CHEMICAL DIAGNOSIS OF THE VOLCANICS FROM THE SOUTHEASTERNMOST PART OF THE HARGHITA MOUNTAINS – PROPOSAL FOR A NEW NOMENCLATURE

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This paper proposes a nomenclature change, based on new chemical data, for the majority of the volcanics in the southeasternmost part of the Harghita Mountains (Ciomadul Massif). Thirty-two chemical analyses (23 complete and 9 partial) and 6 previously executed analyses have been used and plotted on several petrochemical diagnosis diagrams (Peccerillo, Taylor, 1976, La Roche et al. 1980, Le Maitre, 1984). Using the term dacite instead of the term andesite in the southeastern extremity of the Călimani—Gurghiu—Harghita neogene volcanic chain, a better concordance between petrographical petrochemical features and volcanological particularities of this area is obtained.

1. INTRODUCTION

In recent years, as a large number of chemical analyses are available, many researchers tend to prefer the chemical diagnosis criteria for volcanic rocks.

In this paper, based on a sufficient number of chemical data, an attempt is made to apply the petrochemical diagnosis criteria to the volcanics of the Harghita Mts. The particular features of this area have been outlined in previous works (Szöke, 1963 ; Lazăr, Arghir, 1964 ; Rădulescu, 1973 ; Treiber, 1974 ; Moţoi et al., 1975 ; Peltz et al., 1973, 1984 ; Rădulescu et al., 1981 ; Seghedi et al., 1986).

2. GEOLOGICAL SETTING

Neogene volcanic activity in the southeastern part of the Harghita Mts. developed on a folded basement consisting of the flysch series of the East Carpathians.

The volcanic products which occur east of the Olt valley are disposed around the Sf. Ana lake and the Mohoş swamp (Ciomadul massif) and in a few isolated outcrops (Puturosul, Bálványos and Dealul Mare hills). The Ciomadul massif represents a complex volcanic structure made up of a main pyroclastic cone with two craterial areas (Sf. Ana, Mohoş) and of several partial overlapping lava flows and domes. Isolated occurrences outside this massif are built only by massive volcanic rocks.

Petrographically, these volcanics are represented by hornblende and biotite ($\pm$ pyroxene $\pm$ quartz)-bearing types, which were described in previous works under the term andesite. In some small outcrops along the eastern side of the Olt valley pyroxene-bearing rocks appear with no

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connection with the Ciomadul volcanic edifice. Small amounts of hornblende andesite occur also in the Ludmila Hill and south of the Kövesponk Summit. The latter seems to be included in this structure.

3. PETROCHEMICAL DATA

The nomenclature of volcanic rocks is a key problem of modern petrography and in recent times it has been based almost exclusively on the chemical classification scheme (Streckeisen, 1976, Peccerillo, Taylor, 1976, Streckeisen, Le Maitre, 1979, La Roche et al., 1980, Gill, 1981, Le Maitre, 1985). The usefulness of the simple classification schemes based on the SiO_2 content as chief parameter in discriminating various types of volcanic rocks is more and more obvious. The following limits, depending on SiO_2 content, are taken into account : 52% between basalts and basaltic andesites, 56% (57%) between basaltic andesites and andesites, 63% between andesites and dacites, 70% (73%) between dacites and rhyolites.

The new chemical data (23 complete and 9 partial chemical analyses) are presented in Table 1. They represent 8 samples from the pyroclastic cone and 24 samples from lava flows and domes in the upper part of the structure and isolated occurrences of massive volcanics. Spatial distribution of samples is shown in Fig. 1. Six previous analyses (Varga in Szöke, 1963) are plotted on the diagrams.

Table 1 clearly indicates a silica content higher than 63% for the majority of samples. Therefore, their plottings on the petrochemical classification diagrams (Peccerillo, Taylor, 1976, Le Maitre, 1984) are situated within the dacitic fields (Figs. 2, 3). The K_2O-SiO_2 diagram (Fig. 2) points to the high-K nature of the analysed rocks, regardless of their andesitic or dacitic affiliation.

The same remark, concerning the dacitic caracter of the majority of the samples, results from La Roche et al. (1980) diagram which used the totality of the major chemical components (Fig. 4). It is worth mentioning that all samples from the pyroclastic cone, either pumices and bombs or blocks with massive structure, belong to the dacitic domain.

