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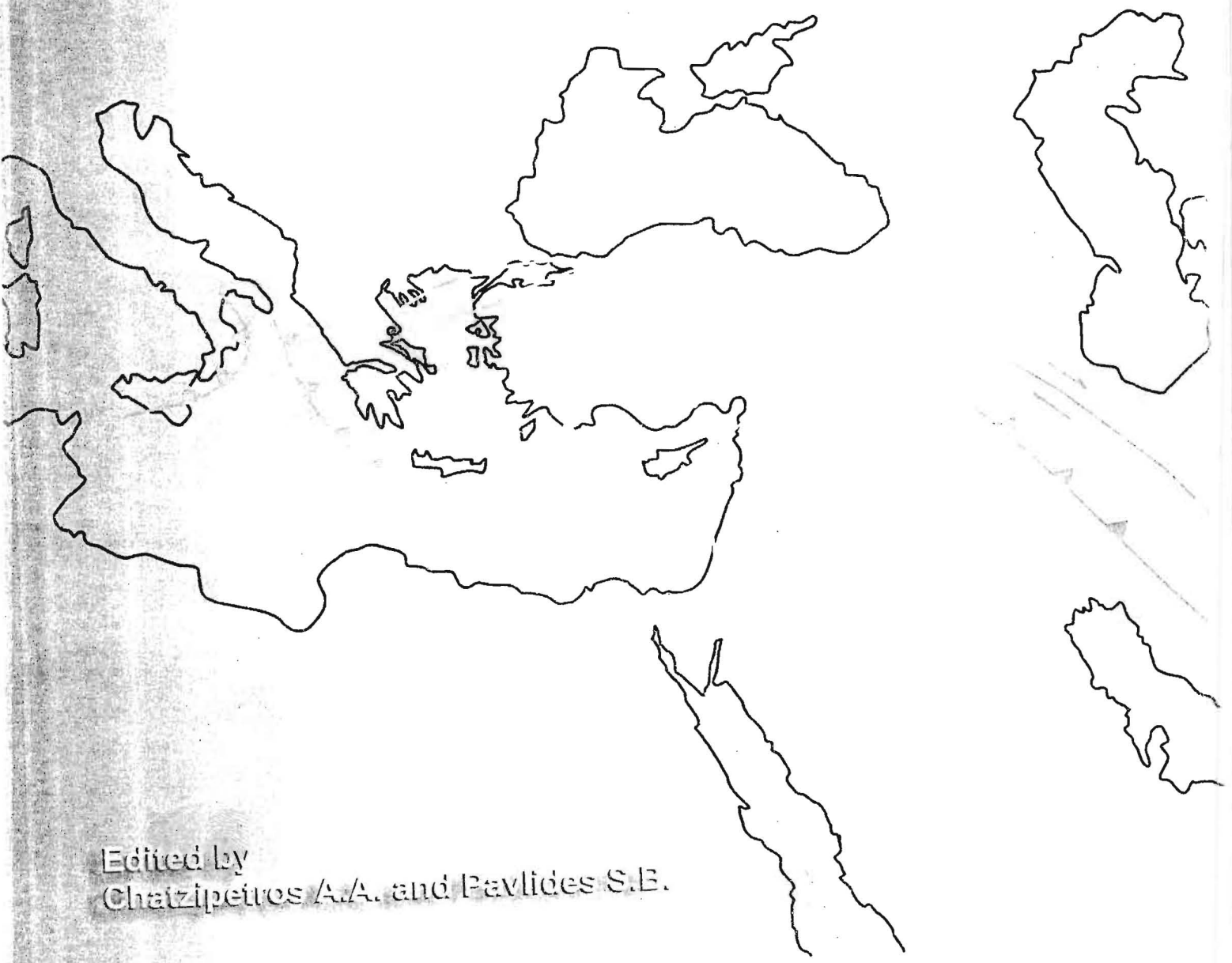

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Tertiary intrusive rocks in the central part of the Vardar zone

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Introduction

The Tertiary intrusive rocks (30.5±0.5 m.y.) within the central part of the Vardar zone can be found in the Kratovo-Zletovo volcanic area. The area is situated between the margins of the Vardar zone and the Serbo-Macedonian massif. It has been the subject matter of investigation of many researchers (Rakicevic, Dumnurdzanov, Petkovski, 1976, Serafimovski, 1993).

