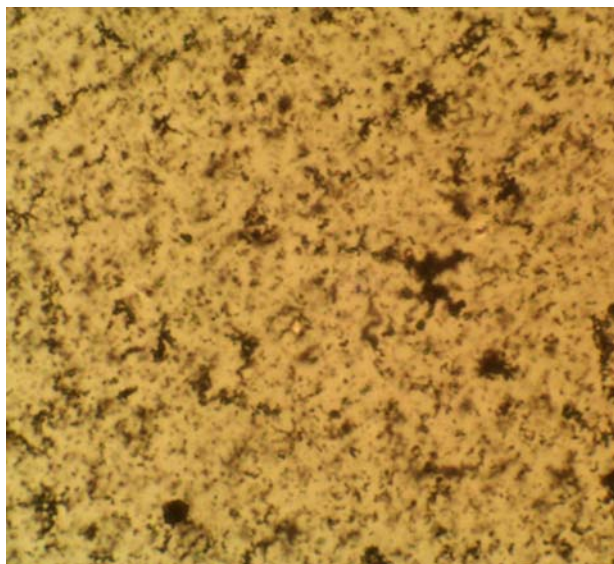
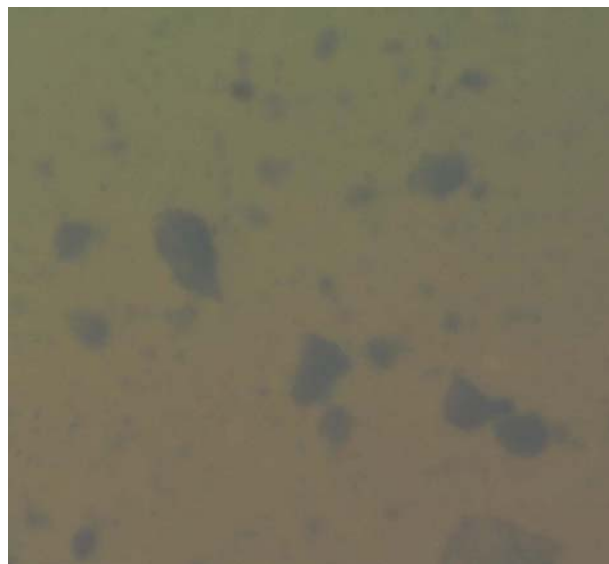


Carbon Black

C (Carbon, Oxygen, Hydrogen) Lamp Black
Bone Black $\text{Ca}_3(\text{PO}_4)_2$



Microscopic appearance of lamp black at x500 mag



Micro appearance of bone black under slightly crossed

Dates of Use

From Ancient times up until the present day.

Summary of Manufacture

Made by collecting the soot of wood burning fires.

Graphite is also made today by collecting the soot from burning natural gas by impingement, flames impinge on metal surfaces from which the soot is scraped.

It is not until fairly recently that different forms of carbon soot were distinguished; such as lamp-black and bone-black, collected as their names suggest. Mars-black and lamp-black are also other well-known forms. In the USA 'carbon black' is specifically used to term the product produced by allowing a smokey flame from natural gas to impinge against a cooled, revolving metal drums from which the black is removed by industrial scrapers. (Gettens & Stout)

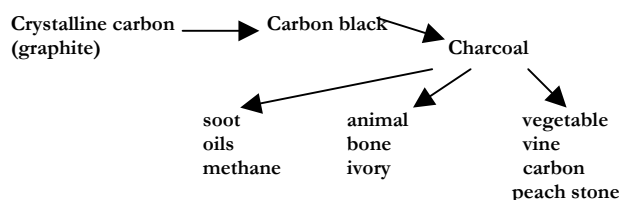
Brief History of Usage

Has been used since prehistoric times as a pigment for drawing and writing. Recent discovery of a number of types of carbon has been manipulated in printmaking for their slightly different hues. Today the pigment is widely used in both the art and industrial industry and is known to have excellent hiding power in all its forms.

Surface Morphology / Microscopic Description

Particles can vary greatly in shape and size although opaque flakes with fractures are generally observed. Particles can vary greatly but usually fall between 1-100µm in size

Bone black particles are usually 1-20µm



Aging Characteristics

All carbon blacks are very stable being unaffected by light, air or hot concentrated acids or alkalis.

They can only be destroyed by burning which converts them to carbon dioxide.

