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CRUSH EVENTS IN GRANITOID PEGMATITES AS RECORDED BY QUARTZ CRYSTALS

INTRODUCTION

The post-emplacement history of granitoid massifs includes many tectonic episodes. Some of them are caused by the out-of-the-massif reasons, other are entirely connected with cooling of the massif and mechanic tensions caused by decreasing temperature of the granitoid body. Part of the events caused by the batholith cooling result in the joints of the rocks and in fissures filled by mineral veins. However, the most distinct consequences of the tectonic movements of various intensity are observable in pegmatites, in which mineral crystals are crushed, and healed and regenerated many times. Quartz is an especially good mineral to decipher the number and sequence of the crush events because its crystallisation ranges from the beginning of the pegmatite formation to the end of this process and its crystals are commonly zoned due to many morphological varieties which may origin during the pegmatite formation. The common sequence of the varieties starts from the gray one which sometimes crystallised as the high-temperature quartz, next morion and smoky quartz of various tints, rock crystal and amethyst. Good transparency of the quartz varieties makes possible to investigate fluid (and solid) inclusions in all the growth zones and in the healed fractures. Zoned quartz crystals that consist of all the varieties of this mineral that occur in an investigated pegmatite are especially valuable for the studies.

SAMPLES AND METHODS

The samples for the present study came from pegmatites of two granitoid batholiths in Lower Silesia, SW Poland: the Strzegom and Karkonosze massifs. The sampled 31 pegmatites from the Strzegom massif occurred at Grabina, Zimnik, Czernica, Rogoźnica and Graniczna; the 27 pegmatites from the Karkonosze massif were found at Szklarska Poręba, Michałowice, Czarne, Staniszków, Marczyce and Karpniki. The selected 73 quartz crystals were investigated from the Strzegom pegmatites and 57 from the Karkonosze ones. The quartz crystals from 1 cm to 23 cm in length were thoroughly observed to distinguish their zoning, regeneration and fissure healing peculiarities, photographed and/or carefully drawn. Fluid inclusions were studied in double-side polished preparations by the heating-

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freezing methods in the microscope Fluid Co. gas-flow stage, as described in details elsewhere (Roedder 1984). For this study 930 inclusions were investigated.

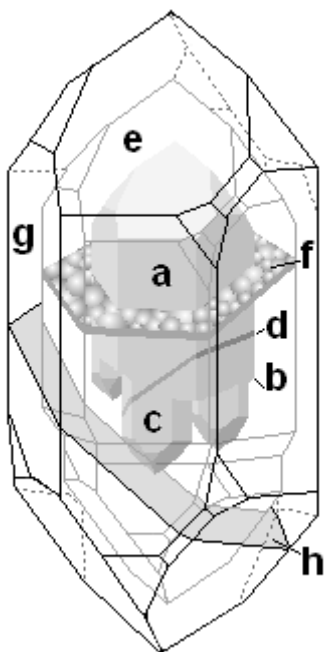


Fig. 1. Euhedral quartz crystal from the pegmatite at Michałowice, Karkonosze massif, crushed, regenerated and healed many times; **a** – gray quartz with primary fluid inclusions (homogenisation temperatures Th 420–380°C), **b** – surface of the crystal breaking, **c** – regeneration of the broken end of the crystal *a* (Th 380–355°C), **d** – healed fissure in the crystals *a* and *c* (Th 350°C), **e** – smoky quartz zone of almost sceptre habit (Th 330–265°C), **f** – healed fissure cutting the crystal zones *a* and *e* (Th 247°C), **g** – rock crystal zone forming the perfect quartz habit (Th 233–137°C), **h** – healed fissure cutting the growth zones *e* and *g* (Th 127°C; other three such fissures in the same crystal yielded Th of fluid inclusions 123°C, 115°C and 109°C).

RESULTS

The features of the mineral fillings of the pegmatites from the Karkonosze and Strzegom massifs, although generally similar, have distinct differences (Figs. 1 and 2). The earliest generation of quartz is gray and it formed before the main episode of crushing; homogenisation temperatures (Th) of fluid inclusions in this quartz ranges from 420 to 330°C. This quartz always is broken into pieces, chipped out of the wall rock and fractured; the fractures or fissures from this quartz frequently continue in the wall rock. Probably this crush episode was caused by thermic contraction of the parent rock, which resulted also in origin of the joint fractures. Most of these damages was healed or regenerated by gray quartz (Th <380°C). In the Strzegom pegmatites the main crush episode was followed by a series of minor crystal breaking events resulting in formation of the quartz pieces which frequently were regenerated to euhedral crystals of unusual and odd habits (Kozłowski 1994). Essentially each pegmatite has its own sequence of the crush events.

