British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

The engineering geology of Loessic Deposits in south east England

David Entwisle[+], Kevin Northmore[+], Tony Milodowski[+] and Ian Jefferson*

[+] British Geological Survey, Keyworth, Nottingham
* Civil Engineering Department, Birmingham University

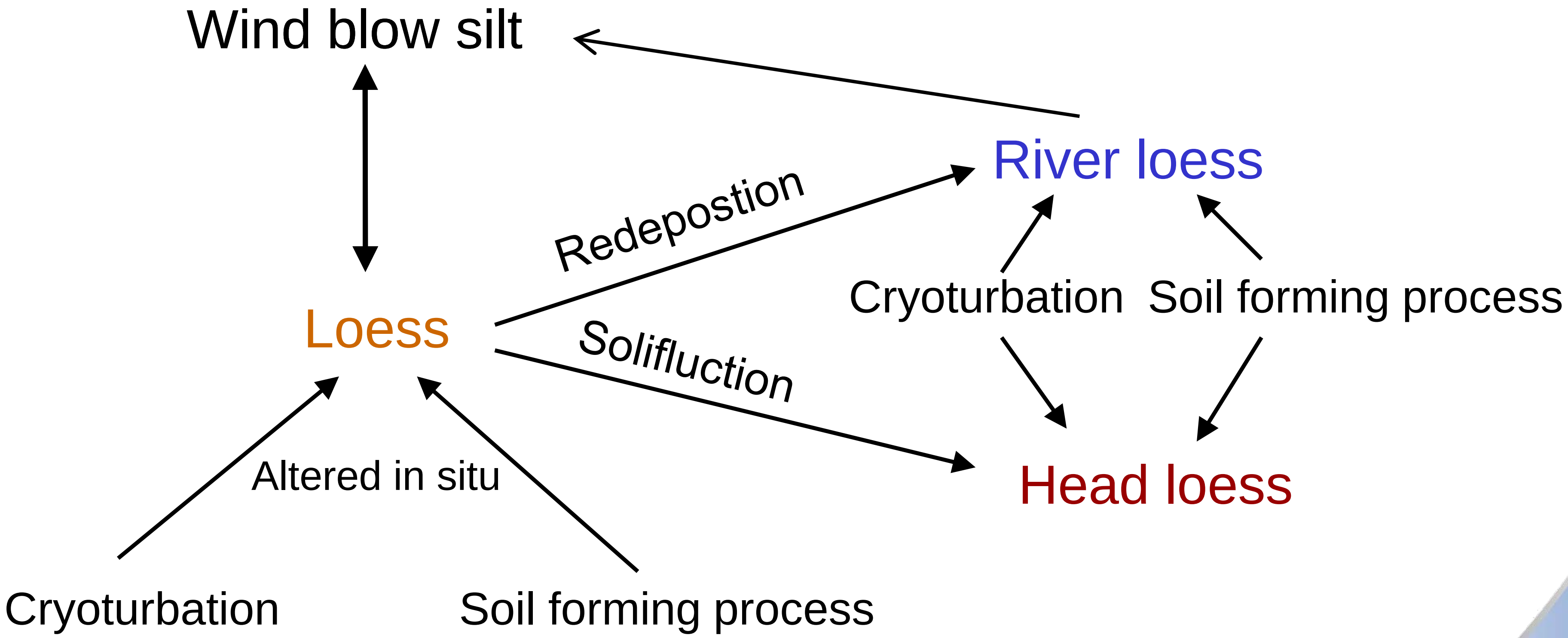
Synopsis

- What are loessic deposits?
- Where do they occur?
- Why are they important?
- Associated geohazards
- Why they may collapse
    - Test site
    - Laboratory test
    - Microstructure

What are Loessic Deposits?

- Aeolian (wind blown) origin
- Predominantly SILT
- Deposited in a dry climate (cold or hot)
- Prismatic jointing
- Open structure (large voids) – free draining

Loessic deposit types



Loessic deposits - Distribution

Cover ~10% of the Earth' land surface

•North America

•South America

•Eastern Europe and Western Russia

•Central Asia

•China (>100 m thick)

For the distribution of European loessic deposits see

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VBC-4NF2NN0-1&_user=1001893&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000027978&_version=1&_urlVersion=0&_userid=1001893&md5=7d88bedcff30a0ed5294d45a1d6703a7.

Southern England Distribution - Geological Map

- Generally patchy distribution - redistributed
- Thickest deposits in South East England generally < 5 m

