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The Conspicuous Colour Blue - *'Lapis Lazuli'* - In the History of Art

***Ernesto Carlos Pujazon Patron[1], Jose Domingo Elias[2]**
[1]Weifang Institute of Technology, Qingzhou. China
[2]Potificia Universidad Catolica del Peru, Peru.

hsecpp@gmail.com
***Corresponding author**

ABSTRACT

Colour plays a fundamental role in human perception and its effects on cognition and behaviour have intrigued generations of researchers. The intent of this two-part paper is to provide a wider understanding of the history and evolution from its early beginnings. It also analyses the diverse characteristics of plant-based colours and minerals that produce this intriguing colour called, 'blue'. Although a large amount of research has been conducted in this domain, the psychological processes through which colour operates, have not been explored comprehensively. As a result, the field has observed certain conflicting results. The first part of this article studies the colour 'blue' as a pigment. Besides, it also offers some early development of the colour 'blue' in the light spectrum set by the initial developments in the history of science. The second part examines how 'blue' has long proven a problem for artists. There are a few materials that are blue in their natural state, that can serve as pigments for painters. During the Renaissance period, artists used a pigment called natural ultramarine (Lapis-Lazuli), lauded for its rich and striking appearance to capture the great beyond, this mineral was introduced by Venetian merchants and brought originally from the mines of Afghanistan, located in the remote province of Badakhshan. It is very common when religion, science, and the arts meet to apply philosophies which are interwoven around historical and social events to present science as human, relevant and a lively endeavour. Finally, this paper brings to a conclusion a short briefing of the works of two of the most expressive artists, Giotto and Titian, and the usage of lapis lazuli - (Ultramarine) in the development of their colour palette.

Keywords: *Lapis Lazuli, Indigo, Ultramarine-Blue, Goa-Blue, Light Spectrum.*

1 INTRODUCTION

Colour has always been an important element in the culture of people all over the world. The past decades have seen enhanced interest in research in the area of colour and its psychological functions. Progress has been made on both theoretical and empirical fronts (Elliot, 2015, 368); 'blue' was used not only for personal embellishment, representing an object or an individual but to indicate importance and hierarchical status, even our medals for bravery and heroism possess this colour. Emotions are also so closely related to that; we use colour terms as descriptions for concepts and feelings that go beyond words and language, like 'feeling blue' or 'white like a ghost' (Bleicher, 2005, 37). Colour plays a vital role in culture and daily life, and it may be the most important aspect in a painting, product or design, and it appeals to our inner emotions. Why do people favour one colour over another and what does it all means? These are some of the few questions that have intrigued mankind. Some colours in their natural form, or after a chemical procedure where they were converted in the form of dyes or dyed textiles were even used to pay taxes (Pujazon, et al., 2021; Donkin 1977; Wouters, et al., 1992). In history and its association, the colour 'blue' represents mostly the sky and the sea with its open spaces, freedom, intuition, imagination, inspiration and sensitivity.

'Blue' may also be associated with trust, loyalty, sincerity, wisdom and confidence. Traditionally, 'blue' is seen as the colour of constancy as well as the colour of sorrow, anguish, plagues and hurtful feelings, and it may also be associated with the male sex (Elizabeth Knowles "blue." The Oxford Dictionary of Phrase and Fable. Retrieved June 11, 2022 from Encyclopedia.com). The informal meaning of 'blue' may mean obscene, indecent, and profane which was developed in the 19th century. The Spanish term *'Sangre azul' (Blue blood),* was attributed to Castilian families who claimed to have no mixture of Moorish, Jewish or any other foreign blood. It may have originated in the blueness of the veins of people of fair complexion, as compared to those of dark skin. There are many connotations and stereotyped perceptions with regard to the colour 'blue' and its cultural and social relationship. We live in a kaleidoscopic world, but colour is more than just a major creation. Colour carries a significant, deep meaning imbedded in our soul. 'Blue' as a colour has changed the way we behave and act, it has also altered the course of history. 'Blue' similar to 'white', 'gold' or 'red' has an intoxicating appeal to our most inner senses. The uniqueness that 'blue' presents all around us, is that it can never be reached or touched by our hands, 'blue' is a colour that naturally recedes in space such as the colour of the sky, the colour of the sea, or the colour of the earth as seen from outer space. In the ancient Greek Cyclades, due to the sea and sky, the colour 'sky blue' was considered a fortuitous shade that could keep evil away, a superstition that continues to find expression in the form of 'blue' cupolas on churches, 'blue' trim around buildings, 'blue' doors, blue-turquoise jewellery and clothing (Lilienfeld, 2004, 32). This uniqueness presents some challenges to be exposed and investigated, for example here are some more questions: why does the colour 'blue' behave in such a manner influencing our cognitive mind, or how does 'blue' capture our vivid mind, our creative imagination? How does 'blue' offer a tantalizing prospect of new definitions? This rare and mythical element-pigment-mineral can only be found in the tiny mine of Sar-e-Sang, squashed between the small town of Faisabad to the north and the even smaller town of Eskazir to the south, in the far remote province of Badakhshan, north eastern Afghanistan (Finlay, 2004, 282). (Figure 1: a) & b). Beneath).

