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Real soils versus fake soils: Does something other than clay minerals influence geopolymerisation behavior in real soils?

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REAL SOILS VERSUS FAKE SOILS:

Does something other than *clay minerals* influence alkali activation behaviour in real soils?

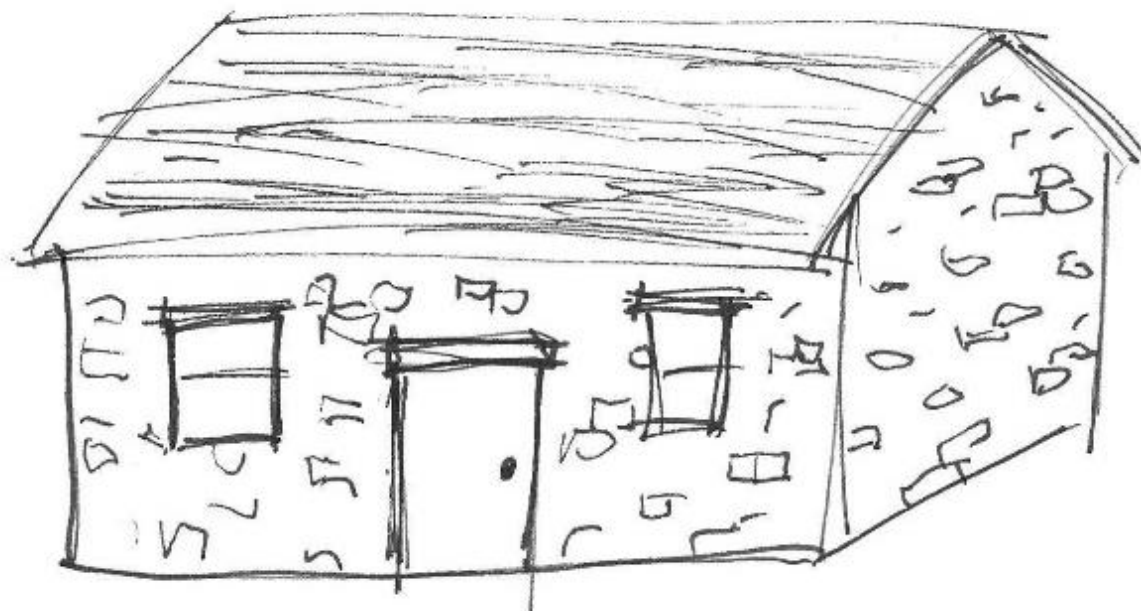
Mr Alastair Marsh

Department of Architecture & Civil Engineering

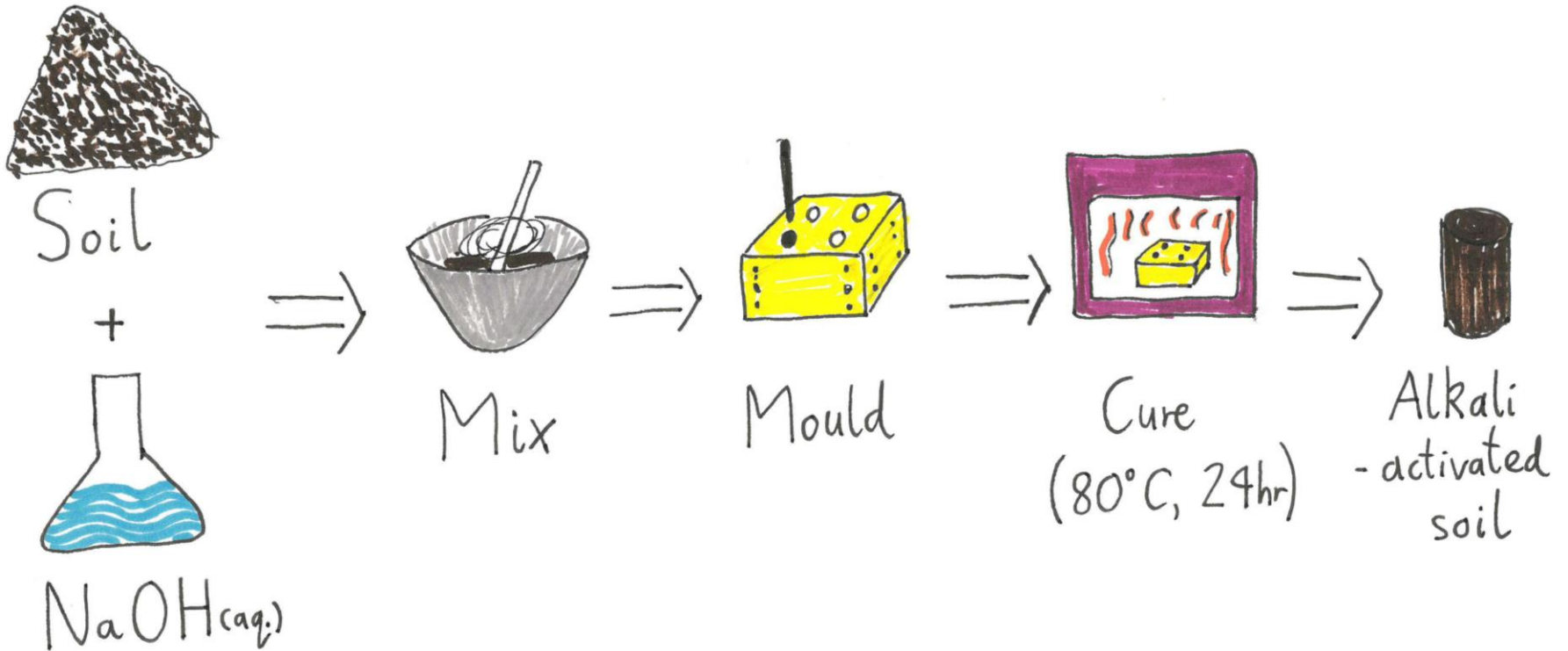
University of Bath

10kU X Lead supervisor: Prof. Andrew Heath 28 SEI

What's it for?



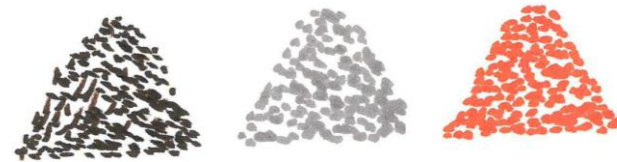
What is it?