Old names

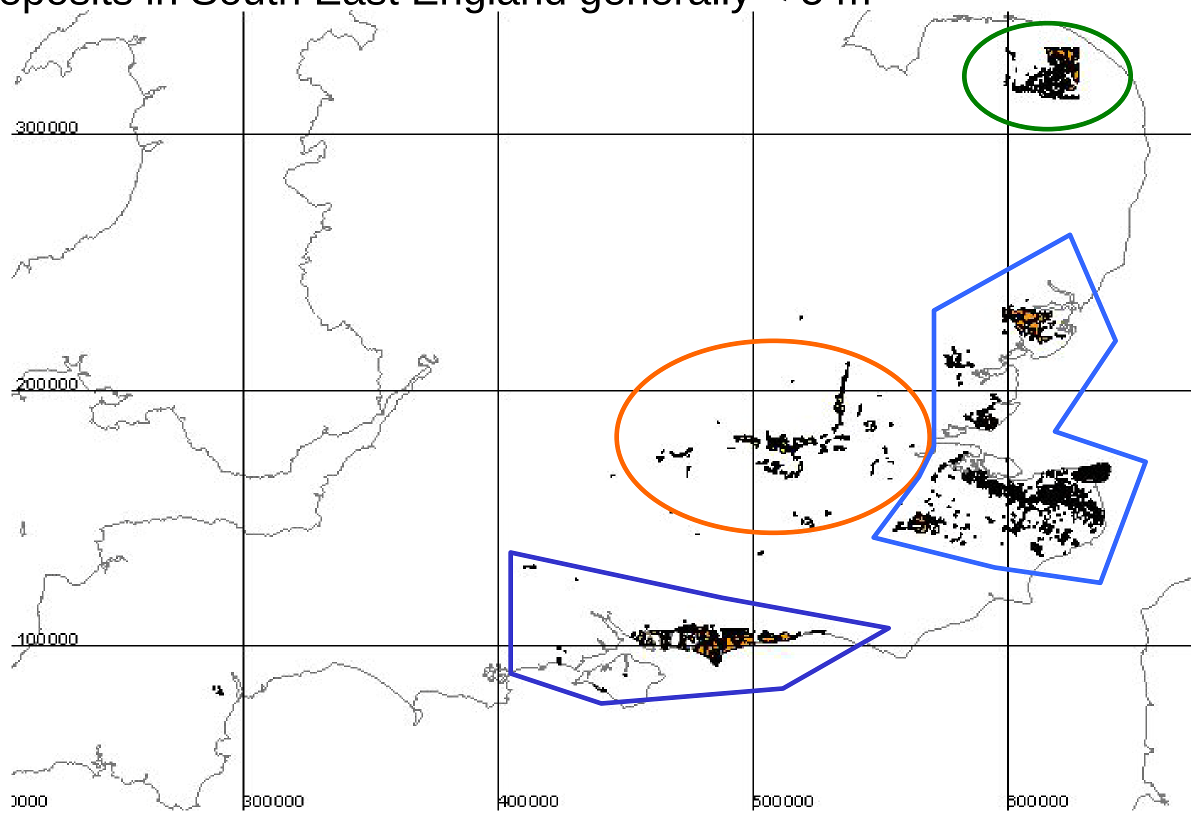
- Brickearth
- Head silt
- Head brickearth
- River brickearth
- Loess

Named Members

- Crayford Silt
- Dartford Silt
- Enfield Silt
- Ilford Silt
- Langley Silt
- Roding Silt

Not a Loessic deposit

- Norwich Brickearth

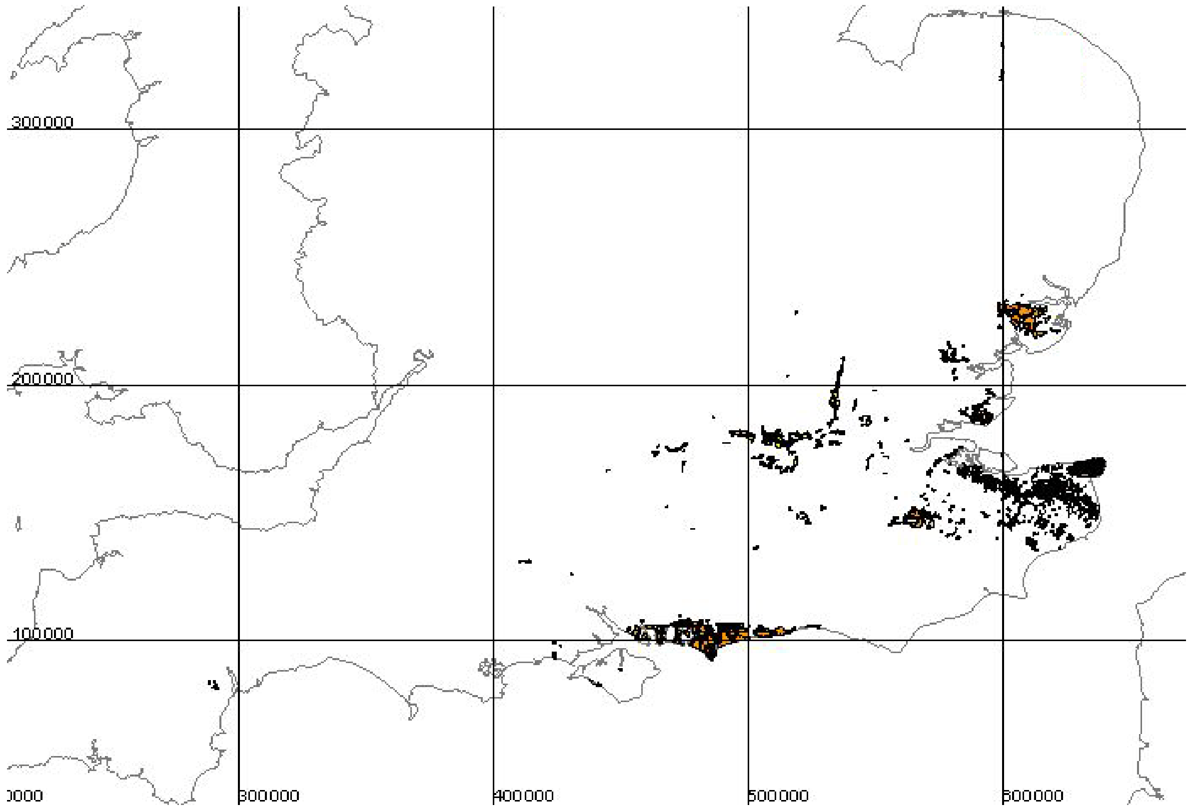


This map is being updated!

Southern England Distribution - Geological Map

Mostly on high permeability materials

- Terrace sands and gravels
- Raised Beach deposits
- Thanet Sand Formation
- Chalk
- Limestone



Why are they important?