In terms of solubility they are fairly stable and also have a good permanence. Carbon oil paints are sometimes slow drying, the freer they are from impurities, the better they dry.

Technical Examination Techniques

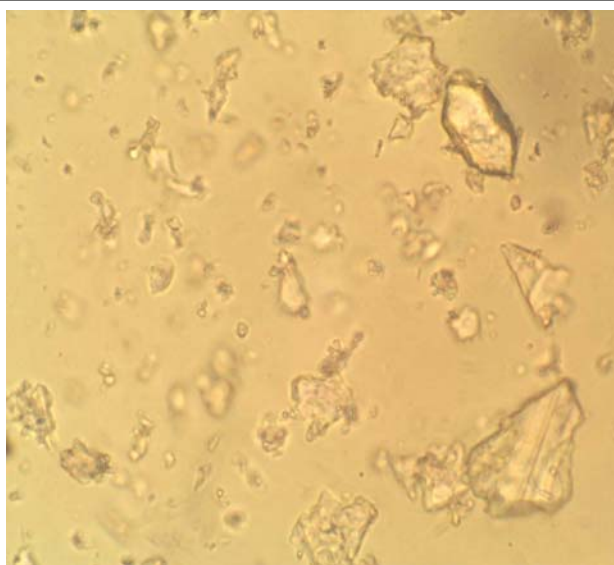
Particles are opaque under the microscope so no light properties can be observed. They also have no birefringence properties and will therefore be invisible at cross-polars. Ivory and bone blacks may be distinguished from other carbon blacks by heating. A grey ash is left which is composed of phosphates.

Does not fluoresce in Ultra Violet Light. Under-drawings in carbon can be seen with the use of infrared light.

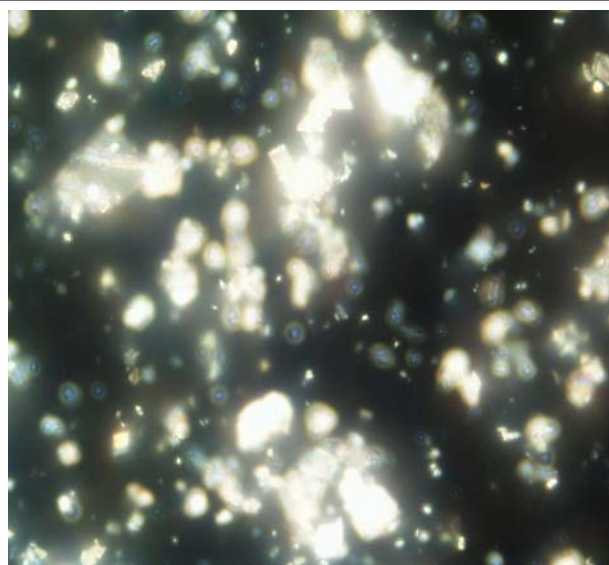
Chalk

CaCO_3 (Calcium Carbonate)

Chalk, Whiting (usually precipitated), Lime white, Limestone



Microscopic appearance at x500 mag



Microscopic appearance under crossed polars

Dates of Use

From Ancient times up to the present day, in both Europe and the Far East.

Summary of Manufacture

Natural chalk is a rock derived from marine and plant life and largely composed of fossils from unicellular algae. Natural deposits can be found on the English Coast, on Northern France, Belgium, Denmark and across Europe, with poorer qualities found in the USA. The white, yellowish or greyish chalk lumps are quarried and ground with water, separating the courser material through levigation. A very fine variety is known as 'guilders whiting'. Artificially made chalk is known as 'precipitated chalk' and is calcium carbonate in its whitest, finest and purest form.

Brief History of Usage

The earliest known white pigment used since Ancient times in drawing and painting. Commonly found in Northern European painting and mixed with glue to form the ground. Found in Chinese and Japanese painting the source of which was chalk ground from oyster shells. Marble was also ground to form the pigment.

Surface Morphology / Microscopic Description

Small colourless crystals with no regular shape and some may appear pale pink in hue. Heterogenous. Coccoliths (Fossil shells) can be seen at 500x mag in a sample of natural chalk. They are distinctive and highly birefracting due to their composition of tiny calcite crystals.

Precipitated chalk is finer, more homogenous and whiter than the natural material with fine uniformly sized particles with no impurities as with natural chalk. Looks similar to plaster of Paris under the microscope. Long needle shaped crystals that have a tendency to mat or felt with each other.

