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Uncertainties Affecting MgO Effectiveness and Calculation of the MgO Effective Excess Factor for the Waste Isolation Pilot Plant

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Magnesium Oxide (MgO) and the WIPP

- MgO is engineered barrier for the WIPP
  - Reacts with CO_2
  - Repository models assume complete consumption of CO_2
- 1.67 moles of MgO placed in WIPP per mole of carbon
  - Excess factor (EF) = 1.67
- DOE wants to emplace EF = 1.2

Hydration of MgO

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Problem Statement

Given the uncertainties involved with modeling the WIPP, can we be confident that emplacing an EF equal to 1.2 be sufficient to consume all CO_2 and, thus, maintain chemical conditions as assumed in WIPP models?

Outline

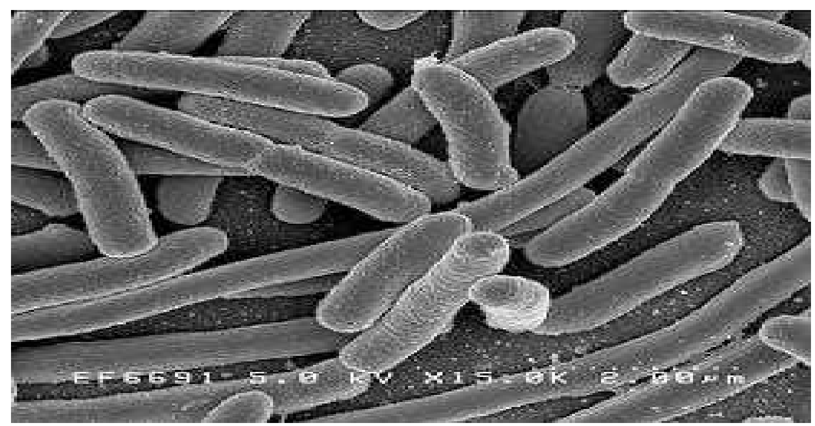
- Role of MgO at the WIPP
- Uncertainties affecting MgO effectiveness
  - Gas generation
  - Quantities of available MgO
  - Rate of CO_2 consumption by MgO
- Effective Excess Factor
- Results & Conclusions

Role of MgO at WIPP

- WIPP is a disposal facility for transuranic (TRU) waste
  - Operated by DOE
  - Regulated by EPA
- Some waste materials contain carbon
- Microbes could consume carbon and produce CO_2
- MgO emplaced to react with CO_2

Gas Generation

- **Assumption: all organic C is consumed**
  - **EPA requirement**
- **Uncertainties include**
  - **Quantities of emplaced carbon**
  - **Microbial respiration pathways**



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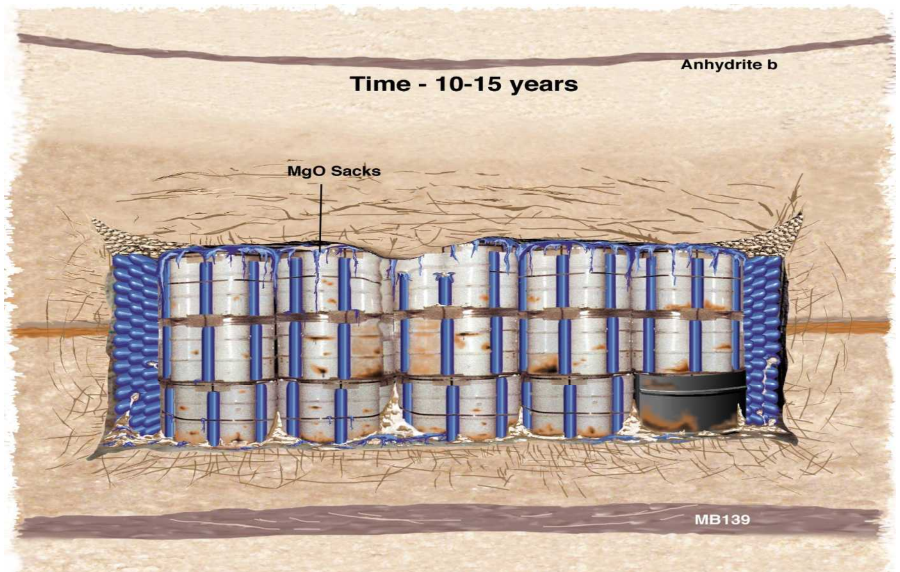
MgO Availability

- **Characteristics of MgO**
  - Variability in reactivity
  - Variability in emplaced mass of MgO
- **Repository processes**
  - Brine outflow
  - Roof collapse
  - Rupture of MgO sacks