Some of the samples which are plotted in the field of andesites are situated nearby to the dacitic field and together with the rocks with dacitic diagnosis formes a compact projection area; others are clearly-separated from this group. In the first case the rocks which belong to the Ciomadul volcanic structure (lava flows and domes) always contain pyroxene and eventually quartz beside hornblende and biotite. It is noteworthy that the pyroxene- and quartz-bearing petrotypes partly belong to dacites. In the second case we have hornblende-bearing rocks (Ludmila Hill) which constitute a small body in the Ciomadul volcanic structure, or hornblende- and biotite-bearing petrotypes from an isolated structure (Dealul Mare). Note that the other isolated occurrences (Puturosul, Bálványos) consist of volcanics with dacitic diagnosis.

4. DISCUSSION AND CONCLUSIONS

Referring to the previous works, the name dacite have already been used for the volcanics of the Ciomadul massif in several outline papers

Table 1

No.	Sample*	Mafic fenocrysts	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	K_2O	Na_2O	P_2O_5	CO_2	H_2O^+	H_2O^-	S	Total	Analyst
1	T72	am	56.92								2.06	3.65							Ianc R
2	T70	am	57.20								1.95	4.11							,,
3	AM60	am, bi	57.90	0.90	20.30	3.93	0.60	0.09	3.25	5.18	2.20	3.65	0.16	0.30	0.65	0.70	—	99.82	Bianu D.
4	AM66	am,py,bi	60.10	0.90	20.23	3.43	0.19	0.10	3.75	5.25	2.42	3.80	0.13	0.15	0.24	0.22	–	100.91	,,
5	T124	am,bi,py	61.32								3.16	4.24							Ianc R.
6	T45	am,bi	62.18								3.30	4.51							,,
7	AM54	am,bi,py	62.40	0.57	19.07	0.71	2.17	0.08	3.50	4.34	2.42	3.60	0.18	0.17	0 05	0 45	0 11	99 81	Bianu D.
8	AM43	am,py,bi	62.58	0.57	18.70	2.25	0.65	0.12	3.10	4.48	2.53	3.90	0.17	0.10	0.20	0.14	0.04	99.53	,
9	AM45	am,bi,py(q)	63.06	0.57	18.70	3.00	—	0.09	3.60	4.00	2.42	3.74	0.12	0.10	0.22	0.26	—	99.87	,,
10	AM8	am,bi,(py)	63.18	0.80	18.84	.079	.1,4	00,0	7.10	0.18	2.97	4.56	0.14	—	0.92	0.26	0.06	100.17	Trofin M.
11	T28p	am,bi	63.43								2.98	4.43							Ianc R.
12	AM56	bi,am	63.44	0.57	18.50	2.64	.—	0.08	2.40	3.92	2.75	3.86	0.10	0.15	0.82	.045	—	99.68	Bianu D.
18	AM40	am,bi,q,(py)	63.55	0.45	18.90	2.90	—	0.10	2.10	4.20	2.53	3.80	0.18	0.17	0.48	0.32	0.04	99.74	,,
14	AM33	am,bi,py	63.61	0.65	17.28	2.73	0.36	0.07	2.10	5.04	2.97	2.32	0.16	—	0.48	0.25	0.03	100.05	Trofin M.
15	AM50	bi,am,py	63.68	0.55	18.20	2.90	—	0.12	3.25	5.18	2.20	3.65	0.16	0.30	0.65	0.70	—	99.82	Bianu D.
16	AM13	am,bi	63.70	0.80	17.94	1.04	1.11	0.07	1.90	4.76	2.97	4.68	0.16	—	0.54	0.17	0.04	100.00	Trofin M.
17	AM69	am,bi	63.92	0.55	18.35	2.07	0.38	0.06	2.00	3.65	2.75	3.65	0.10	0.20	1.00	0.15	—	98.83	Bianu D.
18	B39	am,bi	63.95	0.57	17.70	1.46	1.26	0.07	1.85	4.55	2.86	4.86	0.15	—	0.77	0.20	0.02	100.27	Popescu C.
19	T28	am,bi	64.09								3.27	4.46							Ianc R.
20	AM62	am,bi	64.40	0.55	19.40	2.28	0.19	0.07	1.75	3.90	2.75	3.89	0.15	0.16	0.31	0.25	0.04	100.09	Bianu D.
21	T25	am,bi	64.52								3.21	4.14							Ianc R.
22	AM20	bi,am,(py)	64.72	0.57	16.54	2.10	0.30	0.03	1.70	4.48	2.97	4.41	0.08	—	1.71	0.42	0.04	100.07	Trofin M.
23	AM12	bi,am,(py)	65.04	0.80	19.03	0.40	0.66	0.03	0.65	3.29	3.06	4.44	0.10	—	1.99	0.70	0.07	100.26	,,
24	AM57	am,bi	65.05	.050	18.22	1.28	1.05	0.08	2.50	3.90	2.42	3.60	0.10	0.25	0.10	0.55	0.06	99.66	Bianu D.
25	AM34	am,bi,q,(py)	65.06	0.65	17.44	2.36	0.51	0.09	1.60	4.62	2.89	4.32	0.14	—	0.46	0.11	0.06	100.31	Trofin M.
26	VI/2	am,bi	65.07	0.26	16.72	1.08	1.53	0.06	2.21	4.03	3.14	4.69	0.22	—	0.59	—	0.06	99.66	Călinescu E.
27	T68	am,bi	65.30								3,10	4.62							Ianc R.
28	T44	am,bi	65.82								3.53	4,53							Ianc R.
30	SFA	am,bi	66.08	0.29	16.84	1.79	1.07	0.04	0.46	4.46	2.95	4.80	0.11	—	1.02	—	0.08	100.29	Dumitrescu M.
30	AM35	am,bi	66.87	0.65	14.94	1.53	0.73	0.09	2.70	3.64	3.14	4.44	0.07	—	1.17	0.14	0.03	100.14	Trofin M.
31	T36	am,bi	66.92	0.39	15.79	1.78	0.61	0.08	1.47	3.54	3.21	4.33	0.16	—	1.00	—	0.29	99.57	Ianc R.
31	T67	am,bi	67.70	0.41	16.86	1.16	0.68	0.09	0.89	3.38	3.24	4.30	0.15	—	0.54	—	0.18	99.58	,,

