PABCO Gypsum
a division of Pacific Coast Building Products

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Welcome

To

Pabco Gypsum

Las Vegas, Nv.

Welcome to the Pabco Gypsum, Las Vegas Plant! We are going to take you on a short tour of the facilities, covering the basic aspects of our operations.

Our Las Vegas Plant is located on a site known as "Apex" where we have an abundant supply of rock (500 years of mining). Our gypsum is in a form called selenite and is mixed with some deposits of clay and quartz.

In order to get the gypsum out of the ground, in the past we have used a large dozer for ripping and a scrapper for hauling the material to the Wash Plant. But recently, we have installed a 3,000 foot conveyor and a feeder breaker. A large front end loader (988-B Caterpillar) picks up the blasted gypsum ore and carries it to the feeder breaker where it is crushed and dumped on the conveyor.

The crushed gypsum is carried on a conveyor to a large stockpile and when we are ready to use it, it is carried back to a screening proces and a secondary crusher. The rock is then mixed with a large amount of water in order to wash out clay and other foreign materials. Once the clay has been washed out, the gypsum rock is stored in a large dome. When the gypsum reaches this point it is above 90% purity.

From the dome, the rock may go to three places: 1) It can be fed into trucks, where it is sent to cement companies who use it as an ingredient in Portland Cement. 2) It can be fed into railroad cars for other gypsum companies, and 3) the largest amount of it is transferred to our wallboard plant.

After reaching the Board Plant, the gypsum is stored in large bins. From these bins, the gypsum rock is fed into mills where the temperature of the rock is raised to 350 F and pulverized to a fine powder. At this point, the rock is considered converted into plaster of paris or as we call it "stucco".

The stucco is stored in a large bin and when we are ready to use it, it is further pulverized by a machine called an "entoleter".

The gypsum board is mainly formed by adding water to stucco, but we must add other ingredients to give the board the proper quality. We add starch to help the paper bond to the board. We add finely ground gypsum block to help the mix set up faster. We add a wetting agent such as orzan, and depending upon what product we are making, we either add newspaper fiber in the form of a slurry or glass fiber. On special products we may add other ingredients such as water-resistant material called docal.

The other primary ingredient to the gypsum wallboard, besides stucco is paper. The paper gives the board strength and provides us with a smooth surface for finishing.

As we make the board, we must monitor and control the ingredients very carefully. We mix the stucco with water, foam and other ingredients to form a mud. This mud is forced out of the mixer onto the bottom paper which carries it to a large roll. This roll is used to gauge the thickness of the board.

As the mud passes under the roll, the edges of the bottom paper are folded over and the top paper is put on. The board then travels down a long line to give it time to set up.

When the board reaches the end of the line, it is hard enough to cut to the desired length. The board is cut by a machine we call the "knife". The knife can be set to cut the board any length.

Once the board is cut, we flip it over and send it back through the "dryer". The dryer has 8 decks and takes the board double wide. As the board passes through the dryer, we remove all the excess moisture by blowing hot air over the board. The dryer has 5 different zones so we can control the temperature fairly accurately.

After the board comes out of the dryer, we put 2 pieces together to form a bundle. These bundles pass between 2 saws which cut the board to an exact length. We tape the ends together with a tape that identifies the product.

The bundles are then stacked together with other bundles to form a lift. The lifts are then picked up by a forktruck at the area we call "takeoff" and stored in our warehouse.

Our finished product of gypsum wallboard is then loaded on trucks and railroad cars for shipments locally or to the western states for use in building homes and businesses.

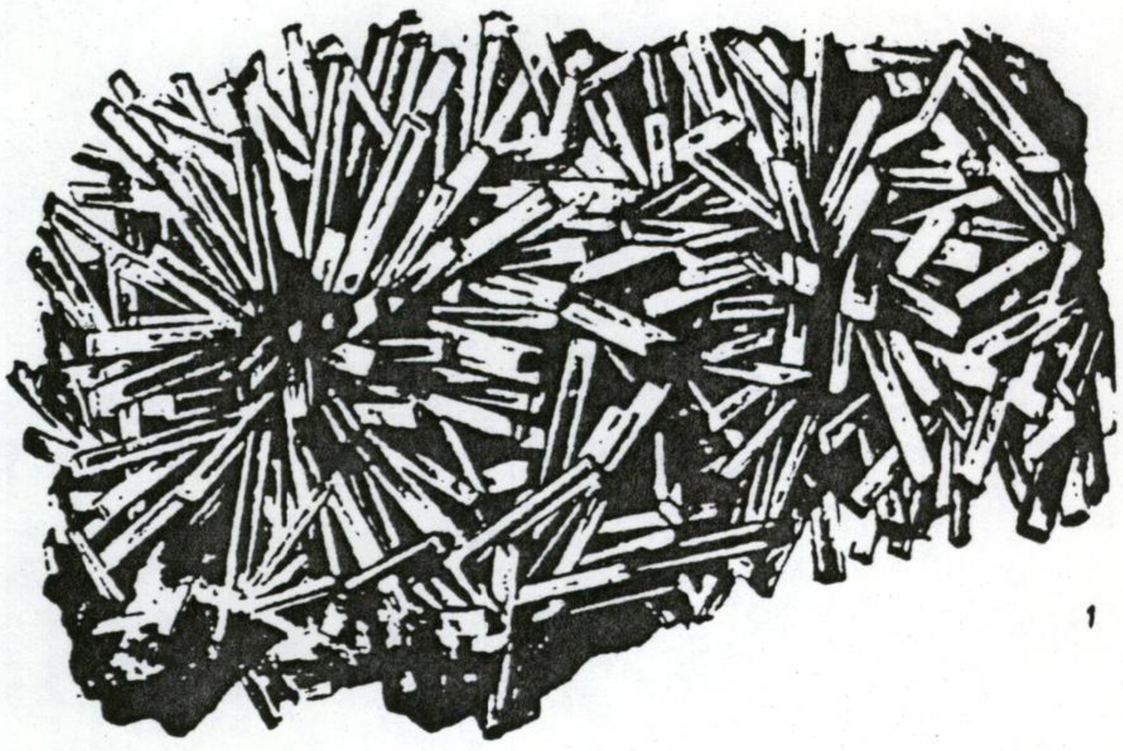
Our wallboard is a vital product in today's world. In fact, the demand is so great at this time that we must allocate board to our customers to fairly distribute the board.

Construction is currently underway to add an additional 2 Imp Mills to the 6 mills currently in use. The additional stucco from these mills will enable the board plant to achieve production levels of 600 million square feet per year.

Both are similar in form as well as chemical composition. Anhydrite, which got its name from the Greek *an* (without) and *hydor* (water), in contrast to gypsum, does not contain water. Gypsum occurs in columnar to tabular crystals resembling mica (Maria Glass). Pure crystallized gypsum is colourless, its massive variety being white or yellowish. Anhydrite is usually compact, rarely cleavable, whitish to bluish. Both minerals are formed by deposition from seawater. They usually occur associated, anhydrite sometimes altering to gypsum due to water absorption. The most important deposits of gypsum are near Volterra (Tuscany), in Spain and Egypt. Anhydrite is found in Slovakia and Poland.

