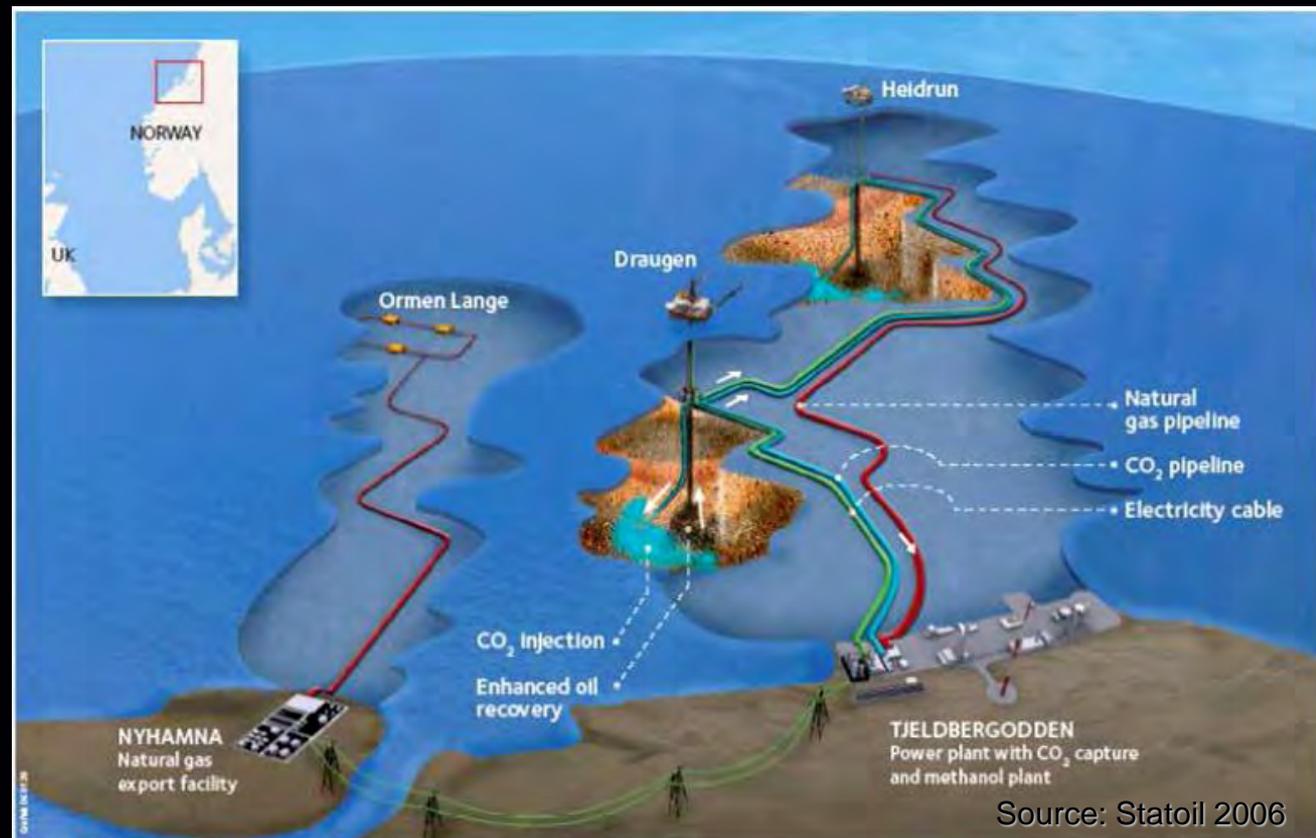


# Geochemical reaction rates following porewater acidification

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Investigate response of North Sea sandstone/porewater systems to acidification (in the absence of carbonate) and evaluate against responses of pure minerals

- Measure geochemical response via changes in fluid chemistry
- Determine acid buffering capacity
- Determine kinetic rates

## LIMITATIONS

- Accelerated laboratory reaction rates (homogenised system)
- Elevated fluid/rock ratios (but less than in most studies)
- Ability to detect small changes in saline fluid chemistry?

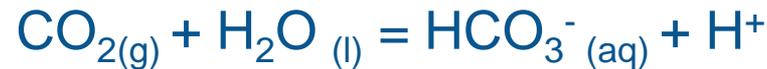
# BACKGROUND:

## Stabilisation of CO<sub>2</sub> in pore water



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Dissolution (reversible):



