C O N T E N T S

CRYSTAL MORPHOLOGY OF SANIDINE PHENOCRYSTS FROM ZVEGOR, REPUBLIC OF MACEDONIA

Tena Šijakova Ivanova[1], Andrea Čobić[2*], Željka Žigovečki Gobac[2], Vladimir Zebec[3], Vladimir Bermanec[2]

[1] *University Goce Delčev, Faculty of natural and technical science, Štip*
[2] *Faculty of Science, Institute of Mineralogy and Petrology, Zagreb, Croatia; *ancobic@geol.pmf.hr*
[3]*Croatian Natural History Museum, Zagreb, Croatia*

Abstract: This paper presents the results of the research carried out on sanidine crystals from Zvegor, Republic of Macedonia. 572 crystals were collected for research: 326 single crystals and 23 randomly intergrown crystals, 100 right-handed and 123 left-handed Carlsbad twins. Results show that left- and right-handed Carlsbad twins are almost equally represented at this locality. Goniometric measurements showed the appearance of six forms: {010}, {110}, {130}, {001}, $\{\bar{1}11\}$ and $\{\bar{2}01\}$. XRPD analysis of the sanidine - crust (Fds_C), showed that it consists of a mixture of three different phases: calcite as a dominant phase, illite and sanidine. The mixture of these phases could be a result of the feldspar crystal alteration which was primary of sanidine composition. The alteration could have been due to influence of solutions which also affected other components of the rock. It could also be a result of a post crystallization reaction of sanidine with the altered rock. XRPD analysis shows that the core of the sample (Fds_S) is sanidine.

Key words: Carlsbad twins, randomly intergrown crystals, sanidine, single crystals, Zvegor

INTRODUCTION

Zvegor is a part of Delcevo municipality in eastern Republic of Macedonia. It is 2.62 km away from the center of the municipality. There is an outcrop of quartz latite rocks which contains sanidine crystals east of the village Zvegor, close to the Macedonian-Bulgarian state border. These rocks pass through Cambrian volcanic sediments, granitoids and Paleogene formations, while Triassic sediments thrust over them and Pliocene is transgressive (Fig.1). Except sanidine, these quartz latite rocks are composed of plagioclase, quartz, amphibole and biotite. Accessory minerals are: apatite, magnetite and titanite. The rock structure is holocrystalline porphyritic. Crystals of sanidine are idiomorphic and quite rich in forms. They are usually 1 to 5 cm long. Crystals are developed as singles crystals, either loose single crystals or agglomerations of randomly intergrown crystals in a form of crystal clusters, and Carlsbad twins, both left- and right-handed. The relatively fast chemical weathering of the host rock results in a large quantity of fresh crystals that are easily released from the rock and can easily be found at the outcrops near the road. In spite of attractive crystals near the main road, they were not described, yet.

