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PETROLOGY AND GEOCHEMISTRY OF CENOZOIC BASALTS FROM TARGOWICA (FORE-SUDETIC BLOCK)

Abstract: The Sośnica Hill near Targowica in the eastern part of the Fore-Sudetic Block represents relatively well preserved Cenozoic scoria cone. The activity of the volcano commenced with accumulation of pyroclastic fall deposits, and later subvolcanic intrusions and lava flows were emplaced. Petrography, mineral chemistry and geochemistry suggest that the alkaline basalts erupted from the volcano represent relatively evolved magmas which underwent some fractional crystallisation and, possibly, crustal assimilation.

Keywords: Cenozoic volcanism, Lower Silesia, basalt, scoria cone, petrology

INTRODUCTION

The Cenozoic (predominantly Miocene) volcanism in Lower Silesia represented a continental intraplate volcanic episode, related to the Ohre rift developed along the NW margin of the Bohemian Massif. The alkaline, mainly basic volcanic rocks of Lower Silesia comprise ca. 300 occurrences, mostly plugs, lava flows and rare relics of pyroclastic cones (Birkenmajer et al. 1970). The basic magmas originate from heterogeneous mantle sources, formed at various depths and degrees of partial melting, and underwent fractionation and limited crustal contamination (e.g. Alibert et al. 1987; Blusztajn, Hart 1989; Dziedzic 1990).

This paper provides a preliminary synthesis on basaltic volcanics cropping out at Sośnica Hill near the village of Targowica (eastern part of the Fore-Sudetic Block). It is suggested that the hill represents relatively well preserved scoria cone. An extensive quarry enables sampling of various volcanic products, including lavas, subvolcanic intrusions and pyroclastic deposits. Field relationships, petrography, mineral chemistry and geochemistry (including mineral analyses obtained with the Microscan 5 microprobe at the University of Wrocław, and analyses of 6 samples by the ICP-OES/MS methods at Actlabs, Canada) put constraints on the interrelated eruptive and magmatic evolution of this volcanic system.

FIELD RELATIONSHIPS AND VOLCANIC EVOLUTION

The main lithologies cropping out in the quarry are basalts and basaltic breccias (Fig. 1). The breccias are found in the north-west and range from unbedded, coarse-grained and poorly sorted deposits (with basalt blocks and volcanic bombs up to 0.5 m in diameter) to bedded, finer-grained and better sorted rocks (strongly

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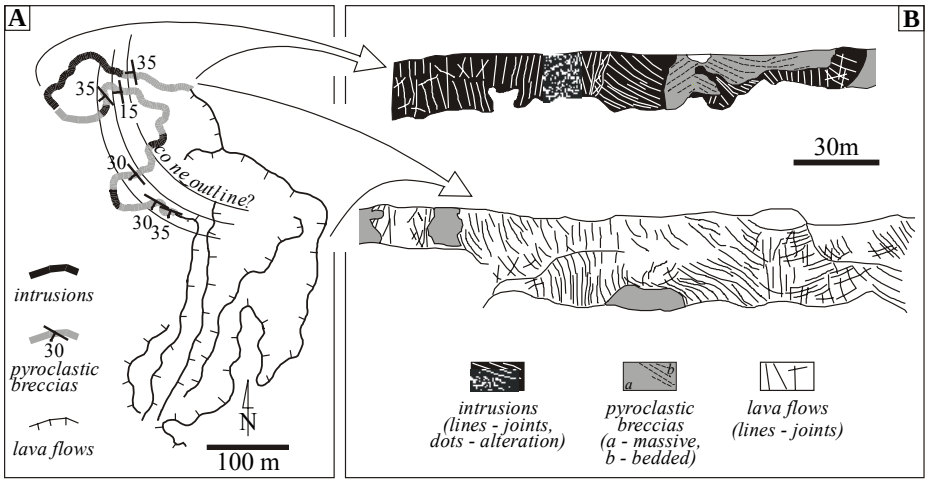

Fig. 1. A - distribution of lavas, pyroclastic deposits and intrusions along the quarry walls at Sośnica Hill. B - sections along the NE part of the quarry showing a SE-ward transition from pyroclastic deposits with intrusions to lava flows.

