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Alteration of granitoids and crystalline rocks and uranium mineralisation in the Bor pluton area, Bohemian Massif, Czech Republic

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ABSTRACT

The Bor pluton belongs to the Variscan granitoid plutons of the Moldanubian zone of the central European Variscides. Along with similar granitoid plutons of the western part of the Bohemian Massif (Leuchtenberg, Babylon, Fichtelgebirge), it is close in its composition to low-F biotite granites of the Saxothuringian zone. This paper investigates the hydrothermal alteration of the Bor pluton in relation to uranium mineralisation. Uranium mineralisation of the Bor pluton is associated with shear zones occurring on the western margin of the pluton on its boundary with high-grade metasediments of the Moldanubian zone (Zadní Chodov) and with metasomatic mineralisation evolved in hydrothermally altered biotite granites of the Bor pluton (Vítkov II, Lhota). Uranium mineralisation in altered granites is accompanied by their intense hematitisation, albitisation, chloritisation and carbonatisation. Hydrothermal alterations of granites were accompanied by the enrichment in U, Na, P, Ti, Mg, Ca and depletion in Si and K. The altered high-grade metasediments occurring in shear-zones on the western boundary of the Bor pluton are enriched in U, Ca, Mg and P and carbonaceous matter. In the Bor pluton area with typical coffinite–uraninite association the presence of brannerite is significant for uranium mineralisation. The observed coffinite is enriched in Y (up to 4.3 wt.% Y_2O_3) and Zr (up to 2.0 wt.% ZrO_2). Unaltered brannerite displays low Ca (0.9–4.5 wt.% CaO), Al (0.0–0.5 wt.% Al_2O_3), Fe (0.7–2.2 wt.% FeO), Pb (0.0–1.4 wt.% PbO) and Th (0.0–2.8 wt.% ThO_2) concentrations. The highly altered brannerite is depleted in U, enriched in Ti, Si and Al. The temperature of the ore stage was estimated using chlorite thermometry and ranged from 122 °C to 258 °C.
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1. Introduction

The Bohemian Massif is part of the European Variscan belt, which hosts a significant quantity of uranium deposits bound on brittle shear zones developed in high-grade metamorphic rocks and/or in granitic rocks (Dill, 1983; Kříbek et al., 2009; René, 2015). These deposits may represent the basement-rock-hosted part of unconformity-type deposits, the overlying sedimentary cover being almost entirely eroded during later geological periods. According to Dahlkamp (1993), these deposits are classified as subunconformity epimetamorphic deposits (e.g., the Beaverlodge district and Fay-Verna deposits in Canada). In the Bohemian Massif, this group of uranium deposits is represented by the Rožná and Okrouhlá Radouň ore deposits in metamorphic rocks series of the Moldanubian zone (Kříbek et al., 2009; René, 2015) and by the Zadní Chodov, Vítkov II, and Lhota ore deposits in area of the Bor pluton. These subunconformity epimetamorphic deposits consist of pen concordant lenses of highly disseminated uranium mineralisation evolved in fractures and/or brecciaed shear zones. The crystalline host rocks (metasediments, granites) of these deposits are strongly altered, exhibiting extensive albitisation, chloritisation, argilitisation and hematitisation. These low-temperature metasomatic rocks are named as aceites according to the recent IUGS classification (Fettes and Desmons, 2007). According to their mineral compositions, the aceites are very similar to episyenites evolved in disseminated uranium deposits of the Massif Central and Armorican Massif in France, which are linked with leucogranite plutons (e.g., Cathelineau, 1986).

The Bor pluton is one of the Variscan plutons in western part of the Bohemian Massif known for its industrially significant uranium mineralisation. The uranium ore deposits evolved in the area of the Bor pluton offer a unique possibility for complex study of evolution of hydrothermal alterations accompanying uranium mineralisation with some focus on behaviour of titanium during alteration of granitic rocks and high-grade metamorphic rock series. The uranium ore deposits hosted in shear zones are evolved in altered granitic rocks (Lhota, Vítkov II) and in surrounding high-grade metamorphic rocks (Dyleň, Zadní Chodov, Wäldel/Mähring) (Dill, 1985; Kříbek et al., 2009). In comparison with other shear zones hosting uranium mineralisation in Bohemian Massif (Rožná, Okrouhlá Radouň) where coffinite and uraninite predominate, in the uranium mineralisation evolved in the Bor pluton and surrounding high-grade metamorphic rocks brannerite is another significant uranium ore mineral. The

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objectives of the presented paper is to present a detailed petrology, geochemistry and mineralogy of the hydrothermally altered rocks of the Bor pluton and associated high-grade metasediments connected with uranium mineralisation.

