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Dacitic glassy lava flow from Trlično at Rogatec, Eastern Slovenia

Steklasta dacitna lava iz Trličnega pri Rogatcu

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Abstract

Glassy lava from Trlično is dacitic in composition and developed by incomplete mixing of two magmas of similar composition but different degree of groundmass crystallinity. By laminar lava flow banded texture developed consisting of bands with different magma types. Abundance of major and trace elements is within the variation range for dacites. Comparison with the Smrekovec andesites in Northern Slovenia indicates that the rocks do not originate from the same volcanic complex, displaced by tectonic activity.

Kratka vsebina

Steklasta lava iz Trličnega ima dacitno sestavo in je nastala z nepopolnim mešanjem dveh magm s podobno sestavo, a različno stopnjo kristalizacije osnovne mase. Zaradi laminarnega tečenja sta se različna tipa magme razporedila v trakove. Glavne in sledne prvine so zastopane v koncentracijah, ki so znotraj variacijskega območja značilnega za dacite. Primerjava z andeziti s Smrekovca kaže, da kamnine najverjetneje ne pripadajo istemu vulkanskemu kompleksu, ki naj bi bil kasneje dislociran zaradi tektonskih premikov.

Introduction

Tertiary volcanic rocks outcropping in the Rogaška Slatina and Rogatec area form a part of a widespread volcanic complex which extend discontinuously from the Smrekovec Mts. towards the southeast along the Donat transpressive zone (Fig.1). The age of volcanism is not solved yet, although recent tectonostratigraphic and biostratigraphic studies (Jelen et al. 2001) indicate the existence of two Tertiary volcanic sequences: the lower, and the upper (Upper Oligocene - Egerian) volcanic sequence. Both sequences have entirely submarine character as evidenced from nannoplankton and plankton foraminifera fauna found in the underlying interstratified, and overlying fine-grained clastic sediments. Lavas and high-level intrusive bodies in the Smrekovec Mts., and in the Rogaška Slatina and Rogatec areas, both seem to belong to the lower volcanic sequence.

The present contribution is focused on petrographic characteristics and chemical composition of a glassy lava flow which outcrops in the easternmost part of the Rogatec area. The influence of depositional environment to the rock structure and a brief comparison with the Smrekovec volcanics is discussed, too.

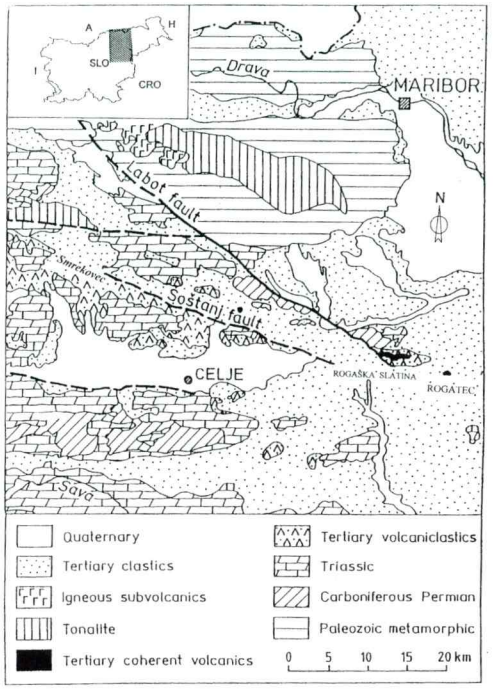


Fig. 1: Simplified geological map of eastern Slovenia (after Aničić & Juriša 1989; Buser 1979 and Mioč 1978)

Brief geological setting

The Rogaška Slatina and Rogatec area forms a part of the southwesternmost part of the widespread system of Pannonian basins. The area is tectonically disturbed by several faults. The most prominent are the Šoštanj and Labot faults which join into the Donat fault near Rogaška Slatina. Along the Donat fault, pre-Teritary carbonate basement outcrops. At the Rudnica Mt., south of Rogaška Slatina, Mesozoic volcanic rocks, mainly spilites, occur. Tertiary sediments are characterised by dominating clastic development, in Rupelian and Oligocene mainly as silts, and in Miocene as interstratified silts, sands and conglomerates. Rupelian to Egerian volcanism produced submarine lavas, pyroclastic deposits, autoclastic and resedimented volcaniclastic deposits. Based on foraminifera fauna occurring in the undelaying and overlying clastic sediments indicate that the environment was marine in the life span of volcanic activity. Basic geological map 1: 100.000, Sheet Rogatec, has been elaborated by Aničić & Juriša (1989).

