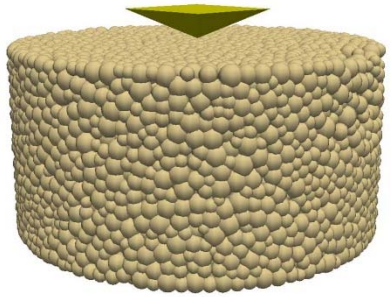
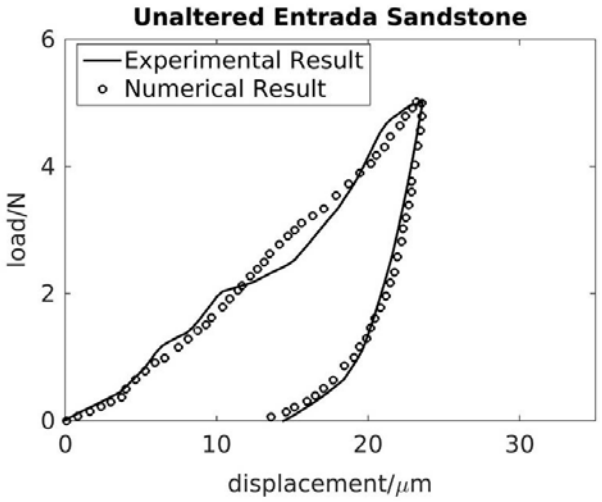
# Discrete Element Modeling of Rock Mechanical Alteration Due to $CO_2$-Charged Brine






Discrete element modeling of indentation test validated against experimental result.

Sun, Espinoza, Balhoff. 2016. Journal of Geophysical Research: Solid Earth 121, 7867-7881

Work was performed at University of Texas at Austin

## Scientific Achievement

**Discrete element method is applied to study $CO_2$-related chemo-mechanical alteration on rocks. $CO_2$-charged brine tends to alter the rock mechanical property by reducing cement size rather than cement strength.**

## Significance and Impact

**$CO_2$-related alteration on rock mechanical properties is critical to host formation structure integrity and long-term secure $CO_2$ storage. The mechanism of $CO_2$-related alteration is investigated in this study.**

## Research Details

- Numerical model is developed and verified against both analytical model and experimental result. Cement size reduction can reproduce the mechanical degradation due to $CO_2$-alteration.
- Parametric study is performed for all model inputs to identify the key parameter representing the $CO_2$-alteration at the particle/pore scale.

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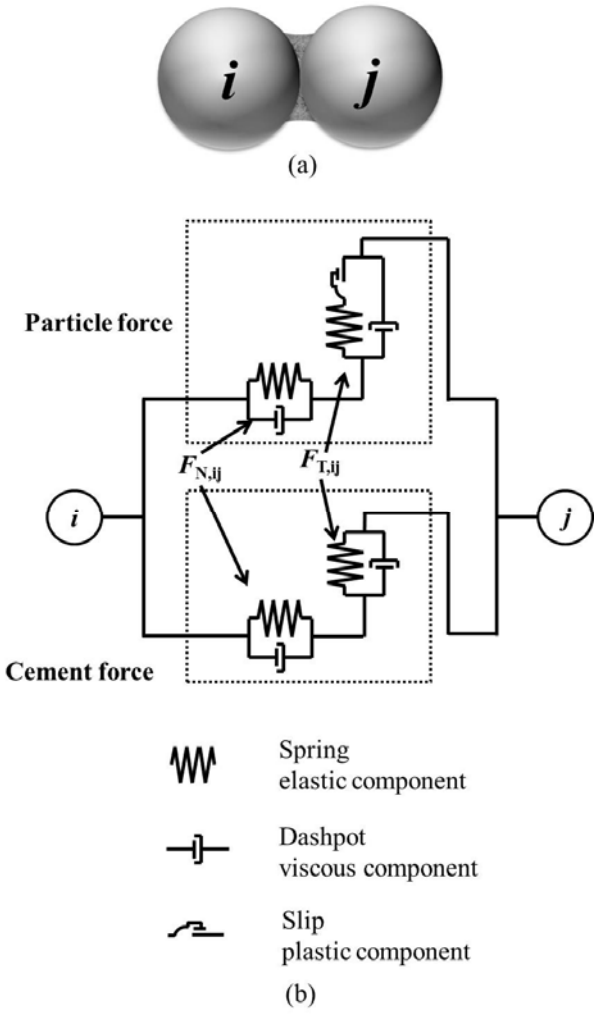
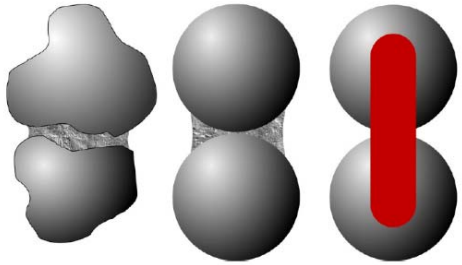
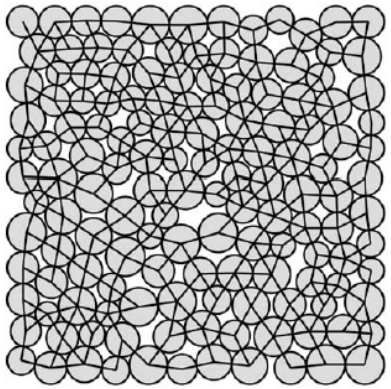
# Discrete element method and bonded-particle model




