Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 735


# Lithologically-Controlled Fluid Pathways on Thin-Section Scale in the Notch Peak Calc-silicate Contact Aureole, Utah, USA

**Peter Nabelek**

Dept. of Geological Sciences, University of Missouri-Columbia, Columbia, MO 65211, USA

The Notch Peak contact aureole, Utah, is an excellent locality to study the response of calc-silicate sedimentary rocks to intrusion of granite magma. Previous studies gave a broad description of the Jurassic contact metamorphism and the associated fluid-rock interaction (e.g. Hover-Granath et al., 1983; Labotka et al., 1988; Nabelek et al., 1984; Nabelek et al., 1992). The metamorphism occurred at depths ~4.5 km. The prograde metamorphism is characterized by the phlogopite, diopside, and wollastonite isograds. Many samples in the wollastonite zone are depleted in $^{18}O$ compared to lower-grade rocks. Their $\delta^{18}O$ values are near the 10‰ value of the granite stock. The low values have been interpreted to reflect infiltration of magmatic fluids, although up-temperature flow of formation fluids has also been proposed (Ferry and Dipple, 1992).

The previous chemical analyses were done on bulk hand samples, which precludes information on how mineralogically different laminae may control fluid flow and fluid-driven metamorphic reactions. In this study, individual laminae within samples representing all metamorphic grades of the Weeks Formation were examined petrographically, by X-ray mapping, and for O and C isotope ratios. The Weeks Formation is an ~360 m thick shaly limestone. In much of the aureole, it contains abundant, poorly crystalline graphite. Unmetamorphosed, graphitic sections are dominated by very fine-grained dolomite, calcite, muscovite, and quartz. A lower, graphite-poor section that is not exposed in the metamorphic aureole, does not contain dolomite. $\delta^{18}O$ and $\delta^{13}C$ (SMOW) values of calcite in the graphite poor rocks are ~17.3‰ and 0‰, respectively. The values of the mixed carbonates in the graphitic section are ~19.6‰ and as low as -14.3‰, respectively. The very low $\delta^{13}C$ values suggest a fluid-facilitated exchange with the graphite ($\delta^{13}C$ = -25‰), as at the rocks' temperature of 150-200ºC, solid-state exchange would have been unlikely. Therefore, the fluids must have been carbonic.

Rocks in the incipient phlogopite zone contain phlogopite, anorthite, calcite, quartz and minor K-feldspar. The assemblage suggests the reaction Ms + Dol + Qtz = Phl + An + Cc + $CO_2$, which at 1.5 kbar occurs between 400 and 430 C at $X(CO_2)_{fluid}$ from 0.33 to 0.68, followed by a slightly higher-temperature reaction, Ms + Cc + Qtz = Kfs + An + $CO_2$ + $H_2O$. Unshifted $\delta^{18}O$ values, the high $X(CO_2)_{fluid}$ of the phlogopite-forming reaction and $\delta^{13}C$ values around -9‰, support the presence of internally-generated carbonic fluid, which again facilitated carbon exchange between calcite and graphite. Just below the diopside isograd, minor tremolite becomes present. Diopside formed either by the metastable reaction Phl + Qtz + Cc = Di + Kfs + $CO_2$ + $H_2O$, which occurs ~20ºC above the tremolite-forming reaction, or by the reaction Tr + Qtz + Cc = Di + $CO_2$ + $H_2O$. Because the tremolite and diopside-forming reactions span a wide fluid composition range, they do not constrain $X(CO_2)_{fluid}$. However, diopside occurs in discreet, graphite-poor, cm-thick laminae that have shifted $\delta^{18}O$ values and often contain scapolite, particularly near the wollastonite isograd. In contrast, laminae with >90% calcite remain graphitic and have $\delta^{18}O$ and $\delta^{13}C$ values of 19‰ and -9‰, respectively. The boundaries between the two types of laminae are very sharp, indicating infiltration of a low$^{18}O$ fluid along the discreet silicate laminae. Similar situation occurs in the wollastonite zone, where laminae dominated by silicates, including wollastonite and diopside, have low $\delta^{18}O$ values, whereas calcite-dominated laminae are shifted by only about 4‰ in zones from which graphite disappeared, probably by the reaction C + $H_2O$ = $CO_2$ + $CH_2$.

This study demonstrates that fluid flow during contact metamorphism can be channelled even on thin-section scale into laminae in which calc-silicate reactions allow infiltration. Laminae dominated by calcite remain largely closed to infiltration. Moreover, in the Notch Peak aureole, infiltration of magmatic fluid occurred only in the highest metamorphic grades. In the outer aureole, fluid composition was internally buffered.

Ferry JM. & Dipple GM, *Am. Mineral.*, **77**, 577-591, (1992).
Hover-Granath VC, Papike JJ & Labotka TC, *Geol. Soc. Am. Bull.*, **94**, 889-906, (1983).
Labotka TC, Nabelek PI & Papike JJ, *Am. Mineral.*, **73**, 1302-1324, (1988).
Nabelek PI, Labotka TC, O'Neil JR & Papike JJ, *Contri. Mineral. Petrol.*, **86**, 25-34, (1984).
Nabelek PI, Labotka TC & Russ-Nabelek C, *J. Petrol.*, **33**, 557-583, (1992).