It is common knowledge that biology shaped the geochemical and geologic evolution of Earth. Did massive biology help shape Mars also?

Three salient features are apparent when studying the body of Mars data obtained over the past decades:

1: The Mars environment has been highly oxidized in the recent geologic past, up until the present.

2: Mars has not only been a liquid water-rich planet but may have supported an atmospheric-surface-and surface hydro-cycle.

3: Mars required a high-pressure green-house gas rich atmosphere to allow the liquid water environment of its past. These three salient features evoke a Mars that is complex, and exotic compared to past models, and seems in some respects, contradictory.

This research proposal will form and test a synthesis concerning Mars past climate evolution, drawing on the body of Mars data, based around the idea of a biology-shaped Mars.

However, the Model described in this proposal can answer these contradictions and allows both a powerful greenhouse environment and mechanisms for its long-term stability. Biology, as it turns out, by providing oxygen through photosynthesis, can chemically stabilize a carbon-dioxide greenhouse while at the same time, the greenhouse, by providing warm temperatures and a liquid water environment, can promote the biology that stabilizes it. Thus, a Martian "Gaia" appears possible. Such a system would leave vast chemical imprints on the Mars regolith, detectable by a rover, an orbiting satellite, and chemical analysis of Mars meteorites, that can provide tests in its analysis.

It is well known that the most common gas candidate proposed for a dense greenhouse environment is Carbon Dioxide, however, the liquid water environment this allowed on Mars' surface destabilizes the greenhouse regime chemically, since the liquid water forms carbonic acid with the atmosphere which attacks the basalts primarily making up the Martian regolith, composed mainly of Fe II and Mg silicates. The carbonic acid forms iron II oxide, thus pulling the carbon dioxide out of the atmosphere and requiring some mechanism to "recycle" the carbon dioxide back up into the atmosphere if the greenhouse is to be sustained.

Nili Fossae may contain such deposits. However, in the presence of free oxygen, Fe II compounds quickly become Fe III for which no carbonate exists. Thus, the presence of large amounts of free oxygen acts as a Carbon Recycling agent, forcing the carbon dioxide to remain in the atmosphere. Carbonates, however, remain rare on Mars' surface and in the Mars' meteorites, being found only in ALH8001 in any quantity.

There remain significant issues however, related to the problems of the "Faint Early Sun Paradox" that can undermine the simple oxygen-stabilized carbonic greenhouse. The Early Solar output is thought to have been weak, causing difficulties in raising environmental temperatures. However, this problem also exists on Earth. In this research these problems will be addressed in terms of appealing to abundant geomorphological evidence of flowing water in both Earth and Mars' distant past. The Paleo-Ocean of Mars, first proposed by the author, which lies on the youngest part of Mars, indicating its longevity, is a compelling piece of evidence for a persistent greenhouse.

Finally, the model of a persistent, bio-stabilized greenhouse, by its robust stability, requires a catastrophe to end it. Nature provides a simple solution to this problem, in the proximity of Mars to the asteroid belt. The Lyot Impact basin in the Northern hemisphere of Mars gives evidence of an Extinction Level Event in recent geologic time on Mars that could have killed most of Mars biology and led to the collapse of the greenhouse effect. Thus, evidence for both an origin and sustainment of a Mars biological greenhouse and stark mechanism for its termination is present.