

Oxygen isotope ratios in mantle xenoliths (Mt. Carmel, Israel): Implications for thermometry and sources of alkaline mafic magmas

J. KAMINCHIK^{1,3}, Y. KATZIR^{1,2*}, M.J. SPICUZZA²,
J.W. VALLEY² AND A. SEGEV³

¹Ben Gurion University of the Negev, Be'er Sheva 84105, Israel (*correspondence: yaron@geology.wisc.edu) (kaminchi@bgu.ac.il)

²University of Wisconsin, Madison WI 53706, USA (spicuzza@geology.wisc.edu, valley@geology.wisc.edu)

³Geological Survey of Israel, Jerusalem 95501, Israel (amit.segev@gsi.gov.il)

A suite of rare mantle pyroxenite xenoliths occurs within Upper Cretaceous mafic pyroclastic sections at Mt. Carmel, northern coastal Israel. The suite solely includes clinopyroxenites with abundant garnet indicating crystallization at $P > 2$ GPa [1]. $\delta^{18}\text{O}$ values of clinopyroxene (Cpx) and garnet (Grt, $\text{Pyr}_{60}\text{Alm}_{30}\text{Grs}_{10}$) from 9 xenoliths range from 4.99 to 5.42‰ and 5.14 to 5.47‰, respectively. All laser fluorination analyses were duplicated with average duplication difference of 0.03‰ for Grt and 0.05‰ for Cpx; $\delta^{18}\text{O}_{\text{Cpx}}$ values were corrected according to [2]. Isotope fractionations are $\Delta^{18}\text{O}_{\text{Cpx-Grt}} = -0.22$ to 0.07 ‰, averaging -0.08 ± 0.06 ‰ (2SE). The Carmel negative Cpx-Grt fractionations (7 out of 9 xenoliths) are outside the overwhelmingly positive $\Delta^{18}\text{O}_{\text{Cpx-Grt}}$ range of 0.0 to 0.6‰ measured in 62 worldwide 'eclogitic' mantle xenoliths [3]. The experimental calibration of diopside-grossular fractionations predicting $\Delta_{\text{Di-Grs}} = 0.17$ ‰ at 1000°C is not applicable here due to the Mg-Fe composition of the garnet. However, calculations based on natural samples predict $\Delta_{\text{Di-Ca-poor Grt}} (1000^\circ\text{C})$ to be -0.06 [2] or -0.02 [4]. If equilibrated, our results extend to $T \approx 1100^\circ\text{C}$, further showing that for the vast majority of igneous and metamorphic rocks diopside-Ca-poor garnet equilibrium fractionation is ≈ 0 ‰ and insensitive of temperature. The 0.6‰ variability in $\Delta^{18}\text{O}_{\text{Cpx-Grt}}$ measured in mantle eclogites [3] may stem from differences in chemical composition, late alteration and analytical precision. Garnet megacrysts ($<10\text{cm}$) that also occur within the pyroclastic sections have chemical composition and $\delta^{18}\text{O}$ (5.43 ± 0.06 ‰) similar to the granoblastic garnet (3–4mm) in the xenoliths. This suggests that metamorphic recrystallization of the pyroxenites prior to uptake by magma did not involve metasomatism by exotic fluids.

[1] Mittlefehldt (1986) *CMP* **94**, 245–252. [2] Kohn & Valley (1998) *JMG* **16**, 625–639. [3] Matthey *et al.* (1994) *EPSL* **128**, 231–241. [4] Valley (2003) *Rev. Min. Geochem.* **53**, 343–385.

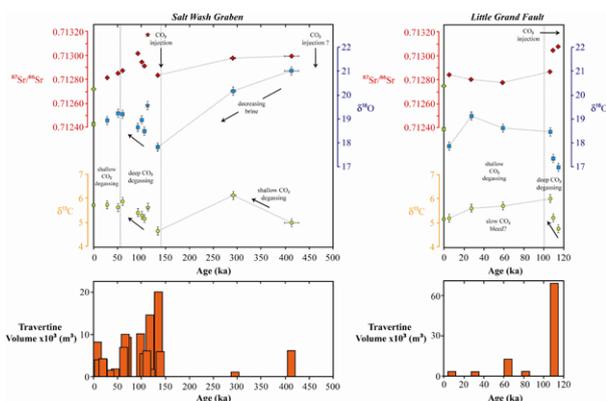
Coupled CO_2 -leakage and *in situ* fluid-mineral reactions in a natural CO_2 reservoir, Green River, Utah

N. KAMPMAN^{1*}, N.M. BURNSIDE², M. BICKLE¹,
Z.K. SHIPTON², R.M. ELLAM² AND H. CHAPMAN¹

¹Dept. Earth Sciences, Downing Street, Cambridge CB2 3EQ, UK (*correspondence: nkam06@esc.cam.ac.uk)

²Geographical and Earth Sciences, The University of Glasgow, G12 8QQ, UK (neil.burnside@ges.gla.ac.uk)

Surface travertine deposits and carbonate veining within the footwall of Little Grand Fault and Salt Wash Graben, Utah, record a 413 ka history [1] of CO_2 leakage [2]. Isotopic analysis of U-series dated carbonate veins reveals a coupling between CO_2 injection into the host aquifer and the rates of surface leakage, CO_2 -promoted silicate mineral hydrolysis reactions within the reservoir [3] and carbonate deposition within fracture conduits through which CO_2 -charge fluids ascend to the surface (Fig. 1). Rapid carbonate precipitation rates, recorded in the kinetic fractionation of $\delta^{13}\text{C}_{\text{HCO}_3}$ and $\delta^{18}\text{O}_{\text{HCO}_3}$, reflect an increase in *in situ* $p\text{CO}_2$ which elevates concentrations of Ca^{2+} and HCO_3^- , lowering the point at which the ascending fluid reaches carbonate supersaturation due to CO_2 degassing. The spatial and temporal relationship of travertine deposition to CO_2 injection, suggests that rapid rates of carbonate deposition initially plug easily exploited leakage pathways causing leakage sites to propagate laterally, but that this blocking rate decreases with dissipation of the CO_2 charge. This has important implications for the prediction of leakage behaviour in storage sites and for modeling the coupling of subsurface geochemical processes to the evolution of surface leakage.



[1] Burnside *et al.* (2009) in *Faults & Top seals*, EAGE. Montpellier, France. [2] Dockrill *et al.* (2010) *J. Struct. Geol.* *in press* [3] Kampman *et al.* (2009) *Earth Planet. Sci. Lett.* **284**, 473–488.