

## **Gibbs energies of formation for hydrocerussite $[\text{Pb}(\text{OH})_2 \cdot (\text{PbCO}_3)_2(\text{s})]$ and hydrozincite $\{[\text{Zn}(\text{OH})_2]_3 \cdot (\text{ZnCO}_3)_2(\text{s})\}$ at 298 K and 1 bar from electrochemical cell measurements**

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### **ABSTRACT**

New values are reported for the Gibbs energies of formation from the elements for hydrocerussite  $\text{Pb}(\text{OH})_2 \cdot (\text{PbCO}_3)_2$  and hydrozincite  $[\text{Zn}(\text{OH})_2]_3 \cdot (\text{ZnCO}_3)_2$ . These  $\Delta G_f^\circ$  values were obtained from electrochemical cells without liquid junction. We determined  $\Delta G_f^\circ [\text{Pb}(\text{OH})_2 \cdot (\text{PbCO}_3)_2(\text{s})] = -1699.8 \pm 1.6$  kJ/mol for hydrocerussite and  $\Delta G_f^\circ \{[\text{Zn}(\text{OH})_2]_3 \cdot (\text{ZnCO}_3)_2\} = -3163.3 \pm 4$  kJ/mol for hydrozincite. These results allow future electrochemical cell experiments to be performed to determine the  $\Delta G_f^\circ$  values of other hydroxycarbonate minerals using either the Pb amalgam-hydrocerussite or the Zn amalgam-hydrozincite as reference electrodes. These reference electrodes provide a strategy for establishing Gibbs energies for phases with two different anions, which are geochemically interesting but difficult to study experimentally.