Suitable Materials for Mineral Carbonation: Composition and Localisation

Project: C0319 — Carbonate production by sequestration of industrial CO_2: revalorization of mine and industrial waste

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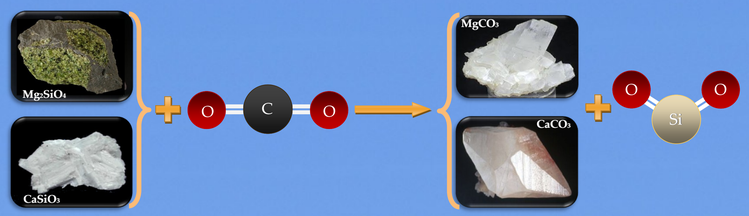
1- Mineral Carbonation Process: from nature to industry

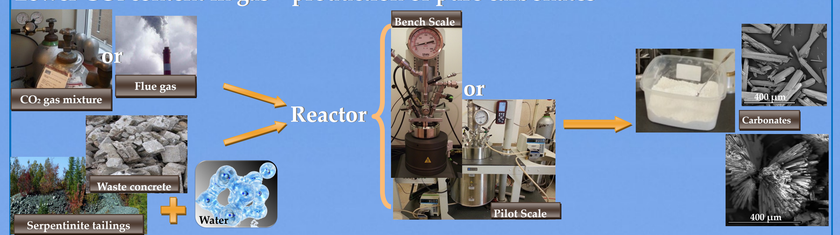
A Natural Process

CO_2 reacts with Mg-/Ca- rich rocks and minerals → carbonates : stable, non-toxic
→ Perfect form to sequester CO_2 permanently but ⚠ Slow kinetics in nature



In an artificial process to accelerate

CO_2 bearing gas mixture or direct flue gas + mine/industrial waste + water → Lower CO_2 content in gas + production of pure carbonates



2- Adequate Material: Choice and Type

Criteria

- Inorganic and solid material for easier storage
- Alkaline for better reaction with CO_2
- High content in Mg and Ca and high sequestration capacity per mass unit
- Mg and Ca in reactive forms of minerals, non-carbonated
- Sufficient amount in geographical zone of CO_2 emitters, with accessibility
- Carbonates and by-products obtained can be valorized
- Non-toxic by-products and limited lixiviation

Numerous possibilities

Mafic and Ultramafic rocks and minerals (rich in Mg, Fe and Ca):

- Ophiolite, serpentinite, peridotite, kimberlite, basalt, olivine, wollastonite, brucite, etc.

→ Some inconvenient: not always accessible, need of mining exploitation and treatment before mineral carbonation

Industrial wastes and residue:

- Waste concrete and aggregates, cement kiln dust, demolition waste, steelmaking slag, APC[1] residue, fly ash, mine tailings and sterile

→ Advantage: no need of mining exploitation, often closer to CO_2 emitters, elimination and valorization of industrial/mining residue

3- Where to find them in Canada?

Canadian Shield and Cordilleran Orogeny:

- Ultramafic rocks and Minerals (not mined)
- Exploitation of metals : Ni, Cr, PGM[2], etc.

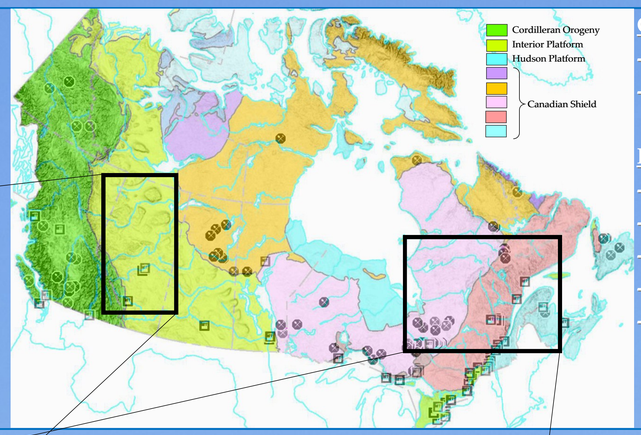
→ Mine tailings, sterile

- Exploitation of Industrial minerals : basalts aggregates, talc, etc.

Dispersed :

- Diamond mines in kimberlite :

→ Tailings, Mineral process waste, etc.