a) 

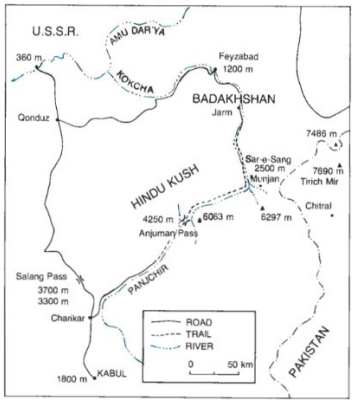
b) 

Figure 1: a) Map of Afghanistan showing the location of the '*lapis-lazuli'* mines;
b) Road, trails and river to transport Lapis Lazuli to Kabul.
(Illustration ©Richard Hughes)

'Blue' is a colour not found in the early history of Western art, such as in the cave paintings, in contrast to red-ochre (ferric oxide), a natural earth-soil which contains iron-ore (Pujazon, et al., 2021; Finlay, 2004, 20). It may be difficult to imagine and measure how much colour is perceived as a colour per se, 'intrinsically' in the early period of human history, or how much the colour was as an essential part of the depicted object (Petru, 2004, 204). Ideas about how colour is studied can be grouped into three broad categories: a) its history and social connotation, b) from the science of physics as the study of the light spectrum set by Newton and its seven hues, the chemistry and its composition; and, c) the perception of colour which involves the field of psychology and cognition (Pujazon, et al., 2021, 699). The Sumerians believed that the spirits of their gods lived within the stone, while the ancient Egyptians saw it as a symbol of the night sky. In addition to natural pigments, ancient Egyptians formulated synthetic type pigments such as powdered glass, synthetic spinel, dyed jasper, and the mixture of pyrite fragments to create Egyptian blue, a distinctive hue used on statues,

walls, and monuments (Wyart, et al., 1981, 184). In the Roman Empire, a rare form of purple sometimes called 'deep-blue' was extracted from a particular kind of snail and, because of its rarity, was used primarily for royal garments. During the Renaissance, a deep 'blue' was made from a finely ground gemstone known as *'lapis lazuli'*. In his *'Book of the Arts – Il libro dell'arte, 1400'*, written by the Italian painter, Cennino d'Andrea Cennini (c, 1360-1427), he expresses his views of the 'lapis lazuli' pigment: A noble colour, beautiful, the most perfect colour' (Wali, 2017). *'Lapis'* is the Latin word for 'stone', and *'lazuli'* derived from 'lajaward', 'lajward' which is the rock's name in old Farsi language, which may have been introduced into the new Persian language as 'lazaward,' then translated into Arabic and onward into medieval Latin as 'lazzulum' or 'azzurun' (Margulies, 2015). The word, 'blue' in several languages is actually derived from *'lazuli'*, for example, 'azzurro' in Italian and 'azul' in Spanish (Merriam-Webster. (n.d.). Blue. In *Merriam-Webster.com dictionary*. Retrieved June 14, 2022). The word, 'blue' itself can be described as being of old high Germanic origin as 'blao' (meaning shimmering, lustrous), from Middle English 'bleu – blewe', which was used until the 18th century (Finlay, 2004, 282); and from the Anglo-French 'blef', 'blew' 'bleu.'. 'Blue' as a pigment may have been used as early as the fifth and sixth centuries in the Buddhist cave temples in Bamiyan, Afghanistan. This valley could have been packed with pilgrims and artisans mixing with trades from Turkey to China; Bamiyan was full of frescos and incense-filled shrines. The first major use of the pigment was in the Buddhist wall paintings of the Kizil and Dunhuang caves in present day China from around the 4th to the 6th centuries A.D. (Margulies, 2015; Finlay, 2004, 291). According to Hamid Naweed, a leading Afghan art historian:

'Giant gilded and lapis-decorated Buddha statues were carved into the cliffside and were surrounded by colourful frescos depicting the heavens' (Wali, 2017).