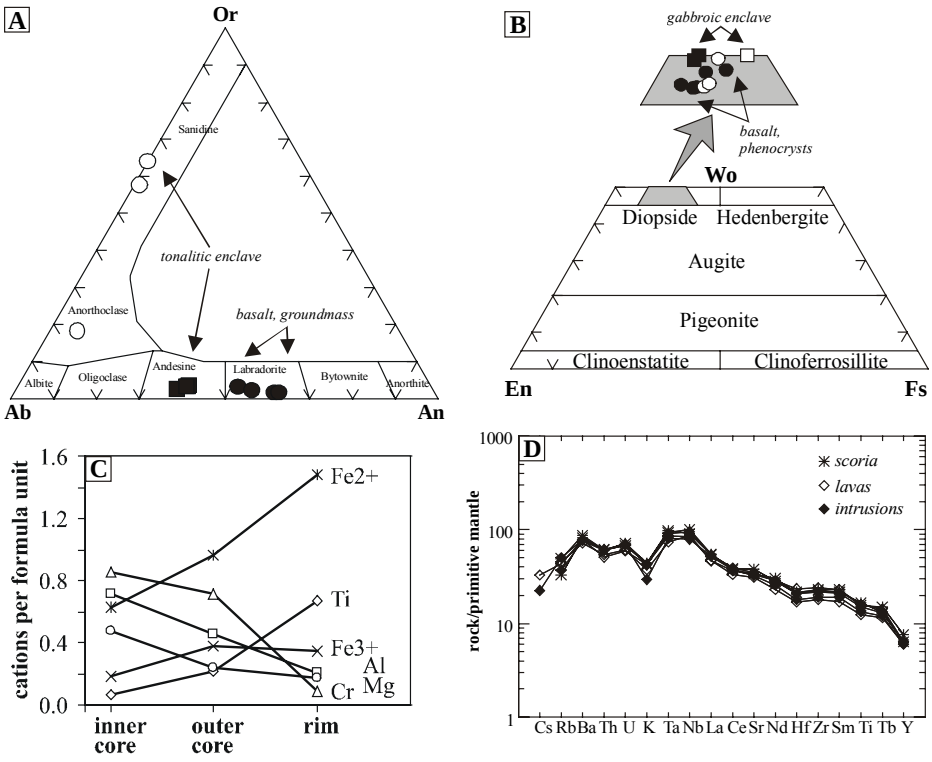

Fig. 2. Selected diagrams illustrating the compositional variatin of feldspars (A), pyroxenes (B), and spinels (C; shows zonation of a spinel phenocryst) in basalts from Targowica and their enclaves. D - primitive mantle normalized trace element patterns of the volcanic rocks (normalization after McDonough et al. 1992, vide Rollinson 1993).

dominated with fine scoria). The bedding dips at 15-35º and the strike variation suggests that the breccia outcrop represents a sector of a cone, with a center north of the quarry. The breccias are intruded with ca. 100 m wide, composite plug, 10 m thick sill and thinner dikes.

Basaltic lavas interdigitate with the breccias and crop out in the central and southern parts of the quarry. The lavas are thick, columnar-jointed aa-type flows brecciated on the top. In the eastern part of the quarry a synclinal arrangement of platy joints and fan-like arrangement of subvertical to inclined columnar joints define two main, southerly-aligned lava flows (followed by the quarry).

The Sośnica Hill represents a relatively well preserved scoria cone. Its vents were located north of the quarry and in its NW part. The activity commenced with explosive, Strombolian-type eruptions, accumulation of pyroclastic fall deposits and cone construction. The cone was 0.5-1 km wide at its base and 90-180 m high. After the initial explosive phase the activity switched to dominantly effusive eruptions. The top breccias of the lavas contain volcanic bombs indicating contemporaneous flow brecciation and accumulation of pyroclastic material, or reworking of older tephra, over the flowing lava. At that stage of activity subvolcanic intrusions were also emplaced, and a westward shift of the vent probably occurred.

PETROGRAPHY AND MINERAL CHEMISTRY

The basalts usually contain 1-3 vol. % of olivine and clinopyroxene phenocrysts up to 2.5 mm long. Some clinopyroxene phenocrysts show rounded, green-coloured, sieve-textured cores. The groundmass is microcrystalline, intergranular, and consists of plagioclase and clinopyroxene (40-45% each), olivine (10%) and opaques (5-10%). Minor components are alkali feldspars and apatite. Basalts of the subvolcanic intrusions show a coarser-grained, chaotic texture, while lavas are finer-grained, trachytic-textured, and in places contain up to 10% of phenocrysts. Vesicular lavas and tephra are characterized by irregular to flattened and aligned vesicles and, due to alteration and/or hydrothermal activity, a strong replacement of olivine with iddingsite and filling of vesicles and pores with clay minerals and carbonates.

The basalts contain igneous inclusions ranging from small enclaves (<10 mm in size) to crystal aggregates and single crystals, and from ultramafic to felsic in composition. The most common are: (1) micro-gabbroic enclaves (composed of diopside, iddingsite, plagioclase, altered glass and opaques), and (2) tonalitic xenoliths (composed of quartz and plagioclase with reaction rims of alkali feldspar around plagioclase and an intergrowth of clinopyroxene and alkali feldspar around quartz). Peridotite enclaves (clinopyroxene in a groundmass of olivine) are scarce.

Groundmass plagioclase of the basalts is of labradorite composition, while andesine rimmed with anorthoclase and sanidine were analyzed in a tonalitic enclave (Fig. 2). Clinopyroxenes represent weakly zoned diopsides. Olivine phenocrysts show homogeneous Mg-rich cores (Fo<85) and thin envelopes

enriched in Fe (Fo>60). Occasionally there are phenocrysts of aluminous (magnesio)chromite rimmed by Ti-magnetite.

The scarcity of mantle–derived peridotite xenoliths, together with the presence of gabboric enclaves (comagmatic cumulates?) and tonalitic enclaves (crustal xenoliths) suggest that the basaltic magmas underwent some fractional crystallization and crustal contamination. Disequilibrium textures in some clinopyroxene phenocrysts suggest a polybaric fractionation.

GEOCHEMISTRY

In the TAS diagram all samples plot in the basalt field, close to the basanite and trachybasalt fields. Fresh samples (lavas and intrusions, LOI< 1%) are characterized by relatively low contents of MgO, Cr and Ni (8-9%, 170-250 ppm and 200-270 ppm, respectively). Scoria samples are strongly altered with LOI values up to 9 %. However, trace element patterns of the fresh and altered samples are very similar, even for such potentially mobile elements as Sr, K, Ba (Fig. 2). The normalized trace element patterns of the basalts indicate a strong enrichment in incompatible elements typical of alkaline intraplate lavas (Fig. 2). The overall geochemical variation of the volcanic products is relatively weak, but the highest contents of several incompatible trace element are observed in the scoria samples.

Consistently with the field and petrographic data, the rather low MgO, Cr and Ni contents suggest that the volcanic rocks do not represent primary magmas, but fractionated melts. Possibly, the earliest eruptive products of the volcano (scoria) represent the most evolved magma compositions. The amount of crustal assimilation may be rather small and hardly detectable in trace element patterns due to a strongly enriched composition of the lavas relative to possible crustal contaminants.

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