PLAINTIFF'S
EXHIBIT
SA-528

Coalinga Asbestos Fiber

A Newcomer to the Asbestos Industry

Of interest to Canadian personnel will be a description of a new asbestos mining and milling operation put into the production stage early in 1962 by Coalinga Asbestos Company Inc. in Fresno County, California. Group 7 chrysotile fibre is extracted from zones of sheared serpentine within an ultrabasic intrusive. Various exploration techniques are discussed and mining and milling operations described.

By **ROBERT C. MUNRO**, Senior Geologist, Johns-Manville Sales Corp., Stockton, Calif., and **KENNETH M. REIM**, District Geologist, Kern County Land Company, Bakersfield, California

Introduction

CHRYSOTILE ASBESTOS has long been known in California and there have been many attempts to develop the known occurrences. Because of the limited size of most of the deposits, the asbestos mining industry in California has had a somewhat erratic history.

The rapid expansion of California industry has resulted in an increasing demand for chrysotile fibers, including the short fibers used in the manufacture of vinyl-asbestos and asphalt-asbestos products. These short chrysotile fibers have been supplied to the West Coast market by eastern Canadian mines, which produce them in addition to a more or less full line of asbestos fiber grades. These short fibers fall under the Canadian classification of Group 7. They are relatively low priced but carry a high freight rate for transporting them to California.

The existing demand for short fibers and the costs incident in their transport from the East make the appearance of a California short fiber industry an interesting and important development.

This new industrial activity centers around the town of Coalinga in Fresno County. Located on the west side of the San Joaquin Valley at the junction of California Highways 33 and 198, Coalinga has been most famous as a center of oil production.

The new asbestos mining sites are located within the geological boundaries of the large New Idria ultrabasic intrusive, whose southeastern tip is located some 16 miles northwest of Coalinga.

This rugged region has supported mining activities since the middle 1800's. Mercury mines, including the New Idria Mine are located on the contact of the ultrabasic with the surrounding sediments, and magnesite and chrome ores have been mined from within the ultrabasic.

Nearly all of this ultrabasic body is characterized by highly sheared serpentine. In many areas of the southeastern portion of the ultrabasic, the plates of sheared serpentine take on a soft, flexible nature. These plates have often been mistaken for mountain leather (a form of actinolite).

When it was demonstrated that this material was chrysotile, the area rapidly became a center of active interest. In 1959, Kern County Land Company acquired land with ore potential which became the basis for a joint venture with Johns-Manville Corporation and the subsequent formation of Coalinga Asbestos Company, Incorporated.

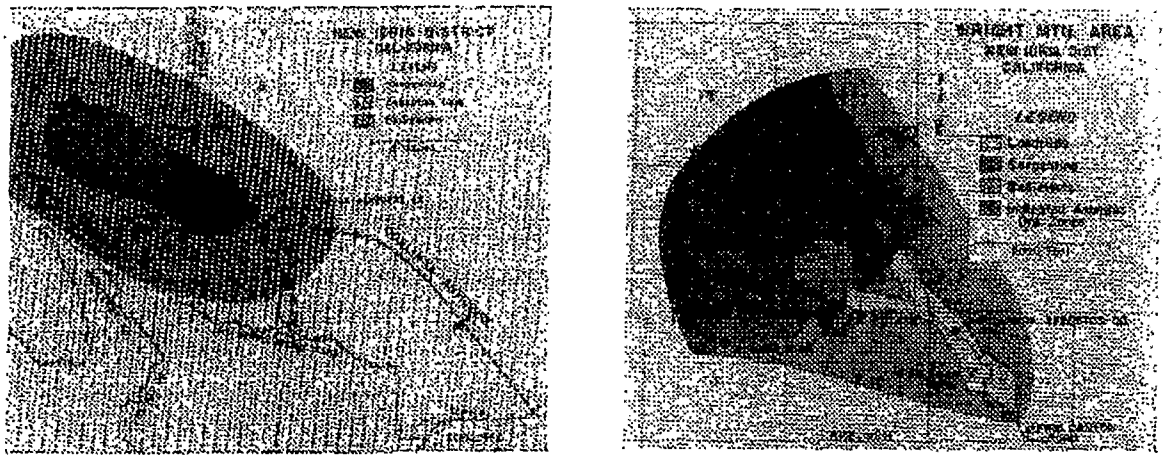
In March 1962, Coalinga Asbestos Company completed construction of a new $1,500,000 asbestos mill and is presently producing Coalinga asbestos fiber, a chrysotile fiber comparable to the Canadian Group 7 grades.

