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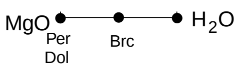
Anna LEWANDOWSKA[1]

SCHREINEMAKERS ANALYSIS IN CM-HC SYSTEMS – THEORETICAL APPROACH AND PETROLOGICAL APPLICATION

INTRODUCTION

The method of geometrical representation of mutual relation of univariant lines in two dimensional space in multi-component systems was developed by Schrenemakers in a series of articles (Schrenemakers 1915-1925) and was summarised by Zen (1966). Later this theoretical approach was found to be extremely useful for representation of the phase equilibria in geological processes. This paper aims to demonstrate application of Schrenemakers analysis of the simple 2-component system to metamorphosed carbonates from the Dębnik anticline near Kraków, where the contact metamorphism of dolomites led to the formation of calcite-brucite marbles (Lewandowska 2000). In the studied rocks the following minerals were recognised: dolomite (Dol), calcite (Cal), brucite (Brc) and periclase (Per).

Minerals and bulk composition of metamorphosed dolomites can be adequately represented in the system CM-HC (CaO-MgO—H_2O-CO_2). This system in the case of the metamorphosed dolomites of the Dębnik anticline can be reduced to 2-component as in all samples calcite was always present. Assuming calcite as an excess mineral phase it is allowed to project the four phases dolomite, brucite, periclase plus metamorphic fluid (H_2O-CO_2) from CM-H triangle on a M-H line (Fig. 1). Consequently we can consider 2-component (binary) and 4-phase system. The reactions possible in this system with calcite in excess are presented in Fig. 1.



[Dol]	Per + H_2O	=	Brc
[Per]	Dol + H_2O	=	Cal + Brc + CO_2
[Brc + H_2O]	Dol	=	Per + CO_2 + Cal

Fig. 1. The position of dolomite (Dol), periclase (Per), brucite (Brc) on the M-H diagram and reactions possible in the system, calcite (Cal) in excess.

SCHREINEMAKERS ANALYSIS

Illustration of the chemographic relation in a binary system requires the calculation of the number of invariant points and univariant curves (Zen 1966). According to the Gibbs phase rule ($f = c - n + 2$, where: *f*-number of phases, *c*-

[1]*Institute of Geological Sciences, Jagiellonian University, Kraków, Poland;
e-mail: ania@geos.ing.uj.edu.pl*

number of components, *n*-number of degrees of freedom), there are 4 phases in a single invariant point (in the invariant point n=0, c=2, f=4, so the number of phases is: f =2-0+2=4).

Since in the studied system there are 4 phases present, the number of invariant points is 1 (the number of 4-element combination of the 4-element set). The number of univariant curves, that is the number of 3-phase assemblages from the 4-element set, is 4. However, the studied system is degenerate, since two phases (Dol and Per) are compositionally coincident (Fig. 1). This fact leads to the decrease of the number of univariant curves to 3. The Schreinemakers rules (see Yardley 1989) allow one to construct the relative arrangements of all univariant curves around the invariant point (Fig. 2).

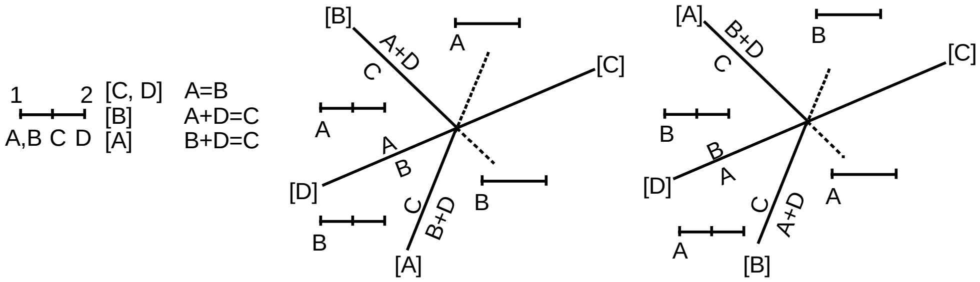


Fig. 2. The possible reactions and two possible arrangements of univariant lines around invariant point in a 2-component (1, 2), degenerate system of four phases (A, B, C, D) (according to Zen 1966).

