Goldschmidt 2024 Abstract
https://doi.org/10.46427/gold2024.24123

Characterizing Earth's mineralogical biosignatures via mineral network analysis

SHAUNNA MORRISON, ANIRUDH PRABHU, ROBERT M HAZEN, MICHAEL L WONG AND AHMED M ELEISH

Carnegie Institution for Science

Presenting Author: smorrison@carnegiescience.edu

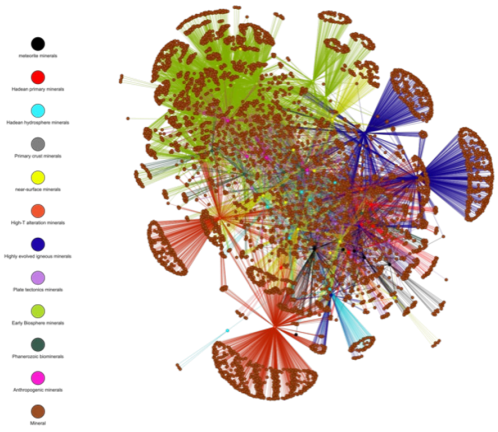

Figure 1. A network representation of the relationships between all known mineral species and their modes of formation in our solar system. Brown nodes represent mineral species. Colored nodes represent paragenetic modes (modes of mineralization). Links demonstrate that a mineral is known to form in the linked paragenetic mode.

Determining the habitability of planets remains a fundamental question in science and society. In this study, we harness network theory to explore the unique patterns exhibited by minerals and their mineralizing environments in both biotic and abiotic contexts throughout the evolution of Earth and other terrestrial bodies in our solar system [1-. By examining mineralogical networks across diverse planetary systems, including early solar system bodies, the early Hadean Earth (closely related to modern-day Mars), plate tectonics, and modern Earth, we gain valuable insights into Earth's history and the factors that have shaped the development and sustainability of life. Our investigation reveals distinct characteristics within biotic networks, setting them apart from their abiotic counterparts.

This research significantly advances our understanding of the intricate interplay between Earth and life. Network analysis offers deeper insights into the connections between minerals and living systems, providing invaluable perspectives on the emergence and co-evolution of life on our planet. Moreover, our findings contribute to identifying and characterizing planetary biosignatures, essential for the search for extraterrestrial life. Recognizing these unique patterns within biotic networks lays the groundwork for developing targeted exploration strategies for detecting potential biosignatures and interpreting the complexities of planetary environments.

Our innovative network analysis of minerals and mineralizing environments sheds new light on the relationships between Earth and life. By delving into the intricate connections within biotic and abiotic systems, we deepen our understanding of Earth's dynamic history and enhance our knowledge of potential habitats for life beyond our planet.

References:

[1] Morrison SM, Liu C, Eleish A, Prabhu A, Li C, Ralph J, Downs RT, Golden JJ, Fox P, Hummer DR, Meyer MB, Hazen RM (2017) Network analysis of mineralogical systems. American Mineralogist, 102, 1588-1596, https://doi.org/10.2138/am-2017-6104CCBYNCND

[2] Morrison SM, Prabhu A, Hazen RM (2023) Exploration of the Biological Influence in Earth's Mineralogical Networks, Geological Society of America Abstracts with Programs. Vol. 55, No. 6, 2023, doi: 10.1130/abs/2023AM-394193

[3] Morrison, S.M., Prabhu, A. and Hazen, R. (2023) Is Earth's biological influence recorded in its mineralogical networks? AGU23.