Whiting (limestone) particles are usually 1-30µm in size whereas chalk and precipitated chalk particles are usually 1-10µm.

Aging Characteristics

Very stable in normal environmental conditions.

Excellent lightfastness.

Incompatible with alkali-sensitive pigments such as Prussian blue. (Pigments through the Ages)

Non-toxic

Technical Examination Techniques

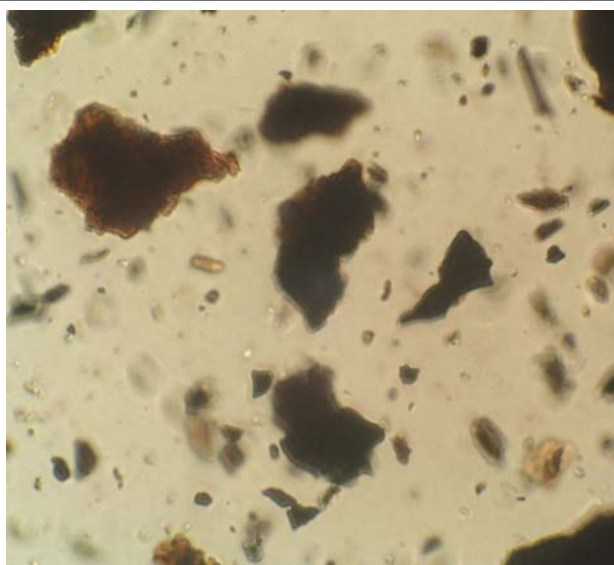
Anisotropic and pleochroic with the surface of the crystals becoming red and green upon rotation.

See Appendices for chemical spot test for calcium in chalk.

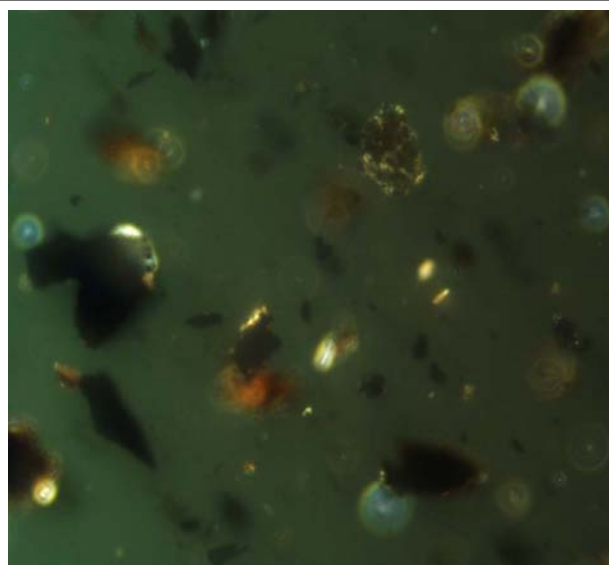
Particles do not exhibit pleochroism.. Polarisation may result in a green or red tint on the surface of some crystals. Confirm natural chalk by the presence of coccoliths or limestone rhombohedra.

Charcoal

Carbon C
(See carbon blacks)



Microscopic appearance at x500 mag



Microscopic appearance under slightly crossed polars

Dates of Use

Since ancient times beginning with cave drawings by Prehistoric man, used and made in the same way to this day.

Summary of Manufacture

Historically, charred wood from the fire was used by Prehistoric man as a tool to draw outlines of animals on cave walls. Today charcoal is produced from vine and willow twigs in special kilns from which air has been excluded. The sticks come in varying thicknesses, averaging $\frac{1}{4}$ " in diameter. The degree of softness also differs. Charcoal types are so-called 'stick' (vine or willow), compressed (powdered and compacted with a binder), pencil and powder form.

Brief History of Usage

Known since ancient times and is the oldest and most versatile drawing pigment. Commonly used in sketches and preparatory drawings before the paint layer. From the watercolour tradition developing in the 18th Century up until the present day, drawing has become a high art form in itself and with it the importance of charcoal. Honoré Daumier (1808 - 1879), Edgar Degas, Renoir (1841- 1919) and Lautrec (1864 - 1901) exploited the medium in their drawing and combined it with other media. Its use today is as prevalent as ever it was.

