Carbon Dioxide Sequestration by Mechanochemical Carbonation of Mineral Silicates

by

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Carbon Dioxide Sequestration

Sequestration encompasses all forms of carbon storage, including storage in terrestrial ecosystems, geologic formations, and perhaps oceans.

- NETL web site

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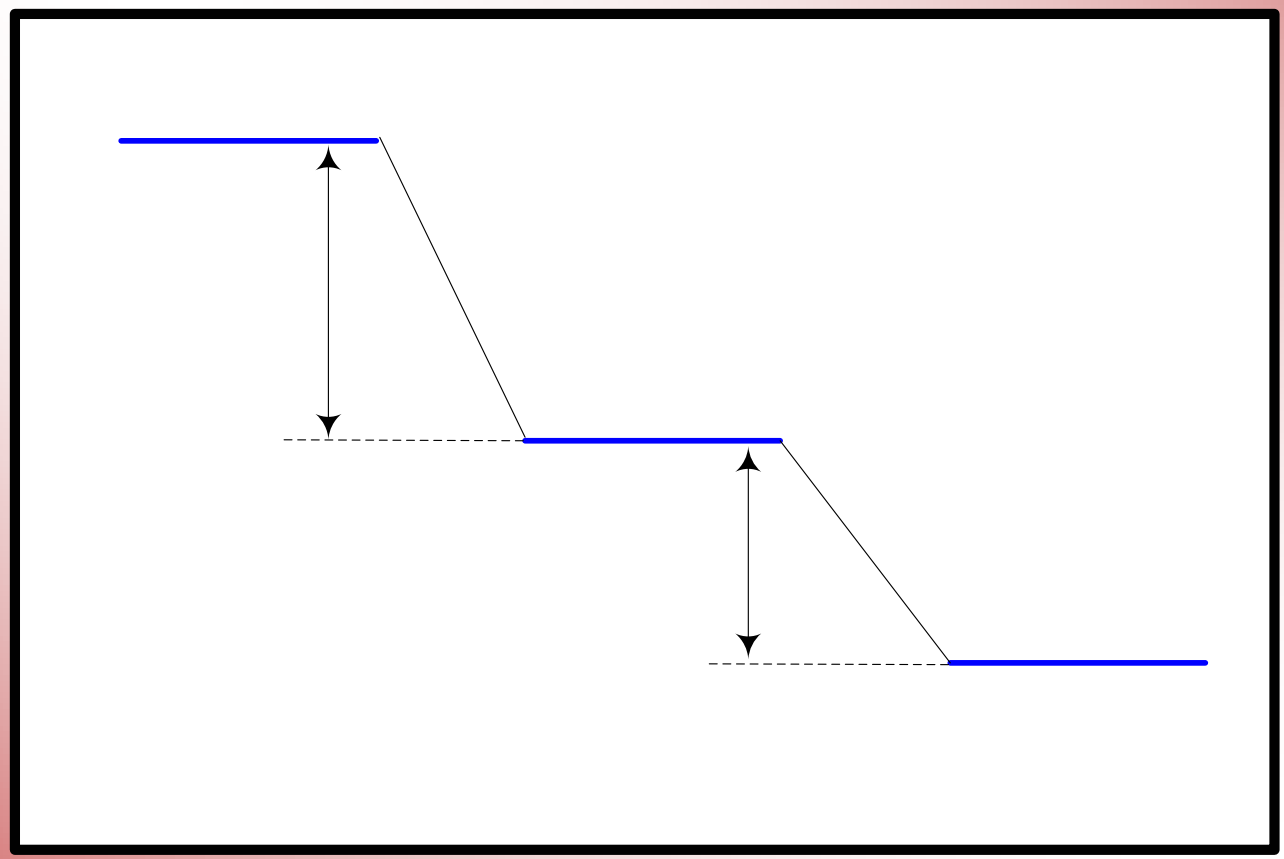
Energy States of Carbon



