Brucite deposits from the Apuseni Mts. (Romania)

CORINA IONESCU[1] and VOLKER HOECK[2]

[1]Babes-Bolyai University, 1 Kogalniceanu str., RO-40084 Cluj-Napoca, Romania
corinai@bioge.ubbcluj.ro
[2]Salzburg University, 34 Hellbrunner str., A-5020 Salzburg, Austria
volker.hoeck@sbg.ac.at

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Abstract

In the Apuseni Mts. (NW Romania) various hornfelses, skarns, and hydrated metasomatic rocks were formed at the contact between Mesozoic sedimentary rocks and two large Late Cretaceous-Early Paleogene granodioritic intrusives. Large brucite-bearing zones occur in the Anisian calcitic-dolomitic marbles forming two main deposits: Budureasa in the north and Pietroasa in the south. The irregular, sometimes lens-shaped brucite-bearing zones range from several metres up to tens of metres in width and from tens to hundreds of metres in length.

Brucite occurs as small thin lamellas. Well-developed larger lamellas are rare. Brucite lamellae group in clusters of various shapes. Three types of clusters could be identified: (1) small, isometric clusters, rarely containing relics of periclase; (2) large, irregular-shaped clusters, often containing carbonate relics; (3) oval-shaped clusters with brucite associated with forsterite relics and serpentine minerals.

The bulk chemical analyses of the brucite-bearing dolomitic limestones point to an inhomogeneous brucite distribution inside both deposits with either brucite-rich (up to 40 %) or brucite-poor domains (less than 5 % brucite).

The studies carried out on the brucite deposits reveal a model of heating and cooling sequences under conditions of very low X_{CO2} during the contact metamorphism. The stratigraphic column of sediments covering the granodiorites at the time of the intrusion range from 2.5 to 4 km, pointing to approximately 0.1 GPa pressure for the contact metamorphism. At this pressure, the upper temperature limit of brucite is 600–610 °C, according to the reaction br = per + H_2O. Lower temperatures, at 400 °C, can be estimated from the decomposition of forsterite according to reaction 20br + atg = 34fo + 51H_2O. The direct decomposition of dolomite according to the reaction dol + H_2O = br + cc + CO_2 could take place over a wide range of temperatures.

Key words: Apuseni Mts., granodiorites, contact aureola, brucite deposits, phase diagrams

Introduction

Brucite $Mg(OH)_2$ represents an industrial mineral with multiple fields of use. It is a high-refractory raw material used for bricks and furnaces as well as a major source for metallic Mg or for Mg used in medicine. As flame retardant, brucite is largely used as mineral filler, for different cables or rubber products. One of main qualities of brucite is represented by its high capacity of sorption of heavy metal ions, so it can be used for the water purifying, for the selective extraction of heavy metal ions, and for the neutralization of acid waste waters.

Geological setting

In the northern part of the Apuseni Mts. (NW Romania) the Late Cretaceous to Early Paleogene intrusions into the surrounding dolomites, limestones and other sediments of Mesozoic and rarely Paleozoic age, generated extended and complex contact aureoles. They comprise skarns, hydrated metasomatic rocks and hornfels respectively (Ionescu and Balaban, 1998). Among them, large brucite-bearing zones occur in the Anisian dolomitic marbles, forming two main deposits: Budureasa in the north and Pietroasa, in the south.

Between 1982 and 1990 the brucite deposits from Budureasa and Pietroasa were investigated by surface pits, drillings and underground galleries and the brucite-bearing zones were sampled at 1 m spacing, resulting in an enormous wealth of analytical, mainly chemical data (Ionescu, 1999).

A schematic and idealized view of the contact of granodiorites with the Anisian dolomites shows a zoned structure (Fig. 1), i. e. a transition from Mg-skarns into brucite-bearing zones and finally to dolomites.

(i) Granodiorites are holocrystalline hypidiomorphic, sometimes with porphyric appearance.