* Sample location in fig. 1.
Note : am : hornblende ; bi : biotite : py : pyroxene ; q : quartz ; ( ) : accessory component

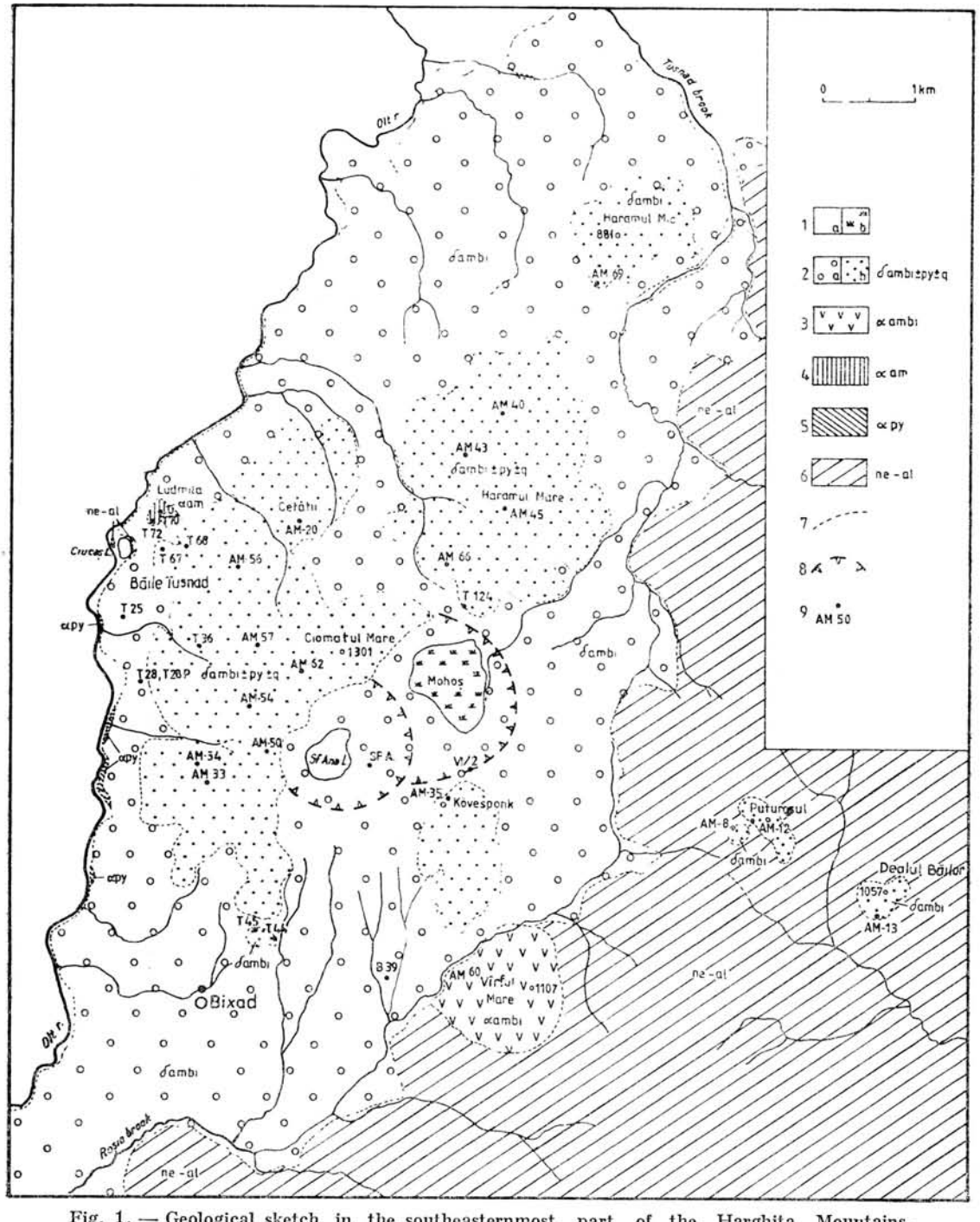

Fig. 1. — Geological sketch in the southeasternmost part of the Harghita Mountains. 1) Quaternary. a) alluvial deposits, b) swamp. 2) δ ambi±py±q Hornblende biotite ± pyroxene ± quartz dacites, a) pyroclastics, b) lava flows and domes. 3) α ambi Hornblende biotite andesites (Dealul Mare type). 4) α am — Hornblende andesites (Ludmila Hill type). 5) α py — Pyroxene andesites (Pilişca type). 6) ne-al — Cretaceous flysch deposits). 7) Geological boundary. 8) crater outline. 9) chemical samples

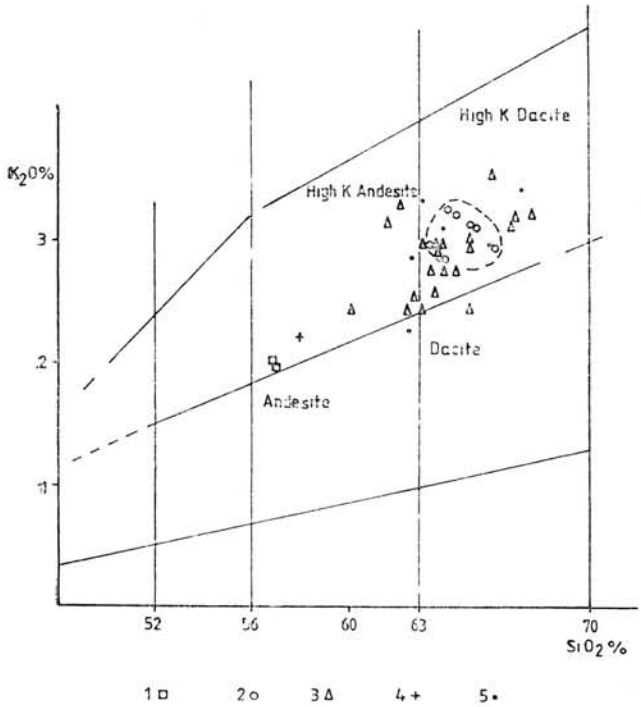