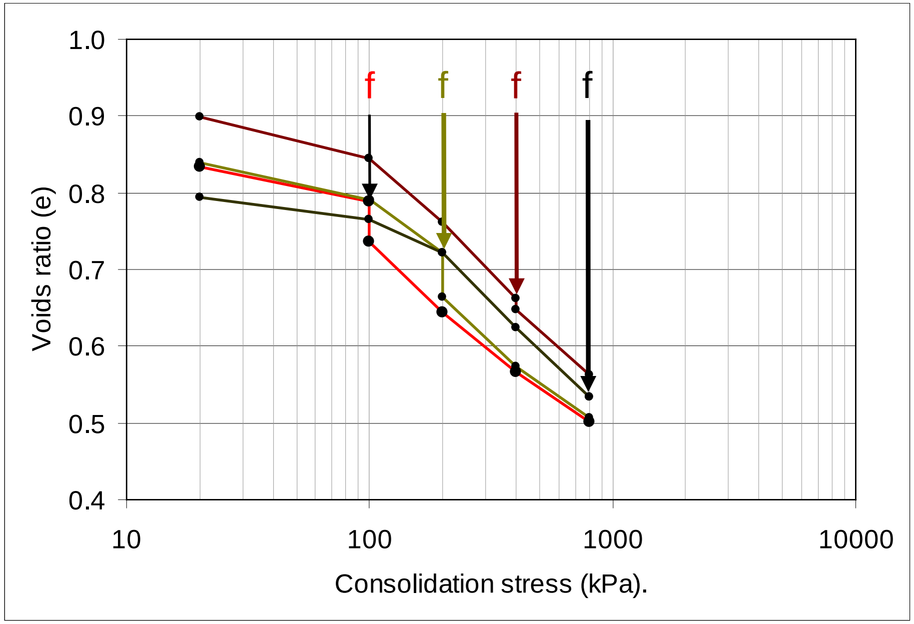
- Cover ~10% of the Earth's land
- Extremely important agricultural soil
- Brick manufacture

Engineering Hazard

- Hydro collapse
- Landslides and unstable during Earthquakes (China)

Hydro collapse – loading + saturation

Painton, Devon



F = Flooding stress

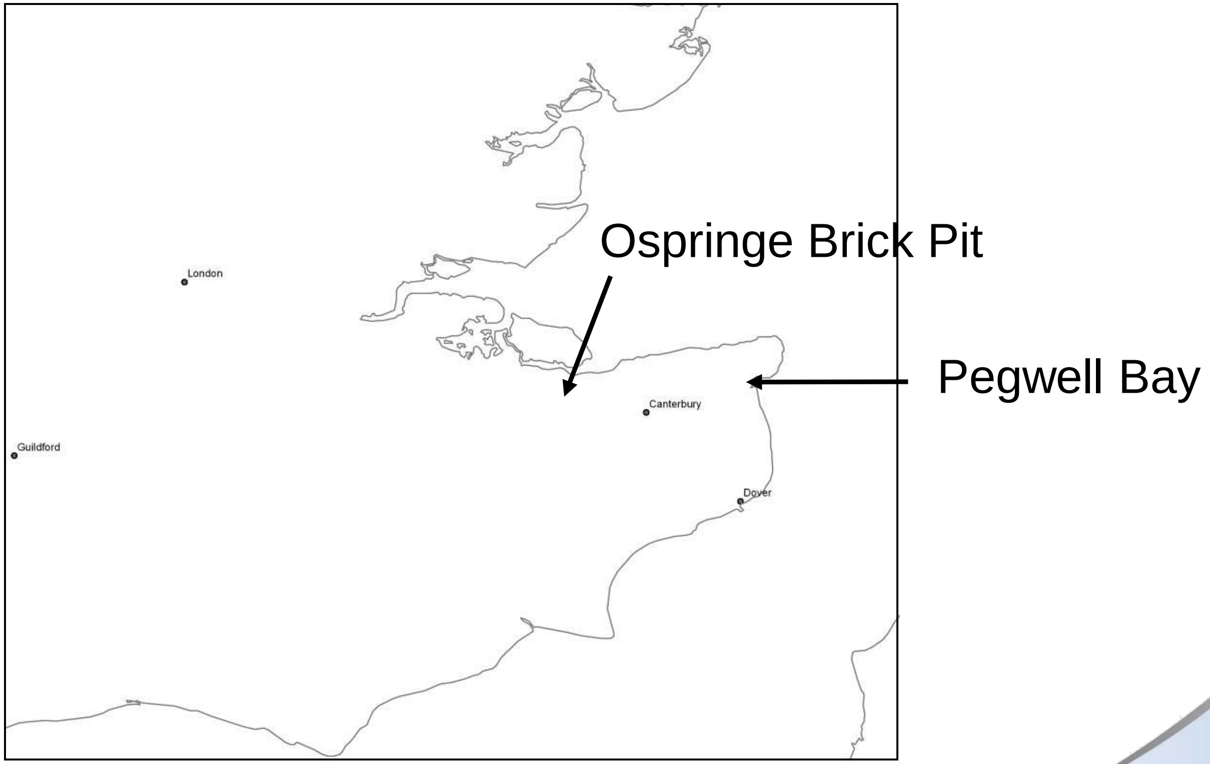
Loading + saturation ⟶ collapse of soil fabric ⟶ foundation distress

Study Sites

- Kent –
  - Ospringe Brick Pit, (Faversham) – 'Head Brickearth'

(NGR 599700, 161200) NERC/ESPRC Loessic Deposits test site
  - Pegwell Bay (Coastal Section)– 'Head Brickearth'

(NGR 635374, 164402)



