**Effects of nanoparticles on clay stabilisation and coal permeability**

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**Project Aims**

This project aims to identify potential nanoparticles (NPs) to prevent clay swelling of the smectite clays and investigate their deployment in the coal seam gas reservoirs.

The main activities include 1) screening NPs for clay stabilisation, 2) optimizing NPs concentration and evaluating effectiveness and 3) investigate the effects on coal permeability.

**Performance of nanoparticles (NP) in distilled water and 4% KCl**

Figure 1 shows the images of a visual swelling test.

The swelling index $I = \frac{h_f - h_i}{h_i}$, $h_i$ and $h_f$ are the initial and final height, respectively.

![Figure 1. Illustration of visual swelling test method](Image)

Figure 2 suggests that except for zinc oxide all of the nanoparticles show potential to prevent clay swelling in distilled water. In the presence of 4% KCl, clay swelling was inhibited with all selected NPs.

**Effectiveness of NP after washing**

To examine long-term performance of the MgO nanoparticle treatment as a clay stabiliser compared to traditional KCl brine treatments, the solution was decanted and refreshed every 24 hrs for up to 40 times.

3D CT images in Figure 6 represent blockage of cleats and reduce cleat/fracture volume. However, the permeability can be recovered back to initial permeability after de-stress and flush as shown in Figure 6. In future work, to mitigate the impact on coal permeability, the NPs size, injection amount and dispersion will be optimised. The NPs deployment methods will also be considered.

**Conclusions**

- SiO$_2$ and MgO nanoparticles show potential to prevent clay swelling in formation water in the absence and presence of KCl.
- The effects of nanoparticle on coal permeability have been examined by in-situ CT core flooding, observing permeability and cleat/fracture change with nanoparticle injection.
- Future work will focus on optimising nanoparticle injection conditions to minimise the permeability drop in the coal. The NPs transportation mode will also be investigated under different stress conditions.

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