Geology

General

In western Fresno County and southeastern San Benito County, an area of ultrabasic rocks three to five miles wides and fifteen miles long is exposed. Erosion has carved this feature into an area of high relief, with ridges rising to over 5,000 feet in

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(Left) Index map of New Idria District, Fresno and San Benito Counties, California, showing serpentine intrusive. (Right) General geologic map of Wright Mtn. area of New Idria District. Fresno County, California.

height and the slopes falling steeply to canyons below the 3,000 foot elevation.

For the most part this ultrabasic mass now exists as highly sheared serpentine, the exposed rock being made up of small serpentine chips and plates, the faces of which have been slickensided. Throughout this sheared material there are residual blocks of serpentine and highly to moderately serpentinized peridotite. The faces of these resistant blocks, which are generally termed "boulders", show rounding and slickensiding and their size varies from pebble size to diameters of over five feet. Certain areas have seemingly resisted the shearing stresses and remain as bodies of moderately fractured serpentine.

Throughout the ultrabasic mass are bodies of silica-carbonate rock, silicified serpentine, and minor concentrations of magnesite and chromite.

An additional feature of the local geology is provided by large landslide areas. These units are composed of serpentine debris derived from the ultrabasic mass. This material, mixed with some sedimentary detritus, forms fans of considerable depth which occupy the lower valleys and locally obscure the underlying geology.

This ultrabasic rock has been intruded into Jurassic sediments (Franciscan Group) along the northwestern extension of the Coalinga anticline. The long axis of this intrusive strikes approximately north 65° west paralleling the regional structure. It is likely that this ultrabasic was emplaced during the late Jurassic or early Cretaceous at the time of the initial folding of the Franciscan formation.

A structurally weak plane in newly folding Jurassic sediments became the locale for the intrusion of an olivine-pyroxene mass of a semi-solid nature whose low temperature conversion to serpentine was effected by the SiO_2 and CO_2 charged waters from the surrounding sediments. Examination of the ultrabasic-sediment contact bears out the idea of a low temperature intrusion, as little or no signs of contact metamorphism are seen. In one location, a rudimentary glaucophane schist was mapped in the Franciscan rocks, however, no relationship with the contact could be shown.

It is apparent that further emplacement of the serpentine in the "cold" state took place. Retaining large portions of the Franciscan rocks, the mass was forced upwards into overlying Cretaceous sediments (Panoche formation). The stresses that accompanied this "cold" intrusion are thought to be responsible for the highly sheared nature of the serpentine.

Continued uplift of the area during the Tertiary period is evidenced by the occurrence of serpentine detritus in the Big Blue member of the upper Temblor formation. The zones of silica-carbonate rock, silicified serpentine and magnesite are attributed to the "flushing" action of the serpentinizing solutions and their subsequent deposition of magnesia, silica and carbonate in northwest trending planes of weakness.

Chrysotile Ore

In the southeastern one-third of the intrusive, the character of the sheared serpentine has been altered noticeably. Here the plates are, to a large extent, soft and flexible. In many areas these soft plates, whose diameters range from microscopic sizes to over an inch, make up visually well over 50 per cent of the rock mass, with the characteristic presence of rounded pebbles to boulder-sized residuals of serpentine and serpentinized peridotite.

Good surface exposures are rare, the best natural outcrops being found in canyons. However, the work of bulldozers in road and sample cuts has provided excellent opportunities to examine ore in the fresh face.