The geological base of the Vardar zone is made up of a series of Paleozoic rocks present as quartz-graphite schists and phyllites in which quartzites, quartz sandstones and chlorite-biotite schists alternate facially.

The series is intruded by gabbros of Mesozoic age. The two earlier mentioned formations have been intruded by quartzmonzonite to quartzmonzonte porphyry intrusive Tertiary rocks. The youngest rocks are Miocene volcanic rocks of amphibolite andesite composition. Quartzmonzonite and quartzmonzonite porphyry occur, as a smaller intrusive body with irregular shapes with slab like to irregular columnar rocks. They are grey, fairly hard with pronounced hypidiomorphic grain-like structure. Essentially, they are made up of intermediary zonar plagioclases and in some cases lamellar twinned, quartz, feldspars, biotite and plagioclase.

Methodology

The intrusive rocks collected in the area under consideration were studied under a microscope, which helped to determine their petrographic characteristics. Chemical and geochemical analyses were carried out in the laboratories of the Faculty of Mining and Geology in Stip by ICP-AES method. Studies on the presence of rare earth in intrusive rocks were carried out by ICP-MS method in the Activation Laboratories in Canada.

Results

The results obtained make it possible to conclude that they are intrusive rocks with hypidiomorphic grain-like structure with sporadic appearance of holocrystalline porphyritic composition. Larger crystals are present as intermediary zonar plagioclases which, sometimes, are polysynthetically lamellar twinned. Biotite occurs in relatively fresh grains, and quartz as irregular crystals. Pyroxene is less common and present as augite affected by processes of transformation. Irregular P-feldspar grains can be seen, the largest amount of feldspars being in the holocrystalline ground mass.

Based on the chemical results (Table 1) it can be inferred that the rocks are intermediary with SiO_2 from 56.79 to 61.57% and pronounced subvolcanic character with CaO amounting from 3.54 to 6.14%. The K_2O content ranges from 4.38 to 4.73%. After the classification of Debon and Le Fort (1983) (fig. 1) the results obtained plot in the field of quartzmonzonites and monzonites.

SiO_2	61.00	55.33	56.79	57.97	61.57	60.57	57.94
TiO	0.61	0.71	0.72	0.75	0.64	0.63	0.79
Al_2O_3	15.43	15.32	15.31	15.60	15.46	15.09	15.71
Fe_2O_3	5.69	7.49	7.58	7.33	7.92	6.23	7.40
MnO	0.18	0.17	0.16	0.16	0.13	0.21	0.14
MgO	1.82	3.67	3.71	2.71	1.72	2.05	3.65
CaO	4.93	5.87	6.14	5.63	3.54	4.89	5.59
Na_2O	2.82	3.06	2.86	2.84	2.98	2.84	2.68
K_2O	4.34	4.33	4.62	4.66	4.65	4.56	4.73
P_2O_5	0.27	0.29	0.30	0.40	0.28	0.29	0.38
LOI	3.35	0.68	2.14	0.93	1.43	2.74	1.14
ppm							
V	118	142	170	162	145	123	162
Cr	22	32	69	59	23	31	59
Co	8	16	12	12	11	3	13
Ni	9	19	22	25	11	11	30
Cu	49	80	37	55	18	19	51
Zn	76	109	114	121	118	83	86
Ga	18.3	19.4	18.2	19.5	19.5	17.8	19.9
Rb	184	194	198	185	216	201	189
Sr	564	765	799	843	545	562	746
Y	30	32	33	34	34	34	36
Zr	190	196	209	207	197	216	202
Nb	20	20	21	21	21	24	21
Ba	967	1169	1533	1576	992	1039	1432

Table 1. Chemical and geochemical composition of the tertiary intrusive rocks in the central part of the Vardar zone

