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CRYSTALLIZATION OF OSCILLATORY ZONED PLAGIOCLASES IN GRANODIORITE MAGMA (THE GĘSINIEC INTRUSIVE, STRZELIN CRYSTALLINE MASSIF, SW POLAND)

INTRODUCTION

The Gęsiniec Intrusive is situated in the northern part of the Strzelin Crystalline Massif (eastern part of Fore-Sudetic Block, SW Poland). It has few hundreds of meters in diameter, and is dominated by tonalites with subordinate granodiorite, quartz diorite and two-mica granite (Oberc-Dziedzic 1999). Granodiorite occurs as veins up to few meters crosscutting the tonalite. In this paper the examples of plagioclase oscillatory zonation in the Gęsiniec granodiorite are presented and interpreted.

Plagioclase grains from five thin sections representing four granodiorite samples from different parts of granodiorite dyke were analyzed. Only the grains being axial sections and exhibiting under optical microscope well defined internal structure were analyzed by electron microprobe (CAMECA SX100 at the Institute of Mineralogy, University of Hannover). Most of the traverses for An were located in direction of fast growing crystal face. Major and trace (Sr, Fe) element data were obtained following measuring conditions described by Ginibre et al. (2002). Detection limits were 150 and 190 ppm for Sr and FeO^{TOT} respectively.

PETROGRAPHY

Granodiorite consists of plagioclase, biotite, alkali feldspar and quartz and shows linear fabric defined by arrangement of plagioclase and biotite. Plagioclases vary in size and were divided in three groups: large (>1mm length of longer axis), medium (0,5-1mm) and small (0,5mm).

Plagioclase grains exhibit complex internal structures. They consist of:

CORES. Small, rounded cores containing 25-35 %An occur in majority of large plagioclase grains (Fig 1). Their Sr content ranges from 157 to 480 ppm and it is always positively correlated with An content, FeO^{TOT} is above 0,1 w.t. %, The cores are often patchy zoned or have resorbed surfaces. In this case they contain 36-38 % An.

INNER MANTLE. Zones richer in An (38-49%), Sr (323-656 ppm) and slightly impoverished in FeO^{TOT} (usually below 1000 ppm) surround cores. Their An content is approximately constant (38-46% An, depending on the grain). The saw tooth

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resorption (STR) oscillations occurs in large grains (wavelength of the oscillations is 30-50μm, with An amplitude up to 8%, Fig 1a).

OUTER MANTLE. The zone with An content decreasing gradually from 38-46% An to 25-30% outwards surround the inner mantle. They often contain alkali feldspar inclusions (Fig 1), strong outwards decrease in Sr content also occurs.

RESORPTION ZONES follow outer mantle in all grains. Three morphological types can be distinguished: (1) rounded, double resorbed (dominating in large grains, Fig 1a), (2) rounded, single resorbed (dominating in small grains) and (3) patchy (occuring in large and medium plagioclase grains, Fig 1b). An content increases outwards from 25-30% at the contact with the outer mantle to 33-52 % (depending on grain). Strontium and iron distribution is highly variable, generally it increases outwards. The resorption zones reach maximal thickness at crystal edges (Fig 1a), on the surfaces of resorption zones smaller grains of plagioclase are often accumulated.

RIMS of 50-100 μm in thickness and An content varying from 27 to 33 % occur on all grains.

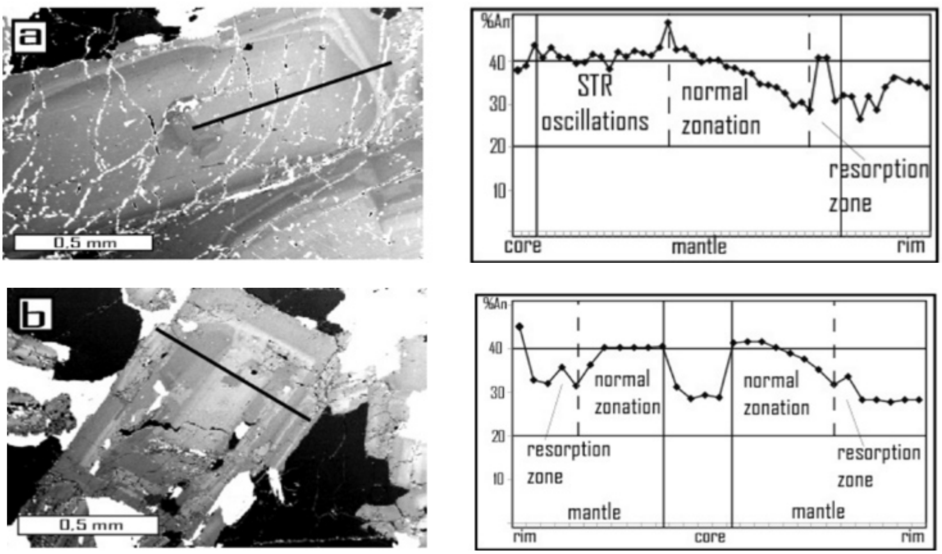

Fig. 1. Representative plagioclases from Gęsiniec granodiorite: BSE images and traverses.

CONCLUSIONS

Due to sluggish diffusion, major and trace element zonation in plagioclases provide valuable information on crystallization conditions in igneous rocks. If the equilibrium crystallization is assumed, apparent Sr content of melt can be ascertained (Blundy and Wood 1991).

Rounded shape of the cores and increase of An and Sr content at the contact between core and inner mantle indicate cores resorption in hotter and compositionally different magma. It was followed by crystallization in chemically undisturbed environment, as is suggested by constant An content in inner mantle. The occurrence of STR oscillations in inner mantles of the larger grains indicates repeated temperature shifts in surrounding magma. This is possible due to movement of these crystals in convection cells or due to multiply recharging of magma in the chamber (Ginibre et al. 2002). Small regular recharge events (6-12 depending on grain for Gęsiniec granodiorite, Fig 1) are of little probability, therefore the first alternative is preferred.

Conditions of crystallization changed as normally zoned outer mantle started to form. This suggests crystallization in a cooling environment. Strong decrease in An and Sr indicate rather fast, diffusion limited growth.

Resorption zones enriched in anorthite and Sr are probably the result of injection of hotter and richer in Sr magma into the magma chamber. Due to the injection, plagioclases were affected first by increase in temperature (rounded resorption zones - simple dissolution) and then by change in magma composition towards the more mafic one (patchy resorption zones - partial dissolution) as observed in experiments of Tsuchiyama (1995). Alternative scenario is equilibrium crystallization in magma richer in water (e.g. as a result of pressure decrease). However resorption zones recorded also fast disequilibrium growth (Fig 1) together with increase in Sr melt content up to the values typical for inner mantle crystallization. This excludes the latter scenario as only cause of resorption. Normally zoned rims crystallized during late stage in cooled granodiorite dyke.

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