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CHLORITE FROM HYDROTHERMALLY ALTERED STRZELIN AND BORÓW GRANITES (THE FORE-SUDETIC BLOCK): AN ATTEMPT OF CHLORITE GEOTHERMOMETRY APPLICATION

INTRODUCTION

Chlorite is a very common mineral, formed in granitoids during their hydrothermal alteration. Chlorite group displays a wide range of chemical composition, that can reflect physicochemical conditions in which the mineral was formed (Cathelineau, Neiva, 1985; Cathelineau, 1988). Chlorite geothermometry was criticised, even discredited by de Caritat et al. (1993) and Jiang et al. (1994). Nevertheless the application of chemical composition of chlorite as a geothermometer was not abandoned (Xie et al. 1997; Krzemiński 2000).

The purpose of this report is to present the characteristics of chlorite formed during hydrothermal alteration of granitoids, as evidenced by chlorite from Strzelin and Borów granites (the Fore-Sudetic Block, SW Poland), and to apply its chemical composition as a geothermometer. These two localities were chosen because of different effect of alteration of the host rock – gradational (unaltered → slightly → medium → highly altered), as in the Strzelin granite and complex (highly altered), as in the Borów granite. Hydrothermally altered the Strzelin and Borów granites were described by August (1994), and Ciesielczuk (2000).

Stępisiewicz (1977) estimated the temperature of the chlorite formation in hydrothermal veins in the Strzelin granite generally from two hundred and tens to hundred and tens degrees Celsius. According to Janeczek (1985) the temperature of chlorite formation in the Strzegom - Sobótka massif ranges from 400 – 230^{o}C.

CHARACTERISTICS OF CHLORITE

Chlorite in investigated granites occurs in post-biotite and spherulitic forms. The localisation of particular grains of chlorite within the granite results from its origin. The post-biotite chlorite, formed as a result of partial or entire replacement of biotite, occupies biotite positions and is acknowledged to be a mineral that originated due to hydrothermal alteration. Spherulitic chlorite could crystallise in two possible ways:
1 – crystallisation from a hydrothermal fluid in fractures, microfractures or intergranular spaces in granite and, 2 – replacement of post-biotite chlorite.

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According to Janeczek (1985) post-biotite chlorite was dissolved and aggregates of spherulitic chlorite recrystallised in the presence of bulk of crystal nuclei.

The size of post-biotite chlorite ranges from 0.1 to 1.5 mm. Spherulitic chlorite forms smaller (0.05 mm), radiant crystals. Both types of chlorite have optically pale green to yellowish pleochroism and display subnormal, greyish-blue interference colours.

The post-biotite chlorite occurs most frequently in slightly altered granites. It is also present in apparently unaltered granites and hardly ever in highly altered ones. Spherulitic chlorite is frequent in medium and highly altered granites, except bleached zones, which surround hydrothermal veins of the Strzelin granite. It is also abundant in hydrothermal veins.

Chemical composition of chlorite was examined on 36 grains. The content of magnesium in chlorites formed in the Borów granite is lower than the one from the Strzelin granite. This fact can be related to lower concentration of magnesium in the host rock. The ratio Fe/(Fe + Mg) in the all investigated grains of chlorite is slightly differentiated and rather high, and ranges from 0.62 to 0.83 for the Strzelin granite and from 0.80 to 0.84 for the Borów granite. The content of aluminium in tetrahedral site $^{IV}Al/Si + ^{IV}Al$ ranges from 0.22 to 0.38 for the Strzelin granite and from 0.27 to 0.34 for the Borów granite (Ciesielczuk 2000).

In the attempt of the application of the chemical composition of chlorites to establish the temperature of their formation two methods were used: according to Cathelineau (1988) and Kranidiotis, MacLean (1987). Chlorite (for an average chemical composition) in the Strzelin granite formed in temperature: 358^{o}C (Cathelineau, 1988) or 208^{o}C (Kranidiotis, MacLean, 1987). Chlorite (for an average chemical composition) in the Borów granite formed in temperatures 343^{o}C or 212^{o}C respectively.

CONCLUSIONS

It follows from the above that the temperature of chlorite formation in the Strzelin granite was underestimated by Stępisiewicz (1977). Only the upper temperature range – two hundred and ten degrees - and higher is possible, likewise in the Borów granite. It confirms the temperature range of chlorite formation as an effect of low-grade metamorphism.

Chemical composition of all investigated chlorites of hydrothermal origin formed either in the Borów and Strzelin granites is convergent. The chemical composition of the chlorite from the Strzelin granite differs a little, but no trend is observed even in gradual effect of alteration. It means that neither degree of alteration of rock nor distance from the vein, nor shape of chlorite, nor kind of process of chlorite formation influenced the differentiation of chemical composition of chlorite, suggested by other authors.

Why is there no convergence then? There are many possible answers:

– temperature is not the main factor influencing chemical composition of chlorite formed in granitoids during the hydrothermal stage,
– the factors determining chemical composition of chlorite were following:

(1) chemical composition of the host rock and (2) fluid parameters such as: oxygen fugacity (facilitating the Fe^{2+}-chlorite formation), activity of Mg^{2+} ions, sulphur concentration, pH or ionic concentration,

– for all that, formation temperature of all chlorites was identical,
– insignificant differentiation in chemical composition of chlorites formed in different sites in granitoid is most likely caused by chemical composition of the host rock or the result of using different analytical methods,
– chemical composition of hydrothermal fluid forced undifferentiated chemical composition of chlorites,
– analyses of chlorites were not correctly performed,
– chlorite geothermometer does not work during hydrothermal stage of granitoid formation,
– chlorite geothermometer does not work during hydrothermal stage of the Strzelin and Borów granites formation.

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