

## Postprint: Effect of Mineralization Reaction on Basalt Microstructure

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**Date:** 2025-07-17T00:00:00+00:00

### Abstract

Utilizing in-situ mineralization reactions of basalt to sequester CO<sub>2</sub> represents an effective approach for mitigating the greenhouse effect. Existing research has demonstrated that while basalt absorbs CO<sub>2</sub> through mineralization reactions, its microstructure concurrently undergoes alterations. The microstructure of basalt not only influences its macroscopic properties but also affects its CO<sub>2</sub> absorption rate. Therefore, investigating how mineralization reactions impact basalt microstructure and developing quantitative methods to characterize these microstructural changes can enhance the efficiency of carbon sequestration projects. This study selected basalt samples from northern Hainan Island and prepared them into 10mm×10mm×5mm blocks. Laboratory experiments were conducted to simulate basalt mineralization reactions under atmospheric pressure at 60°C and 75°C, employing optical microscopy and X-ray diffraction (XRD) to document microstructural changes during the reaction process, and analyzing the patterns of microstructural evolution based on experimental results. During the reaction, basalt porosity exhibited an initial increase followed by a decrease, with overall pore size reduction and pore distribution concentrating toward sample edges. After 15 days of reaction at 75°C, porosity decreased from 10.739% to 8.857%, yielding an overall pore change rate of 0.357% per day. Under 60°C conditions, sample porosity increased from 10.552% to 11.544%, with an overall porosity change rate of 0.133% per day. Following the experiments, pyroxene content in the basalt decreased while new minerals such as kaolinite and magnesite formed. The sample reacted at 75°C exhibited significantly greater microstructural alteration compared to the 60°C sample, with a faster porosity change rate observed at 75°C. Experimental results indicate that both mineralization reaction rate and reaction extent influence microstructural changes in basalt: higher reaction rates produce more intense microstructural changes, while greater reaction progression yields larger microstructural alterations. As reactions proceed, more stable minerals are formed.

## Full Text

### Preamble

#### The Influence of Mineralization Reactions on the Microstructure of Basalt

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### Abstract

In-situ mineralization of CO<sub>2</sub> using basalt is an effective approach for mitigating the greenhouse effect. Previous studies have demonstrated that while basalt absorbs CO<sub>2</sub> through mineralization reactions, its microstructure undergoes concurrent changes. These microstructural alterations not only affect the macroscopic properties of basalt but also influence its CO<sub>2</sub> uptake rate. Therefore, investigating how mineralization reactions impact basalt microstructure and quantifying these changes is crucial for enhancing the efficiency of carbon sequestration projects.

This study selected basalt samples from northern Hainan Island and prepared them as 10 mm × 10 mm × 5 mm blocks. Laboratory experiments were conducted to simulate mineralization reactions under atmospheric pressure at 60°C and 75°C. Optical microscopy and X-ray diffraction (XRD) were employed to document microstructural changes during the reaction process, and experimental results were analyzed to characterize the evolution patterns of basalt microstructure.

During the reaction, basalt porosity exhibited an initial increase followed by a subsequent decrease. Overall pore sizes became smaller, and pore distribution shifted toward the sample edges. Under 75°C conditions, porosity decreased from 10.739% to 8.857% after 15 days, yielding an overall change rate of 0.357% per day. Under 60°C conditions, porosity increased from 10.552% to 11.544%, with an overall change rate of 0.133% per day. Following the experiments, pyroxene content in the basalt decreased, while new minerals such as kaolinite and magnesite formed. Samples reacted at 75°C exhibited significantly greater microstructural alterations compared to those at 60°C, with a faster porosity change rate.

Experimental results indicate that both the reaction rate and extent of mineralization influence microstructural changes in basalt: higher reaction rates produce more dramatic microstructural changes, while greater reaction extent

leads to more pronounced alterations. As the reaction progresses, more stable mineral phases form.

**Keywords:** Hainan basalt; mineralization reaction; microstructure

*Note: Figure translations are in progress. See original paper for figures.*

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