

Definition of clay minerals

Lecture 1

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- Clay minerals are a diverse group of hydrous layer aluminosilicates that constitute the greater part of the phyllosilicates family of minerals. They are commonly defined by geologists as hydrous layer aluminosilicates with a particle size $< 2 \mu\text{m}$, while engineers and soil scientists define clay as any mineral particle $< 4 \mu\text{m}$. However, clay minerals are commonly $> 2 \mu\text{m}$, or even $4 \mu\text{m}$ in at least one dimension. Their small size and large ratio of surface area to volume gives clay minerals a set of unique properties, including high cation exchange capacities, catalytic properties, and plastic behaviour when moist.

Properties of the clay minerals

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- Can absorb or lose water between the silicate sheets
 - negative charge *attracts* H₂O

When water is absorbed, clays may

Expand !

- water in spaces between stacked layers
- Montmorillonite most expandable
- Kaolinite the least

Clay Minerals – *capacity for water*

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- i) **Kaolinite** (*China clay*) Water absorption, approximately **90%**
- ii) **Montmorillonite** (*Bentonite, Smectite*) Water absorption, approximately **300 - 700%**
- iii) **Illite** Intermediate water absorption

Clays

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- ❑ Clay minerals are not stable entities in soils.
- ❑ Weathering gradually changes clays by dissolving some minerals and re-precipitating others.
- ❑ Intensity of weathering increases with higher temperature and is higher in moist than in dry soils.
- ❑ Since clay minerals are the products of chemical weathering of rocks, both the climate and parent rocks influence the type of minerals found.

• Summary of occurrence of clay minerals in soils

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Clay mineral group	Occurrence
Kaolinite	Highly weathered soils with good drainage. Generally in older soils. Common in tropical and subtropical areas.
Montmorillonite	Results from weathering of volcanic rocks/ash in marine water or under poor drainage. Common in sediments of arid areas and often mixed with clay mica. Main minerals in bentonite.

Lecture 1

Clay mineral group	Occurrence
Clay mica (illite)	In soils derived from weathering of sedimentary rocks in arid regions. Dominant minerals in slate and shale
Chlorite	Areas of metamorphic rocks. Common in marine sediments and sedimentary rocks. Not normally present in dominant proportions.