Ore in the fresh face consists mainly of soft pale gray flakes of serpentine whose platy structure ap-

pears to be governed by closely spaced, obliquely intersecting sets of shear planes. The aligned flakes give the effect of parallel lineation to the mass. Throughout this material, the fragments and boulders of serpentine are generally but not always oriented with regard to the main direction of lineation.

Other minerals commonly noted in the face are:

a. Lenses of crystalline carbonate with scaley serpentine coverings.
b. Nodules of secondary hydromagnesite which are considered a surface feature.
c. Small crystals and crusts of magnetite.
d. Fibrous brucite and picrolite.
e. Occasional serpentine boulders containing veinlets of chrysotile cross-fiber.

Small landslide areas on the ultrabasic mass have been common, and old land surfaces have been exposed several feet under material originally considered "in place."

The flexible flakes of serpentine have been shown to be made up of short fibers. There is no doubt that these fibers are chrysotile. Petrographic, X-ray and chemical analyses have shown that they are identical to Canadian chrysotile. The main difference lies in the fact that the fibers, rather than occurring in vein form, are randomly oriented and matted in flakes.

The name Coalinga asbestos fiber is used to distinguish this new short fiber from the Canadian Group 7 product.

Origin of Coalinga Asbestos Fiber

The origin of Coalinga asbestos fiber is not easy to postulate. Veins of cross-fiber are easily examined and the characteristics of the vein structure can be noted and theorized upon. Unfortunately for the eyeball theorist, the key to the origin of Coalinga asbestos fiber is less accessible. However, Coalinga asbestos fiber is chrysotile and the theories of the origin of chrysotile must, with some modifications, apply. The authors offer the following generalization for consideration.



Asbestos mine and mill of Coalinga Asbestos Company Inc., located in upper Pine Canyon.

After a low temperature serpentinization of the original dunite-peridotite mass, the ultrabasic continued to be thrust upward in the manner of a "cold" intrusion. Shearing and faulting were the natural companions of this process. During this period of stress a second wave of low temperature serpentinization took place in what is now the southeast one-third of the mass. Solutions from the surrounding sediments again entered the ultrabasic body following zones where pressure was relieved by shearing. This second wave of serpentinization, coupled with synchronous stresses, is offered as the reason for the local crystalization of serpentine as chrysotile.

Favourable areas for the occurrence of chrysotile fiber within the southeastern portion of the New Idria ultrabasic are thought to be as follows:

a. Along the contacts of the ultrabasic with the surrounding sediments.
b. Northwest regional trending shear zones within the ultrabasic.
c. Secondary shear zones within the ultrabasic cutting across the strike of the regional structure.
d. The intersection of any of the above structures.

Further exploration in the Coalinga area has revealed the existence of other fiber-bearing serpentines similar in nature to the New Idria intrusion. The presence of these bodies argues for the existence of a short-fiber "genetic province" in the Diablo Range. The only occurrence, known to the authors, outside of California is at the Stragari Mine in Yugoslavia.

Exploration Program

The exploration program of Coalinga Asbestos Company was formulated to provide information on the ultrabasic intrusive, and to outline ore bodies of commercial grade where a cutoff point of 20 per cent fiber recovery was tentatively selected.

The program was carried out during the summer of 1960 and the winter of 1960-1961; and consisted of geological mapping, trenching and sampling, drilling, a magnetic survey, and the stripping of areas proposed for mining.

Geological Mapping

The ultrabasic rock of this area is readily identified in outcrop. Brown-weathered serpentine boulders and fragments are to be found on the surface. Bluish-gray areas of fresher serpentine are also encountered. On the top of ridges careful examination can reveal platy particles in the soil mantle, and sometimes aggregations of cemented fiber plates are found on the surface. These aggregated bodies may range in size from a fraction of an

inch to massive outcrops and consist of fiber plates cemented with carbonate and possibly silicate.

High cost of transportation and the time required to make milling analyses of fiber samples made it necessary to develop a visual fiber grading procedure classifying ore into good, medium, poor, and waste categories. This procedure was not developed to a high degree of accuracy.