Petrography and chemical composition

Lava flow from Trlično is a plagioclase-augite-magnetite vitrophyre which consists of glassy groundmass, phenocrysts, microphenocrysts and microlites. The rock is relatively fresh, except for marginal, autobrecciated parts which may grade into peperites. In a hand specimen, the rock is black; plagioclase phenocrysts are up to 1,5 mm sized and amount up to 10 % of the bulk rock. Under the microscope, in most of the plagioclase phenocrysts, lamellar twinning and zonation is seen. The composition of plagioclases ranges from andesine to labradorite. Augite phenocrysts are less common than plagioclases, and they are frequently associated with irregularly shaped magnetite. Sometimes, they contain inclusions of plagioclase microphenocrysts. Up to 0,5 mm sized olivine microphenocrysts are rarely fresh. They are replaced by brownish-green filosilicate minerals. Plagioclase microlites are not very abundant, but still they indicate flow texture.

The bulk of the glass contains very small greenish crystallites with elongated prismatic habitus and very high index of refraction. Most probably, they belong to augite. In the crystal surface, a few micrometer sized irregular inclusions or exsolutions of opaque minerals - very possibly magnetite – occur, and impart dark color to the rock.

The lava flow is actually a mixture of three magmas of similar composition, but slightly diverse degree of groundmass crystallinity, i.e. the size of (augite) crystallites and plagioclase microlites. The smallest crystallites attain some μm, the intermediate sized microlites some ten μm, and the largest some 100 μm. Magmas with different degree of crystallinity seem to start mixing during the lava flow. In the zone of laminar flow, the bands with different degree of groundmass crystallinity developed, but in more turbulent zone of the lava flow, more irregular lenses formed. Locally, sediment inclusions occur. The included sediment is fine-grained and strongly altered.

There are cracks in the rock, related to the hydration processes, and they are infilled with brownish-green filosilicates. In the same thin section, the cracks may form angular and subangular or rounded perlitic parts. Locally, lava margins grade into peperite,

the mixture of still flowing lava and the enclosing sediment. Peperite is strongly altered into filosilicates, mainly montmorillonite, quartz and analcime.

Chemical composition of the rock is slightly variable owing to the mixing processes (Table 1).

Table 1: Chemical composition of glassy lava from Trlično

Oxide/ Element	Unit	Tr 10/01	Tr 11/02
SiO_2	%	63,9	65,0
TiO_2	%	0,605	0,606
Al_2O_3	%	15,8	16,0
Fe_2O_3	%	5,55	1,65
FeO	%		4,2
MnO	%	0,10	0,10
MgO	%	0,98	0,97
CaO	%	4,75	4,62
Na_2O	%	4,16	4,32
K_2O	%	1,33	1,21
P_2O_5	%	0,14	0,15
CO_2	%	<0,01	<0,01
L.O.I.	%	1,85	1,80
Li	ppm	<1	2
Be	ppm	2,5	2,5
B	ppm	31	23
Sc	ppm	20,1	20,6
V	ppm	37	38
Cr	ppm	40	22
Co	ppm	24	31
Ni	ppm	3	2
Cu	ppm	13,3	6,6
Zn	ppm	86,1	86,1
Ga	ppm	17	17
Ge	ppm	<10	<10
As	ppm	10	10
Se	ppm	<5	<5
Br	ppm	1	4
Rb	ppm	65	68
Sr	ppm	264	268
Y	ppm	36	33
Zr	ppm	149	151
Nb	ppm	14	15
Mo	ppm	<1	<1
Ag	ppm	0,4	0,6
Cd	ppm	<0,2	0,3
In	ppm	<0,5	<0,5
Sn	ppm	4	5
Sb	ppm	0,8	0,6
Cs	ppm	3	10
Ba	ppm	521	517
La	ppm	47,9	42,3
Ce	ppm	103	91,9
Pr	ppm	10,9	9,6
Nd	ppm	44,8	38,8
Sm	ppm	10,3	8,1
Eu	ppm	1,90	1,70
Gd	ppm	8,3	7,6
Tb	ppm	1,4	1,3
Dy	ppm	9,9	8,5
Ho	ppm	1,87	1,68
Er	ppm	5,8	4,6
Tm	ppm	0,8	0,8
Yb	ppm	5,2	4,8
Lu	ppm	0,83	0,71
Hf	ppm	13	1
Ta	ppm	4	4
W	ppm	130	158
Au	ppm	41	110
Hg	ppm	<5	<5
Tl	ppm	1,0	1,0
Pb	ppm	10	11
Bi	ppm	<5	<5
Th	ppm	13,7	12,3
U	ppm	0,7	4,0

The lava from Trlično is dacitic in composition according to classification based on SiO_2 vs. $Na_2O + K_2O$ (after LeBas et al. 1986), and the Zr/TiO_2 vs. SiO_2 contents (Fig. 2, after Winchester & Floyd 1977). On the SiO_2/K_2O diagram (after Peccerillo & Taylor 1976) the samples belong to calc-alkali dacites. In comparison with the data for dacites (after Ewart 1979), the samples from Trlično are very low in magnesium and phosphorous with respect to the silica content.

