PLASTER OF PARIS
The History of Gypsum

By D. Sendigere*

THE MINERAL we know as alabaster or Satin Spar has been known by man for very many centuries. The ancient greeks knew it as "GYPSUM", the origin of the accepted name for the mineral. It is found in a variety of colours and crystalline form; a colourless transparent one was used for Greek Temples, admitting a soft glow resembling moonlight. This gypsum was named "Selena" after the Greek Moon Goddess : hence the peresent day title of "Selenite" for the mica-like form of this mineral.

The ancient Egyptians used gypsum mixed with water for plastering walls, which covered with mural paintings are still to be seen in the tombs in the valley of the kings. Similar plaster was known to the Assyrians and later to the Romans. Probably they had accidentally discovered the effects of heat on gypsum, with the production of a powder which mixed with water, produced a creamy paste that set rapidly with a smooth surface.

The Roman invasion first brought plaster to Britain. It is still to be seen in their coffins discovered at York and on the walls in the military barracks of the Second Augustan Ligion excavated at Caerleon in Monmouthshire. Nothing more was heard of plaster after the end of the Roman occupation. In the mediaeval times gypsum was used only for alabaster statuary. There is a story told of the rediscovery of plaster by accident. A house or building standing on a gypsum deposit in France, was destroyed by fire. The heat calcined the gypsum producing plaster and the rain which fell afterwards provided the water for setting. Imprints of feet and other objects were found when the debris was cleared. Subsequent investigation of the phenomenon led to the rediscovery of calcined gypsum as an ideal plaster for building and other purposes. The burnt building stood near Paris. The name "plaster of paris" was a natural sequel. There is another explanation. King Henry III visited Paris in 1254 and admired the fine white walls so much that he introduced similar plastering to Britain where it became known as **PLASTER OF PARIS.**

Gypsum, the mineral, was formed in the remote past when stream of water containing calcium bicarbonate flowed into seas in which sulphates were dissolved. Relatively insoluble calcium sulphate dihydrate was precipitated, Ca, SO_4, $2H_{20}$. With the passage of time, the deposit consolidated, coloured by such impurities as clay. In very warm or hot seas containing large amounts of other salts in solution the calcium was deposited in the anhydrous form (Ca SO_4), the mineral called "anhydrite."

Deposits of gypsum in Britain are found in Permian Treassic and Jurassic Systems. For work on a commercial scale a stratum of gypsum needs to be 90 per cent pure and 8 feet thick (Haddon). In England deposits are rarely over 15 feet, but in the Harz Mountains in Germany they exceed 100 feet in thickness.

In Nottinghamshire, England, smaller strata are used as a source of gypsum because of its purity of 99.8 per cent and its fine white colour. Plaster of paris from this source, in addition to other uses, is ideal for surgical bandages. Further, it is exported to the United States of America for "Burtonising" the water used in brewing. The famous beers of Burton-on-Trent owe part of their character to the local water, the hardness of which is due to calcium sulphate.

Depending on the depth of the stratum from the surface, gypsum may be quarried by a process resembling open cast mining of coal rather than the quarrying for stone or it may be mined by the so-called "pillar and stall" system, with access to the deposits by shaft and central roadway.

The lumps of gypsum after trimming to remove any mark of discolouration on the surface, are calcined by heating in a kiln of the pan or kettle type depending on the purpose for which the end-products is intended. The mineral may be kilned in lumps or may be previously ground. More recently, the method of dehydration of the gypsum by the use of steam pressure in an autoclave has been developed.

Calcined gypsum is ground to a powder by milling and so becomes "plaster of paris" which is used for a wide variety of purposes. Screening after grinding ensures optimum size of the grain depending on the use for which a particular powder form is required.

One interesting method of producing plaster of paris is by dry calcination. Gypsum is dried, ground and calcined in a mill through which hot air is passed. Resulting from the manner in which the gypsum is treated the amount of water of crystallisation is reduced. When water is added to plaster of paris. The more soluble form of calcium sulphate returns to the relatively insoluble form with the production of heat.

The process may be illustrated by the equation.

$$2(Ca\ SO_4.\ 2\ H_2O.) + Heat \rightleftharpoons 2(Ca.SRe4\tfrac{1}{2}\ H_2O + 3H_2O$$

Gypsum — Plaster of Paris — Water

When plaster is mixed with water to give a cream, the water that is present is insufficient to dissolve all the plaster at once. What happens is that a little of the plaster dissolves and forms a sugar saturated solution of the dihydrates, which precipitates out, leaving the unreacted water available to dissolve more plaster. The process continues by instalments. The crystals are deposited in felted layers with interlocking. Thus there is formed a solid mass, well cemented together.

