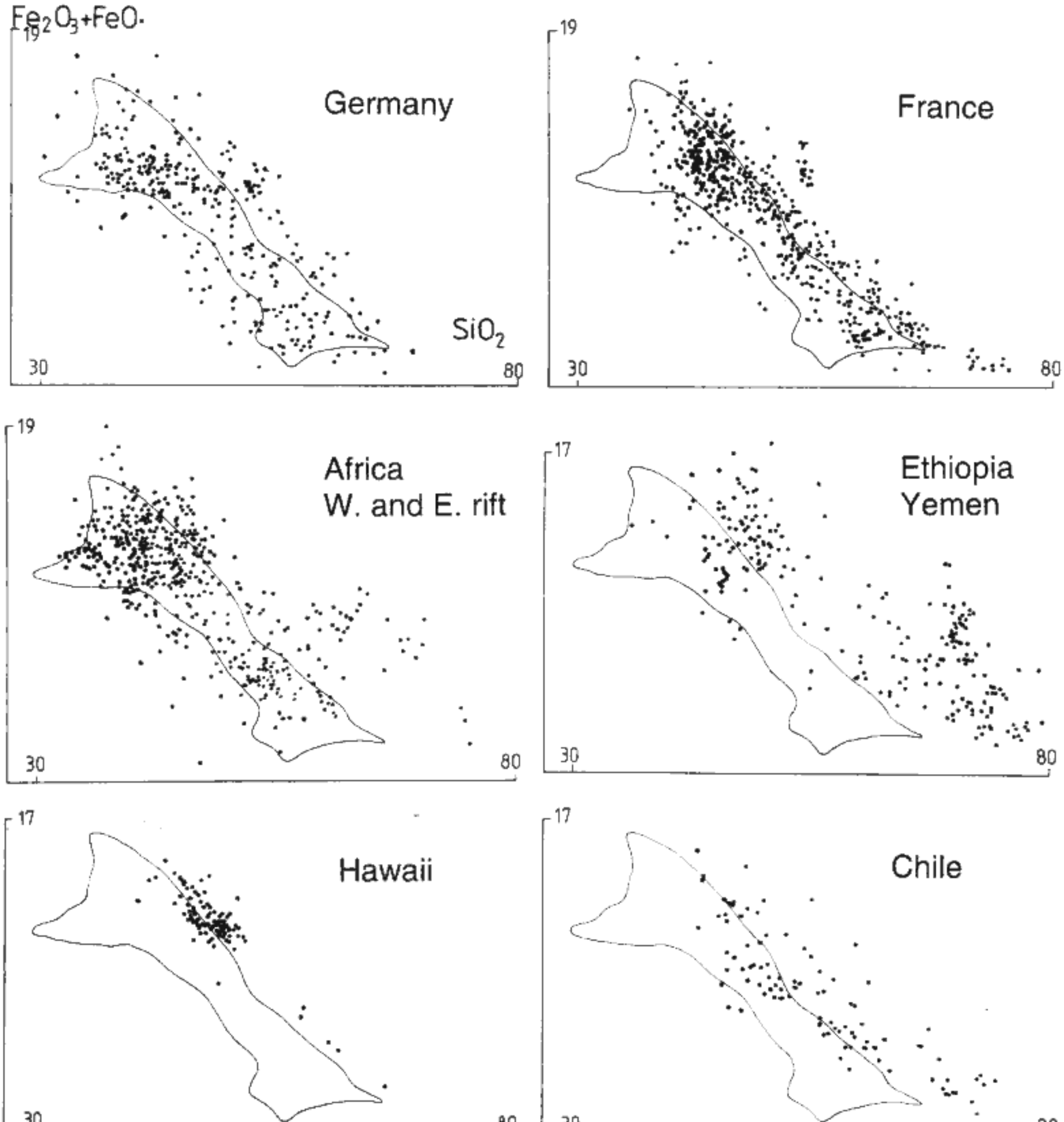

Fe_2O_3+FeO·
19
Germany
SiO_2
30
80
19
France
30
80
19
Africa
W. and E. rift
30
80
17
Ethiopia
Yemen
30
80
17
Hawaii
30
80
17
Chile
30
80
19
Japan
30
80
17
Slovakia
30
80

