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*Nonna BAKUN-CZUBAROW*[1], *Anna BIAŁOWOLSKA*[2]

## ŚNIEŻNE KOTŁY BASALTOID DIKE (KARKONOSZE-IZERA BLOCK): A CASE OF GRANITIC CONTAMINATION OF BASALTIC MAGMA

Basaltoid forming two dikes (ca. 1 m thick each) in the area of Śnieżne Kotły (ŚK) in the Polish part of the Karkonosze National Park (Birkenmajer 1967) belongs to the Tertiary basaltic formation of Lower Silesia, being the part of large Central European province, where the rocks are undersaturated with silica. Almost uncontaminated parts of the basaltoid show composition of alkali olivine basalt and plot in the basalt field, close to basanites on the TAS diagram (Le Bas *et al.* 1986).

Table 1. Representative microprobe analyses of olivine and spinel phenocrysts as well as of spinel microlites from the Śnieżne Kotły basaltoid.

| | Olivines | | | | | Spinels | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Phenocrysts | | | | | phenocrysts | | microlites | |
| | 1 big | 2 small | 3 core zoned | 3 rim zoned | 4 aggreg. | 5 in olivine | 6 | 7 | 8 |
| $SiO_2$ | 40.03 | 39.63 | 39.42 | 39.20 | 40.25 | 0.23 | 0.25 | 0.35 | 0.56 |
| $TiO_2$ | 0.01 | 0.13 | 0.03 | 0.07 | 0.00 | 18.34 | 13.65 | 27.56 | 24.42 |
| $Al_2O_3$ | | | | | | 3.54 | 5.34 | 1.15 | 2.93 |
| $Cr_2O_3$ | | | | | | 7.76 | 9.22 | 0.02 | 1.28 |
| $Fe_2O_3$ | | | | | | 22.36 | 29.18 | 14.68 | 17.26 |
| FeO | 14.05 | 13.43 | 14.94 | 16.60 | 12.81 | 43.12 | 37.68 | 53.42 | 47.71 |
| MnO | 0.23 | 0.21 | 0.26 | 0.27 | 0.16 | 0.84 | 0.05 | 0.89 | 0.94 |
| NiO | 0.03 | 0.13 | 0.17 | 0.19 | 0.43 | 0.04 | 0.00 | 0.15 | 0.00 |
| MgO | 45.61 | 45.61 | 44.37 | 43.25 | 46.32 | 3.16 | 4.77 | 1.79 | 3.88 |
| CaO | 0.31 | 0.24 | 0.14 | 0.32 | 0.20 | 0.10 | 0.13 | 0.15 | 0.10 |
| Total | 100.27 | 99.38 | 99.33 | 99.90 | 100.17 | 99.49 | 100.27 | 100.16 | 99.08 |
| Fo | 85.1 | 85.6 | 83.9 | 82.0 | 86.4 | | | | |
| Ulv | | | | | | 50.0 | 36.3 | 76.0 | 66.4 |

The basaltic magma intruded into the late Variscan Karkonosze granite and underwent a strong granitic contamination. One can observe in the basaltoid lighter spots where granitic xenoliths as well as quartz or alkali feldspar grains coming from the granite disaggregation were dissolved and completely assimilated. Relatively big, spheric, melt-carved granitic xenoliths can be also found. Among basaltoid phenocrysts, olivine and clinopyroxene grains predominate over plagioclases, while spinels are subordinate. In the centre of the basaltoid dike,

[1] *Institute of Geological Sciences, Polish Academy of Sciences, ul. Twarda 51/55, 00-818 Warszawa, Poland; e-mail: nbakun@twarda.pan.pl*
[2] *Institute of Geochemistry, Mineralogy and Petrology, Warsaw University, al. Żwirki i Wigury 93, 02-089 Warszawa, Poland.*

Table 2. Representative microprobe analyses of the clinopyroxene phenocrysts and microlites.