Fig. 2. — K_2O—SiO_2 diagram. 1) Ludmila Hill lava flow. 2) Ciomadul pyroclastics. 3) Ciomadul, Puturosul and Balvanyos lava flow and dome rocks. 4) Dealul Mare dome rocks. 5) Rocks analyses from published papers (Varga in Szoke, 1963).

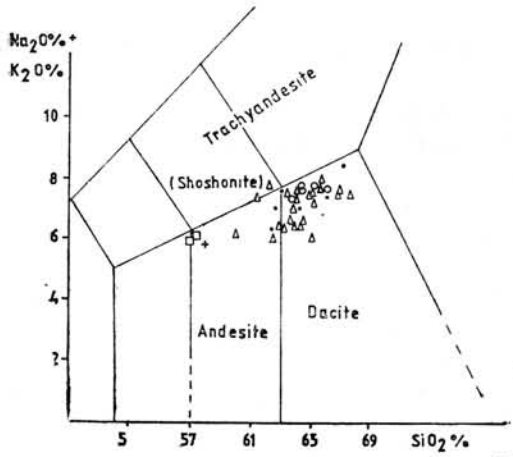

Fig. 3. — K_2O+Na_2O—SiO_2 diagram (Le Maitre, 1984). Symbols as in fig. 2.

(Peltz et al., 1984, Seghedi et al., 1986), but without a detailed justification of this change of nomenclature.

The petrochemical data presented in the previous section argue sufficiently the necesity of the new terminology — dacite — for most of the volcanics belonging to the Ciomadul volcanic structure and for some isolated occurrences (Puturosul and Bálványos hills). In petrographic terms this terminological change aims all the petrotypes containing hornblende and biotite, except Dealul Mare type for which only one analysis is available.