***Neutralisation of acidity may stabilise dissolved CO<sub>2</sub>***

Surface Ion Exchange

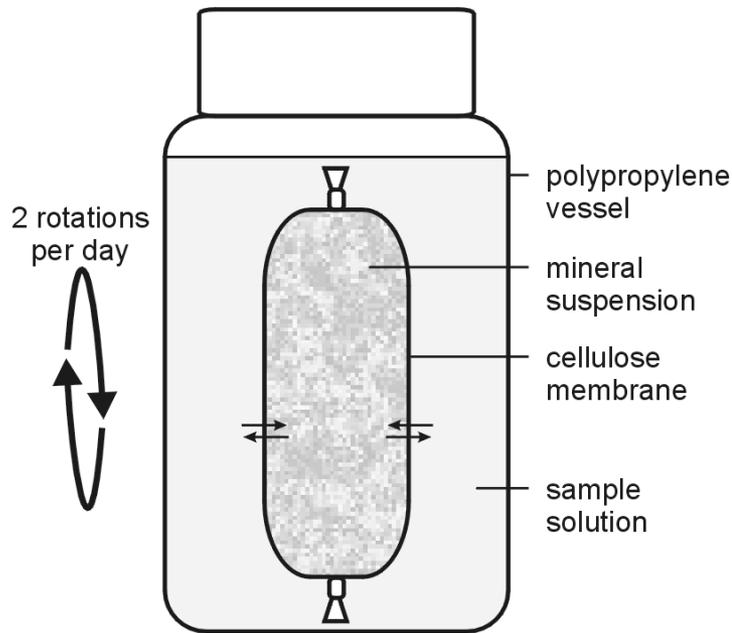


Carbonate Dissolution



Feldspar Destruction



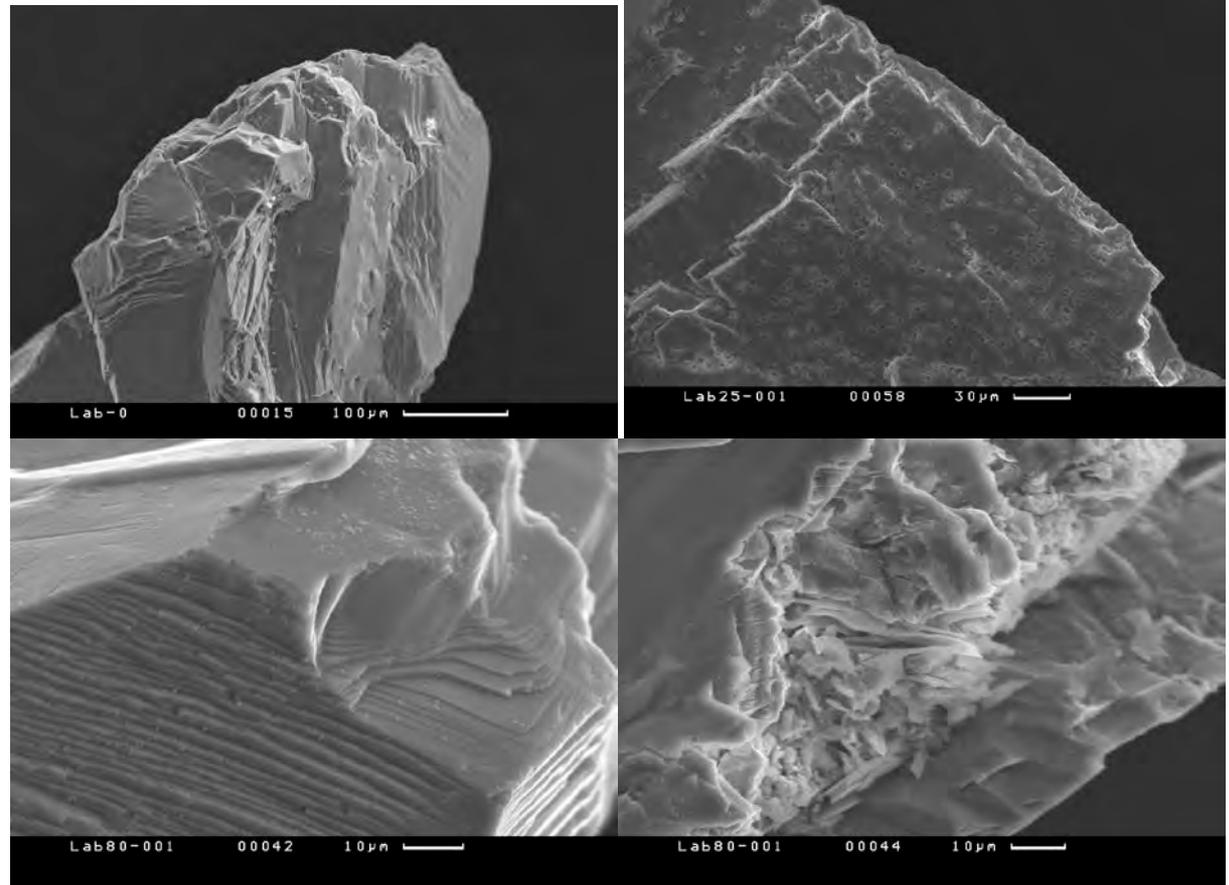


## Dissolution experiments on pure minerals and North Sea sandstones

These batch experiments were designed to minimise the fluid:rock ratio by enclosing a suspension in a membrane which is immersed in, and rapidly equilibrates with, the external sample solution. This was maintained at pH=3.

