Deliquescence Relative Humidities of Salts and Dusts Deposited Inside the Drifts of a Potential High-Level Waste Repository

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In underground facilities such as the potential high-level waste disposal facility at Yucca Mountain, Nevada, environmental conditions inside the repository drift are important to estimating the life expectancy of waste packages and wasteforms. Inorganic salts present in evaporated groundwater or dusts that deposit inside such facilities may absorb moisture from humid air (deliquesce) and form brines potentially corrosive to metallic engineered barriers and ground support materials. In this study, deliquescence measurements were conducted on inorganic salts and synthetic dust mixtures representative of those that may deposit inside the drifts of the potential Yucca Mountain repository. Dust samples were taken from inside the Exploratory Studies Facility at Yucca Mountain to characterize the mineralogic composition and inorganic salt content and to measure the mutual deliquescence relative humidity (MDRH) of the salts present in the dust. X-ray diffraction analysis showed the dust samples are predominantly quartz, with albite, anorthite, and calcite also present. Initial chemical analysis showed that the soluble fraction is less than 10% of the total mass of the dust sample, with Ca^{2+}, Na^{+}, K^{+}, SO_4^{2-}, Cl^{-}, and NO_3^{-} as the major ions. Because the salt fraction was too low to measure the MDRH given the sample volume, the deliquescence measurements were conducted on simulated salt mixtures prepared from reagent-grade chemicals. The MDRH of the salt mixtures was determined using an electrical conductivity method in a humidity chamber, where deliquescence relative humidity is determined by the relative humidity at which conductivity across an electrochemical cell dramatically increases. To evaluate the effect of the insoluble fraction of dust, the synthetic salt mixture also was tested for deliquescence in combination with various ratios of clean quartz dust of similar particle size to natural dusts.