Surface mapping of the ultrabasic-sedimentary contact and other geological features outlined areas for more detailed exploration.

Trenching and Sampling

Favourable fiber areas were trenched using a dozer. The soil mantle is very thin, and usually at a depth of one to six feet weathered ore was exposed. Serpentine boulders are weathered to a depth of about ten to twenty feet. Organic material and weathering stains often extended to similar depths so that in obtaining samples for test purposes, it was desirable to obtain material from as great a depth as possible.

Over 200 tons of Coalinga asbestos fiber ore was mined from sample pits, shipped to Asbestos, Quebec, and milled in the Johns-Manville Mill at that location. These samples were analyzed for fiber recovery, colour, absorptivity, and milling properties. The fiber recovered from the samples was used in floor tile production tests.

Drilling

In drilling this property certain problems had to be overcome. The material could not be economically cored and the high moisture content of the rock made the success of a rotary air drill seem doubtful. The following drilling procedure was considered satisfactory.

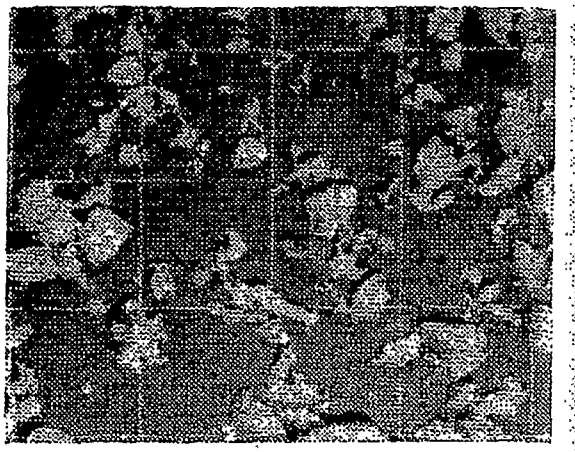
A truck mounted auger drill with an auxiliary air compressor was used to drill 4 inch diameter holes to a maximum depth of about 100 feet. A tricone rock bit was adapted for interchangeable use with the auger's drag bit. This rotary bit on the end of the auger drill rods, used with the air compressor, permitted the hole to be continued through boulders. It proved desirable to use compressed air at all times during drilling to facilitate the removal of cuttings from the hole and reduce the time lag of samples arriving at the surface. Mill analyses of samples were made and areas of specific interest were drilled on a grid. Most drill holes were found to develop standing water at a depth of 40 feet or so within one or two days after drilling.

Magnetic Survey

The vertical intensity magnetometer, always an important tool in the exploration of ultrabasic rocks, was used to locate possible ore zones. A magnetic survey of a small area shows various rock units to have relative values in the following ranges:

Sediments, 800 gammas;

Landslide materials, 800 to 1,000 gammas;



Typical asbestos ore mined—grid equals one inch.

Ore zones, 1,500 to 2,500 gammas;

Boulder zones, erratic readings up to 6,000 gammas.

These results demonstrate that magnetic surveys have a place in the exploration for Coalinga asbestos fiber ore bodies.

Exploration Results

The results of the exploration program can be summarized:

a. Large volumes of fiber-bearing material are present in the area explored, however, only portions meet present grade specifications.
b. Landslide material is not generally of ore grade, but slump blocks, which have moved short distances within the ultrabasic, may be very high grade.
c. Weathering stains continue to depths of twenty feet generally, and occasionally deeper.
d. The grade of ore is highly variable over short distances.
e. Where ore is in place, there was no sign of bottoming within the range of 40-foot to 100-foot drill holes.
f. The magnetometer is a useful tool for the outlining of target zones.
g. The ore is usually saturated with water at depths greater than 40 feet.

These exploration methods outlined three areas where ore grade material was indicated to be present in considerable volume. These zones are related to the sedimentary-ultrabasic contact or to shear zones within the ultrabasic and are located in sections 27, 33, and 34, T18S, R13E, M.D.M.