Surface Morphology / Microscopic Description

Particles look small, opaque, elongated and splintery. Charcoal is light, inert and porous and may retain some of the fine structure of the wood it was made from. The particles are not bound to the surface of the paper, making them easy to smudge and blur. All charcoals are hydroscopic and therefore need to be dried before being bound in oil. Charcoal withdraws the majority of organic colouring matters from suspension, and even from solution in water.

All are bluish-black in hue. (This has often been imitated by mixtures of lamp black and indigo.)

Particles can vary greatly in size but are usually between 1-100 μ m.

Aging Characteristics

Excellent permanence

Although charcoal is an extremely permanent pigment if it has been badly washed or imperfectly carbonised it may become greyer or less brown following prolonged exposure to light.

Non-toxic

Technical Examination Techniques

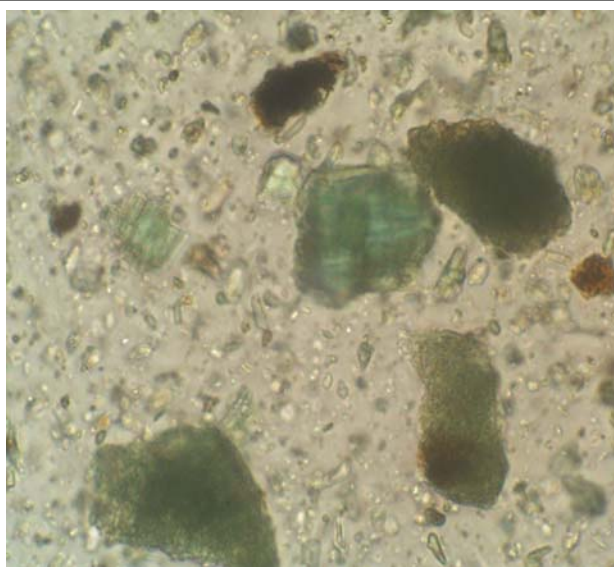
Particles are opaque therefore no microscopic effects can be seen.

Infrared light can detect under-drawings in paintings such as graphite and carbon.

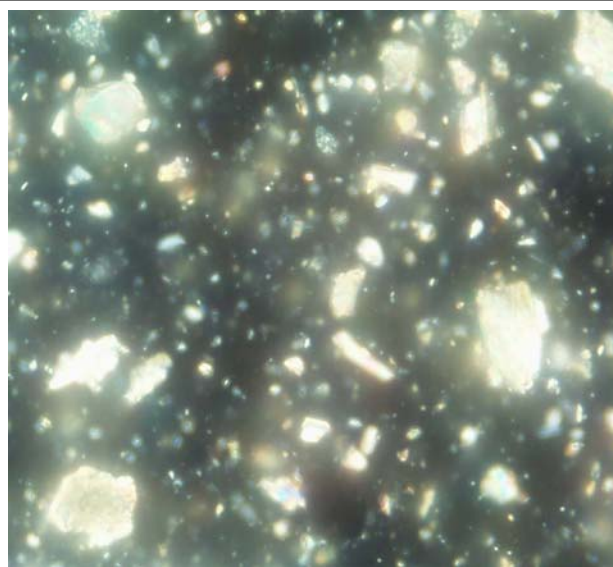
Bogus pigments which may appear to look like charcoal (i.e. mixtures of lamp black & indigo) can be detected by heating in a test tube (indigo will give off a purple vapour).

Malachite

$\text{CuCO}_3 \cdot \text{Cu(OH)}_2$ (basic copper carbonate)
Mountain Green



Microscopic appearance at x500 mag



Microscopic appearance under crossed polars

Dates of Use

Ancient times up until but rarely in the present day. Occasionally still used in the East but rarely in the West.

Summary of Manufacture

Naturally occurring mineral similar in composition to azurite but essentially containing more combined water. Occurs across the world where secondary copper ore deposits are found and like most mineral pigments it is prepared through a series of grinding, washing and sieving to extract the pure green particles. (Gettens & Stout) (Meyer)

Brief History of Usage

Large deposits can be found in Egypt and Sinai as well as smaller deposits being found across the world. Close in relation and history to azurite, malachite is one of the oldest bright green pigments found in paintings in both the East and West. Found commonly in China from Ancient times and in Europe more prolifically in the Middle Ages. Today its use continues in the East, but rarely in the West as synthetic greens took over in popularity and quality of colour. As a mineral particles are large and like azurite dramatically and characteristically granular in comparison to the finer synthetic version of today.

