

1.1: Introduction:

1.1.1: Definition of chalk:

Chalk is a soft, white, porous sedimentary carbonate rock, a form of limestone composed of the mineral calcite. Calcite is calcium carbonate or CaCO_3 . It forms under reasonably deep marine conditions from the gradual accumulation of minute calcite shells (coccoliths) shed from micro-organisms called coccolithophores. Flint (a type of chert unique to chalk) is very common as bands parallel to the bedding or as nodules embedded in chalk. It is probably derived from sponge spicules or other siliceous organisms as water is expelled upwards during compaction. Flint is often deposited around larger fossils such as Echinoidea which may be silicified (i.e. replaced molecule by molecule by flint).

Chalk as seen in Cretaceous deposits of Western Europe is unusual among sedimentary limestone in the thickness of the beds. Most cliffs of chalk have very few obvious bedding planes unlike most thick sequences of limestone such as the Carboniferous Limestone or the Jurassic oolitic limestones. This presumably indicates very stable conditions over tens of millions of years.



Figure (1-1): Calcium sulphate

"Nitzana Chalk curves" situated at Western Negev, Israel are chalk deposits formed at the Mesozoic era's Tethys Ocean

Chalk has greater resistance to weathering and slumping than the clays with which it is usually associated, thus forming tall steep cliffs where chalk ridges meet the sea. Chalk hills, known as chalk downland, usually form where bands of chalk reach the surface at an angle, so forming a scarp slope. Because chalk is well jointed it can hold a large volume of ground water, providing a natural reservoir that releases water slowly through dry seasons.

1.1.2 Deposits of chalk:

The Chalk Group is a European stratigraphic unit deposited during the late Cretaceous Period. It forms the famous White Cliffs of Dover in Kent, England, as well as their counterparts of the Cap Blanc Nez on the other side of the Dover Strait. The Champagne region of France is mostly underlain by chalk deposits, which contain artificial caves used for wine storage. Some of the highest chalk cliffs in the world occur at Jasmund National Park in Germany and at Møns Klint in Denmark - both once formed a single island.

1.1.3 Formation of chalk:

Ninety million years ago what is now the chalk downland of Northern Europe was ooze accumulating at the bottom of a great sea. Chalk was one of the earliest rocks made up of sub-microscopic particles to be studied under the electron microscope, when it was found to be composed almost entirely of coccoliths. Their shells were made of calcite extracted from the rich sea-water. As they died a huge thickness gradually

built up over eons and, through the weight of overlying sediments, eventually became consolidated into rock. Later earth movements related to the formation of the Alps raised these former sea-floor deposits above sea level.

1.1.4 Composition of chalk:

The chemical composition of chalk is calcium carbonate with minor amounts of silt and clay. It is formed in the sea by sub-microscopic protozoa which fall to the sea floor and are then consolidated and compressed during diagenesis into chalk rock.

1.1.5 Uses of chalk:

Chalk is a source of quicklime by thermal decomposition, or slaked lime following quenching with water.^[1] In southeast England, deneholes are a notable example of ancient chalk pits. Such bell pits may also mark the sites of ancient flint mines, where the prime object was to remove flint nodules for stone tool manufacture. The surface remains at Cissbury are one such example, but perhaps the most famous is the extensive complex at Grimes Graves in Norfolk.

Woodworking joints may be fitted by chalking one of the mating surfaces. A trial fit will leave a chalk mark on the high spots of the corresponding surface. Chalk transferring to cover the complete surface indicates a good fit. Builder's putty also mainly contains chalk as a filler in linseed oil.

Chalk may be used for its properties as a base. In agriculture, chalk is used for raising pH in soils with high acidity. The most common forms are CaCO_3 (calcium carbonate) and CaO (calcium oxide). Small doses of

chalk can also be used as an antacid. Additionally, the small particles of chalk make it a substance ideal for cleaning and polishing. For example, toothpaste commonly contains small amounts of chalk, which serves as a mild abrasive. Polishing chalk is chalk prepared with a carefully controlled grain size, for very fine polishing of metals.^[2] Chalk can also be used as fingerprint powder.