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Typical Silicate Minerals

Olivine

Serpentine

Talc

Zircon

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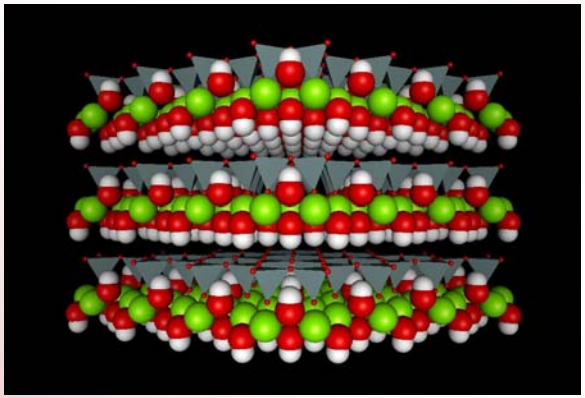
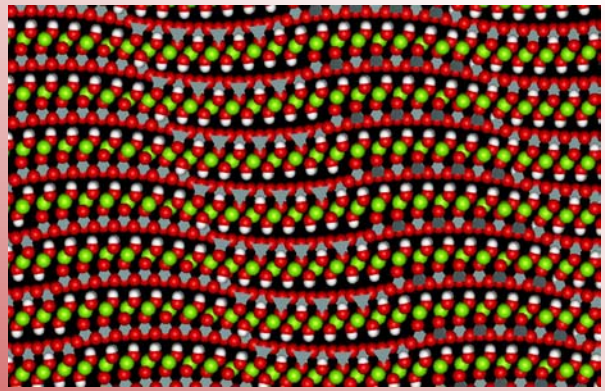
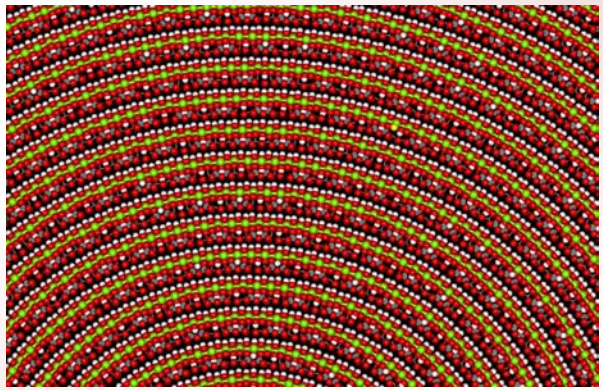
Complex Silicate Structures



Serpentine (Lizardite variety): $Mg_3Si_2O_5(OH)_4$



Antigorite



Chrysotile

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Natural Weathering

- Silicate minerals become carbonates
- The process is slow
- Silicate minerals are abundant

Accelerating Slow Reactions

- Add energy
  - heat
  - pressure
  - mechanical
- Use a catalyst

Ideal Reactions

Serpentine

$$Mg_3Si_2O_5(OH)_4 + 3\,CO_2 \rightarrow MgCO_3 + 2\,SiO_2 + 2\,H_2O$$

Olivine

$$Mg_2SiO_4 + 2CO_2 \rightarrow 2MgCO_3 + SiO_2$$

Typically exothermic

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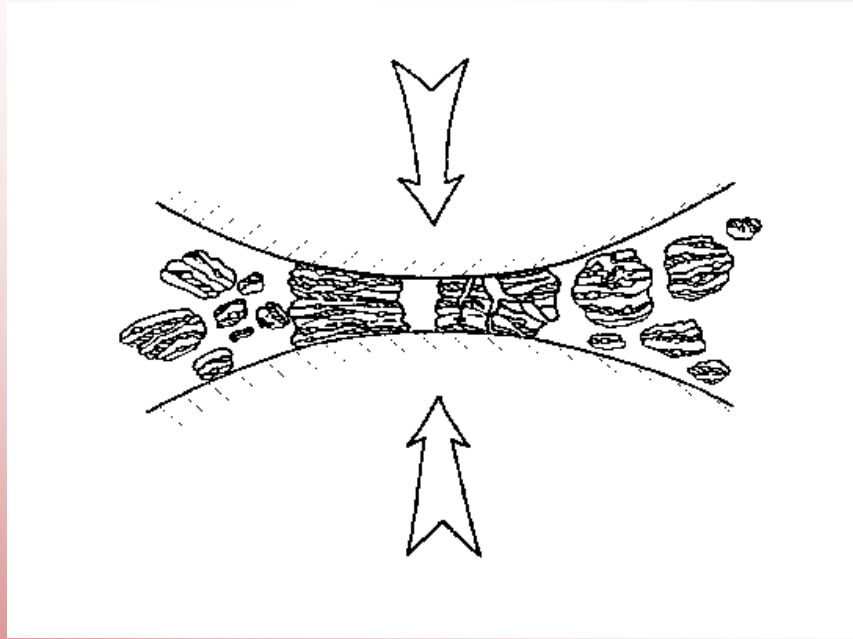
Mechanochemical Reactions