What are we doing?

- *Why soils?*

- Soil is abundant
- Locally sourced material



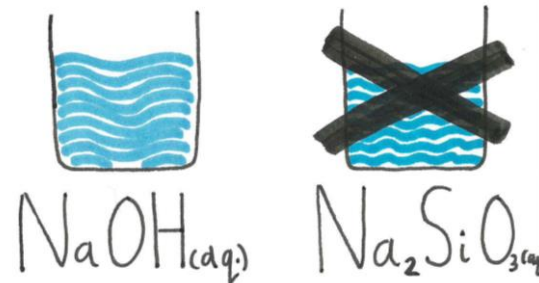
- *Why not calcined?*

- Lowest possible environmental impact?
- Don't need high strengths



- *Why no soluble silicate (NaOH only)?*

- Simple system
- Understand behaviour of soil components



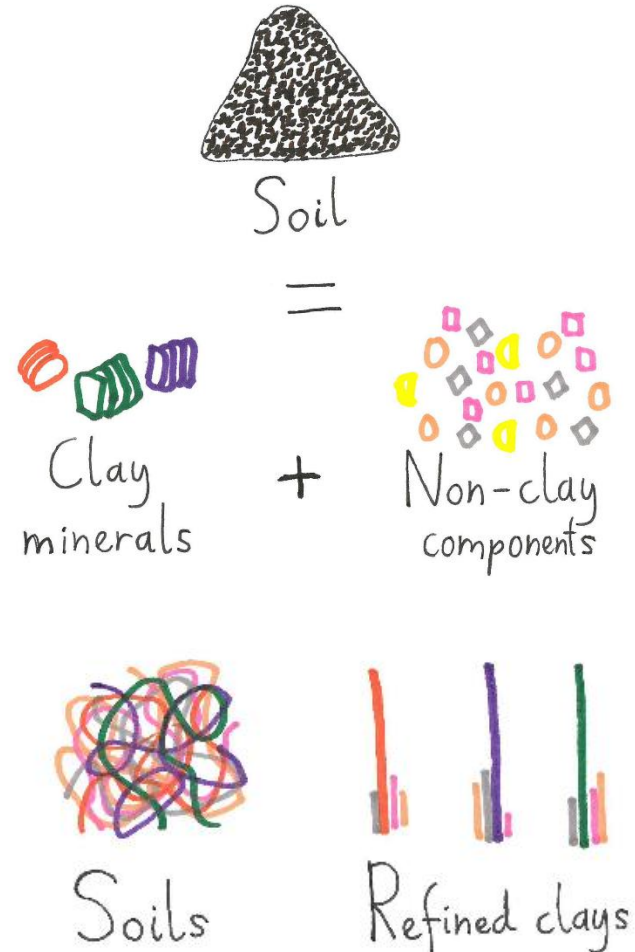
Coming up...

- Introduction to alkali-activated soils
- **Aims of the study**
- Meet the soils
- Alkali activation of individual clays
- Alkali activation of soils
- Conclusions
- What next?

What are the aims of this study?

In alkali activation of soils...

1. What is the influence of *clay minerals* and *non-clay components* on phase formation?
2. Can we explain behaviour of soils using refined clay minerals?



How did we do it?

FAKE

SOILS

How did we do it?

Real soils v. fake soils

Real soils

= clay minerals
+ associated minerals

Fake soils

= Same clay minerals
composition...
... but no associated
minerals (as far as
possible) – just quartz



Common clay minerals in soils



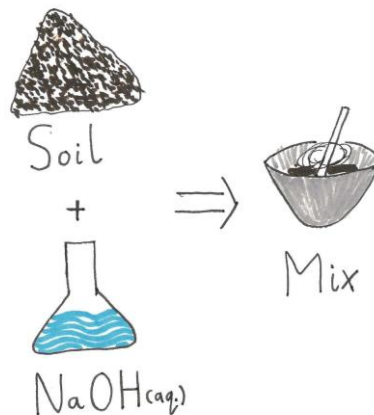
Si:Al molar ratio	1:1	2:1	2:1
Clay used for fake soils	Speswhite Kaolin <i>Imerys</i>	K10 Montmorillonite <i>Sigma-Aldrich</i>	Illite IMt-2 <i>Clay Minerals Society</i>

How did we do it?

Alkali activation

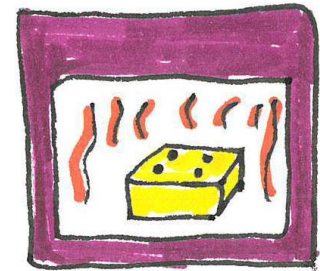
- Na:Al molar ratio = 1
- Wet mix consistency at plastic limit

→ NaOH solutions from 4 - 13 M



Curing

- 80 °C
- 24 hours

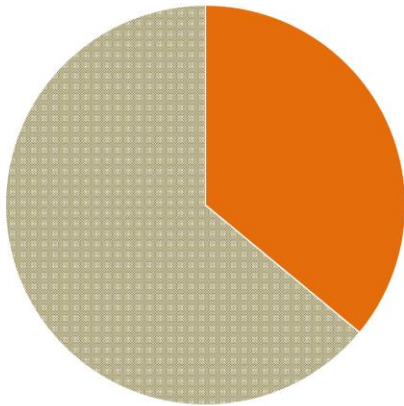


Ageing

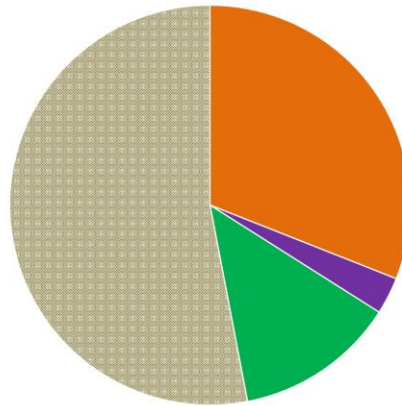
- 20 °C
- 50% relative humidity
- 28 days