(ii) Mg-skarns comprise periclase, forsterite, pyroxenes, garnets, vesuvianite, as well as clinohumite, tremolite, phlogopite, talc, chlorite, epidote-zoisite, apatite, serpentine

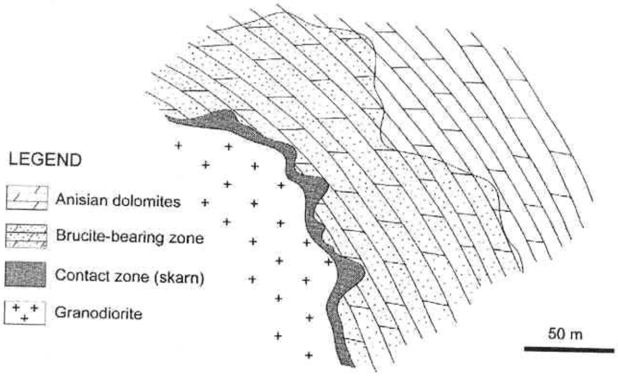

Fig. 1. Idealized sketch through the contact between granodiorites and Anisian dolomites.

minerals, quartz a.o. The skarn thickness around the granodioritic bodies is relatively small, ranging from 0.5 up to 5–7 m.

(iii) Brucite-bearing zones occur only at some distances from the contact. The irregular, sometimes lens-shaped brucite-bearing zones range from several metres up to tens of metres in width and from tens to hundreds of metres in length. The average thickness of the brucite-bearing zones is about 50 to 100 m.

The average content of brucite is 10.5 % in the Budureasa deposit and 7.6 % in the Pietroasa deposit respectively. The bulk chemical analyses of the brucite-bearing dolomitic limestones point to an inhomogeneous brucite distribution inside both deposits with either brucite-rich (up to 40 %) or brucite-poor domains (less than 5 % brucite).

(iv) Outside brucite-bearing zones, only almost pure Anisian recrystallized dolomite occurs, without or with very low Si and Al content occur.

Brucite mineralogy

The mineralogical features of brucite were investigated by polarized light microscopy, scanning electron microscopy, XRD and microprobe.

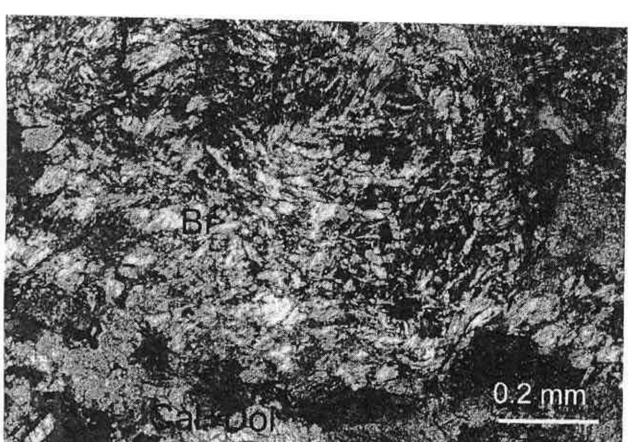

Fig. 2. Cluster with brucite (Br) lamellae in a carbonate (Cal + Dol) matrix N+.

The Si-poor Anisian dolomites transformed directly upon heating into periclase-bearing and brucite-bearing dolomitic limestones respectively. Other minerals such as forsterite, antigorite and chlorite occur only rarely together with brucite.

Brucite forms small lamellae of 20 x 20 x 2 μm up to 80 x 50 x 6 μm (Fig. 2). Large lamellae, over 1 mm in length were only exceptionally found.

Brucite lamellae group in clusters of various shapes and sizes (50 μm to 1.3 mm in average). The fillings of small veinlets or isolated crystals are rare.

Three main types of brucite clusters could be identified:

a. Small, isometric clusters, about 50 μm in diameter, rarely containing relics of periclase.

b. Large, irregular or rhombohedral-shaped clusters, often containing carbonate relics; the diameter of these clusters range from 0.5 up to 1.6 even 1.8 mm sometimes.

c. Oval-shaped clusters, about 0.1 x 0.3 mm in average, with brucite associated with forsterite relics and serpentine minerals.

Microprobe investigations reveal 86.05–86.51 % MgO in brucite, as well as the presence of the same mixture of calcite + dolomite grains inside the brucite cluster as in the surrounding carbonate mass.

The XRD performed on the whole brucite-bearing dolomitic limestone proved the presence of brucite, calcite and dolomite. Calculated values of elementary cell are close to those reported in the literature for pure minerals.

