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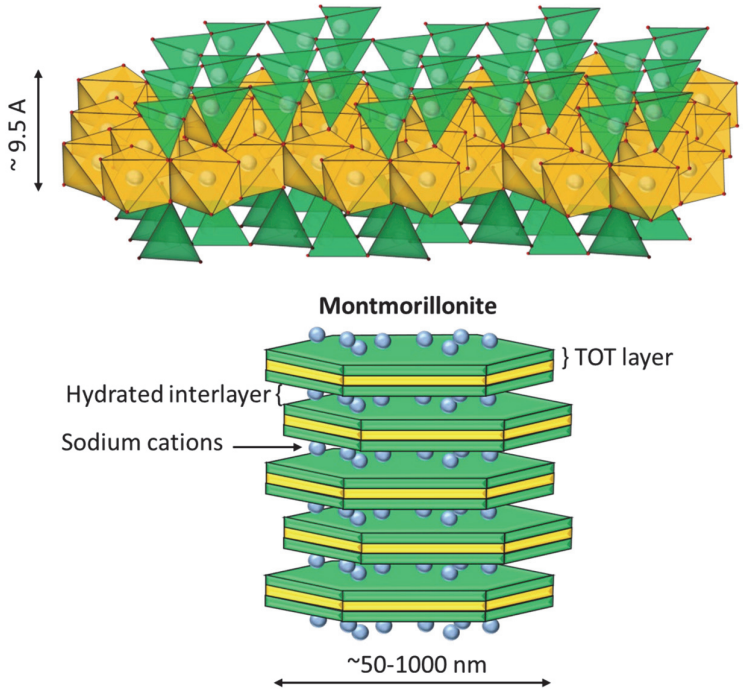
Discover bentonites, the heroes of radioactive waste repositories

Infosheet 2: Bentonites

Bentonite is a rock composed essentially of a crystalline swelling **clay**-like **mineral** consisting mostly of montmorillonite (a type of smectite), along with other minerals such as feldspar, calcite, and quartz. It is formed by the **devitrification** and accompanying chemical alteration of a glassy **igneous** material, usually a tuff or volcanic ash.

Bentonite formations in El Toril, Almeria, Spain
Image courtesy of the author

Montmorillonite is an aluminium phyllosilicate mineral with a crystallographic structure made of three sheets of tetrahedra–octahedra–tetrahedra (TOT) layers, with a weakly negative electrical charge, which is neutralized by calcium or sodium cations. Thus, bentonites can either be sodium–montmorillonite or calcium–montmorillonite.



Schematic representation of bentonite. The green sheet indicates a tetrahedral silica layer (T), the yellow sheet indicates an octahedral alumina layer (O), and the blue spheres represent sodium cations.
Image: Materials, 2022, 15.

Physical and chemical properties

Bentonite has several physical and chemical properties that make it useful in various fields.

- Bentonite has a soft, fine texture and is easily crumbled to form a fine, white to light-yellow–brown powder.
- It has a high swelling capacity: bentonite can increase in volume and form a gel-like consistency when mixed with water. It can absorb several times its weight in water.
- It has a high cation-exchange capacity, which allows it to attract and exchange cations, such as calcium, sodium, magnesium, and potassium.

Image courtesy of the author

Overall, the physical and chemical properties of bentonite make it a highly absorbent material, with the ability to exchange cations and stabilize structures. These properties make it useful in a wide range of industries, including drilling, construction, agriculture, cosmetics, pharmaceuticals, and **environmental remediation**.

Industrial uses of bentonite

The industrial uses of bentonite include:

1. Environmental remediation: bentonite is used to seal and contain contaminated soils and waste materials, preventing them from contaminating the surrounding environment.
2. Drilling: bentonite is used as a drilling fluid to lubricate and cool drill bits and to remove cuttings from the well.
3. Civil engineering and construction: bentonite is used in the construction of foundations, tunnelling, and excavation to provide stability and prevent water infiltration.
4. Foundry: bentonite is used as a bonding agent in **foundries** to bind and mould sand in the production of metal castings.
5. Cosmetics and personal care: bentonite is used in the formulation of cosmetics and personal-care products, such as face masks and body scrubs, for its ability to absorb oils and impurities from the skin.
6. Pharmaceuticals: bentonite is used as an **excipient** in the production of pharmaceuticals, as a binder and disintegrant in tablets, and as a suspending agent in liquid formulations.
7. Agriculture and animal feed: bentonite is used as a feed supplement for livestock to improve their health and digestion and as a soil amendment to improve soil quality and water retention.
8. Papermaking: bentonite is used as a filler and coating in the production of paper, improving its strength and printability.

Glossary

Clay: a natural earthy material that is plastic and soft when wet and hard when dry or baked, consisting essentially of hydrated silicates of aluminium.

Mineral: any of a class of substances occurring in nature, usually comprising inorganic substances, such as quartz or feldspar, of defined chemical composition and usually of defined crystal structure.

Devitrification: the process of crystallization in an amorphous (crystal-free) glass.

Environmental remediation: clean up of hazardous pollutants from the environment.

Igneous: formed under intense heat, such as that from volcanos.

Foundry: a factory where metal is melted and poured into specially shaped containers to produce objects.

Excipient: a pharmacologically inert, adhesive substance, such as honey, syrup, or gum arabic, used to bind the contents of a pill or tablet.