Gypsum has been known since Ancient Times. The ancient sculptor Lysistratos was the first to use plaster in his work. Gypsum and anhydrite are mainly used in the production of plaster. Gypsum heated at 300—400 °C yields the plaster of Paris, which has the property of setting or becoming hard after being mixed with water. It is used in the building industry, medicine, and for casts. If heated to more than 400 °C, it does not absorb water. It is then used in paints and cement. The white, fine-grained variety — alabaster — is used for statues.

Calcium sulphates: gypsum — hydrated — $CaSO_4 . 2H_2O$; anhydrite — anhydrous — $CaSO_4$; gypsum monoclinic; anhydrite orthorhombic. *Hardness:* gypsum 1.5—2; anhydrite 3.0—3.5. *Sp. gr.:* gypsum 2.3; anhydrite 2.89—2.98. *Streak:* colourless to white, in anhydrite also grey.



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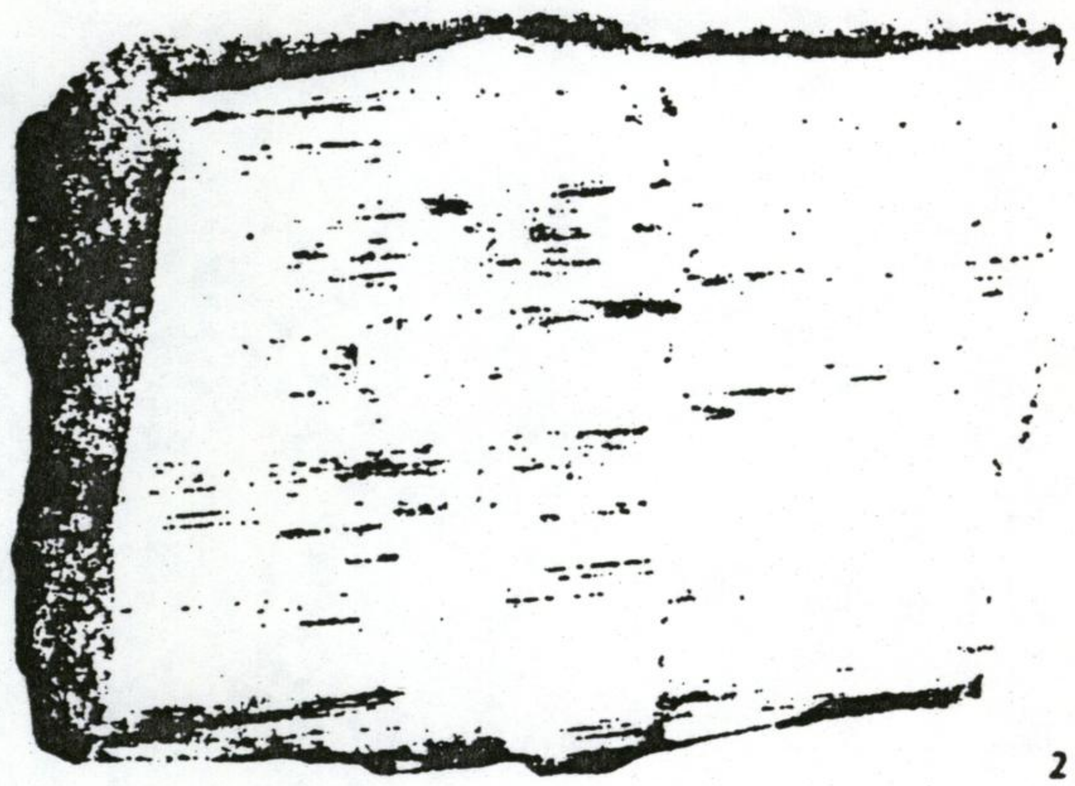

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1 — crystallized gypsum (Salzkammergut, Austria), 2 — fibrous gypsum (Volterra, Tuscany)

GYPSUM, *JIP suhm* (chemical formula, $CaSO_4 \cdot 2H_2O$), is a white or yellowish-white mineral used to make plaster of Paris. The large beds of gypsum are supposed to have been formed when the water evaporated from solutions of the mineral. Gypsum is so soft that it can be scratched with the finger nail. Sometimes it comes in transparent crystals called *selenite*.

The chemical formula of gypsum shows that it is a *hydrate* of calcium sulfate. A hydrate contains water in addition to its other substances. When the gypsum is heated, it loses three-fourths of its water. This process, called *calcination*, changes it to the fine white powder called *plaster of Paris*. The plaster hardens quickly after it is mixed with water and exposed to the air. Plaster of Paris is used to make casts of all sorts.

Heating the gypsum at higher temperatures will drive off all the water. Calcined gypsum in this form is used in the building industry for base-coat plaster, Keene's cement, plasterboard, lath, and wallboard. It is also used as a filler in such products as candy and paint.

Ground gypsum (*land plaster*) is sometimes used as a fertilizer for soils that need lime. It is not used much today, because ground limestone and prepared fertilizers have greater amounts of lime. An important use of raw gypsum is to keep portland cement from hardening too quickly. Raw gypsum is also used to make paint, terra alba, filters, insulation, and wall plaster.

Most of the "hard" water from springs and wells contains gypsum in solution. When the water is boiled, some of the gypsum forms a white crust in the vessel.

The United States produces more gypsum than any other country. It also uses most of the output of Canada, the second largest producer. Gypsum has been produced in the United States since 1850. The leading states are Michigan, California, Iowa, Texas, and New York. Oklahoma, Nevada, Kansas, and several other Western states also supply important quantities. France is one of the leading sources outside the United States. The name *plaster of Paris* comes from the important gypsum deposits in the Paris Basin. Britain, Germany, Spain, Italy, and Russia are important producers. The largest producing area in North America, near Halifax, Nova Scotia, has been worked since 1955. WILLIAM C. LU-

