6.1: Separating group IV cations

After removing chloride insoluble salts as the group I, and sulfide insoluble salts as group II and group III, the cations that may still be present in the solution from the initial mixture include Ca^{2+}, Ba^{2+}, Na^{+}, and K^{+}. Group IV comprises Ca^{2+} and Ba^{2+} that are separated from the other two ions based on the insoluble ions rule#2 described in chapter 1 which states "Carbonates (CO_3^{2-}), phosphates (PO_4^{3-}), and oxide (O^{2-}) are insoluble with the exception of alkali metals and ammonia." Carbonate ion is introduced as ammonium carbonate ($(NH_4)_2CO_3$):

$$(NH_4)_2CO_3(s) + 2\,H_2O(l) \longrightarrow 2\,NH_4^+(aq) + CO_3^{2-}(aq)$$

Addition of $(NH_4)_2CO_3$ solution cause precipitation of Ca^{2+} and Ba^{2+} as white precipitates $CaCO_3$ and $BaCO_3$, as shown in Figure 6.1.1:

$$Ca^{2+}(aq) + CO_3^{2-}(aq) \rightleftharpoons CaCO_3(s, \text{white})\downarrow \quad K_{sp} = 6 \times 10^{-9}$$

$$Ba^{2+}(aq) + CO_3^{2-}(aq) \rightleftharpoons BaCO_3(s, \text{white})\downarrow \quad K_{sp} = 3 \times 10^{-9}$$

The precipitates of group IV cations are separated by centrifugation and decantation. The precipitate is used to separate and confirm group IV cations and the supernatant is kept for the analysis of group V cations.

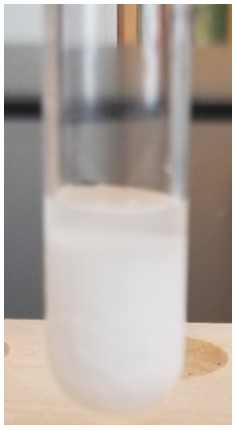

Figure 6.1.1: Group IV precipitates, $CaCO_3$ and $BaCO_3$.