| | | Phenocrysts | | | | | | Microlites | |
|---|---|---|---|---|---|---|---|---|---|
| | | 9 | 10 | 11 core | 11 rim | 12 | 13* | 14 | 15** |
| | $SiO_2$ | 46.10 | 45.54 | 46.81 | 39.17 | 42.70 | 54.09 | 50.93 | 52.58 |
| | $TiO_2$ | 2.94 | 2.97 | 2.27 | 5.42 | 5.03 | 0.50 | 1.93 | 0.31 |
| | $Al_2O_3$ | 5.56 | 6.18 | 4.91 | 10.79 | 9.57 | 0.00 | 2.15 | 0.11 |
| | $Cr_2O_3$ | 0.18 | 0.04 | 0.24 | 0.16 | 0.18 | 0.03 | 0.08 | 0.00 |
| | FeO | 7.52 | 8.55 | 6.99 | 10.08 | 7.93 | 8.48 | 10.31 | 8.31 |
| | MnO | 0.16 | 0.00 | 0.14 | 0.04 | 0.05 | 0.31 | 0.48 | 0.29 |
| | MgO | 13.21 | 12.39 | 13.42 | 9.67 | 10.94 | 13.47 | 12.50 | 13.51 |
| | CaO | 24.00 | 23.70 | 24.09 | 23.76 | 23.34 | 22.93 | 20.31 | 24.56 |
| | $Na_2O$ | 0.33 | 0.28 | 0.26 | 0.43 | 0.36 | 0.57 | 0.70 | 0.47 |
| | $K_2O$ | 0.11 | 0.01 | 0.06 | 0.07 | 0.01 | 0.05 | 0.06 | 0.11 |
| | Total | 100.11 | 99.66 | 99.19 | 99.59 | 100.11 | 100.43 | 99.45 | 100.25 |
| 6 oxygens | | | | | | | | | |
| T | Si | 1.713 | 1.708 | 1.752 | 1.487 | 1.602 | 2.009 | 1.924 | 1.954 |
| | $Al^{IV}$ | 0.244 | 0.273 | 0.216 | 0.483 | 0.398 | | 0.076 | 0.005 |
| | $Ti^{IV}$ | 0.043 | 0.019 | 0.032 | 0.030 | | | | 0.009 |
| | $Fe^{3+}$ | | | | | | | | 0.032 |
| M1 + M2 | $Al^{VI}$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.026 | 0.000 | 0.020 | 0.000 |
| | $Ti^{VI}$ | 0.039 | 0.065 | 0.032 | 0.125 | 0.142 | 0.014 | 0.055 | 0.000 |
| | Cr | 0.003 | 0.002 | 0.007 | 0.005 | 0.005 | 0.001 | 0.002 | 0.000 |
| | $Fe^{3+}$ | 0.189 | 0.163 | 0.165 | 0.263 | 0.110 | 0.000 | 0.000 | 0.077 |
| | $Fe^{2+}$ | 0.045 | 0.105 | 0.053 | 0.057 | 0.139 | 0.263 | 0.326 | 0.149 |
| | Mn | 0.005 | 0.000 | 0.004 | 0.001 | 0.002 | 0.009 | 0.016 | 0.009 |
| | Mg | 0.732 | 0.692 | 0.749 | 0.547 | 0.611 | 0.746 | 0.705 | 0.748 |
| | Ca | 0.956 | 0.952 | 0.966 | 0.967 | 0.938 | 0.912 | 0.822 | 0.978 |
| | Na | 0.024 | 0.020 | 0.019 | 0.032 | 0.026 | 0.041 | 0.051 | 0.034 |
| | K | 0.005 | 0.000 | 0.003 | 0.003 | 0.000 | 0.002 | 0.003 | 0.005 |
| | *mg* | 0.94 | 0.87 | 0.93 | 0.91 | 0.81 | 0.74 | 0.68 | 0.83 |

