

Can pyrite dissolution produce H₂ under natural storage conditions: insights from high P, T experiments

ARKAJYOTI PATHAK, SHIKHA SHARMA AND SAMUEL
BOWMAN

West Virginia University

Presenting Author: ap00115@mix.wvu.edu

Future energy storage will likely be facilitated by hydrogen (H₂), which can be produced by using the surplus energy from renewable sources. Consequently, large-scale H₂ storage is required as a major component for the energy transition in several subsurface systems (such as salt caverns, depleted hydrocarbon fields, and porous rock aquifers). Nonetheless, limited research has examined the interactions between fluid, rock and H₂ under circumstances that are pertinent for anoxic subsurface storage environments at 40-120 °C and up to 500 bars of pressure. Pyrite is an abundant component in anoxic sedimentary reservoirs, but its reductive dissolution in such environments has not been well studied.

In this study, H₂ generation capability of pyrites are being investigated through a set of experiments. The current approach attempts to address the potential of pyrite to release Fe(II) after dissolving, and subsequently producing H₂ through oxidation. This involves studying the reaction kinetics of the reductive dissolution of pyrite, under conditions relevant for subsurface H₂ storage. These investigations are being carried out in stainless steel stirred batch reactors at T = 100 °C and P up to 50 bars (filled with N₂). The experiments are based on crushed natural pyrite grains (<5 mm) reacted with different concentrations of NaCl solutions buffered at various pH (5-9), under anoxic conditions. The experimental duration is 100 days where pyrite is expected to reductively dissolve and release aqueous Fe(II). The temporal evolution of dissolved Fe(II) will be determined through ICP-MS and sulfide through electrochemistry. SEM and XRD will be performed on the reacted pyrite surface at the end of experiments, to check for secondary pyrrhotite, FeS or any potential Fe(III) solid overgrowth. Headspace gas will be collected intermittently and measured via gas chromatography (GC) for monitoring the temporal variation in H₂ concentration.

These investigations have implications for understanding the geochemical behavior of iron-bearing minerals inside deep, anoxic sedimentary basins. Additionally, mitigation of steel corrosion by H₂S, which is a major concern on subsurface storage infrastructures, can also be addressed through the experiments. Our study will provide more insights on the complex subsurface thermodynamic interactions related to storage of H₂.