Surface Morphology / Microscopic Description

Bright green, crystalline and fairly characteristic microscopically.

Crystals are homogenous and some may appear to be clear to pale green.

As can be seen in the photographs, crystals vary greatly in size. Their size will also depend upon the manufacturing process and the amount of grinding carried out.

Bottle green, glass-like cleavage fragments.

Particles are usually between 1-50µm in size.

Aging Characteristics

Moderate permanence

As a carbonate it is decomposed by acids but is unaffected by light.

More often seen in oil than in tempera medium

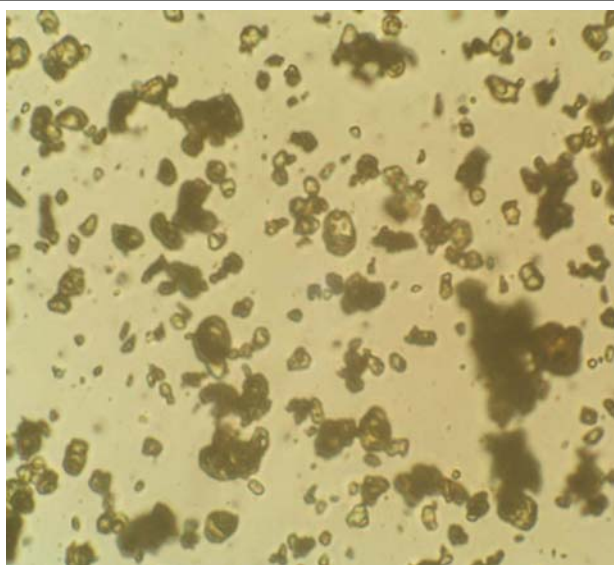
Technical Examination Techniques

Particles exhibit high birefringence and are anisotropic. Particles exhibit parallel extinction, no pleochroism. Transmission colours with the Chelsea Filter = dark grey-green

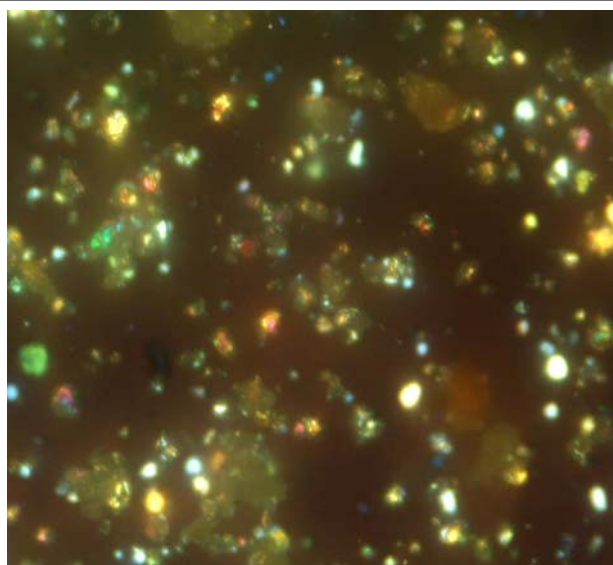
The halo on each crystal does not appear to move and therefore its refractive index is around that of the mount medium, meltmount. See Appendices chemical test for the presence of copper(II) ions.

Massicot

PbO (yellow monoxide of lead) lead oxide
Litharge



Microscopic appearance at x500 mag



Microscopic appearance under crossed polars

Dates of Use

Ancient times up until, but less commonly, today.

Summary of Manufacture

Both massicot and litharge often terms used for the same pigment, but more correctly each are lead monoxides derived from different sources. **Massicot** is the unfused monoxide of lead made by the gentle roasting of white lead at 300°C. The white lead reacts upon heating and gives off carbon monoxide and water. Massicot, the soft, sulphurous yellow powder is left.

(Litharge is the fused and crystalline oxide, which is formed from the direct oxidation of molten metallic lead. Today the molten lead is atomized by whirling propellers and allowed to oxidize through contact with the air. It is essentially the by-product of refining silver by the cupellation process.)

Brief History of Usage

Litharge is more orange in comparison to massicot due to the content of some red lead. Litharge is rarely seen used as a pigment in comparison to massicot but was more commonly employed in varnishes and glazes. The manufacture of yellow monoxide has been known since Ancient times and found in Egypt, Italy, Germany, across Europe in general and in the North and South Americas.