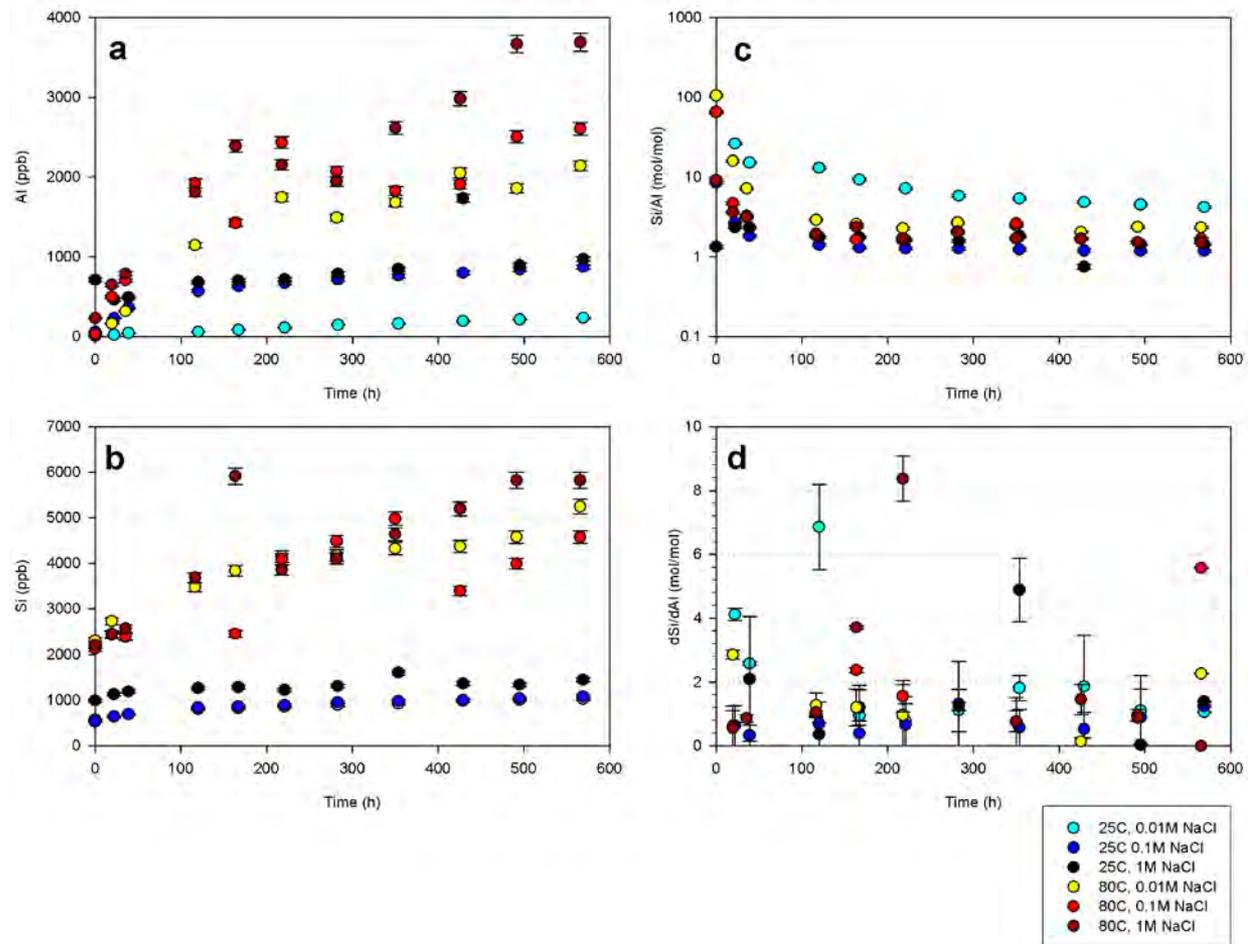


Secondary electron images of labradorite grains. a) Labradorite starting material, pre-treated in HCl and ultrasonically cleaned. b) Labradorite reacted at pH 3 at 25°C in 0.01M NaCl for 420 h. Note the onset of etch-pit formation. c) Crystal steps, interpreted to have been revealed by the dissolution of irregular, reactive fracture surfaces. Note the tiny platelets of a secondary phase on the top phase (80°C run). d) Formation of a secondary, platy mineral from a 80°C experiment.