Trace element abundance is in the variation span for dacites (Ewart 1979). Among incompatible elements, Li and Rb are relatively low. K/Rb ratios amount to 148 and 158 respectively, and they are lower than in

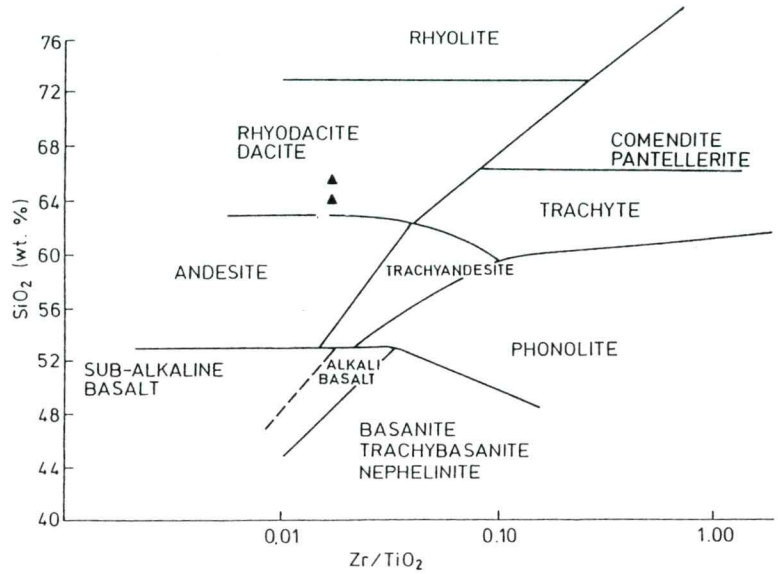


Fig. 2. The samples from Trlično (closed triangles) in the diagram of Zr/TiO_2 vs. SiO_2 contents (after Winchester & Floyd 1977)

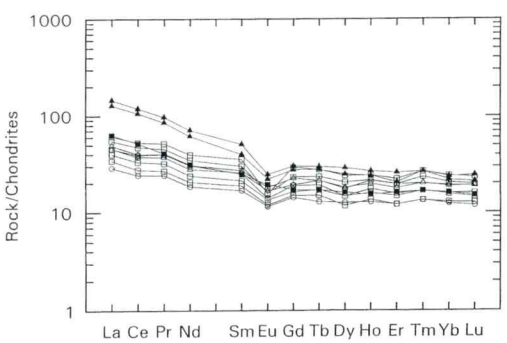


Fig. 3. Chondrite normalised REE abundance for the samples from Trlično (closed triangles) and andesite from Zagaj at Rogaška Slatina (closed square) and the Smrekovec volcanic rocks (open squares, triangles, circles)