- Originally for powder metal alloys
- Recently for reactive metals



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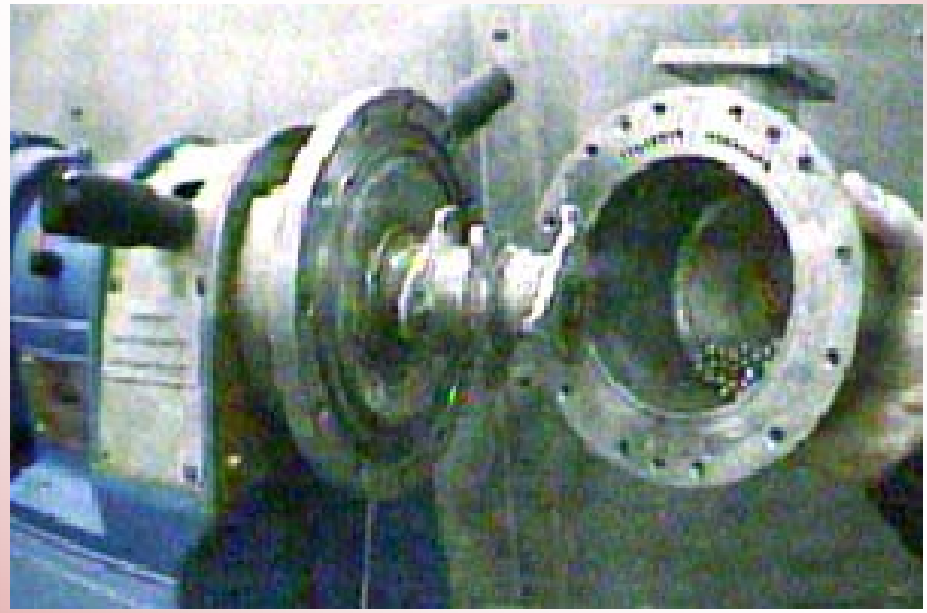
University of Idaho Reactor



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University of Idaho Reactor

Provision for adding inert or reactive gasses

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University of Idaho Reactor

Provision for
adding slurry feed

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University of Idaho Reactor

Primarily used to produce reactive metals:

- Titanium
- Magnesium
- Niobium

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University of Idaho Reactor

Instrumentation allows monitoring of reaction kinetics

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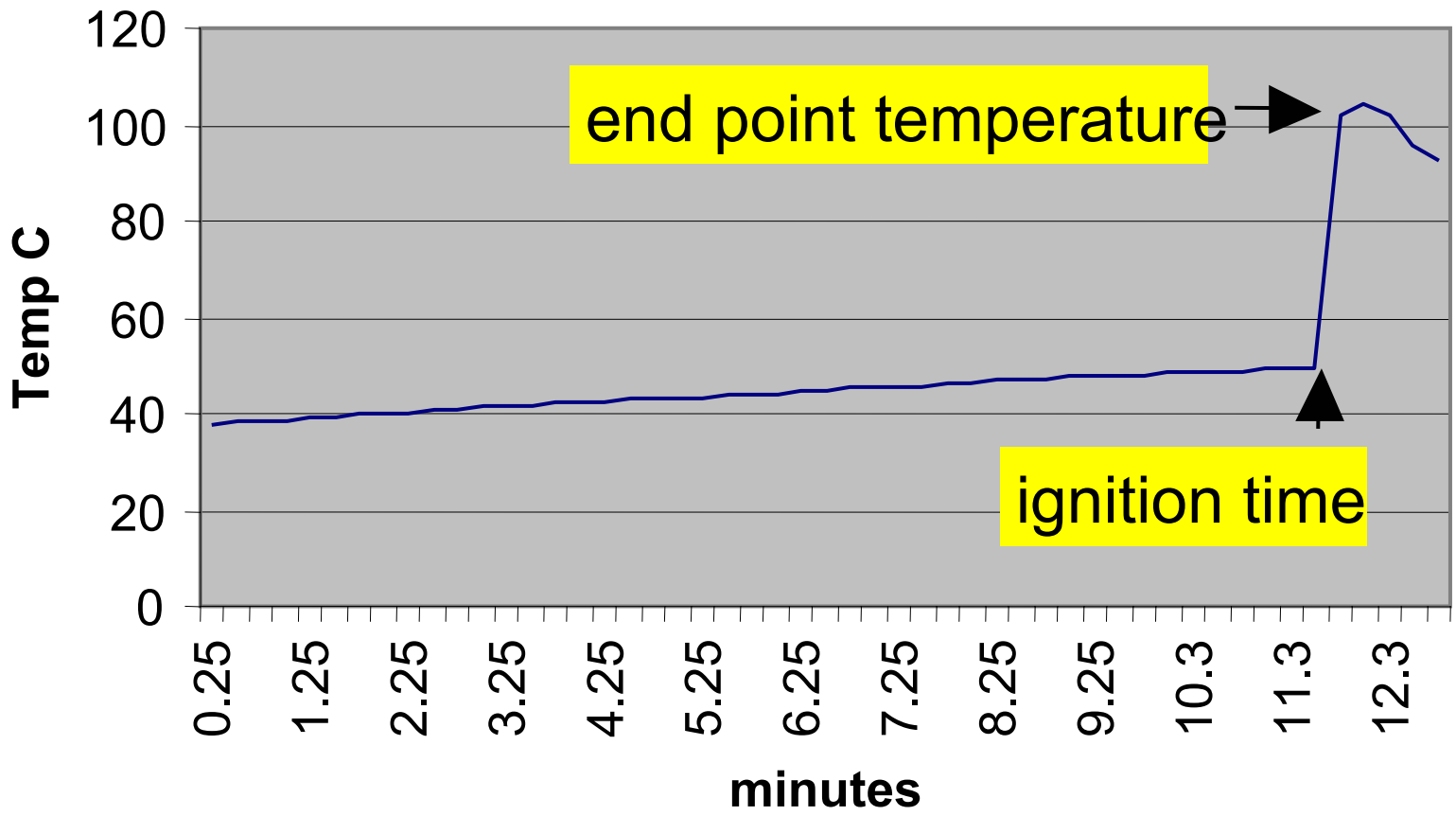

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Mineral Carbonation Tests

University of Utah/University of Idaho

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Mineral Carbonation Tests

- Initial reaction studies at University of Utah
- Pilot plant tests at University of Idaho

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Method Development

- Sample size
- Gas addition
- Gas containmnent
- Product recovery

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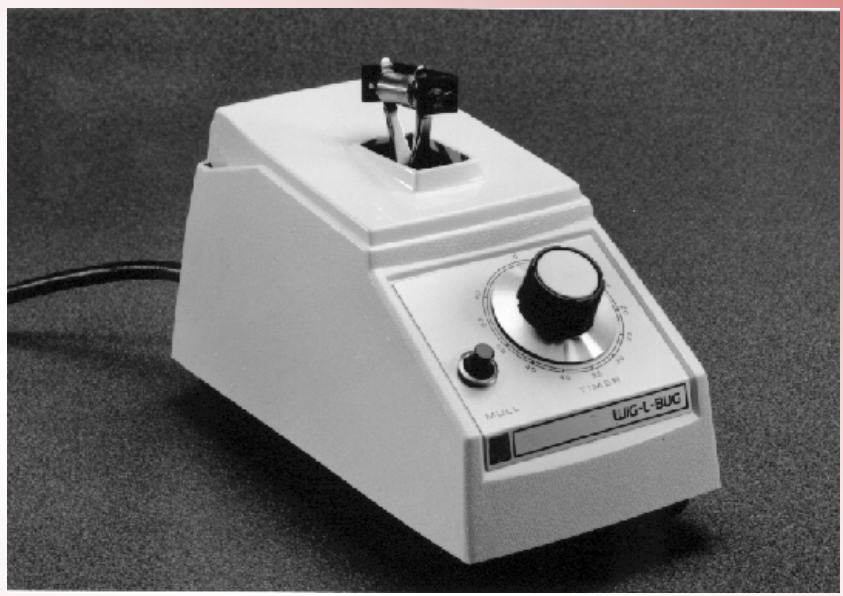
Lab Reaction Tests

- Small scale
- Chemical test materials
  - calcium silicate
  - magnesium silicate
- Mineral test materials
  - serpentine (lizardite)
  - olivine (forsterite)
  - zircon
  - beryl



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