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DESERT MINERALS, INC.

DEFINITIONS ASBESTOS & TALC MINERALS

Segregated September 9, 1971

Definitions from "Industrial Minerals and Rocks" - Third Edition A.I.M.E. 1960 by Seeley W. Mudd Series.

ASBESTOS (Pages 23 to 53)

Broad term for a number of fibrous mineral silicates. Incombustible and can be separated by mechanical means into fibres of various lengths and thicknesses but differing in chemical and other properties. Six varieties:

1. CHRYSOTILE - finely fibrous form of serpentine.

--- and five minerals of the AMPHIBOLE group:

2. AMOSITE - not fully recognized as a mineral but accepted in asbestos terminology.

3. ANTHOPHYLLITE

4. CROCIDOLITE

5. TREMOLITE

6. ACTINOLITE

CHRYSOTILE

Chrysotile is the result of hydrothermal reactions within the serpentine rock whether it be peridotite, dunite, pyroxenite of serpentinized dolomitic limestone. It is the most highly fibrous of asbestos minerals and is the grade most generally used in asbestos cements, insulation, gaskets, etc. None of the minerals from which asbestos is derived appear to be among those associated with talc. The fibres may be easily separated and can be spun or woven.

CROCIDOLITE and AMOSITE

Crocidolite and Amosite occur in metamorphosed siliceous-ferruginous sediments, again not common with talc.

ANTHOPHYLLITE and TREMOLITE

Both have a low ignition loss. Anthophyllite is similar to tremolite except it is a magnesium, ferro silicate whereas tremolite is a calcium magnesium silicate. Anthophyllite has a laminar fibrous "asbestiform" structure whereas tremolite consists of long, prismatic and fibrous aggregates. Neither is possessed of fibres sufficiently flexible to be spun nor with tensile strength required to make them valuable in asbestos cements. Both are known to be present in some talcs or associated with them.

CHRYSOTILE

Chrysotile constitutes about 93% of the current world production of asbestos, almost all of which is derived from lost rocks which are ultrabasic in composition, the balance being derived from serpentized dolomitic limestone. Approximately 5.4% of the world production is from amosite and crocodolite. Tremolite and anthophyllite account for only 1.6% of the world production, mostly for filler use.

Production of the Amphibole varieties of asbestos, other than amosite and crocidolite is comparatively limited. In the United States the production of anthophyllite has been on the decrease with principal production being in North Carolina.

See attached tables for detailed types of asbestos.

CONCLUSIONS

Chrysotile is almost entirely used for its fibre structure. It is the most dangerous when breathed. Tremolite is an almost negligible type industrially.

TALC and SOAPSTONE (Pages 835 to 850)

Talc, the mineral, is a hydrous magnesium silicate with a suggested theoretical formula $H_2Mg_3(SiO_3)_4$ or $H_2O.3MgO.4SiO_2$, which postulates 63.5% SiO_2, 31.7% MgO, and 4.8% H_2O.

Industrial talcs do not approach above composition but are "mixtures of silicates that contain appreciable proportions of magnesia." Other minerals common in industrial talc are serpentine, chlorites, TREMOLITE, ANTHOPHYLLITE, diopside, and quartz. The carbonates are also present --- calcite, dolomite, and magnesite.

Some of these minerals have a pronounced effect on the properties of the talc. Some are highly desirable for a specific use. "An example of this type is the highly desirable tremolitic 'talc' mined in New York state and California and ideally suited for use in some paints and ceramics." Much of this type of talc contains 50% or more of TREMOLITE.

STEATITE TALC

Massive talc-rich material and refers to an especially pure talc that contains no more than 1.5% CaO, 1.5% combined FeO and Fe_2O_3, or 4% Al_2O_3.

Pure [illegible] as a hardness of 1.0 to 1.5, is relatively inert and remains undecomposed in contact with acids.

Most talc and soapstone deposits occur in altered ultrabasic igneous rocks and in metamorphosed dolomitic limestones. (Page 837 - Occurrence and Distribution).

Most deposits are localized along shear and shatter zones in a nearby static environment. On the other hand, in the SILVER LAKE district of California and at GOUVERNEUR, New York zones of talc schist, intimately associated with massive bodies of tremolitic rock appear to have been formed during strong rock deformation.

TALC and SOAPSTONE (continued)

Especially productive and high grade talc deposits formed by the alteration of magnesium carbonate sedimentary rocks, occur in Northern New York, Eastern California, and Montana.

The New York deposits near Gouverneur, New York, consists of "fibrous talc" composed largely of tremolite, anthophyllite, serpentine, and talc.

In the region of Southern Death Valley and the Kingston Mountains talc deposits are composed of fine-grained tremolite and the mineral talc in both foliated and massive varieties.

