The freshwater pearl mussel: one species – several proxies

S.M. BAIER[1], B.R. SCHÖNE[1] AND J. FIEBIG[2]

[1]Department of Applied and Analytical Palaeontology and INCREMENTS Research Group, Institute of Geosciences, University of Mainz, Germany (baiers@uni-mainz.de and schoeneb@uni-mainz.de)

[2]Institute of Geosciences, Section Palaeontology, University of Frankfurt, Germany

Recently, bivalves became a powerful tool to supplement climate proxy data gathered from trees, stalagmites or lake sediments. Riverine bivalves provide an ideal junction between terrestrial, freshwater and marine proxy archives.

Here, we studied shells of freshwater pearl mussels from Northern Sweden using a combination of sclerochronology (growth rate analyses) and isotope geochemistry ($\delta^{13}C$, $\delta^{18}O$). Valves were cut perpendicular to the direction of growth. After grinding and polishing, one of two “mirroring” thick sections was immersed in Mutvei’s solution. Sections were digitized and growth increment widths measured. Inherent age-related growth trends were extracted from the chronologies by estimating ontogenetic trends with cubic splines. Age trend removal was performed by dividing measured by predicted growth. Standardized growth records of different individuals were combined to a single master chronology and overall growth patterns and cycles were analyzed.

In addition, the remaining cross-sectioned shell portion was micromilled for stable carbon and oxygen isotope analyses. Following the shape of the growth increments, aragonite powder samples of annual resolution were milled. Oxygen isotope ratios of shell aragonite were used to calculate water temperatures. With increasing ontogenetic age stable carbon isotope values became shifted towards more positive values. After removal of age related trends, $\delta^{13}C$ values exhibited a high degree of running similarity, permitting the construction of a $\delta^{13}C$ master chronology.

Wavelet analyses of standardized shell growth and $\delta^{13}C$ master chronologies revealed periodicities of 2-4 years, 6-7 years and 16 years. These oscillations closely resemble those well known from the North Atlantic Oscillation (NAO) and the tripole pattern in sea surface temperature anomalies.

Carbon in the peralkaline association: Footprints in the ashes

KEN BAILEY AND STUART KEARNS

Department of Earth Sciences, University of Bristol, Queens Road, Bristol, BS8 1RJ, U.K. (ken.bailey@bris.ac.uk)

Peralkaline felsic volcanism in the central Kenya rift, around Lake Naivasha, is well documented (age 0.4-0 Ma). Less known is the interspersed, contemporaneous mafic activity, comprising basaltic flows following initial effusion of tuffs and tuff cones. The latter include peperites with fresh basanitic glass lapilli enclosing abundant immiscible calcite globules (up to 45%): the enclosing matrix is largely comminuted lapilli, with a few accidental clasts. Some quench textures, and rare streaks of platy calcite, in the matrix indicate that this may have been still hot when erupted. Older volcanics (1.7 Ma) form the underlying rift floor. Carbonate sediments are absent from the area, and formation of calcite globules in glass by assimilation of any cold sedimentary limestone would impose impossible thermal requirements. No external source for the carbonate is known, and the carbonate globules enclosed in glass are an integral part of the eruption. Immiscible textures show all the forms expected from experimental studies for carbonate and silicate melts in equilibrium: these two melts must either have mingled or unmixed at high T. Primary carbonate is known in the phonolites and peralkaline trachytes of adjacent volcanoes; contemporaneous nephelinite-melilitite-carbonatite, as well as commercial CO_2 wells, are found along the rift, where this range of activity has prevailed for at least 23 Ma. Hence, these peperites are but a new form of carbonate volcanism, in intimate association with intensely peralkaline activity, spectacularly re-affirming the key role of CO_2 flux in rift magma genesis. Known natural samples of glass + carbonate are rare (five?), and basanite-calcite melt immiscibility has not been reported previously (the expected silicate phase from experiments is alkaline ultramafic/phonolitic, but 9 basanite + 1 calcite is equivalent to melilitite + CO_2). The P-T-X conditions for coexisting basanite-calcite melts remain to be defined, but the Kenyan peperites are not an isolated case (five others, from outside Africa, are currently under investigation). Although also from well-known provinces these too have gone unreported due to insufficient study being devoted to pyroclasts.

References

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