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NEOGENE AND QUATERNARY RYROCLASTICS ON THE TERRITORY OF BULGARIA – A REVIEW AND NEW DATA

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A B S T R A C T

On Bulgarian territory the Neogene tuffs are established in the Sarmatian, Meotian-Pontian (?) and in the Pliocene. The tuffs are mainly vitroclastic, more or less altered into bentonites and kaolinite clays. They are rhyolitic and rhyodacitic and belong to the high-K calc-alkaline series. The sources of supply are still not identified. The three of the five occurrences of Quaternary ash-tephra are located in caves. The tephra is vitroclastic, trachytic. It belongs to the Campanian ignimbrites series and is connected to the Neapolitan caldera formation (Italy) in the time span between 38,7 and 24,1 ka.

INTRODUCTION

Acid and intermediate pyroclastics of unknown origin occur in different levels of the postpaleogene stratified sections at various localities in Bulgaria.

The aims of the present contribution are: 1. To summarize the scattered literature data on the geological position, the age and the peculiarities of the Neogene pyroclastics and in this way to help the future regional Balkan and Transbalkan tephrocorrelations; 2. On the basis of literature sources and new data of the authors to understand the origin of the Quaternary pyroclastics.

NEOGENE PYROCLASTICS

Neogene pyroclastics and some products of their alteration are established in the Sarmatian, Meotian-Pontian (?) and in the Pliocene (Fig. 1). The acid tuffs near the village of Dve mogili (Russe district) described as Oligocene rocks (Filipov et al., 1972) are probably also of Neogene age (Ruskova, 1974).

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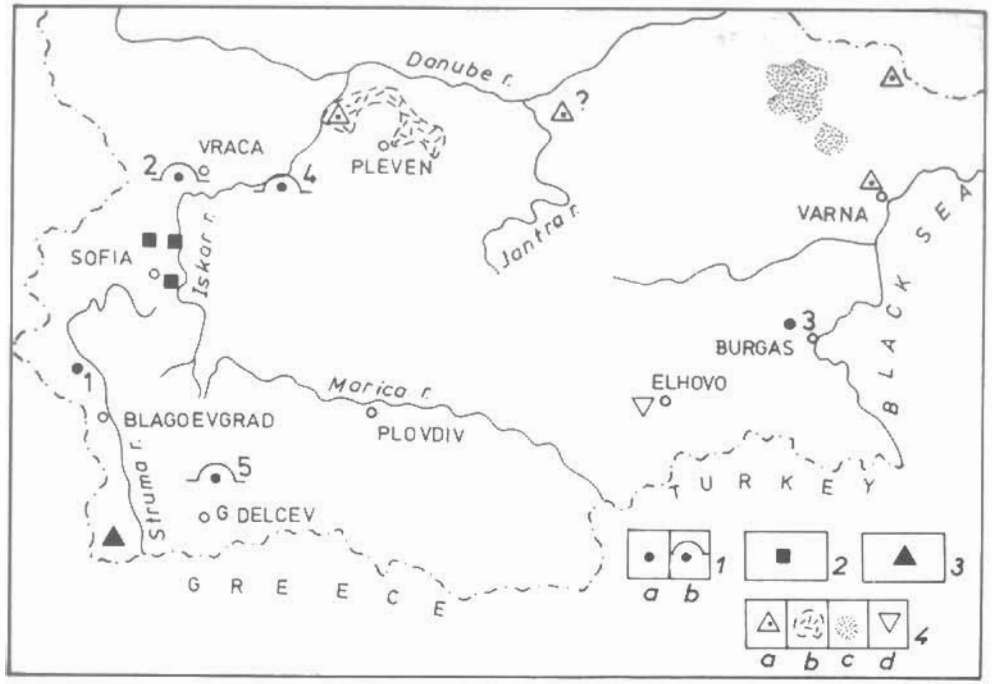

Fig. 1. Distribution of Neogene and Quaternary volcanoclastics in Bulgaria (according to Dabovski et al., 1989, modified).
1 - Quaternary tephra: a. surface outcrops, b. in caves;
2 - Pliocene tuffs and pyroclastic-sedimentary rocks;
3 - Meotian - Pontian (?, -up to Pliocene?) tuffs and pyroclastic-sedimentary rocks; 4a - Sarmatian tuffs or bentonites; 4b - dispersed pyroclastics in Sarmatian sediments;
4c - pyro- and epicrystalloclastics in Sarmatian sediments;
4d - Miocene (?) bentonitizied tuffs in boreholes.