Fig. 7/3

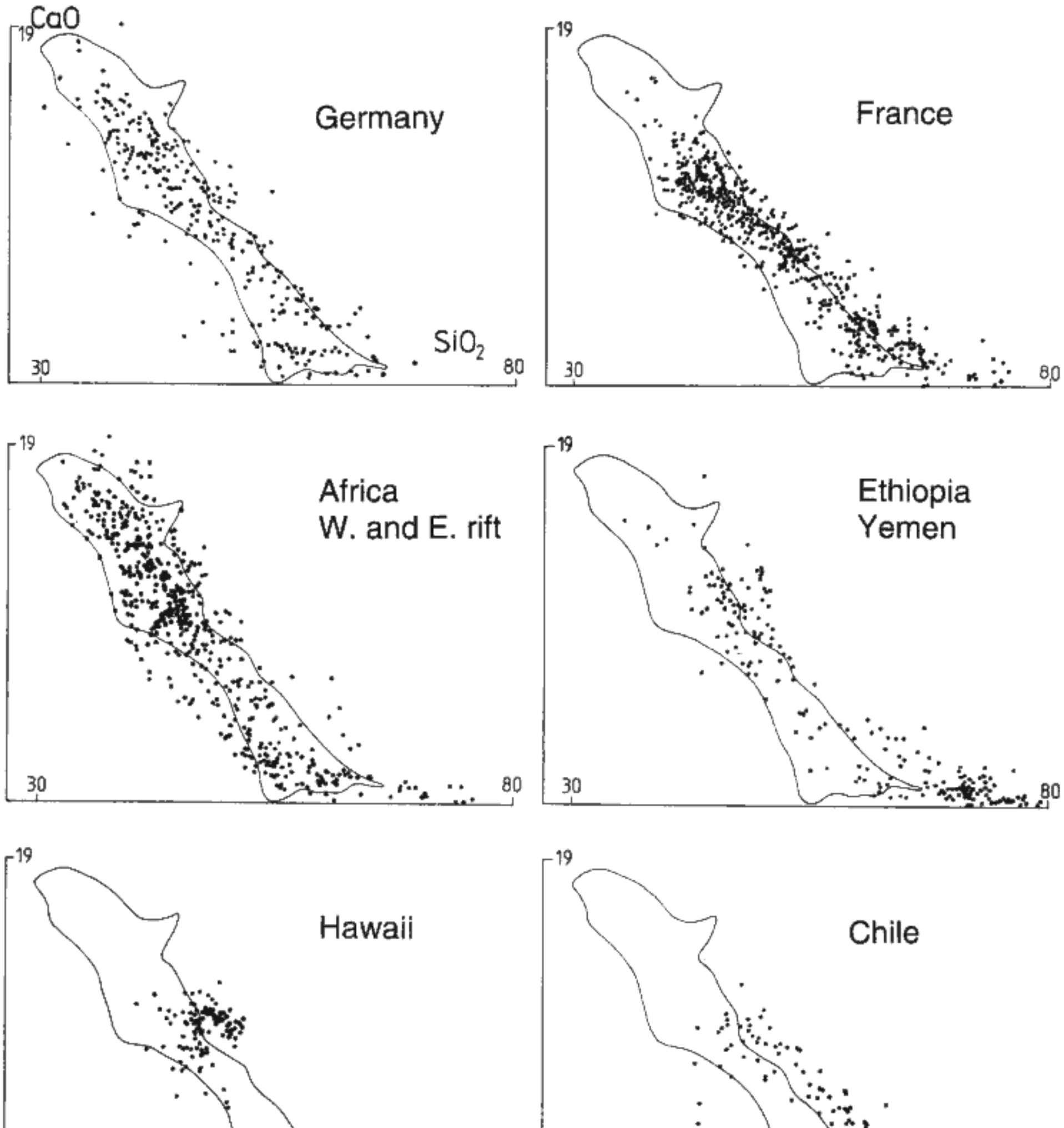

CaO
19
30
80
SiO_2
Germany
France
Africa
W. and E. rift
Ethiopia
Yemen
Hawaii
Chile
Japan
Slovakia