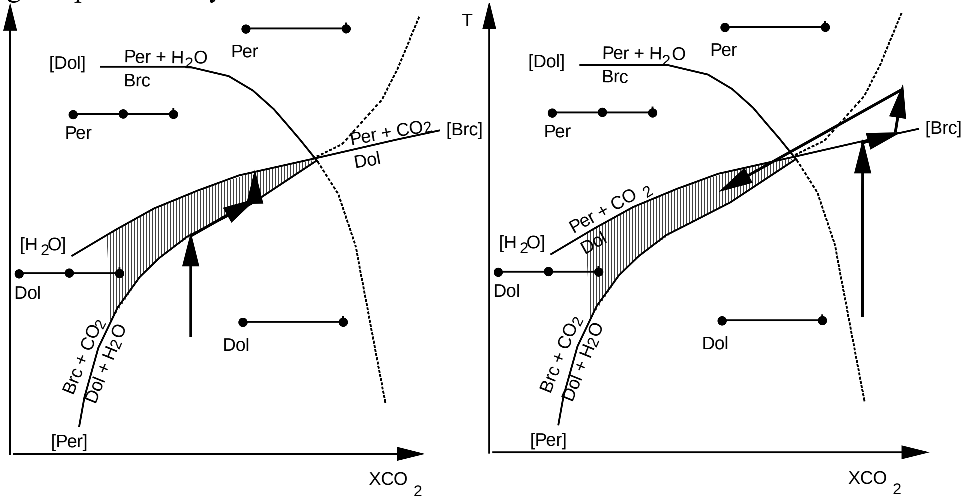
The distinction between two enantiomorphic diagrams at Fig. 2 and the slopes of univariant lines cannot be recognised until thermodynamic data are employed. The problem of the slopes of univariant lines and their mutual relations in mixed volatile system was solved by Kerrick (1974). This enabled the construction of the TXCO_2 diagram (Fig. 3) for the system of contact aureole from the Dębnik anticline.

The differences of metamorphic TXCO_2 paths from outer and inner contact aureole are presented at Fig. 3 a) and b), respectively.

In the outer aureole (Fig. 3a) the thermal decomposition of dolomite went through the reaction [Per] Dol+H_2O→Cal+Brc+CO_2. In zones of easy CO_2 removal (faults, crack) this reaction continued until complete dolomite decomposition and paragenesis of brucite and calcite is observed. However, in other zones (in more closed system), the increase in XCO_2 ceased the reaction and same dolomite has been preserved.

In the inner aureole (Fig. 3b) the thermal decomposition of dolomite went through reaction [Brc+H_2O] Dol→Cal+Per+CO_2. The reaction of periclase formation required higher temperatures and CO_2 enrichment in fluid, as evident from Fig. 3b. The first condition was fulfilled in the vicinity of the rhyodacite intrusion. The relative enrichment in CO_2 might be attributed to meteoric waters penetrating outermost aureole and decreasing the XCO_2 value in distant zones. The retrogression processes overprinted this path causing the reaction: [Dol]

Per+H_2O→Br. Hence the paragenesis in the inner aureole, primarily composed of periclase and calcite have been detected inasmuch as brucite pseudomorphs after regular periclase crystals were found.



a) b)

Fig. 3. Metamorphic T*X*CO_2 paths for the rocks of outer (a) and inner (b) contact aureole in the country rocks of the Dębnik anticline, shaded area represents contemporary mineral assemblages in both zones (symbols as in Fig. 1).

CONCLUSIONS

The chemographic relations of the phases determine the sequence of univariant curves around the invariant point. The application of the method combined with computation of thermodynamic data allows one to gain insight into the possible conditions of formation of the corresponding mineral assemblages.

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