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SPECIAL COLLECTION: EARTH ANALOGS FOR MARTIAN GEOLOGICAL MATERIALS AND PROCESSES

Formation of the ferruginous smectite SWa-1 by alteration of soil clays

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Abstract

Clay minerals found in and near the surface of Mars contain unique information about the geochemical environment in the martian near-surface in the ancient past. To interpret this information, it is necessary to fully understand the environments in which different clay minerals form. Studies of terrestrial analog materials and environments are a useful way to address such questions, and some terrestrial materials are also important standards for remote sensing and in situ chemical and mineralogical analyses. This study presents new information on the formation environment of an unusual standard clay, the Clay Minerals Society source clay SWa-1 ferruginous smectite of Grant County. The SWa-1 collection locality is in the Columbia River Basalts (CRB), at the contact between a paleosol and a capping basalt flow. Features at the contact indicate the paleosol soil was wet when the capping flow was emplaced, that lava-sediment mixing occurred, and that both the soil and the capping lava were hydrothermally altered. The soil was hydrothermally enriched in Fe, Mn, and Si. The SWa-1 sample was collected from within the altered zone, suggesting it formed through alteration of paleosol clays by addition of Fe. Similar environments are widespread in the CRB, particularly at the plateau margins, suggesting that altered clays may occur frequently at lava-sediment contacts. Such environments are likely to occur wherever basalt flows are emplaced under warm, wet conditions promoting weathering—such as Mars >3.5 Ga before the present, when clay minerals were forming at its surface. This information has important implications for the use of clay compositions to inform clay formation environments on Mars.

Keywords: Nontronite, Mars, clay minerals, Columbia River Basalts, SWa-1