Pyroclastics of Sarmatian (including Low Sarmatian) age are described in Northeast and Central North Bulgaria. In the Northeast Bulgaria they are represented by tuffs and dispersed pyroclastics. The tuffs (Ruskova, 1974) crop out as a 40 cm thick layer near the village of Vladislavovo (Varna district). They are massive, grey-white, vitroclastic, with siltic texture. More than 50% of the glass shards are 0,1-0.01 mm in size and about 13% > 1 mm. Their composition is rhyolitic (Table I; Fig. 2). According to K_2O/SiO_2 they belong to the high-K calc-alkaline series (Fig. 3). The refractive index is 1,499. The rare crystalloclastics are represented by quartz, andesine, red-brown biotite. Single grains of these minerals, together with pyroxene and moassanite grains, are found in the underlying sediments. The Sarmatian bentonites

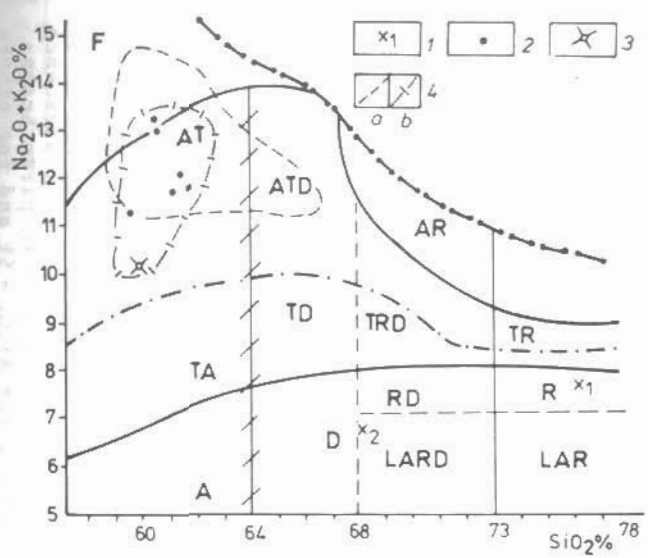

Fig. 2. $Na_2O + K_2O/SiO_2$ diagram (Bogatikov, 1983) for the composition[x] of the Neogene and Quaternary pyroclastics.
1 - Neogene pyroclastics (see Table 1); 2 - Quaternary tephra;
3 - glass shards from Francheti cave (Peloponnesos, Greece);
4 - "Campanian ignimbrites series": a - field of the tephra-layers from the Quaternary Mediterranean deposits, 4b - field of the Campanian ignimbrites. A - andesites; D - dacites; LARD - low alkaline rhyodacites; LAR - low alkaline rhyolites; TA - trachyandesites; TD - trachydacites; RD - rhyodacites; TRD - trachyrhyodacites; R - rhyolites; TR - trachyrhyolites; AT - alkaline trychates; ATD - alkaline trachydacites; AR - alkaline rhyolites; F - phonolites.
[x] Water free content.

(25-40) cm) near the villages of Isvorovo and Krassen (Northeast Bulgaria) are identified as completely altered acid tuffs (A. Goranov, oral communication).

The dispersed volcanoclastic products are represented (Ruskova, 1972) by rare grains of bipyramidal and "drop-like" quartz (0,05 to 0,25 mm). They are established in a number of sections of the Middle Sarmatian. The same quartz (redeposited?) is present in the post-Upper Sarmatian, but pre-Quaternary sands of Northeast Bulgaria. It is found also in the kaolinite clays of controversial origin (Varna district).

