Crystallochemical Basis of Synthetic Mineral Immobilisation

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Designing contemporary methods for immobilising pollutants is underpinned by crystal chemical and mineralogical principles [1], with the selection of a ceramic or synthetic mineral immobilisation matrix governed by several considerations. First, toxic metals should be incorporated in their least toxic chemical states. For example, substances that eschew As^{3+} and Cr^{6+} in favour of less dangerous As^{5+} and Cr^{3+} are preferable. Second, as this illustration indicates, it is sometimes necessary to simultaneously accommodate the oxidized and reduced species of different metals, restricting the suite of mutually compatible minerals that can be selected. Third, crystal structures are preferred that have multiple cation and/or anion acceptor sites as this minimizes the number of phases required to crystallise simultaneously, and allows greater flexibility to respond to variations in waste stream composition. This in turn limits the chance of undesirable compounds forming. Finally, phases with large numbers of appropriate cation acceptor sites are advantageous, as they result in higher waste loadings and less ‘bulking’ of the waste product through the introduction of inert additives. These matters will be illustrated by reference to the zirconolites [2], already being used for nuclear waste treatment, and the apatites [3,4] that are potential materials for the fixation of hazardous waste.

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