

CO₂ Mineralisation Potential of Indian Basalts

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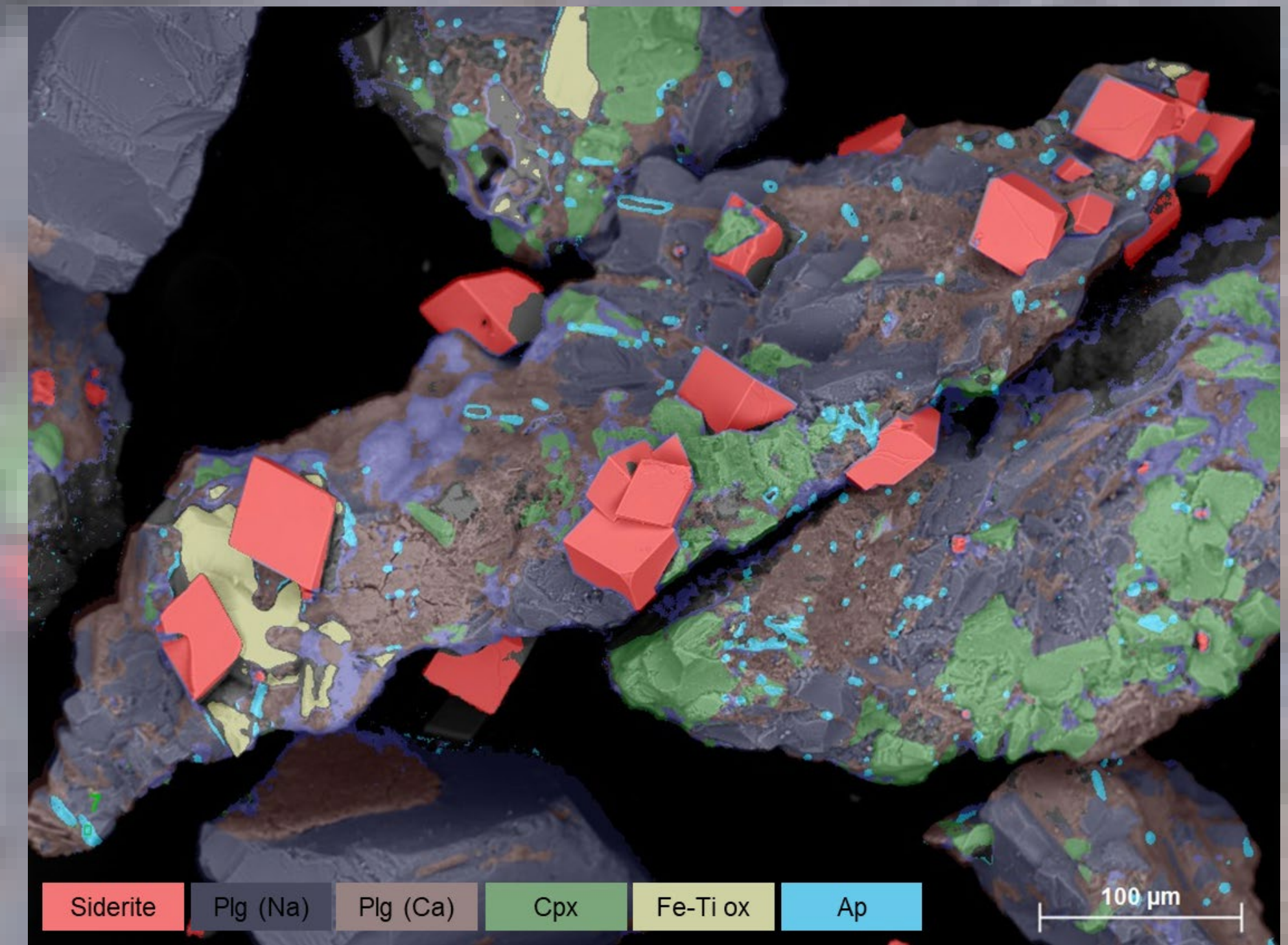
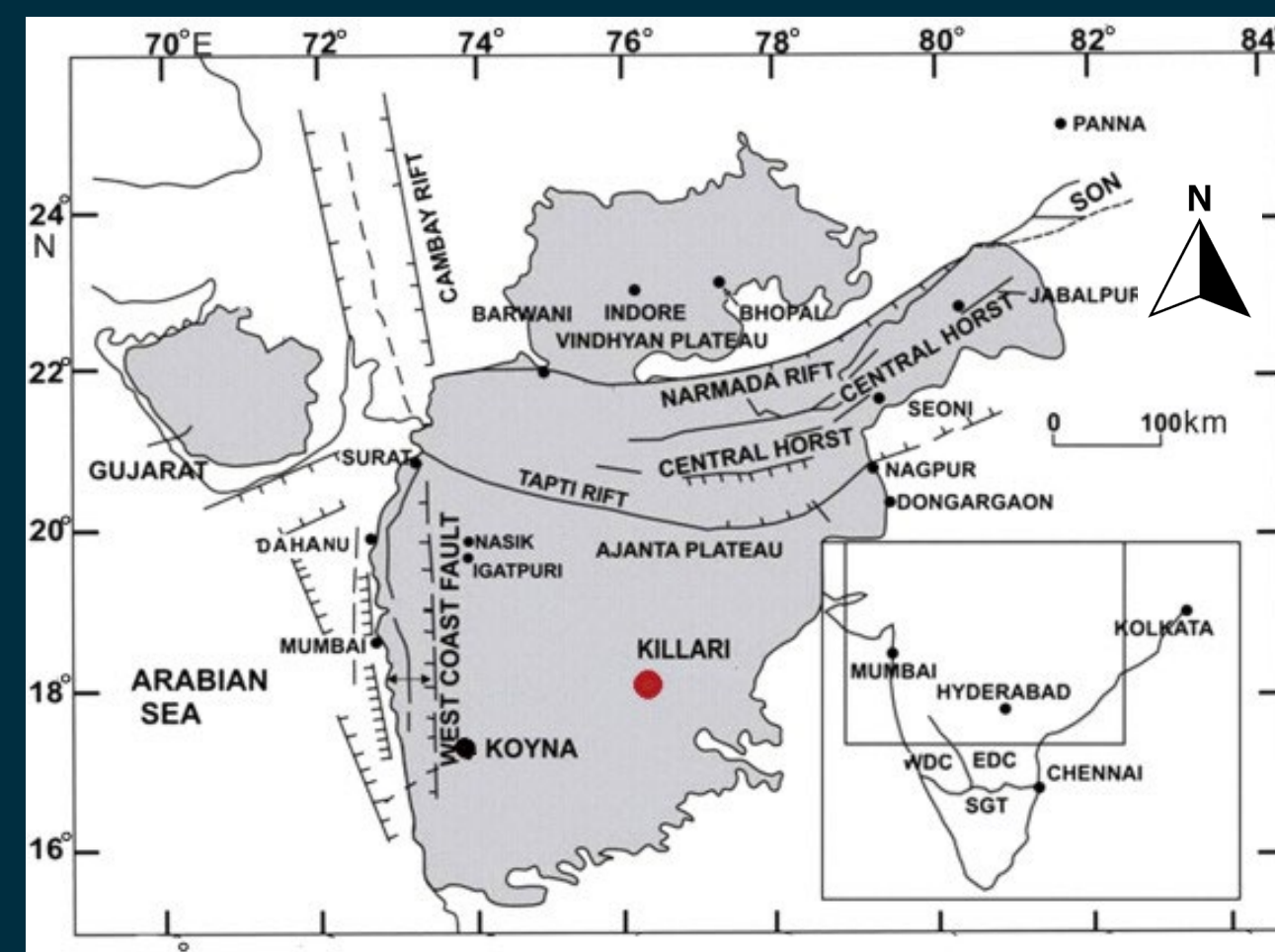
Background

