Chemical associations in legacy materials from nuclear testing in carbonate and seawater environments

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Radionuclides from a nuclear event can have prolonged presence in the environment due to the long-lived nature of several actinides and fission products. During the era of above ground nuclear testing, tests were conducted in a limited range of near-surface environments (terrestrial deserts and carbonate islands). In silica-rich environments, fallout glasses laced with radionuclides form when local environmental soils are swept up into the fireball and partially or fully melted. Such glasses form a vitrified, relatively immobile host for these radionuclides, inhibiting subsequent mobility to the environment. A more limited amount of information regarding the incorporation of radionuclides into environmental materials in carbonate-rich environments. In this work we are seeking to gain insight on the formation of fallout produced in a carbonate - sea water environment. We compare the characteristics and geochemistry of natural soil samples to materials sampled in the vicinity of a nuclear event collected decades after the detonation occurred. We establish the spatial distribution of radioactivity in the materials using autoradiography and report the morphological and chemical characteristics of the local environment using SEM imaging and ICP-MS. Although strong sample weathering and sample alteration were expected, results demonstrate that the samples retain trace anthropogenic chemical signatures decades after the event occurred. We then examine elemental associations between residual actinide terms and trace element constituents. A strong interaction with seawater is implied based on an observed signature of Na, S enrichment. We hypothesize about the effects of carbonates and seawater on the speciation of radionuclides and formation of fallout in carbonate rich environments.

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