The interlocking of crystals may be poor if the plaster is disturbed during the setting process, a point which should be carefully noted when the strength of the set plaster is of prime importance. To give a cream of workable consistency more water is needed than that is required to convert all the plaster into gypsum. This unreacted quantity is generally referred

*Royal National Orthopaedic Hospital, Stanmore, England.

to as "excess water". In drying out, the gypsum loses the excess water until it reaches its maximum strength.

The setting of unmodified plaster starts about ten minutes after the mixing of plaster and water and is complete in about 45 minutes. According to Haddon there is an expansion of about $\frac{1}{3}$ per cent, whilst Rugh who investigated the change in 1904 recorded it as 1/25th inch expansion. He found that contraction never occurred because the crystals when forming tended to impinge end to end. The less water that is used the more the linear expansion that occurs, and it is stated by Andrew's to be 0.4 per cent.

The setting or crystallising process may be speeded up or slowed down by the presence of certain substances known respectively as accelerators and retarders. Metallic salts of mineral acids such as potassium sulphateare effective accelerators while sodium borate (Bor ax) works well as a retarder.

About 1600 BC the Egyptians were using self setting bandages, probably derived from those used by the embalmer preparing the dead for burial. (Edwin Smith Papyrus) (1600 B.C.) Chicago 19330) The coatings for walls was derived from gypsum (probably calciner were known in Egypt in those days). But this knowledge does not seem to have been applied to the making of bandages or splints in the treatment of the injured. One thousand two hundred and fifty years later Hippocrates wrote of the use of bandages containing waxes, resins etc.

Almost as long afterwards Rhazes, an Arabian, devised a mixture of lime and egg albumen which he recorded would set "as hard as a stone." It is interesting to note that in some place the same mixture is used today, not surgically, but to attach silver covers to glasspots and the resulting paste does indeed set with stone-like hardness.

In India some sort of clay was employed for encasing fractured limbs. In 1852 Ballingall, a military surgeon, wrote about this. In 1828 in Berlin plaster was be ng used but as a cream poured into a box containing the limb. In 1887 Krause was using walking plaster for fractures of the leg but he was careful to wait until swelling had subsided before applying his casts.

In 1894 Bardeleben advised applying plaster before any considerable swelling had developed. A new and valuable use for plaster was first published by Winnett Orr in 1923 when he described its use in the treatment of acute Osteomyelitis. In 1931 the first successful commercially prepared plaster bandages were available in Germany. They were made by spreading plaster, mixed with volatile liquids on soft cloth. Methods of manufacture were being improved continuously to meet the particular needs of surgeons by constant collaboration with the suppliers of the plaster of paris.

The plaster of paris used with "Cellona" bandages was of a superfine quality obtainable only from the quarries of Nottinghamshire.

In 1946 in modern "Cellona" bandages, (renamed 'Gypsona') the mixing of powder and solvents was done mechanically and the plaster cream or "mass" so formed is led to a spreading machine in which specially woven cloth receives a coating of suspended plaster, optimum in thickness for the type of bandage being produced. The wide plaster sheets are also produced. This form is particularly useful in the construction of plaster beds. Wide width gypsona used with standard patterns were designed just prior to the out break of the Second World War, specially for use by trained teams of Army Surgeon and personnel, to save time in the preparation and application of the plaster slabs.

ICN 75th Anniversary

The 75th anniversary of the International Council of Nurses (ICN) was celebrated officially on March 29 with a reception hosted jointly by ICN and the Swiss Nurses Association at ICN headquarters in Geneva.

The close to 100 invited guests included the ambassadors to the United Nations and to Switzerland from the nations represented by the ICN Board of Directors, as well as officials from the International Committee of the Red Cross, the League of Red Cross Societies, the World Health Organization, and other national and international associations.

Highlight of the evening was the presentation to ICN of a flag, which is the gift of former President Margrethe Kruse of Denmark. In presenting the flag on behalf of Miss Kruse to ICN President Dorothy Cornelius, Docia Kisseih, First Vice-President, shared with guests at the reception this message from Margrethe Kruse : "I am donating the flag to ICN in gratitude for 27 years of continuous inspiration and in the hope that it may inspire future generations to find new ways and means for ICN to approach the goal set before us by our founders: the one world in nursing, a world to which all nurses belong, whatever is their nationality, race, creed, colour or political belief."

The ICN flag, gift of past President Margrethe Kruse, is displayed for guests at the 75th anniversary reception in Geneva. Presentation on behalf of Miss Kruse was made by First Vice-President Docia Kisseih (left) to President Dorothy Cornelius.