The fine acid pyroclastics from the Sarmatian (Upper Volhynian) sections of the Central North Bulgaria are completely altered (Atanasov et al., 1974). In the marine sections they changed

Table 1. Major-element compositions of the Neogene tuffs and Quaternary tephra

	Neogene tuffs		Quaternary tephra		Volcanics of the "Campanian ignimbrite series" (in the sense of Paterne et al., 1988)				
	1	2	3	4	5	6	7	8	9
SiO_2	72,0	61,67	57,80	58,47	59,88 (1,68)	61,64	60,27	60,19 (1,38)	60,05 (1,38)
TiO_2	0,16	0,29	0,49	0,49					0,47 (0,06)
Al_2O_3	11,84	18,78	17,56	17,93	18,88 (0,71)	19,4	9,09	19,25 (1,01)	18,20 (0,69)
Fe_2O_3	0,49	0,75	$3,3^x$	$3,33^x$	$2,72^x$ (0,21)	$2,73^x$	$4,15^x$	$3,05^x$ (0,14)	$2,93^x$ (0,13)
FeO	0,79	0,77							
CaO	1,2	1,28	3,27	2,26	1,74 (0,18)	3,03	3,64	1,76 (0,29)	1,76 (0,29)
MgO	0,8	0,79	0,86	0,8	0,32 (0,07)	0,21	0,16	0,33 (0,07)	0,33 (0,07)
Na_2O	2,58	3,98	4,98	4,69	3,53 (1,70)	3,67	3,60	5,13 (1,77)	5,13 (1.77)
K_2O	4,38	2,74	6,1	6,51	6,83 (0,98)	8,9	8,52	7,23 (0,40)	7,23 (0.40)
H_2O^+	0,4	1,39	-	-	-	-	-	-	-
LOI	5,0	7,68	5,49	5,37	-	-	-	-	-

1 - Tuff (Sarmatian - Ruskova, 1974); 2 - Tuff (Pliocene - Aleksiev, Gnoevaia, 1963); 3 - Temnata Dupka cave; 4 - Manuilova Dupka cave; 5 - Francheti cave (Peloponnesos, Greece - Thunell et al., 1979); 6 and 7 - glass shards from some ash-layers in the Mediterranean Quaternary deposits (Paterne et al., 1988): 6 - layer C_7 (26,9 ka), 7 - layer C_{10} (33,5 ka); 8 and 9 - volcanic glass from Campanian ignimbrites (Thunell et al., 1979). 1-2 - wet analysis; 3-4 - X-ray fluorescence analysis (Geol. Inst. Bulg. Acad. Sci.); 5,8,9 - electron probe analysis, SD in parantheses; 6,7 - electron probe analysis (with reproducibility for SiO_2 - 2%; for Al_2O_3 - 5% and for others oxides - 20%).

^{x} Total iron.

