IsoMAP: A web-GIS workspace for modeling isotope ratios in the environment

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Researchers have amassed a vast quantity of data on the stable H and O isotope ratios of environmental waters during the past 6 decades, and these data have supported the development of numerous paleoenvironmental, paleoecological, and paleoclimatic proxies. As new analytical instrumentation supports the gathering of water isotope data at increasing rates, these measurements promise to spawn new approaches to studying our contemporary environment. A key element in the development and interpretation of H and O isotope-based applications is the development of models for water isotope data to describe and predict relationships between these parameters and environmental variables.

In order to support widespread access to large water isotope databases and facilitate modeling of water isotopes and their propagation into hydrological and biological systems we have developed a web-GIS workspace called IsoMAP (Isoscape Modeling, Analysis and Prediction; http://isomap.org). IsoMAP consists of a set of Graphical User Interface that runs within the user's internet browser, server-side databases that host and serve isotopic and climatic monitoring data and GIS layers, and codes supporting the development and use of statistical and process-based models for environmental isotope ratio variation. Working through the GUI, users can select data and specify model parameterizations, submit and manage jobs, and visualize, download, or publish output including statistical descriptions of models and map predictions of the geographic variation in environmental isotope ratios.

Potential and demonstrated applications of the current version of IsoMAP include quantification of water isotope/climate relationships for different regions and time periods, evaluation of the stability or difference in isotope/climate relationships among regions and times, calibration of H- and O-isotope based proxies, and interpretation of H and O isotope data from biological and geological materials as a geographic source tracer. Future updates will provide additional functionality such as forward-modeling of H and O isotopes in plant leaf water and biological compounds.

Tracking the evolution of phase changes in ilmenites in microbial fossilization experiments: Understanding the role of microbes in diagenesis

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Ilmenite and related Fe-,Ti-oxides are ubiquitous components of beach sands and sedimentary rocks [1]. In many ancient sedimentary rocks, "fossil" microstructures that are used as biosignatures often contain mineral assemblages dominated by these metal oxides, and in some cases, are preserved along with trace amounts of graphitic carbon [2,3]. Passive microbial biomineralization occurs in a wide range of natural environments, and can dictate the types of minerals that precipitate [4]. Furthermore, complicated histories and atmospheric inputs also influence much of the mineralic makeup of the rocks present today. Thus, the assemblages in these rocks may not be the same as what was originally formed in the newly lithified sediments billions of years ago. To constrain the effects of microbial processes on diagenesis, phase changes in natural ilmenites (Fe_3TiO_4) were observed in the presence of microbes amd compared to those without microbes under laboratory controlled conditions of increasing temperatures. To identify the mineral phases in these samples, micro Raman spectroscopy, SEM, and XRD were used. Collectively, the results show a correlation bewteen Fe- and Ti-oxide phase changes and the presence of microbes under early diagenetic conditions (T<70ºC), where the precipitation of maghemite (γFe_2O_3) and magnetite (Fe_3O_4) starts to occur on the ilmenite surface. The preliminary results presented here are part of an ongoing collaborative study to understand the role of biological processes in diagenesis. In the process, mineralic biosignatures can be established as we continue to perfect analytical instrument techniques for future planetary life exploration missions.

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