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Barry Castleman Comments - In English, it has a section on talc in cosmetics starting at p. 25. On 27-28, it is noted that health departments accept hard silicates (tremolites, chrysotiles) at traces level. On 28, it is noted that many talcs have hard silicates (tremolites, chrysotiles, etc.) and that Pinerolo (SVC) talc has hard silicate contents "extremely low (only traces).

Società Talco e Grafite Val Chisone

PRACTICAL GUIDE TO THE RECOGNITION OF IMPURITIES IN TALC

IMPURITIES PRESENT IN TALC

The harmful elements according to pharmacopoeias and cosmetics

USE OF TALCS OF PINEROLO IN PHARMACEUTIC - COSMETIC SECTOR

REMARKS ON THE GRINDING OF THE TALC

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summary

PRATICAL GUIDE
TO THE RECOGNITION
OF IMPURITIES IN TALC

PRESENCE AND DIFFERENTIATION OF ACICULAR, FIBROUS AND FASCICULAR CRYSTALLINE FORMS IN TALCS

Recent regulations state that for cosmetical or pharmaceutical use a talc must be free from acicular and fibrous particles, of amphibolic or serpentine type, i. e. free from serpentine amianthus or asbestos or at least, if present, it must be in a minimum quantity.

It is first of all necessary to give an exact interpretation of the terms mentioned: amianthus, asbestos, amphibole amianthus, serpentine amianthus, and, by inference, actinolite, tremolite and other similar crystallisations that have very varied mineralogical terminology, but can be reduced to these fundamental types.

It must be explained first that the terms amianthus and asbestos are synonyms and so indicate the same physical state: amianthus from the Greek αμιαντος means incorruptible and is the same as asbestos ασβεστος which means inextinguishable, i. e. both terms indicate that these fibres are indestructible by fire. Though they have a vegetable or animal appearance, our ancestors discovered that they could not be destroyed by fire.

Let us consider Serpentine first. According to Artini the chemical composition is as follows: $H_4 Mg_3 Si_2O_9$ i. e. $2H_2O - 3MgO - 2 SiO_2$ and in percentage $H_2O = 13\%$; $SiO_2 = 43.35\%$; $MgO = 43.65\%$. It is never crystallised in distinct forms but almost always in aggregates that sometimes have a lamellar structure and sometimes fibrous; very fine aggregates are especially common, with interwoven lamellae or fibrils that are absolutely compact to the naked eye. Hardness 3 - 4. Specific weight 2.6 - 2.7. Not very brittle. It is always a mineral of secondary origin, formed by alteration of other silicates, principally olivine. Pyroxenes too, especially rhombics, give rise to serpentine.

A variety, which is remarkable in appearance, is the fibrous variety which fills the lithoclases in rocks formed of compact serpentine. If the fissure is narrow and the fibres, normal to the walls, are fairly rigid and coarse then we have CHRYSOTILE, the colour is greenish and the silky brilliance is splendid (photograph 1).

If the fibres are white, longer often oblique to the walls of the lithoclases, flexible and soft we have the filamentous variety, called amianthus or asbestos (photographs 2 and 3).

We will now go on to the amphiboles. As far as chemical composition is concerned they are similar to pyroxenes that include a large number of silicates of magnesium, iron, calcium and sometimes even aluminium and sodium, mainly of a metasilicate type, rarely pure, and more often formed of fairly complex isomorphous mixtures. Its prevailing habit is short, thick prismatic, and the physical properties vary regularly with its composition, so that the specific weight which is = 3.1 where it is richest in magnesium reaches 3.5 where it is more ferriferous.

Amphiboles (monoclinc) can be divided into non aluminiferous and aluminiferous, the latter being the more numerous. The former are the result of an isomorphic mixture of two silicates $Mg_3\ Ca\ (SiO_3)_4$ and $Fe_3\ Ca\ (SiO_3)_4$ i. e. $(Mg, Fe)_3\ Ca\ (SiO_3)_4$. Some also contain Titanium and Manganese.

The chief varieties of amphiboles include tremolite, actinolite, nephrite, horneblende etc.

Tremolite and actinolite interest this survey in particular because of their fibrous and filamentous structure.

TREMOLITE

This is the name given to the monoclinic amphibole resulting from $Ca\ Mg_3\ (SiO_3)_4$ when it is pure or nearly pure. In percentage it is: 4 SiO_2 = 57.57%; CaO = 13.43%; 3 MgO = 29.0%. It is formed in very long bacillary crystals, mostly aggregated or fasciculated, that are white in colour (photograph 4).

ACTINOLITE

This is called also actinote and is the amphibole in which a notable quantity of $Ca\ Fe_3\ (SiO_3)_4$ is found associated with the silicate of tremolite. This mineral is also in long prisms (photograph 5), that are intercluded

or aggregated and sometimes rayed. The colour is green, greeny blue or shades up to bottle green.

Sometimes actinolite is filamentous, with fairly flexible fibres, and forms amianthus from amphibole.

CHLORITES

The chlorites present a certain similarity, morphological in particular, to micas but they differe from them essentially because they are without alkalis, the lamellae are less thin and less foliaceous and because they have a distinctly basic character. Chemically chlorites are basic silicates of aluminium, magnesium and iron, without alkalis. The hardness is always very low (unlike the micas) and the colour is always green (Greek etymology).

