

## The weathering engine conveyor belt and corestone size distributions

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In weathering profiles developed at Gettysburg (Pennsylvania, U.S.A.), unweathered diabase bedrock fractures and chemically alters by spheroidal weathering to produce a population of corestones surrounded by rindlets overlain by saprolite. It appears that once corestones reach a limiting size they no longer form new rindlets but weather strictly by a diffusion-limited infiltration mechanism.

We model the gross features of the chemistry and mechanics of rindlet formation and the production of weatherable surface area for a steady erosion rate  $W$ . The model yields a steady state profile of corestone volume fraction,  $f_c$ , decreasing upwards to the erosional surface from a value  $f_c \approx 1$  at a depth,  $H$ , where chemical weathering is negligible. Populations of corestones in eroding or eroded material and initial block sizes were determined for the Pennsylvania diabase. The model, analogous to a conveyor belt, was fit to these data using a partial set of independently-estimated parameters in order to constrain the remaining parameters and to investigate the model. The model can be used to calculate the average size of corestones produced by the conveyor belt.

In addition, we have chemical and mineralogical data for 4 meters of saprolite developed on the same diabase versus depth that document the weathering reactions. Two depth intervals are observed where plagioclase and augite are weathering. An upper interface occurs at approximately 125 cm and appears to be coincident with maximum concentrations in organic acids. An additional reaction front is located at approximately 350 cm. We are seeking to develop a model that incorporates both chemical weathering reactions and evolution of corestone and mineral grain sizes as a function of depth.

## Solubility of pyromorphite-mimetite solid solutions at 5-65°C: Variability of thermodynamic stability of minerals from pyromorphite – mimetite series at 5 - 65°C

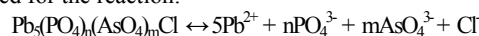
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The precipitation of pyromorphite and mimetite are effective methods of immobilizing toxic ions in contaminated soils and wastes (Maneck *et al.* 2002; Comba *et al.*, 1988). Though the solid solution series of these minerals is confirmed to be continuous, our knowledge about thermodynamic properties of pyromorphite and mimetite and their solid solutions is sparse (Nriagu, 1973; Ingbenebor *et al.*, 1989; Bajda *et al.* 2006).

Solubility of seven synthetic phases from pyromorphite - mimetite solid solution series was measured for three months in dissolution experiments at 5, 25, 45, and 65°C at pH=2 in 0.05 M KNO<sub>3</sub> background electrolyte. Plateau on [Pb] evolution patterns was used to determine equilibrium. This was confirmed by precipitation experiments.

There is a linear increase in solubility constant  $\log K_{SP}$  calculated for the reaction:



with increasing As content in the series, from -79.60±0.02 for Pb<sub>5</sub>(PO<sub>4</sub>)<sub>3</sub>Cl, through -78.54±0.2 for Pb<sub>5</sub>(PO<sub>4</sub>)<sub>1.5</sub>(AsO<sub>4</sub>)<sub>1.5</sub>Cl, to -76.32±0.25 for Pb<sub>5</sub>(AsO<sub>4</sub>)<sub>3</sub>Cl at 25°C. For all phases the solubility product decreased linearly with the inverse temperature indicating a constant enthalpy of dissolution reaction in the experimental range.

For pyromorphite Pb<sub>5</sub>(PO<sub>4</sub>)<sub>3</sub>Cl:  $\Delta H_f^\circ = -4096 \pm 10$  kJ/mol,  $S_f^\circ = 665 \pm 33$  J/mol,  $\Delta G_f^\circ = -3765 \pm 10$  kJ/mol.

For Pb<sub>5</sub>(PO<sub>4</sub>)<sub>1.5</sub>(AsO<sub>4</sub>)<sub>1.5</sub>Cl:  $\Delta H_f^\circ = -3542 \pm 14$  kJ/mol,  $S_f^\circ = 635 \pm 46$  J/mol,  $\Delta G_f^\circ = -3203 \pm 14$  kJ/mol.

For mimetite Pb<sub>5</sub>(AsO<sub>4</sub>)<sub>3</sub>Cl:  $\Delta H_f^\circ = -2985 \pm 17$  kJ/mol,  $S_f^\circ = 599 \pm 55$  J/mol,  $\Delta G_f^\circ = -2636 \pm 17$  kJ/mol. A linear increase of  $\Delta H_f^\circ$  and  $\Delta G_f^\circ$  and a linear decrease of  $S_f^\circ$  with increasing As content in the series are apparent.

### References

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