See also ALABASTER; HARDNESS; MINERAL (color · ture); PLASTER OF PARIS

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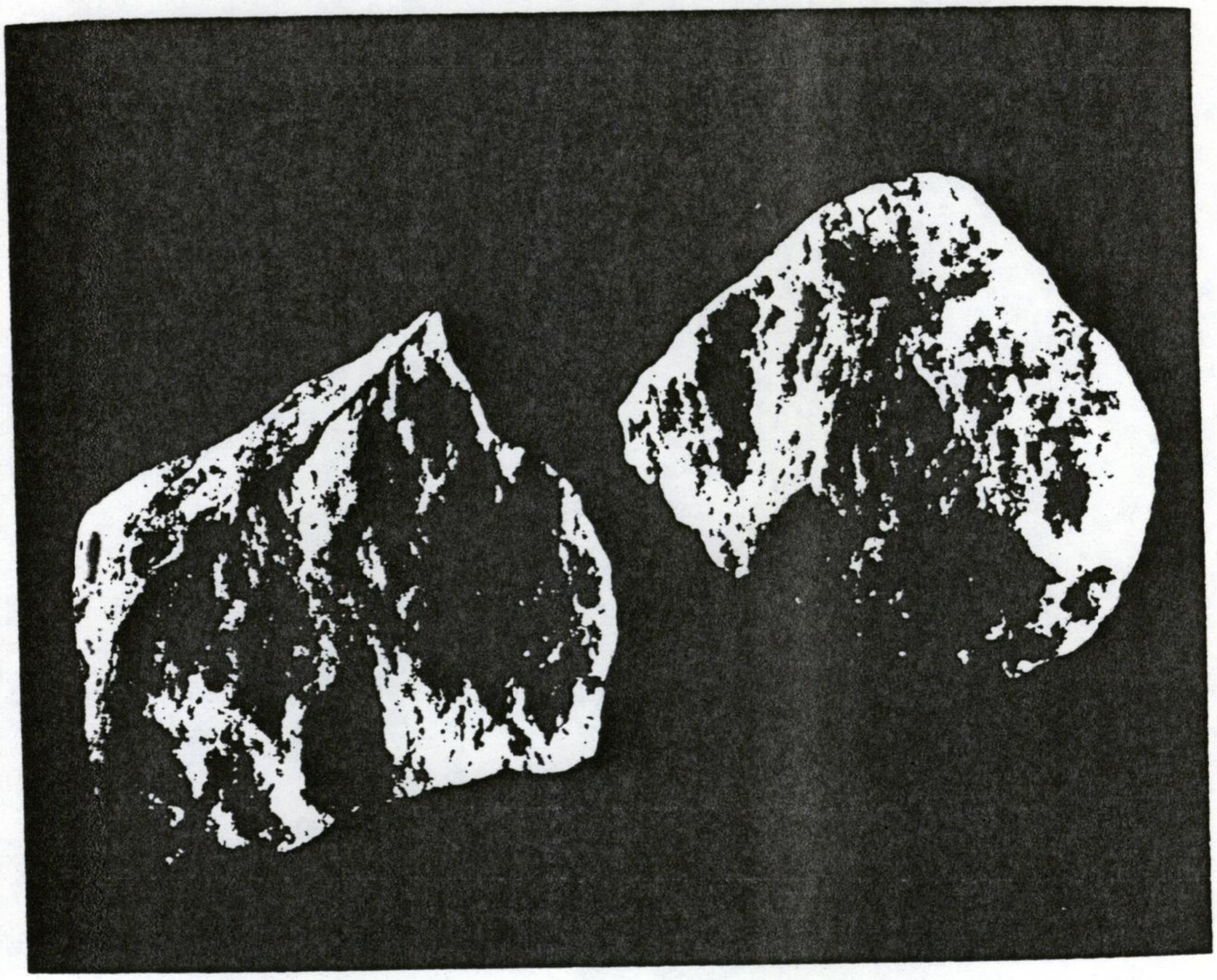
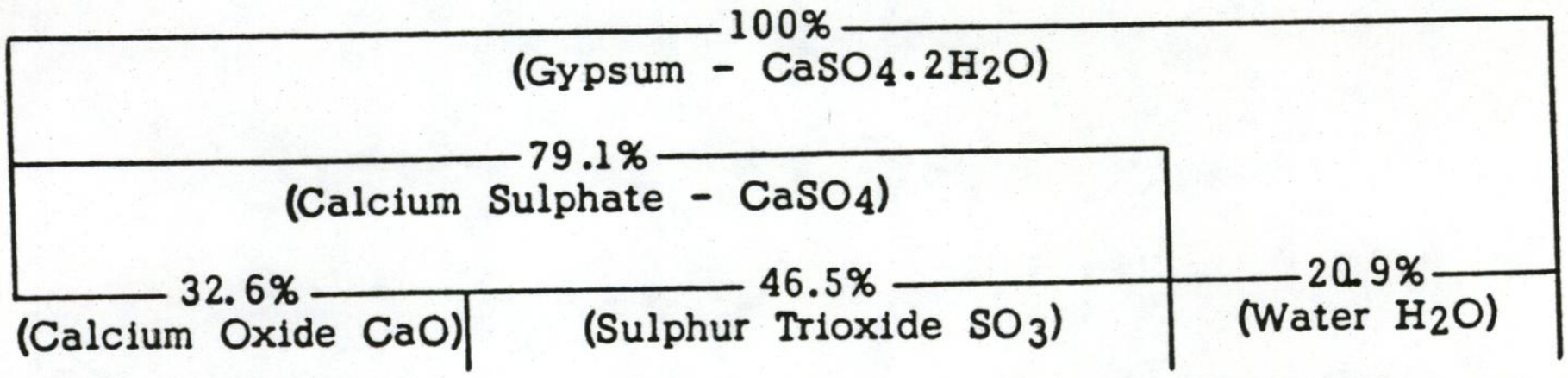
GYPSUM

Gypsum, a non-metallic rock is found in abundance throughout the world. In its many forms it is widely used in industry and as a building material. Its fire-protective values make it outstanding among the common cementitious materials.



Chemically, gypsum is a hydrous calcium sulphate and has the chemical formula of $CaSO_4.2H_2O$, or one molecule of calcium sulphate combined with two molecules of water. The water is not "liquid water" but is chemically combined water locked in the molecules of gypsum. This chemically combined water or "water of crystallization" gives gypsum its fire-resisting qualities.

When reduced to percentage of weight, gypsum rock consists of:



The specific gravity of gypsum is 2.3 to 2.4. It is one of the softer minerals, its hardness being placed at 1.5 to 2.0 in Moh's scale of hardness in physical minerology, in which talc is the softest mineral at No. 1 and a diamond, the hardest at No. 10.

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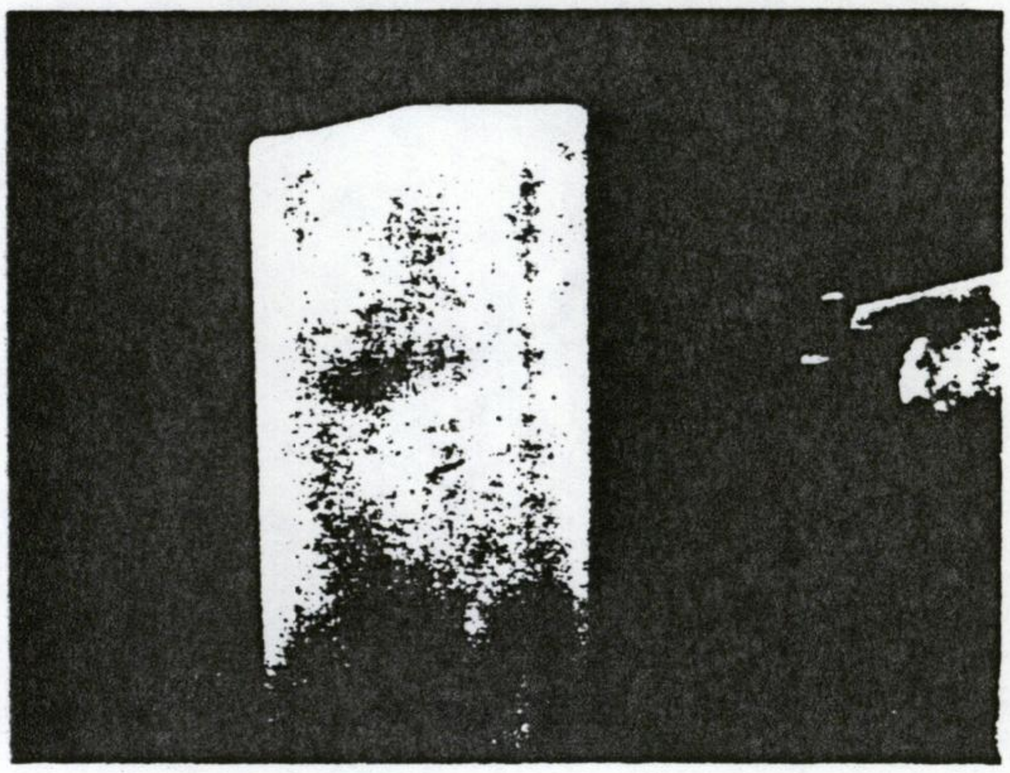
The average weight of gypsum, per cubic foot is:

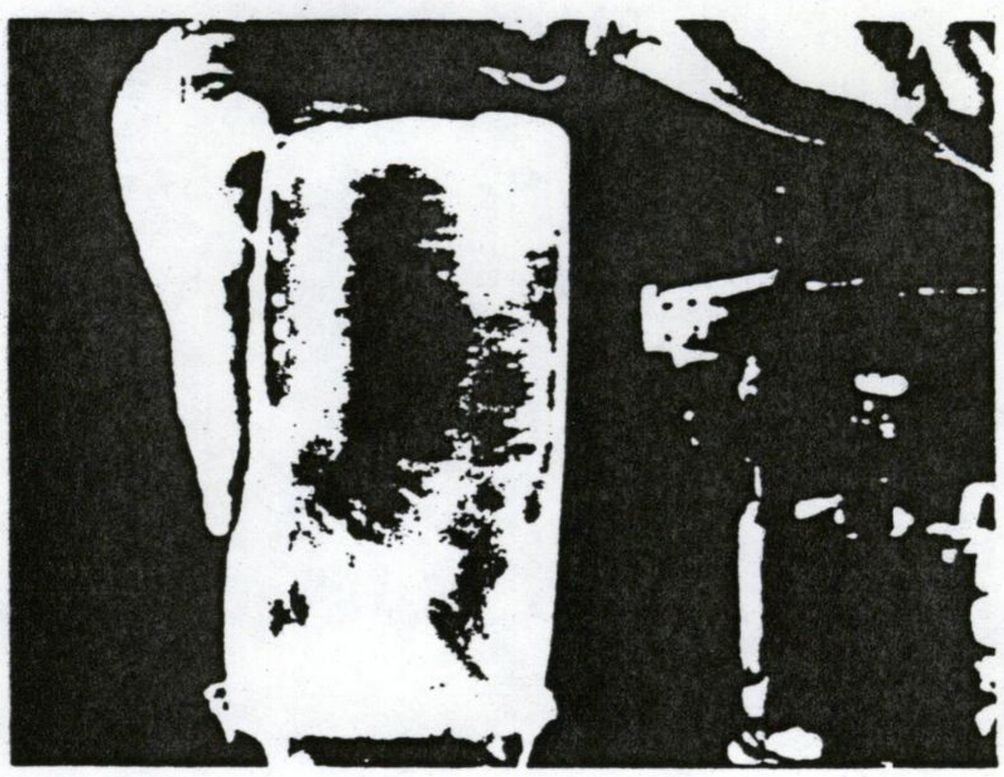
Gypsum rock - solid	140-145 lb.
Crushed gypsum rock	80-100 lb.
Calcined gypsum	60-70 lb.

Gypsum varies in color from shades of light gray, pink, dark gray to black depending upon the quantity of sand, shale or other minerals mixed with the gypsum.



GYPSUM IS FIRE-RESISTANT

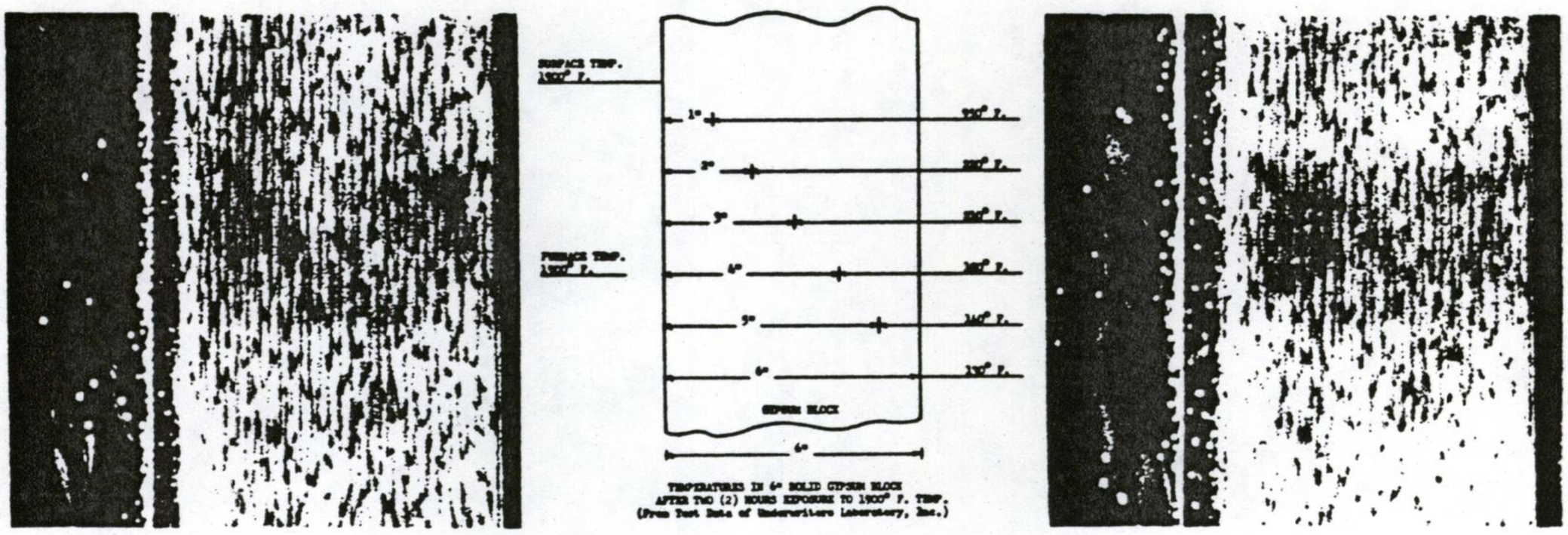
Gypsum when exposed to heat of over 300° F. but under 400° F., releases three quarters (75%) of its water of crystallization (chemical water) and becomes a hemi-hydrate of calcium sulphate, having the chemical formula of $CaSO_4.1/2H_2O$. This release of water of crystallization under heat, in the form of steam, is termed "calcining" or the "calcining process". The ability of gypsum to calcine under heat without expansion or contraction gives it a unique position as a fire-resistant material. Calcined gypsum (stucco) is the basic ingredient of the gypsum plaster, finish plaster, gypsum block, gypsum wallboard, sheathing and lath used in building construction.