Example sites – Ospringe and Pegwell Bay

Two distinct Loessic deposits

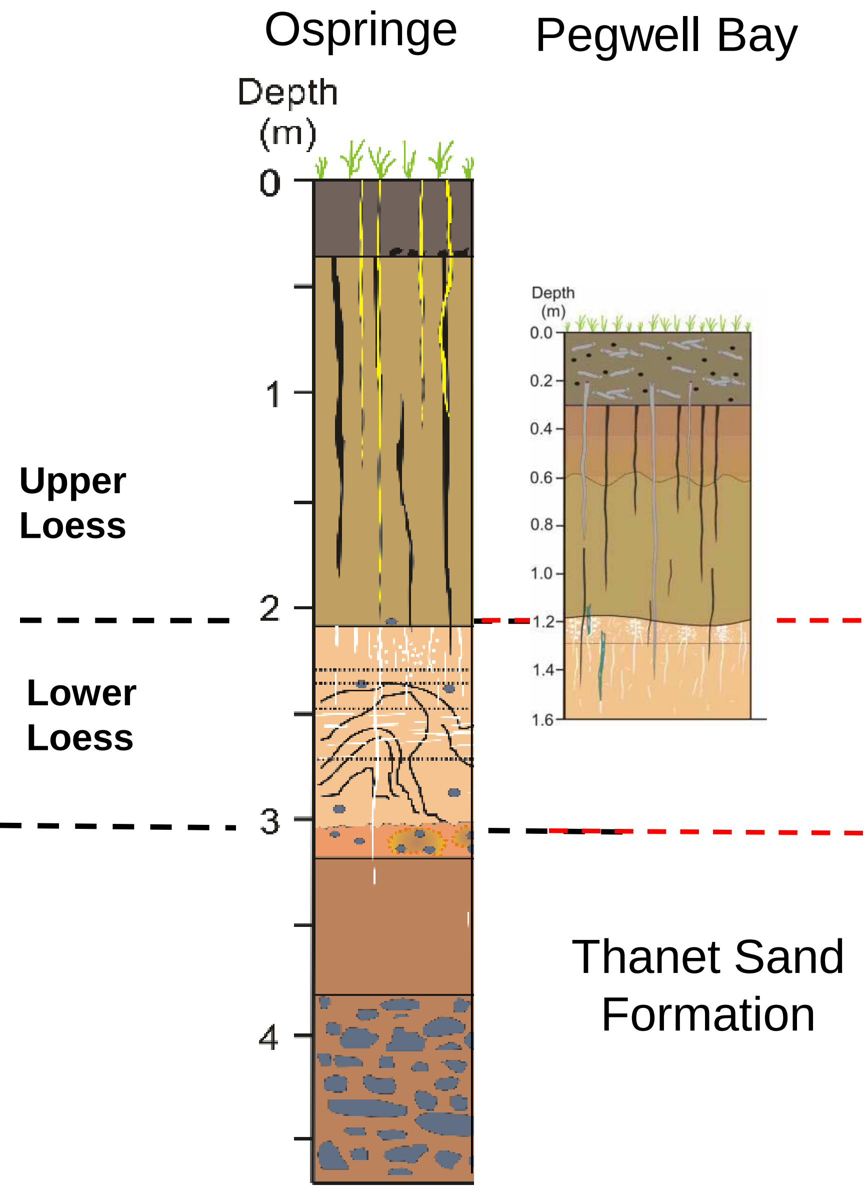
Part of Section, Ospringe

Bench Section, Pegwell Bay

Upper Loess

Lower Loess

Example – Ospringe and Pegwell Bay



- Well drained light olive brown silt with clay
- Open root channels + fissures

Erosional surface

Vertical calcified root structures + nodular calcite (calcrete)

Horizontal calcified root structures + cryoturbated fabric

Lower loess detail

Vertical and horizontal calcified root structure

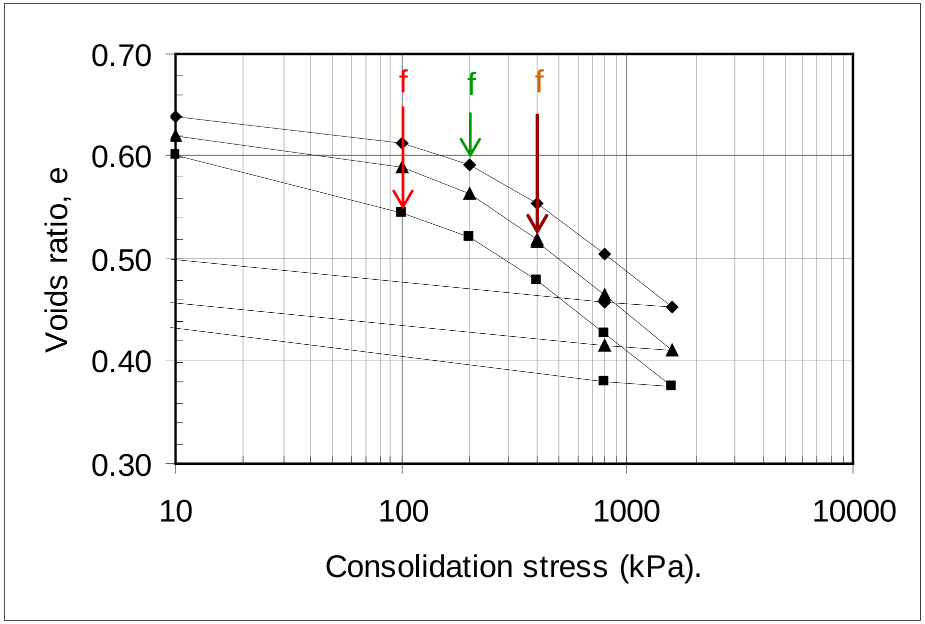
Distorted laminae (Cryoturbation?) below picture on the left

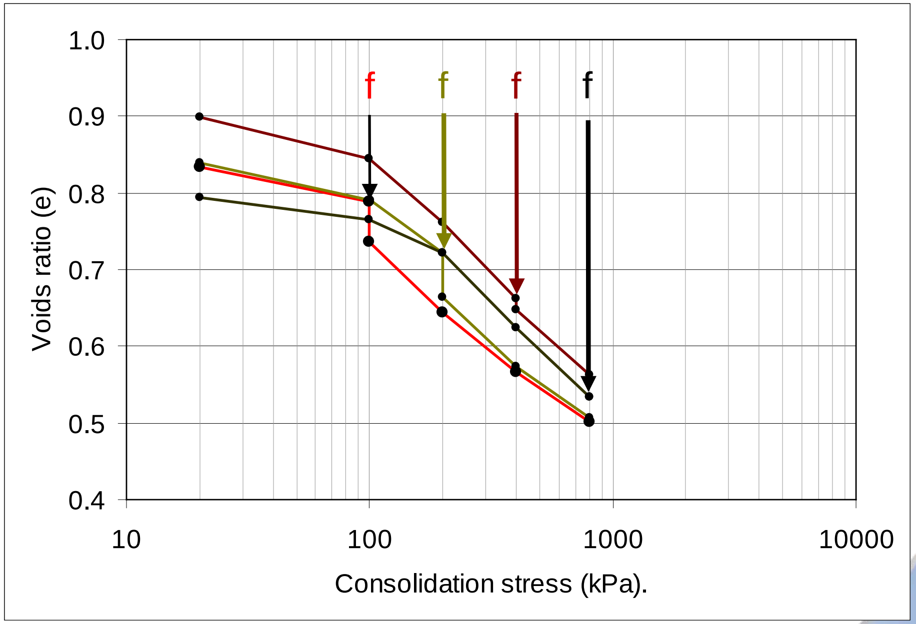
Engineering Characteristics – Typical Consolidation Behaviour

