PLAINTIFF'S EXHIBIT

UC-2560

INTRODUCTION

During an investigation of nickeliferous laterites in the western part of the country, Mr. J. H. Bright, of our Exploration Department, examined a large number of weathered serpentinite bodies in California, Washington and Oregon. Late in 1957 he visited a number of asbestos occurrences within the highly altered New Idria serpentinite, located on the county line between Fresno and San Benito Counties, about 35 miles northwest of Coalinga, California. Although little nickel was detected in the samples from these occurrences, considerable interest was aroused in the large tonnages of soft, friable, light-colored asbestos material which was apparently present throughout the area. The asbestos-like character of this material had been known for many years, but little commercial interest had been generated by any of the several companies who had examined the ore, since it was not the typical cross-fiber type of material generally used in the asbestos industry. In recent years many of the higher-grade areas had been claimed by small, independent groups, such as the Condor syndicate, although large expanses of good ore were still available in 1958.

The early reports to this company indicated that the New Idria material was either antigorite or mountain leather, neither of which was currently being used in the asbestos industry. Although the California Division of Mines reported a deposit of chrysotile in the Condor Pit area of the mass (Anonymous, 1957), it was not until January of 1959 that this company was fully aware that chrysotile was the major phase of the ore; a realization that led to futher speculation that important commercial uses might be found. Prior to this, throughout 1958, the possibility of acquiring the mining rights to these deposits was considered, and a general evaluation of the asbestos requirements of potential West Coast comsumers was undertaken. During this period numerous claims by other groups were filed on land adjoining the Condor Syndicate property, and small-scale mining was carried out by one. Late in 1958 and during the spring of 1959, this company obtained the mining rights to the Condor Syndicate property and entered into a large-scale program of claiming and property evaluation by means of bulldozer trenching and bucket drilling.

By this time the town of Coalinga had become a center of asbestos exploration activities and the asbestos occurrences of the New Idria serpentinite became known as the Coalinga asbestos deposits. Several large companies, including Johns-Manville, Kern County Land, Atlas Corporation, and Asbestos Corporation of America, were attracted to the area and were successful in obtaining small parcels of property, as did a number of independent groups. By the end of 1959, Union Carbide Corporation had acquired the mining rights to more than two hundred claims on what appeared to be the choicest asbestos ore. An equal number of claims was also held by other interests, although many of these were on only marginable ore (Merrit, 1962; Rice, 1963). During this period, several hundred drill-core samples were taken to evaluate our property and were shipped to the Sterling Forest Research Center, and to other laboratories, for evaluation and preliminary development work.

From the middle of 1959 to the end of 1960 an asbestos development program was carried out by the Sterling Forest group with initial objectives of:

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(a) determining the amount and grade of the asbestos ore available on our Coalinga property, (b) developing a commercial milling procedure for the Coalinga ore, and (c) demonstrating the utility of the refined asbestos in such products as asbestos wallboard, asbestos-cement shingles, and asbestos and vinyl floor tile. Emphasis was placed on demonstrating that the Coalinga asbestos was identical to the very short, Grade 7 fiber from the Canadian deposits, in such applications. Similarly, all of the refining procedures were based upon the tried and true, dry-lifting methods employed throughout the asbestos industry. In general, these programs were quite successful, and by the middle of 1960 it was known that multimillion tonnages of usable asbestos ore were present on the property controlled by the company, and that standard dry-lifting milling techniques could be used. Sales and development efforts had shown that the refined Coalinga fiber was well suited for many floor-tile applications, potentially the largest outlet for the material (Jordan and Reichard, 1962). In this respect, however, our Coalinga asbestos would have to compete directly, not only with several of the short-fiber grades from the Canadian producers, but also with refined asbestos produced by several other companies from the Coalinga asbestos deposit itself.

Consequently, without a distinct advantage in either applications or in milling, major appropriations to expand the company's interest in Coalinga asbestos were not authorized at that time. Instead, the company was encouraged to develop new and proprietary uses. Thus, product development work was continued aimed primarily at introducing the Coalinga asbestos into various types of building materials, including asbestos-phosphate boards and panels, and phenolic resin-asbestos formulations.