Schematic of DEM + BPM



Idealization of cemented rock

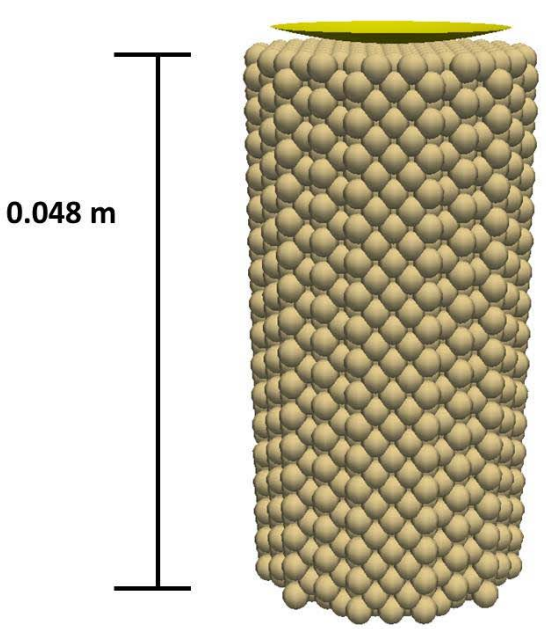


Obermayr et al. 2012

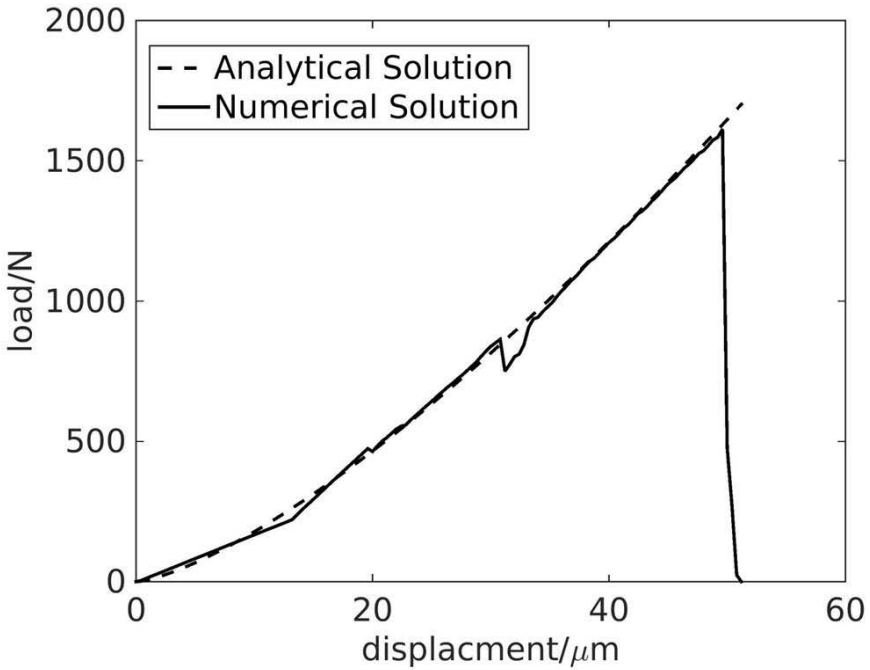
BPM schematic for 2D

DEM + BPM model inputs: Bond/particle modulus, bond strength, bond size.

