# UQ Gas & Energy Transition Research Centre

## Evolution of Proppant Embedment and Its Impact on Shale Permeability

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### Introduction

Proppant embedment can reduce fracture conductivity resulting in reduction in gas recovery rates. This study aims to quantify the impact of proppant embedment on permeability over time by utilizing a series of experiments. Furthermore, this study designs new methods to induce long-term proppant embedment in proppant-supported fractures and measures the embedment depth real time.

### Experiment Methodology

Two types of shale samples with different maturity and mechanical properties were collected from Eromanga Basin, Australia and Sichuan Basin, China. Small cubic samples with the size of 20*20*20 mm were utilized for the proppant embedment and permeability test.

The samples were cut in half and the proppants are fixed on the cut surface. An elastic rubber sleeve was designed and used with the cubic sample for the permeability test. The surface parameters were characterised by the Zeta-300 optical profiler.

#### Samples for experiment

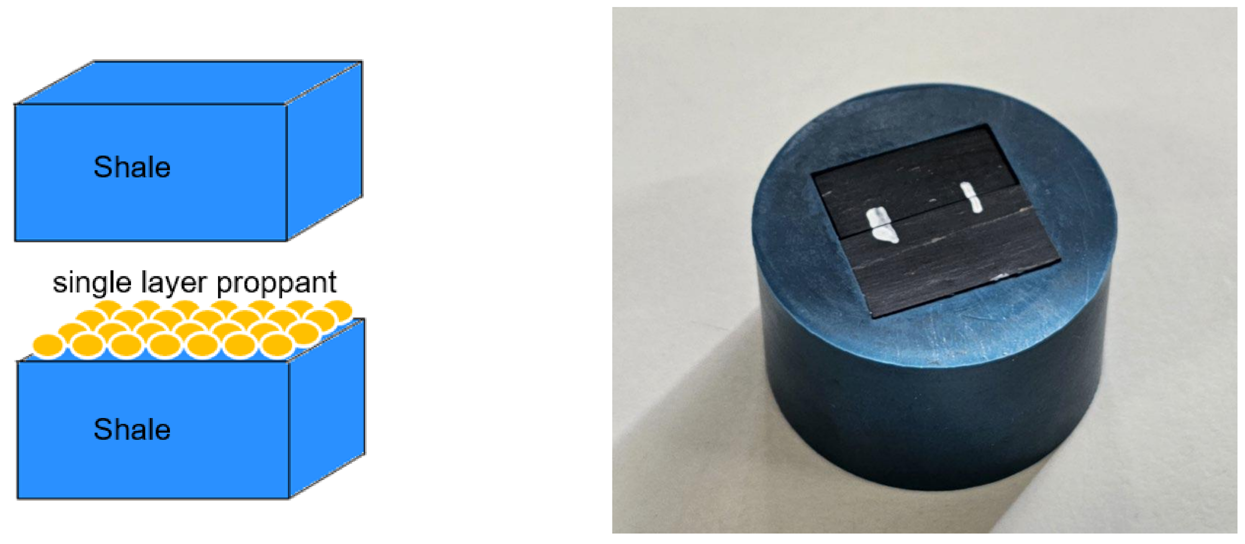



Figure 1. A shale sample with proppants placed in the fracture.