According to Tschermak true chlorites, or orthochlorites, are mixtures of two silicates in different proportions: serpentine and amesite.

Amesite $H_4 Mg_2 Al_2 SiO_9$ is much more basic than serpentine.

Recent research and opinions maintain that chlorites are not mixtures but form a clearly defined mineralogical group of their own, though still within the large complex of schistose rocks.

The large number of crystalline forms of chlorites are included in the group of phyllosilicates (foliaceous silicates) in which the crystal lattice comes from the superimposing of folias or strata of a definite chemical composition that are fixed in their structure by precise chemical-physical valences of the constituent elements. In this specific case the strata are formed of tetrahedrons of SiO_4 placed in a mesh of hexagonal shape and forming a lattice that stretches without limit in both surface directions.

Looking at the crystalline structure in this way we can see that there is considerable difference between chlorite and talc because the strata or folia that determine the crystallisation are different.

In talc there is a sequence of identical strata the unitary composition is as follows:

$$(OH)_2 Mg_3 (Si_2 O_5)_2$$

In chlorites, and chiefly in clinochlore, the chlorite nearest to talc, in fact it belongs to the series of talco-chlorites (Pennine, Sheridanite, Prochlorite, etc.), the crystal lattice is not so uniform; the specific folium of talc is intercalated, and sub-divided by another formed by brucite. If

we consider also the possible and frequent replacement of magnesium and silicium with iron and aluminium, the crystal structure of clinochlore or chlorite we have the following appearance in nature:

$(Mg, Al)_3 [(OH)_2 \mid Al Si_3 O_{10}]$	stratum of talc whith possible replacement by aluminium
$Mg_3 (OH)_6$	brucite stratum

As can clearly be seen from the above description, even the physical characteristics of the two minerals, talc and chlorite, are considerably different.

In the first place the hardness of chlorite is more than double that of talc and reaches from 2 - 2.5 in general, compared with talc which, being first on the scale, has a hardness of 1.

As far as specific weight is concerned there is no difference worthy of mention; chlorite also, like talc, has values that vary from 2.6 to 2.8, though in talc it is nearer 2.8 and chlorite tends towards 2.6.

As regards colour, even though the term correctly indicates the chromaticity of this mineral, it is not rare to find in nature chlorites and clinochlorites that have a white - nacreous appearance, owing to the scarsity of iron as a replacement element of Magnesium and Silicium, and which could be classified as pure talcs after a superficial examination.

The differentiation between talc and chlorite is very easy when they are examined under a microscope. First of all the unitary stratum structure of talc gives rise to very thin and soft lamellae which cannot be obtained with a heterogeneous foliated structure like that of chlorite.

In the second place there is the colour of the lamella which under the microscope is always transparent colourless for talc and tending towards a fairly definite green for chlorite.

If the minerals are observed under polarised light, the interference colours are also very different in the two mineral varieties; they are almost non-existent for talc and bright for chlorite.

The final, but not least important consideration, is the different way in which talc and chorite behave with acids and heat. Talc is insoluble in acids ,even when concentrated, whereas chlorite when subjected to a lengthy treatment, even only on steam bath, will show its high solubility.

Of course, everything we have set out here about the differentiation between talc and chlorite is very important when we are considering the use of these products for pharmaceutical and cosmetical purposes.

From the pharmaceutical point of view the greater solubility of chlorite is a highly negative factor, as is also proved by the requirements of pharmacological standards concerning the solubility of "talc" for such purposes.

In the cosmetological field the hardness of chlorite, which is double at least that of talc, makes it an element that is clearly in contrast with the need for very soft materials, such as talc, for dermatological treatment especially for infants, or for very delicate skins, or people affected by skin diseases. In fact in this case it is the solubility itself, together with the hardness, that can cause the greatest harm; since the soluble parts, the replacement elements of the recurring crystal molecule, are the very ones that are most dangerous and harmful (On this question see the booklet "Impurities present in talc - toxic elements").

STRUCTURE OF ACICULAR - FIBROUS MATERIALS UNDER THE MICROSCOPE

CHRYSOTILE

This crystallisation is examined first because, on account of its form, it is the most dangerous.

Recent research seems to show a chemical and physical differentiation between chrysotile and what we call asbestos, that is the substance that is most well-known and used for fireresistant textiles and materials.

Since here we are dealing with a mainly microscopic examination, we can say first that Chrysotile shows itself in the form of rectilineal, thin, fairly brittle needles. Furthermore it is this needle-form itself that presents the greatest dangers for the skin and for the internal mucous tissue when it is absorbed or inhaled or makes contact with internal cavities of the body.

These needles are always coloured and their chromaticity varies from pink bright red, often with shades of yellow, from which comes "criso" (χρισος) gold, the root of the name.

