**"Mineralogical Co-Evolution of the Geo- and Biospheres:
Metallogenesis, the supercontinent cycle, and the rise of the terrestrial biosphere"**

The near-surface environment of terrestrial planets and moons evolves as a consequence of selective physical, chemical, and biological processes—an evolution that is preserved in the mineralogical record. Mineral evolution begins with approximately 12 different refractory minerals that form in the cooling envelopes of exploding stars. Subsequent aqueous and thermal alteration of planetessimals results in the approximately 250 minerals now found in unweathered lunar and meteorite samples. Following Earth's accretion and differentiation, mineral evolution resulted from a sequence of geochemical and petrologic processes, which led to perhaps 1500 mineral species. According to some origin-of-life scenarios, a planet must progress through at least some of these stages of chemical processing as a prerequisite for life. Once life emerged, mineralogy and biology co-evolved and dramatically increased Earth's mineral diversity to >4800 species.

Sequential stages of a planet's near-surface evolution arise from three primary mechanisms: (1) the progressive separation and concentration of the elements from their original relatively uniform distribution in the presolar nebula; (2) the increase in range of intensive variables such as pressure, temperature, and volatile activities; and (3) the generation of far-from-equilibrium conditions by living systems. Remote observations of the mineralogy of other terrestrial bodies may thus provide evidence for biological influences beyond Earth.

Recent studies of mineral diversification and metallogenesis through time reveal striking correlations with major geochemical, tectonic, and biological events, including changes in ocean chemistry, the supercontinent cycle, the increase of atmospheric oxygen, and the rise of the terrestrial biosphere.