India's Deccan Trap basalts are being investigated for their carbon capture and storage by mineralisation (CCSM) potential. They are principally composed of olivine, pyroxene, plagioclase and basaltic glass. The Deccan Traps consist of layers of solidified flood basalt up to >2,000 m in thickness. The volume of basalt exceeds 1,000,000 km³, and represent a significant theoretical potential for high-volume sequestration of anthropogenic CO₂ in mafic rock.

Method

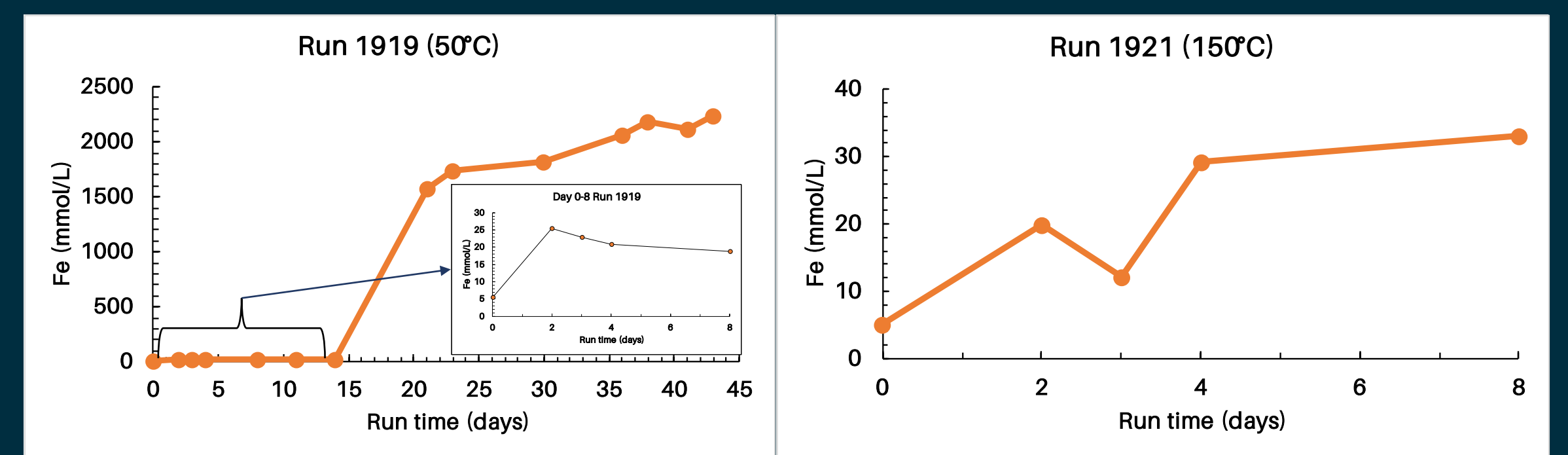
To understand the potential CO₂-water-rock reactivity of the basalt, a rock sample from the Killari borehole (see map) was crushed and powdered into a 125 to 250 μm fraction. To produce basalt-equilibrated fluid for the experiment, this powder was placed in a 1 litre container of deionised water at 70°C for one week.

Three batch vessels containing crushed starting material and the equilibrated fluid was pressurised first with nitrogen, and then with CO₂ to 90 bar. Each vessel had a different temperature (50, 100, and 150°C). These ran for up to 43 days.



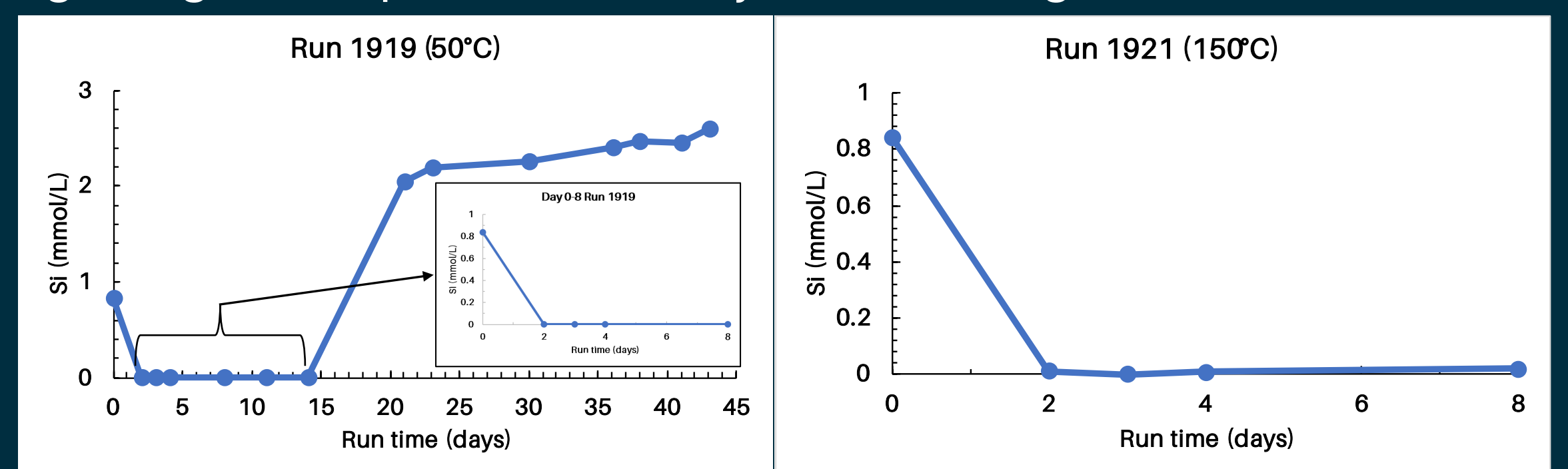
False colour SEM image showing rhombohedral crystals of siderite formed during laboratory experiment using Deccan Trap basalt and CO₂ bearing fluid at 150°C