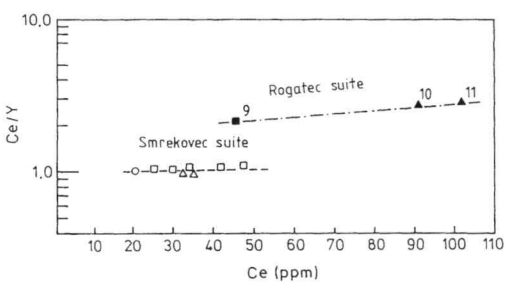


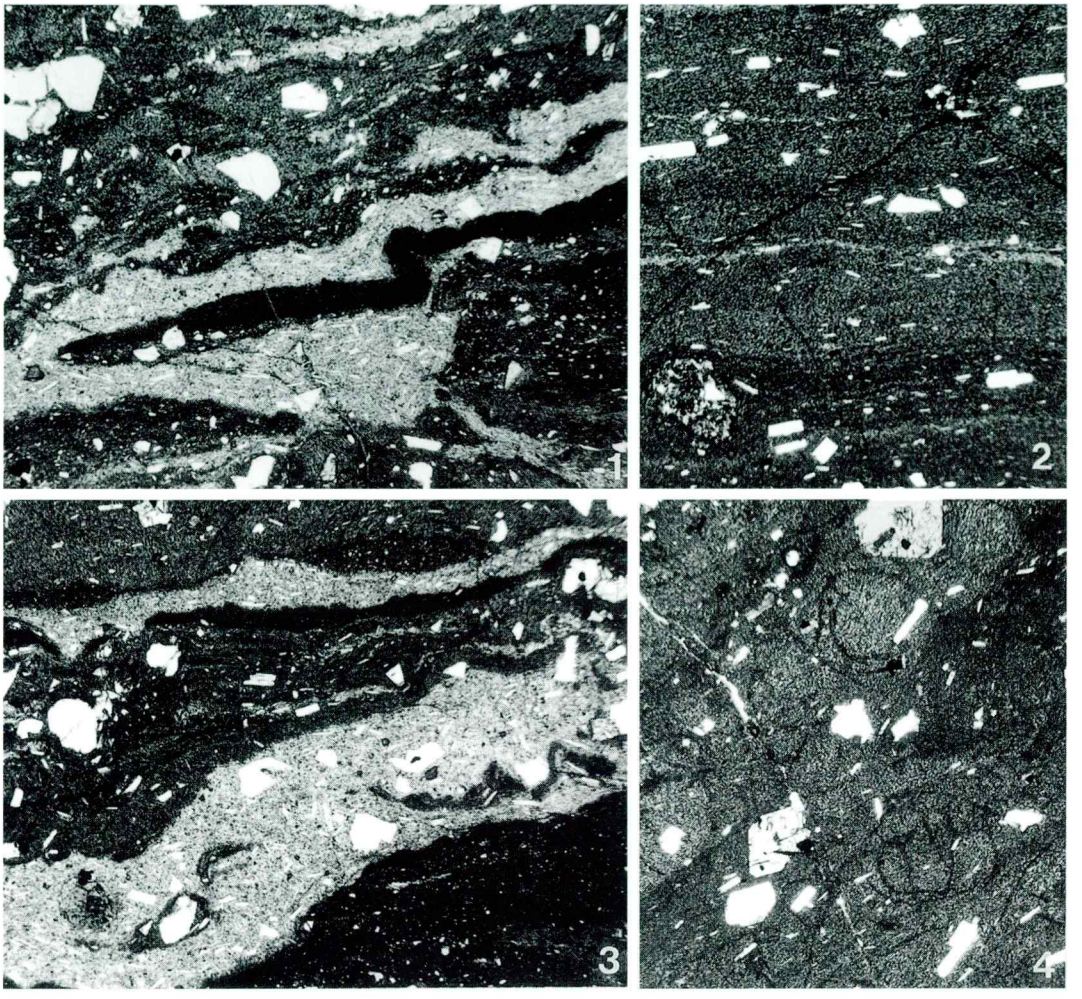
Fig. 4. The Ce/Y vs. Ce diagram with the samples from Trlično (10, 11) and Zagaj at Rogaška Slatina (9) and the Smrekovec volcanic rocks (open squares, triangles and a circle)

Plate 1 – Tabla 1

1,2. Incompletely mixed magmas with different degree of groundmass crystallinity in the glassy lava from Trlično, PPL, magnification 14,5 x

3. Banded section of the lava flow, PPL, magnification 14,5x

4. Perlitic structure of the lava flow, PPL, magnification 14, 5x



the Smrekovec andesites (Kralj 1996). Abundance of compatible trace elements Cu and Ni is low. The samples are very rich in Nb and rare earth elements with respect to the avearge dacite composition after Ewart (1979). In comparison with the Smrekovec andesites and with respect to a relatively higher silica content, the analysed samples seem to be rich in scandium, chromium, cobalt, zinc, arsenic, rubidium, yttrium and barium and very low in zirconium. Rare earth element abundance is higher than in the Smrekovec volcanics (Fig. 3), what can be expected from a higher silica content, but the diagram of the ratios Ce/Y vs. Ce (Fig. 4) two different lines for the Smrekovec and Rogatec volcanic rocks.

Conclusions

Glassy lava from Trlično at Rogatec is banded and shows flow texture. It seems to form by mixing of two magmas with similar composition but diverse degree of groundmass cristallinity. Chemical composition is within the variation range for dacites, although magnesium and phosphorous are relatively low. Among trace elements, lithium, rubidium, copper, nickel and vanadium are low, and rare earth elements and niobium are high. Comparison with the chemical composition of Smrekovec andesites suggests that the rocks probably do not belong to the same volcanic complex, displaced by tectonic activity.

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