The soils

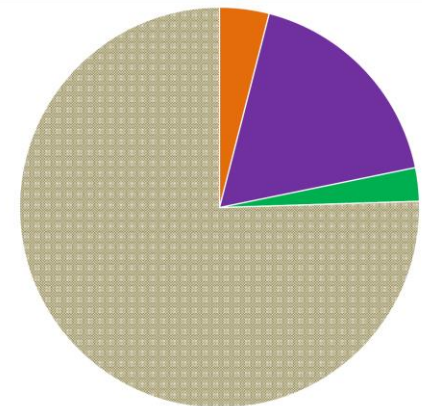
Karnataka Soil



Cattybrook Soil



Mayoo Soil



■ Kaolinite ■ Montmorillonite ■ Illite

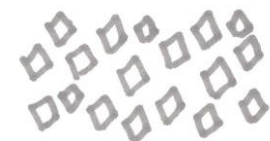
■ Non-clay components

REAL SOILS
= associated minerals



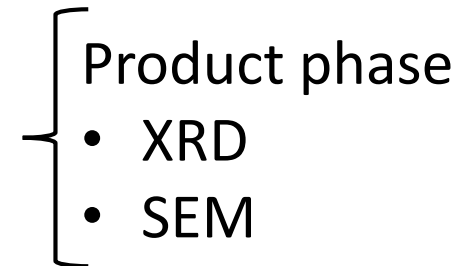
inc. quartz, feldspars,
iron compounds...

FAKE SOILS
= quartz only



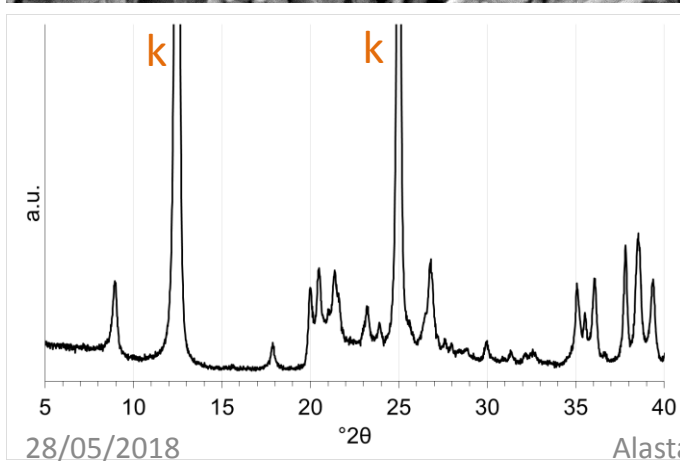
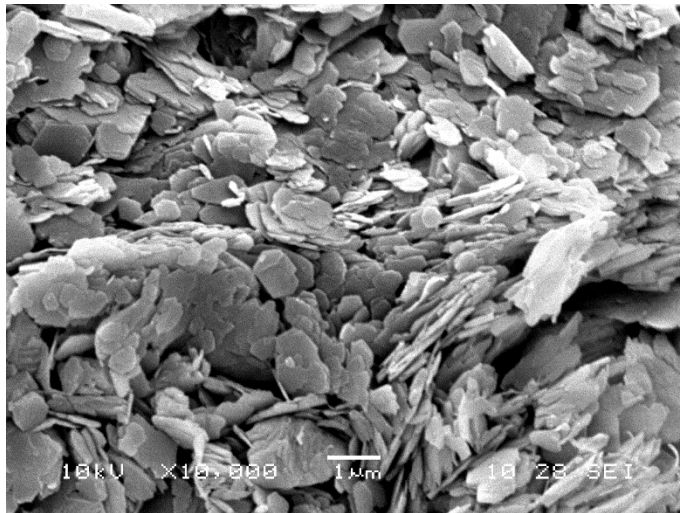
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- **Alkali activation of individual clays**
- Alkali activation of soils
- Conclusions
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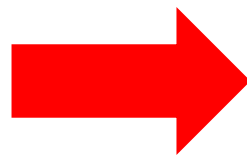
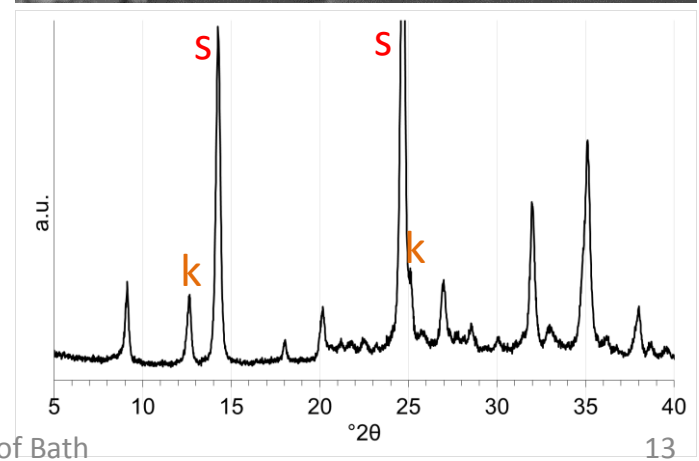
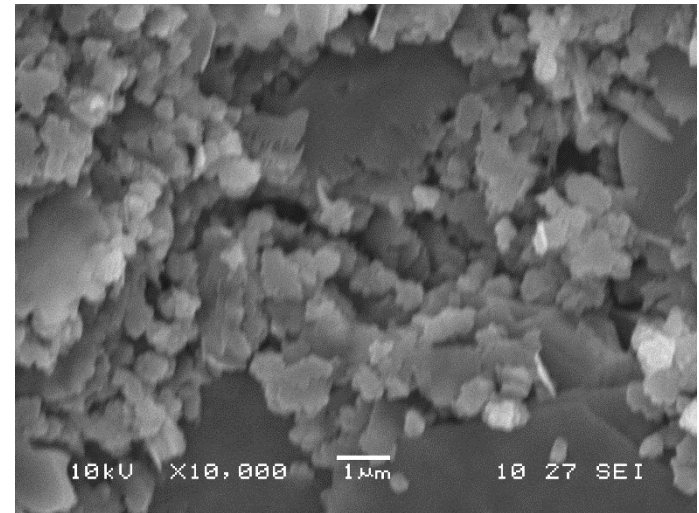