1.1.6 Previous uses:

The traditional uses of chalk have in some cases been replaced by other substances, although the word "chalk" is often still applied to the usual replacements. Blackboard chalk is a substance used for drawing on rough surfaces, as it readily crumbles leaving particles that stick loosely to these surfaces. Although traditionally composed of natural chalk, modern blackboard chalk is generally made from the mineral gypsum (calcium sulfate), often supplied in sticks of compressed powder about 10 cm (4 in) long. Sidewalk chalk is similar to blackboard chalk, but it is shaped into larger sticks and often colored. It is used to draw on sidewalks, streets, and driveways. Tailor's chalk is traditionally a hard chalk used to make temporary markings on cloth, mainly by tailors. However, it is now usually made from talc (magnesium silicate).

Chalk was also traditionally used in recreation. In field sports, such as tennis played on grass, powdered chalk was used to mark the boundary lines of the playing field or court. If a ball hits the line, a cloud of chalk or pigment dust will be visible. In recent years, powdered chalk has been replaced with titanium dioxide.^[3] In gymnastics, rock-climbing, weight-lifting and tug of war, chalk — now usually magnesium carbonate — is applied to the hands and feet to remove perspiration and reduce slipping.

Chalk may also be used as a house construction material instead of brick or wattle and daub: quarried chalk was cut into blocks and used as ashlar, or loose chalk was rammed into blocks and laid in mortar.^{[4][5]} There are still houses standing which have been constructed using chalk as the main building material. Most are pre-Victorian though a few are more recent.

1.2 Calcium sulphate

1.2.1 Definition:

Calcium sulfate (or calcium sulphate) is a common laboratory and industrial chemical. In the form of γ -anhydrite (the nearly anhydrous form), it is used as a desiccant. It is also used as a coagulant in products like tofu.^[6] In the natural state, unrefined calcium sulfate is a translucent, crystalline white rock. When sold as a color-indicating variant under the name Drierite, it appears blue or pink due to impregnation with Cobalt(II) chloride, which functions as a moisture indicator. The hemihydrate ($\text{CaSO}_4 \cdot \sim 0.5\text{H}_2\text{O}$ or $(\text{CaSO}_4)_2 \cdot \text{H}_2\text{O}$) is better known as plaster of Paris, while the dihydrate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) occurs naturally as gypsum. The anhydrous form occurs naturally as β -anhydrite. Depending on the method of calcination of calcium sulfate dihydrate, specific hemihydrates are sometimes distinguished: alpha-hemihydrate and beta-hemihydrate. They appear to differ only in crystal shape. Alpha-hemihydrate crystals are more prismatic than beta-hemihydrate crystals and, when mixed with water, form a much stronger and harder superstructure.

1.2.2 Industrial applications:

Calcium sulfate is a compound found in nature in both a hydrated form and a dry, crystalline form. It is odorless and is most often found as

a white powder, but the color may be different, such as having a yellowish tinge, because of impurities. The various industrial uses of this chemical include as an ingredient in plaster of Paris and quick-setting cement, and as a pigment. The food and pharmaceutical industries use calcium sulfate as a calcium supplement.

When hydrated calcium sulfate is heated, some of its water molecules are lost, making it a hemihydrate. This type of calcium sulfate reacts differently from the hydrated and dry forms, turning into a paste-like substance that dries hard. In this application, it can be used as plaster of Paris for art projects and is also mixed with cement to create quick-drying cement.

Paints need pigments to create colors. Calcium sulfate, without impurities, is a white color that is typically mixed with paints to create white paint. This type of paint is used for art painting and both exterior and interior paints.

The paper industry often makes paper with a coating that either gives the paper extra sheen or extra durability. Calcium sulfate is used as a coating agent for papers and adds thickness and durability, making the paper harder to rip. It does not offer any extra sheen or luster to paper. It is also used a filler, so lesser amounts of other components are used to make the paper.

Fertilizers have additives that help raise or lower the acidity of the fertilizer, which makes it suitable for certain types of plants and environments. As an additive, this ingredient creates an acidic fertilizer. Some plants that do better with this type of fertilizer are azaleas and rhododendrons.