*from the strongly contaminated magma; ** from corona around the quartz grain

euhedral olivine phenocrysts predominate over clinopyroxene ones. Single, homogenous or zoned olivine grains are rimmed by brownish serpentine. The olivine serpentinization, particularly strong in the vicinity of granite xenoliths, was caused by the reaction between olivine and $H_2O$-rich melt, during the process of granitic contamination. Apart from single grains, aggregates of several olivine crystals can be also found. The olivine composition (Table 1) ranges from $Fo_{82}$ to $Fo_{87}$. Forsterite-richest olivine phenocrysts of an older generation are usually intensively corroded. Clinopyroxene phenocrysts are also strongly diversified. The biggest clinopyroxene phenocrysts of an older generation show the composition of salites, relatively rich in $Al_2O_3$ (up to 10.8 wt %; cf. Table 2). Zoned phenocrysts display a distinct increase of $Al_2O_3$ and $TiO_2$ contents and a decrease of *mg* number rimwards. Smaller phenocrysts of younger generation can crystallize either from uncontaminated basaltic magma, as aluminous clinopyroxenes, or from strongly contaminated magma, as alumina-poor ones. Similar clinopyroxenes can form microlites around the quartz grains. Among matrix microlites augites can be seldom met. Plagioclases and nepheline belong to primary light minerals of the basaltoid. The An-richest plagioclases (up to $An_{63}$) were preserved only in matrix. Composition of the other plagioclase crystals ranges from $An_{28}$, which is typical for granitic one, to $An_{49}$. Relatively rare spinel phenocrysts are chromiferous titanomagnetites, while spinel microlites show the composition of ulvospinel-rich titanomagnetites.

Table 3. Chemical composition of uncontaminated basaltoid as well as melts from groundmass and those rimming the granitic minerals.

| | whole rock, dark | melts | | | |
|---|---|---|---|---|---|
| | | matrix glass | | glass around | |
| | | dark | light | Fsp | Qtz |
| | 16* | 17** | 18** | 19** | 20** |
| $SiO_2$ | 45.90 | 52.20 | 57.15 | 53.95 | 63.00 |
| $TiO_2$ | 2.84 | 1.05 | 1.48 | 1.19 | 0.35 |
| $Al_2O_3$ | 10.90 | 21.73 | 6.02 | 15.11 | 11.80 |
| FeO | 9.84 | 4.04 | 8.73 | 2.67 | 3.21 |
| MnO | 0.19 | 0.10 | 0.09 | 0.05 | 0.14 |
| MgO | 12.19 | 3.67 | 5.26 | 3.08 | 3.30 |
| CaO | 13.54 | 10.11 | 10.93 | 13.11 | 5.20 |
| $Na_2O$ | 1.90 | 4.43 | 3.14 | 3.58 | 3.23 |
| $K_2O$ | 1.88 | 0.60 | 4.81 | 4.65 | 6.58 |
| Total | 99.28 | 97.93 | 97.61 | 97.39 | 96.81 |

*AAS analysis, **defocused beam probe analyses

As compared to the whole-rock composition of uncontaminated ŚK basaltoid, all the analyzed glasses are distinctly richer in $SiO_2$ and $Na_2O$, but poorer in MgO, FeO and $TiO_2$ (Table 3). In the matrix, the dark glass corresponds to metaluminous olivine tholeiite, while the light one shows the composition of peralkaline quartz trachyte. The light glass rimming the single grains of granitic feldspars corresponds to metaluminous tephritic phonolite, while the glass around the quartz grains displays the composition of peralkaline quartz latite. Thus after granitic contamination the scale of magma homogenization within the studied dikes was very limited.

Primary magma of the ŚK basaltoid resembles that of the basanite-nephelinite rocks of the Złotoryja region (Białowolska 1993) being typical for the Tertiary Lower Silesia depleted basaltic volcanics (Blusztajn, Hart 1989). The great mineral and chemical diversity of the ŚK basaltoid is caused, on one hand, by a strong granitic contamination of primary magma and, on the other hand, by a high cooling rate, which precluded the magma homogenization within the dike.

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