

## An experimental study of the diffusion of C and O in calcite in mixed CO<sub>2</sub>-H<sub>2</sub>O fluid

T.C. LABOTKA<sup>1\*</sup>, D.R. COLE<sup>2</sup>, M.J. FAYEK<sup>3</sup>  
AND T. CHACKO<sup>4</sup>

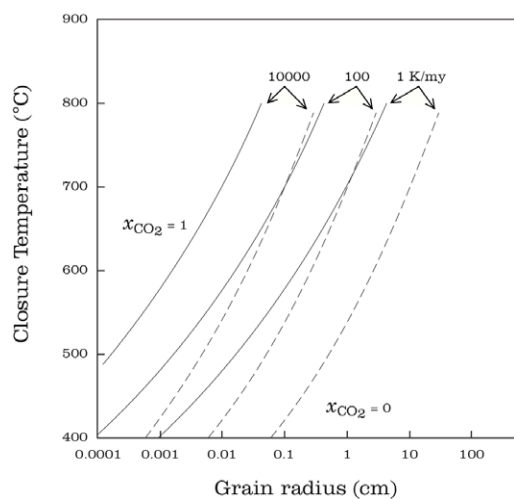
<sup>1</sup>Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, Tennessee 37996-1410

<sup>2</sup>Chemical Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6110

<sup>3</sup>Department of Geological Sciences, University of Manitoba, Winnipeg MB R3T 2N2

<sup>4</sup>Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton AB T6G 2E3

The diffusivity of C and O in calcite in mixed CO<sub>2</sub>-H<sub>2</sub>O fluid was determined over the range in  $x_{\text{CO}_2}$  from 1.0 to about 0.2 primarily at 700 °C, 100 MPa, with selected experiments conducted at pressures to 250 MPa and temperatures of 600 and 800 °C. The diffusivity of C,  $D_C$ , varies little with  $x_{\text{CO}_2}$ , although there is some evidence for a slight increase in  $D_C$  from  $\sim 5 \times 10^{-18}$  to  $\sim 5 \times 10^{-17}$  cm<sup>2</sup>/s with decreasing  $x_{\text{CO}_2}$ . Despite the large uncertainty, we observed that  $D_O$  increases from  $\sim 2 \times 10^{-16}$  to  $\sim 5 \times 10^{-14}$  cm<sup>2</sup>/s with  $x_{\text{CO}_2}$  decreasing from 1.0 to 0. There is a good correlation at 700 °C between  $\log D_O$  and  $\log f_{\text{H}_2\text{O}}$  regardless of the total pressure, matching the observations of previous workers. The data are consistent with a simple model for the diffusion of O in calcite with two components in the fluid phase, one for diffusion in the presence of CO<sub>2</sub> and one for the presence of H<sub>2</sub>O:  $D_O = D_O^{\text{CO}_2} + D_O^{\text{H}_2\text{O}} a_{\text{H}_2\text{O}}$ . The activity of H<sub>2</sub>O is relative to the fugacity at 100 MPa, 700 °C.  $D_O^{\text{CO}_2}$  is  $3.45 \times 10^{-16}$ , and  $D_O^{\text{H}_2\text{O}}$  is  $3.8 \times 10^{-14}$  cm<sup>2</sup>/s. The model implies that there is little dependence of the diffusivity on pressure over the range investigated. With this model and the values of  $D_O$  in pure CO<sub>2</sub> and in pure H<sub>2</sub>O, the value of  $D_O$  is predicted over the temperature range 600–800 °C and  $p_{\text{H}_2\text{O}}$  up to 300 MPa, the range of the data. Calculated closure temperatures for O-isotope exchange between calcite and fluid are reduced by about 150 °C in the presence of an aqueous fluid (figure).



## Particulate matter pollution: An environmental magnetism study with biological collectors in urban areas of Northern Portugal

M.J. LACERDA<sup>1</sup>, H. SANT'OVAIA<sup>1\*</sup> AND C.R. GOMES<sup>2</sup>

<sup>1</sup>Centro de Geologia da Universidade Porto, DGAOT, FCUP, R Campo Alegre, 4169-007 Porto, Portugal

(\*correspondence: hstantov@fc.up.pt)

<sup>2</sup>CGUC, DCT, Universidade de Coimbra, Portugal

This work presents an evaluation of the pollution levels in plant leaves from five selected sites, 4 in urban areas (2 zones in Porto, 1 in Valongo and 1 in Braga towns) and one in a rural area. An environmental magnetism study was used with particle biological collectors, leaves from *Nerium oleander*, *Quercus* spp., *Tilia* spp. and *Platanus* spp. The sampling was conducted in July, August, October, November and December 2009 and January 2010. A total of 34 samples was obtained. Magnetic parameters, low-field magnetic susceptibility ( $\chi$ ) and isothermal remanent magnetization (IRM) determinations, were used to indicate the source of the magnetic particles.

The magnetic susceptibility ( $\chi$ ) values are comprised between  $2.54$  and  $17.17 \text{ E}^{-8} \text{ m}^3\text{kg}^{-1}$  in Porto,  $3.78$  and  $5.70 \text{ E}^{-8} \text{ m}^3\text{kg}^{-1}$  in Braga,  $2.85$  and  $8.28 \text{ E}^{-8} \text{ m}^3\text{kg}^{-1}$  in Valongo and, finally, between  $-0.66$  and  $-0.21 \text{ E}^{-8} \text{ m}^3\text{kg}^{-1}$ , in the rural area. The town of Porto shows the higher  $\chi$  comparing to Braga and Valongo. The samples of the rural area showed always negative values of  $\chi$  and very low values of  $\text{IRM}_{1T}$ . The values of  $\text{IRM}_{1T}$ , measured for the *Tilia* spp. in Porto and in the rural area have a relationship 9.92:1.00. In Porto, when comparing neighbouring trees of different species (*Platanus* spp, *Quercus* spp. and *Nerium oleander*) in the same area, the highest values of  $\chi$  are always obtained in the *Quercus* leaves. A comparison of the values of  $\chi$  for the different months shows that in the month of December, these values are, on average, higher. In November, compared with October, there was a decrease of  $\chi$ , which can be explained by the rainfall which had the effect of removing particles from the leaves. In January, it seems to have had an increase of  $\chi$ , although the sampling had been limited to evergreen species. The average values of  $S_{300}$  was 0.96 (N=26), indicating the presence of ferrimagnetic particles magnetite-like. The values of  $S_{25}$  (mean=0.27, N=26) were consistent with the presence of particles with a PM10 diameter. The results pointed out the contrast between areas with high traffic and the countryside. We come to the conclusion that *Quercus* leaves showed a higher efficiency to accumulate particles than the *Platanus* leaves.