The food and pharmaceutical industries use calcium sulfate as an additive and as a supplement. Many pills that are used as calcium supplements, or foods such as cereals that are enriched with vitamins, use this as a cheaper form of calcium. This reduces the cost, making it easier to produce the product. According to the U.S. Food and Drug Administration (FDA), this is regarded as safe.

In metalworking, fluxes are substances used to reduce or eliminate impurities. They are needed, because most metals in nature have impurities that need to be removed, or the metal cannot be made properly. As a flux, calcium sulfate is used to help remove impurities to create aluminum

1.2.3 Occurrence:

The cores of salt domes of the North American Gulf Coast consist virtually of pure halite (sodium chloride) with minor amounts of anhydrite (calcium sulfate) and traces of other minerals. Layers of white pure halite are interbedded with layers of black halite and anhydrite. German salt dome cores contain halite, sylvite, and other potash minerals. In Iranian salt domes, halite is mixed with...

1.2.4 Hazards and toxicity:

Compared with other metals, the calcium ion and most calcium compounds have low toxicity. This is not surprising given the very high natural abundance of calcium compounds in the environment and in organisms. Calcium poses few serious environmental problems, with kidney stones the most common side-effect in clinical studies. Acute calcium poisoning is rare, and difficult to achieve unless calcium

compounds are administered intravenously. For example, the oral median lethal dose (LD⁵⁰) for rats for calcium carbonate and calcium chloride are 6.45 and 1.4 g/kg, respectively.

Calcium metal is hazardous because of its sometimes-violent reactions with water and acids. Calcium metal is found in some drain cleaners, where it functions to generate heat and calcium hydroxide that saponifies the fats and liquefies the proteins (e.g., hair) that block drains. When swallowed calcium metal has the same effect on the mouth, esophagus and stomach, and can be fatal.

Excessive consumption of calcium carbonate antacids/dietary supplements (such as Tums) over a period of weeks or months can cause milk-alkali syndrome, with symptoms ranging from hypercalcemia to potentially fatal renal failure. What constitutes “excessive” consumption is not well known and, it is presumed, varies a great deal from person to person. Persons consuming more than 10 grams/day of CaCO₃ (=4 g Ca) are at risk of developing milk-alkali syndrome, but the condition has been reported in at least one person consuming only 2.5 grams/day of CaCO₃ (=1 g Ca), an amount usually considered moderate and safe.

Oral calcium supplements diminish the absorption of thyroxine when taken within four to six hours of each other. Thus, people taking both calcium and thyroxine run the risk of inadequate thyroid hormone replacement and thence hypothyroidism if they take them simultaneously or near-simultaneously.

Excessive calcium supplementation can be detrimental to cardiovascular health, especially in men.

1.3 Gypsum:

1.3.1 Gypsum:

Is a soft sulfate mineral composed of calcium sulfate dihydrate, with the chemical formula $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$. It can be used as a fertilizer, is the main constituent in many forms of plaster and in blackboard chalk, and is widely mined. A massive fine-grained white or lightly tinted variety of gypsum, called alabaster, has been used for sculpture by many cultures including Ancient Egypt, Mesopotamia, Ancient Rome, Byzantine empire and the Nottingham alabasters of medieval England. It is the definition of a hardness of 2 on the Mohs scale of mineral hardness. It forms as an evaporite mineral and as a hydration product of anhydrite.

1.3.2 Etymology and history:

The word gypsum is derived from the Greek word γύψος (gypsos), "chalk" or "plaster". Because the quarries of the Montmartre district of Paris have long furnished burnt gypsum (calcined gypsum) used for various purposes, this dehydrated gypsum became known as plaster of Paris. Upon addition of water, after a few tens of minutes plaster of Paris becomes regular gypsum (dihydrate) again, causing the material to harden or "set" in ways that are useful for casting and construction.

Gypsum was known in Old English as spærstān, "spear stone", referring to its crystalline projections. (Thus, the word spar in mineralogy is by way of comparison to gypsum, referring to any non-ore mineral or crystal that forms in spearlike projections.) Gypsum may act as a source of sulfur for plant growth, which was discovered by J. M. Mayer, and in the early 19th century, it was regarded as an almost miraculous fertilizer.

