BRUCITE MARBLES OF DEVGAD BARIA AREA, PANCHMAHALS DISTRICT, GUJARAT

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Abstract

Geological investigations of the area around Devgad Baria have revealed the occurrence of brucite marbles in proximity to the graphite bands in the Banded Gneissic Complex. The detailed field and petrographic studies have shown that brucite is developed from the dolomite in a single reaction during the contact metamorphism and the associated graphite is a result of this reaction formed from the expelled carbon.

Introduction

In the course of detailed geological investigations of the area around Devgad Baria (22° 42′ : 73° 54′ 30″) brucite marbles have been encountered in the Banded Gneissic Complex. The purview of literature on the area indicates that there is no detailed account of the brucite marbles except for the passing reference made by Sahu and Mungee[1]. The detailed geological studies on the then Baria State by Rama Rao[2] did not record the brucite marbles.

The various rock types of the Banded Gneissic Complex include biotite-schists and -gneisses, arkoses, calc-silicate rocks, marbles, graphite-schists and -gneisses and amphibolites striking east-west in general with local variations to WNW-ENE and dip towards north at angles ranging from 40° to 70°. They are banded intricately and the bands show variation in thickness, colour and mineral assemblage, and are intruded by granitic veins.

The marbles crop out as disconnected lenses at many places, but the brucite marbles are found in the vicinity of graphite bands near Sewania (22° 35′ : 73° 59′) and to the north of Nadatod (22° 36′ : 73° 57′) villages. They exhibit different colours in shades of green, greyish blue and white and show gradual variation through calc-silicate rocks to the arkoses.

Petrography

The *brucite marbles* are coarsely crystalline containing dull yellowish white crystals of brucite amidst the pale grey to bluish grey crystals of dolomite and calcite. They have a specific gravity of 2·63. Small flakes of mica showing yellowish brown colour are also common in the rocks. A rude banding of the rocks seems to have been disturbed by the formation of brucite.

In thin section, the rocks show granoblastic texture and comprise brucite, calcite, dolomite, phlogopite, clinochlore, graphite, diopside and wollastonite. Modally brucite forms 36% of the rock, calcite and dolomite combined together ranges upto 57% and the rest is in accessory amounts.

Brucite which has been confirmed by staining tests (Heinrich, p. 13)[3], is colourless, rounded in form and is fibrous with roughly concentric onion-like (whorls) shells. The layers are made up of tiny concave scales of fibrous nature. The fibres lie at right angles to the scale surfaces and so radial to the layers. Some are, however, at an angle of 45° to this direction. In a few cases, the fibres in adjacent scales are inclined in opposite directions, giving a herringbone pattern. There is no relict periclase inside brucite, but some calcite grains are enclosed in the mineral. Thin veins of calcite cut across the brucite and the enclosed calcite and a few graphite flakes are found in association with brucite. *Calcite* shows typical rhombohedral cleavage and characteristic lamellar twinning, with their twin lamellae often bent. *Dolomite* is identified by the presence of twin lamellae parallel to the short diagonal, and in some cases to both long and short diagonals of the cleavage rhomb thus forming rectangular grid, and by simpler forms. *Phlogopite* occurs in flaky form; pleochroic from colourless to yellowish brown; and $Z \wedge a$ is 5°. Some crystals are bent indicating the effect of shearing stress. *Clinochlore* is colourless and gives straight extinction. The interference colour is grey of first order. The crystals are bent, 2 V is (+) 30° and the mineral is often oblique to the alignment of phlogopite flakes probably indicating its formation later than the phlogopite (Harry)[4]. *Graphite* is flaky and has crinkled margins. It is disseminated throughout the section, but is abundant in the bluish grey band associated with brucite. *Diopside* is subhedral to euhedral in outline; it is colourless; cleavage traces parallel to (100) are prominent; $Z \wedge c$ is 44°; the maximum interference colour is blue of second order and 2 V is (+) 57°. *Wollastonite* is bladed in form, slightly lower in relief than the diopside and displays yellow and grey of first order interference colours. Z ∧ c is 30°. The minerals diopside and wollastonite occur in the form of small veinlets cutting across the brucite marble.

Metamorphism

The mineral assemblage of calcite, dolomite, and phlogopite in the present rocks and the occurrence of amphibolites and forsterite marbles along with the directed textures in the Complex indicate that the rocks were initially metamorphosed to amphibolite facies (Turner)[5].

Later the intrusion of granitic rocks has brought about contact metamorphism in the country rocks (Narayana)[6]. The development of brucite and diopside suggest relatively high temperature and low pressure conditions of metamorphism diagnostic of hornblende-hornfels facies (Chaudhuri)[7]. Wollastonite is noticed in the form of minute veins in brucite marble, and it is taken as an indication of pyroxen-hornfels facies developed in proximity to the intrusions in the area following Chaudhuri[7]. This conclusion gets support from the mineral assemblages of the xenoliths (amphibolites, phyllites and quartzites) found in the granitic rocks of the area (Narayana)[8].

Thus the marbles along with the other components of the Banded Gneissic Complex of the area have suffered amphibolite facies of regional metamorphism followed by hornblende-hornfels facies of thermal metamorphism which attained pyroxene-hornfels facies close to the granitic intrusions.

Formation of Brucite

There are three ways in which brucite can originate in calcareous rocks undergoing contact metamorphism:

(*a*) alteration of serpentine,

(*b*) de-carbonation of magnesian limestone to form periclase, which subsequently gets hydrated to form brucite, and

(*c*) de-carbonation of dolomitic limestone with accompanying hydration and without the formation of periclase as an intermediate member.

The brucite in the marbles of the present area shows no evidence of its formation by alteration of serpentine. Rounded grains of serpentine occur in some of the marbles which do not contain brucite and, moreover, the serpentine often forms along the margins and cracks of forsterite. Further, the absence of any residual periclase in the brucite casts doubt on the applicability of the second mode of formation mentioned above to the genesis of brucite.

On the other hand, presence of calcite inside brucite and association of graphite with brucite are suggestive of the mineral being formed directly at the expense of dolomite by the elimination of CO_2 and substitution of H_2O in a single reaction of the metasomatic process. Lemberg (1874, referred to by Brown)[9] proved the change of dolomite to a mixture of calcite and brucite experimentally under similar conditions. Brown[9] and Smolin[10] have also described brucite formed in this way. Thus the vein-like calcite cutting the brucite and the calcite enclosed in brucite may represent the released product during the formation of brucite from dolomite and the association of graphite flakes with brucite may also suggest, in a similar way, their formation from the expelled carbon.

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