COOLER AND WETTER CONDITIONS FAVOR FE-RICH AMORPHOUS MATERIAL FORMATION AND PERSISTENCE IN TERRESTIAL SOILS CHEMICALLY SIMILAR TO SEDIMENTS AT GALE CRATER, MARS

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X-ray amorphous material has been detected in all samples measured within Gale crater, Mars to date, with smectites commonly found in ancient fluviolacustrine mudstones. Chemical data indicate the amorphous material is Fe-rich and at least partly incipient weathering products. Despite its prevalence, little is known about the nature of the Fe-rich amorphous material or its relationship with the crystalline phases present. In this study we investigate pedogenesis within terrestrial Mars-analog ultramafic soils of different ages within mediterranean, subarctic, and desert climates. Bulk and selective digestion methods and Rietveld refinements of powder XRD patterns are utilized to examine climatic effects upon soil mineralogy and chemistry and the formation and longevity of Fe-containing amorphous material.

X-ray amorphous content is high in the clay size fraction of the youngest soils in both the mediterranean and subarctic climates, but decreases in the older soils in the mediterranean climate concurrent with a rise in smectite abundance. In contrast, X-ray amorphous material dominates the clay size fraction of all soils in the subarctic climate with no observed decrease in X-ray amorphous material nor formation of smectites in any of the examined soils. The least amount of amorphous material is observed within the desert soils. Selective dissolutions indicate that secondary Fe within the subarctic climate soils is almost entirely found within amorphous Fe-oxyhydroxides and silicates, with Fe predominantly incorporated into crystalline oxyhydroxides and clay minerals in soils within the mediterranean and desert climates. Fe-rich amorphous material formation and persistence thus appears influenced by climatic conditions, with wet conditions necessary for the formation of amorphous material and cooler conditions favoring the longevity of Fe-rich amorphous material. These results suggest the Fe-rich amorphous material at Gale crater likely formed under cool and wet conditions, with continuing cool conditions post-formation permitting preservation of the amorphous material to the present.