American farmers were so anxious to acquire it that a lively smuggling trade with Nova Scotia evolved, resulting in the so-called "Plaster War" of 1812.

1.3.3 Physical properties:

Gypsum is moderately water-soluble (~2.0–2.5 g/l at 25°C) and, in contrast to most other salts, it exhibits retrograde solubility, becoming less soluble at higher temperatures. When gypsum is heated in air it loses water and converts first to calcium sulfate hemihydrate, (bassanite, often simply called "plaster") and, if heated further, to anhydrous calcium sulfate (anhydrite). As for anhydrite, its solubility in saline solutions and in brines is also strongly dependent on NaCl concentration.

Gypsum crystals are found to contain anion water and hydrogen bonding

1.3.4 Crystal varieties:

Gypsum occurs in nature as flattened and often twinned crystals, and transparent, cleavable masses called selenite. Selenite contains no significant selenium; rather, both substances were named for the ancient Greek word for the Moon.

Selenite may also occur in a silky, fibrous form, in which case it is commonly called "satin spar". Finally, it may also be granular or quite compact. In hand-sized samples, it can be anywhere from transparent to opaque. A very fine-grained white or lightly tinted variety of gypsum, called alabaster, is prized for ornamental work of various sorts. In arid areas, gypsum can occur in a flower-like form, typically opaque, with embedded sand grains called desert rose. It also forms some of the largest

crystals found in nature, up to 12 metres (39 ft) long, in the form of selenit

1.3.5 Occurrence:

Gypsum is a common mineral, with thick and extensive evaporite beds in association with sedimentary rocks. Deposits are known to occur in strata from as far back as the Archaean eon. Gypsum is deposited from lake and sea water, as well as in hot springs, from volcanic vapors, and sulfate solutions in veins. Hydrothermal anhydrite in veins is commonly hydrated to gypsum by groundwater in near-surface exposures. It is often associated with the minerals halite and sulfur. Pure gypsum is white, but other substances found as impurities may give a wide range of colors to local deposits.

Because gypsum dissolves over time in water, gypsum is rarely found in the form of sand. However, the unique conditions of the White Sands National Monument in the US state of New Mexico have created a 710 km² (270 sq mi) expanse of white gypsum sand, enough to supply the construction industry with drywall for 1,000 years. Commercial exploitation of the area, strongly opposed by area residents, was permanently prevented in 1933 when president Herbert Hoover declared the gypsum dunes a protected national monument.

Gypsum is also formed as a by-product of sulfide oxidation, amongst others by pyrite oxidation, when the sulfuric acid generated reacts with calcium carbonate. Its presence indicates oxidizing conditions. Under reducing conditions, the sulfates it contains can be reduced back to sulfide by sulfate reducing bacteria. Electric power stations burning coal

with flue gas desulfurization produce large quantities of gypsum as a byproduct from the scrubber

1.3.6 Mining:

Commercial quantities of gypsum are found in the cities of Araripina and Grajaú; in Brazil, Pakistan, Jamaica, Iran (world's second largest producer), Thailand, Spain (the main producer in Europe), Germany, Italy, England, Ireland, Canada and the United States. Also, a large open pit quarry is located at Plaster City, California, in Imperial County, and in East Kutai, Kalimantan. Several small mines also exist in places such as Kalannie in Western Australia, where gypsum is sold to private buyers for changing the pH levels of soil for agricultural purposes.

Crystals of gypsum up to 11 m (36 ft) long have been found in the caves of the Naica Mine of Chihuahua, Mexico. The crystals thrived in the cave's extremely rare and stable natural environment. Temperatures stayed at 58°C (136°F), and the cave was filled with mineral-rich water that drove the crystals' growth. The largest of those crystals weighs 55 tons and is around 500,000 years old

1.3.7 Synthesis:

Synthetic gypsum is recovered via flue-gas desulfurization at some coal-fired power plants. It can be used interchangeably with natural gypsum in some applications.

