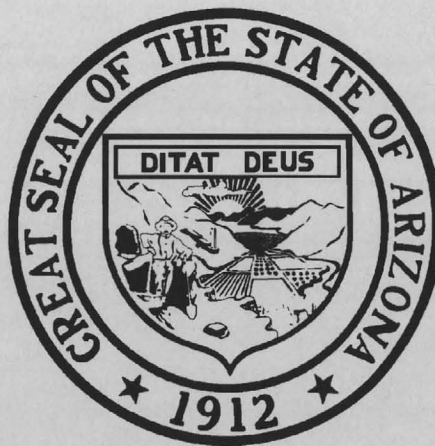

INDUSTRIAL MINERALS IN ARIZONA'S WALLBOARD JOINT CEMENT INDUSTRY

Open File Report 89-2
July, 1989

by Ken A. Phillips
Chief Engineer



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ABSTRACT

This report briefly describes Arizona's wallboard joint cement industry and, in more detail, the specifications and quantities of industrial minerals consumed.

The Arizona wallboard joint cement manufacturing industry uses a larger quantity of industrial minerals as extender pigments and functional fillers than any other Arizona industry. Minerals used include limestone, talc, mica, kaolin clay, attapulgite clay, and perlite. More than 50 million pounds of minerals, with a value in excess of 2 million dollars, are imported by Arizona annually for use in manufacturing joint cement. Since a number of these minerals are not currently produced here a market for local material exists.

Development of mines and production of these minerals in Arizona would aid the state's economy. Additionally, these minerals could be available to manufacturers in Arizona, California, and other southwestern states at lower prices due to savings in transportation costs.

Acknowledgements

I would like to take this opportunity to express my appreciation to all of the Arizona manufacturers who provided assistance and information. Without their cooperation the data to assemble this report would not have been available.

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Development Potential in Arizona

An opportunity for development of Arizona mineral deposits exists because few of these minerals are currently mined in Arizona, despite the likelihood that significant deposits occur within the state. Further, there are additional markets in the Southwest and potential export markets.

Wallboard Joint Cement

The wallboard joint cement manufacturing industry in Arizona uses a larger quantity of industrial minerals as functional fillers than any other industry in the state. For the purpose of this report, products such as wallboard texture coatings and ceiling texture spray coating are included.

Wallboard joint cement is known by a number of common names including 'dry wall mud,' 'tape joint compound,' 'joint cement,' and 'mud.' It is the sealer and adhesive used to attach joint tape to the junctions between sheets of gypsum wallboard on walls and ceilings. Wallboard is also called gypsum board and sheet rock®. In addition to being used with joint tape to hide or conceal joints, it is also used to cover nail and screw heads and to cover the wallboard's paper surface to provide an equally absorbent and uniform surface prior to the application of a decorative coating such as paint.

Wallboard joint cement is produced in a number of different varieties for use in various applications. Types such as chemically setting, lightweight, topping, and all-purpose are all made for differing applications or environmental conditions of application. Wallboard joint cement is manufactured as both a wet ready-to-use product and as a dry powder that must be

mixed with water at the job site prior to application.

Wall and ceiling texture compounds are manufactured for application to wallboard surfaces after taping and sealing to provide a decorative texture for walls and ceilings. Wall texture coatings are nearly always subsequently painted, while ceiling texture coatings do not necessarily require painting.

Wallboard joint cement is a mixture of raw materials. It generally consists of a starch or latex (for wet ready-to-use products) or vinyl resin (for dry mix products) binder, water, ethylene glycol (to prevent freezing or control drying time), various dryers and preservatives, and mineral fillers. The mineral fillers make up the major portion of the product. Wall and ceiling texture coatings additionally contain hiding pigments such as titanium dioxide. Ceiling coatings usually contain coarsely ground expanded polystyrene particles. Ceiling coatings requiring acoustical properties may contain expanded vermiculite or popped perlite.

Ready-to-use wallboard joint cement is packaged in four gallon boxes weighing 50 pounds, one gallon pails, and pails weighing 62 pounds. Dry mix joint cement is packaged in 25-pound bags. Lightweight joint cement made in Arizona is packaged in four-gallon boxes weighing 40 pounds.

