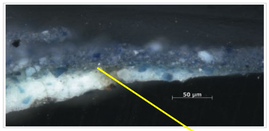
Lapis Lazuli

Ultramarine • Oltremare • Lazurite

(Italian for Ultramarine) (Name of Mineral)

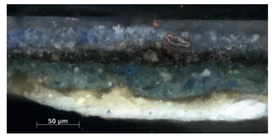
Michelle Tremblay and Mitchell Famulare



Paint Cross Section from the sky. The bottom layer consists of azurite and lead white and the second layer consists of natural ultramarine and a little lead white.

Leonardo da Vinci, *The Virgin of the Rocks*, c. 1491, oil on poplar

Detail showing the degradation of ultramarine on the angel's drapery revealing a reddish brown under layer.

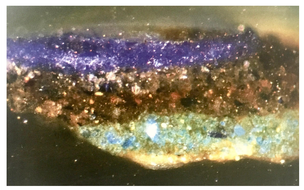


Paint cross section from the Virgin's blue cloak (neckline) → this shows the extent of ultramarine blanching in the surface layer. Notice how the color is dull and contains a white coat.

- Da Vinci's piece serves as an excellent example of how ultramarine responds to oil paint.
  - It is known that ultramarine is sensitive to acidic conditions.
- when acids dissolve into the air they interact with the sulfides in ultramarine to create a yellow color
- The oil paint provides a different dilemma. Since ultramarine was applied as an extremely thin glaze, during its drying process it cracked in several areas. This occurs because the lapis interacts with the protein-like bands of the oil binder in a way that causes it to degrade.

Pietro Perugino, *The Virgin and Child with an Angel*, c.1496-1500, oil with some egg tempera on poplar

The drapery contains a layer of azurite(a cheaper blue pigment) with lead white. On top of this is a thick glaze of ultramarine in oil. The midtones are painted in finely-ground, high quality ultramarine. The paint in this piece is laid so thickly that it harnesses a three dimensional quality rather than a drapery of of intense color.



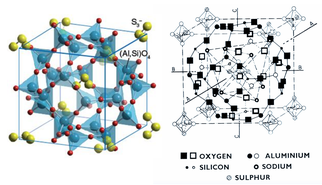
Paint cross section from the Virgin's robe with ultramarine and lead white at the surface over a discolored ultramarine glaze. A layer of azurite is seen at the bottom layer.

- Perugino's use of oil as a medium in this piece shows a very convincing means of expressing the volume and quality of fabrics as well as a more effective way of modelling.
- Modelling is a technique where the painter shows shadow and light by switching values of color. Another form of modelling is known as *cangiante* or hue shift, where the painter shifts to a totally different color when producing shadows/highlights.
- Differing from tempera paint where the binder is egg yolk, oil paint allows the layering of paint in order to convey different shades of color. Thus, the pigments must show a degree of translucency.

Damage in *The Virgin and Child with an Angel*

Natural ultramarine/lapis was used for the blue draperies in this painting. The high saturation of the blue attends to why it was a pigment of choice adding to the fact that the most expensive pigment be used for the drapery of the Virgin. This image has suffered from the fact that lapis is a poor drier in oil. Although it is capable of being used as a glaze without lead white, it tends to crack without it. Lead white is often used with lapis in order to aid the drying process. The shadows are the most affected by this fault.

Lapis Lazuli Chemical Structure



$$(Na,Ca)_8(AlSiO_4)_6(SO_4,S,Cl)_2$$

Ultramarine Sickness

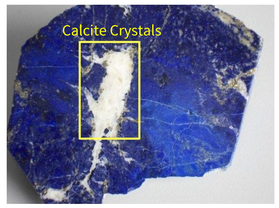
Dilute mineral acids (dilute HCl, HNO_3 or H_2SO_4) rapidly destroy the blue color with evolution of hydrogen sulphide gas

$$2\,H^+_{(aq)} + S^{2-}_{(aq)} \rightarrow H_2S_{(g)}$$

from acid — from lapis

Lapis Lazuli Quality

The quality and grade of the lapis lazuli pigment has to do with the impurities in the lapis lazuli mineral. The main type of impurity found in lapis lazuli are calcite crystals. Other metallic appearing impurities are iron pyrites or "fool's gold."