Mining and Milling Operations

The soft nature of the ore material permits simple mining and milling operations. A bulldozer removes surface materials and weathered ore, leaving benched faces of fresh ore and a working place accessible to trucks.

A front-end loader mines ore from the face and loads directly into a waiting truck. The front-end loader can perform the secondary functions of segregating the larger boulders, and stockpiling and windrowing ore for partial sun-drying.

Ore is trucked downhill a distance of about a mile to the millsite in Upper Pine Canyon.

From wet-rock storage, ore passes through a trommel screen designed to remove most of the solid serpentine particles and is then conveyed to a rotary dryer. Dry ore passes over a single deck scalping screen to dry-rock storage.

The milling of dry ore is accomplished by the use of hammer mills and grinders, the products of which are screened, under-sized material being sent to tailings. The fibrous product is collected in an air separator and packed in 100-lb. bags.

At this time the mill is designed to produce 12,000 tons of fiber annually.

At present, the Coalinga Asbestos Company mill is producing two grades of fiber. The second or Blue Brand is a product that is designed for customers whose specifications call for a fiber similar to a good quality Canadian Group 7 fiber. The first or Red Brand fiber is produced for customers who can fully utilize the superior qualities of whiteness and absorptivity possible in Coalinga type asbestos fiber.

Characteristics of Coalinga Asbestos Fiber

Research on Coalinga type asbestos fiber by Johns-Manville has revealed much about the nature of this new fiber product.

Chemically, this fiber is a hydrous magnesium silicate to all purposes identical in chemical composition to Canadian chrysotile.

Petrographic analysis of milled fiber shows a typical Canadian fiber to consist of chrysotile fibers, singly and in prills, with traces of magnetite, brucite, mica, and dolomite. Petrographic analysis of Coalinga asbestos fiber shows chrysotile fibers, singly and randomly orientated in mats, with traces of magnetite, brucite, and dolomite.

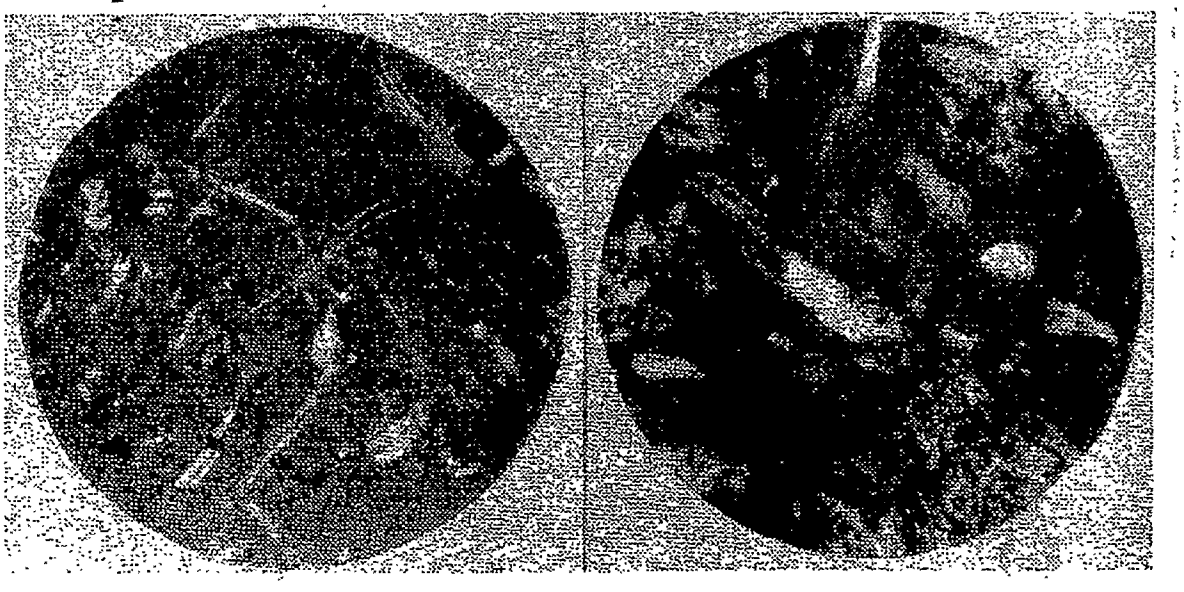
X-ray diffraction analysis shows similar patterns for both Coalinga fiber and Canadian Group 7 fiber.