Talc deposits in the Myo Mountains of California and the Palmetto-Oasis district in Western Nevada are of steatite and "near-steatite" variety. Similar talcs are also produced in various sections of Montana.

Both the fibrous, semi-fibrous, and steatite varieties are used by and favored by paint, paper, plastics, rubber, roofing, insecticide, flooring, textile, composition flooring, and many other filler uses. Pharmaceuticals and cosmetics account for about 20,000 tons per year including soaps, creams, salves, rouges, and toilet powders. "Talcs for such use necessarily must be free of grit, of excellent color, and of small particle size."

E.J.E.

Attachments

TABLE 1—Properties of Asbestos Fibers

Property	Actinolite	Amosite	Anthophyllite	Chrysotile	Crocidolite	Tremolite
Structure	Reticulated long prismatic crystals and fibers	Lamellar. Coarse to fine fibrous and asbestiform	Lamellar. Fibrous asbestiform	Usually highly fibrous fibers fine and easily separable	Fibrous in iron-stones	Long. Prismatic and fibrous aggregates
Mineral association	In limestone and in crystalline schists	In crystalline schists, etc.	In crystalline schists and gneisses	In altered peridotite adjacent to serpentine and limestone near contact with basic igneous rocks	Iron rich siliceous argillite in quartzose schists	In Mg limestones as alteration products of highly magnesian rocks. Metamorphic and igneous rocks
Origin	Results of contact metamorphism	Metamorphic	Metamorphic. Usually from olivine	Alteration and metamorphism of basic igneous rocks rich in magnesian silicates	Regional metamorphism	Metamorphic
Veining	Slip or mass fiber	Cross fiber	Slip. Mass fiber unoriented and interlacing	Cross and slip fibers	Cross fiber	Slip or mass fiber
Essential composition	Ca.Mg.Fe. Silicate water up to 5 pct	Silicate of Fe and Mg higher iron than anthophyllite	Mg silicate with iron	Hydrosilicate of magnesium	Silicate of Na and Fe with some water	Ca and Mg silicate with some water
Theoretical formula	$Ca(Mg,Fe)_3(SiO_3)_4 \times H_2O$	$(Fe,Mg)SiO_3$. 1–5 pct H_2O	$(Mg,Fe)_7Si_8O_{22}(OH)_2$	$3MgO.2SiO_2.2H_2O$	$NaFe(SiO_3)_2.FeSiO_3 \times H_2O$	$Ca_2Mg_5Si_8O_{22}(OH)_2$
Crystal structure	Long and thin columnar to fibrous	Prismatic. Lamellar to fibrous	Prismatic. Lamellar to fibrous	Fibrous and asbestiform	Fibrous	Long and thin columnar to fibrous
Crystal system	Monoclinic	Monoclinic	Orthorhombic	Monoclinic (pseudo-orthorhombic?)	Monoclinic	Monoclinic
Color	Greenish	Ash gray or brown	Grayish white. Brown-gray or green	White. Gray. Green. Yellowish	Lavender-blue. Metallic-blue	Gray-white. Greenish. Yellowish. Bluish
Luster	Silky	Vitreous. Somewhat pearly	Vitreous to pearly	Silky	Silky to dull	Silky
Hardness	6±	5.5–6.0	5.5–6.0	2.5–4.0	4	5.5
Specific gravity	3.0–3.2	3.1–3.25	2.85–3.1	2.4–2.6	3.2–3.3	2.9–3.2
Cleavage	110 perfect	110 perfect	110 perfect	010 perfect	110 perfect	110 perfect
Optical properties	Biaxial negative extinction inclined	Biaxial and positive extinction parallel	Biaxial positive extinction parallel	Biaxial positive extinction parallel	Biaxial ± extinction inclined	Biaxial negative extinction inclined
Refractive index	1.63 ± weakly pleochroic	1.64±	1.61±	1.51–1.55	1.7 pleochroic	1.61±
Length	Short to long	2" to 11" varies	Short	Short to long	Short to long	Short to long
Texture	Harsh	Coarse but somewhat pliable	Harsh	Soft to harsh. Also silky	Soft to harsh	Generally harsh. Sometimes soft

1 lb. ea.