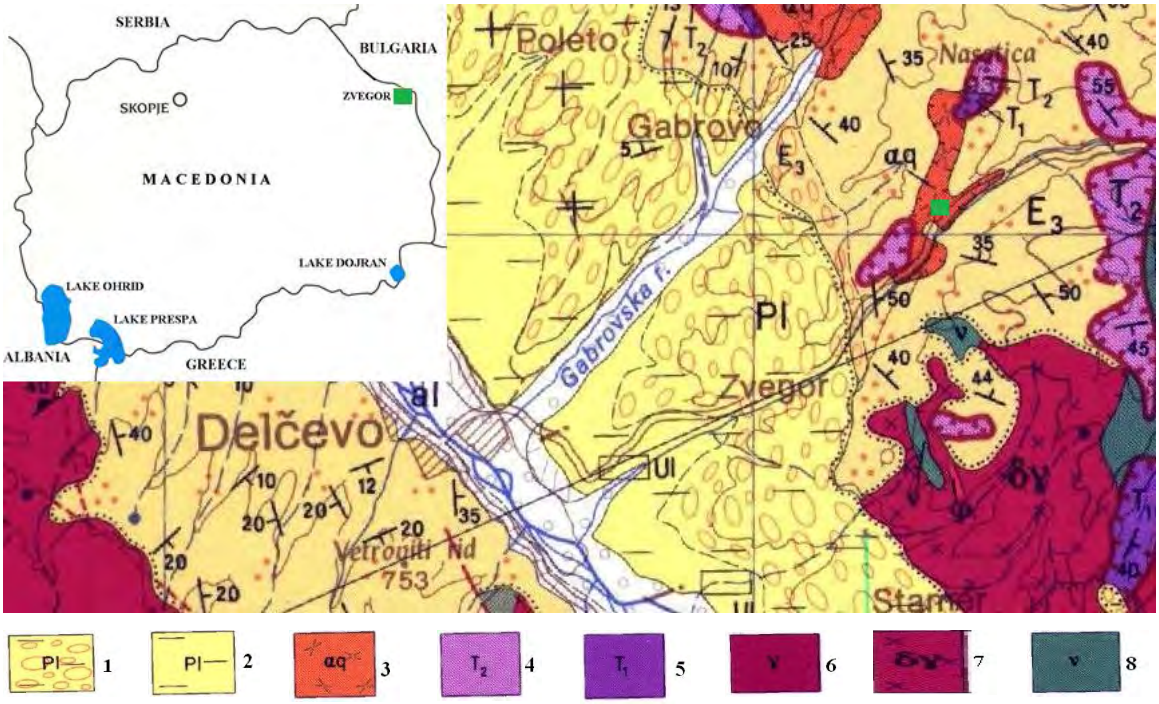

Fig. 1. Geological map of Zvegor, scale 1 : 100 000 (OGK, List Delcevo, 1981)
1. sand and gravel; 2. clay and sand; 3. quartz latite; 4. limestone; 5. sand and conglomerate; 6. aplitoide granites; 7. granodiorites; 8. metagabbro-diabase; ■ pace where the samples were taken

EXPERIMENTAL

Crystal morphology of 572 collected crystals of alkali feldspar was examined to evaluate statistical distribution of different crystal habits.

Representative twin crystal was chosen for goniometric measurements. For goniometric measurements, twocircle goniometer was used. Identification of forms was done using orientation after Goldschmidt (1897).

Representative sample was chosen for X-ray powder diffraction analysis. The crust (Fds_C) and the core (Fds_S) of the sample have been analyzed separately. X-ray powder diffraction data were collected using a Philips PW3050/60 X'Pert PRO X-ray powder diffractometer with Cu Kα radiation, accelerated by 40 kV and a current of 40 mA. Step-scan was employed in order to obtain XRPD patterns. Step size was 0.02° and counting time 1s per step. X-ray pattern analyses were performed using X'Pert High Score Plus v. 2.1 software (Panalytical, 2004) and unit cell calculations were performed using "Unit Cell" software (Holland & Redfern, 1997).

RESULTS AND DISCUSSION

The sanidine crystals are easily released from the rock which could be due to early rock alteration. Only loose crystals were collected for this study of crystal morphology. Collected crystals have been separated in two main groups which are subdivided each to two groups (Table 1). First group comprises of 349 crystals which appear as single loose crystals (326 crystals: Fig. 2a, Table 1) or agglomerations of randomly intergrown crystals (23 agglomerations; Fig. 2b, Table 1). Second group comprises of 223 Carlsbad twins, 123 left- handed (Fig. 2c, Table 1) and 100 right-handed (Fig. 2d, Table 1) which can point to the fact that they are almost equally represented at this locality. Twinned

crystals developed according to the most usual twinning law for sanidine crystals - Carlsbad's law (Goldschmidt, 1916; Smith, 1974). No other twinning law was observed. When a basal pinacoid, {001}, is oriented towards the observer and the twin crystal is on the left side, it is a left-handed Carlsbad twin (Fig. 2c) and vice versa for right-handed Carlsbad twins.