Activation of kaolinite

Kaolinite



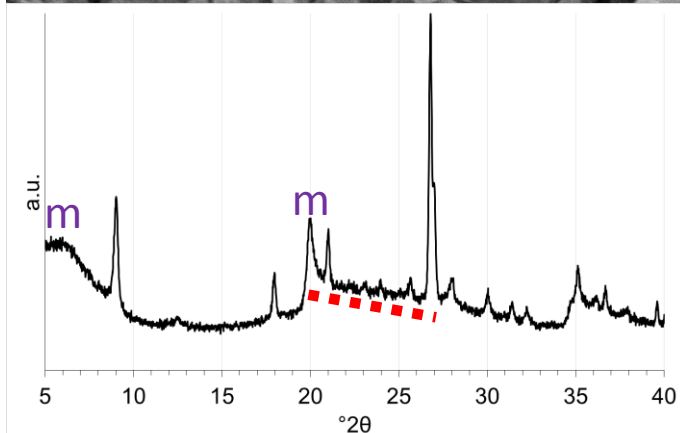
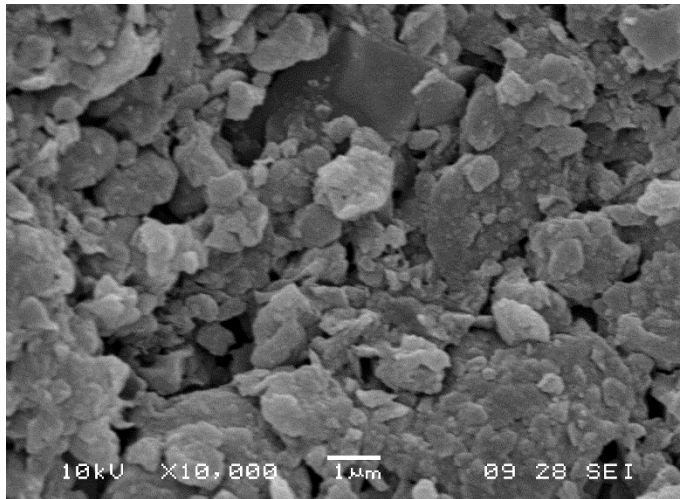
Sodalite



$\text{NaOH}_{(\text{aq.})}$
80 °C, 24 hr

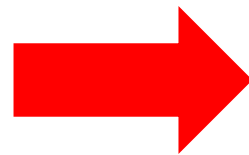
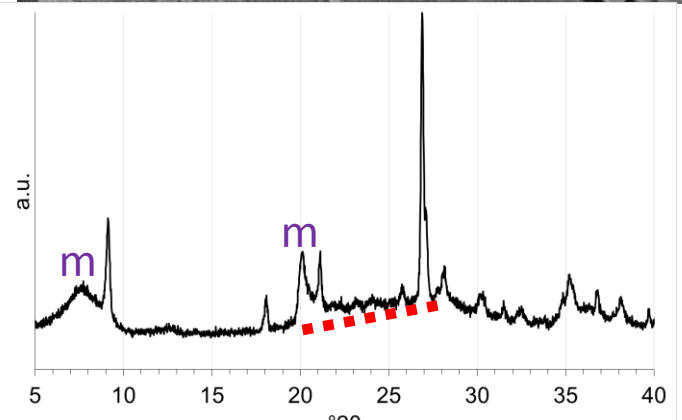
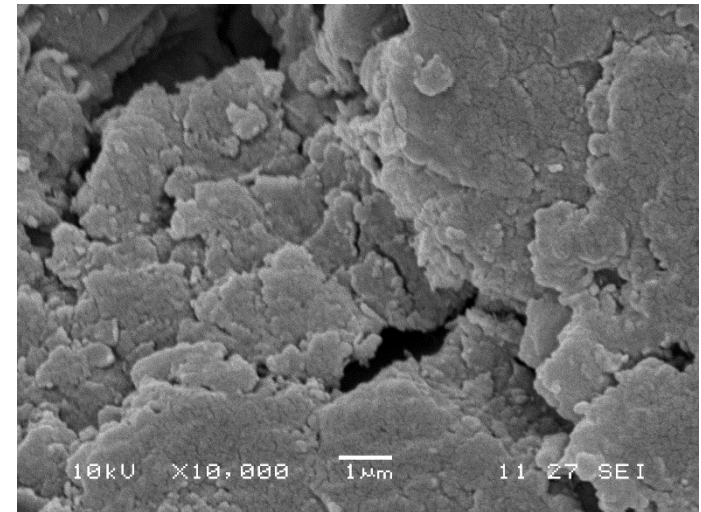
Activation of montmorillonite

Montmorillonite



28/05/2018

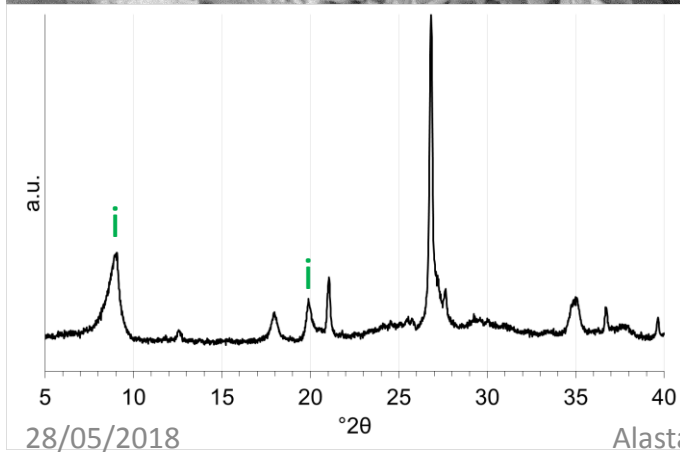
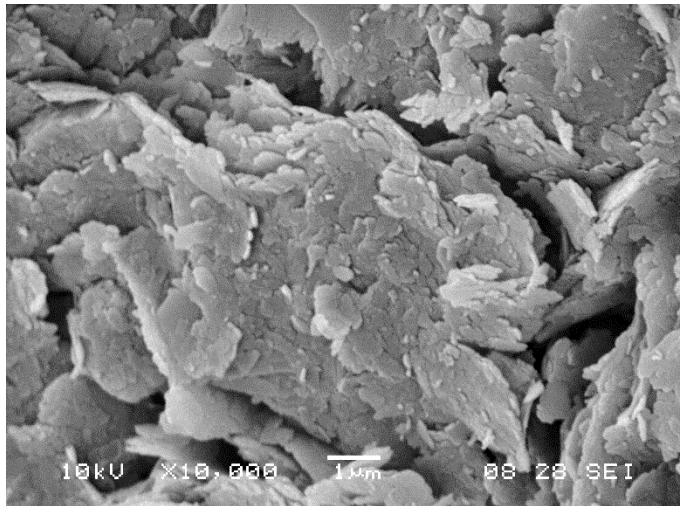
Geopolymer