In the fall of 1961, a series of experiments based on chemical-dispersion techniques (from the literature) indicated that a highly purified asbestos product could be prepared from the Coalinga ore. Chemically dispersed asbestos possessed several favorable properties, such as high brightness, low bulk density, and low magnetite content, which suggested that it could be used where ordinary short-fiber asbestos failed. Simultaneously, wet-processing techniques, involving the use of screens, jigs, and shaking tables, were also investigated and found to be highly successful. Products prepared in this manner proved to be applicable to an entirely new spectrum of uses in the paper industry, in water clarification, and in other specialized applications; consequently, a second major effort on the development of large-scale, wet-processing methods for the Coalinga ore, and of industrial applications for highly refined asbestos, was undertaken (Woolery, 1963).

In the spring of 1962, a research project was initiated on the mineralogy of the Coalinga asbestos deposit, with three main objectives: (a) the determination of the physical and chemical properties of the bulk asbestos ore and of the constituent mineral phases; (b) a knowledge of the distribution of minerals within the over-all asbestos deposit and the surrounding serpentinite body; and (c) the distribution of the asbestos minerals, and of the gangue phases, during the milling and refining processes. Since any project involving an industrial mineral is, by definition, concerned with the origin, distribution, and separation of mineral phases, rather than the extraction and isolation of particular elements, a mineralogical study of the original ore and of the products derived therefrom was an essential part of the program. Many of the objectives of the mineralogical study have been accomplished, and the general mineralogy of the Coalinga asbestos deposit is now well known.

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SURVEY OF ASBESTOS NOMENCLATURE, OCCURRENCE AND PRODUCTION

NOMENCLATURE

The term "asbestos" is derived from the Greek word ασβεστος meaning incombustible, and was originally applied to the monoclinic amphiboles, tremolite and actinolite, when they occurred as fine, silky fibers. Today, asbestos is a commercial term for a group of fibrous silicate minerals that are not only fire-proof, but also can be processed into flexible fibers of various lengths and widths. Six different mineral species have been classified as "asbestos" minerals: chrysotile, amosite, anthophyllite, crocidolite, actinolite and tremolite, with chrysotile accounting for more than 95% of the world's production. Each of the six however, is different chemically, and possesses distinctive physical properties that make it useful in particular industrial applications. A comparison of these physical properties is shown in Table I.

OCCURRENCE AND PRODUCTION

In almost all of the world's commercial deposits, chrysotile asbestos occurs in cross-fiber or slip-fiber veins within large masses of serpentinite rock. Serpentinite, by definition, is a fine-grained rock composed almost entirely of minerals of the serpentine group, formed by the alteration of pre-existing peridotites and dunites. During serpentinization, cracks formed by the differential expansion of the original rock were filled with chrysotile oriented perpendicular to the vein walls. In some places chrysotile veinlets occur along faults or slips within the serpentine and contain fibers oriented parallel to the veins. Such material is called slip-fiber chrysotile and is generally longer than cross-fiber material, although the fiber strength is somewhat less. Most of the world's serpentinite bodies contain appreciable amounts of cross-fiber chrysotile veins, varying from microscopic thickness size to almost six inches. The quantity and length of the separable fibers, however, are usually small and the commercial exploitation of most bodies is uneconomical.

Chrysotile asbestos has also been mined from serpentinite lenses within dolomitic limestones, where the limestones have been altered by intruding ultrabasic rocks. From deposits of this type, longer fibers of chrysotile can generally be obtained that are also unusually free of magnetite. The size of these bodies, however, is quite small and the total producation from such occurrences is limited.

Most of the world's production of asbestos comes from Canada, near Thetford, Quebec; although significant quantities are also produced from the Cassiar deposit in British Columbia and from deposits in western Ontario. In 1963, Canada produced over 1.2 million tons of asbestos. Similar deposits in Russia now yield over one million tons of chrysotile per year and may exceed that quantity in the future. The United States asbestos production, prior to 1962, was limited to a single area in northern Vermont, environmentally similar to the near-by Canadian deposits, and totalled only about 40,000 tons per year. In 1963, however, due to the newly developed deposits at Copperopolis and Coalinga, California, 66,000 tons of asbestos were produced, with several times this output predicted within the next five years.

