DESERT VARNISH: MINERALOGY OF THE FERROMANGANESE OXIDES

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We have found infrared spectroscopy to be particularly useful for the mineralogical analysis of ferromanganese oxides because of its suitability for the study of disordered phases, very fine particles and their mixtures. We have used infrared spectroscopy, in conjunction with optical spectroscopy, electron microscopy and chemical analysis, to determine the mineralogy of desert varnish, a dark coating of clay minerals and ferromanganese oxides found on rock surfaces exposed in dry regions throughout the world. Varnish from the Mojave and Sonoran Deserts, Death Valley, and the Colorado Plateau was found to have a characteristic mineralogy independent of locality. Comparison of the infrared data with spectra of well-characterized standards indicates the presence of the manganese oxide birnessite and suggests the presence of romanechite or hollandite as a second manganese oxide phase. This is consistent with chemical data, which show an average manganese oxidation state of +3.9 and up to 1.2% barium. Optical spectroscopy indicates that iron oxide is present as hematite. Electron microscopy shows no recognizable oxide crystal morphology to a resolution of 5 Å. Desert varnish is clearly distinguished from manganese nodules, manganese dendrites, and ferromanganese river deposits by its invariably high clay content and its oxide mineralogy.