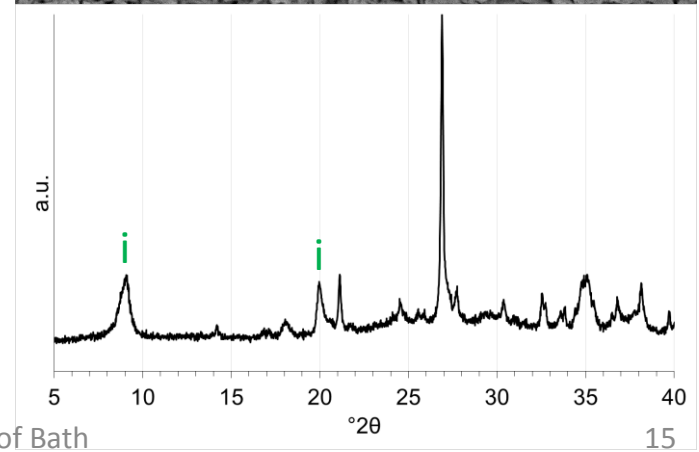
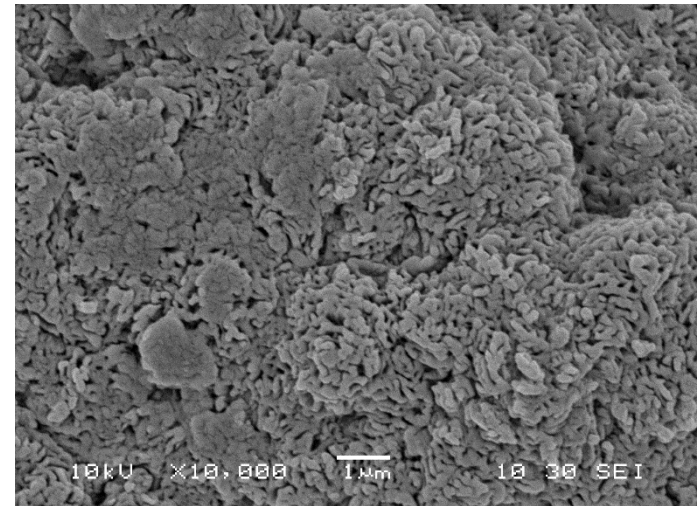
$\text{NaOH}_{(\text{aq.})}$
80 °C, 24 hr

Activation of illite

Illite



Structural breakdown

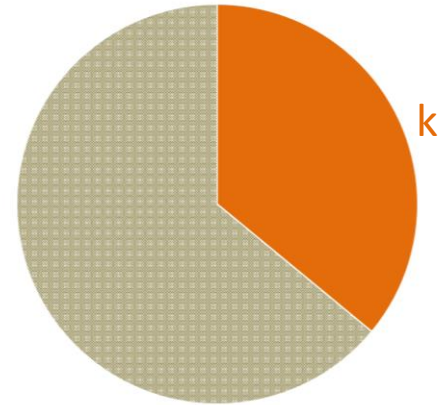
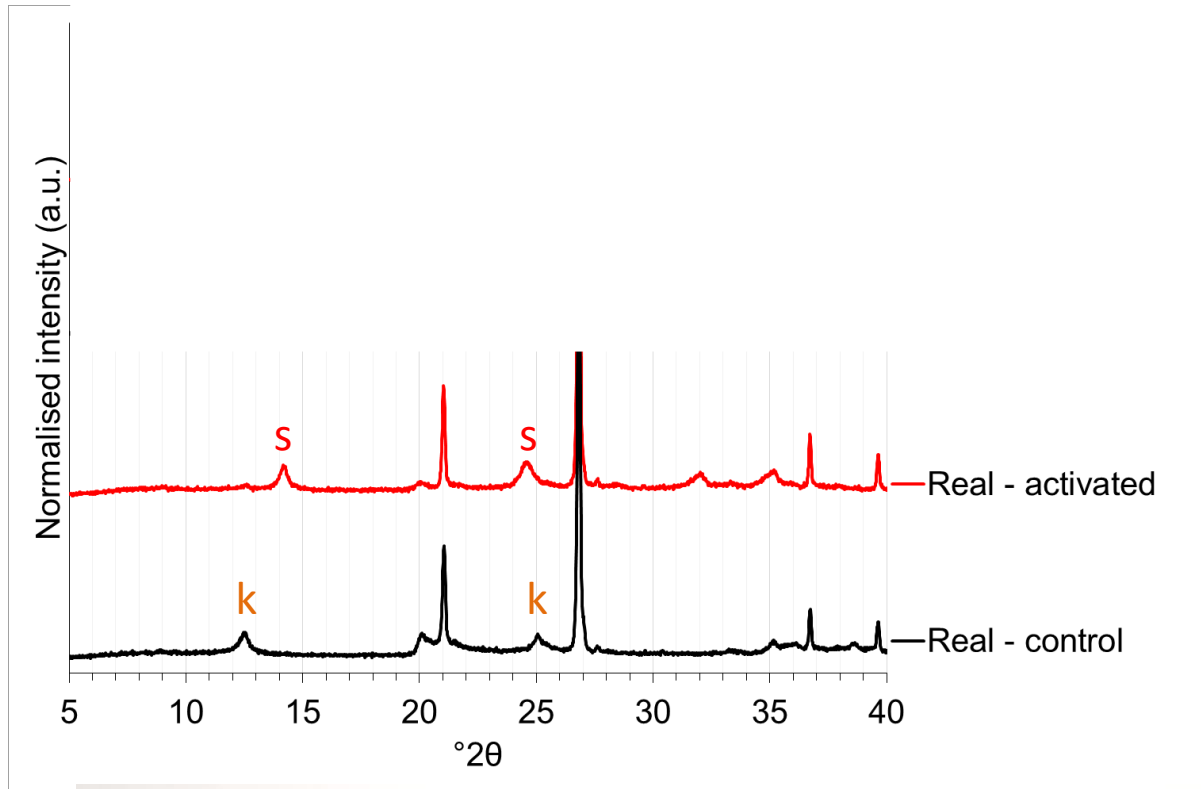


$\text{NaOH}_{(\text{aq.})}$
80 °C, 24 hr

Coming up...