Cities and municipalities:

- Landfill
- Municipal Solid Waste Incinerator

Industrial parks:

- Industrial wastes and residue
- Steelmaking plant
- Blast furnace
- Cement factory
- Mineral process waste

Examples in Alberta

Rocks and Minerals:

- Kimberlite pipe (see map)
- Mafick rocks (NE Alberta)
- Mafic sills and lava (Southern Alberta Rockies)

Industrial wastes and residue:

- Landfills (concrete, aggregates):

Calgary, Edmonton and region, Red Deer, Camrose, Grande Prairie, Lethbridge, Medecine Hat, Fort McMurray, etc.

- Steel Foundries:

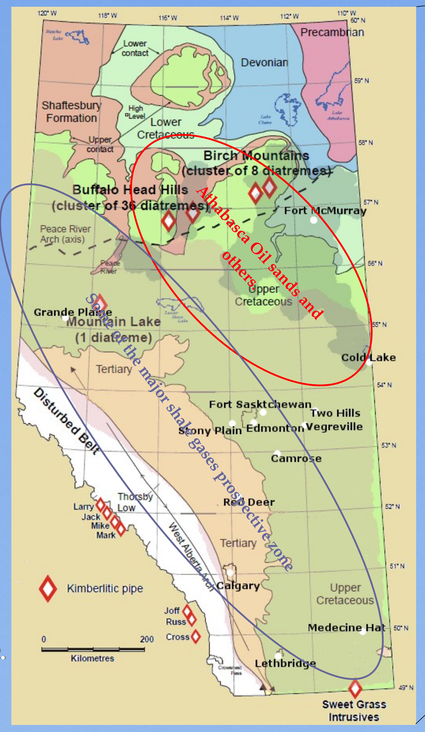
Calgary, Edmonton, Stony Plain, etc.

- Steel Works, Blast furnaces, Coke Ovens:

Spruce Grove, Fort Saskatchewan, Nisku, Acheson, Edmonton, Calgary, etc.

In Alberta context

→ *Industrial wastes are more common and would be better materials for Mineral Carbonation*



Examples in Québec

Rocks and Minerals:

- Minerals showings : Wollastonite (Saguenay)
- Active mines (Fe, Cr, Ni, PGM)

→ Ultramafic tailings

- Aggregates : basalts...

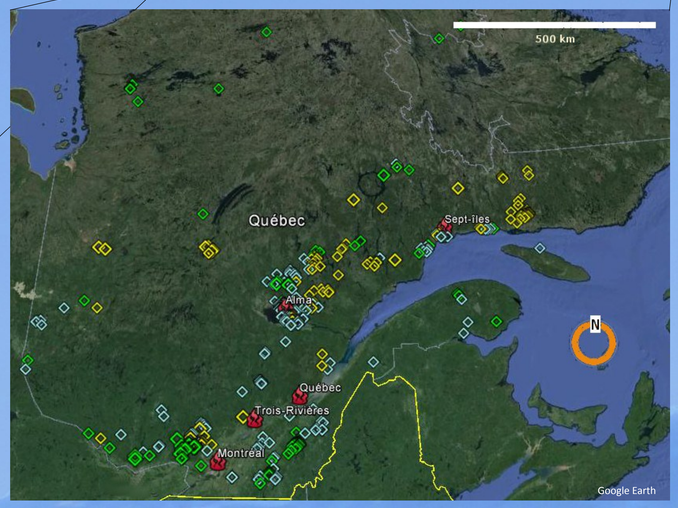
Industrial Wastes and Residue:

- Landfills (concrete, aggregates) and MSWI[3]: Québec, Montréal, Trois-Rivières, etc.
- Industries (Steel, Concrete, Lime...)

Montréal, Joliette, Trois-Rivières, Sept-îles, Contrecoeur, etc.

In Quebec context

→ *Industrial wastes as well as rocks and minerals could be used as materials for Mineral Carbonation*



4- Conclusion

Various materials exist, either in nature or human made, that can be used in the mineral carbonation process.

The choice of material will depend on:

- Quantity of material;
- Reactivity and mineralogy;
- Proximity and accessibility of the site of origin.

Advantages of the mineral carbonation process

- *Process can work with a wide range of materials*
- *Can be adapted to various context*

References

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[1]APC: Air Pollution Control ; [2]PGM: Platinum Gold Metals ; [3]MSWI: Municipal Solid Waste Incinerator