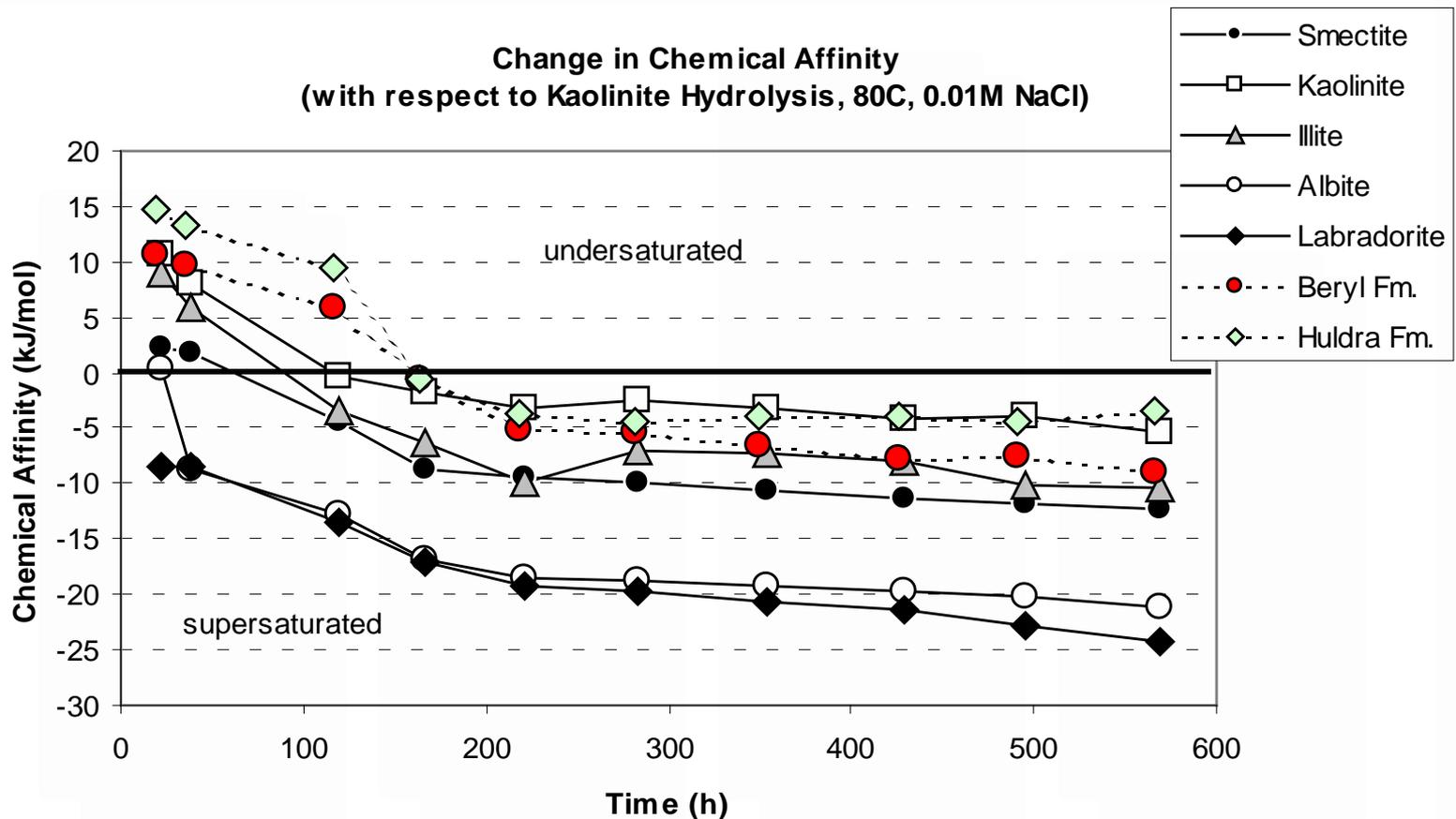


Kaolinite (KGa-1b) Dissolution at pH 3





Changes in chemical affinity at 80°C, 0.01M NaCl with respect to kaolinite hydrolysis. All systems, including bulk rocks, reach theoretical kaolinite saturation within 100



- Cation exchange reactions consume  $H^+$  rapidly and favour  $CO_2$  dissolution;
- Aluminosilicate dissolution is slower, and will generally be ineffectual because of more rapid reaction of carbonates;
- The reaction of silicate minerals with bicarbonate waters which have been first neutralised by carbonate dissolution provides an effective long term stabilisation of carbon in solution, but depends on different reactions from those that neutralise acidity;
- Introduction of oxygen with the  $CO_2$  stream may trigger oxidation reactions: pyrite oxidisation is an important secondary source of acidity, which may (1) encourage corrosion of injection hardware, (2) limit the short-term acid-buffering capacity of a reservoir and (3) result in barite ( $BaSO_4$ ) precipitation which may influence porosity-permeability properties near injection sites.