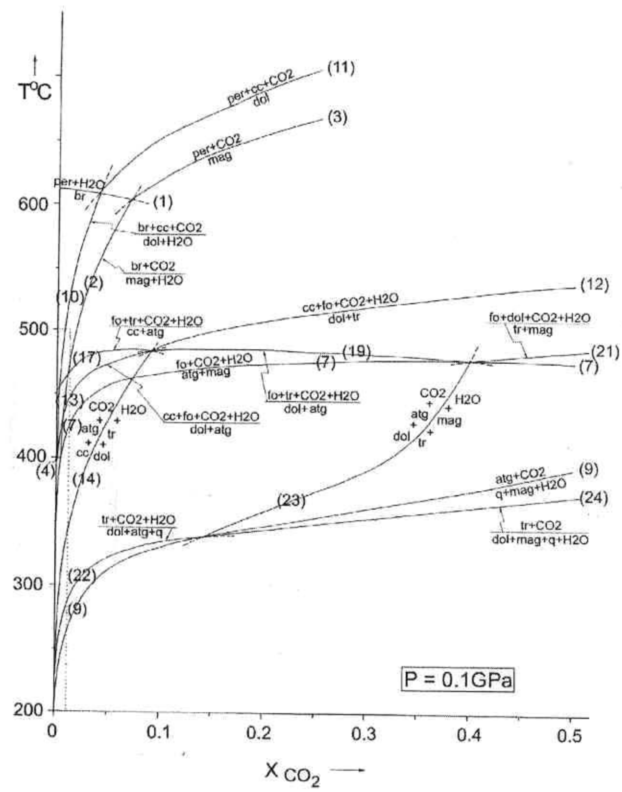

Fig. 3. A phase diagram for brucite calculated with Thermocalc (Powell and Holland, 2001).

Petrogenesis of the Brucite-bearing rocks

It can be concluded, from mineralogical and field observations that brucite formed:

- by a prograde reaction, which generated periclase: dol → per + cc + CO_2 followed by a retrograde reaction, which generated brucite: per + H_2O → br
- directly from dolomite by decomposition: dol + H_2O → br + cc + CO_2 or
- quite rare, by decomposition of forsterite: fo + H_2O → br + atg

Phase diagrams. The brucite-bearing assemblages can be described in the CaO-MgO-SiO_2–H_2O-CO_2 system (Fig. 3), with the minerals: calcite-dolomite-periclase--brucite-forsterite-antigorite-(magnesite-tremolite and quartz; Ionescu and Hoeck, 2004).

Among the several possible reactions (calculated with Thermocalc by Powell and Holland, 2001) the most important for brucite genesis are the followings:

(1) per + H_2O = br
(4) 34fo + 51H_2O = 20br + atg
(10) dol + H2O = br + cc + CO_2
(11) dol = per + cc + CO_2

The stability fields for the main dolomite bearing assemblages in Budureasa and Pietroasa brucite deposits show that:

- The stability field of brucite is restricted to the very low X_{CO2} (< 0.05) in a wide range of temperatures, up to 610 °C;
- Brucite can form also in the original field of dolomite, at very low X_{CO2} or at the conditions of external influx of H_2O-rich fluids (from the granodiorite);
- At even lower X_{CO2}, brucite forms from forsterite.

Conclusions

• The studies carried out on the brucite deposits reveal a model of heating and cooling sequences under conditions of very low X_{CO2} during contact metamorphism of the Anisian dolomites caused by the Late Cretaceous-Early Paleogene (hydrous) granodiorites.

• The pressure estimates for the heating and cooling paths can be based on field relations: the stratigraphic column of sediments covering the granodiorites at the time of the intrusion ranges from 2.5 to 4 km, pointing to approximately 0.1 GPa pressure for the contact metamorphism.

• At 0.1 GPa pressure, the upper temperature stability limit of brucite is near 600–610 °C, according to reaction (1) br = per + H_2O.

• Lower temperatures, close to 400 °C, can be estimated from the decomposition of forsterite according to reaction (4) 20br + atg = 34fo + 51H_2O.

• The direct decomposition of dolomite according to the reaction (10) dol + H_2O = br + cc + CO_2 can take place over a wide range of temperatures.

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