Fig. 7/5

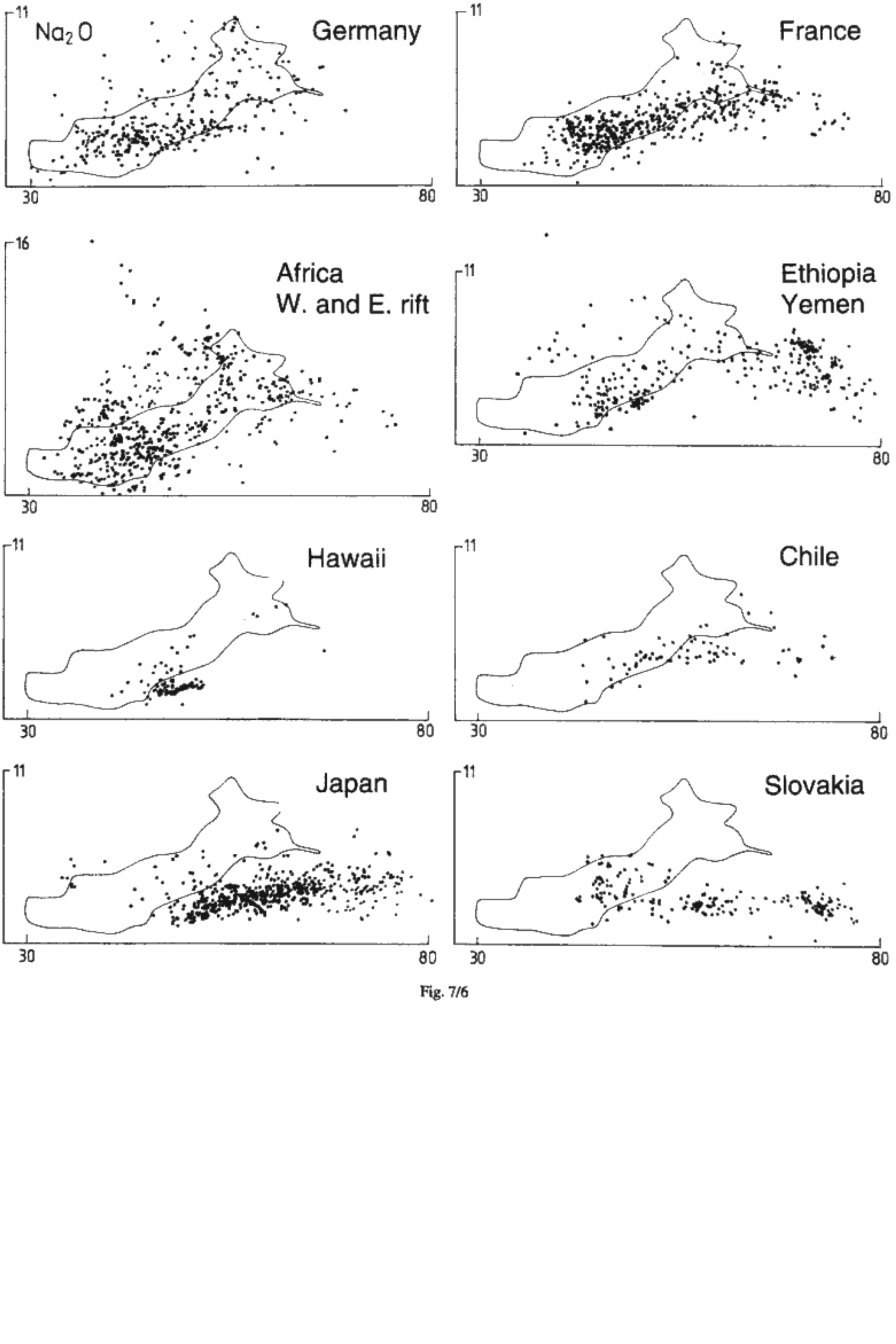

11
Na_2O
Germany
30
80
11
France
30
80
16
Africa
W. and E. rift
30
80
11
Ethiopia
Yemen
30
80
11
Hawaii
30
80
11
Chile
30
80
11
Japan
30
80
11
Slovakia
30
80