#### Experimental apparatus

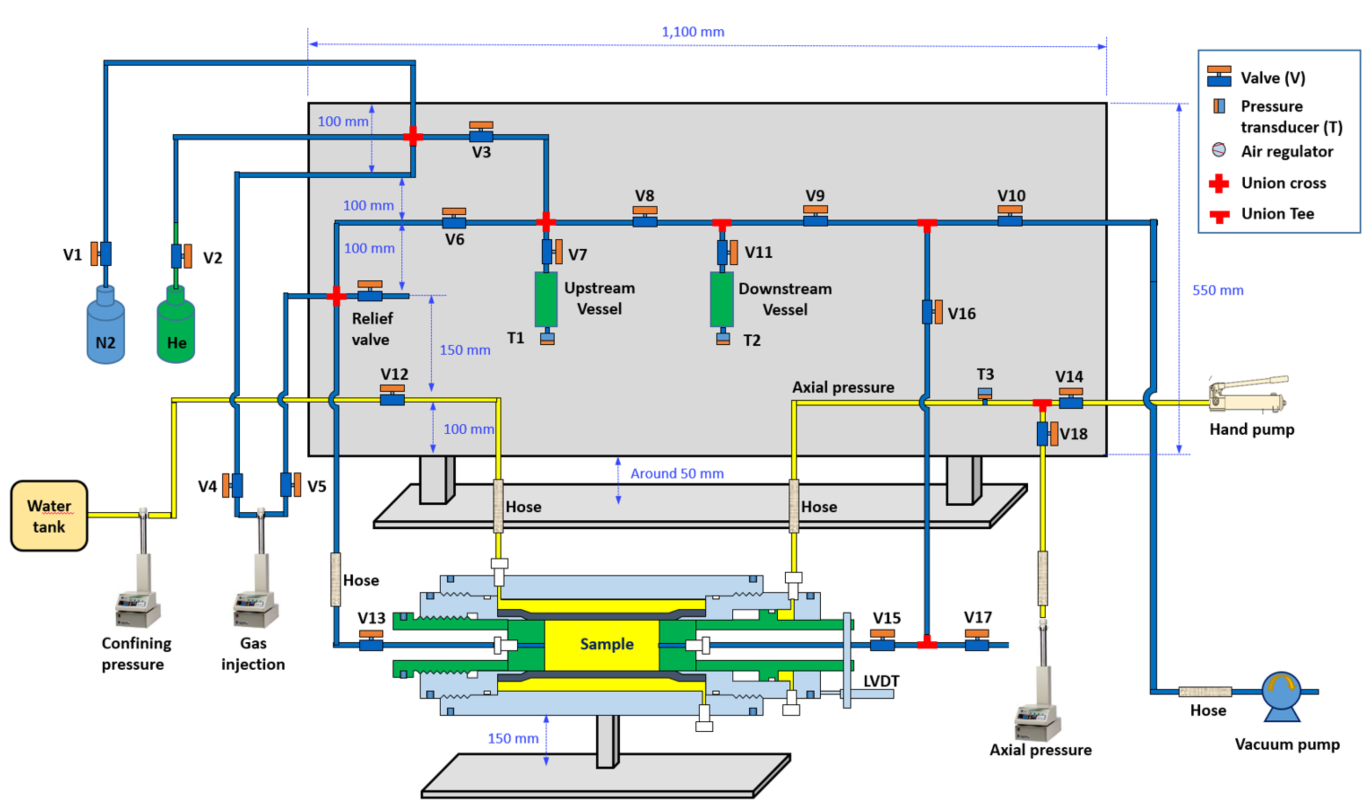



Figure 2. The schematic diagram of permeability testing system.