AMIANTHUS FIBRES

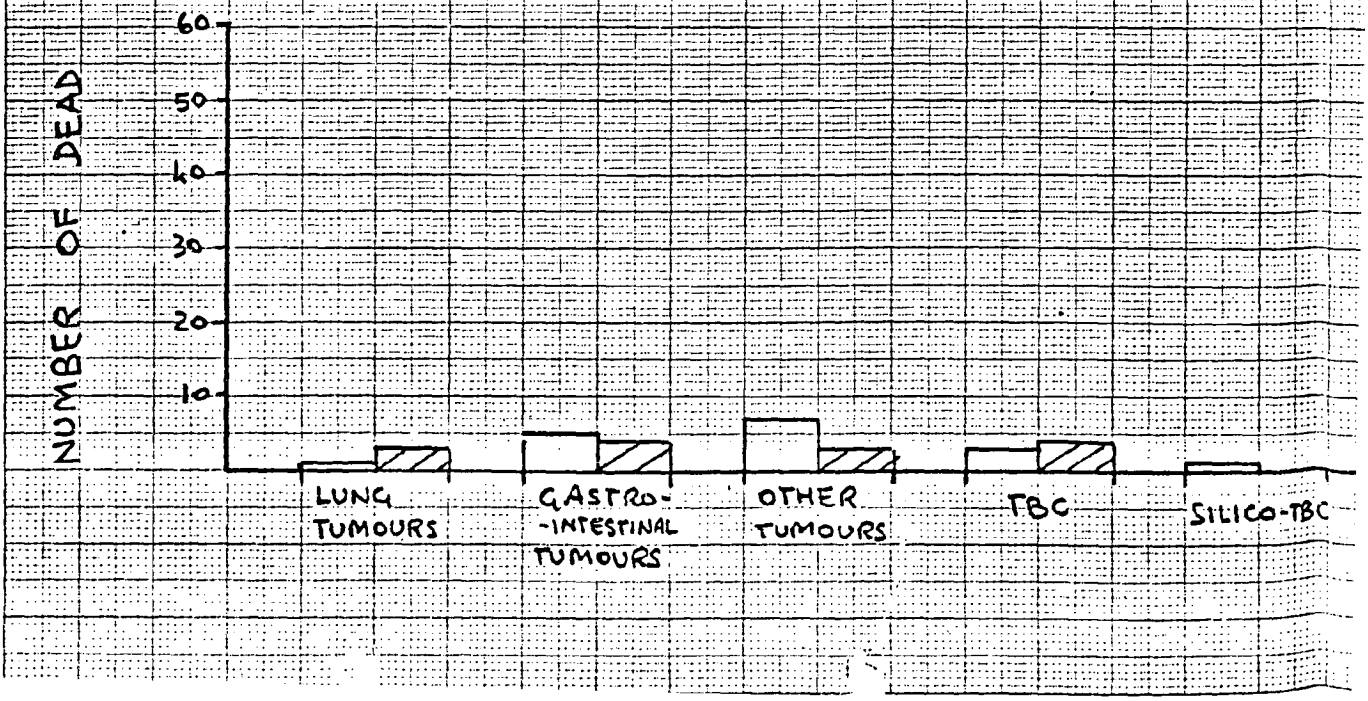
They can be of different types and colours.

The prevalent colour is a slightly pinky white, and there are also shades that go from pink to bright red, and from pale green to dark green and bottle green.

There is the short and thick form of the fibres that has rounded ends and clearly visible characteristic interlacing inside that forms a lengthened lattice within the fibre.

MILLERS : COHORT 1936 - 1950

DEATH CAUSES DISTRIBUTION



MILLERS 65

CONTROL SAMPLE 9

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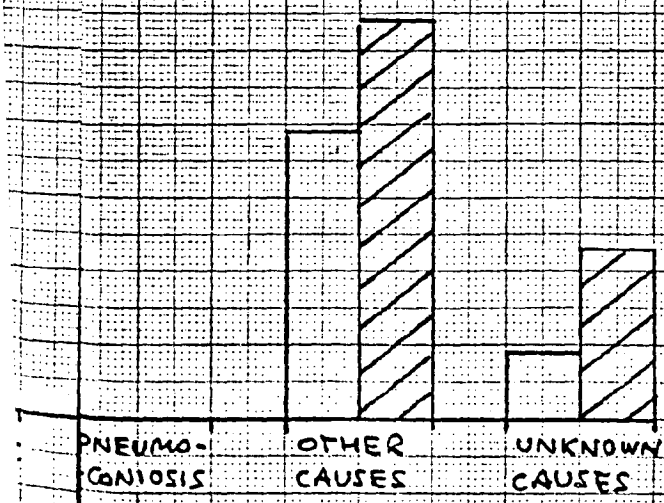

There are also very thin fibres that unwind from a fairly compact skein; they can be linear, in very short fragments, or curved in the longer ones.

Fibres which seem single in body have, however, streaks all along the filament and end in a small brush which is sometimes clean cut and sometimes in irregular bands as far as the length of the fibrils is concerned as they broaden out at the ends.

There are compact, darker fibres that are contorted with knuckle bends, and at these points they have a node formed by a crystal of silicate (serpentine).

The inclusion of small fragments of silicate in the fibres is a characteristic of amianthus from serpentine.

Finally, we sometimes find in certain serpentinous minerals a short, thick, almost linear form of amianthus fibre that is usually coloured reddish, and is very hard (photograph 6).

AMPHIBOLE FIBRES - ACTINOTE - AMPHIBOLE AMIANTHUS

If these are coarsely ground or if they are residual fragments they are always linear flow fibrils or fascia. The single fibres are rectilinear needles that are white or rarely coloured light green to dark green.

Often the group opens at the ends to free the fibrils in a fan shaped form, as is characteristic of the amphibole present in Chinese talcs (photograph 7 - 8).