2. Geologic setting

The Bor pluton consists of a N-S elongated body formed previously by biotite granites. It is emplaced in the shear zone, which is a part of

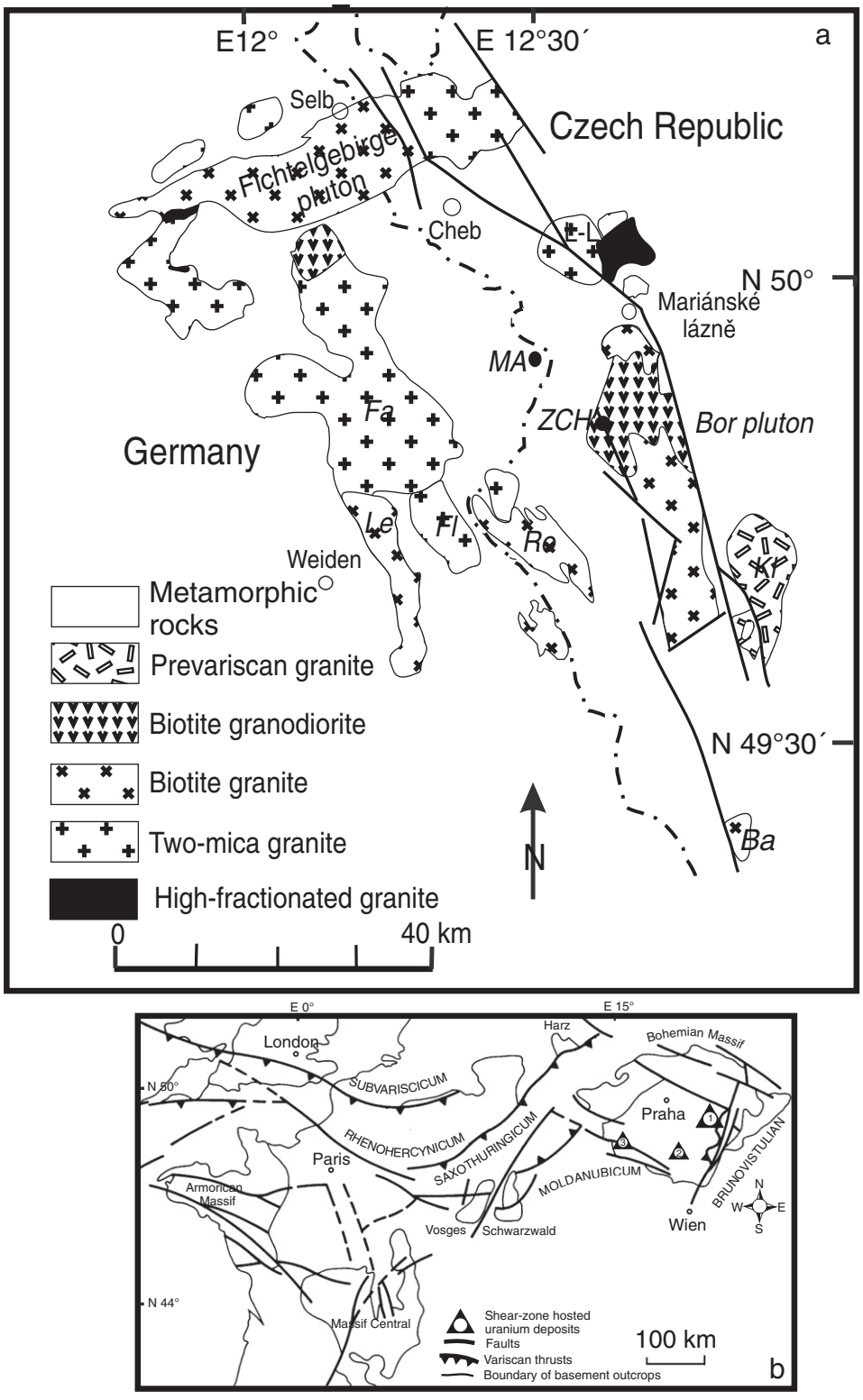

Fig. 1. a Geological map of the granitoids in the western part of the Bohemian Massif ZCH – Zadní Chodov uranium deposits, MA – Mähring/Wäldel uranium deposit, Ba – Babylon pluton, Fa – Falkenberg pluton, Fl – Flossenbürg pluton, Kl – Kladruby pluton, L-L Mariánské Lázně granite pluton, Le – Leuchtenberg pluton, Ro – Rozvadov pluton (after Breiter and Sokol, 1997; Siebel et al., 1997, modified by author). b Sketch map of the Variscan belts of western and central Europe with three shear-hosted uranium deposits in the Bohemian Massif (1 – Rožná, 2 – Okrouhlá Radouň, 3 – Zadní Chodov) (after Kříbek et al., 2009, modified by author).

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