The crystalline structure of gypsum may be likened to a solid block of ice.

When the intense heat from a blow torch is directed against one face of the block of ice, the ice melts, because the temperature on the opposite side will remain at 32° F. until the heat from the torch has melted all the ice. Even though the ice thickness is only 1/4" it will not transmit the intense heat until completely melted.

Similarly, the water of crystallization in the gypsum dissipates the intense heat of fire. As the surface of the gypsum is heated to 212° F., the boiling point of water, the chemically combined water is released in the form of steam which repels the fire and dissipates the heat. With continued application of intense heat more combined water is released. As the water leaves the gypsum mass, a white chalky material remains on the surface to further insulate against the flame.



TEMPERATURES IN 6" SOLID GYPSUM BLOCK
AFTER TWO (2) HOURS EXPOSURE TO 1900° F. TEMP.
(From Test Data of Underwriters Laboratory, Inc.)

After approximately fifteen minutes of exposure to the intense heat of fire, the combined water will be released to a depth of approximately 1/4" and the temperature immediately behind the 1/4" depth cannot greatly exceed 212° F. because the combined water in the remaining gypsum would boil at that temperature.

After thirty minutes of fire exposure the water in the gypsum will be released to a depth of approximately 1/2". Similarly, the temperature at 3" will not, theoretically exceed 212° F. This is the process of "Calcination".

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HOW GYPSUM IS FORMED

Nature has formed gypsum in numerous ways:

1. Under desert conditions there have been some spectacular accumulations of pure gypsum sands, the most famous example being the Sands of Alamogordo in New Mexico and Fillmore, Utah, which are so extraordinary that they are now largely enclosed in a national monument.

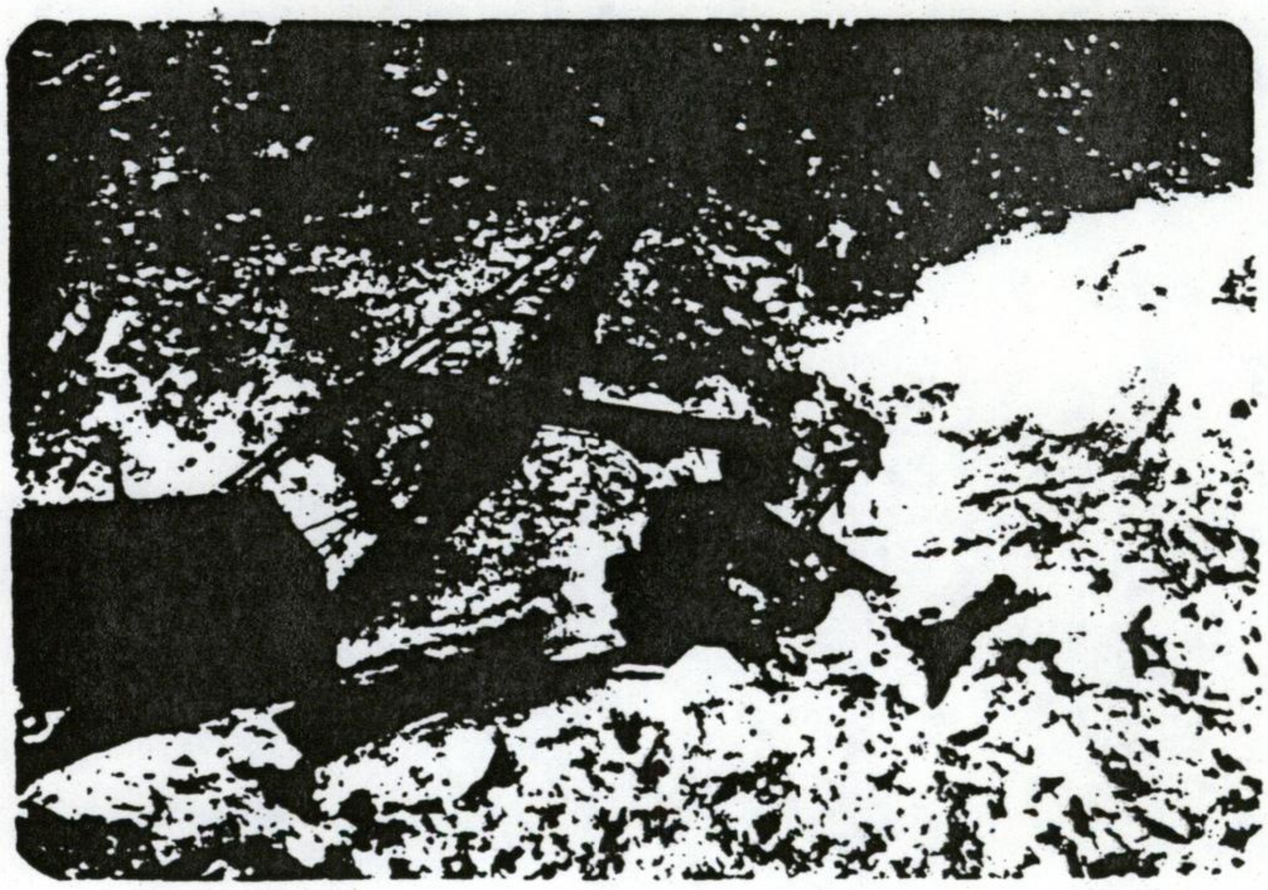
2. Where natural sulphuric acid has had an opportunity to work on lime-bearing materials, gypsum is formed in a solution and may be deposited. This sort of gypsum deposit is frequently found around volcanoes and hot springs but is rarely of any commercial interest.

3. When precipitation of gypsum takes place from underground waters, in clays and shales or other rocks, Satin Spar and Selenite are usually formed.

   If this precipitation takes place under desert conditions in an inland lake or pond, a deposit of gypsum crystals, usually quite impure due to mixture with sand and clay, will be formed. Gypsite is in this general classification.

4. Geologists generally believe that the most important manner of formation was the precipitation of gypsum from sea water, which is believed to have been the principal way in which commercial deposits have been formed. The theory is that shallow parts of the sea become partly land-locked by the development of bars so that lagoons of sea water are formed.

   As the water evaporated the salts in the water steadily precipitated. More sea water was washed in over the bar maintaining the supply of salts. Of the most common minerals, limestone was the first to be formed. Gypsum came next, either as gypsum or sometimes as Anhydrite which may later be altered to gypsum. Finally, common salt precipitated. While this so-called "modified bar hypothesis" is accepted by geologists as the most probable theory, it is difficult to conceive how some of the great pure gypsum deposits could have been formed in this manner, so that their origin really remains a most intriguing mystery.



VARIETIES OF GYPSUM

Nature has done some juggling with gypsum, both with the combined water and with its crystal form.