Upper Loess

f = flooding stress

Lower Loess



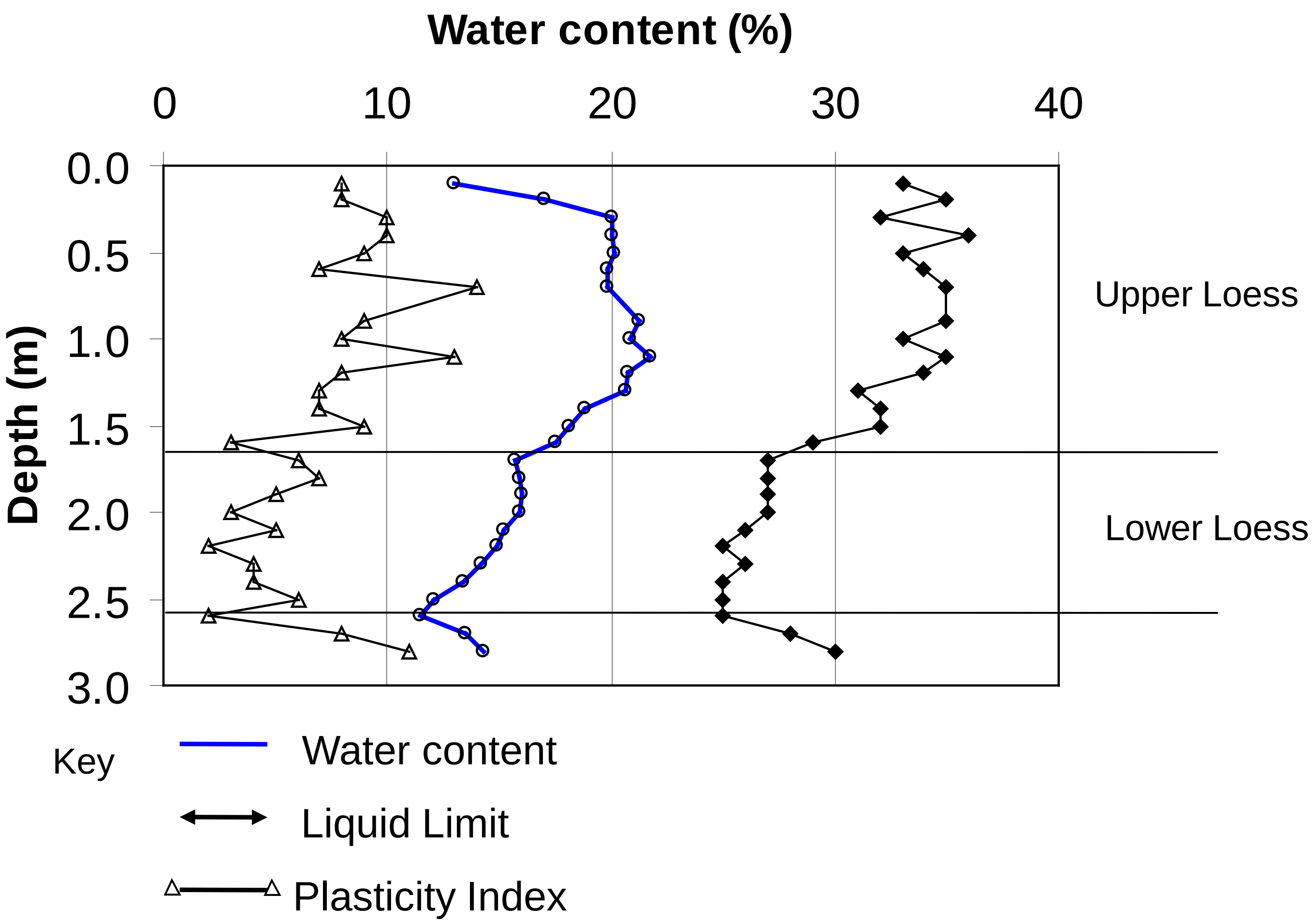


No Collapse

Collapse

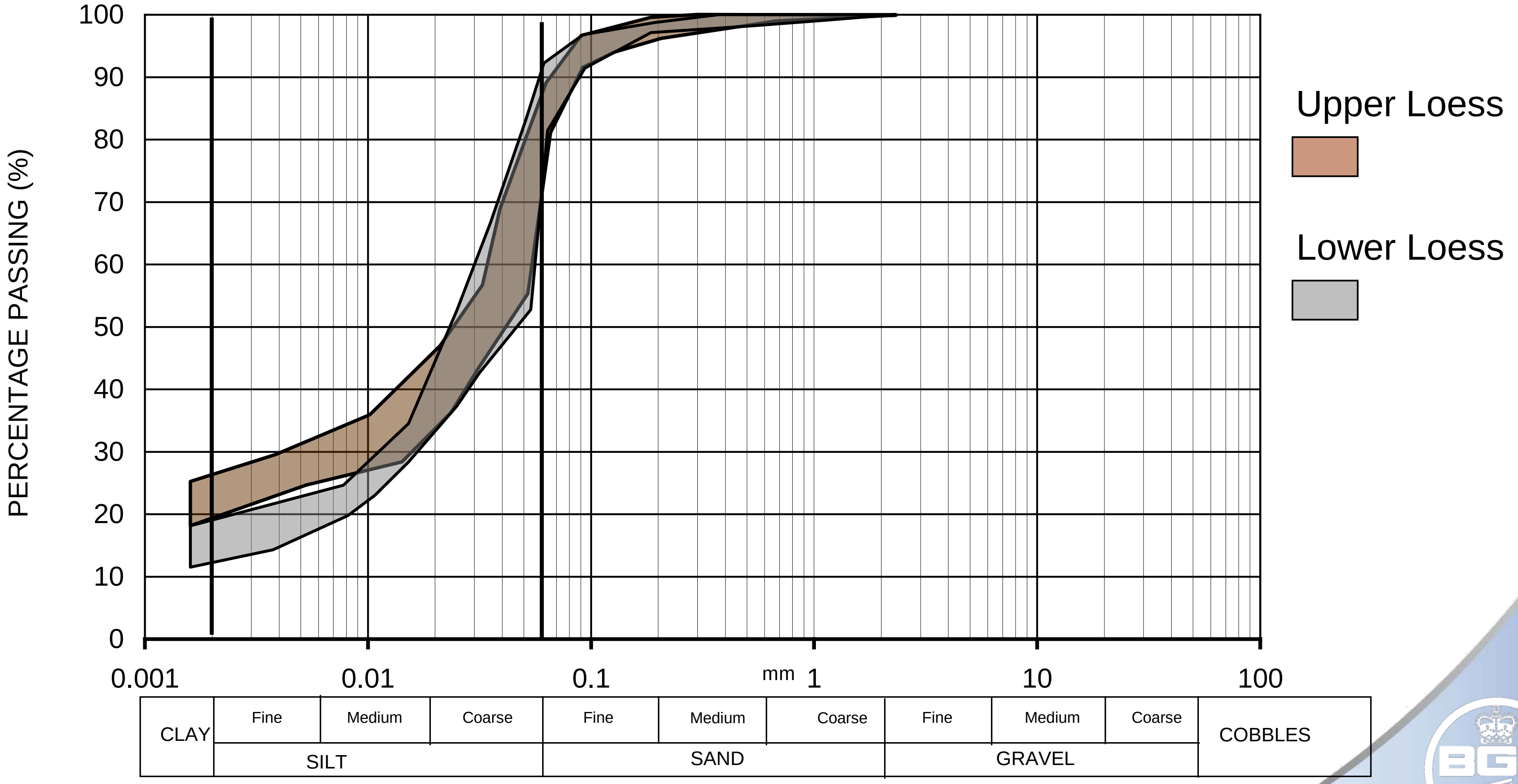
Engineering Characteristics

Ospringe site

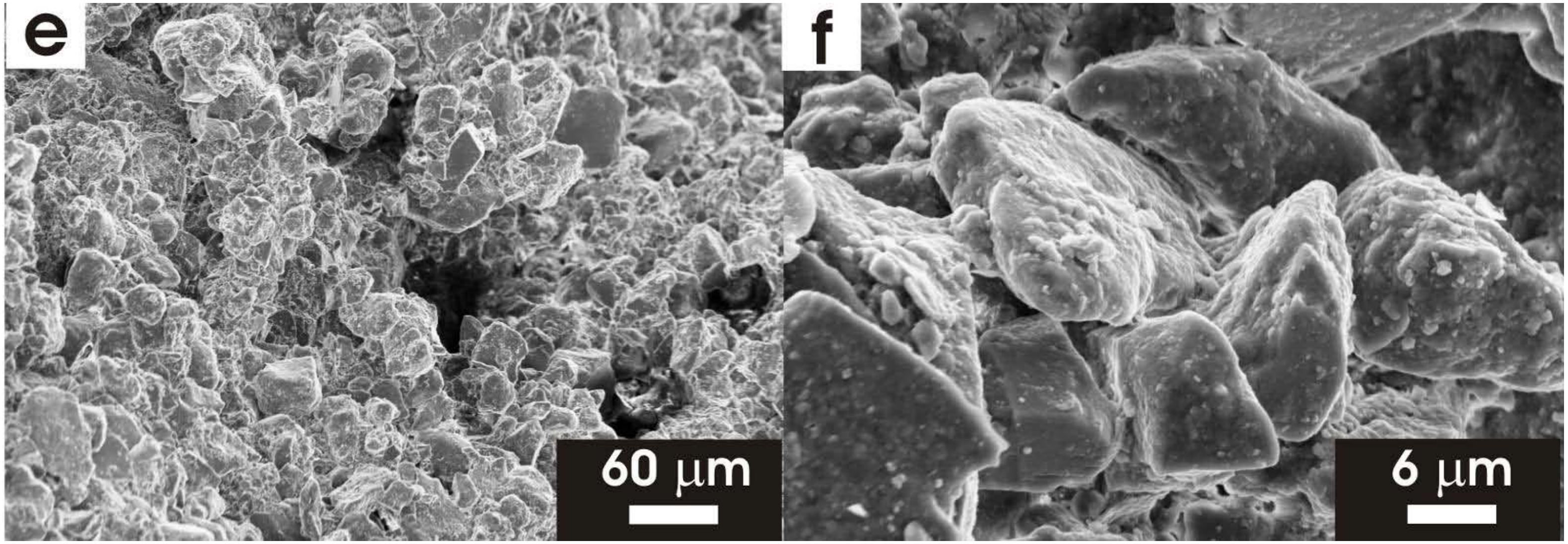


Engineering Characteristics

Particle Size distribution