Goniometric measurements have yielded six common forms: {010}, {110}, {130}, {001}, $\{\bar{1}11\}$ and $\{\bar{2}01\}$ (fig. 2). Single crystals are elongated along [100] (fig. 2a) while twinned crystals are elongated along [001] (fig. 2c-2d).

XRPD analysis of the sample-core (Fds_S), which is transparent, has confirmed a sanidine crystal structure (PDF: 01-086-0682, ICCD, 2004; Fig. 3) yielding following unit cell parameters: a = 8.512(3) Å, b = 13.024(4) Å, c = 7.181(4) Å and ß = 115.99(2) °. XRPD analysis of the crust (Fds_C), which is white, thin and readily detached, showed that it consists of a mixture of three different phases: calcite as a dominant phase, illite and sanidine (Fig. 4). The mixture of these phases could be a result of the feldspar crystal alteration which was primary of sanidine composition. Surface of sanidine phenocrysts could be altered due to influence of CO_2-rich solutions which also affected other components of the rock. It is also possible that the crust of sanidine crystals is a result of a post crystallization reaction of sanidine with the altered rock.

Table 1. List of collected samples

single crystals			Carlsbad twins			SUM
single loose crystals	agglomerations	total (%)	right-handed	left-handed	total (%)	
326	23	61	100	123	39	572

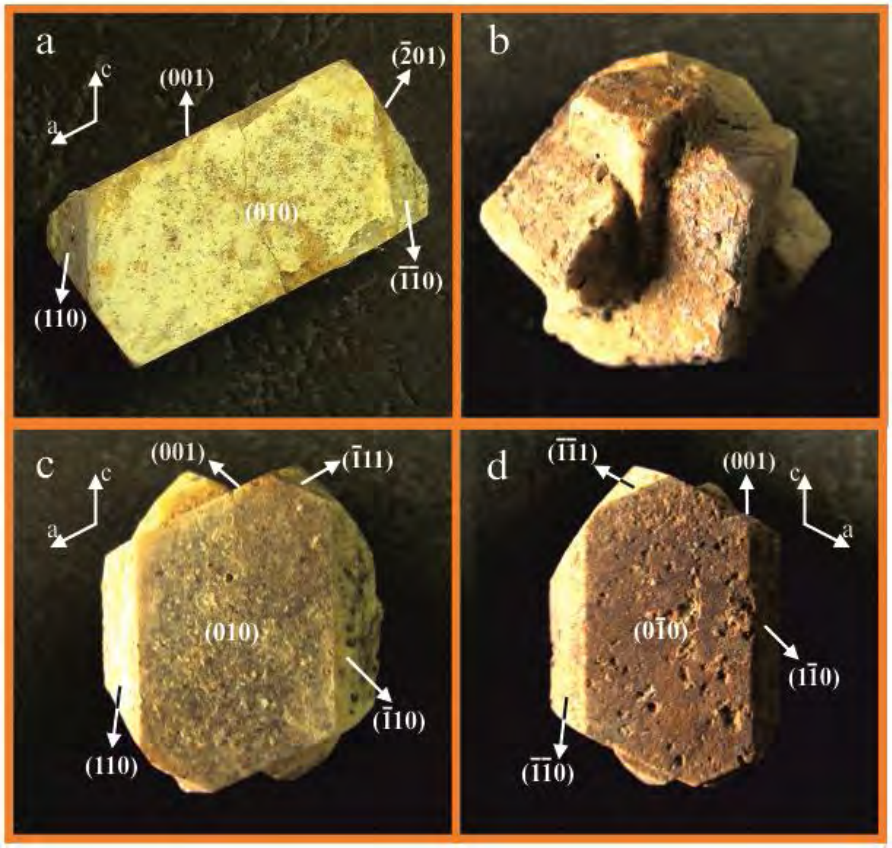

Fig. 2. Single crystals (a), agglomerations of randomly intergrown single crystals (b), Carlsbad twins: left-handed (c), right-handed (d); crystals and twins in the figure are 1 to 3 cm long

