

Patterns and pathways of H and O isotope incorporation in keratin and chitin

GABRIEL J. BOWEN^{1*}, KRISTINE E. NIELSON¹,
THURE E. CERLING² AND JAMES R. EHLERINGER²

¹Earth and Atmospheric Sciences Dept., Purdue University,
West Lafayette, IN 47906, USA

(*correspondence: gabe@purdue.edu)

²Biology Dept., University of Utah, Salt Lake City, UT 84113,
USA

Hydrogen and oxygen isotope ratios of organic tissues from some heterotrophic organisms have been shown to correlate with the isotopic composition of environmental water at the location of tissue growth, therefor providing information on the geographic origin of the tissue. Despite the growing adoption of these tracers in ecology and forensic science, relatively little work has assessed the pathways by which H and O in heterotroph tissues are inherited from the environment, or how these mechanisms affect the nature and variability of the empirically observed relationships. We have investigated patterns of H and O isotopic variability in field-collected human hair and in chitin produced by laboratory raised brine shrimp (*Artemia franciscana*). Through the use of controlled and 'natural' experiments, as well as comparative analysis of H and O isotope ratios within tissues, we have hypothesized models describing physiological and biochemical controls on the assimilation of keratin and chitin H and O from food and water.

We find that in both organic systems H and O isotope ratios are strongly coupled, but their covariation deviates from the 8:1 ratio typical of fresh waters. In both tissues, H isotope ratios are more closely linked to dietary H, which we propose reflects inheritance of C-bound H through molecular routing and/or inheritance from substrate molecules used in biosynthesis. Our results show that contributions of food-derived H to human hair keratin exceed those expected from simple inventories of structural H in amino acids and known mixing ratios of diet- and water-derived H in human body water. This suggests that elevated concentrations of metabolic H within the intracellular environment may contribute to H fixed in keratin amino acids, making amino acid H a potential bio-recorder of isotope ratios in the intracellular environment. In contrast, O isotope ratios in both keratin and chitin are strongly related to environmental water isotopic composition, implying more complete exchange of O on dietary proteins and sugars and/or exchange that occurs in an environment less influenced by the products of metabolism.

Micro Raman spectroscopic investigations of mineral and carbonaceous materials: Redefining parameters for the detection of biosignatures

D.M. BOWER^{1*}, A. STEELE¹ AND L. KATER²

¹Carnegie Institution of Washington, Geophysical Laboratory,
Washington, D.C. 20015, USA

(*correspondence: dbower@ciw.edu)

²WiTec-ULM, Germany

Introduction

We used micro Raman spectroscopy on a suite of fossiliferous chert samples and carbonaceous meteorite samples to investigate the mineral and carbonaceous components. The unique mapping capabilities of micro Raman spectroscopy provide a greater view of the spatial relationships between carbonaceous materials and other features in ancient rocks (Fig. 1).

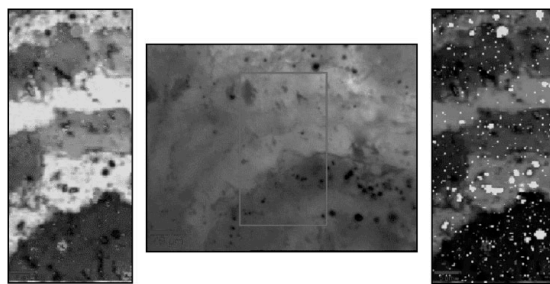


Figure 1: Micro Raman spectral maps show spatial relationships in stromatolitic layers with carbon and sulfides.

Conclusions

Spectral maps show that the spectral characteristics of carbon occurring within grain boundaries are similar to those that are associated specifically with microfossils. The spectral features of the carbonaceous material found in biologically associated structures are also similar to those of either questionable or abiologic origin [1, 2, 3]. Only by fully exploring the spatial relationships and spectral characteristics will the establishment of biosignatures for life detection in ancient rocks on Earth and those from other planets be made.

[1] Beyssac *et al.* (2003) *Spectrochimica Acta Part A*, **59**, 2267–2276. [2] DeGregorio *et al.* (2009) *Geology* **37**, 631–634. [3] Van Zuilen *et al.* (2007) *Geochimica et Cosmochimica Acta*, **71**, 655–669.