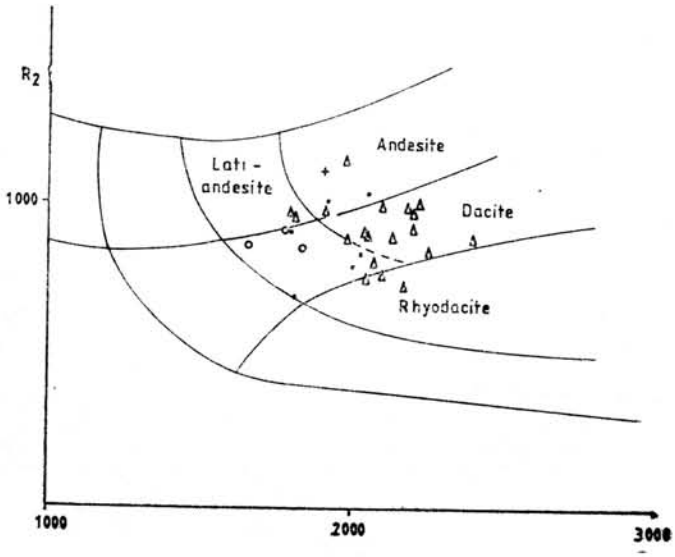

Fig. 4. — R_1—R_2 diagram (La Roche et al., 1980). Symbols as in fig. 2.

Although there are some sensible differences, these rocks form a well-individualised natural petrographical and chemical group whose centre of gravity is situated, in all used diagrams, in the dacitic fields. This conclusion is amplified by the SiO_2 content frequency histogram in the volcanics for which we use the name dacite, which shows two frequency peaks, both of them at $SiO_2 > 63\%$ values (Fig. 5). The frequency of samples with $SiO_2 > 63\%$ exceeds 80%.

In this situation the only rocks — except pyroxene-bearing andesites along the Olt eastern coast, with a western origin — for which the retaining of the name andesite is justified, are those with hornblende of Ludmila Hill and those with hornblende and biotite of Dealul Mare isolated structure. It is very likely that the small volume of volcanics with hornblende ± pyroxene south of the Kövesponk summit — for which no chemical analyses are available — belong to andesites too.

In conclusion, the volcanics in the southeastern extremity of the Harghita Mts. (east of the Olt valley) may be grouped into the following petrotypes :

1. dacites — for which, for a better terminological individualisation, we propose the name "Ciomadul dacites" — with varieties : a) hornblende biotite dacites ; b) hornblende biotite pyroxene ± quartz dacites ;

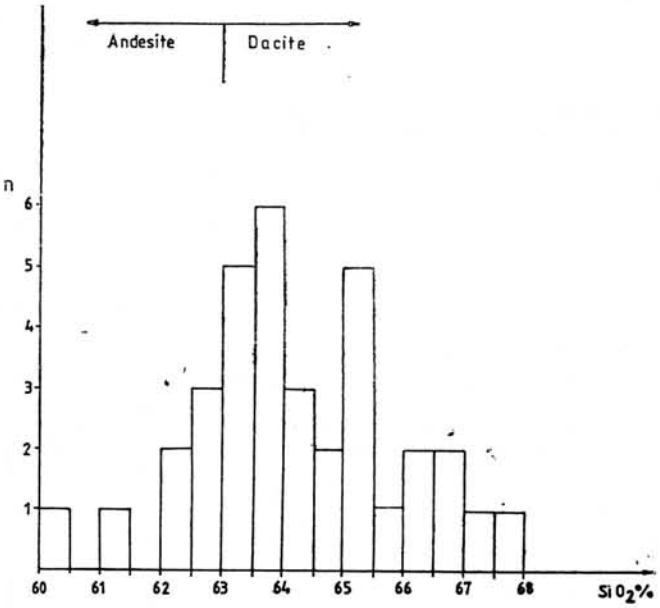

Fig. 5. — Histogram showing the distribution of SiO_2 content in dacitic rocks of the studied area.

2. andesites, with varieties : a) pyroxene andesites (originated west of the Olt valley) ; b) hornblende ± pyroxene andesites (Ludmila Hill, south of Kövesponk summit) ; c) hornblende biotite andesites (Dealul Mare Hill).

Using the term dacite for the volcanics of the southeasternmost part of the Călimani-Gurghiu-Harghita neogene volcanic chain a better concordance between petrographical-petrochemical features and volcanological particularities (Rădulescu, 1973, Szakács et al. in print) is obtained.

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