- Introduction to alkali-activated soils
- Aims of the study
- Meet the soils
- Alkali activation of individual clays
- **Alkali activation of soils** {
 - Real v. fake soils
 - Control + activated samples
 - XRD
 - SEM
 - Photos
- Conclusions
- What next?

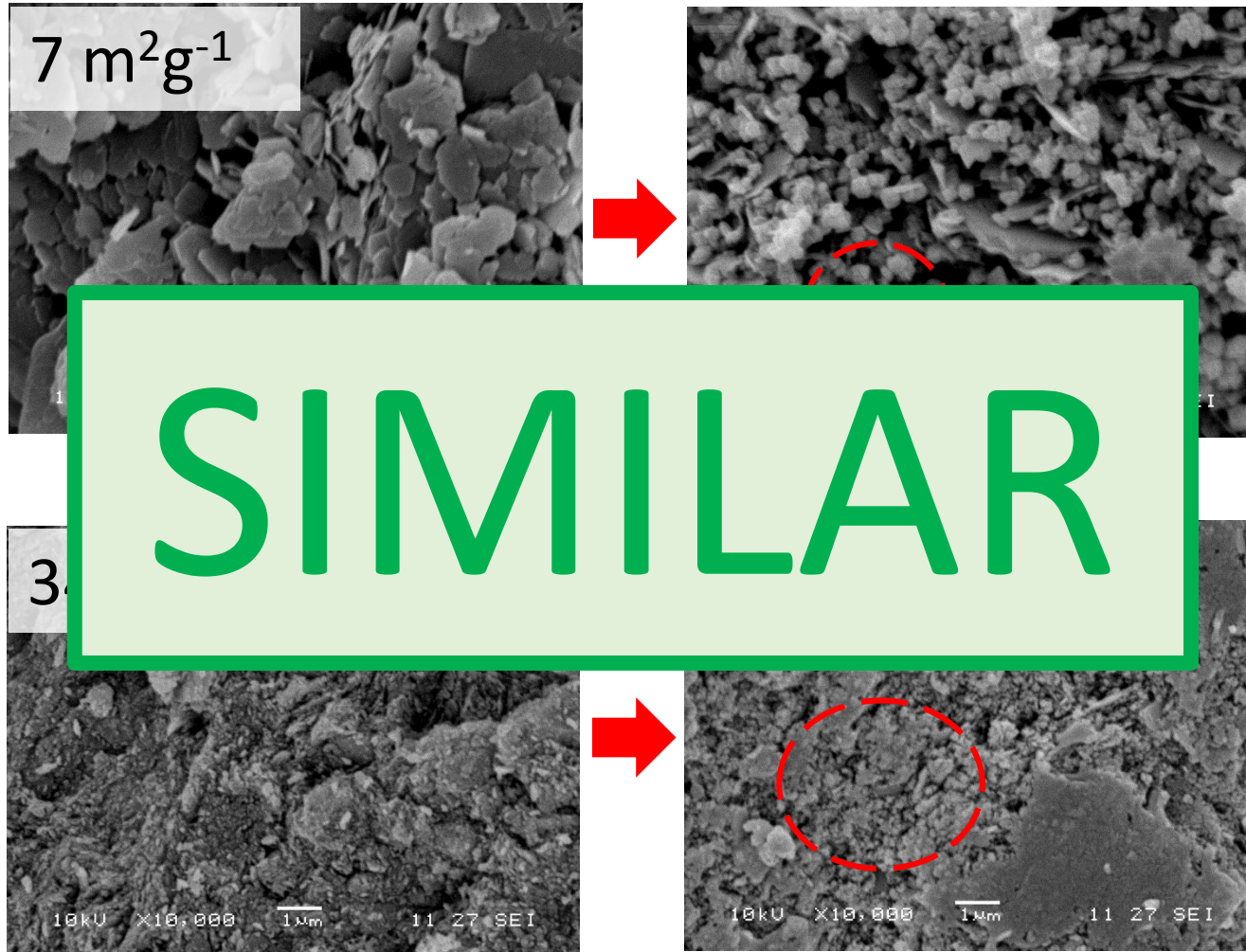
Alkali activation of Karnataka soils



Fake soil
→ Sodalite
Real soil
→ Sodalite



Karnataka soils

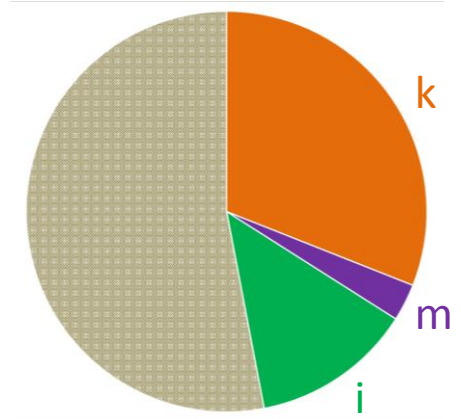
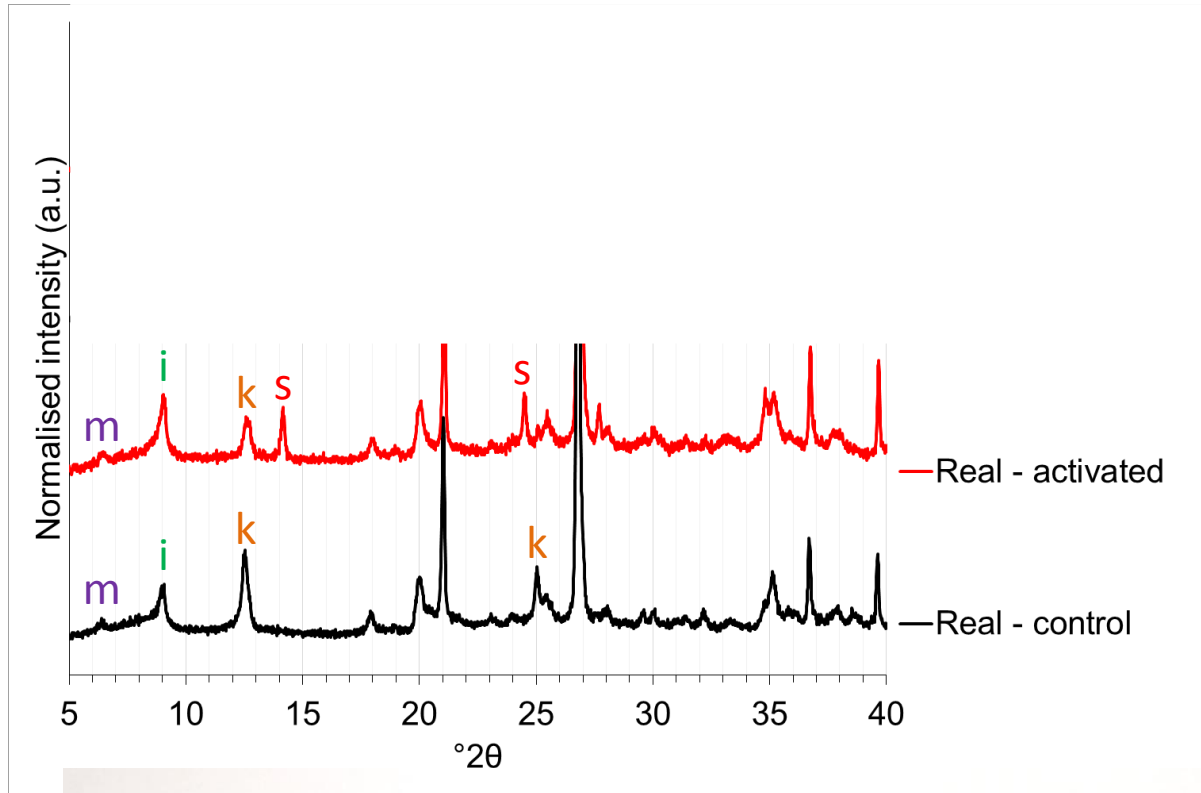


