# SIC-SOC-DYN (ID 111)

## Organic and inorganic carbon dynamics in calcareous soils

**Coordinator**

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**Project partners**

| Country | Organization |
|---|---|
| **Canada** | Agriculture & Agri-Food Canada |
| **France** | l'Institut français du pétrole |
| **Hungary** | Geographical Institute, Research Centre for Astronomy and Earth Sciences |
| **Italy** | University of Milan |

**Summary**

Soil is the largest continental carbon (C) sink and contributes to the global C cycle. Two thirds of soil C is organic (Soil organic carbon, SOC). SOC results from the balance between captured atmospheric CO2 (via photosynthesis) and the incorporation of litter decomposition products, and the CO2 emissions, via the respiration of roots and heterotrophic microorganisms. SOC plays a key role in the physical, chemical, and biological properties of soils. Understanding its dynamics is a major challenge for maintaining soil fertility while participating in the storage of C. However, one third of soil C is inorganic (Soil Inorganic Carbon SIC). SIC consists of lithogenic, or petrogenic, (primary) carbonate inherited from the bedrock and pedogenic (secondary) carbonate precipitated in the soil. Because SIC pools are generally considered more stable and less impacted by human activities than SOC pools, the SIC dynamics are of less interest in the short-term. Moreover, analytical difficulties in studying SOC and SIC separately have impeded knowledge on the dynamics of SOC in carbonate soils. The C stocks of these soils, even though they cover one third of the Earth's surface, are given little consideration in the global C balance.

Although interactions between SIC and SOC pools have been described in the short-term, they are poorly understood. Isotopic analyses have shown that carbonate soils emit CO2 from both C pools. There is also an inherited or neoformed origin of SIC, as organisms (bacteria, roots, fungi) have the ability to precipitate biominerals from metabolic pathways of organic matter transformation.

Our project proposes the study of both SOC and SIC contents, quality and dynamics in various contexts. The main objectives are to propose innovative analytical tools and to acquire knowledge on the C balance in carbonate soils according to their use and management.

Knowledge of these processes and the development of analytical methodologies specific to these soils will facilitate the acquisition of data distinctive of these soils. Knowledge sharing will focus on training of young scientists (MS, PhD, post-doc), exchanges between scientific communities (geochemists, soil scientists, agronomists) and raise awareness in soil analysis.

The project is based on 3 scientific work packages and a work package for coordination:

1- Integrated methodology to study SOC and SIC forms

We propose to develop soil analysis on C pools in carbonate soils. A diversity of carbonate soils in terms of SIC features will be characterized. Protocols to analyse SOC and SIC pools will be compared and develop. We propose to couple thermal and isotopic analyses to characterise the forms of SIC and SOC in carbonate soils in a rapid and partially automated way.

2- Processes of SOC stabilisation in carbonate soils

Thermal, physical (size), chemical and morphological analysis of SOC in different calcareous contexts will help to explore the relationships between soil properties and SOC. The quantification of SOC in its different forms would allow understanding the processes of SOC stabilisation in these specific soils.

3- Contributions of SIC and SOC to C fluxes between soil and atmosphere
Relationships between soil properties, SIC and SOC forms and dynamics will be studied through soil incubations and modelled.
Research will mainly focus on the solid phases of SOC and SIC in a collection of soils with varying SOC and SIC contents. Specifically, our objectives are (i) to establish protocols to measure SIC and SOC contents and their 13C natural abundance (ii) to identify stabilized SOC pools in soils with different SIC features and (iii) to approach C balance in various carbonate environments. Finally, our ambition is to develop a scientific community studying C cycle in carbonate soils.

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