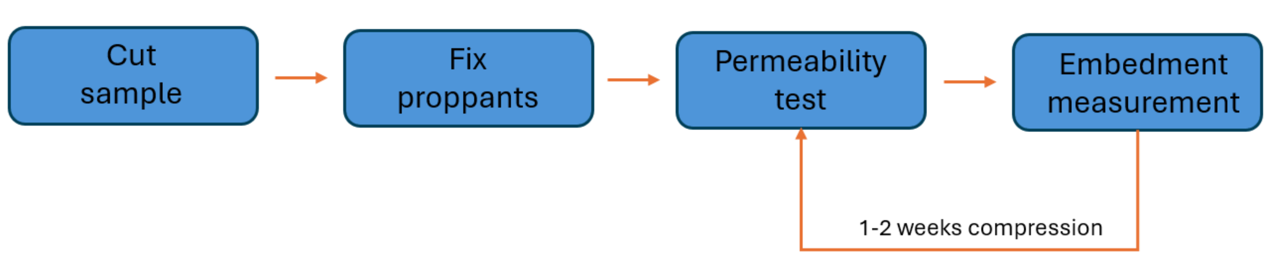
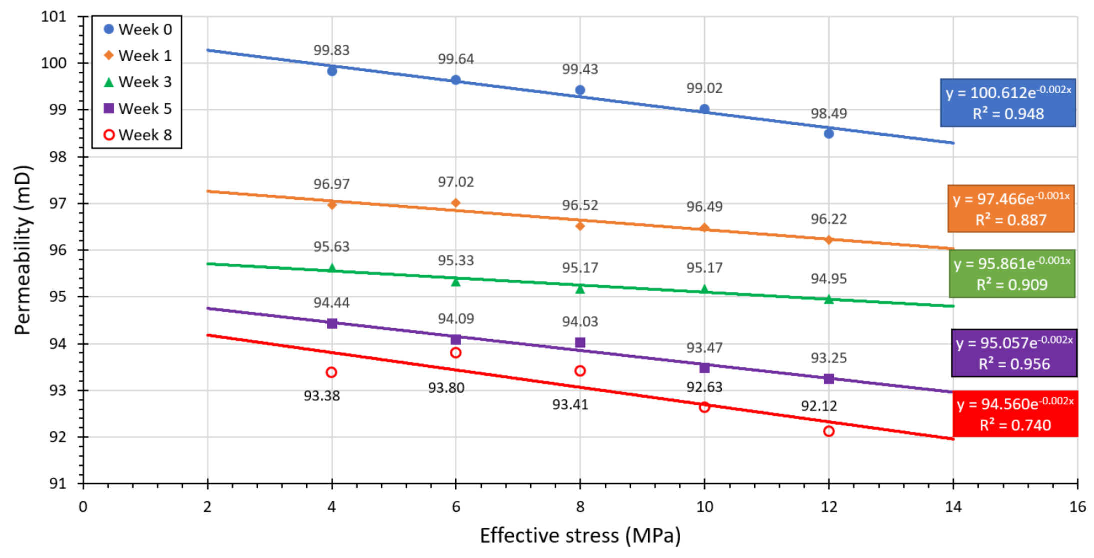
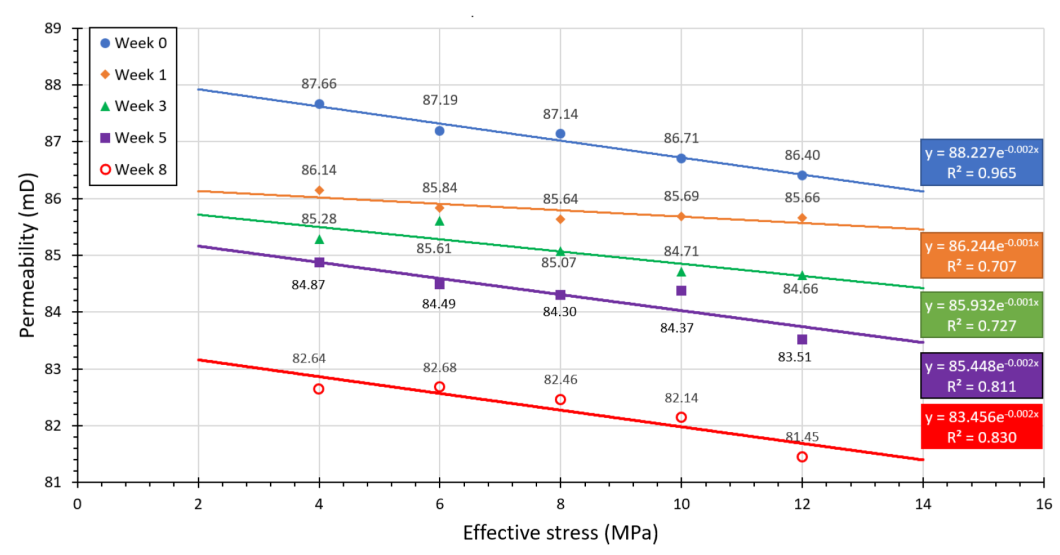



Figure 3. Experimental procedure.