Fluid Chemistry



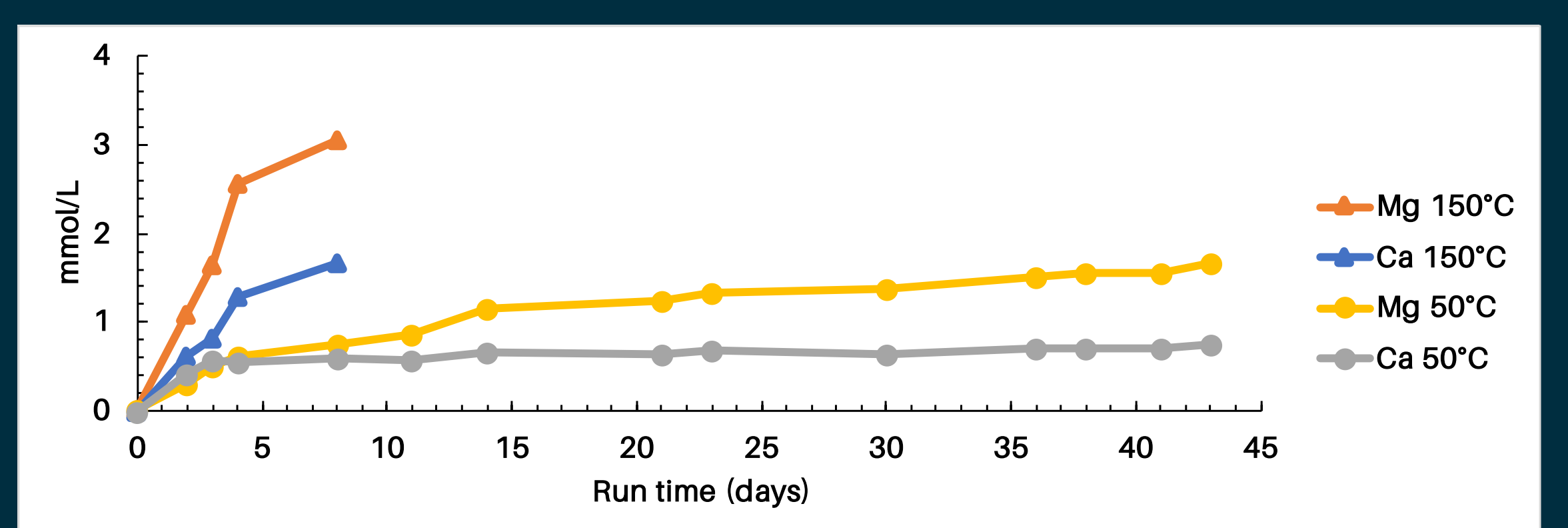
Fe Concentration

Iron concentrations in the reaction fluid are higher in the 50°C experiment than in the 150°C experiment, reflecting the greater amount of secondary minerals forming at higher temperature, notably siderite being the main host of Fe.



