

Seasonal microclimate control on calcite fabrics, stable isotopes and trace elements in modern speleothem from St. Michaels Cave, Gibraltar

DAVID P. MATTEY¹, IAN J. FAIRCHILD²
AND TIM C. ATKINSON³

¹Department of Earth Sciences, Royal Holloway University of London TW20 0EX

²School of Geography, Earth & Environmental Sciences, University of Birmingham B15 2TT

³Department of Earth Sciences, University College London WC1E 6BT

A recent study of a modern stalagmite from New St. Michaels Cave (NSM) revealed annual growth laminae which preserve exceptionally well-defined seasonal $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ cycles [1]. Detailed monitoring of three drip sites in NSM reveals strongly coherent seasonal patterns in dripwater compositions despite each site having significantly different flow paths and discharge patterns. Calcite saturation is found to be closely linked to regular seasonal variations in cave air $p\text{CO}_2$ caused by chimney ventilation linked temperature difference between the exterior and interior of the cave. We present a coupled CO_2 degassing – calcite precipitation model which links seasonal $\delta^{13}\text{C}$ variations in coexisting dripwater, cave air CO_2 and speleothem calcite to switching $p\text{CO}_2$ driven by seasonal cave ventilation. Mapping of stable isotope, Sr and speleothem fabrics measured across calcite laminae at a temporal resolution equivalent to weekly growth also shows that $\delta^{13}\text{C}$ and Sr topology are also consistent with a degassing – calcite precipitation where the $\delta^{13}\text{C}$ compositions of drip water and calcite are highly responsive to rapid degassing and seasonally switching cave air $p\text{CO}_2$ whereas slower calcite precipitation rates drive enrichment of Sr at a slower and more complex manner. High resolution speleothem fabric, trace element and isotope records from caves that have been closely monitored can provide crucial links between the local climate and the way that climate is recorded during speleothem deposition. In Gibraltar, lowest cave air $p\text{CO}_2$ in summer is the opposite to what has been revealed by cave monitoring elsewhere and shows that caution is needed when linking paired speleothem fabrics to specific seasons without knowledge of local processes operating in the cave. Furthermore, monitoring shows that the climate recording process may vary among sites even in the same cave resulting in differing bias to winter and summer growth depending on the timing of ventilation and hydrological cycles.

[1] Matthey *et al.* (2008), *EPSL*, **269**, 80-95.

Incomplete mixing of silicate-carbonatite magmas during the explosive eruption of Oldoinyo Lengai (September 2007)

H.B. MATTSSON* AND E. REUSSER

Dept. of Earth Sciences, ETH Zurich, Clausiusstr. 25,
CH-8092 Zurich

(*correspondence: hannes.mattsson@erdw.ethz.ch)

Ash samples collected three days after the onset of the explosive September 2007 eruption of Oldoinyo Lengai (Tanzania) show evidence for partial mixing between natrocarbonatitic and nephelinitic magmas.

The samples are well-sorted and fine-grained (<500 μm), consisting of individual ash particles/aggregates that display rounded, droplet-shaped, morphologies. The aggregates are predominantly composed of carbonate minerals such as nyerereite and gregoryite, but also contain a significant amount of silicate phases. The predominant silicate minerals are clinopyroxene, Ti-andradite, nepheline, wollastonite and melilitite. The silicate minerals are thus similar to that reported from mixed ashes from the explosive 1966 eruption [1]. Intercalated with the ash aggregates are euhedral crystals of clinopyroxene and broken pieces of nepheline and sanidine. Occasional vesicular fragments of a rapidly quenched nephelinitic magma with microphenocrysts of clinopyroxene and nepheline are present.

XRF analyses of the ashes show SiO_2 -contents ranging from 8 to 12 wt%, and $\text{CaO}+\text{Na}_2\text{O}+\text{K}_2\text{O}$ values of approximately 65 wt% which is higher than that reported from natrocarbonatitic lavas during the period 1988-2006 [2].

Textures of some carbonatitic droplets/fragments show evidence for being resorbed by the silicate magma. Later samples from the same eruption are dominated by the silicate magma containing a similar mineral assemblage as our samples [3].

Therefore, we interpret the early ashes as being the result of an incomplete mixing in the very first stages of the eruption. At this stage purely carbonatitic material is ejected simultaneously with silicate material, while some ash particles indicate mixing of the two magmas. The carbonatitic magma were probably rapidly consumed as indicated by the dominance of the silicate magma only two weeks later [2].

[1] Dawson *et al.* (1992) *Mineral. Mag.* **56**, 1-16. [2] Mitchell & Dawson (2007) *Mineral. Mag.* **71**, 483-492. [3] Keller *et al.* (2007) *Geochim. Cosmochim. Acta*, **71**, 15, A475.