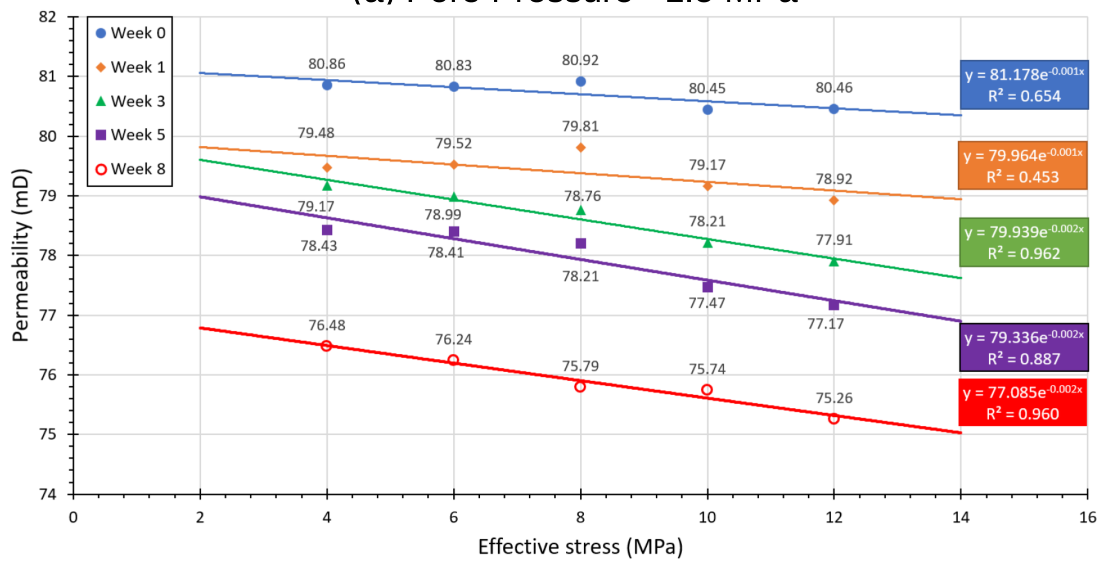
### Experiment Results



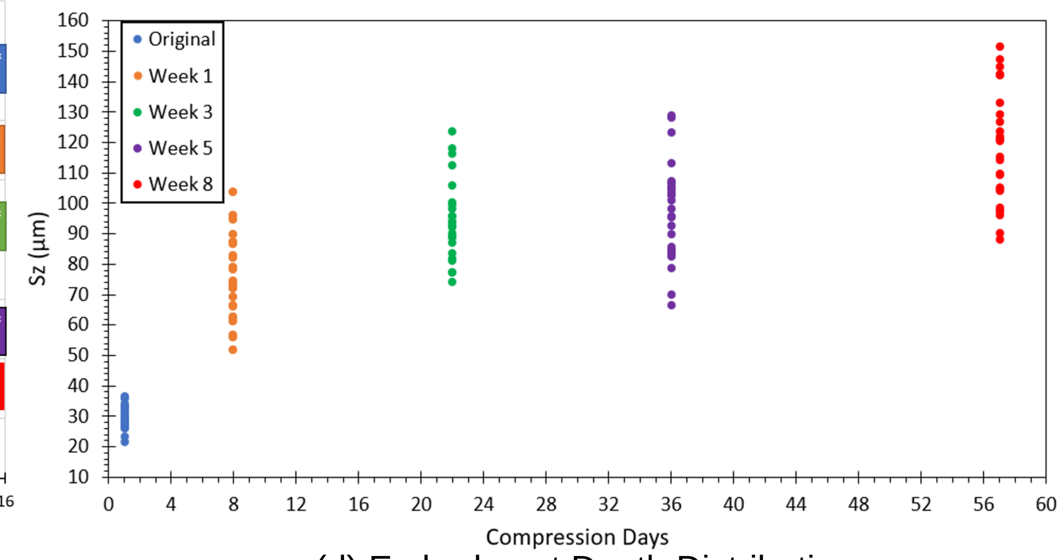
(a) Pore Pressure =1.5 MPa



(b) Pore Pressure =2 MPa

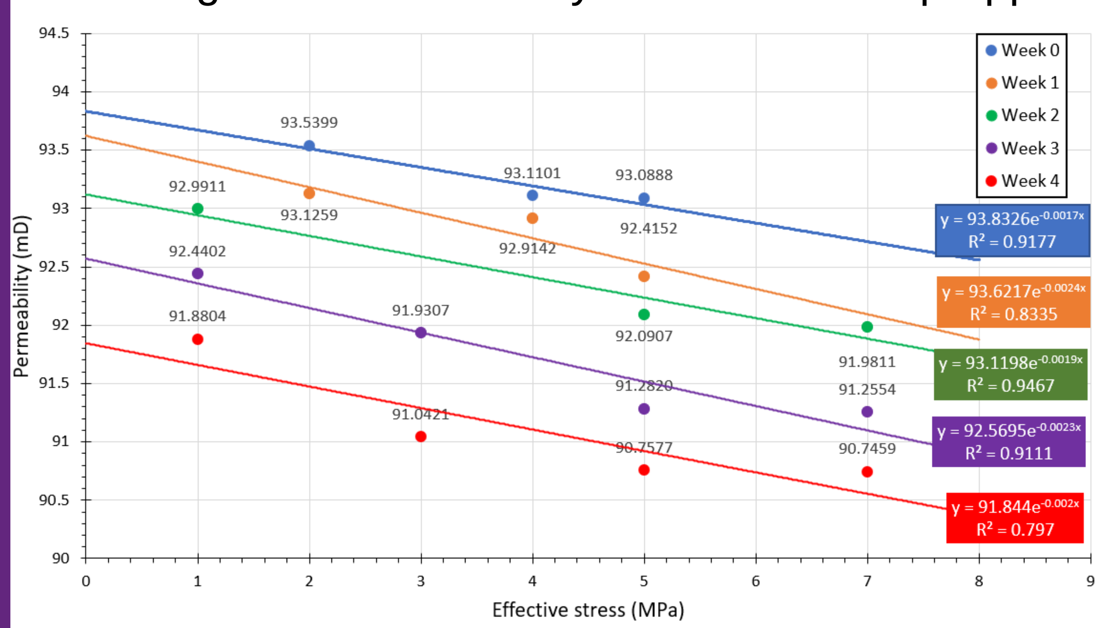


(c) Pore Pressure =2.5 MPa