Si Concentration

Basalt-equilibrated fluid contained ≈0.85 mmol/L. The early decrease in Si concentration in the experimental fluid may be related to early precipitation of secondary silicates and/or amorphous silica. The subsequent increase in concentration is likely the result of gradual dissolution of original silicate minerals, notably plagioclase and pyroxene.



Ca and Mg Concentration

Calcium and magnesium concentrations in the reaction fluid both increase over the course of the experiment. This is evidence of continual basalt dissolution.

Discussion and future work

The sampling tube blocked during the 150°C experiment due to the large amount of precipitate formed. This precipitate was identified by SEM to be calcium carbonate and amorphous silica. Either a larger sample tube or different sampling method could be used to enable this. For future experiments, the higher temperature experiment should be run for longer.

Conclusions

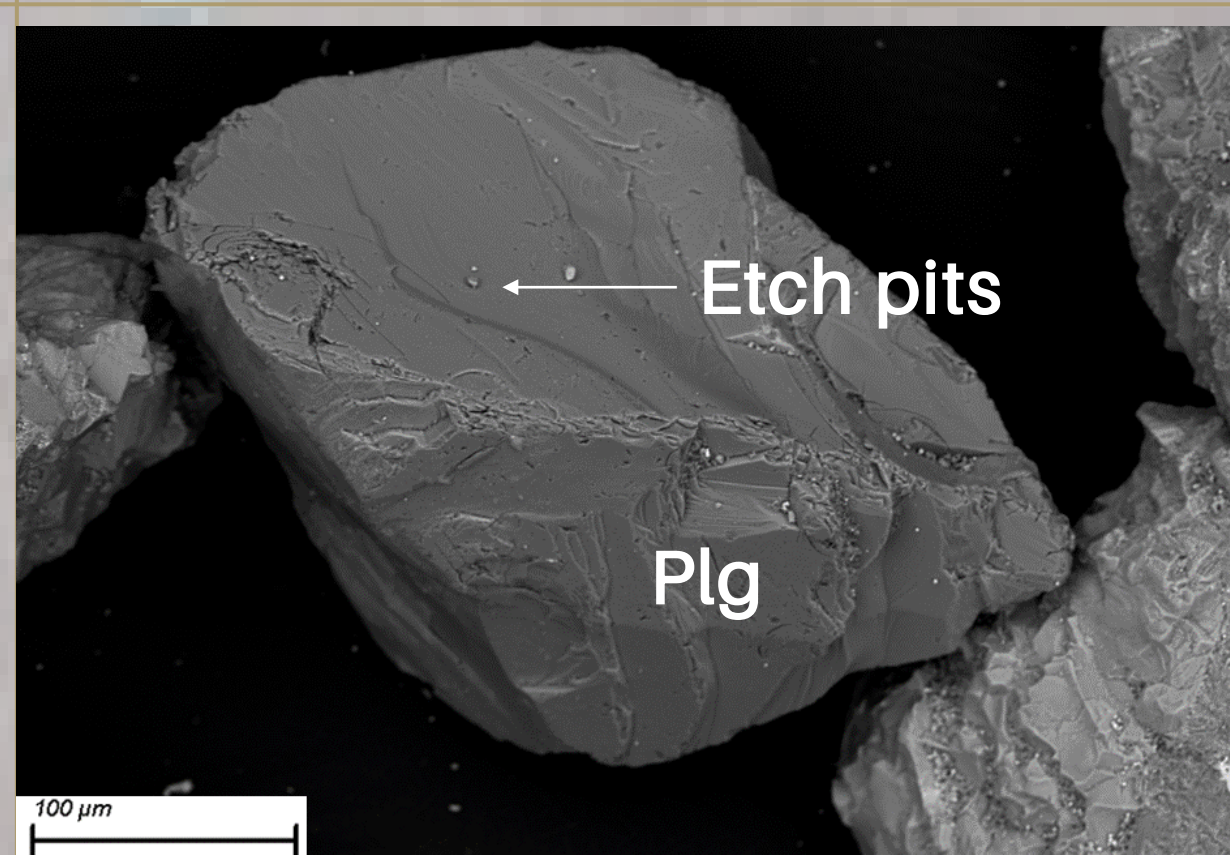
- The research shows that siderite is formed faster and in greater quantities when basalt is exposed to CO₂ at 150°C
- Both the 50 and 100°C experiments had very similar chemical and mineralogical results
- Whilst very small amounts of siderite formed on a short timescale at lower temperatures, far less CO₂ was removed than in the 150°C experiment