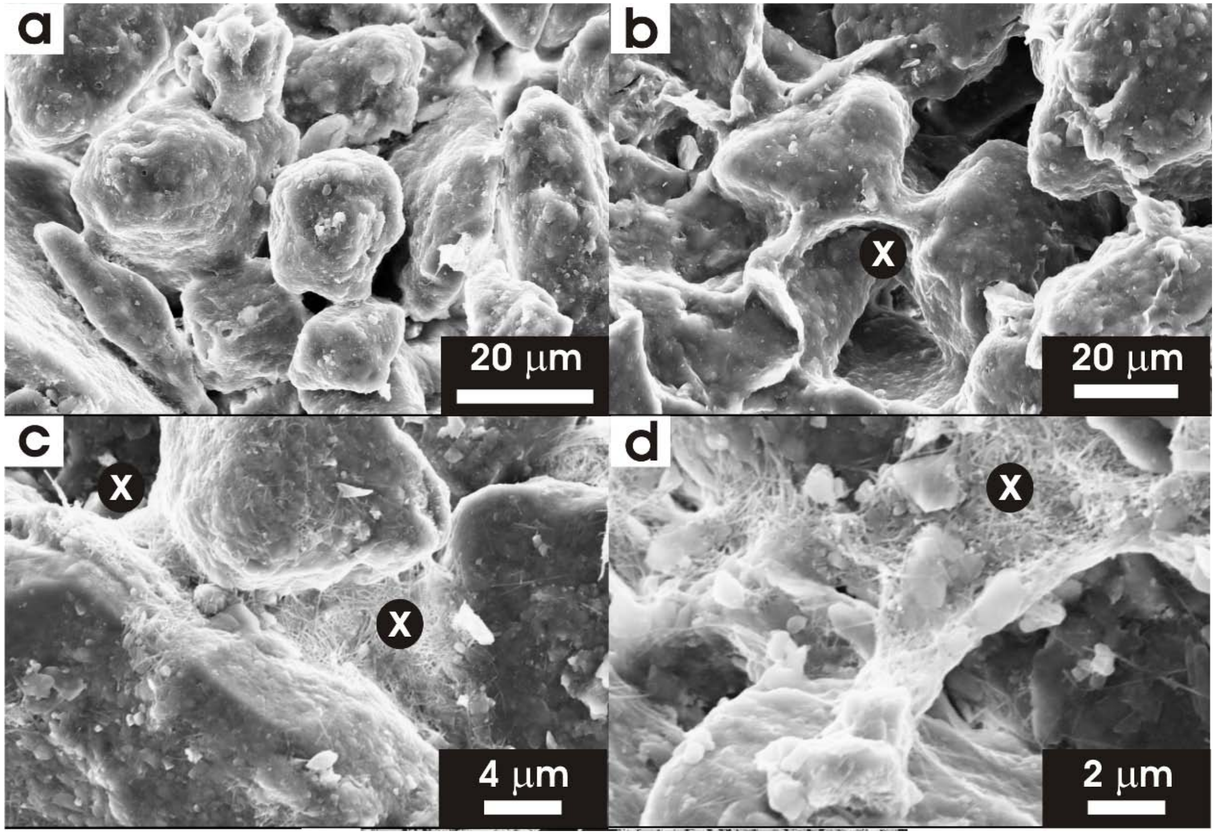
Microstructure upper loess



e) Close-packed silt grain sometimes interlocked grains
Large voids representing root hair channels

f) Silt grains completely coated with clay

Microstructure lower loess

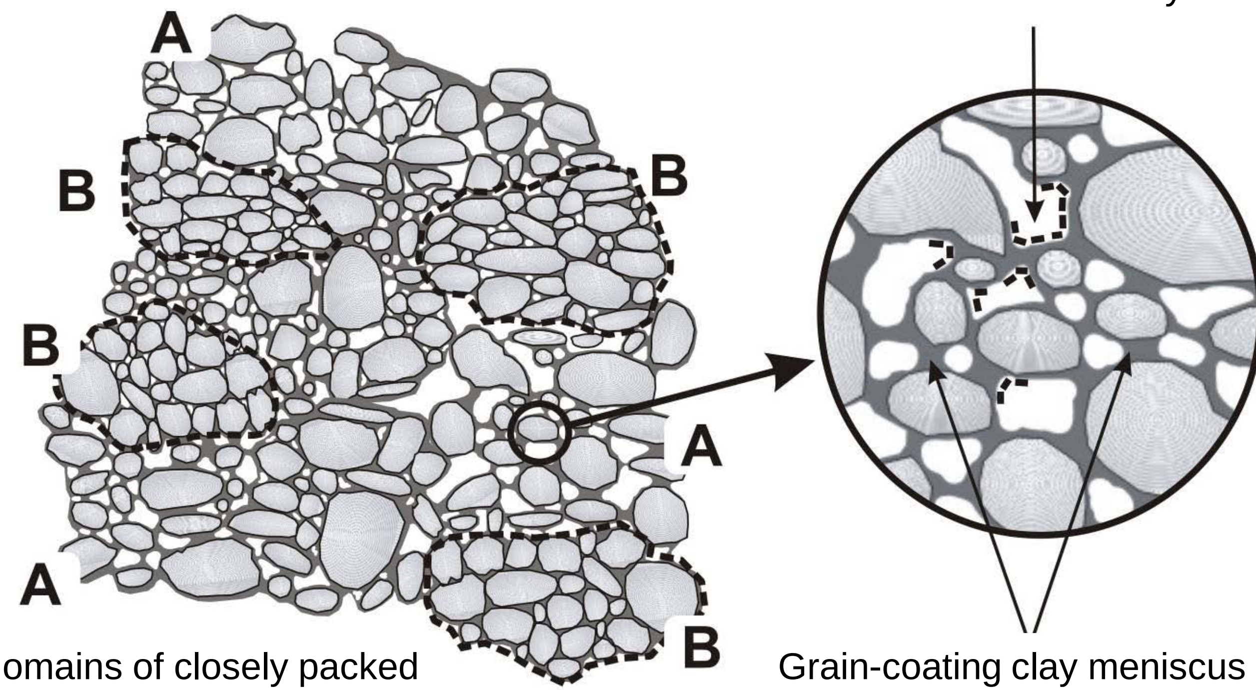


a) Loose packed framework of silt grains coated is clay film
b) Clay forms meniscus 'bridges' (x) bonding dispersed silt grains
c) Fine needle calcite (x) forming a meniscus film 'bridges' between silt grains
d) Meshwork of fine needle calcite (x) forming meniscus 'bridges' forming scaffold for clay