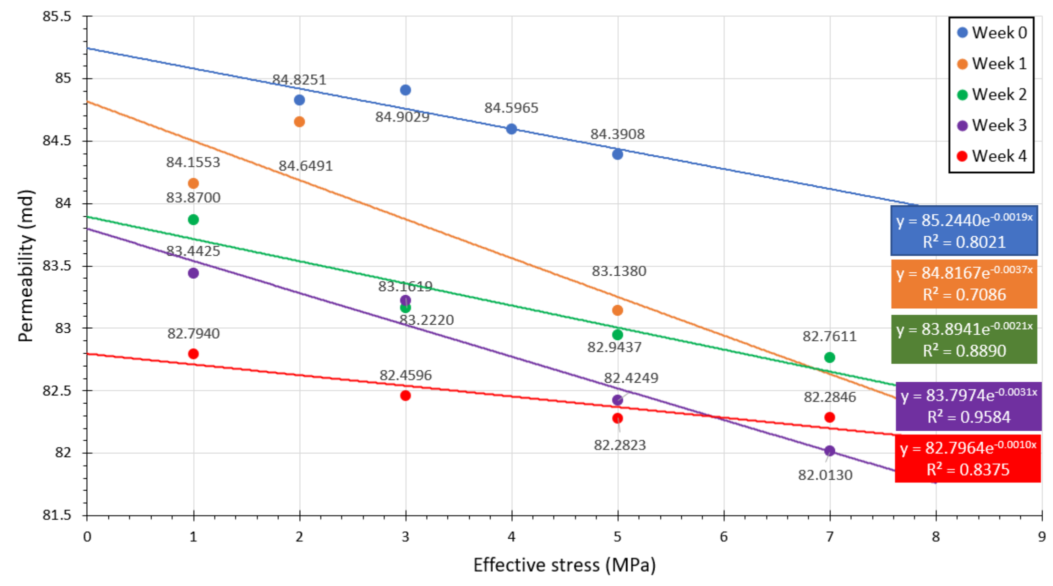


(d) Embedment Depth Distribution

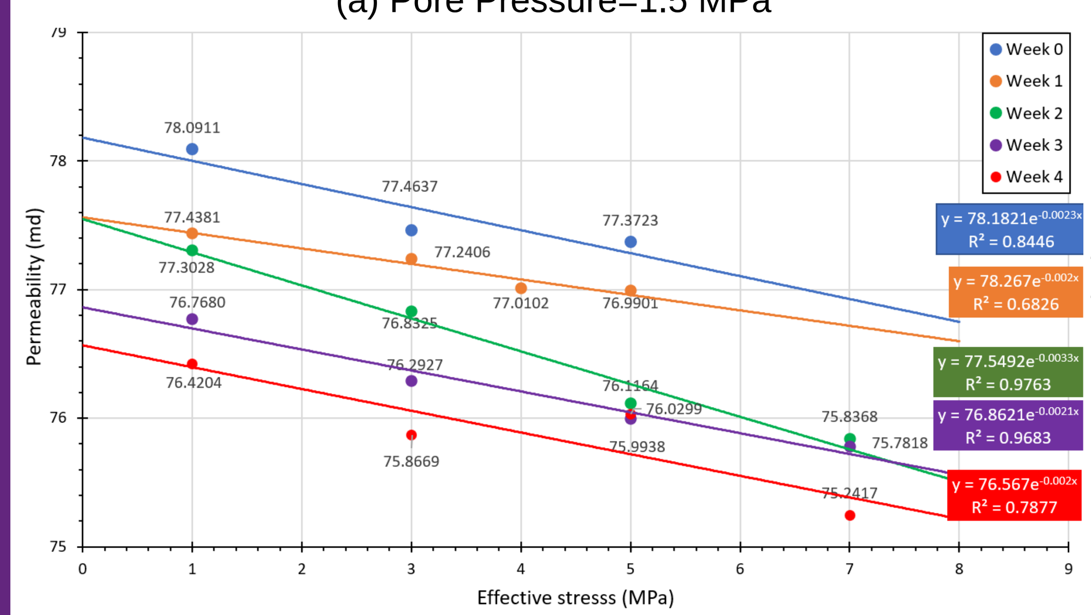
Figure 4. Permeability test results and proppant embedment distribution for Sichuan Basin, China.