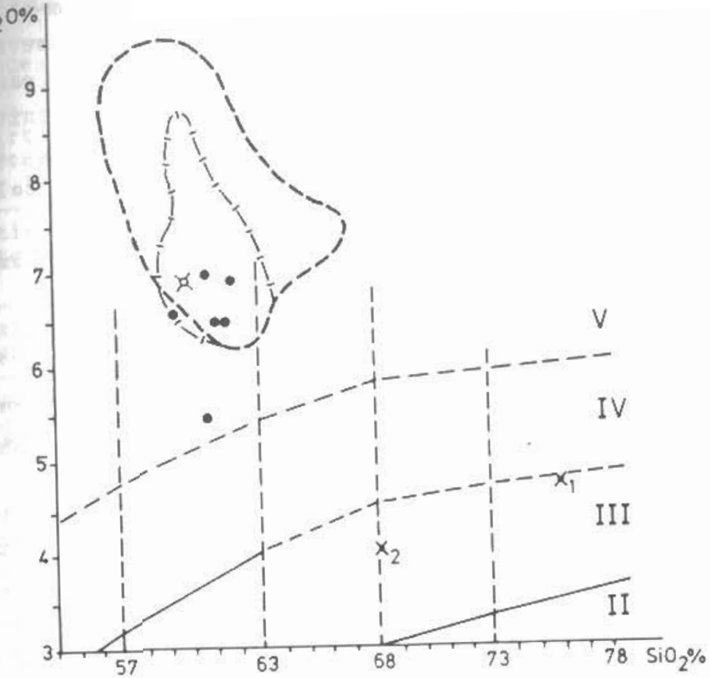

Fig. 3. K_2O/SiO_2 diagram (According to Peccerillo, Taylor, 1976; modified after Dabovski et al., 1989) of the Neogene pyroclastics and the Quaternary tephra. Petrochemical series: II - calc-alkaline; III - high-K calc-alkaline; IV - shoshonitic; V - high-K transitional. Same remark and legends as in Fig. 2.

into pure bentonites (several cm. thick) while in the continental ones - into kaolinite clays.

Three layers of tuffs and mixed pyroclastic-sedimentary rocks are described (Stoeva et al., 1984) in the upper levels of the Meotian-Pontian (?, -to Low Pliocene?) sections in the Strumeshnitsa graben (Southeast Bulgaria) (Nedialkov et al., 1988). The tuffs are light to white, crystallo-vitroclastic and have a siltic to psamitic texture. Their thickness range is from 8 to 80 cm (up to 4-5 m in one section) and decreases eastwards. According to the crystalloclastic assemblage (quartz, biotite, plagioclase, rare sanidine) the tuffs are acid, but from the published analysis (Bozkov et al., 1984) we infer, that the rocks have been carbonatized. It is assumed (Stoeva et al., 1983) that the source of this pyroclastics was on the territory of Greece or Yugoslavia.

The Pliocene pyroclastics crop out as a 5-7 cm thick layer in the northeastern part of Sofia graben (Aleksiev & Gnoevaia, 1963). They are described as vitroclastic tuffs. The volcanic glass (N = 1,513) is unevenly, but at some places highly bentinitized. Their composition is obviously rhyodacitic (Table 1, Fig. 2). According to K_2O/SiO_2 they can be refered to the high-K calc-alkaline series (Fig. 3).

Some of the main major element petrochemical characteristics of the Neogene pyroclastics are given on Figs. 4-8.

QUATERNARY TEPHRA

It was established and described in three occurrences by Aleksiev (1964) - Fig. 1. Recently two new ones (Fig. 1) have been found by M. Zlatkova (some data are given in this paper).

Quaternary tephra is only poorly consolidated in some occurrences. More than 95% of it is represented by glass shards. In the western deposits shards 0,1-1 mm in size dominate, while in the easternmost one the shards are 0,01 mm in size (Aleksiev, 1963). In the caves Manuilova Dupka and Prohodna they are from 0,036 to 0,09 mm. The shards are angular with concave or convex ends. They are elongated or irregular and contain a number of microcavities. As a rule the glass is isotropic with N = 1,523 and LOI from 3,81 to 5,49 wt%. In the three first occurrences Aleksiev (1963) determined rare crystalloclastics: fresh andesine, biotite, albite (?), sanidine, nepheline (?), diopside, apatite.