Calcite is a rock form of calcium carbonate $CaCO_3$

Distinguishing Lapis Lazuli from other blues

Heat Resistance

- The blue color of ultramarine remains unchanged, whereas azurite is converted to black copper oxide
- This distinguishes ultramarine from azurite

Refractive Index

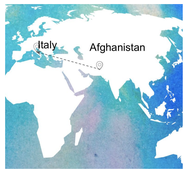
- Refractive light is how light bends as it goes through the material
- The RI of lapis is lower than all other pigments at 1.5
- Different crystals bend light in different ways → this affects what we see

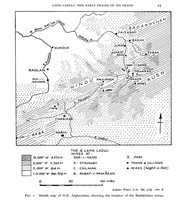
Polarized-Light Microscopy

- When viewed under polarized light, less light is let in
- Polarized-light microscopy is used to study the structure of the pigment particles
- Can differentiate between different structures based on how they interact with the polarized light

Sebastiano del Piombo, *The Daughter of Herodias* or *Salome*, c. 1510, Oil on wood

The ability of oil to produce convincing images of fabric are exploited in this piece. Here, Salome's satin sleeve is painted with zigzagging highlights of glazes of high quality ultramarine and lead white. This is an excellent example of the color ultramarine can produce. You can see the bluish violet color especially in the shadows.





Herrmann, Georgina. "Lapis Lazuli: The Early Phases of Its Trade." *Iraq*, Vol. 30, no. 1, 1968, pp. 21–57.

Origins of Lapis Lazuli

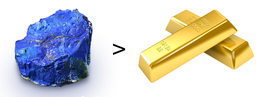
- Lapis Lazuli came from the ancient quarries of Badakhshan (modern day Afghanistan)
- Today there are four known Lapis Lazuli mines in the Kerano-Munjan valley located at Chilmak, Shaga-Darra-i-Robat-i-Paskaran, Stromby and Sar-i-Sang
- Badakhshan produced practically all the Lapis Lazuli used in Europe
- Lapis Lazuli was imported into Europe by way of Venice, a principal port city
- In Venice Lapis Lazuli would have been sold by *vendecolori* (color sellers) rather than *spezieri da grosso* (apothecaries)

Ambrogio Bergognone, *The Virgin and Child with Saint Catherine of Alexandria and Saint Catherine of Siena*, c. 1490, oil on poplar

Ultramarine, due to its high cost, was primarily used for the drapery of the Virgin or Christ. It was a convention to paint the Virgin and Christ in the most expensive material. This is an example of **color iconography.** This is one of the best preserved examples of ultramarine bound in oil.

Cost

"More expensive than gold"
-The National Gallery, London



The prices of the pigments of ultramarine and azurite depended on the quality of the raw materials and the way they were refined

Azurite
40-400 *soldi* per pound
Less valuable types could cost 24-60 *soldi* per pound

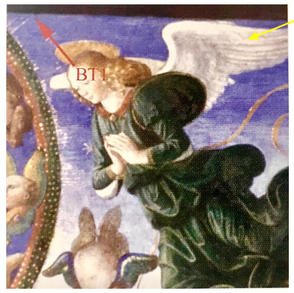
Ultramarine
1400s → 940-5,500 *soldi* per pound
1500s → 5,000-16,800 *soldi* per pound

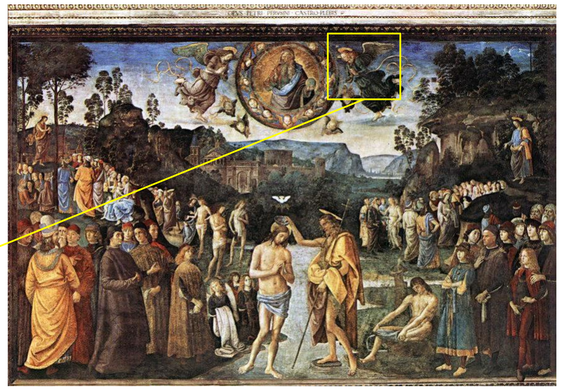
At one point one pound of ultramarine cost as much as 10 donkeys!

With the average cost being around 3,400 *soli* per pound, it would take a skilled worker to work almost a whole year to afford one pound of lapis lazuli.

