Mineral Aqueous Carbonation using Chrysotile Tailings

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The Green House Gases Problem:

Green House Gases (GHG) are important contributors of climate change. The Quebec province has engaged itself to reduce it's CO_2 emissions by 2012. In 2008, Quebec's emissions were estimated at 82.7Mt CO_2 eq. (MDDEP, 2010) and 29.9% (24.7Mt CO_2 eq.) of the 2008 emissions were from industrial sector.

The solutions:

A low cost process that capture/sequester CO_2.
Investigated routes are:

- Flue gas separation
- Oxyfuel Combustion
- Precombustion Capture
- Geological sequestration

} No profitable solution yet

Mineral Carbonation:

Studied in the USA and in Europe, mineral carbonation consist of using a magnesium/iron/calcium rich minerals, such as olivine, serpentine or wollastonite to sequester CO_2 by carbonating it to obtain $MgCO_3$/$FeCO_3$/$CaCO_3$.

A Mining Heritage:

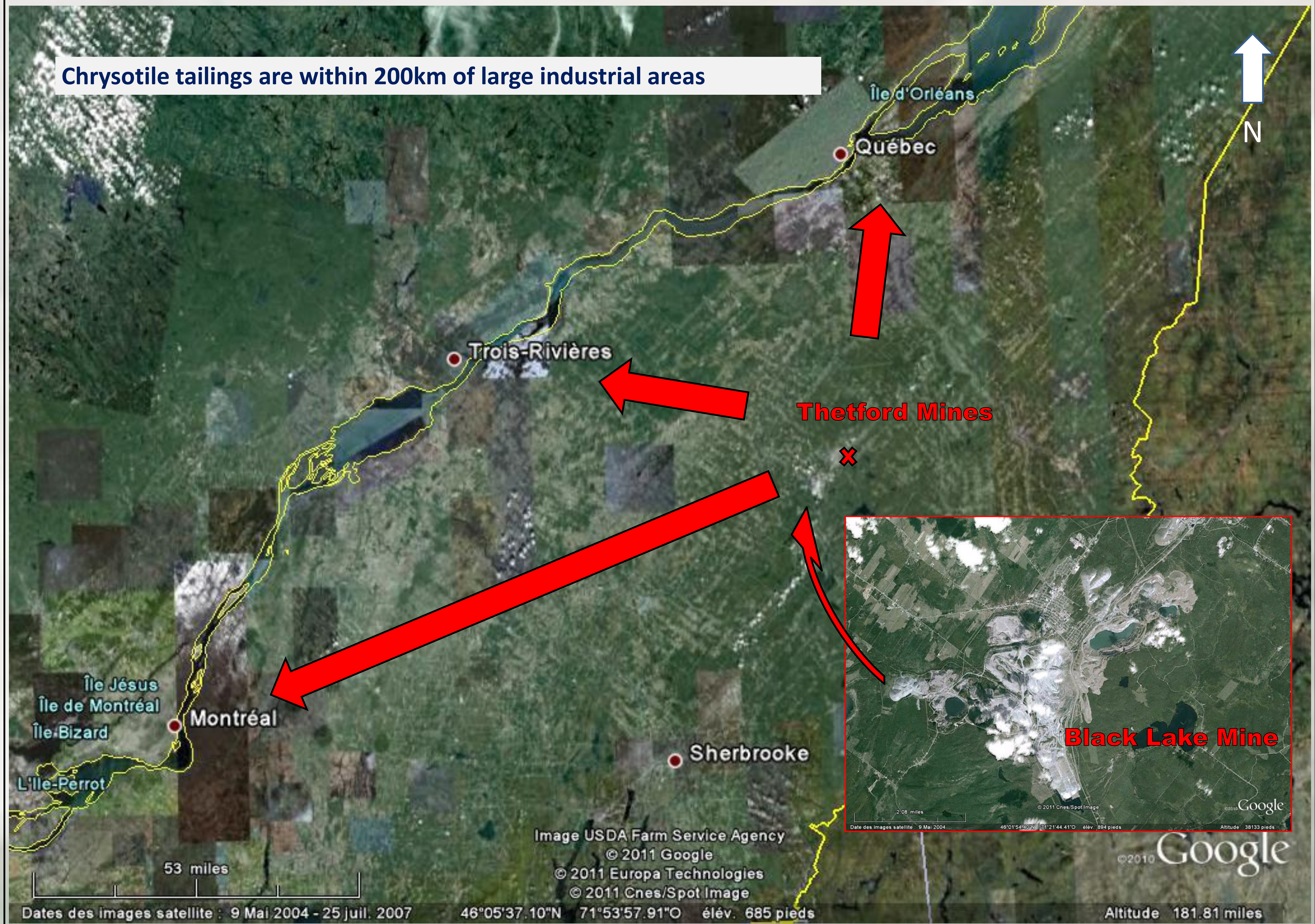
Chrysotile asbestos exploitation started in 1876, after deposits were discovered in the Thetford mines region (Quebec). Intensive exploitation of asbestos produced large quantities of ultramafic tailings (≈2Gt, Huot et al., 2003)