It is possible to have fairly long, single almost linear fibres

FIBRES (and small scales) FROM TREMOLITE

Tremolite is often found as a pure, clearly separate and distinct crystallisation in the mineral which it occours, or rather in the host mineral. When it is found in talc it takes on a particular characterisation in that it tends to transform itself into talc, both as far as structure and chemical composition are concerned. As regards the structure, the presence at the same time of both fairly short and fine needles and lamellae can be clearly seen. This corresponds to an incomplete metamorphosis of the silicate, or rather, the change from tremolite to talc is not complete. Owing to interruption of the evolutionary process, or the ceasing of suitable conditions, tremolite remains in an intermediate form as far as crystallisation

is concerned, but it is already complete as far as physical characteristics of softness and composition are concerned (photograph 9).

Long crystal forms are rarely found, especially since the macro-crystalline form is segmentary and no longer fibrous in the interclusion itself, and keeps a certain degree of hardness owing to constriction during crystal formation in the host mineral; however, once the apparent structure has been broken, the constituent disaggregates lose the roughness that is characteristic of tremolite and adopt a certain degree of softness.

Calcium (CaO), the soluble part of tremolite, was washed away at the high temperatures and pressures which were present during the solid reactions before the solidification of metamorphous rocks and sedimentation on the earth's crust, and has been in part replaced by water, thus giving rise to metasilicate of magnesium.

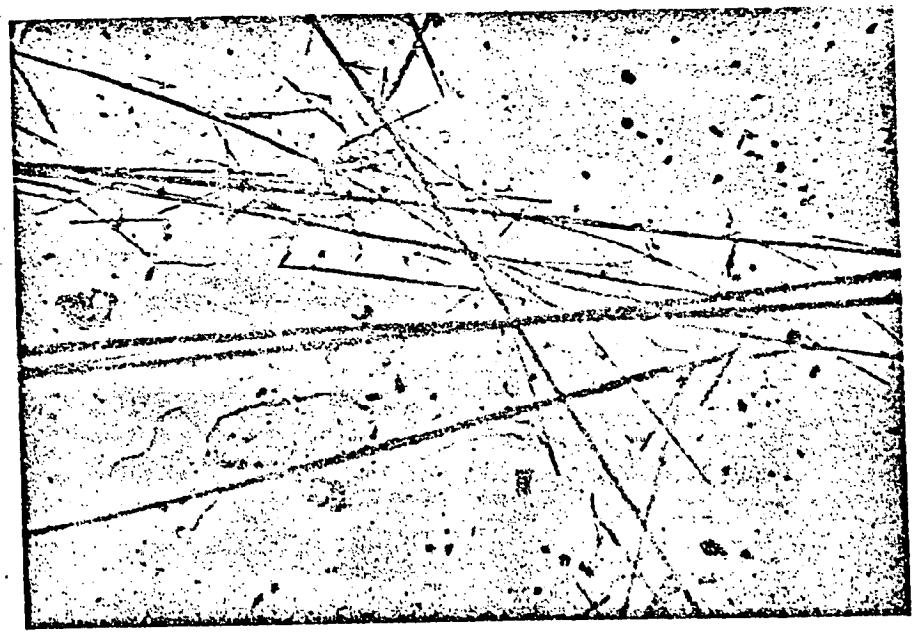

Photo no. 1 - CHRYSOTILE

IMPURITIES PRESENT IN TALC

The harmful elements according to pharmacopoeia and cosmetics

A brief enquiry into the presence of harmful elements in talcum powder, from the pharmaceutical and cosmetological point of view. Contents of lead, titanium, iron, arsenic, copper and chrome are axemined in detail, on the basis of tolerances established by the standards that regulate this field.

INTRODUCTION

The mineralogical origin of talc is still discussed today and, in spite of different theories that convince to a certain extent, there is no certainty at all. The reason for this is that talc is very widespread and is found in rocks that are fairly dissimilar from each other and amongst metamorphical material of different origins.

This fact explains, however, the considerable differences in physical structure and the large range of impurities that are found in talcs coming from different countries or regions.

It is worth pointing out that pure talc, i. e. metasilicate of magnesium, is formed only of silica, magnesia and water. However, pure crystallisations are fairly rare in nature and talc is also subject this rule.

As has been said, talc can contain impurities that depend on the environment of its formation and can be determined by the original rocks, by promiscuous sedimentation, by scouring or by the contribution of clastical elements present during its formation.

These elements, which are oxydes, silicates, carbonates and sulphurs, vary greatly both as regards presence and quantity amongst talcs of different origins. In fact to a certain extent they are a peculiar characteristic which sometimes permits the origin of the talc to be recognized with some degree of certainty.

Of course it is these impurities themselves that decide the value of a talc; not because of their presence, however, but because of their absence.

GENERAL REMARKS

Talc is present in many pharmaceutical preparations as a constituent, and is the basis of many cosmetics so that the authorities responsible for public health have rightly been concerned to establish standards that set the limits of tolerance as regards potential or actual impurities that are harmful to man and present in talc.

Since there is as yet no international unification of the standards adopted in different pharmacopoeias or cosmetologies we will quote each time those that in our opinion are more suitable or more precise in their specifications.