By dry screen analysis, this fiber is shown to be comparable to Canadian Group 7. However McNett wet screening analysis shows that the minus 200 mesh fraction is substantially less and the plus 100 mesh fraction is considerably greater than the corresponding Canadian Group 7.

The ability of short fibers to absorb hydrocarbons is important to manufacturers. As a measure of this quality several standard tests are used to measure the ability of fiber to absorb kerosene. In these tests, Coalinga fiber showed a substantially higher kerosene absorption factor than the comparable Canadian Group 7 grade. Surface area is also a measure of absorptivity and Coalinga fiber shows a higher relative surface area in square centimeters per gram by the Blaine-Dyckerhoff test.

A comparative test of color by standard testing methods shows that this new fiber is considerably lighter in color than other Group 7 grades. This increased whiteness results in decreased costs for whitening pigments in the manufacture of light coloured floor tiles, as well as other products.

The results of these tests are important in emphasizing the efficiency of Coalinga fiber and in demonstrating its ability to compete with Canadian Group 7 asbestos.



Photomicrographs. (left) typical Canadian Group 7 chrysotile fiber. (Right) Coalinga type chrysotile fiber, magnification approximately 62.5X.

Actual manufacture of floor tile in Johns-Manville plants has borne out this efficiency. Canadian fibers have been replaced in equivalent tile formulations with one-third to one-half the standard amount of Coalinga fiber, the balance being made up with a less expensive limestone filler and resulting in an equivalent quality floor tile.

A typical Canadian Group 7 fiber sells for $41 per ton and costs about $30 per ton to ship to the West Coast. Costs of over $70 per ton are incurred by West Coast customers.

Coalinga asbestos fiber is presently produced in two grades. The second grade is designed to compete directly with the Canadian fibers.

In the light of the fiber's advantages and high substitution value, Coalinga asbestos fiber's position in the market appears excellent. With economic and physical advantages in the present market and new uses a distinct possibility, the future of California's new asbestos industry looks bright. ●

Acknowledgements

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Symposium on Canadian Exploration

A feature of the March, 1962 Annual Meeting of the Prospectors and Developers Association which attracted the interest of the entire attendance. Chairmen were C. C. Huston and J. A. Sadler. Discussed by the thirteen panelists in turn were the roles of the prospector, geologist, mining engineer, geophysicist, lawyer and the law, and the mining company.

THE PROSPECTOR — By H. H. Heustis, President Bethlehem Copper Corp.

AS A PROSPECTOR and mine developer who has concentrated most of his activities in the West, I will confine my observations on prospecting to that section of Canada.

It is my firm belief that the prospector is now more important than at any other time in the history of Canadian mining.

Most of the easily located outcroppings of mineral such as were discovered at the turn of the century were easily prospected by the oldtimers in their search through the woods and hills. Today, outcroppings of mineral are more difficult to uncover and the problems of finding them have become more complex. However, the modern prospector, possessing a far superior knowledge of mineralogy, geology and general prospecting techniques than his forefather, is proving himself to be the most efficient and most successful "tool" for the discovery of new mines. I am confident this situation will continue for many years to come.

I think it is obvious to all of us that there is no simple method of finding mines . . . no great scientific invention that is a "cure-all" for the problems of mineral exploration. Mines are still found by mixing the ingredients of hard work, sweat, curiosity, ambition, determination, and luck, backed by the maximum amount of native intelligence and knowledge. In spite of what I believe to be an excess of propaganda to the contrary, our mines generally are not found by machines . . . they are found by men.