Finer scale
sodalite phase

Real-control

Real-activated

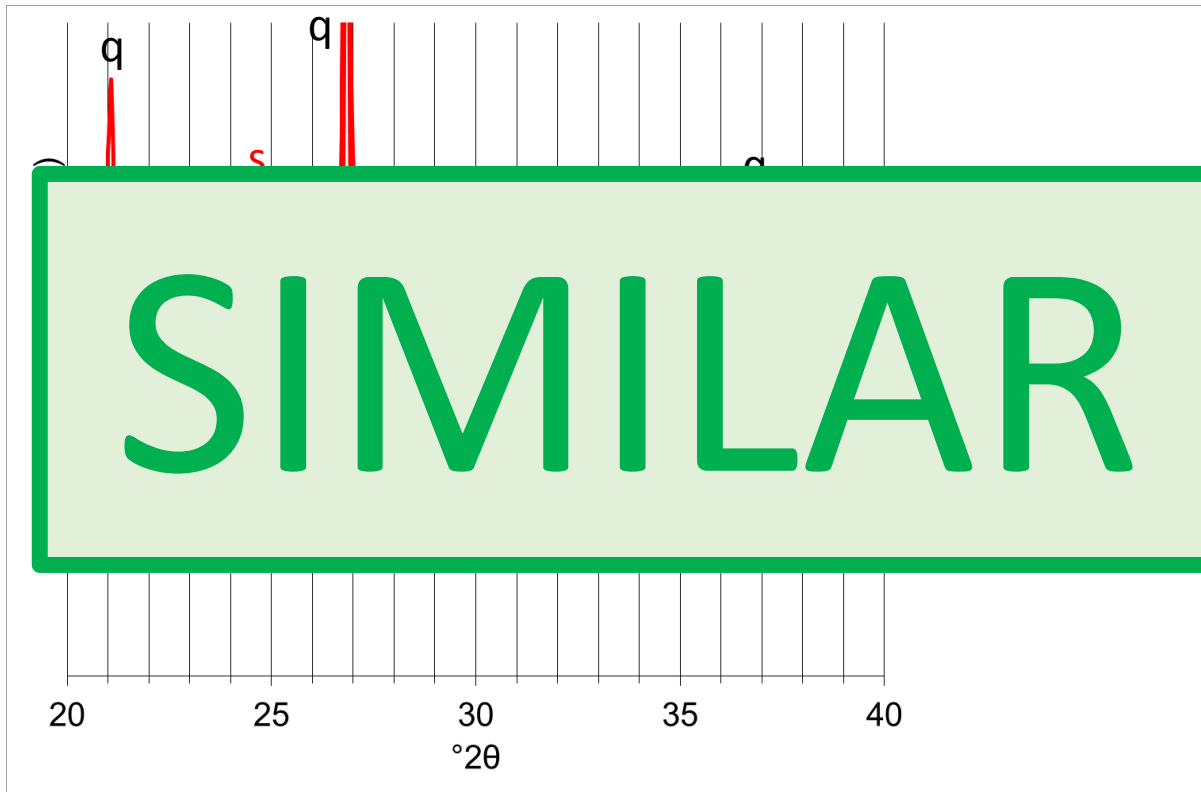
Cattybrook soils



Fake soil
 → Sodalite
 Real soil
 → Sodalite

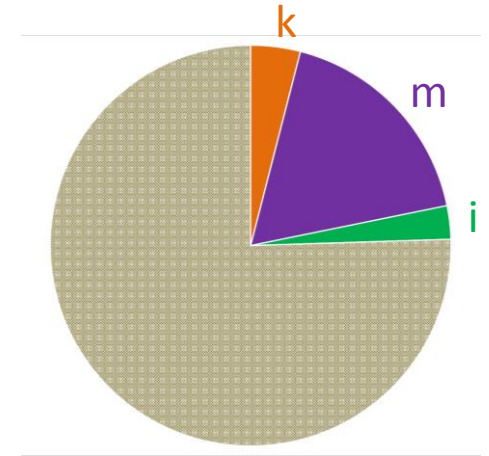
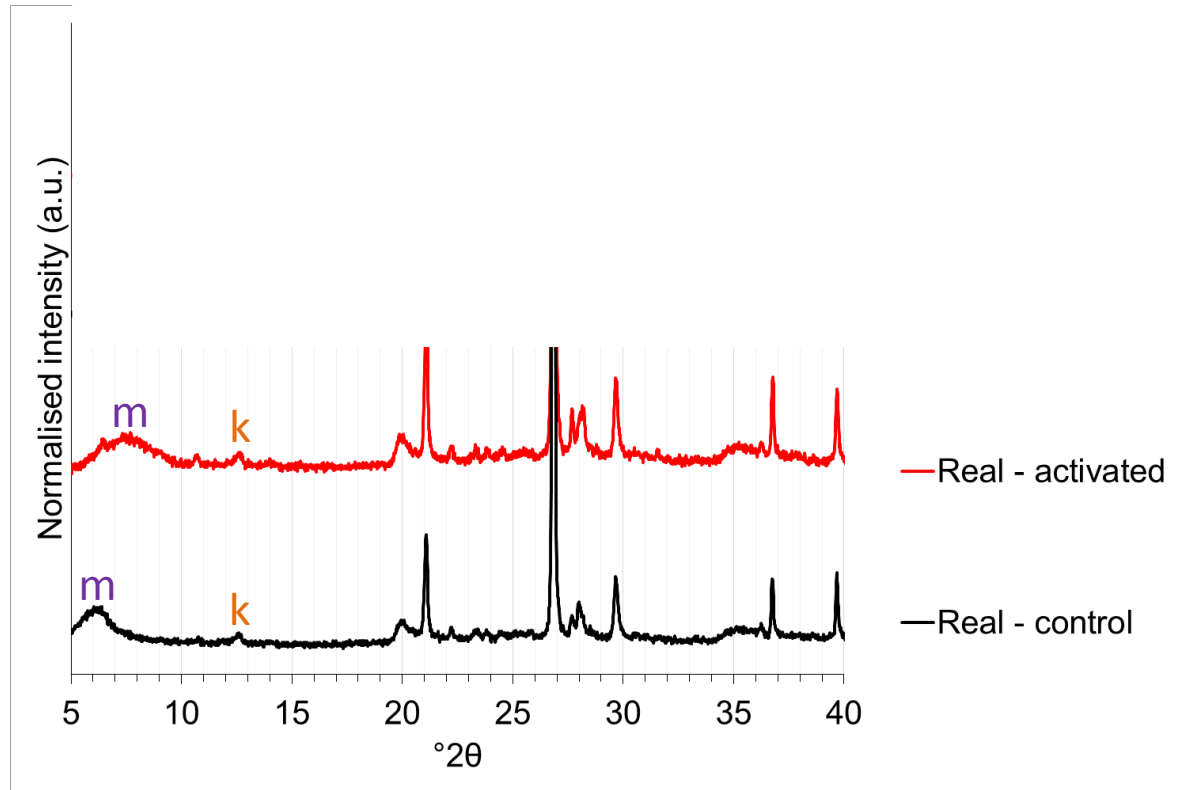


Cattybrook soils

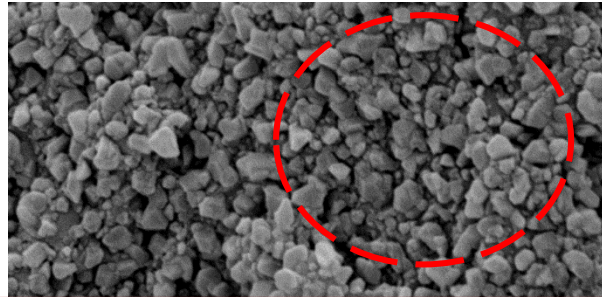
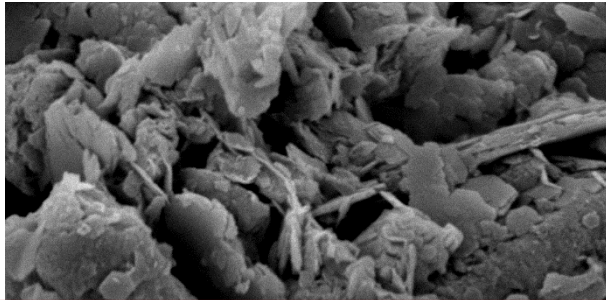


*Slightly
different
sodalite
phases
formed*

Mayoo soils (work in progress)

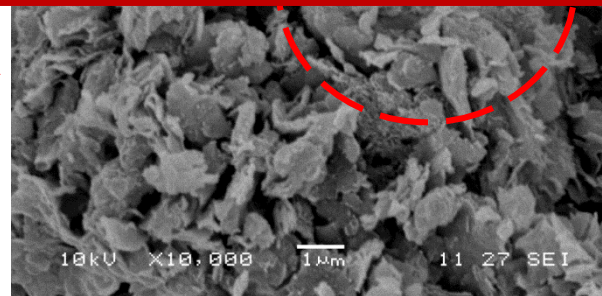
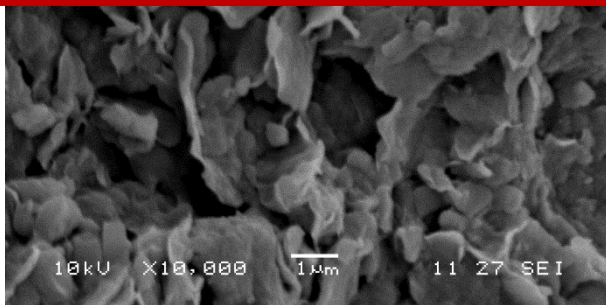


Mayoo soils (work in progress)



Clear change
in phase
morphology

DIFFERENT



Particles
edges more
'ragged'

Real-control

Real-activated

What did we find out?

***Aim 1:** What is the influence of clay minerals and non-clay components on phase formation?*

☺ Nature of **clay mineral** influences the exact **product phase** formed

☺ **Iron oxide phases** do not seem to prevent formation of **zeolitic phases**

☹ **Non-clay components** of soil *sometimes* affect reaction products

What did we find out?

Aim 2: Can we explain behaviour of soils using refined clay minerals?

😊 **Refined clays** *can* be used to explain behaviour of **some real soils**

😐 **Other soils** are a work in progress

What next?

- More **soil types**



- **Strength and durability** testing
- Geological approach - which regions have most suitable resources?

Thanks to...



Prof Andrew Heath
(lead supervisor)



Dr Mark Evernden



Prof Pete Walker



Dr Pascaline Patureau



Prof Venkatarama Reddy
(Indian Institute of Science)

Thanks to...

- Centre for Decarbonisation of the Built Environment (dCarb)
- Institute of Materials, Minerals and Mining (IOM3)
 - Andrew Carnegie Fund
- UK Mineralogical Society
 - Clay Minerals Group
 - Applied Mineralogy Group





Any questions?

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