Another consideration which we feel is necessary concerns the opinions about how toxic different elements are, since here too there are differences from one country to another, or, indeed from one researcher to another. As an example we can consider boric acid in which, according to the latest views, a degree of toxicity has been ascertained but which all pharmacopeias prescribe as a disinfectant in spite of the fact that it is a bacteriostatics and in no way disinfectant.

SURVEY OF THE ELEMENTS CONSIDERED HARMFUL BY THE PHARMACOPOEIAS AND ON WHICH INFORMATION IS GIVEN ALSO IN COSMETOLOGICAL STANDARDS

IRON

In talcum powder iron can be found in different mineralogical forms and even in the form of free iron. The most common compounds of iron, as far as minerals are concerned, are magnetite, haematite, siderite, pyrrhotite and pyrite. These compounds generally have a low solubility, but when they are reduced to the fineness to which talc is ground their solubility increases considerably. It is also necessary to take into consideration the different conditions of use to which they are subject and which can influence considerably their solubility e. g. pH, concentration, heat, etc.

In its free state iron derives mainly from wear of the machines that are used to grind the talc.

The VII edition of the Italian Pharmacopoeia gives: « Ferric salts soluble in water: 10 g. of talc are kept in b. m. with 100 ml of water for 15 minutes. Filter. A part of the filtered liquid is acidified with hydrochloric acid: the solution must not colour blue with the additon of solution of potassium ferrocyanide ». The U.S.P. XVIII is practically the same.

The English one is more precise in that it prescribes a quantity test, according to which the maximum tolerable limit of iron soluble in water is 0.8 mg per cent. For iron soluble in acid the limit rises to 0.20 g% (as Fe_2O_3) for the standard taken from the American and English specifications of a cosmetological nature, and 140 p. p. m. according to the Swiss regulations for purified pharmaceutical talc ("purified" is specified since according to pharmaceutical regulations for purified talc is intended talc treated

with diluted hydrochloric acid and washed thoroughly with water; in this way the remaining iron is reduced practically to a few p. p. m. and we are no longer dealing with natural talc).

The other pharmacopoeias, Dutch, Belgian, French, Swiss etc. generally refer to the above mentioned standards, or are less severe than those given above, as, for example, cosmetics. In fact the T. G. A. prescribes a maximum level of 0.75% of Fe_2O_3 soluble in acid.

Even if the methods given in the different specifications do not correspond exactly the quantities given and defined as limits are fairly consistent and a large number of production control tests on the best brands of Talc of the Val Chisone fully satisfy all the requirements, both pharmaceutical and cosmetological, as far as iron is concerned.

The level of iron soluble in water, of SVC talcs for pharmaceutical and cosmetological purposes, in accordance with the various methods, is much lower than the standards. Iron soluble in acids does not reach the level of 0.1% (compared with the 0.75% of the T. G. A.).

LEAD

This element is not found in talc in its free state. Its most common and well-known mineral is galena, lead sulphur PbS, with 86.6% of Pb.

The hardness of these crystals is fairly low, in fact it barely reaches 2.5; consequently the ease with which they can be finely reduced and the increase of their solubility is considerable, even more since this mineral is often found in very finely grained minute aggregates where the aggregate is fairly easy to destroy.

The pharmacopoeias and cosmetological standards are rightly fairly severe as far as this element is concerned as it is well known for its toxicity.

Generally speaking we find limits that reach 20 p. p. m. of Pb, whereas others usually add together lead and heavy metals and give a limit of 40 p. p. m.

Looking at the pharmacopoeias we have 70 p. p. m. for purified pharmaceutical talc, but this quantity comprises lead and copper together; others give 20 p. p. m. as a limit and in general refer to the U. S. P. XVIII.

The methods of analysing lead can vary from the classical ones of scholastic analysis to sophisticated modern methods relying on up-to-date equipment. In each case, however, there is no discrepancy in the results.

The pharmaceutical and cosmetic qualities of SVC talcs are so pure that the level of lead in them is very far from any of the limits given above.

In fact, taking into consideration the normal fluctuations for a product from a mine, the quantities vary from 0 to 1 - 2 p. p. m.

ARSENIC

This metalloid is not found in a free state as an element in ground talc. It derives from arsenious and arsenic compounds, and from arsenious pyrite, which are fairly common in nature. The peculiar characteristics of this element are its volatility, its ease of reduction and the formation of hydrogenate compounds in special reductive and hydrogenate environments. Because of these characteristics and because of its high toxicity in any form, the limit allowed is fairly low and varies from 2 to 3-p. p. m. in pharmaceutical and cosmetological standards all over the world.

The level of arsenic (As) in SVC talcs for pharmaceutical and cosmetological use varies from 0.3 to 0.7 p. p. m. maximum, in other words far from the limits generally set.

COPPER

This element is found also in a free state in nature, however in talc it is usually found in the sulphide, double sulphide and, rarely, oxide state.

This element is not often mentioned in the standards we have been discussing, but it should not be overlooked because its toxic action as an oxide is considerable, and as its influence as a catalyst in coagulation and densifying processes. To go outside the specific field of cosmetology we can give as an example the rubber and plastic sector in which very precise limits are set for the content of copper in talc.

As far as copper is concerned once again the best SVC talcs have such low contents, from 2.5 to 4 p. p. m., that they can meet any requirements for use and processing in any industry.