The restoration of the tailings is problematic:

- Low capacity to accept flora.
- The powdering capacities present a danger for public health (lungs cancer)

Existing solutions:

- Land burial
- Metal extraction such as magnesium (≈30% MgO).



The Tailings Opportunity:

Chrysotile exploitation residues offers a great opportunity for aqueous mineral carbonation. It presents various mineral phases, containing:

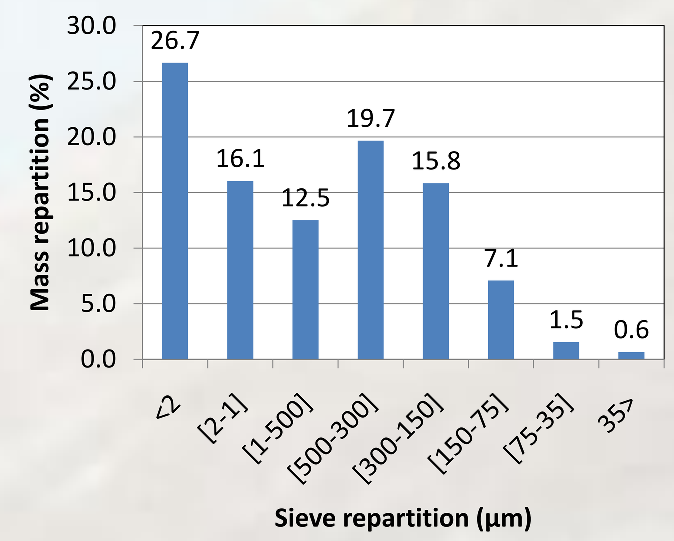
- Serpentine - $Mg_3Si_2O_5(OH_4)$ (chrysotile, antigorite, lizardite)
- Brucite - $Mg(OH)_2$
- Magnetite - Fe_3O_4
- Chromite - Cr_3O_4

Reaction for the aqueous carbonation of chrysotile:

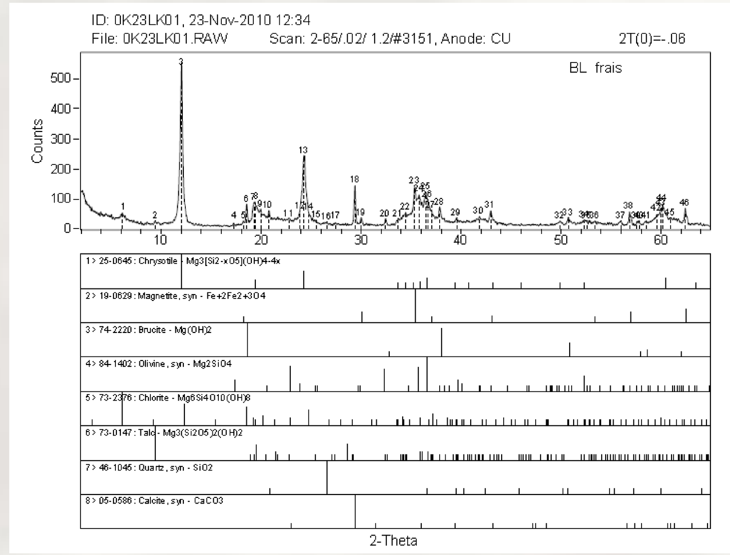
$$Mg_3Si_2O_5(OH)_4 + 3CO_2 + 7H_2O \rightarrow 3MgCO_3 + 2SiO_2 + 3\,H_2O \qquad \Delta H = -209{,}17 kJ \text{ at } 298°K$$

The analysis reveal a Magnesium content of 36,4% MgO in the residues

Carbonation naturally occurs on tailings



Size of particles comprising Black Lake tailings



DRX analysis of Black Lake residues

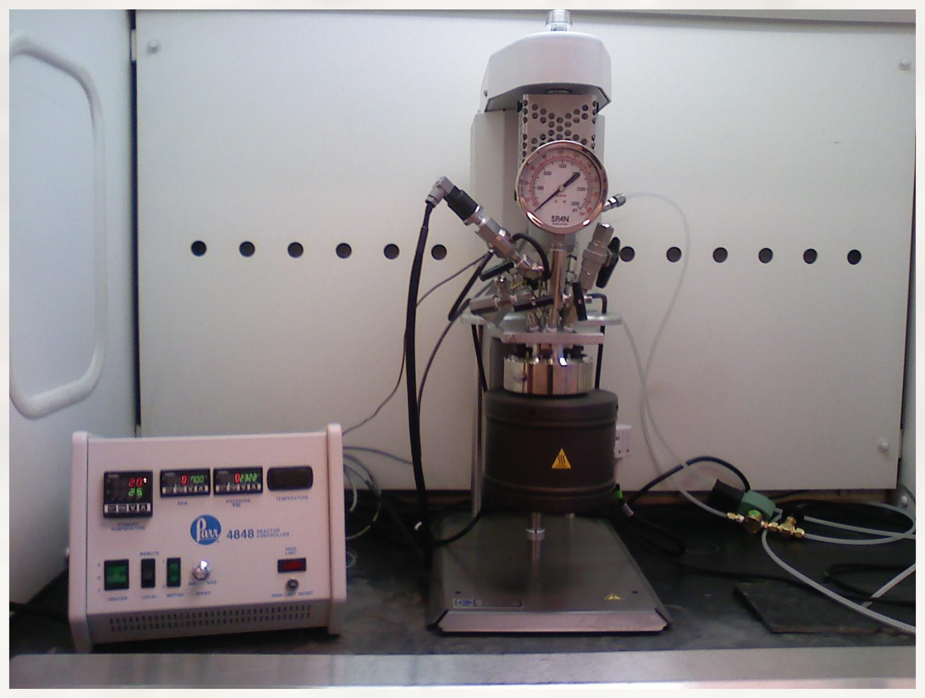
Background:

Examination of the literature on aqueous mineral carbonation:

- 100% CO_2 gas.
- 80% of conversion
- No energetically profitable.

An industrial gas exhaust is:

- 10-20% CO_2
- Mixture with N_2, O_2, CO_2...