Functional Fillers

Functional fillers for wallboard joint cement can, for the purpose of discussion, be divided into two groups; those which impart some useful property such as strength or sag resistance to the final mixture and those that fill space, add bulk, and extend the usefulness of the other constituents. Ground limestone is the most common bulk filler in joint cement, but many white, non water-soluble mineral fillers could be used in its place. Functional fillers used include mica, talc, kaolin clay, attapulgite clay, and popped perlite.

ARIZONA'S JOINT CEMENT MANUFACTURING INDUSTRY

Arizona's joint cement manufacturing industry consists of four plants producing over 1.5 million boxes (average weight per box: 50

pounds or the equivalent in pails and dry mix material) of joint cement and wall texture coating a year. These plants manufacture about 80 percent of the joint cement consumed in the state. Most, if not all, of the remaining 20 percent is shipped in from California. Two plants produce joint cement only, while the other two produce both joint cement and wall/ceiling texture coatings. All of the plants are Arizona operations of out-of-state corporations. A major gypsum wallboard manufacturer operates one plant.

Wallboard joint cement is used in new and remodeling construction only. Thus the economic health of that industry directly affects the quantity of joint cement consumed. Further it is used when gypsum wallboard is used as an interior wall or ceiling covering. Neither wood or vinyl paneling nor lathe and plaster require joint cement. Within the last few years, actual production of joint cement in Arizona has ranged from slightly under 1 million boxes to over 2 million.

Industrial Minerals in Joint Cement

Arizona joint cement manufacturers consume at least six different industrial minerals as functional fillers. They are listed in Table No. 1 along with typical annual consumption and prices. Typical price ranges are given to help estimate the size of the market. The lowest prices are often those paid by warehouses and the largest bulk users, while the highest prices are often in quantities of single pallet loads and materials obtained through distributors' warehouses. Material may be supplied in bulk rail cars, bulk trucks, 'super sacks' (bulk bags that hold from 1000 to 3000 pounds), or in 50-pound paper bags. The larger consumers often negotiate prices and delivery contracts directly with the mining-processing-supplier company at terms lower than published prices.

The industrial minerals used in joint cement manufactured in the state are described in the remainder of this chapter. All are very finely ground and must conform to detailed specifications. Some are interchangeable in certain uses.

One Arizona producer of wallboard joint cement has in the past mined and ground raw mineral materials, particularly mica, themselves.

Although not presently operating their own mines, they hope to produce some of their raw materials again and market excess production to other manufacturers.

Those interested in developing new sources of these minerals should be fully aware of the idiosyncrasies of the industrial minerals industry. Suppliers of minerals to the industry are expected to provide considerable technical data and support to potential consumers.

Commodity	Quantity (tons)	Consumers' prices	
		minimum per ton	maximum per ton
Limestone	20,725	48	78
Mica	1,968	238	270
Talc	1,270	102	124
Kaolin	538	134	960
Attapulgitic Clay	410	208	
Perlite	30		

Table 1. Typical annual consumption of Arizona's wallboard joint cement manufacturers.

Calcium Carbonate

The most commonly used filler in joint cement is calcium carbonate, primarily as fine ground white limestone or marble. It is ground much finer than 325 mesh with the mean particle size being in the range of 10 to 15 microns. Calcium carbonate supplies volume solids or bulk at a low cost. At about \$0.025 per pound (or 62 to 75 cents per 50 pound box), it is the cheapest ingredient in joint cement.

Calcium carbonate's tendency to 'frost' or 'chalk' when repeatedly exposed to moisture does not present a problem in joint cement. Joint cement is seldom used in exterior applications and is always protected by painting.

The three most important specifications for ground calcium carbonate to be used in joint cement are whiteness, chemical stability, and particle size. Whiteness is important because the finished product must be white to avoid showing through paint coating applied over the joint cement, especially since most interior walls in residential construction are painted white or

very light colors. Whiteness should be above 90. Fine and consistent particle size is important to manufacturing joint cement that applies evenly. The necessity for chemical stability is somewhat nebulous. Limestone or marble that can be ground for joint cement use must be free of water soluble or water absorbable foreign minerals that could cause tape adhesion problems or the appearance of blemishes in the wall coating. Common clays are typical impurities that should be avoided. However, the limestone or marble need not be pure CaCO_3 . Dolomitic limestone or marble can be used if white. Many white silicate minerals such as a feldspar or pyrophyllite could also be used, but must compete on a price basis with ground limestone.