NICKEL AND COBALT

These two elements are treated together because they usually occur together in nature too. They are of more interest for industry, as was mentioned for copper, than for pharmaceutical and cosmetological purposes. They are dealt with here, therefore, because we are considering all the impurities present in talc, and to give further proof of the purity of SVC talcs in which the content of these metals does not exceed 9 p p. m.

TITANIUM

Titanium is very common in silicates. It is usually in the form of rutile or titanium dioxide. Its hardness of 6.5 places it amongst the crystalline forms that can be harmful if present in talc used for care and treatment of the skin, i. e. in cosmetics. Its relatively high density also creates problems of uniformity in suspension and mixtures. This fact is also met in other similar crystalline forms and causes marks, spots etc. in the finished product, especially if the talc has not been ground with sufficient fineness.

These dangers or disadvantages that come from titanium minerals are not present in SVC talcs, either pharmaceutical or cosmetic, since their TiO_2 content reaches a maximum of 0,08%.

CADMIUM

According to very recent research, carried out also by the Italian Minister of Health and his Institutes, cadmium has been recognised as being highly toxic, especially bacause it is accumulated by the human urganism, the kidneys in particular.

The limits of tolerance, which have already been set in other countries, are in process of being established in Italy too. The level is very few p. p. m.

In consideration of the purity of SVC talcs, we can already affirm that they will be satisfactorily within the limits that will shortly be set for this elements.

CHROME

We have intentionally left this element to the end because at present considerable research is being done it owing to its high toxic level and especially because it is accumulated by animal and vegetable organisms and there is no way in which they can eliminate it. The Public Health Authorities, who are very concerned about this matter. have introduced very severe standards to ensure that pollution from this element (hexavalent chrome) by industry is kept to a minimum. We ourselves have carried out very careful research on the level of chrome in SVC talcs, especially those for pharmaceutical and cosmetic purposes, so as to ensure that these products fully meet all health requirements. The level of chrome in SVC talcs is about 0.01%; a quantity that is so low that it ensures maximum safety in use.

USE OF TALCS
OF PINEROLO
IN PHARMACEUTIC-COSMETIC
SECTOR

It is known since many years that some talcs with more peculiar chemico-physical characteristics may be defined the best in the pharmaceutical-cosmetic sector.

This is determined by incontestable characteristics of mineralogical structure, and by an extremely low impurity content.

Talc impurities may be classified as follows:

1) Very hard silicates, as chrysotiles and tremolites, of amphibolitic derivation, namely with strict asbestos content.

2) Chlorites, that can also reach 60%, Moh's hardness of 3 at least.

3) Noble chlorites, they reach up to 60%, Moh's hardness 2.

4) Calcite, dolomite, ankerite, quartz, actinolite, ferromagnesium silicates of different nature, iron oxides, manganese or titanium, simple or complex sulphides.

It is considered today in modern cosmetology, although if not officially controlled by Hygiene Offices or by Health Departments, the acceptability of tolerance for hard silicates, as tremolites, or chrysotiles (see n. 1), at traces level.

Soft silicates are considered to be dangerous when their percentage becomes much far higher in comparison with the aggregate mass content

As per analysis:

a) many talcs have a hard silicate content reaching also the 10% (tremolites, chrysotiles, etc.);

b) other talcs of various origins have a soft silicates content that can also reach the 60% (chlorites, etc.).

With that, we think to have been sufficiently clear about the characteristics of talcs available for the cosmetic market.

The talc of Pinerolo, for cosmetic use, that's mined from the deposits of the Chisone and Germanasca Valleys in the North-Western Alps, has to be considered as a product of very high quality because:

1) the hard silicate contents are extremely low (only traces), as it is demonstrable by the testings of qualified Technological Institutes;

2) the content of soft silicates is also very low (our talc is nearly free);

3) the impurities stated in point n. 4 can be considered practically negligible;

4) its structure, that is extremely lamellar, not fibrous and not needle-shaped and unciform, guarantees the highest degree of unctuosity, softness and smoothness at touch.
In fact it can be clearly proved by practical tests of microscopic magnification (e. g. electron microscope) that a needle-shaped structure, by the absorption on the part of pores, can badly corrode the cellules of a tissue, because, if we want to make an exemple, the point of a knife is always more hurtful than the flat surface of the same.

The acknowledgment of these peculiar characteristics, common only to very few talcs present in bulk on the crust of the earth, brought to it an undiscussed international favour. This is at the basis of the very strong current of exportation, established since many years towards every Country of the world.

All our talc is deeply mined from deposits ranging between 200 and 600 mt. under the surface. It is included between the characteristic rocks of this part of the Alps: gneiss, mica-schits and dolomitic limeston; it is extraneous and very far from every horizon of serpentine and asbestos rocks that could invalidate its purity. It is exploited in accordance with

rational mining techniques that defend from every possible pollution, and it is processed in special mills located west of the town of Pinerolo.

Talc is previously subjected to sorting, crushing and drying processes, and then it is ground in special closed circuit mills and packed in paper or jute or polythene bags of 25-50 or 100 Kgs.

For cosmetic uses a fineness is generally required, allowing 99-99,5% through 200 mesh sieve (6200 meshes p. sq. cm.). For special requirements it is also micronized to the finenesses of 30-20-10 microns. As to whiteness, it oscillates, according to the types, between 90 and 95 Photovolt points (absolute value).

