



## **Biologically-assisted silicate dissolution : a possible alternative for atmospheric CO<sub>2</sub> sequestration**

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Accumulation of Ca and Mg in oceanic waters, key elements for the precipitation of Ca, Mg-carbonates and draw down of CO<sub>2</sub>, is the result of inorganic rock weathering, in early in Earth's history. Improving the efficiency of such a process requires the increase in the dissolution rates of silicates, which can be obtained in the present environment with living microorganisms. Soil is the privileged place of biotic alteration of rocks, soil microorganisms being responsible of this alteration. The soil compartment constitutes a vast source of microorganisms capable to induce minerals weathering which can drive the biologically-assisted silicate dissolution for the atmospheric CO<sub>2</sub> sequestration.

To unravel the mechanisms underlying the alteration of silicates by microorganisms, we have developed an experimental model system based on the soil bacterium *Agrobacterium tumefaciens* strain C58. Strain C58 may destabilize minerals through the production of Fe-complexing agents, e.g. siderophores, which improve Fe bioavailability, as well as through the release of organic acids, which will lower the pH at the bacterium/mineral interface. Potentially released in the medium, Mg and Ca cations, as well as Fe, which are major elements in both microbial cells and minerals, will react with dissolved inorganic carbon (DIC) HCO<sub>3</sub><sup>-</sup> or/and CO<sub>3</sub><sup>2-</sup> to yield MgCO<sub>3</sub> and/or CaCO<sub>3</sub> precipitates. These reactions depend on pH, mineral and

solutions composition.

Experimental model consisted in cultures of *Agrobacterium tumefaciens* strain in presence of olivine powder (10mg) as Fe and Mg exclusive potential source and mannitol (28mg) as carbon source. Essays were conducted in both buffered and un-buffered culture media in closed-reactor. No mannitol biodegradation occurred without olivine. In un-buffered medium, a 100% mannitol biodegradation was obtained after 200 hours and the carbon from mannitol was distributed into atmospheric CO<sub>2</sub> (58%) and into C-biomass (not measured). The final pH was  $5.5 \pm 0.2$ . In buffered medium, at pH 8, the carbon distribution (complete mannitol biodegradation) was respectively atmospheric CO<sub>2</sub> (27%), C-biomass and CO<sub>2</sub> inorganic species DIC (32%), considering equal C proportion incorporated into biomass in both buffered and un-buffered conditions. CO<sub>2</sub> dissolved in culture medium was pH and organic carbon source concentration dependent.

Mg cations originating from mineral dissolution (12  $\mu\text{mol}$ ) was in excess, considering biomass requirement (0.2  $\mu\text{mol}$ ) and could be considered as Mg cations available to sequester CO<sub>2</sub> as carbonates.

The experiments undertaken in this work well illustrated that the *Agrobacterium tumefaciens* strain was able to weather the olivine as Fe and Mg mineral growth sources. Mg and Fe in excess in culture medium can drive biologically-assisted CO<sub>2</sub> precipitation into mineral carbonate species and clearly indicates the possible importance of microbial activity on the carbonate cycle at the geological scale.