According to the $Na_2O + K_2O/SiO_2$ the Quaternary tephra shows an alkaline trachytic composition (Fig. 2) and according to the K_2O/SiO_2 it belongs to high-K transitional series (Fig. 3). Its peralkaline index (PI - Le Maitre, 1984) varies from 0,58 to 0,78. According to K_2O/Na_2O (Fig. 4) the tephra falls mainly into the potassium field. These and some others major element petrochemical features (Figs. 5-8) show that: 1. The Quaternary tephra is very close to the tephra, established in Francheti cave (Peloponnesos, Greece) and related genetically to the so called "Campanian tuffs" (Thunell et al., 1979); 2. The tephra composition falls into the field of the tephra from several major ash layers among the Quaternary deposits in the Mediterranean sea as well, as in the field of their ignimbrite correlates (Table I - 6 and 7 and 8 and 9 respectively). These are the fields of the volcanics of the

Table II. Geological features of the Quaternary tephra

Occurrences after Fig. 1	Geological position	Size in the cross-section	Reference
1. Chetirtzi vill. (Kijstendil distr.)	cover of old terrace (?)	100 × 10 m	Aleksiev (1964)
2. Ledenika cave (Vratca distr.)	deposited after the stalactites	several tens of m^3	- " -
3. Bulgarovo vill. (Bulgas distr.)	unknown		- " -
4. Prohodna-Temnata Dupka cave system (Loucovit distr.)	cover of clays with paleolithic artefacts; covered by talus with paleolithic artefacts	40 cm layer; 80 cm layer	M. Zlatkova's data (in this paper)
5. Manouilova Dupka cave (Gotze Delchev distr.)	a filling of the negative forms on the floors of two dry galleries	20 × 1 × 0,7 m; 12 cm layer	- " -

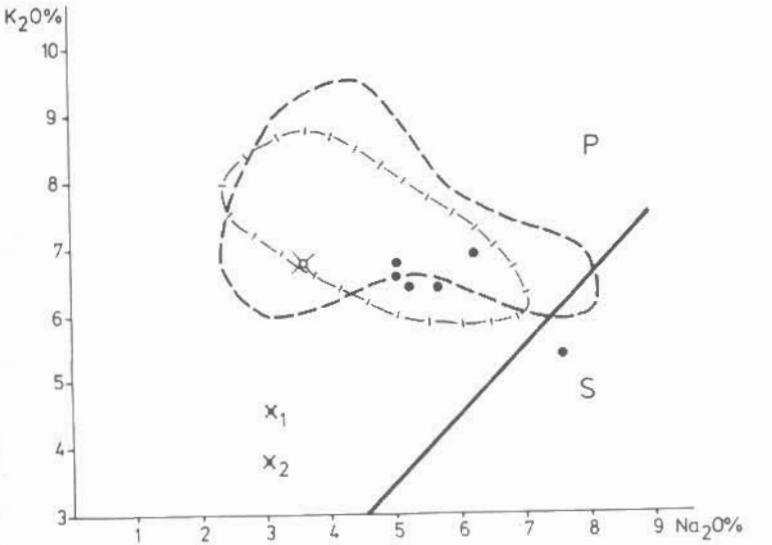

Fig. 4. K_2O/Na_2O diagram for the Neogene pyroclastic and Quaternary tephra. The line (after Le Maitre, 1984) separates the potassium (P) from the sodium (S) field. Same remark and legends as in Fig. 2.

"Campanian ignimbrites series" (in the sense of Paterne et al., 1988). Of particular interest are the diagrams on Fig. 5, 6 and 8B, which are used as diagnostic ones (Federman, Carey, 1980; Paterne et al., 1988) to distinguish the glass shards of Campanian origin from the Quaternary vitroclastics of other sources.