Scanning electron microscopy observations of post-test materials

50°C
43 days
Run 1919

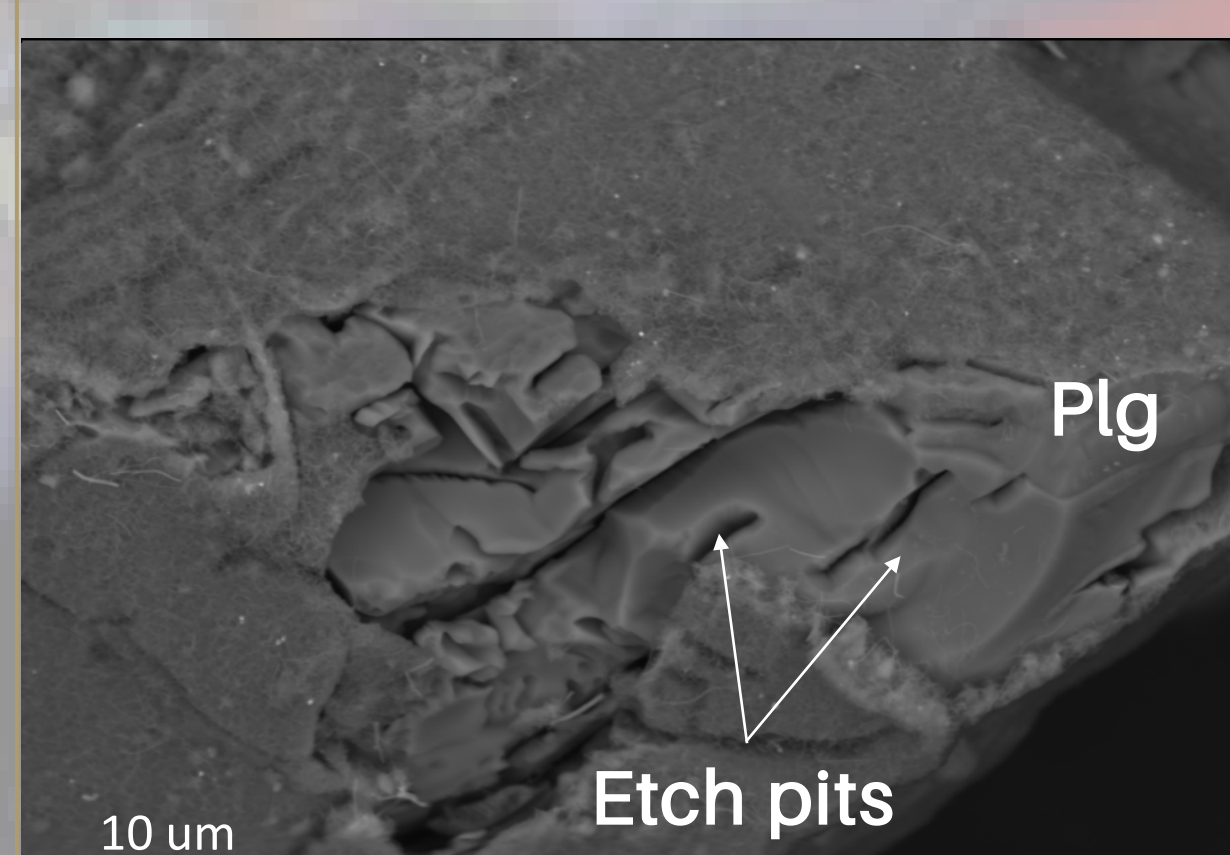
- No siderite crystals
- Little evidence for mineral dissolution

100°C
43 days
Run 1920



- Notable dissolution of plagioclase
- No clear evidence of carbonate precipitation

150°C
8 Days
Run 1921



- Significant *dissolution* of original components
- *Precipitation* of secondary phases, including rhombohedral crystals of siderite (40-50 μm) and silicate minerals, likely smectite and phases belonging to the zeolite mineral group