Nearly all of the ground limestone used by Arizona joint cement manufacturers is imported from Lucerne Valley in southern California. The cost of shipping ground limestone from Lucerne Valley to Phoenix area manufacturers is approximately \$25.00 per ton in bulk trucks.

Calcium carbonate used in joint cement is typically one of two average particle sizes; 10 microns or 15 microns. (US sieve mesh 325 is approximately 44 microns.) A typical specification for fine ground calcium carbonate used in the manufacture of wallboard is shown below:

Typical chemical analysis (Calcium carbonate)

CaCO_3 - minimum 97-98%, MgCO_3 - 1%, Acid insoluble 2%

Typical particle size distribution

Mean particle size - 10 microns

Percentage by weight finer than:

Microns	%
44	90 min.
20	50
15	40
5	13
2	8

Typical physical characteristics

Dry brightness	91
Gallons per pound	0.0445
Pounds per gallon	22.5
Specific gravity	2.71
Moisture	less than 0.20%
Ph Factor	9.5
Oil absorption	8

Kaolin

Kaolin, also known as kaolin clay or kaolinite, and sometimes referred to as china clay or aluminum silicate, is a functional filler that is white, has some hiding power, provides some strength, and ties up water to control drying. Its hiding power is a result of the delaminated clay particles piling up and overlapping. As a filler it is chemically inert. It also improves spreadability.

Ground kaolin used by Arizona joint cement manufacturers is imported from northern California. The cost of shipping ground kaolin from northern California to Phoenix area manufacturers ranges from \$35.00 to \$40.00 per ton in truckload quantities. A typical specification for fine ground kaolin is shown below:

Typical chemical analysis

Al ₂ O ₃	38.8%
SiO ₂	45.2%
Na ₂ O	0.05-0.3%
TiO ₂	0.6-1.7%
CaO	0.02%
Fe ₂ O ₃	0.3-0.9%
MgO	0.03%
K ₂ O	0.05-0.2%
Loss on ignition	13.6-14.2%

Typical particle size distribution (Kaolin)

Retention on 325 mesh screen	0.15%
Mean particle size	4.8 microns (Equivalent spherical diameter)

Percentage by weight finer than:

Microns	%
20	99+
10	85
5	50
2	21

Typical physical characteristics

Physical form	Highly pulverized powder
Dry brightness	79-82
Specific gravity	2.58
Moisture	less than 1.0%
Ph factor	3.5-5.10
Oil absorption	30-35
Refractive index	1.56
Bulk density (loose)	24 lb/cu ft
" " (tamped)	45 lb/cu ft

Attapulgitic Clay

Attapulgitic clay is a gelling clay used as a thickener and/or thixotropic agent. It provides sag control, aids in spreadability of the final

product, and the holding of ingredients in suspension.

Nearly all of the attapulgitic clay used by Arizona joint cement manufacturers is imported from the Georgia-Florida area of the southeastern United States. The cost of shipping attapulgitic clay from the southeast U.S. to Phoenix area manufacturers is approximately \$90.00 per ton in truckload quantities.

Mica

Ground mica is used in joint cement where its platy structure and high aspect ratio (area: thickness) provides a number of useful properties. It prevents packing of the other fillers, adds strength to the applied layer on the wallboard, and aids in shrink and cracking control. Mica for use in joint cement must be white when ground and free of dark particles of other minerals. Air ground or micronized muscovite is most commonly used, but dry ground sericite or muscovite has been occasionally used. Both muscovite and sericite have been mined in Arizona in the past for use in joint cement. Most of the ground muscovite mica used by Arizona joint cement manufacturers is imported from North Carolina. The cost of shipping ground muscovite mica from North Carolina to Phoenix area manufacturers is in the range of \$80 to \$110 per ton in truckload quantities. A typical specification for fine ground mica is shown below:

Typical chemical analysis

Theoretical chemical formula H₂KAl₃(SiO₄)₃

Typical physical characteristics

Color	white and lustrous
Particle shape	very thin and platy
Particle size distribution	
+60 mesh	nil
-60 +100 mesh	1.5% max
-100 +200 mesh	10.0% min
-325 mesh	50.0% min
Chemical activity	essentially inert except to H ₂
Loss on ignition	4-5%
Specific gravity	2.8-3.0
Moisture	0.25%
Oil absorption g/mg	80.0
Refractive index	1.58
Bulk density (apparent loose)	14 lbs/cu ft
Hardness (MOHS)	2.5
Ph	5.75
Surface area m ² /g	6.64

Ground pyrophyllite could be used in joint cement in the same manner as mica.

Talc

Talc is less expensive than mica and can replace some of the mica in joint cement where it provides similar properties. Its platy grain structure helps keep the mixture in suspension and aids workability.

Most of the ground talc used by Arizona joint cement manufacturers is imported from Montana, while some is still supplied from central California. The cost of shipping ground talc to Phoenix area manufacturers ranges from \$30 to \$55 per ton in truckload quantities. A typical specification for fine ground talc is shown below:

Typical chemical analysis

SiO ₂	61.5 – 63.1%
MgO	31.0 – 32.9%
Al ₂ O ₃	0.93 – 2.37%
CaO	0.19 – 3.90%
Fe ₂ O ₃	1.00 – 1.30%
K ₂ O	0.01 – 0.13%
TiO ₂	0.05 – 0.20%%
Loss on ignition	5.50 – 6.20%

Typical particle size distribution (talc)

Retention on 100 mesh screen	nil
Retention on 200 mesh screen	nil
Retention on 325 mesh screen	2.0%

Typical physical characteristics

Dry brightness	80-84
Specific gravity	2.70
Apparent density	28.7 lbs/cu ft
Tapped density	56.5 lb/cu ft

Perlite

Perlite is used in a ground, then expanded form, as a lightweight filler. Bag-house-fines from perlite expanding (also called popping) plants are also used. Perlite used in wallboard joint cement must be very white when expanded. It is used in place of some of the calcium carbonate.

Diatomaceous Earth (Diatomite)

Diatomaceous earth or diatomite is a filler primarily used in joint cement for its low effective

density in light weight products. Because of the physical structure of the individual particles making up diatomaceous earth, they lay in a random, three-dimensional pattern that stiffens, reinforces and improves the durability of the final product. The variety of shapes also provides low density. The effective density of diatomaceous earth fillers is among the lowest of any mineral fillers at 1.98 to 2.33 grams per cubic centimeter. Diatomaceous earth occupies up to 30 percent more volume per pound than most other filler minerals.

Diatomaceous earth is not currently used by any of the Arizona wallboard joint cement manufacturers.

Feldspar

White feldspar, if locally available, could replace limestone as the primary filler in wallboard joint cement. Increased grinding costs would have to be compensated for by reduced transportation costs.

Wollastonite

Wollastonite could be used in place of some mica and limestone in wallboard joint cement where the acicular shape of the ground wollastonite particles would provide many of the same properties provided by ground mica.

Conclusions

Arizona's wallboard joint cement industry uses the largest quantity of industrial minerals as fillers of any industry in Arizona. All of these are currently imported into Arizona. Occurrences of most of these minerals, in particular, limestone, mica, kaolin, perlite, pyrophyllite, and diatomaceous earth, are known in Arizona. The consumption of these minerals in joint cement might be sufficient to justify a small specialized multi-mineral producer operating a number of small mines, each producing a specific mineral, but utilizing a common grinding/processing plant.

Additionally, many of the minerals used in joint cement have nearly the same specification as those used in Arizona's paint industry, although the quantities used in paint are much smaller. Thus a multi-mineral producer could

produce for more than one Arizona industry. Further, southern California is a large market for industrial minerals in wallboard joint cement as well as paint. It is expected that investigation of other industries in Arizona and southern California will yield consumption data that will produce totals of sufficient quantities to justify development of new mines in Arizona.