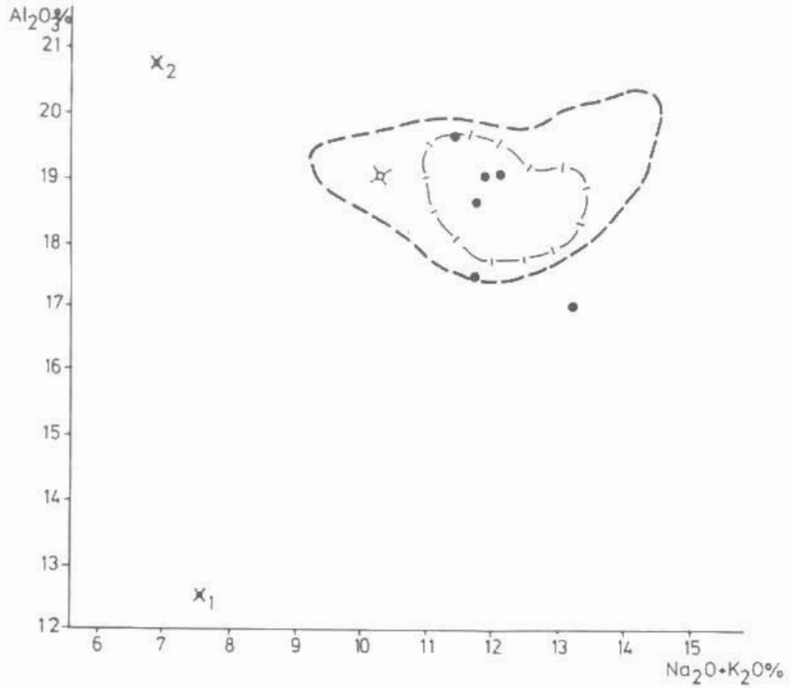

Fig. 5. $Al_2O_3/Na_2O + K_2O$ diagram for the Neogene pyroclastics and Quaternary tephra. Same remark and legends as in Fig. 2.

The volcanics of the "Campanian ignimbrite series" (ignimbrites and air fall tephra of trachytic composition with $K_2O > Na_2O$) are products of a number of freatomagmatic eruptions which accompanied the formation of the Neapolitan caldera (Italy - Barberi et al., 1978; Rosi et al., 1983) between 38,7 and 24,1 ka (Paterne et al., 1988). The major element petrochemical features of the Quaternary tephra in Bulgaria are due to its genetic connection to these events. The big distance (over 1200 km) of the tephra deposits from the feeding source (Neapolitan caldera - Italy) and the morphological features of the glass shards suggest a connection with an extremely powerfull freatomagmatic eruption. According to Paterne et al.

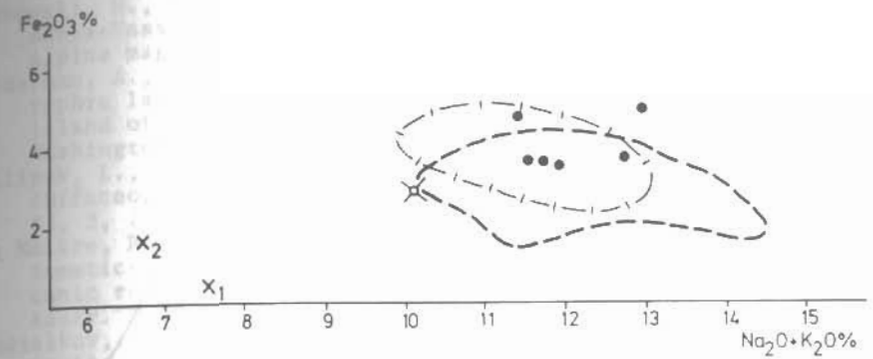

Fig. 6. $Fe_2O_3^t/Na_2O + K_2O$ diagram for the Neogene pyroclastics and the Quaternary tephra. Same remark and legends as in Fig. 2.