Anhydrite ($CaSO_4$)

This mineral has the same $CaSO_4$ combination as gypsum, but it completely lacks any combined water. It is an entirely different mineral from gypsum, but through natural processes a great deal of gypsum has been formed from Anhydrite. It is usually light colored, hard and glossy and weighs approximately 180 lb. per cubic foot. It is usually found very deep in a gypsum rock formation.

Anhydrite has little commercial use except as a concentrated calcium sulphate fertilizer, but it provides a large reserve of raw material because research has developed processes that can duplicate those of nature and form gypsum from Anhydrite on a commercial scale, if in future generations this should be necessary.

Gypsum ($CaSO_4.2H_2O$)

The gypsum used in industry and building construction is non-abrasive and can be processed by calcining to a hemi-hydrate, $CaSO_4.1/2H_2O$, on a commercial scale at temperatures slightly above 300° F. It is slightly soluble in water, which is both a strength and a weakness. This solubility is a characteristic that is recognized because it follows through to the final product, except in a few products where research has introduced water resistance by special processing. Gypsum practices, what might be called, reincarnation as it will return to Anhydrite under proper conditions below the earth's surface.

Other varieties of Gypsum are:

a. Selinite is a form of gypsum which resembles mica. It has only one minor commercial use as an optical plate in certain types of microscopes.

b. Satin Spar is a fibrous form of gypsum frequently mistaken for asbestos but it does not possess the useful properties of asbestos.

c. Gypsite is a mixture of gypsum clay and sand. It is processed commercially and sold in a localized market.

Synthetic Gypsum

Synthetic Gypsum is the by-product of the chemical industry. Most commonly obtained from the reaction of sulphuric acid on rock phosphate or bone phosphate in the production of sulphuric and phosphate chemicals. It is used in the manufacture of Gypsum Products and as a retarder in the Portland Cement Industry.

Pabco Gypsum Products

DEVELOPMENT OF THE GYPSUM INDUSTRY

Use in Agriculture

Early settlers in the United States used raw ground gypsum, imported from Europe before deposits were located and worked in the United States. Today gypsum is used extensively on soils where legume crops are grown, for mushroom culture, for peanut production and to counteract black alkali in desert soil and irrigated areas.

Processed Gypsum

As gypsum deposits were discovered in United States and Canada, small calcining plants were erected to manufacture gypsum plaster. The quick setting, approximately 20 to 30 minutes, prevented extensive use of the material as a wall plaster In 1890, patents were issued covering the use of a retarder, a commercial organic material, which delayed the setting action of the gypsum plaster several hours, thus permitting general use of gypsum as a plastering material.

Use in Building Construction

Expansion in the industry has been consistent with the ever increasing demand for gypsum products and today gypsum is used for basecoat and finish coat plasters, gypsum lath, gypsum wallboard, gypsum sheathing, and for fire-resistant roof decks.

a. Gypsum Plaster - falls into two categories:

Basecoat Plaster - mixed with proper proportions of aggregate, sand, perlite, vermiculite or other lightweight materials confined to local markets. Basecoat Plaster is applied directly over approved plaster bases, such as Grip-Lath, insulation lath, metal lath, gypsum or clay tile, and brick in sufficient thickness to hide the framework of the structure and provide the architectural design, contour, angles, curves or plane surfaces.

Finish Plaster - as the name implies, is used to complete the architectural design and forms the base for decoration.

Prior to the first World War, lime plasters were in general use, the jobs using gypsum plaster were individually sold, in neighborhoods of the calcining mills or sanded plaster plants. In the early 20's the change over to gypsum plaster had become so general that little lime or other cementitious materials were used for basecoat plastering.

b. Gypsum Lath

Gypsum Lath, consisting of gypsum stucco, sandwiched between several layers of paper was the first gypsum board manufactured. Later through market demand and improved processing a solid gypsum core, paper covered board was

developed. The panel size was eventually reduced to 16" x 48" and was packaged six pieces to the bundle. Pacific Coast manufacturers standardized on 16.2" x 48" packaged five pieces per bundle or three square yards.

c. Gypsum Wallboard

Gypsum wallboard with open edges followed the development of gypsum lath. The first gypsum wallboard with folded paper edges was manufactured in 1917. The perfection of the recessed edge and joint concealment system greatly accelerated the use of gypsum wallboard during the early 1930's. Tapered edge and improved joint concealment system today has set a new standard for crack free walls and ceilings.

d. Gypsum Sheathing

Gypsum Sheathing, panel size, 48" wide and 96" long, 1/2" thick, with "V" tongue and grooved edges was used in small quantity as early as 1925. The board size was reduced in width to 36", then to 32" and finally to the present width of 24". The board was improved by adding a special asphaltum compound to the gypsum core to produce a water resistant core and by using a water repellant black paper. Today gypsum sheathing has become a standard building material for the undercourse of exterior walls of residential construction.

e. Gypsum for Fire-Resistance

In fire-resisting construction, gypsum is used for the protection of structural steel columns, beams and girders, for roof decks and for dividing partitions of all spaces within a building. No matter how simple or ornate the surface of any room in commercial, industrial or residential building, the desired results may be obtained easily, simply and better with gypsum.

Use in Industry

Gypsum is used in industry in a variety of forms and to many specifications. In Portland Cement production, raw gypsum rock is added to the clinker as a retarder. To retard the set of Portland Cement, sulphur trioxide (SO_3), is required and without the ready availability of sulphur trioxide in the calcium sulphate of the gypsum rock, the Portland Cement industry could never have attained its volume peak of the last decade.

Gypsum is used as a filler in paints; as a bed on which plate glass is ground and polished. Gypsum pottery plasters are used in the ceramic industry and gypsum cements are used in dental laboratories, for statuary and models, in the production of yeast, as a filler for paper and in pattern shops and foundries. In this latter field, gypsum found wide use during the accelerated production of World War II, and was one of the reasons for many of the production records.

