Understanding biological control and environmental influence – unlocking the secrets of biomineralisation

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In the natural world of biominerals elegant, functional structures are produced from the most basic of resources. Vertebrates have skeletons made from calcium phosphate (apatite) while invertebrates tend to assemble mineral structures from silica or calcium carbonate. Although the ingredients are simple, the control of how these fundamental building blocks are put together is very much under the control of biological processes. Understanding this biological control and its rôle in the formation of biominerals has implications in a number of diverse areas. Understanding the biomineralisation process will provide a much more accurate interpretation of the climate information stored within marine biominerals, e.g. brachiopods and corals. An exploration of the biological control exerted in biomineral formation in several phyla provides the context for the consideration of the recording of environmental information.

C, O and H isotope compositions of the Wilmott and Yungul 'carbonatites' and the associated fluorites in the Speewah Dome, Kimberley Region, Australia

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The Yungul and newly discovered Wilmott 'carbonatites' (carbonate-cemented breccias and carbonate veins), as well as the associated fluorite veins are located on the eastern margin of the Kimberley Block (NW Australia). The C and O isotope compositions of Wilmott carbonatites show a distinct negative trend different from that observed for Yungul 'carbonatites', in which the $\delta^{13}C$ and $\delta^{18}O$ values form a positive trend and has been explained by high-temperature rock-fluid interaction and H_2O degassing. However, the observed $\delta^{13}C$ shift in Wilmott 'carbonatites' requires additional processes such as CO_2 and H_2O degassing. Inclusion-hosted H_2O contents (determined by vacuum crushing) range from 250 to 1300 ppm for Yungul, whereas the Wilmott 'carbonatites' yielded H_2O contents between 250 and 510 ppm. The H isotope compositions determined for inclusion-hosted H_2O show a large range for Yungul 'carbonatites' (from -83‰ to -24‰) with the Wilmott rocks at the lower end (from -85‰ to -60‰). δD-H_2O variations in both 'carbonatites' indicate an open system in which the H_2O degassing took place at relatively high temperature (>400°C). The associated fluorite veins are characterized by high H_2O contents (600-2300ppm) with relatively high δD values (between -30‰ and -17‰) forming a positive linear trend related to close system evolution. The fluorite and 'carbonatite' trends converge to the same isotopic composition, thus, although the fluid regimes were likely different for fluorites and 'carbonatites' (i.e. open – closed systems), the ultimate origin of the fluids could be the same.