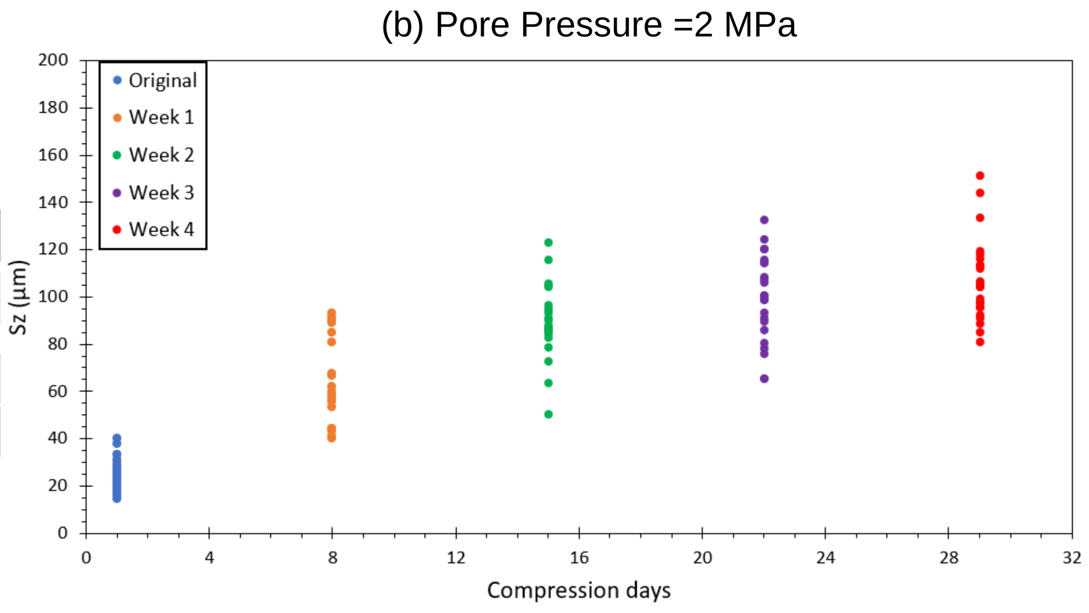
(a) Pore Pressure=1.5 MPa



(b) Pore Pressure =2 MPa

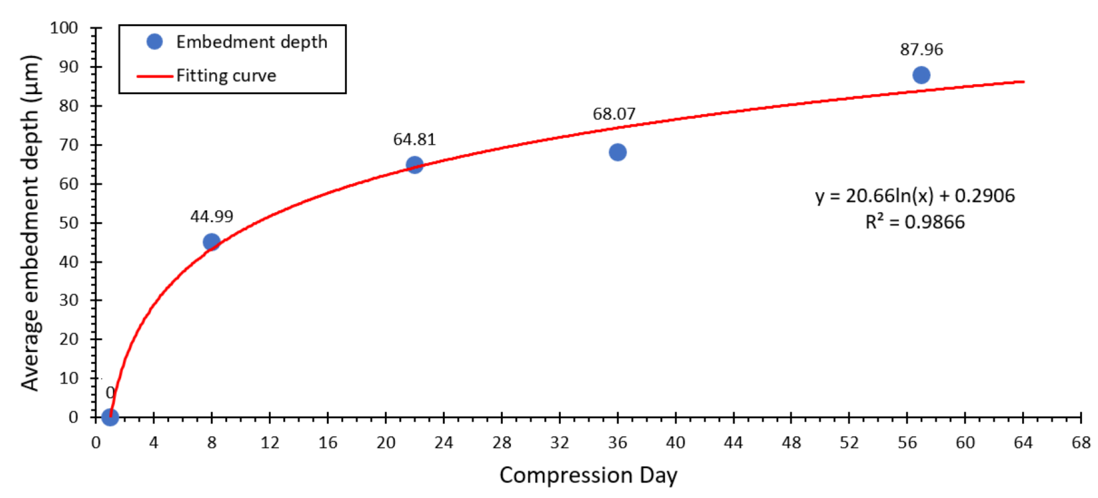


(c) Pore Pressure =2.5 MPa

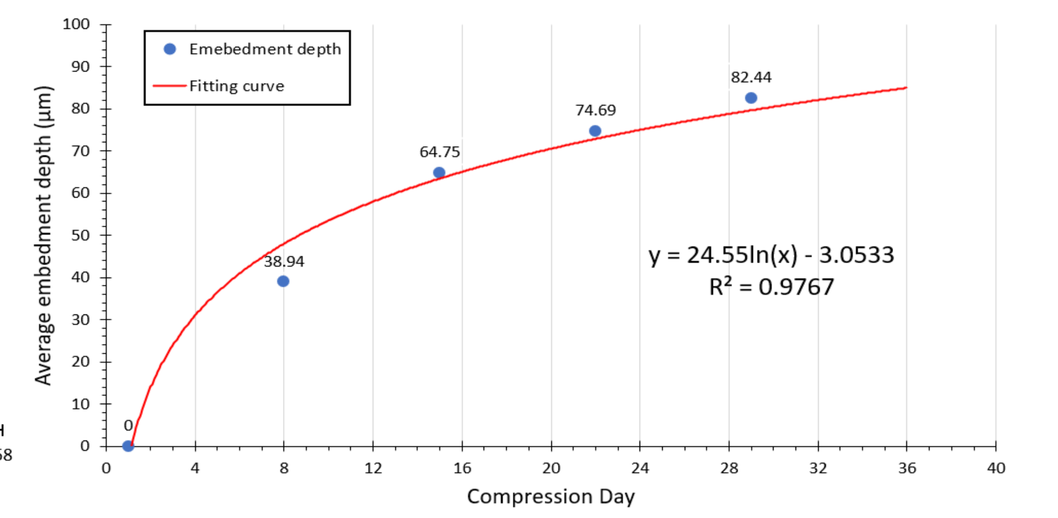


(d) Embedment Depth Distribution

Figure 5. Permeability test results and proppant embedment distribution for Eromanga Basin, Australia.




(a) Sichuan Basin




(b) Eromanga Basin

Figure 6. Correlation between the average embedment depth and the days of compression.

### Conclusions

1. The results showed that the permeability loss after 8 weeks of compression ranges from 4.38 mD to 6.44 mD, and the percentage ranges from 6.74% to 8.89%.
2. The change rate of the average embedment depth drops after 3 weeks of the continuing compression because of the increasing contact area between proppants and shale fracture surfaces. The average embedment depths are 64.81 μm and 87.96 μm after 3 and 8 weeks of compression, respectively.
3. The time-dependent change of the proppant embedment depth can be modelled with a logarithmic function.

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