

## It's an OLD problem!!



e.g. mining Ngwenya  
Mine ~ 40'000 years old

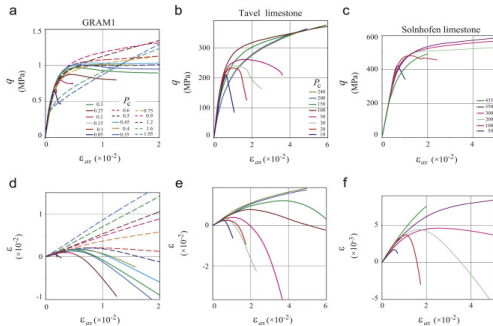


or foundations Barnenez  
(France), ~ 7000 years old

## Yet very current...

Title	Type	↓ SJR	H index	Total Docs. (2015)	Total Docs. (3years)	Total Refs.	Total Cites (3years)	Citable Docs. (3years)	Cites / Doc. (2years)	Ref. / Doc.	
1 <a href="#">Reviews of Geophysics</a>	journal	8.833 Q1	107	31	65	7005	857	58	12.42	225.97	
2 <a href="#">Earth and Planetary Sciences Letters</a>	journal	3.628 Q1	177	635	1723	37073	7770	1650	4.42	58.38	
3 <a href="#">Geophysical Research Letters</a>	journal	3.323 Q1	185	1493	3334	51508	13613	3227	4.06	34.50	
4 <a href="#">Journal of Petrology</a>	journal	2.992 Q1	124	38	300	3887	1056	290	2.88	102.29	
5 <a href="#">Tectonics</a>	journal	2.628 Q1	96	178	293	12615	1049	276	3.59	70.87	
6 <a href="#">Contributions of Mineralogy and Petrology</a>	journal	2.582 Q1	112	111	434	8262	1315	412	3.12	74.43	

They are:  
highly non-linear

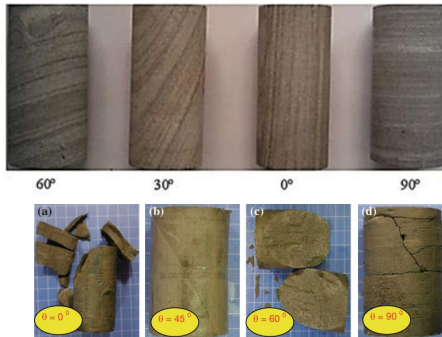


They are:  
highly non-linear  
heterogeneous





They are:  
highly non-linear  
heterogeneous  
anisotropic



Their mechanical behaviour heavily depends on  
(and affects):

temperature  
confinement  
pore water pressure  
chemistry

And this is true of MOST of them in MOST  
natural and engineering conditions...

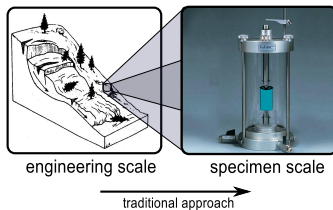
Their mechanical behaviour heavily depends on  
(and affects):

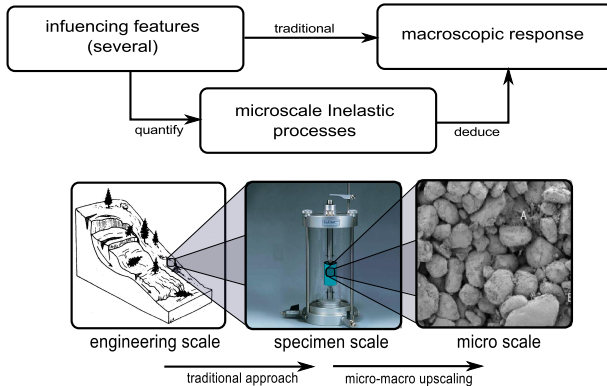
temperature  
confinement  
pore water pressure  
chemistry

→

Very complex and cumbersome models  
(20+ parameters).