Lower loess - Structure

A - Open Fabric – loosely packed grains supported by meniscus clay bridges

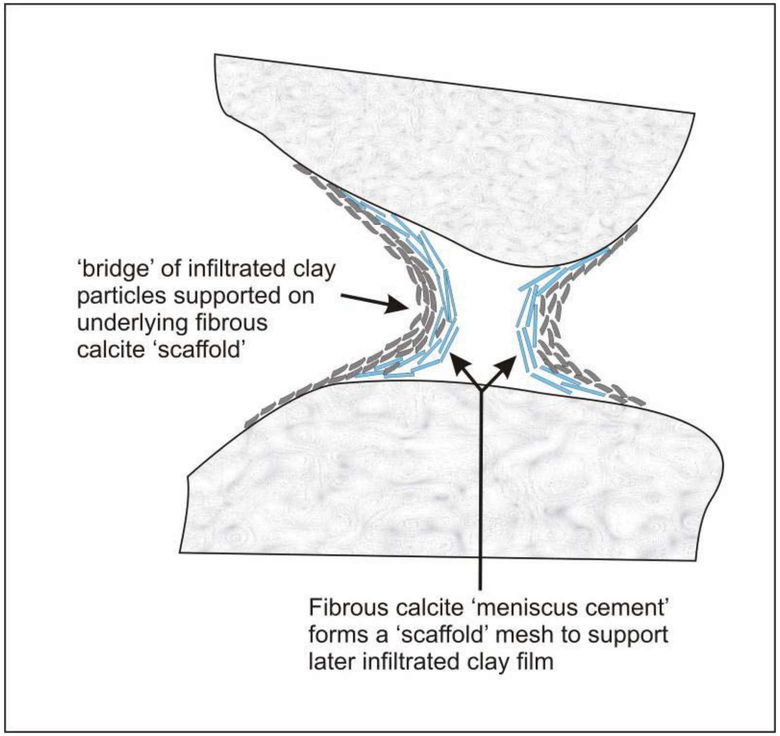
Authigenic carbonates precipitate on the surface of the clay minerals – stronger bridges

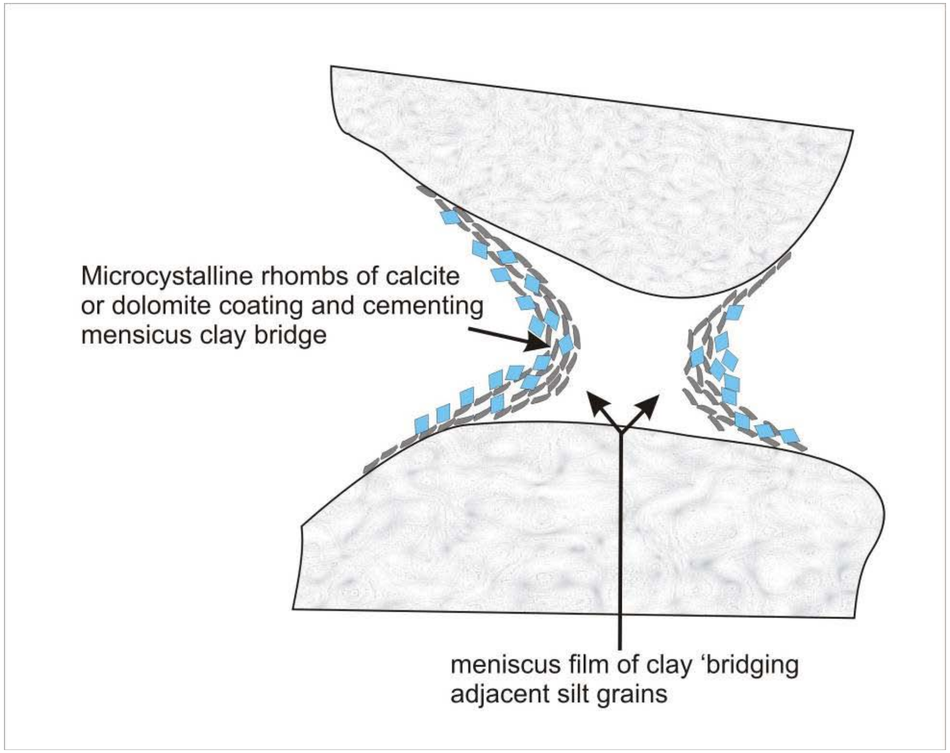


B – discrete domains of closely packed grains with clay grain coatings

Grain-coating clay meniscus around grains – bridges across pore throats – supports open loose packing – fabric **A**

Lower loess - Microstructure





Formation of Calcium Carbonate

•Calcium ions from breakdown of minerals (plagioclase, chalk and microfossils)

•Carbonate ion from root respiration, soil atmosphere, organic decomposition, dissolution of carbonate minerals

•Calcium Carbonate precipitates out when the pore water is supersaturated from evaporation

Review - Differences between Loess types

Upper Loess
Non collapsing – fairly consistent structure
Mineralogy + particle shape proportion of glacial origin
Very little calcareous material (fossils and recent precipitation in root tracts)
Saturation ratio generally > 75%
More clayey > 18%
w_L >30
Origin – Solifluction deposit (Head) - OSL Dating 18-19000 yrs BP

Erosion

Lower Loess
Collapsing – variable, some open structure
Mineralogy + particle shape – mostly local origin (Thanet Sand Formation)
Groundwater calcrete and rhizocrete
Saturation ratio generally < 75%
Less clayey <18%
w_L < 30
Origin – An original loess altered by freezing/thaw in Tundra conditions
OSL Dating 23-24000 yrs BP

Conclusions

- Loess and loessic deposits are silt-rich deposits of aeolian origin
- Cover c10% of the earths surface
- Post depositional processes have a marked influence on their engineering behaviour
- In Kent (and Essex) two distinct loessic deposit are present - laid down during separate depositional events.
    - Upper loessic deposit does not collapse: probably a solifluction (Head) deposit
    - Lower loessic deposit is meta-stable is probably a primary loess modified in situ by freeze/thaw giving rise to open structure. Structure maintained by bridging inter-particle bonds.
    - The upper is not a leached horizon.

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ex University of Birmingham.

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