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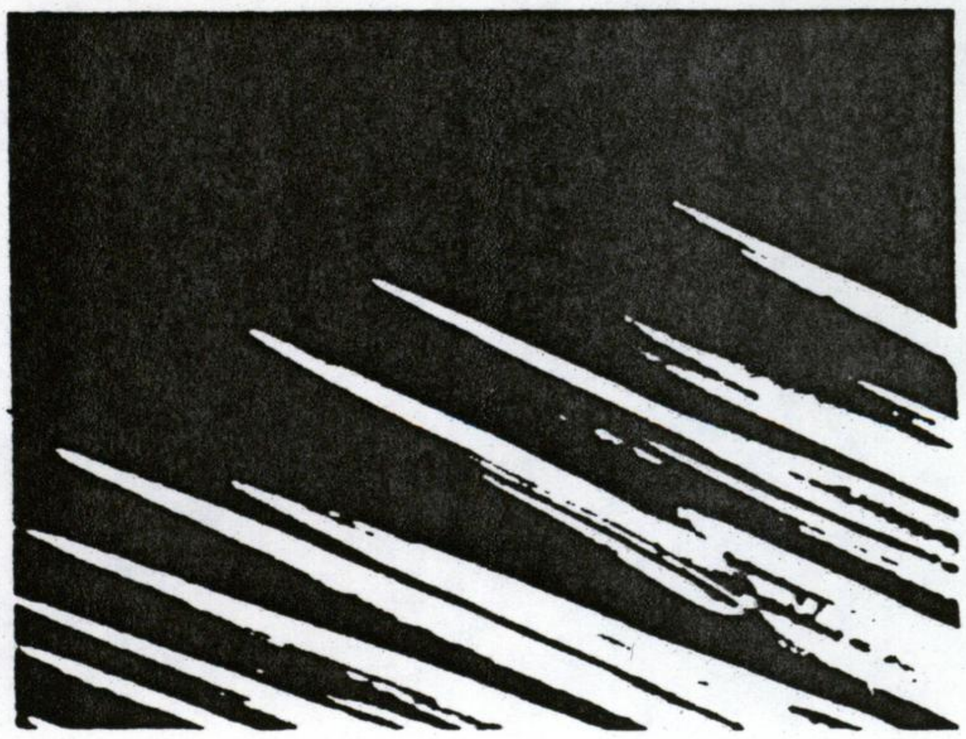
Science has found a way of producing a crystalline formation called alpha gypsum which is the basis for a whole new series of super strength gypsum cements, in which compressive strengths up to 12,000 pounds per square inch are possible from liquid pouring slurries and up to 25,000 pounds per square inch from plastic mixes. They have no shrinkage after setting and they can be made to have a controlled expansion during the setting. With the super strength gypsum cements, patterns and models, heretofore requiring months to produce, are made in hours for the aircraft, marine and machine tool industry. Today it is possible to pour special alloys in gypsum molds so that the finished product requires little or no machining. These molds are made from super strength gypsum cements and not from ("Plaster of Paris" - Stucco).

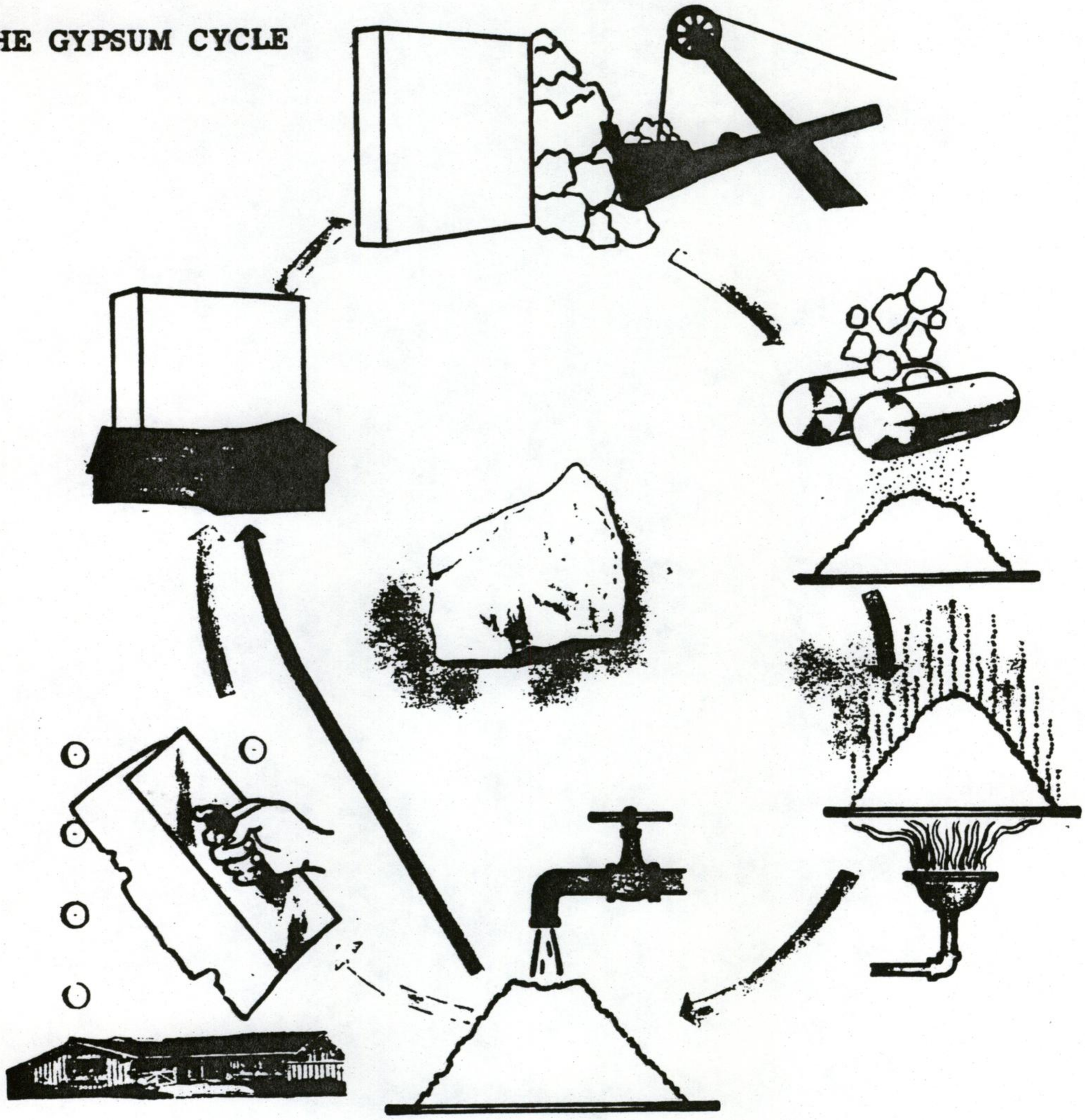
Setting of Gypsum

When calcined gypsum is mixed with water, needle-like crystals are formed, slowly at first, and then more rapidly, developing a complete interlocking network. This crystallization and knitting together of the crystals takes place when gypsum plaster sets on the wall or calcined gypsum sets during the manufacture of gypsum lath, wallboard, or sheathing. When attacked by fire the gypsum again expels the water in the form of steam, retarding the hazard from fire.



When water is added to calcined gypsum part of the gypsum dissolves in the water and in a short time the water contains more gypsum than it can hold in solution. This frees some of the water, which again precipitates more gypsum forming needles which interlock with those formerly formed. The cycle continues until the setting period is complete and the material has become rock again.