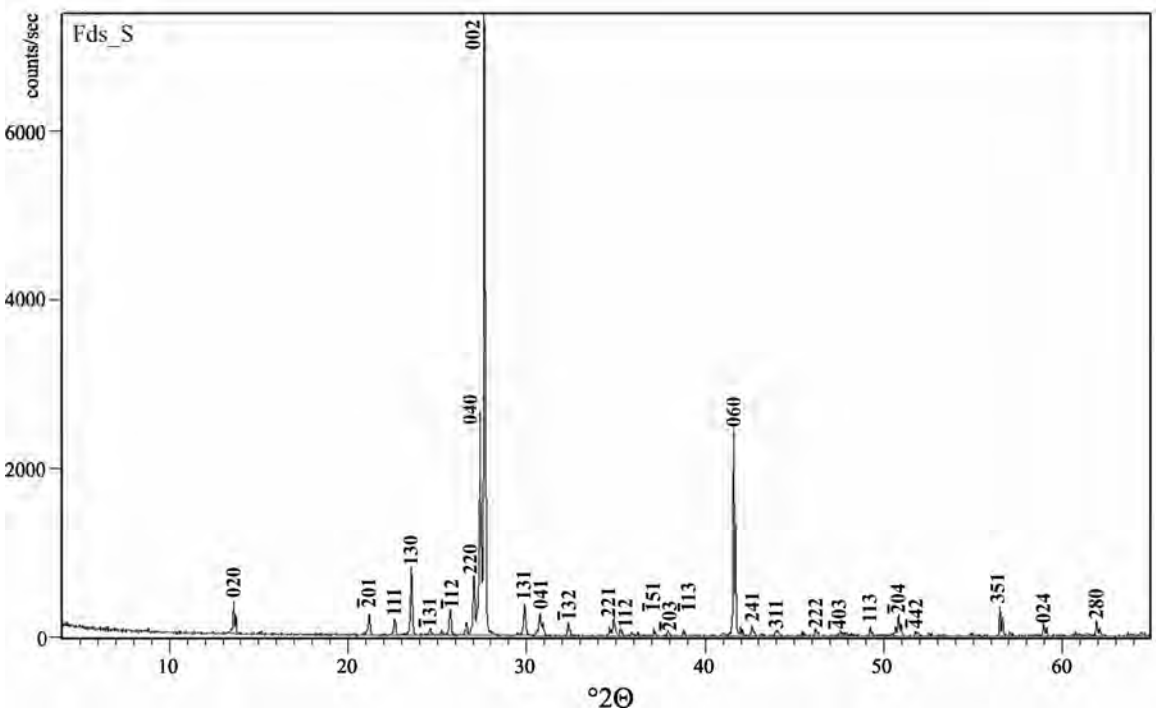

Fig. 3. X-ray diffraction pattern of sanidine sample-core from Zvegor (Fds_S). Pattern is indexed according to PDF: 01-086-0682 (ICCD, 2004)

