Early Earth and rocky extrasolar planet characterization

Scientists are currently designing instruments, telescopes, and spacecraft to search for evidence of life beyond Earth. This search for life beyond Earth comes with an expectation to detect life that is different than the life found on modern-day Earth. But scientists will also be expected to provide compelling proof behind any claims that we are not alone. These two expectations are seemingly at odds with each other, because it will be easiest to provide compelling evidence for life when we have a deep understanding of the life we are looking at.

The study of Earth history provides a means to reconcile this tension. Different periods of Earth history present us with biospheres that are dramatically different from modern-day Earth, but for which we have abundant data. This informs our understanding of habitability, because of the variety of global chemical and climatic conditions in Earth history for which we know life has thrived. The study of Earth history also informs our understanding of how to detect life; as the global influences of life have completely changed, so have the detectable features of Earth's biosphere.

The appreciation of our home planet as a tightly coupled system also provides us top-level lessons for how to search for an even broader set of biospheres with a wider variety of detectable features. The study of Earth history has taught us that life is a both a function of and critical forcing on the planetary environment. Numerical models of these interactions can by driven by our understanding of Earth history, and be validated against the geological and geochemical data. These models can then be applied to a wider variety of planetary conditions. This will help scientists determine what kinds of life are possible, and eventually help them recognize and confirm the presence of life on rocky planets around other stars.