$1.20/lb. $4.25/lb. $1.40 $3.75 $4.25 $1.20

TABLE 1—Properties of *Asbestos Fibers* (Continued)

Property	Actinolite	Amosite	Anthophyllite	Chrysotile	Crocidolite	Tremolite
Specific heat B.t.u./lb/°F	0.217	0.193	0.210	0.266	0.201	0.212
Tensile strength, lb/sq in.	1,000 and less	16,000 90,000	4,000 and less	80,000 100,000	100,000 300,000	1,000 8,000
Temp. at max. ignition loss, °F	—	1,600 to 1,800	1,800	1,800	1,200	1,800
Filtration properties	Medium	Fast	Medium	Slow	Fast	Medium
Electric charge	Neg.	Neg.	Neg.	Pos.	Neg.	Neg.
Fusion point, °F	2,540	2,550	2,675	2,770	2,180	2,400
Spinnability	Poor	Fair	Poor	Very good	Fair	Poor
Resistance to acids and alkalies	Fair	Good	Very good	Poor	Good	Good
Magnetite content	—	0	0	0–5.2	3.0–5.9	0
Mineral impurities present	Lime, iron	Iron	Iron	Iron, chrome, nickel, lime	Iron	Lime
Flexibility	Poor	Good	Poor	High	Good	Poor
Resistance to heat	—	Good. Brittle at high temp.	Very good	Good. Brittle at high temp.	Poor, fuses	Fair to good
Ionizable salts, micro-mhos (Relative elec. conductance)	—	1.34	0.58	1.82	0.84	—

Glossary of Terms;
A Dictionary of Mining, Mineral, and Related Terms
U.S. Dept. of the Interior - Bureau of Mines
1968

Separated 8-3-71

ACTINOLITE $Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$

a natural hydrous - Calcium - Magnesium - iron Silicate
Green color; monoclinic; luster vitreous to silky;
fibrous to granular; fibres brittle, Mohs hardness 5;
Specific gravity 2.9 to 3.1. Used as a Mineral
Asbestos Mineral and in building; an Amphibole

AMPHIBOLE $A_{2-3}B_5(Si,Al)_8O_{22}(OH)_2$

A Mineral Group

Where A is mainly Mg Fe, Ca & Na; B is mainly Mg Fe, Ca & Na; B is mainly Mg, Fe, Al, & Fe. Common in rock forming Minerals, most importantly ANTHOPHYLLITE ORTHORHOMBIC; the Cummingtonite - grunerite series monoclinic; the glaucophane, riebeckite series Monoclinic; the tremolite - actinolite series, the hornblende, & crocidolite.

ANTHOPHYLLITE $(Mg,Fe)_7Si_8O_{22}(OH)_2$

A clove brown orthorhombic amphibole;
usually massive and normally occurring in Magnesium and iron — a variety of Asbestos

Mineral Definitions — 2 — 8-3-71

ASBESTINE

A silicate of magnesium much used in paint. Also marketed as "French Chalk" and talc. Origin: G. Of, pertaining to, or having the characteristics of asbestos. Incombustible.

ASBESTOS (CHRYSOTILE): $3MgO.2SiO_2.2H_2O$

A name applied to a group of naturally fibrous minerals. The principal variety is CHRYSOTILE, a hydrous magnesium silicate. Other commercial kinds are AMOSITE, a complex iron-magnesium silicate and CROCIDOLITE, a sodium-iron hydrous silicate. Of minor importance are tremolite and anthophyllite. Chrysotile is the principal variety of commerce.

ASBESTOSIS A lung disease caused by breathing asbestos dust.

ASBESTOS MINERALS

Certain minerals which have a fibrous structure, are heat resistant, chemically inert and possessing high electric insulating qualities and are of commercial flexibility to be woven. Main groups, the serpentines and amphiboles. Asbestos proper is actinolite. Chrysotile is fibrous serpentine. Amosite is is fibrous anthophyllite. Crocidolite is fibrous soda-amphibole.

SOAPSTONE.

Is used broadly by miners + others, any soft impure rock, such as micaceous shale or sericite schist. Also as Talc, massive, Magnesium silicate. Pearly, greasy feel. Mohs 1. Specific gravity 2.7 to 2.8.

STEATITE $Mg_3Si_4O_{10}(OH)_2$

Massive form of the mineral TALC.
Uses in Ceramics to be detailed.

TALC, STEATITE $Mg_3(Si_4O_{10})(OH)_2$

Usually occurs as a Natural alteration Magnesium silicate rocks or in metamorphosed dolomites. Compact, massive varieties may be called steatite in distinction to the foliated varieties which are called talc. Monoclinic. Color white, apple green, gray. Luster pearly or greasy. High resistance to acids, alkalis and heat. Mohs hardness 1 to 1.5. Specific gravity 2.7 to 2.8.

CRMC-HT-TALC-000122

TREMOLITE $Ca_2Mg_5(Si_8O_{22})(OH)_2$

An Amphibole. Monoclinic - Usually gray or white. Occurs in bladed crystals or fibrous aggregates associated with Metamorphic rocks.