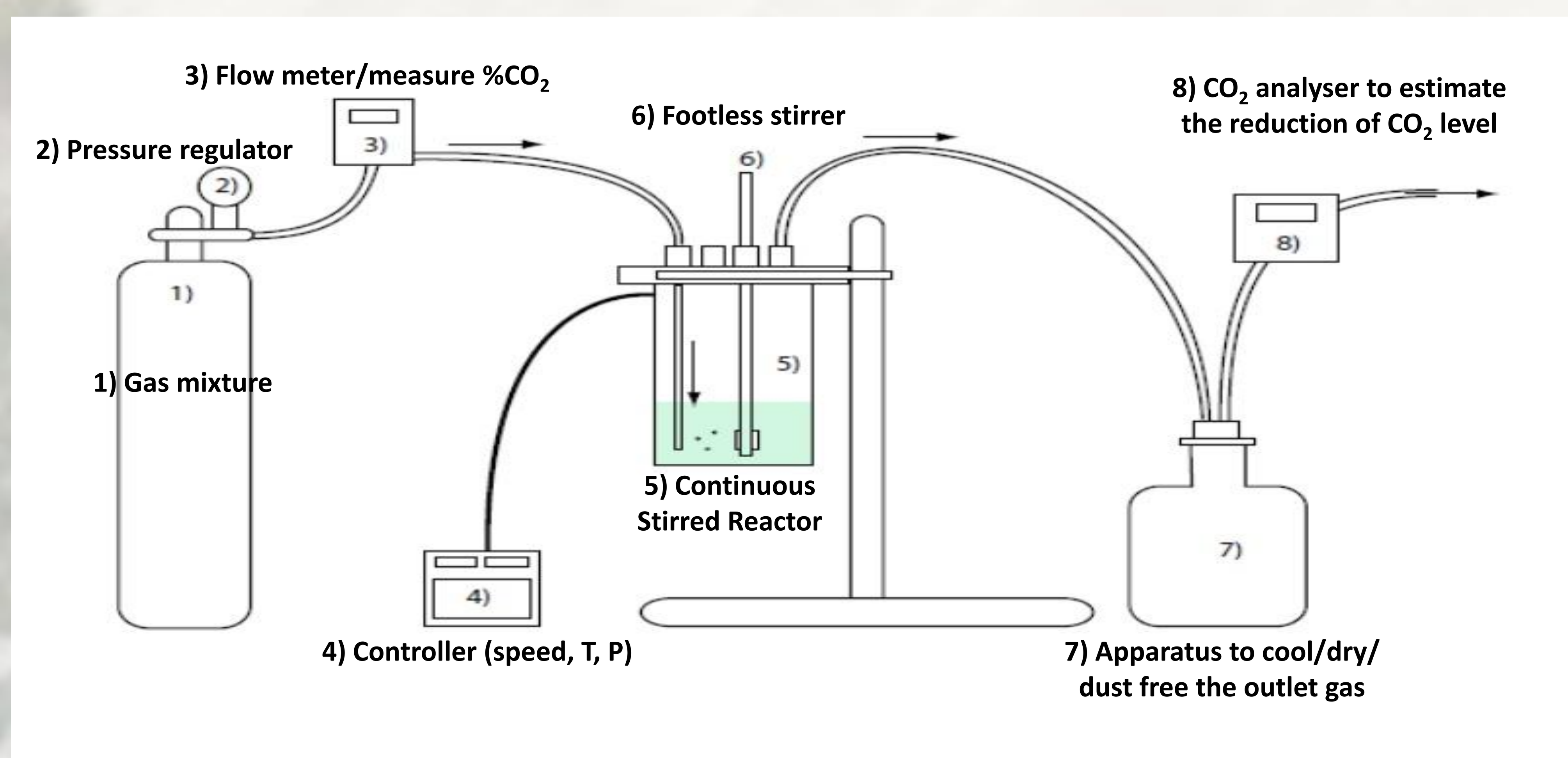


New research hypothesis:

- Lower the CO_2 level to match industrial gas
- Possibility to reuse reaction by-products ($MgCO_3$)

Project Goals:

- Find the ideal conditions
- Have the best CO_2 conversion
- Low process cost
- Offer a technology to the Québec's industries



Schema of the reaction dispositive

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