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The effect of particle size on weathering and salt release from coal mine spoils

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Coal mining activities produce considerable amounts of spoil (waste rocks), which are dumped on the land surface. When weathering processes occur and during rainfall events, spoil can create environmental hazards, such as the seepage of solutes to the surrounding areas. In particular, the dissolution of salt from coal mine spoil can result in undesirable levels of surface water and groundwater salinity. To reduce the risk of seepage, and to manage the spoil deposition and rehabilitation, understanding salt dynamics and estimation of salt generation from spoil is essential. This study was conducted to understand the effect of particle size and degradation characteristics on the amounts and dynamics of salt release from coal mine spoils. Two spoil types (rock-like and soil-like), were collected from a mine site in Queensland, Australia. The samples were sieved to different particle size fractions (<2mm, 2-6mm and >6mm) and were subjected to seven wetting and drying cycles, in which the samples were periodically (approximately one-month interval) leached with deionised water. Concentrations and loads of total salinity and major ions were measured during each leaching cycle. After 15 pore volumes of leaching, cumulative Na+ production approached 10.5, 9.5 and 5.2 mmol L-1 for rock-like spoil sieved to <2mm, 2-6mm and >6mm, respectively. The release of other major ions from rock-like spoil also followed similar pattern to the Na+ production. This indicated that there is a relationship between salt production potential and particle size, in which, for the same spoil, larger particles produced lower amounts of solutes at the same number of pore volumes of leaching. Major cations depletion rates suggested that soil-like spoil degraded after the third wet-dry cycles, which caused an increase in salt leaching, possibly due to an increase in cation exchange and dissolution. This study highlights that a greater macro-pore volume and fast water movement as a result of larger particle size fractions are associated with a lower rate of cation exchange and salt dissolution, which results in lower salt generation.