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The remaining five asbestos minerals mentioned above are all amphibole minerals, however, only anthophyllite, amosite and crocidolite have any current commercial significance. In 1963, 77,000 tons of amosite were produced from the Transvaal and 87,000, 15,000, and 11,000 tons of crocidolite from the Republic of South Africa, Australia, and Transvaal, respectively. Only minor quantities of anthophyllite have been mined from North Carolina sources in recent years. These species are considerably coarser and more brittle than chrysotile, and consequently are less desirable for textile applications. Anthophyllite is also an alteration product of peridotite, and occurs as either slip-fiber, or as massive, unoriented bundles of short fibers. Despite its poor spinnability, it finds application where high-acid resistance is desired. Crocidolite, also known as Cape Blue or Australian Blue asbestos, is highly prized as long-fiber and high strength material, selling for as much as $300 - $600 per ton. It occurs as cross-fiber veins in highly metamorphosed, banded siliceous ironstones, and retains its deep blue color throughout processing. Amosite is a yellow-gray to white variety of crocidolite and has been found only in the Transvaal in essentially the same geologic environments as crocidolite. Amosite fibers are unusually long (up to 11 inches) and are harsher and slightly weaker than chrysotile. (See Table I)

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TABLE I. PHYSICAL PROPERTIES OF ASBESTOS MINERALS

PROPERTY	CHRYSOTILE	ANTHOPHYLLITE	CROCIDOLITE	ACTINOLITE	TREMOLITE	AMOSITE
Composition	$Mg_3Si_2O_5(OH)_4$	$Mg_7Si_8O_{22}(OH)_2$	$Na_2Fe_3Fe_2Si_8O_{22}(OH)_2$	$Ca_2Fe_5Si_8O_{22}(OH)_2$	$Mg_5Ca_2Si_8O_{22}(OH)_2$	$(Fe,Mg)_7Si_8O_{22}(OH)_2$
Crystal Habit	Fine, thin, easily separable fibers	Prismatic crystals and fibers	Long brittle fibers	Prismatic crystals and fibers	Prismatic crystals and fibers	Prismatic crystals and fibers
Color	White, gray, greenish	Gray-white	Blue	Green	White, gray-white, greenish	Ash gray or brown
Luster	Silky	Vitreous to pearly	Silky to dull	Silky	Silky	Vitreous to pearly
Occurrence	Altered ultrabasics and intruded limestone	Crystalline schists and gneisses	Fe-rich, argillaceous schists	Metamorphosed limestones and crystalline schists	Metamorphosed limestones and Mg-rich rocks	Crystalline schists
Veining	Cross-fiber, Slip-fiber, Massive fiber	Slip-fiber Massive fiber	Cross-fiber	Slip-fiber Massive fiber	Slip-fiber Massive fiber	Cross-fiber
Hardness	2.5-4	5.5-6	4	6	5.5	5.5-6
Specific Gravity	2.4-2.6	2.8-3.1	3.2-3.3	3.0-3.2	2.9-3.2	3.1-3.3
Refractive Index (mean)	1.51-1.55	1.61	1.7	1.63	1.61	1.64
Texture	Soft to harsh also silky	Harsh	Soft to harsh	Harsh	Harsh	Harsh
Tensile Strength (psi)	80,000-100,000	< 4000	100,000-300,000	< 1000	1000-8000	16,00-90,000

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TABLE I. PHYSICAL PROPERTIES OF ASBESTOS MINERALS (Cont'd)

PROPERTY	CHRYSOTILE	ANTHOPHYLLITE	CROCIDOLITE	ACTINOLITE	TREMOLITE	AMOSITE
Electric Charge	Positive	Negative	Negative	Negative	Negative	Negative
Resistance to acids and alkalis	Poor	Very good	Good	Fair	Good	Good
Flexibility	Very good	Poor	Good	Poor	Poor	Good
Impurities usually encountered	Magnetite, chromite, calcite	Magnetite	Magnetite	Calcite	Calcite	Magnetite

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