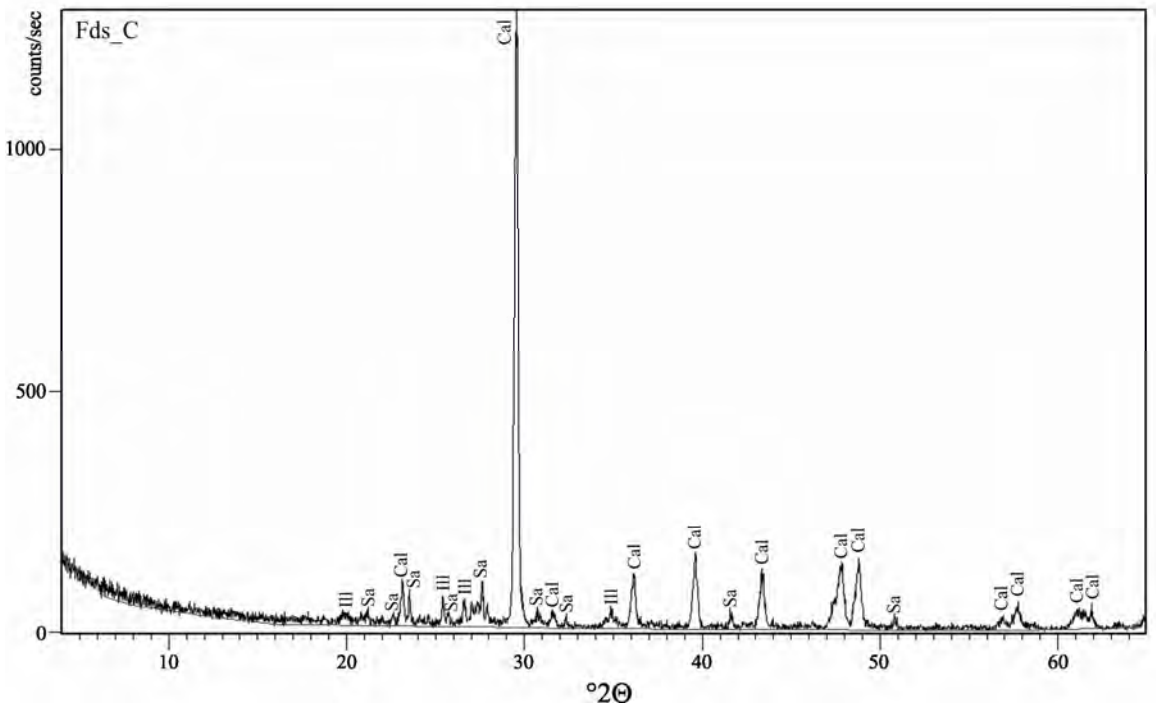

Fig. 4. X-ray diffraction pattern of sanidine sample-crust from Zvegor (Fds_C); Cal-calcite, Ill-illite, Sa-sanidine

CONCLUSION

In general, after summarizing all the facts, which have resulted from this research it can be concluded that left- and right-handed Carlsbad twins are almost equally represented at this locality while the most frequent are single crystals of sanidine. Six

forms appear on sanidine crystals: {010}, {110}, {130}, {001}, $\{\bar{1}11\}$ and $\{\bar{2}01\}$. Single crystals are elongated along [100], while twinned crystals are elongated along [001] and flattened on (010).

XRPD analysis showed that the phenocrysts is sanidine and that the crust of these samples consists of a mixture of three different phases: calcite as a dominant phase, illite and sanidine. The mixture of these phases could be a result of the feldspar crystal alteration during crystallization of the rock. Surface of the phenocrysts of sanidine could be altered due to influence of CO2-rich solutions which also affected other components of the rock and caused later destruction of the volcanic rock. The other possible reason for alteration is a post crystallization reaction of sanidine with the altered rock.

REFERENCES

Goldschmidt, V. (1897): Krystallographische Winkeltabellen, Verlag von Julius Springer, Berlin, 432 p.

Goldschmidt, V. (1916): Atlas der Krystallformen, Tafeln, Band III, Carl Winters Universitätsbuchhandlung, Heidelberg

Holland, T. J. B & Redfern, S. A. T. (1997): Unit cell refinement from powder diffraction data: the use of regression diagnostics. *Mineral. Mag*. **61**, 65-77

ICCD (2004): PDF-2 – Release 2004, Newton Square, U.S.A.

Kovacevik, M., Rakikevik, T., Arsovski, M., (1981) Osnovna geoloska karta 1:100 000 list, K34-82, Delcevo, Geoloski zavod Skopje, SFRJ, Belgrad

Kovacevik, M., Petkovski, P., Temkova ,V., (1981) tolkuvac na list, K34-82, Delcevo. Geoloski zavod Skopje, SFRJ, Belgrad

Panalytical (2004): X'Pert High Score Plus, version 2.1, Panalytical, Almelo, The Netherlands

Smith, J.V. (1974): Feldspar minerals 2: Chemical and Textural Properties. Springer-Verlag, Berlin, 690 p.