Quartz replacement by sepiolite at the Věžná I pegmatite, Czech Republic; An initial stage of a complex desilicification process

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ABSTRACT

Quartz replacement by sepiolite was observed at a graphic unit of the desilicated pegmatite Věžná I hosted in serpentinite. Sepiolite is an interaction product of quartz and Mg-rich fluids originating from host rock and this process is also associated with albitization of oligoclase producing also small domains of K- feldspar locally Ba-rich K-feldspar, pectolite, celadonite and titanite. Sepiolite pseudomorphs together with enclosed quartz relics were later only locally completely removed as a consequence of weathering, which produced empty cavities in graphic unit.

Keywords: *quartz, sepiolite, replacement, desilicification, pegmatite, serpentinite, Věžná.*

INTRODUCTION

Desilicification is a common feature in many pegmatite bodies cutting serpentinite. It usually does not mean a complete quartz removal, although such examples also exist (e.g., lepidolite pegmatite at Radkovice, Czech Republic). Quartz core, if evolved, usually remains intact and only smaller grains are susceptible for replacement. This feature most commonly occurs in outermost pegmatite units, e.g., in graphic zone of pegmatite bodies. These outer portions are more sensitive to tectonic stress leading to origin of open cracks – fluid pathways and close to outcoming fluids.

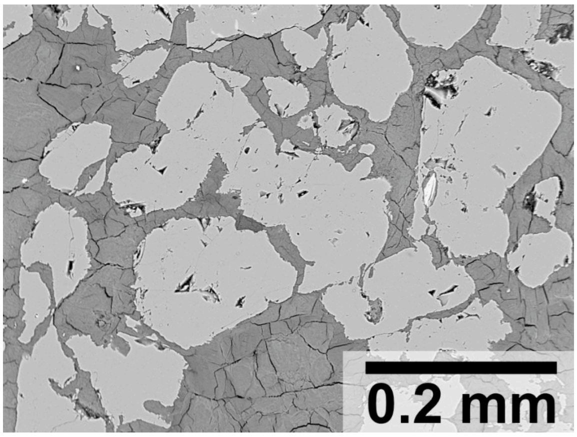

FIGURE 1. BSE image of sepiolite (dark) replacing relics of quartz.

Desilicification is generally thought to be a result of simple quartz dissolution by fluids. We hereby present an example of polystage desilicification from the pegmatite Věžná I. The pegmatite forms a NW-striking dike, steeply dipping, about 4 m thick and up to 130 m long, cutting serpentinite (Strážek Moldanubicum). The dike exhibits almost symmetrical zoning consisting of: a narrow, medium- to coarse-grained granitic wall unit; a dominant intermediate unit of graphic quartz + K-feldspar and/or oligoclase; an intermediate unit (core-margin) of blocky K-feldspar + subordinate albite, which surrounds isolated central pods of a quartz core. Beryllian cordierite, beryl, schorl to dravite, biotite, muscovite, niobian rutile, monazite-(Ce), xenotime-(Y) and zircon occur in minor to accessory quantities. A small pod consisting of pollucite-analcime associated with lepidolite, elbaite and zeolites was also found. Cordierite and beryl exhibit high degree of hydrothermal alteration producing celadonite, milarite, bavenite, epidydimite, eudydimite and bertrandite (Černý 1968, Novák et al. 2003). Highly weathered reaction rim between pegmatite and serpentinite, up to 10 cm thick, consists of anthophyllite, tremolite, phlogopite, vermiculite, chlorite, and fluorapatite.

RESULTS

Fresh graphic zone consists of quartz intergrowing with homogeneous oligoclase (An_{13-14},Or_3) or orthoclase (see also Černý et al. 1984). Diameter of the individual "letters" commonly does not exceed 5 mm. Quartz replacement by sepiolite proceeded along fractures in quartz, which is either completely replaced or surrounded by sepiolite mass in relics (Fig. 1). Sepiolite crystallized almost exclusively in the expense of quartz, it was only exceptionally observed as small veinlets cutting feldspar among several former quartz "letters". Albitization of oligoclase is closely spatially related to the feldspar-sepiolite boundary (Fig. 2) but albitization is not developed at the contact with K-feldspar. Newly-formed albite (Ab_{100}) is accompanied by small domains of K- feldspar (Or_{100}). Alteration also produced pectolite, rare inclusions of Ba-rich K-feldspar (up to 11 mol. % celsiane), and celadonite, titanite and K-feldspar in sepiolite.