THE GYPSUM CYCLE



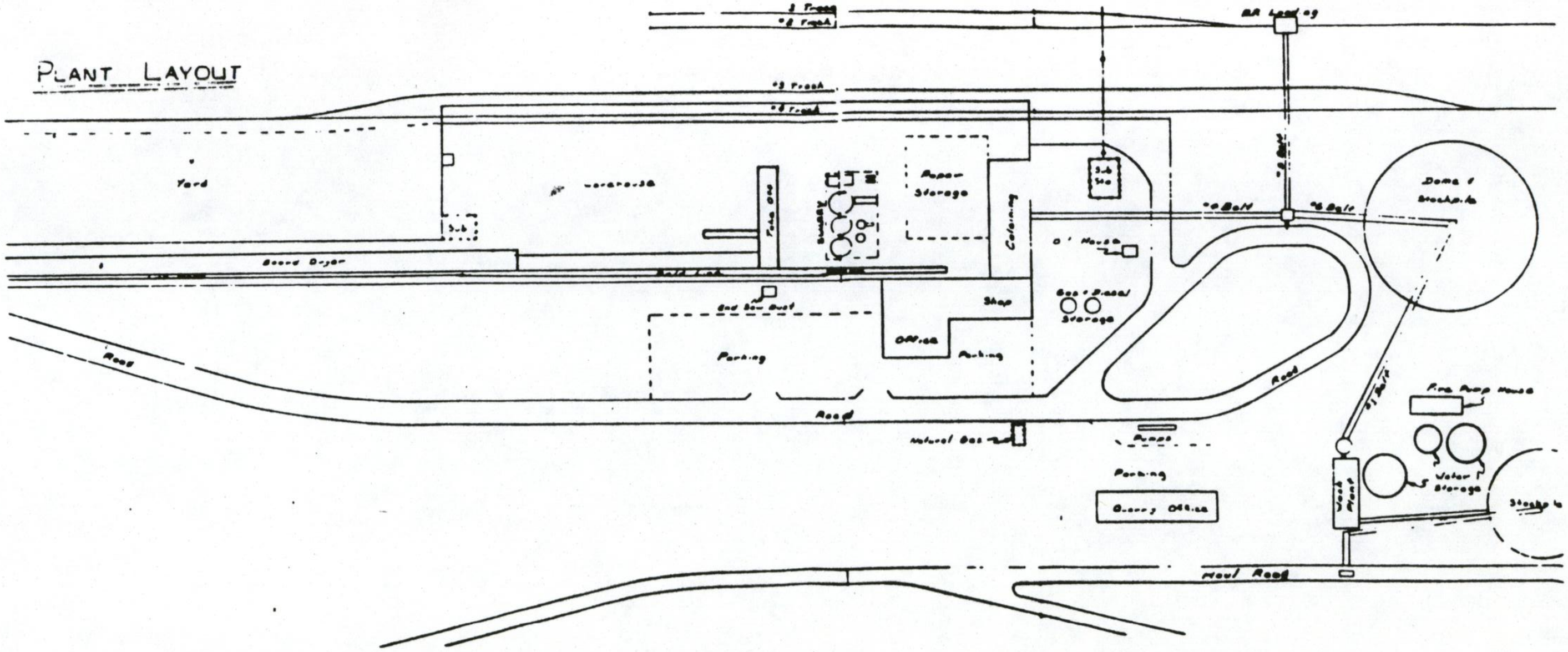
1. Raw gypsum rock is taken from the mine or quarry, reduced to small size in primary crushers and conveyed to the gypsum mill.

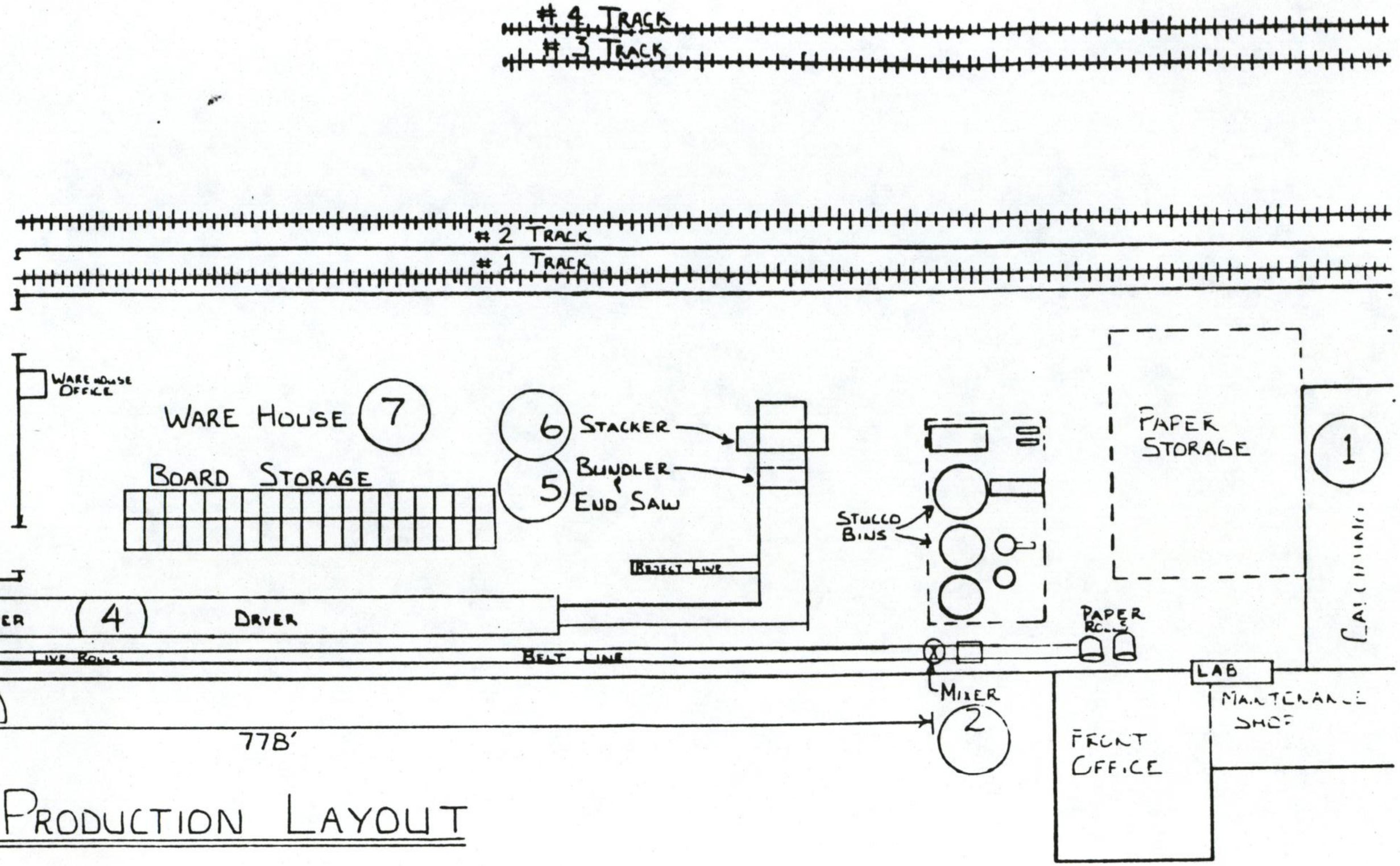
2. At the mill the rock is further processed through hammer mills to reduce the rock to 1/2" to dust.

3. The crushed rock is converted to calcined gypsum (stucco - plaster of Paris) by heat treatment. The heat removes approximately 75% of the chemically combined water, changing the gypsum ($CaSO_4.2H_2O$) to a hemi-hydrate ($CaSO_4.1/2H_2O$).

4. When water is added to the calcined gypsum the material reabsorbs the water and becomes a plastic mass which reverts to rock in the form of a plastered wall or is formed into gypsum wallboard, sheathing or lath.

PLANT LAYOUT





PRODUCTION LAYOUT