Describing the earliest colour palette which was confined to a very small rage of natural colours found from our local surroundings, such as ochres (yellow-browns) from various colours of earth, blacks and greys from ashes and burned bones, wood or charcoal; reds and yellows primarily from minerals, plants, and later from insects (Pujazon, et al., 2022). These were the colours used in the palaeolithic caves found in France and Spain; as such 'blue' was an exception. In the early history of colour, the Egyptians left to us precise records of their daily life in their paintings, papyri and hieroglyphs. Surviving inscriptions and wall paintings also depicted the roles of their gods and rules. They developed a highly sophisticated spiritual life and their connection with divinity was ever present (Lawless, et al., 2002, 12). They used their knowledge of raw materials and paints and artistry skill purely for aesthetic reasons. They portrayed and associated certain colours with their gods, for example the god, 'Amun' also known as 'Amun-Ra', was the chief of the Egyptian gods. In the early stages of the civilization, he was worshiped as two separate entities, 'Amun' was the god who created the universe, and 'Ra' was the god of the sun, the Lord of the light and air, and the primeval creation who travelled across the sky every day in a burning boat, whose skin was depicted as 'blue' (Lazaridis, 2015, 47). Another explanation may have been that the colour was associated with the degree of their powers (Baqai, 2018). For the houses of the wealthy and the places of worship, *'lapis lazuli'* and azurite were ground to make 'blue', while heated galena (lead ore) produced a range of colours from white through red. Greens were made from crushed malachite and chrysoprase; a further range of blue and green tones was also made from the acidic corrosion of copper, the Verdigris-(viridian), would be produced by suspending copper plates over ammonia, vinegar or urine (Lawless, et al., 2002, 13). The Minoan civilisation on ancient Crete borrowed and developed skills from the Egyptians. By the first millennium BC, Egyptian culture was in decline, but their workers and knowledge had passed to the rising culture of Greece. The Greeks coloured all their monuments; however, today, only a small portion remains of these decorations. The ancient Greeks took a more scientific approach to colour. The pre-Socratic philosopher, Empedocles (c, 494 - c, 434 BC - flourished, 444-443 BC) best known for originating the cosmogonic theory of the four classical elements which refer to water, earth, fire, air, and (later) aether also established that colour fell into four categories: white/light, dark/black, yellow, and red [(Kingsley, K. Scarlett and Richard Parry, "Empedocles", *The Stanford Encyclopedia of Philosophy* (Summer 2020 Edition), Edward N. Zalta (ed.)]. Pliny the Elder (c, 23/24-79 AD), was a Roman author and natural philosopher, who wrote the encyclopaedia of *'Naturalis Historia'* (Natural History). He described *'lapis lazuli'* as a

'fragment of the starry vault of heaven', the most exotic of semi-precious stones and pigments (Margulies, 2015). This mineral may also be found in the region of Lake Baikal, Siberia, Chile, Canada, Zambia-Angola and Italy (Margulies, 2015; Finlay, 2004, 281). With the exception of a few Russian Icons which may have been painted with 'blue' from Siberia, all the real 'ultramarine', in Western and Eastern art has come from those places (Finlay, 2004, 282). (Figure 1: a) Above)

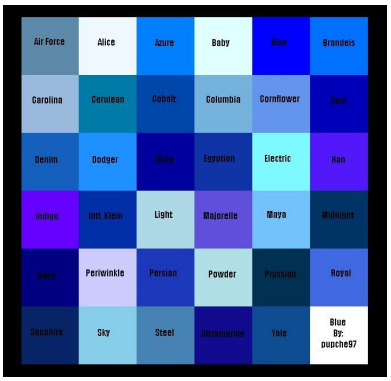
Another more recent interpretation of 'blue' as the colour of the skin can be seen in the American epic science fiction blockbuster, Avatar, directed and produced by James Cameron. 'Blue' was chosen as the colour for the main character of the movie. 'Blue' has no bias as representing the skin colour of people, it is more eligible and has a positive response, rather than any other colour with its intrinsic connotation, such as black, brown or yellow colours which represent a significant portion of the of the human race (Figure X: a), beneath). Modern ideas about colour were greatly refined at the beginning of the fifteenth century by architect and art theorist, Leon Battista Alberti (1404-1472, Italy), in his treatise, *Della Pittura* (*On Painting*), published in 1435, Alberti stated:

'Through the mixing of colours infinite other hues are born, but there are only four true colours from which more and more other kinds of colours may be thus created. Red is the colour of fire, 'blue' of the air, green of the water, and grey of the earth . . . white and black are not true colours but are alterations of other colours.'