Scanning Electron Microscope - Energy Dispersive Spectra (SEM-EDS)

- In SEM-EDS analysis, electrons are sent in at the sample and x-rays are given off
- SEM-EDS analysis has proved that Perugino applied lapis lazuli using the "true fresco" technique in *The Baptism of Christ* in the Sistine Chapel
- The lapis lazuli was found between the sky and the frame





Pietro Perugino, *The Baptism of Christ*, c. 1482, fresco

Ultramarine was not commonly used buon fresco mainly because of the cost but also because of the possibility of damage to the silicate structure (SiO_4) depending on how long it is in contact with the calcium hydroxide

Processing Lapis Lazuli

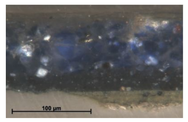
"*Here begins the practice of extracting the azure from the lapis lazuli*...Take the stone, which is a mineral, and after washing it with ley, heat it on burning charcoal, and afterwards extinguish it in good and very strong white vinegar...Choose the good pieces, and grind them fine in a brass mortar...when very finely ground put the powder into an earthen dish and pour over it hot water or hot ley with a little honey and clay, rubbing the azure with your hands or with a stick, in order to extract the refined azure...Afterwards strain it through a linen cloth into a well-glazed earthenware basin, and pour off the water, or, still better, the ley, leaving the powder of the lapis lazuli settled in the basin; wash the azure...until the saline particles of the ley are washed away, and let the azure dry in the shade..."

-Bolognese Manuscript, 15th century, author unknown, taken from Medieval and Renaissance Treatises on the Arts of Painting by Mary P. Merrifield

Andrea del Verrocchio, *The Virgin and Child with Two Angels*, c. 1467-9, tempera on wood

Tempera and Lapis

Egg tempera is the essential medium for ultramarine. When ultramarine dries in tempera, where the binder is egg yolk, it does not crack. Instead it holds onto its deep royal blue color. However when lead white is mixed with ultramarine in tempera, it reduces its saturation, seen in Verrocchio's piece. In oil, when lead white is added, the intensity of the blue is increased.



Paint cross-section of the Virgin's blue cloak showing a thick layer of ultramarine and lead white over the gesso(the basis for tempera)

Titian, *Bacchus and Ariadne*, c. 1520, oil on canvas

Natural lapis lazuli is the most predominant blue pigment in this piece. It is mixed with lead white in the sky, the highlights and midtones of blue draperies, the distant landscape, and some of the flowers. In the blue cloak of Ariadne(specifically the shadows) and the drapery of the Bacchante, ultramarine is used without lead white. Ultramarine is also mixed with lead white and a red lake for the drapery of the Bacchante with the tambourine. In the places where ultramarine was used without lead white, a series of cracks can be seen due to the top thick glaze of ultramarine. A thin glaze would prevent this.

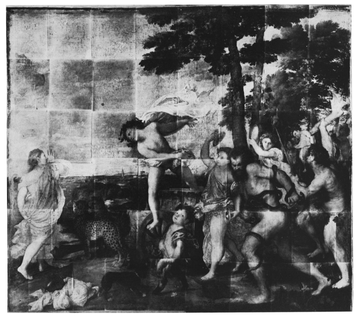
Characteristics of Lapis Lazuli

The lazurite mineral stone provides a very deep violet blue color. The first extractions of the stone provide the best high quality pigment. However, when ground to finely, the deep blue color is lost, leaving **ultramarine ash.** Ultramarine ash comes from the final extractions of the stone, providing a very pale blue color. Often in paintings, different grades of ultramarine would be used. Lower grades were far cheaper than the very high quality deep blue grades of ultramarine. The ash provided a means for attaining a fine pale blue color at a reasonable cost.

Cima, *The Incredulity of Saint Thomas*, c. 1502-4, oil on poplar

Cima's piece provides a perfect example of the use of different grades of ultramarine. Cima painted a lower grade of ultramarine over a layer of azurite and lead white for the sky. He used the same combination for the robe of St. Peter except with a higher grade of ultramarine. This makes sense that a more expensive grade be used for a robe of a Saint rather than the color of the sky.

Infrared image of Titian's *Bacchus and Ariadne* taken before cleaning and restoration



The infrared photography of this image shows the abundance of pure ultramarine. Ultramarine reflects infrared light, meaning that it appears white under it. So wherever you see white where the blue once was, it assures the viewer that it is ultramarine. On the contrary, azurite(another blue pigment) absorbs infrared light so it would appear a very dark gray color rather than white. This is a primary way of telling the difference between azurite and ultramarine.