Surface Morphology / Microscopic Description

Light yellow rounded particles

Colour can vary from yellow to a reddish yellow. Litharge is usually more orange in hue.

Appears to possibly be amorphous.

Generally difficult to identify as particles vary greatly depending upon the manufacturing process.

Massicot and litharge are furnace products and therefore particles can appear 'fluffy', uniform, small and rounded.

Particle luster is greasy to dull.

Crystals are generally opaque but some can be transparent as can be seen in the samples above.

Cleavage is distinct in two perpendicular directions but difficult to see.

Aging Characteristics

Good permanence

Good hiding power.

Dissolves in nitric and acetic acids and has similar properties as all lead pigments.

Technical Examination Techniques

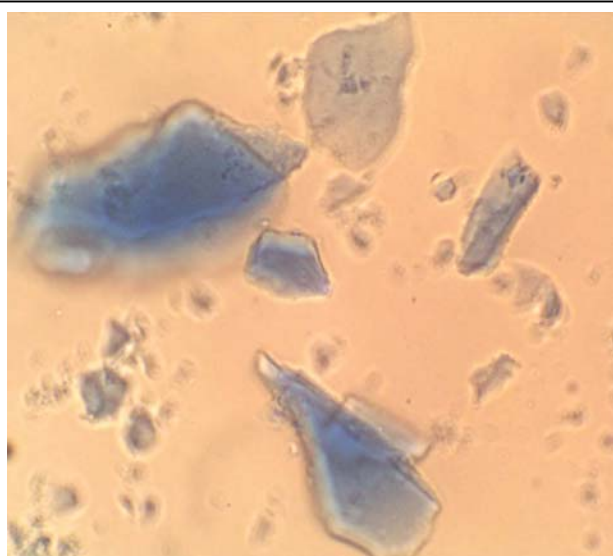
Particles exhibit high anomalous birefringence and anomalous polarization colours but do not exhibit pleochroism. Refractive indices of 2.51 (α) to 2.71 (γ).

Confirm with a microchemical test for lead.

Massicot is the orthorhombic variety of PbO whereas litharge is the tetragonal variety of PbO.

Smalt

CoO (Cobaltous oxide) K, Co(Al), silicate (glass)
Cobalt



Microscopic appearance at x500 mag



Microscopic appearance under slightly crossed polars

Dates of Use

Ancient times up until the nineteenth century.

Summary of Manufacture

Artificial in nature it is a potash silicate, highly coloured with cobalt oxide and reduced down to a powder. It seems to have been manufactured in Ancient Times by roasting cobalt minerals such as cobaltite and smaltite to form cobaltous oxide. The oxide was then added to molten glass and the mixture poured into cold water. The resulting broken particles were then ground and washed and allowed to settle repeatedly in order to separate out the finer particles.

Brief History of Usage

The earliest of the cobalt pigments, in painting and, particularly in the colouring glass in Ancient Egypt, in Venetian glass making and even across to Asia and the Far East. Laurie in 'The Pigments and Mediums of Old Masters' mentions the word, smalto, as being used as early as 1492 and a glass pigment called, azzuro di smalto, being described in 1584. As a pigment it has been suggested that smalt has been used since the late sixteenth century in Europe. However with the introduction of French ultramarine and other artificial blues its use decreased in the 19th Century and it is rarely used today.

Surface Morphology / Microscopic Description

Smalt particles are essentially glass particles with a conchoidal fracture and quite distinctive in appearance.

Large particles can exhibit a purple-blue hue while small ones may appear pale blue.

Despite their glassy characteristic, they can have varying shapes, some appearing like sharp splinters or shards of glass; others are more square and angular.

Tiny air bubbles are common and a good indicator of the pigments identity.

Particles are usually between 1-50µm in size.

Aging Characteristics

Excellent permanence

Poor hiding power and a tendency to streak or settle in application of the paint film due to its coarse particles and the necessity to use it in thick application.

Arguably insoluble, even in most acids but gradually pales becoming grey with reaction to moisture and carbonic acid in the air. (Artists Materials & Techniques)

Technical Examination Techniques

Particles are isotropic and do not exhibit pleochroism or birefringence.

Transmission colours with the Chelsea Filter = rose-red or bright red.

Refractive index ca. 1.55

Confirm with a test for potassium.