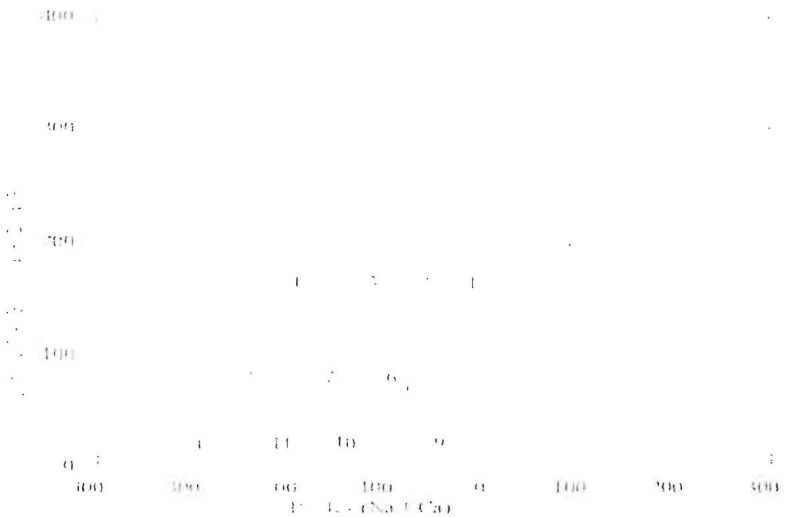

Figure 1. Classification of intrusive rocks of the central part of the Vardar zone (Debon and Le Fort, 1983).

The Batchelor and Bowden diagram (1985) was created (fig. 2) in order to define the geotectonic affiliation of the intrusive rocks and their relationship to the processes. The diagram points out the relationship of the rocks to the post collision uplifts.

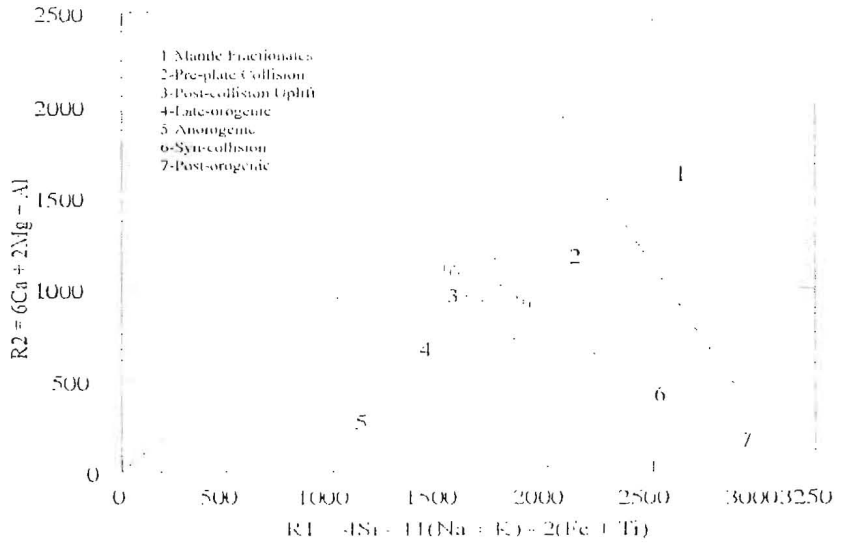

Figure 2. The relationship of the intrusive rocks of the central parts of the Vardar zone to certain geotectonic processes (Batchelor and Bowden, 1985).

Conclusion

The intrusive rocks, quartz-monconite and monconite are mainly composed of plagioclase, K-feldspar, biotite, clinopyroxene, and some quartz. Its chemical composition is identical to that of the latites of the firts phase of magmatic activity. Distribution of the normalized trace elements contents show high enrichment of LILE elements and a progresive decreasing from HFS to Fe-Mg elements with very low contents of Ni and Cr.

In terms of the tectonic evolution of the rocks it can be said that they are products of continental collision between the Pelagonian block and the Serbo-Macedonian mass that took place after the closure of the Vardar Ocean.

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