From this early framework, others made further discoveries.

Another aspect of colour in which history, and particularly the history of the language of colour has a major role to play, involves the question of the harmony of colours, an aspect which perhaps still attracts the most widespread interest today. Sir Isaac Newton's (1643-1727) discovery in the 1660s is that colours are simply a function of the variable refractility of white light which describes the sensation caused by variations in the wavelength and intensity of light as it interacts with the human eye (Gage, 2000, 15; Pujazon, 2021) (Figure 2: a) Beneath)

Visible light is the small portion of the electromagnetic spectrum that can be seen by humans. When the white light of the sun passes through a prism, it is refracted into the colours of the rainbow from red through orange, yellow, green, blue, indigo to violet; in a linear band of the spectrum of light. (Figure 2: b) Beneath)

a) 

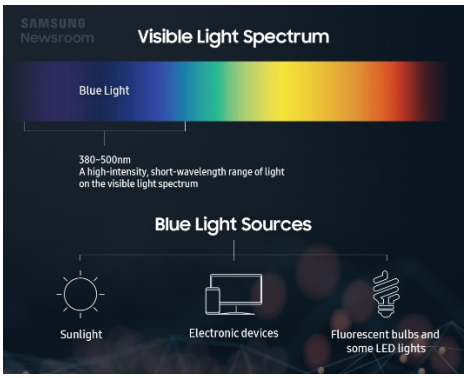
b) 

Figure 2 a) Common shades of blue, b) Visible light spectrum

1.1 Aim / Objective

This study aims to define and investigate the steps taken in the history of the colour 'blue' during the early development through the middle-age to finally arrive at the modern synthetic manufactured colour, which can be reached through an objective unbiased discussion. The authors will present a sound detailed explanation with regard to the colour 'blue'. The findings and implications may aid in the demonstration of new ideas in the area of aesthetics, education, and the preparation of knowledge,

particularly in the social context. The authors hope that this article will spark a greater number of intellectual debates in the fields of education, the arts and other related forms of expressions.

2 LITERATURE REVIEW

There is a vast bibliography of publications about the colour ‘blue’ ranging from the light spectrum system set by Isaac Newton to the physical colour-circle/wheel system, employing a substance known as pigment set by the Bauhaus in the early 20th century. Nonetheless, this study employs a historical method as the primary point of reference for comprehending the colour ‘blue’ in its physical form and behaviour. The discourse expands on providing essential terminology which is utilized to describe the colour ‘blue’. This discussion compares various colours of ‘blue’ from organic composition, such as plants, to mineral forms such as *‘lapis lazuli’*, offered by several scientific theories from the fields of chemistry, physics, and psychology. Finally, the focus of this article is to examine how ‘blue’ has been applied as a painting colour device. Classification can then be used to understand the work of literature, which is available in print copy or electronically on the internet. This discussion may contribute as evidence in the field of fine arts, particularly painting; raising awareness among institutions, students, teachers, and art practitioners about the effort to understand these distinguishing factors and underlying process for art experts using the eye-hand colour selection and mixing method. The authors believe that this discussion will serve as a springboard for additional studies on the subject of "Colour theory" as part of a continuing effort to support creative practices in general.