The actual production of Soc. Talco e Grafite Val Chisone for cosmetic purposes amounts to 45.000 tons a year; 80% of that is shipped abroad.

REMARKS ON THE GRINDING OF THE TALC

Grinding reveals the hidden structure of a material: it shows up its virtues if the material is of good quality, or heightens its defects if there are any.
On the other hand, if the grinding is not done well and to a sufficient extent, it can have a negative effect on the material and lower the quality of both appearance and characteristics.

THE GRINDING OF TALC AND ITS DEGREE OF FINENESS IN RELATION TO ITS USES FOR PHARMACEUTICAL AND COSMETOLOGICAL PURPOSES

Talc is the main constituent of rocks that are generally known by the names of Saponites, Steatites and Talc-schists. A large number of industrial products from the earth, classified as talc, contain a large variety of other minerals such as chlorite, serpentine, tremolite, dolomite, calcite, quartz, etc.

The ideal composition of talc is a silicate of magnesium hydrate

$$Mg_3\ Si_4\ O_{10}\ (OH)_2$$

from this formula the percentage composition can be calculated:

SiO_2	63.5% in weight
MgO	31.7% in weight
H_2O	4.8% in weight

Slight changes of composition are found in the natural product.

Talc, like mica, has a lamellar structure in which a layer of magnesium ions is sandwiched between two layers of tetrahedral silicon. These layers or lamellae are electrically neutral, so no additional cation, such as potassium, can be inserted between them as is the case with mica. It is important to recognize the complete symmetry of the superficial characteristics of talc, which makes the two faces of each individual layer perfectly identical.

Owing to the lamellar structure and the neutrality of the surfaces, there is a definite trend towards the delamination of the talc, wich is

linked also to the smoothness between the layers that reveals the well known lubricating properties of talc itself. The layers are held together by the « Van der Waals » force London type.

The accumulation of individual lamellae, one on the other, does not follow a logical order and the difference revealed by X-rays was not sufficient to make the problem clearer. The reason must be sought in the limited cohesion of the lamellae to each other, which enables them to take up different orientation with respect to the others without difficulty. Amongst other things this property explains the well known softness of talc.

Because of the lamellar structure of talc, special technological procedures are required in order to reduce it to a fine powder.

The elastic and very smooth lamella makes the grinding process particularly difficult, especially when we consider that it is necessary for the product to conserve all its physical characteristics of softness and greasiness, since it is these characteristics that distinguish it and make it a principle material for cosmetology; and when we consider the absolute necessity of avoiding all pollution or contamination so as not to reduce the high degree of purity when it is used for pharmaceutical products.

EXTRACTION

The talc of the Western Alps, which is reserved mainly for these uses, is all extracted underground from layers of Pre-triassic age made up of gneiss and mica-schists with masses of dolomite of varying size interposed. The genesis itself of this type of talc entirely excludes the presence of serpentinous rocks or derivatives that form the parent rock of other talcs of different origins.

Present extraction of the talc takes place at a depth between 200 and 500 m. below surface. This depth is essential to ensure the biological purity of the mineral, especially when all technical measures are taken to avoid or limit its contamination. It is in fact obvious that the conditions are very different when the mineral is extracted from open quarries or mines, where the protection from external agents is of limited efficiency.

Day by day, mining experts with many years of tried experience, supervise the work of extraction in order to exploit only the purest mineral. They are aided in their work by the timely laboratory analysis of the material extracted.

The mining sistems for extraction are conditioned by the physical characteristics of SVC talc and are indeed specific for the purpose since there is extensive use of reinforcements to counterbalance the very strong pressures that occur in the stopes. Another requirement is represented by the waste filling operations after the mining, which are necessary to eliminate as far as possible dangerous empty spaces that may remain in the stoping areas.

The operation of mining and reinforcement must still be entrusted mainly to the manual work of highly skilled workers, thought with the help of up-to-date machinery. A peculiarity of this mining activity is the selective mining that is carried cut on the layer of talc, which is in fact a first quality selection of the material to be extracted. This operation slows down output, but is nevertheless one of the basic factors that ensure the mineralogical purity of the product.

TREATMENT OF THE UNREFINED MATERIAL

There are two very modern works, situated on an important highway, where the unrefined mineral is ground to reduce it to the different degrees of fineness that are required today in the modern technologies of the use and processing of powdered talc.

The talc that comes from the mine, packed in special crates, undergoes first the processes of crushing and sorting. It is then treated in rotary driers to remove moisture. These driers, of the tubular kind in which the talc does not come into contact with the combustion products, are a valid contribution to the biological purification of the mineral. As proof of this there are the results of recent analyses, which are given separately.

For particular products where the highest degree of whiteness is required, an electronically controlled optical sorter is used in which the talc, previously prepared in pieces of the same size, is checked by rays from photoelectric cells and selected according to requirements.

Further proof that the raw material is treated under the best possible conditions is that all the mineral is transported on specially designed mechanical shovels or conveyors, to avoid the introduction of foreign substances, as happens for example in a manual treatment. In fact the contaminating effect of the soles of the workers' shoes is sufficient to pollute a material that is destined to end up on a baby's delicate skin or in the tablets of a medicine.