Fig. 7/6

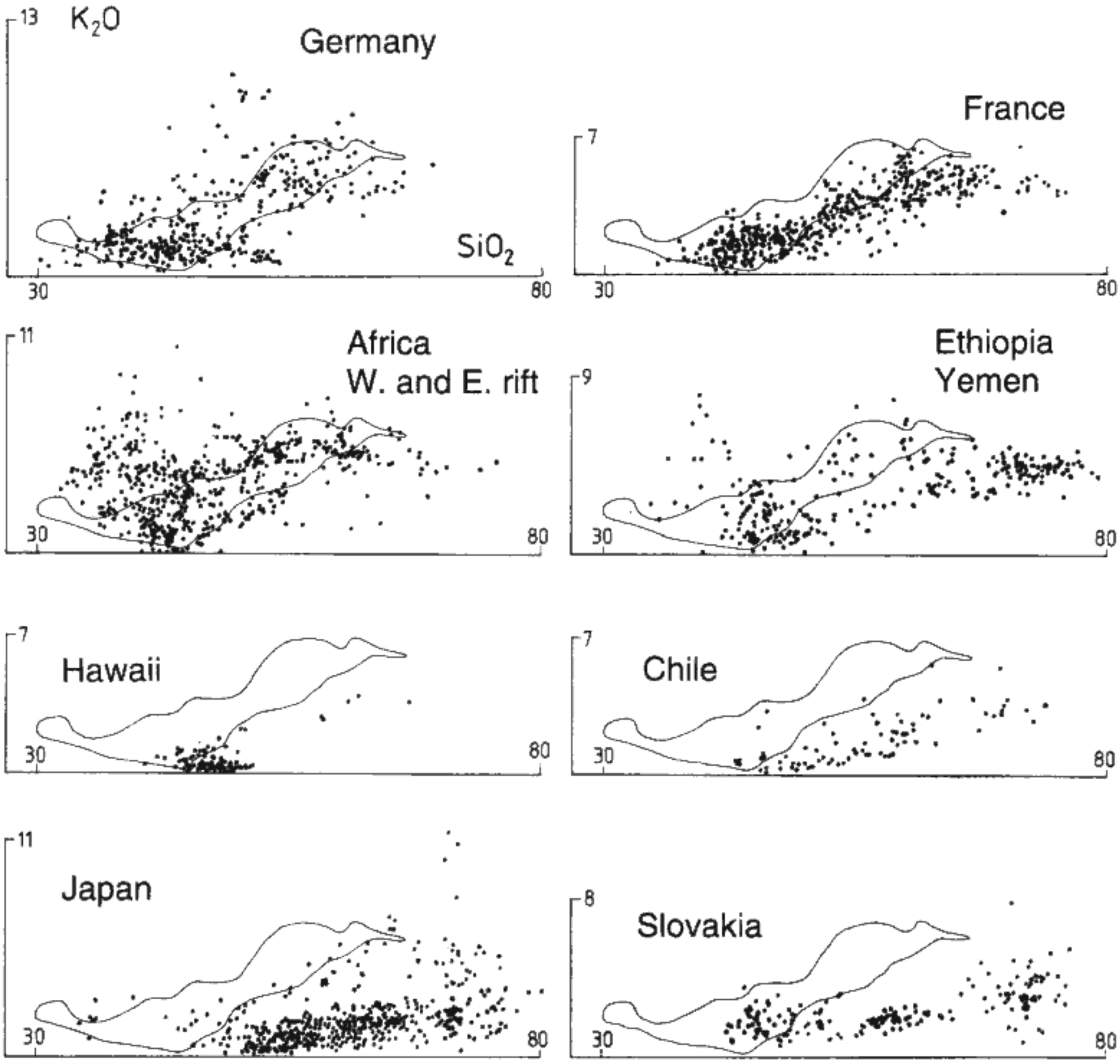
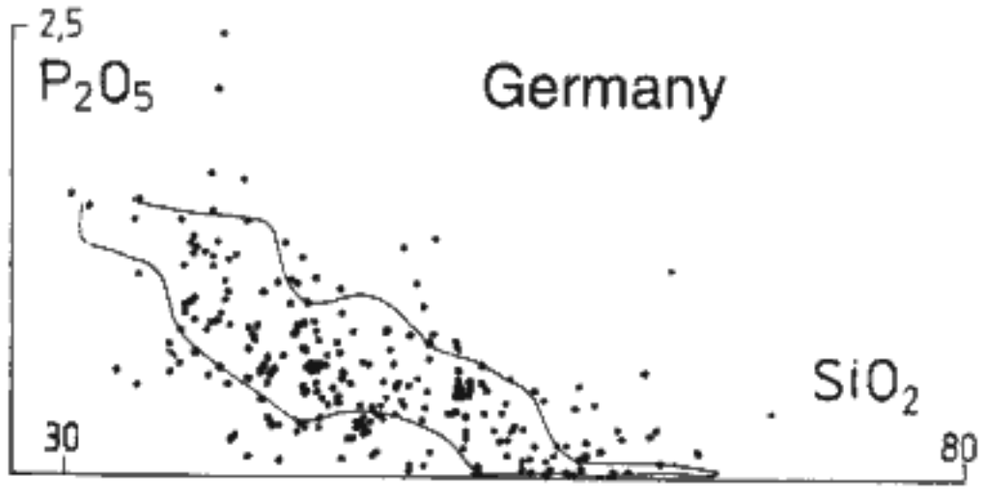