3 METHODOLOGY

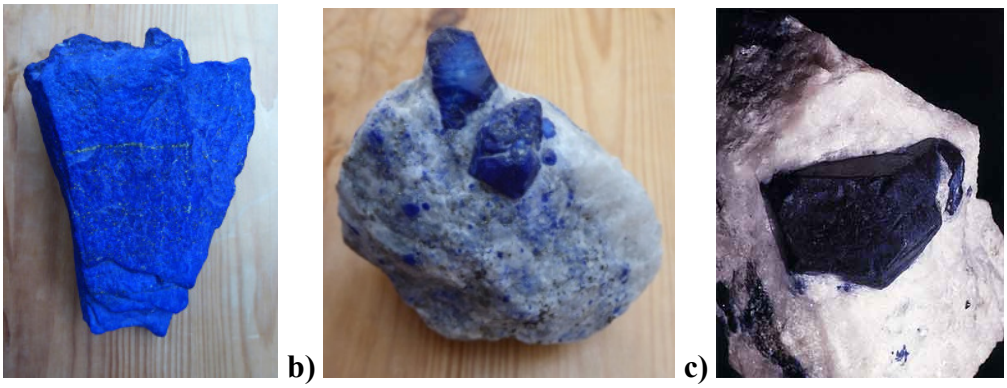
An appropriate direction for an artistic research evaluation is usually one taken in accord with hermeneutical knowledge that constitutes interest. The goal of this article is guided by hermeneutics, which offers multiple interests and interpretations into the phenomena of the colour ‘blue’. Through this approach, it addresses the interpretation of the colour ‘blue’ and its connotations in the works of the artists presented. Hermeneutics addresses a set of problems that have been the corner stone of human life that are consistently subject to considerations and interpretations of a ubiquitous activity which unfolds every-time humans aspire to grasp an interpretation which they deem significant. In every field of knowledge represented, whether in the realm of science or humankind, a certain mode of knowing is developed, thus following a particular methodology that corresponds to its object of attention. This suggests that the discourse will rely heavily on textual data to analyse, comprehend, evaluate and explain the complexities of the events under inquiry. This object of discourse is not a static entity, but rather a dynamic semiotic entity which aims to investigate how this magnificent colour ‘blue’ has transformed and communicated meaning which may be susceptible to future reinterpretations and generate new discussions.

4 DISCUSSION AND RESULTS

The properties of natural earth pigments can vary depending on the composition of the particular place of earth from which they were mined. Earth pigments are composed of clay containing different types of iron-oxide, plus manganese. It is this various combination of materials that determines the natural colour of the pigment. Some other pigments may be roasted after extraction in order to produce further colours (Lawles, et al., 2002, 37).

Although there are many different ‘blues’ in their natural-organic form, such as plants or in their mineral form such as *‘lapis lazuli’*, there are also many synthetic dyes of ‘blue’ currently manufactured in large quantities to supply industry in various ranges. Much of what is written about this gem-stone *‘lapis lazuli’* and the pigment that comes out of it, is surrounded with myths and mistakes, or simple translation errors from language to language. *‘Lapis lazuli’* is a complex rock whose composition is defined by the presence of the mineral, *‘lazurite’*

$(Na,Ca)_8(AlSiO_4)_6(SO_4,S,Cl)_2$ (Ganio, et al., 2017; Nečas, et al., 2017, Wyart, 1981). It is an aluminosilicate with a sodalite structure (Sodalite minerals contain frameworks of alternating silica and alumina creating large cubes of octagonal shapes), containing entrapped sodium ions and two types of sulfuric groups, which are responsible for its overall 'blue' hue (Nečas, et al., 2017). This mineral has been the object of many studies, particularly with regard to its special and characteristic colour (Wyart, 1981). Primarily, it has been used as a blue pigment in graphic and visual art since primordial ages. In the past, the blue *'lazurite'* pigment was obtained from the rock called, *'lapis lazuli.'* Due the fact that natural *'lazurite'* was expensive and inaccessible, a method of artificial production was searched (Nečas, et al., 2017). Royal 'Blue'- *'Lapis lazuli'* is from a gem variety of *'lazurite'* which is an opaque beautiful gemstone, composed of aluminum and sodium mineral of considerable complexity, known as 'sapphire.' The *Oxford English Dictionary* defines 'royal blue' as 'a deep vivid and saturated blue' which became an especial interest between the twelfth and fourteenth century when 'blue' assumed an aesthetic dimension and had associations with royalty and the portrait of the Virgin Mary, the Queen of Heaven, grafted onto it (Petzold, 2011, 156). The *Cambridge English Dictionary* defines it as a 'strong, bright blue colour'; and the *Collins English* Dictionary defines it as a 'deep blue colour'. Merriam-Webster (Merriam-Webster. (n.d.). Blue. In *Merriam-Webster.com dictionary*. Retrieved June 14, 2022), provides a further description towards purple, reddish or purple blue. The most prized *'lapis lazuli'* stone is dark which is close to blackish blue, much deeper than the blue-turquoise and more intense than 'sodalite' or 'azurite' (Wyart, et al., 1981, 184). This *'lapis lazuli'* is usually massive and more or less impure single mineral that varies greatly in compositions and colour (Wyart, et al., 1981, 185) [Figure 3: a), b), & c) Beneath]. 'Azurite', is a by-product of copper mines and is the sister stone of malachite, thus, it normally tends towards the green side of the spectrum, whereas 'ultramarine' made of 'lapis lazuli' veers towards violet. Its chemical formula is 2CuCO3 · Cu (OH) 2, that is of malachite, mineral and green pigment, is CuCO3 · Cu (OH) 2: the two minerals have a different ratio between copper carbonate (CuCO3) and copper hydroxide Cu (OH) 2. In contact with humidity, azurite (blue) tends to become malachite (green), taking on a more stable form in those specific conditions (Finlay, 2004, 287). Cheap or low-quality materials normally fade faster than expensive materials.

