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Effect of co-injection of acidic impurity gas and seawater on geological sequestration of CO₂ in basalt

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Carbon Capture and Storage (CCS) can be realized efficiently and safely by collecting atmospheric carbon dioxide (CO₂) and injecting it into basalt formations in a dissolved state by co-injection of CO₂ and water. In the actual storage, the collected CO₂ may also contain a variety of soluble acidic impurity gases, and co-injection of acidic impurity gases with CO₂ can significantly reduce the economic cost of gas collection, but the acidic impurity gases will be reacted before CO₂, and there is a possibility of inhibiting the carbonation process of the minerals. In addition, the co-injection of CO₂ and water is highly efficient, but it requires high freshwater resources. For coastal areas, seawater can be used instead of freshwater to reduce the dependence on freshwater resources, but at the same time, seawater injection is also more likely to affect the process of mineral sequestration. We used transparent quartz capillary tubes to simulate the reaction process between CO₂ and basalt under geological reservoir conditions, and quantitatively observed the mineral reaction process after the addition of sulfur dioxide (SO₂) and sodium carbonate (Na₂CO₃) solutions with the help of in-situ Raman spectroscopy, so as to reveal the influence of SO₂ acidic gas and carbonate solution on the sequestration process of CO₂ basalt. The results show:

- (1) In the system consisting of only CO₂ and pure water, CO₂ is dissolved into water first, and then carbonate will gradually appear on the surface of basalt particles.
- (2) When SO₂ is added, SO₂ and CO₂ are dissolved into water at the same time, but sulfate and sulfite minerals appear first on the surface of basalt particles, and carbonate rocks appear on the surface of basalt particles only after SO₂ is consumed by the reaction and the process of CO₂ mineral sequestration occurs.
- (3) The addition of Na₂CO₃ significantly limits the dissolution of CO₂ into the water, but does not affect the dissolution of SO₂. This allows SO₂ to still react with basalt, while CO₂ has difficulty reacting with basalt to produce carbonate minerals. This suggests that the presence of carbonate in solution further inhibits CO₂ mineralization from occurring.

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References

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