The Karkonosze pegmatites bear quartz crystals, which after the main crushing episode recorded four distinct crush events. Th of fluid inclusions in quartz healing the then formed fissures in quartz crystals had the following values: 350–330°C (**d** in Fig. 1), 270–250°C (**f** in Fig. 1), 210–180 °C (Fig. 2) and 130–105°C (**h** in Fig. 1). Other Th in healed fissures occur rarely, which are developed in limited ranges. Moreover, the sequence of the quartz varieties crystallisation is probably bound to distinct temperature ranges in all the studied pegmatites (Fig. 2), whereas in the Strzegom pegmatites the Th in quartz varieties are rather variable.

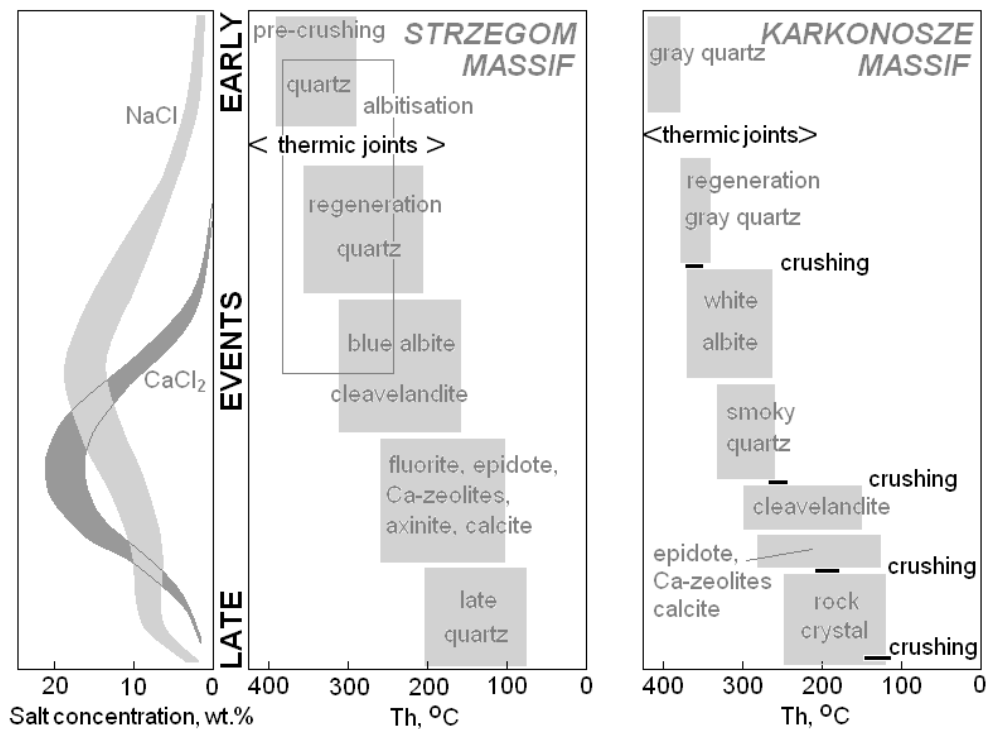


Fig. 2. Sequence of the pegmatite mineral crystallisation, crush events and changes of concentrations of the main salts dissolved in mineral-forming solutions. Potassium feldspar and mica formation not shown here.

Fracturing always opened paths for solution migration and caused changes of the solution composition e.g. due to albitisation (Fig. 2). Note, that albitisation in the Karkonosze pegmatites had not so distinctly limited Th ranges as in the Strzegom pegmatites, thus it is not marked in the summarizing plot (Fig. 2). Changes of the salt concentrations in solutions may be connected with the use of water to crystallisation of hydrous phases and formation of the Na- and Ca-bearing minerals.

The study was financed by the grant of the Faculty of Geology of the Warsaw University No. BW1567/18.

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