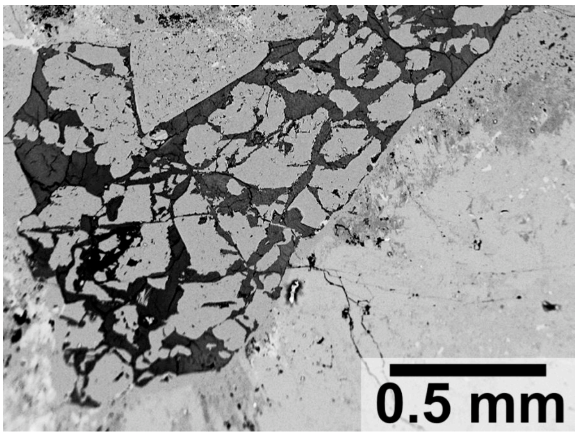

FIGURE 2. BSE image of sepiolite (dark) replacing quartz "letter" rimmed by albitized oligoclase locally with alteration products of K,Ba-feldspars (light).

Removement of weathered sepiolite or other clay mineral (smectite?) and formation of open space in graphic unit represents the final stage of the desilicification process.

DISCUSSION

Formation of sepiolite after quartz has not been described disregarding replacement of quartz by *kerolite* from the Věžná pegmatite II (Černý 1968). Hence also experimental works concerning this problem are scarce. Abtahi (1985) synthesized sepiolite from $MgCl_2$ solution and SiO_2 under room temperature. This model of sepiolite genesis seems to be suitable for our example because of elevated Cl contents (up to 1300 ppm Cl) found in sepiolite from Věžná being well above the electron microprobe detection limit. However, the room temperature conditions used by Abtahi (1985) to synthesize sepiolite are unlikely because of relatively widespread albitization of oligoclase and formation of exsolutions of K-feldspar locally Ba-rich. The presence of Ba-rich K-feldspar originated during albitization suggests that this process is likely related to host ultrabasic rock and it may have occurred simultaneously with the sepiolite formation. Notably, harmotome associated with late pollucite, lepidolite and chabasite-(K) was found at Věžná I pegmatite as well (Teertstra et al. 1995)

Host serpentinite cropping out in nearby quarry is often hydrothermaly altered. Alteration products are commonly represented by lizardite. Both lizardite and sepiolite minerals might be result of single hydrothermal event producing both lizardite ($Mg_3Si_2O_5(OH)_4$) in places with lower amount of accessible Si (fissures in serpentinite) and sepiolite ($Mg_4Si_6O_{15}(OH)_2.6H_2O$) in pegmatite with higher activity of Si.

The desilicification process is evidently enhanced by tectonic deformation resulting in netlike fractures within some individual quartz “letters”. Feldspars are fractured only slightly or not at all, which is probably caused by their different rheological behavior and/or partial healing during albitization.

The way of sepiolite breakdown forming empty perimorphs after quartz is not clear, but there are several options. According to Komarneni (1989) it is possible to transform sepiolite into smectite by its interaction with Mg-rich fluids and suitable source of Na and Al (feldspars) under low temperature hydrothermal conditions. Then, smectite would be more susceptible to be washed out. Golden et al. (1985) observed, that sepiolite is unstable in soil environment and it may transform to smectite. Sepiolite could have been also removed by younger hydrothermal activity. Direct dissolution of sepiolite under atmospheric conditions seems to be improbable due to its low dissolution rates (Stoessel 1988, Birsoy 2002). However, mechanical weathering of clay mineral (either sepiolite or smectite) by surface water seems the most possible.

CONCLUSIONS

The overall mineral assemblage replacing quartz, involves sepiolite, albite, oligoclase and exsolved K,Ba-feldspars. It is a result of complex process, which could be divided into these stages.

1) Local tectonic fragmentation of the graphic unit close to the contact with host serpentinite.

2) Communication with host rock, through open cracks working as pathways, for fluids rich in Mg and perhaps Cl necessary for forming of sepiolite.

3) Newly formed sepiolite has been removed as a consequence of its potential transformation to smectite during later hydrothermal activity or more likely weathering.

The study revealed that desilicification including formation of open space in granitic pegmatite is a polystage process with the probable sequence: quartz – sepiolite – smectite (?) – open space. Consequently, we have to consider desilicification as a more complex process then simple quartz dissolution. Such process may occur not only in granitic pegmatites but also in e.g., episyenites. Consequently, we have to take into account that conditions of direct quartz dissolution and polystage removal of quartz might proceed at very different conditions.

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