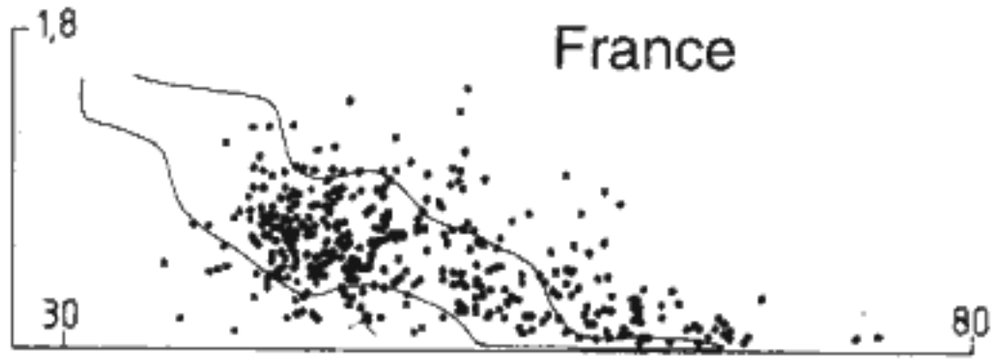
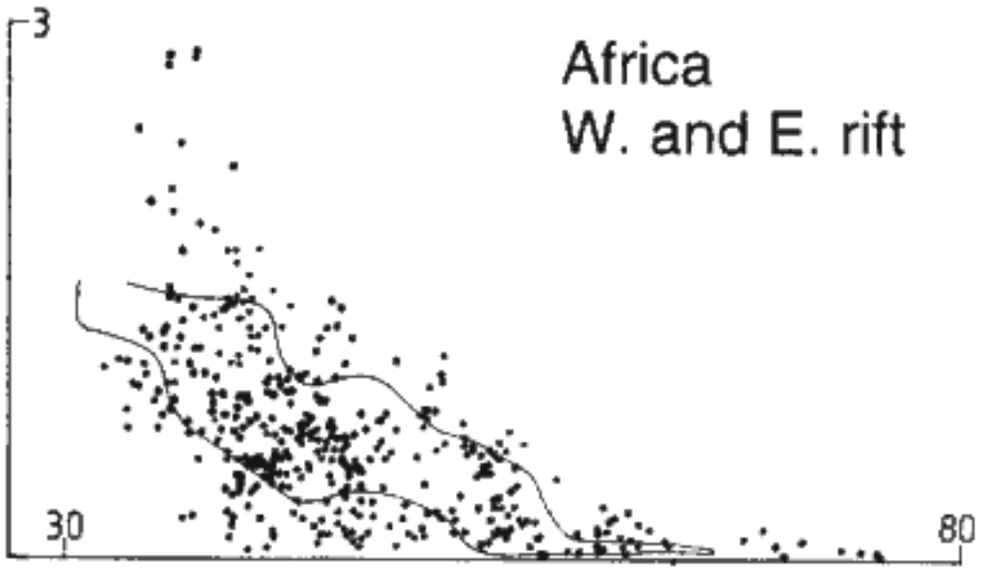
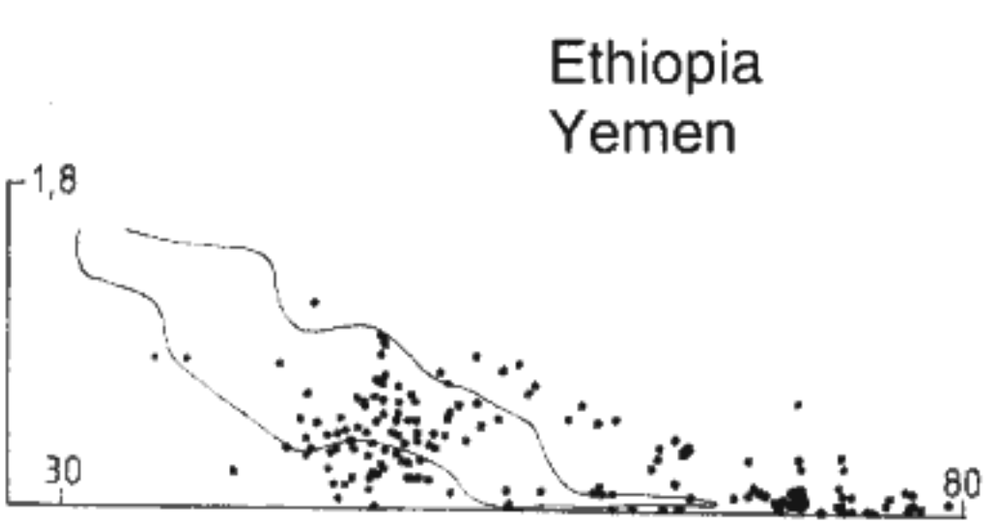