# Verification against Cavity Expansion Model



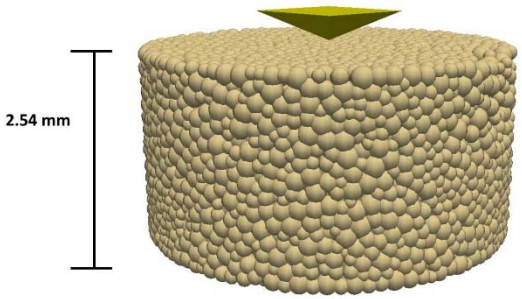

Model setup




Verification result

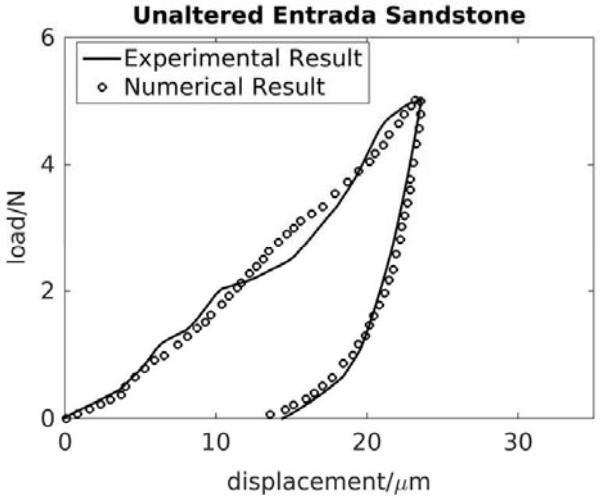
Alehossein et al., 2000

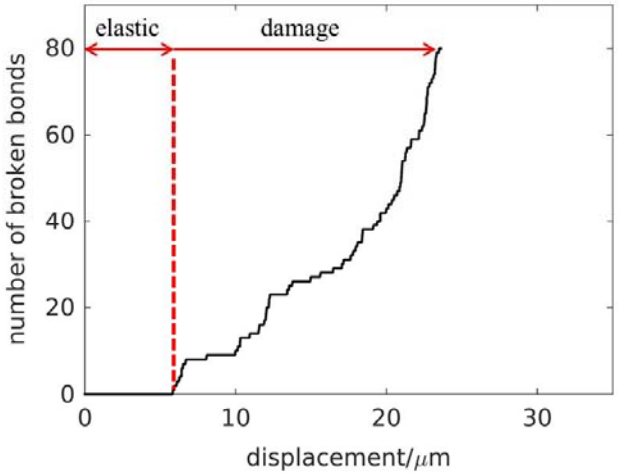
# Validation against experiments




Model setup

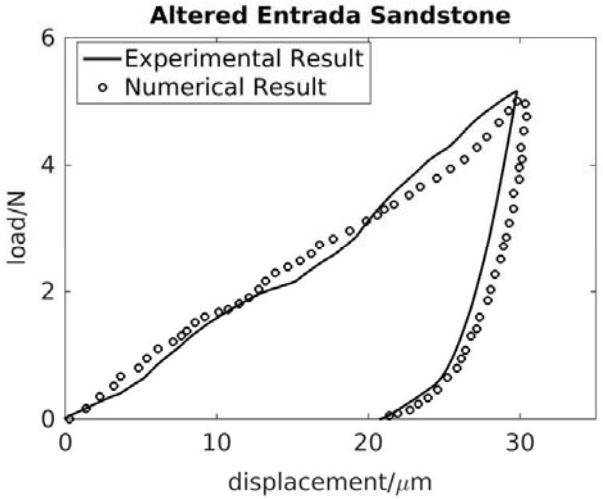
Thick bonds ($\lambda = 0.5$)

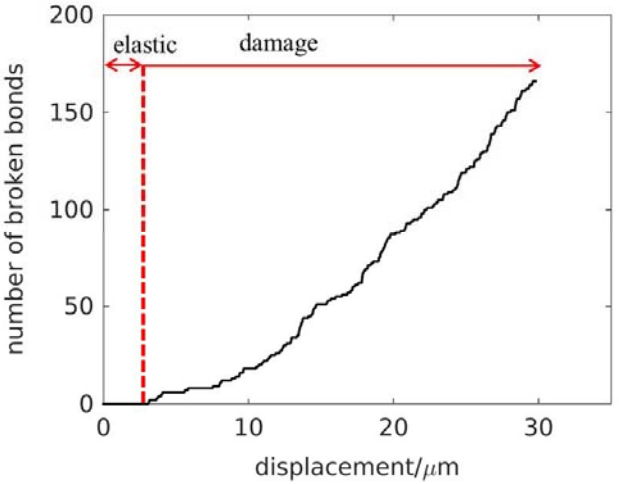



Thin bonds ($\lambda = 0.29$)

All variable are invariant except the bond size $\lambda$.



# Conclusions

- Bonded-Particle Model successfully models indentation on cemented sandstones
- $CO_2$-related mechanical rock degradation in bleached Entrada sandstone can be ascribed to the degradation of interparticle cementation
- $CO_2$-related degradation on cement bonds is likely due to the reduction of cement size rather than cement strength