Geochemical and microbial characteristics of waste disposal sites affected by seawater intrusion and high alkalinity

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Constructing underground waste storage sites can cause dramatic changes in groundwater quality as well as groundwater flow direction and level decline, which may also influence subsurface microbial activities and community compositions. We collected several groundwater and sediment samples from the underground waste storage sites near coastal region in South Korea. To understand how the underground construction influences the subsurface environments, we investigated geochemical variations, major mineral precipitates and microbial community compositions at different locations of the waste disposal sites (S1~6). Type of water from S1, S2, S3, and S5 was Ca-Cl-type with relatively high TDS, while that from S4 and S6 was Ca-Na-HCO_3 type. Seawater mixing extent calculated by the Cl and $\delta^{18}O$ ratios showed that the groundwaters were affected by seawater at S1(15%), 3(2%) and 5(5%). Various sulfate reducing bacteria were identified with relatively high concentrations of sulfate due to the seawater intrusion at these locations. High abundance of *Gallionella* and *Geobacter* at S3 indicated that they contributed to a high Fe concentration in grondwater, and subsequently the formation of iron minerals (i.e., $Fe(OH)_3$, α-FeOOH, $FeCO_3$). S5 and S6 showed extremely high pH (>10) and very high abundance of *Hydrogenophaga* previously discovered in alkaline groundwater (pH>10) or sediment as alkali-tolerant benzene-degrading bacteria. Thermoanaerobacterales, halophilic, alkalithermophilic bacteria, was also predominant at S5 and S6. This study suggests that underground construction can create distinct, localized geochemical conditions (i.e., high alkalinity, salinity and oxidation) and also impact microbial community structure. The changes in the biogeochemistry at this site may produce hydrogen sulfide from biological sulfate reduction and result in clogging from mineral precipitation. Long-term monitoring is necessary to better predict the impact of the subsurface biogeochemical changes on the site.