13
K_2O
Germany
SiO_2
30
80
France
7
Africa
W. and E. rift
11
Ethiopia
Yemen
9
Hawaii
Chile
Japan
Slovakia
8

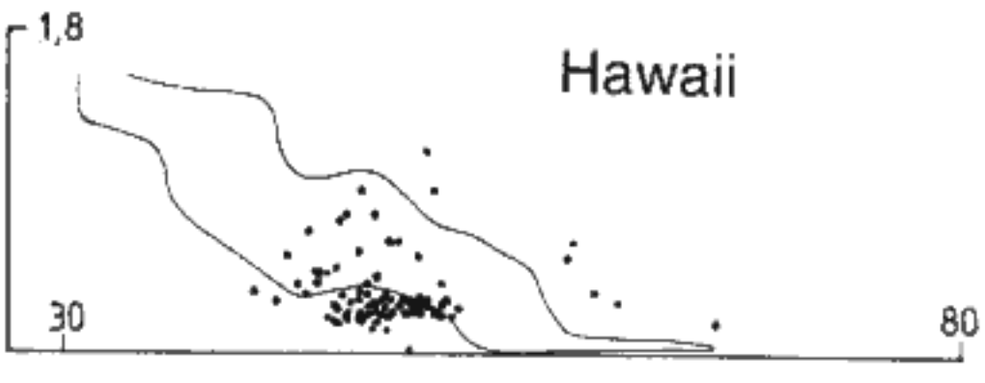
Fig. 7/7

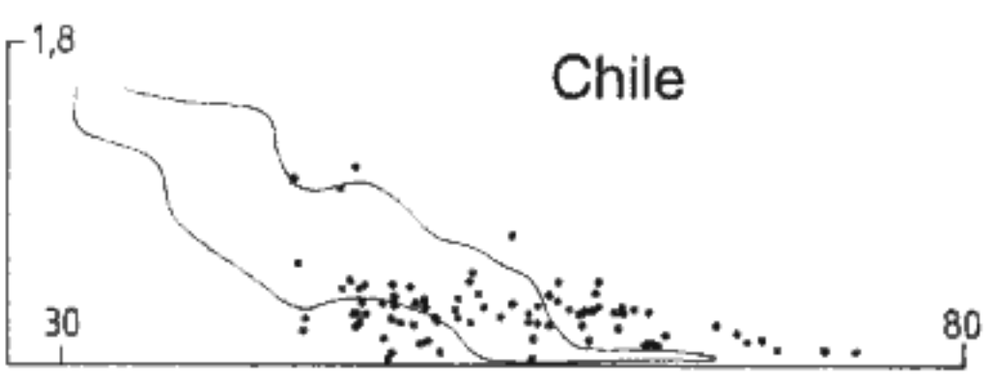

2,5
P_2O_5
Germany
SiO_2
30
80

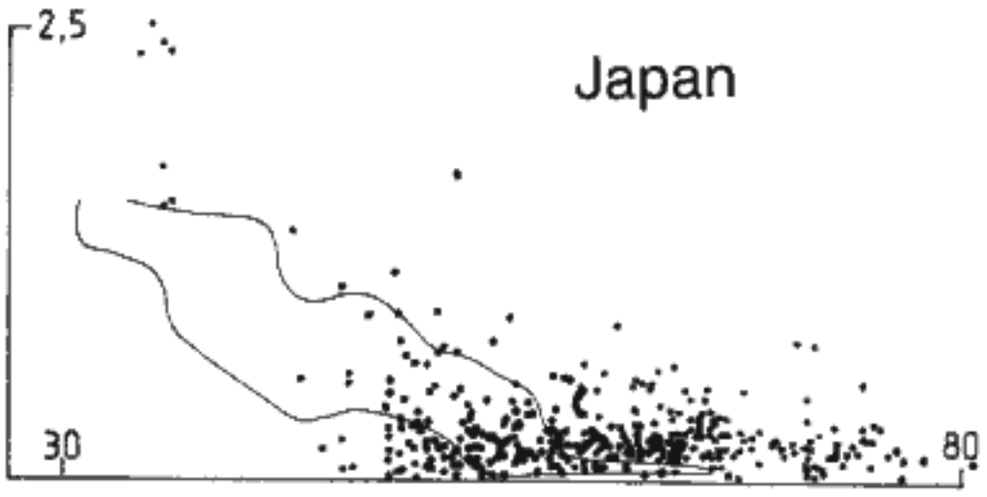

1,8
France
30
80


3
Africa
W. and E. rift
30
80


Ethiopia
Yemen
1,8
30
80


1,8
Hawaii
30
80


1,8
Chile
30
80


2,5
Japan
30
80

Slovakia
1,8
30
80

Fig. 7/8

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Abstract

Young, predominantly Tertiary alkaline volcanites of the Czech Republic are as a whole characterised on the basis of average content of 46 major and trace elements in rock types according to rhe mineralogical classification and the chemical classifications (the international - IUGS and that for the Bohemian Massif by Shrbený). Mutual relations of the elements are expressed by the correlation coefficients. Rock association of the Bohemian Massif is compared with other associations of young volcanites.