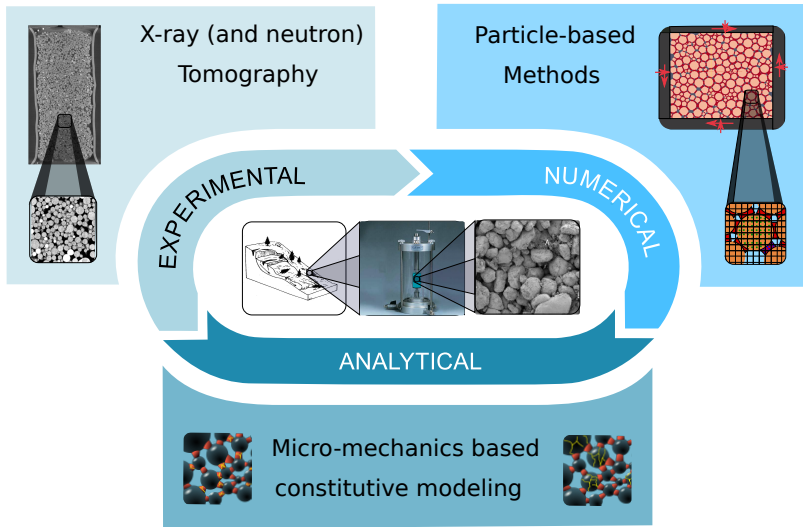
And this is true of MOST of them in MOST  
natural and engineering conditions...





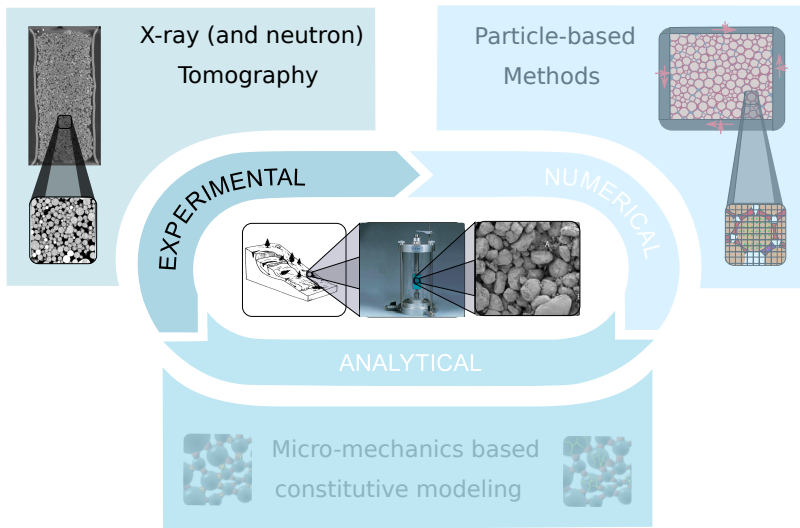
What are geomaterials, why do they matter?  
What do we want to measure?  
Image analysis for discrete materials  
Conclusions

Examples of open engineering challenges  
Key features of geomaterials  
Micro-mechanics and the role of imaging



What are geomaterials, why do they matter?  
What do we want to measure?  
Image analysis for discrete materials  
Conclusions

Examples of open engineering challenges  
Key features of geomaterials  
Micro-mechanics and the role of imaging



what do we intend with metrology?

what can be defined as quantitative imaging?

images are measures.  
Studying images is  
quantitative imaging

from Beer-Lambert law  
I can extract either thicknesses  
of absorption coefficients

extracting measures of  
relevant quantities from images. This allows the  
removal of the arbitrariness of the human eye



what do we intend with metrology?

what can be defined as quantitative imaging?

images are measures.  
Studying images is  
quantitative imaging

from Beer-Lambert law  
I can extract either thicknesses  
of absorption coefficients

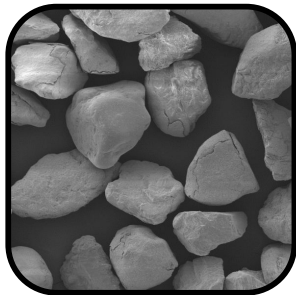
extracting measures of  
relevant quantities from images. This allows the  
removal of the arbitrariness of the human eye

## Continuum



e.g. granite,  
basalt, marble...

## Discrete



e.g. sand,  
powders, clay...

## Continuum



e.g. granite,  
basalt, marble...

## Discrete



e.g. sand,  
powders, clay...