Archean cherts: are they reliable paleo-seawater proxies?

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Archean cherts represent some of the oldest sedimentary rocks on Earth. It is commonly thought that they could be useful paleo-environment indicators, assuming that the silica phase retained the composition of the fluid from which it precipitated. In this study, we conducted geochemical and isotope analyses of three types of cherts (seawater-derived precipitates, fracture-filling cherts and silicified sediments) from the Barberton greenstone belt (3.5-3.2Gy), South Africa, in order to test their reliability for paleo-environment studies.

We show that Archean cherts are a mixture of (*1*) a silica phase that has extremely low concentrations of trace elements and contributes only SiO_2 to the bulk composition, and (*2*) another phase that dominates the trace element composition and varies from site to site. We calculated that 3-4% of phyllosilicate, 20% of carbonaceous matter and only 2% of carbonate is enough to control the chert chemistry and mask the silica composition. Carbonate-rich cherts could be of interest because this phase has long been known to retain oceanic fluid chemistry.

Because the silica phase is easily contaminated, the use of cherts for paleo-environment reconstructions is seriously limited and requires high purity precipitates. Massive white chert layers at Buck Reef have SiO_2 close to 100wt% and extremely low concentrations in all the trace elements. We argue that these chemical features are the sole reliable criteria available for now to recognize a pure precipitate, i.e. one that lacks continental contributions, but that they are not sufficient to rule out a possible hydrothermal contribution. Otherwise, only systematic field and petrographic studies can help to distinguish the various chert types, as their composition does not depend on the formation process.

The high purity white cherts from Buck Reef display strong LREE depletions, positive La anomalies and superchondritic Y/Ho ratios that resemble modern seawater. However, these commonly used proxies for the recognition of seawater-derived precipitates fail to distinguish the origin of the silica, these characteristics being similar to those found in hydrothermal, metamorphic and pegmatitic quartz. An unusual feature is the strong positive Sm-anomalies of these samples which have never been observed in any other terrestrial rock.

Prediction of Effects of Acetogens on Hot Spring Biogeochemistry

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Acetogens are a broad category of obligately anaerobic bacteria that are found in a variety of ecosystems and are able to use diverse electron donors and acceptors. Activity of acetogens has been studied in many terrestrial environments, but the activity of acetogens in hot spring environments is not well understood. For this reason, acetogens in hot spring may have a wider impact on hot spring geochemical cycles and microbial populations, beyond just acetogenic activity. One method to predict the impacts of versatile metabolisms on the flow of energy and material through microbial systems is metabolic stoichiometric modeling, which extracts systemic information from molecular-level network structure and conservation relationships, depending on electron donors and acceptors in the growth environment. To test this hypothesis, an intitial model has been constructed from the annotated genome of the well-studied acetogen, *Moorella thermoacetica*, and the output data have been sorted against various cellular strategies, including maximal efficiency of biomass yield per substrate, and substrate consumption in the presence of high exogenous concentrations of produced metabolites. Output from such models has successfully predicted substrate concentrations that yield elevated ethanol production, as opposed to acetate, when *M. thermoacetica* was grown on CO_2 and H_2. This research has shown the utility of metabolic modeling in predicting electron donor and acceptor use and production of organic acids and alcohol in the *M. thermoacetica*. These types of models will help to predict the effects of acetogenic activity on the overall biogeochemistry in hot spring environments.

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