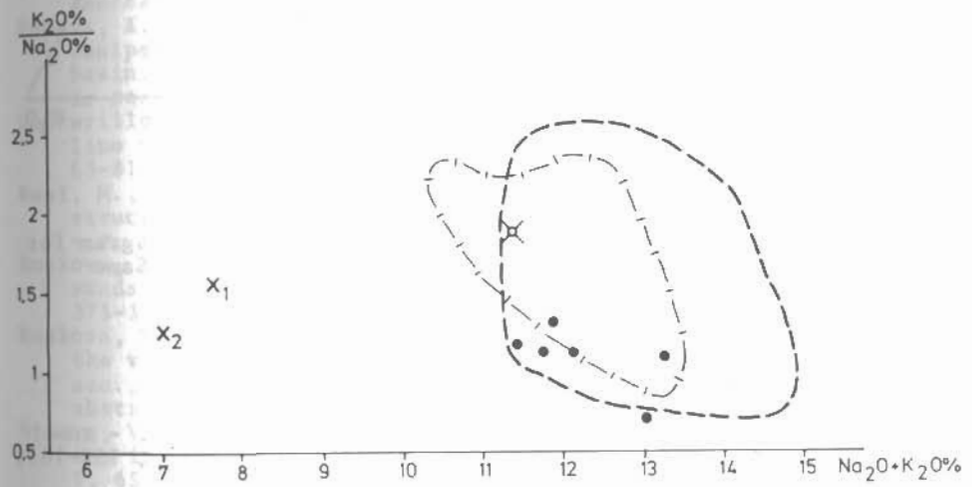

Fig. 7. $K_2O/Na_2O/K_2O + Na_2O$ diagram of the Neogene pyroclastics and the Quaternary tephra. Same remark and legends as in Fig. 2.

(1988) the most widespread trachytic ash-layers in the Mediterranean area have been formed at 36, 33,5 and at 24,9 ka. The presence of a Campanian ash tephra on Bulgarian territory is obviously refered to one of them. Up to now we have no reason to assume whether the trachytic tephra from the Francheti cave (Peloponnesos, Greece) is a product of the same (or of another?) Campanian event.

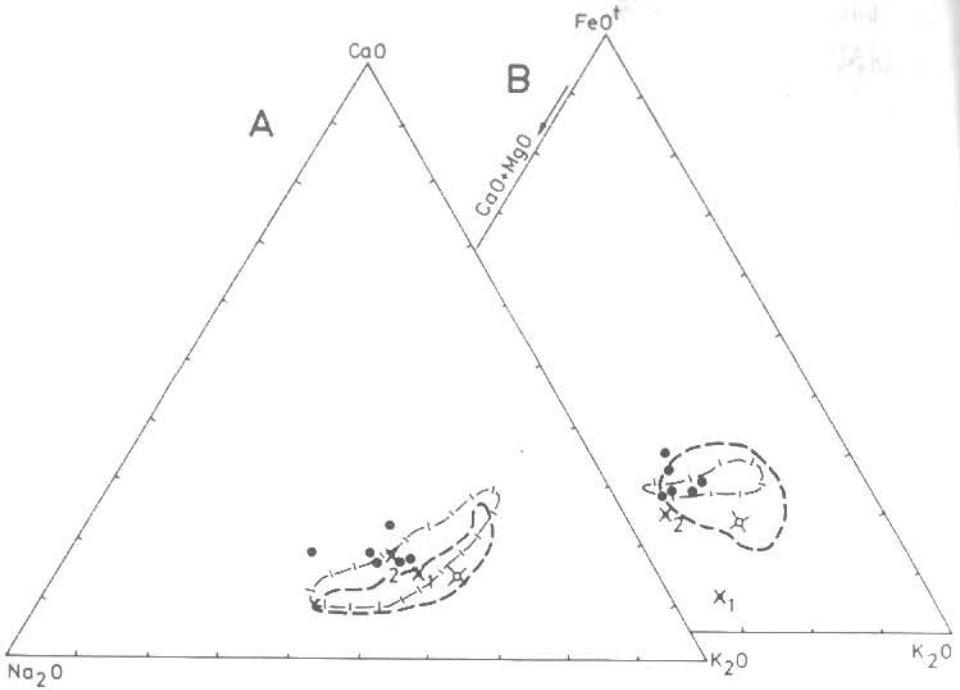

Fig. 8A - Na_2O-CaO-K_2O diagram; 8B - CaO + MgO - FeO^t - K_2O diagram for the Neogene pyroclastics and Quaternary tephra. Same remark and legends as in Fig. 2.

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