Even if SVC talc is extracted from mines and not from the open, as has been mentioned, it can still contain microbes, anaerobic or aerobic

bacteria that have been brought by the machinery, the miners' shoes or any other equipment that comes into contact with the unrefined matter.

To eliminate this contamination from bacteria, spores and germs, as much as possible, the unrefined mineral goes into the continuous drying and sterilizing ovens that were mentioned before.

The oven is several meters long and contains a large number of pipes inside that work as heating elements. It rotates on its longitudinal axis at a slight inclination, so that the material moves forward at a calculated speed in order to give maximum sterilization. The temperature reaches over 240° C and this, together with the time of treatment, achieves the intended purpose.

In order to show how efficient the use of this series of ovens is, tests have been carried out to analyse the quantity of bacteria contained in different samples of powdered talc, produced from material treated in different ways.

The samples were numbered ar follows:

no. 1: fine, unrefined talc, exposed to all weathers, and subjected to contamination by the treading of workers' shoes, ground but not treated in the drying ovens;

no. 2: unrefined talc in pieces as above, not treated in the drying ovens;

no. 3: fine, unrefined talc, exposed to all weathers and the treading of workers' shoes, ground after treatment in the drying ovens.

Quantity of bacteria in 0.1 g.	1	2	3
Cultures in aerobiosis, no. of colonies	5700	900	100
Cultures in anaerobiosis, no. of colonies	800	50	50
Cultures for research of sporogenous species, no. of colonies	100	10	20

In addition, no sign of fecal pollution was found in any of the samples. These analyses were made by the Institute of Hygiene of the University of Turin, on January 24th, 1974.

In another analytical report by the same Institute, but which was made for control purposes at a different time, there is the following information:

Quantity of bacteria (in aerobiosis and anaerobiosis).

The semination, even of a gram of the material from the different samples, led to the development of only a few colonies.

Research for fecal indication = constantly negative.

Research for pathogenic sporogenous aerobic and anaerobic species = constantly negative.

Bacteriological tests carried out on samples of SVC talc have constantly demonstrated the absence of specific germs (Cl. Welchii, Bac. anthracis, Pl. tetani).

The fact that in all the samples were present, as an exception, only a few saprophytic bacterial units per gramme of seminated matter, means that the product can be considered « practically sterile ».

When is comes out of the sterilisation ovens, the mineral is carried in a mechanical shovel to the grinding mills.

GRINDING THE TALC

Grinding is the main operation in the treatment of talc, and much research and technological experience ha gone into its realisation.

In order to preserve the lamellar structure of our talc, which is its chief characteristic, from the large range of machinery it was necessary to choose pendular mills, in which trituration takes place by means of squashing the particles. They work a completely closed cycle, and separation of the product is done pneumatically. Some are fitted with devices to expel particles of a greater hardness, generally formed of impurities (pyrite, quartz, dolomite, chlorite), but in any case in very small percentages.

There are ten pendular type mills installed just for the talc of the Pinerolo region, of between 100 and 150 HP each. The fineness of the product to which they are adjusted is between 99 and 99.8% passage through a USBS sieve of 200 mesh (opening 74 microns). This is the optimal fineness for the cosmetics industry.

To achieve greater fineness, second grinding mills are in use, of the Impact kind that are called vertical mills.

These mills, in which the ratio between quantity of product obtained and energy used is very low, give different degrees of fineness, all situated below the USBS 325 mesh sieve and indicated with the conventional number of the Fisher diameter: 1.50 - 1.20 - 1.05 which corresponds roughly to a fineness of 30 microns, 20 microns and 10 microns.

Further grinding is done by means of fluid energy micronizers, using, in our case, the expansion of air compressed to 7 atm. At present they give a product that is about 6 microns and indicated with the Fischer diameter of 0.80.

The ground product is conveyed pneumatically in stabilized bins of different capacities and is then usually packed in 50 Kg. bags for talcs of a normal fineness and 20 and 25 Kg. bags for micronized talcs. An installation for dispatching the loose product in tank trucks and tank wagons has recently come into use.

To return to comments on the processing we can add that when the product is homogeneous, as far as structure and composition are concerned, the work of grinding is established by the physical and mechanical parameters of the product itself and the working of the machine is determined by the basic structure of the mineral that is to be treated.

If, however, the mineral is not homogeneous, other factors or parameters enter into the milling process that are determined by the characteristics of the various components.

If we examine these characteristics we find in the first place the hardness of the components, then the structure, which includes the cleavage according to specific, predetermined planes of the mineral, or a conoid breakage, and in certain cases, as is clearly seen in Chinese talcous minerals, the crushing is conoid and granular up to a certain point, after wich the grain, which is usually shapeless, realises small, squat lamellae which are thick on the surface, and in this way reveals its true original structure.

In this latter case fine grinding has shown up the real basic structure of the mineral.

With a mineral that is rich in chlorite, as is the case with some European products, a fairly similar phenomenon occurs with fine particles that are not very different from each other.

As has been shown in another part of this report, there is a clear difference both in hardness and crystallographic structure between talc and chlorite. The hardness of chlorite is more than twice that of talc, and its basic lattice is formed of two layers, whereas that of talc has only one.

During the process of disaggregation, which occurs with the grinding operation, it is obvious that talc reduces to extraordinarily thin and soft lamellae, which could not be obtained from a crystalline structure with two layers.

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