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Rate of CO_2 Consumption

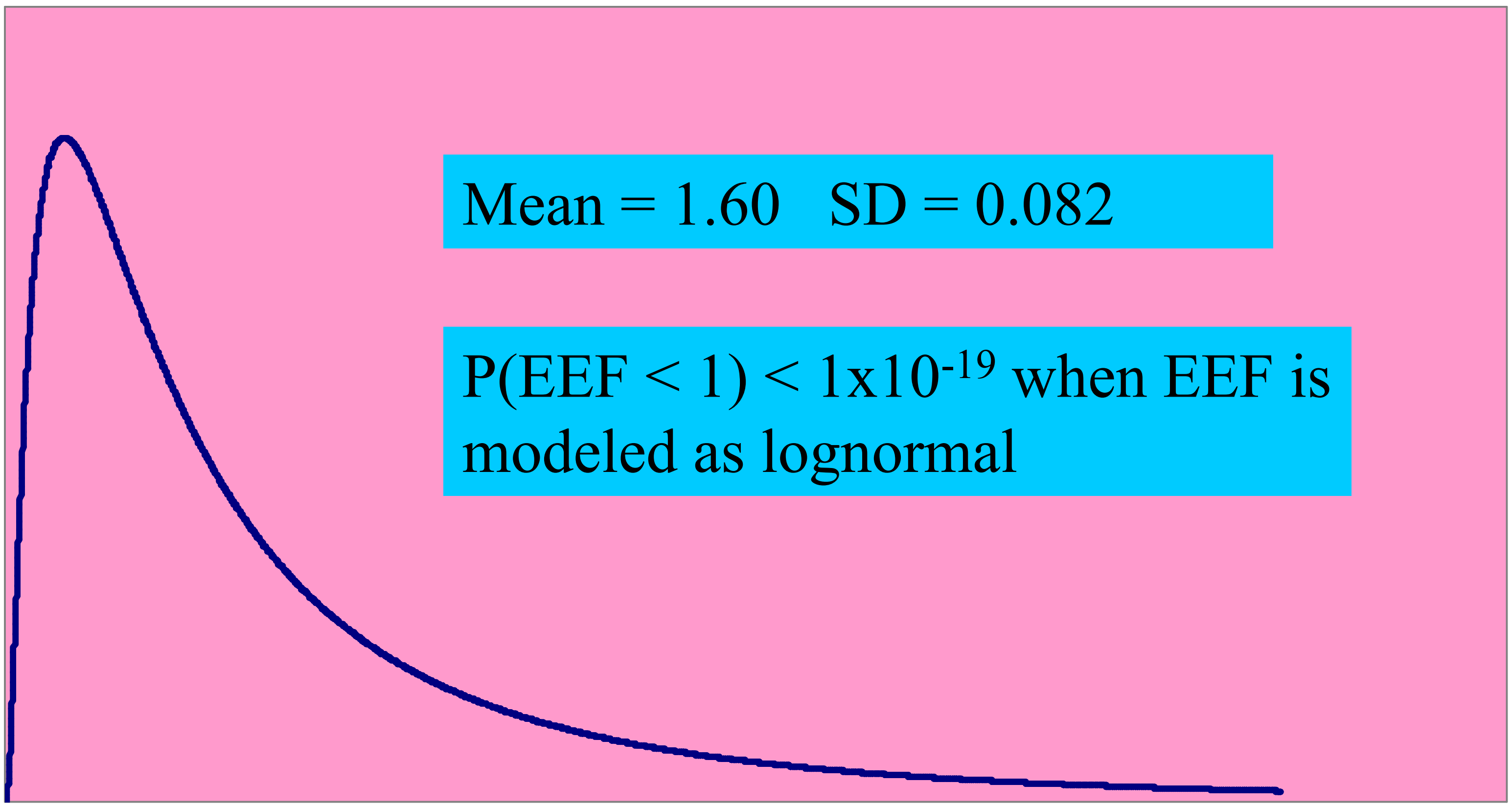
- Formation of magnesium carbonates
  - Hydromagnesite vs. magnesite
- Consumption of CO_2 by other materials
  - Iron, lead, lime
- Incorporation of carbon into biomass

The MgO Effective Excess Factor (EEF)

- **Individual uncertainties quantified**
  - As random variables (when possible)
  - Via assumption
- **EEF defined to assess combined impact of individual uncertainties**
  - EEF is function of several random variables
  - EEF > 1 implies all CO_2 will be consumed

$$EEF = \frac{\text{quantity of available MgO}}{\text{quantity of } CO_2 \text{ generated}} \times \frac{\text{moles of } CO_2 \text{ consumed}}{\text{1 mole MgO}}$$

Results: EEF Distribution



Mean = 1.60   SD = 0.082

P(EEF < 1) < 1×10^{-19} when EEF is modeled as lognormal

Summary and Conclusions

- Major uncertainties affecting MgO effectiveness were identified
- Uncertainties were quantified as random variables when possible
- Cumulative impact of the uncertainties on MgO effectiveness was quantified in the MgO EEF
- Analysis indicates that there is a high probability that emplacing an EF=1.2 will be more than sufficient to consume all CO_2

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