Gypsum also precipitates onto brackish water membranes, a phenomenon known as mineral salt scaling, such as during brackish water desalination of water with high concentrations of calcium and sulfate. Scaling decreases membrane life and productivity. This is one of the main

obstacles in brackish water membrane desalination processes, such as reverse osmosis or nanofiltration. Other forms of scaling, such as calcite scaling, depending on the water source, can also be important considerations in distillation, as well as in heat exchangers, where either the salt solubility or concentration can change rapidly.

A new study has suggested that the formation of gypsum starts as tiny crystals of a mineral called bassanite ($\text{CaSO}_4 \cdot 0.5\text{H}_2\text{O}$). This process occurs via a three-stage pathway: (1) homogeneous nucleation of nanocrystalline bassanite; (2) self-assembly of bassanite into aggregates, and (3) transformation of bassanite into gypsum.

1.3.8 Uses of gypsum:

- Gypsum board is primarily used as a finish for walls and ceilings, and is known in construction as drywall, sheetrock or plasterboard.
- Gypsum blocks are used like concrete blocks in building construction.
- Gypsum mortar is an ancient mortar used in building construction.
- Plaster ingredients are used in surgical splints, casting moulds and modeling.
- Fertilizer and soil conditioner: In the late 18th and early 19th centuries, Nova Scotia gypsum, often referred to as plaster, was a highly sought fertilizer for wheat fields in the United States. It is also used in ameliorating high-sodium soils.
- A binder in fast-dry tennis court clay
- As alabaster, a material for sculpture, it was used especially in the ancient world before steel was developed, when its relative softness made it much easier to carve.

- A wood substitute in the ancient world: For example, when wood became scarce due to deforestation on Bronze Age Crete, gypsum was employed in building construction at locations where wood was previously used
- A tofu (soy bean curd) coagulant, making it ultimately a major source of dietary calcium, especially in Asian cultures which traditionally use few dairy products
- Adding hardness to water used for brewing
- Used in baking as a dough conditioner, reducing stickiness, and as a baked-goods source of dietary calcium The primary component of mineral yeast food.
- A component of Portland cement used to prevent flash setting of concrete
- Soil/water potential monitoring (soil moisture)
- A common ingredient in making mead
- In the medieval period, scribes and illuminators mixed it with lead carbonate (powdered white lead) to make gesso, which was applied to illuminated letters and gilded with gold in illuminated manuscripts.
- In foot creams, shampoos and many other hair products
- A medicinal agent in traditional Chinese medicine called shi gao
- Impression plasters in dentistry
- Used in mushroom cultivation to stop grains from clumping together
- Test have shown that gypsum can be used to remove pollutants such as lead or arsenic from contaminated waters.

2.1 Apparatus and materials

- Arabic gum
- Gypsum
- Water
- Oil
- gypsum mold
- Talc

2.2 Preparation of mold:

Mold was made from fiber and gypsum by certain measurements according to the length and thickness of standard chalk.

2.3 Preparation of chalk:

Gypsum was mixed with suitable amount of water till it was became agreeable for chalk making by using stirrer or another apposite look for mixing, smaal amount of arabic gum were added to the mixture till it was agreeable for chalk making by using stirrer or another apposite look for mixing, small amounts of talc were added to the mixture till it was became more thickness. and more whitish, then some oil was put on gypsum mold to avoid chalk from adheres by mold, the gypsum was added into vacuums of mold, the mold was left was left for 30 minutes till the chalk was dried and became more thickness.

2.4 Physical properties of chalk:

Practically we found that, the chalk was dissolved in both acids (like HCL and water in strength way.



Figure (2-1) chips of chalk



Figure (2-2) chips of chalk

3.1 Discussion:

Practically we found that if we want to make standard chalk, we must take care for basic things:-

1-the effect of the ratio of length and diameter in chalk making.

2-Be carefully, that the suitable standard chalk using in school its length equal one meter long and 1.5 wide.

3-The specific gravity (percent of water to material)

4-The percent of water and binder (Talc Or Arabic gum) in the mixture of gypsum.

5-The quantity and quality (softness) of gypsum

6-Before we put the mixture of gypsum into the mould, we must put some oil on the mould to avoid the sticking of chalk with the mould

7-The time required for mixture dryness

8-we must take care during cannibalizing the chalk from the mould

9-At the end, we can add some bleaching agents to make chalk more whitish.

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