

# Isotopic Proxies for Microbial and Environmental Change:

Insights from Hydrogen Isotopes and the  
Ediacaran Khufai Formation

Thesis by  
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In Partial Fulfillment of the Requirements for the  
degree of  
Doctor of Philosophy



CALIFORNIA INSTITUTE OF TECHNOLOGY

Pasadena, California

2013

(Defended May 28, 2013)



## ACKNOWLEDGEMENTS

This thesis would not have been possible without the generous help and support from many individuals and organizations. Specifically I would like to thank my advisors John Grotzinger and Alex Sessions, who have been pillars of support and guidance throughout this process. I would also like to acknowledge my current and former committee members Woody Fischer, Tim Lyons, Victoria Orphan, and Joe Kirschvink. In addition, I would like to thank the many other GPS professors that have contributed to my interests and background through classes and field trips including John Eiler, Jess Adkins, Jared Leadbetter, George Rossman, and Ken Farley. I am thankful for the editing prowess of Mitchell Barklage and Morgan Raven who were subjected to first drafts of parts of this thesis. Funding is a critical to modern science as well, which indebts me to the NSF GRFP, Petroleum Development Oman, the Gordon and Virginia Eaton Fellowship, and the Agouron Institute for their generous financial support.

Many people contributed directly and indirectly to the works presented here. I would like to acknowledge the additional coauthors on these manuscripts, John Spear, Chuck Pepe-Raney, Kristin Bergmann, Jeremy Owens, and Kat Dawson. I would particularly like to thank Kristin who has additionally served over the years as my field partner, cherished friend, and partner in crime. I have benefitted from the cooperative environments of the Sessions and Grotzinger lab groups over the years, in particular Lichun Zhang, Morgan Raven, Kat Dawson, Ying Wang, Guillaume Paris, Adam Subhas, and Sebastian Kopf for their direct and material assistance. A number of high school students and undergraduates assisted in rock and sample preparation including Haley Barnes, Sean Dembowski, Emma Dodd, and Angela Gerhardt. Lora Wingate, Ken Macleod, and Bob Criss were instrumental in generating carbon isotope data. Finally, I am thankful to Steve Bates who oversaw the preparation and analysis of sulfur isotopes.

The Caltech environment is one where anything is possible if you know whom to ask. The GPS administrative staff has been particularly helpful including Janice Grancich, Kathy Lima, Marcia Hudson, Liz Boyd, and Dian Buchness. I have also been lucky

enough to work closely with the Graduate Dean's office and would like to thank Felicia Hunt and Joe Shepard for enriching my life and allowing me to shake the boat. Various Caltech programs and organizations have contributed to my happiness during my time here including the Women Mentoring Women program, the Graduate Student Council, the Graduate Honor Council (Rob Craig in particular), and the Caltech community garden.

The strong support of family and friends was critical to my success. I would not be here without the encouragement of my parents Bob and JoAnne Osburn. I don't think they meant to turn me into a geologist, but with the multitude of early National Park focused road trips combined with canoeing, caving, and WashU geology field trips, I am not sure there was an alternative. My husband Mitchell Barklage was my rock during this process and I owe him a great deal of credit for helping maintain my sanity and enthusiasm. I still work hard every day to live up to the potential that he has seen in me from the very beginning. My friends both inside and outside of GPS have made my experience here really enjoyable.

I would be remiss if I did not include my early mentors and teachers in this list of gratitude. This begins with my sixth and seventh grade science teacher Wayne Baldwin who taught me the scientific method and encouraged my creativity with a very long leash. My string of excellent science teachers continued in high school with my chemistry teacher Dr. Bob Becker, who truly believed in hands-on science and whose thermite demonstration still might be the most impressive chemical reaction that I have ever seen. I must thank Dr. Everett Shock who took a chance on bringing a fourteen year old me to Yellowstone National Park as a field assistant. These experiences lead into my undergraduate work with D'Arcy Meyer-Dombard and Jan Amend where my interests began to take their current form. These scientists are not only great mentors, but also future collaborators and constant sources of inspiration.

## ABSTRACT

Microbes have profoundly influenced the Earth's environments through time. Records of these interactions come primarily from the development and implementation of proxies that relate known modern processes to chemical signatures in the sedimentary record. This thesis is presented in two parts, focusing first on novel proxy development in the modern and second on interpretation of past environments using well-established methods. Part 1, presented in two chapters, builds on previous observations that different microbial metabolisms produce vastly different lipid hydrogen isotopic compositions. Chapter 1 evaluates the potential environmental expression of metabolism-based fractionation differences by exploiting the natural microbial community gradients in hydrothermal springs. We find a very large range in isotopic composition that can be demonstrably linked to the microbial source(s) of the fatty acids at each sample site. In Chapter 2, anaerobic culturing techniques are used to evaluate the hydrogen isotopic fractionations produced by anaerobic microbial metabolisms. Although the observed fractionation patterns are similar to those reported for aerobic cultures for some organisms, others show large differences. Part 2 changes focus from the modern to the ancient and uses classical stratigraphic methods combined with isotope stratigraphy to interpret microbial and environmental changes during the latest Precambrian Era. Chapter 3 presents a detailed characterization of the facies, parasequence development, and stratigraphic architecture of the Ediacaran Khufai Formation. Chapter 4 presents measurements of carbon, oxygen, and sulfur isotopic ratios in stratigraphic context. Large oscillations in the isotopic composition of sulfate constrain the size of the marine sulfate reservoir and suggest incorporation of an enriched isotopic source. Because this data was measured in stratigraphic context, we can assert with confidence that these isotopic shifts are not related to stratigraphic surfaces or facies type but instead reflect the evolution of the ocean through time. This data integrates into the chemostratigraphic global record and contributes to the emerging picture of changing marine chemistry during the latest Precambrian Era.

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