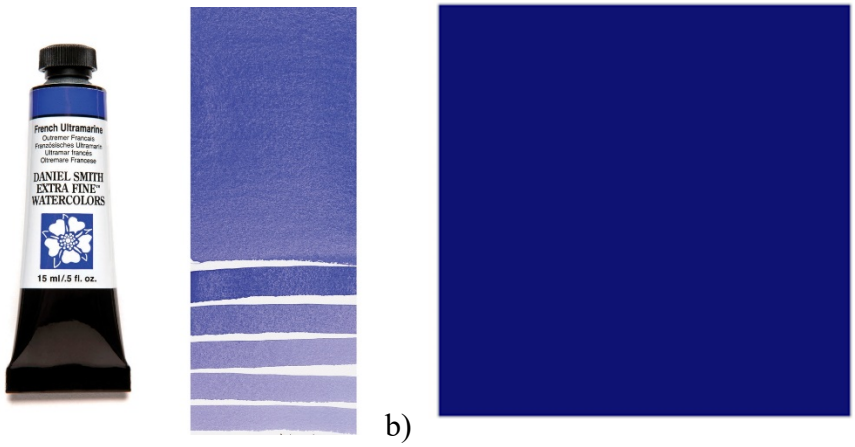


a) **b)** **c)**

Figure 3: a) Lapis-lazuli stone; b) Lazurite-crystal, c) Lazurite-crystal in marble.

Lapis lazuli is an ornamental stone that has been found, exploited and prized for its deep colour 'blue' since at least the 5th millennium BC (Ganio, et al., 2017). The cities of Mesopotamia, situated in the fertile valleys between the Tigris and Euphrates rivers, in modern-day Iraq, Kuwait, Turkey and Syria; were the commercial centre for this treasured material transformed by its artists into objects of luxury (Wyart, et al.,1981). This semi-precious stone was first used in artifacts such as jewels, amulets, seals, and inlays of some of the oldest civilizations, such as in the Sumerian tombs of Ur around the 3rd dynasty, which testify to the highest degree of sophistication attained in sculpture and gem engravings, located near the Euphrates River in lower Iraq. These tombs contain some well-executed statuettes of birds, deer, rodents, dishes, beads and cylinder seals (Ganio, et al., 2017). Undoubtedly, the stones used in these carved artifacts were mined from Northern Afghanistan (Bancroft, 1984). Lazurite is frequently found in lighter shades, commonly mixed with streaks of calcite.

The pigment that is obtained from lapis lazuli is known in English as *'genuine or blue ultramarine'*. The term, 'genuine' is to assist in differentiating it from the synthetically made 'French-Ultramarine'. 'French-ultramarine' was so called because it was Jean-Baptiste Guimet (1795-1871), an industrial chemist, who in 1828 won a prize of 6000 francs offered by the Société d'encouragement pour l'industrie nationale (Society for the Development of National Industry, which was an organization established in 1801 to support the French industry); for developing a synthetic alternative to the mined *'ultramarine'* (Finlay, 2004, 312). French-Ultramarine is light warned and redder than its counterpart, the 'genuine-blue Ultramarine' which is cooler. Ironically, during the early crusade 1096-1272 to the Holy Lands, it was the French who named the Holy States of 'Outremer', in parts of present-day Syria, Iraq and Lebanon. Outremer is pronounced 'Oo-tray-mare', transfigured to Latin for 'ultra-marinus' or 'the land beyond the sea' and subsequently this semi-precious stone became *'ultramarine'* in English (T. F. Hoad "ultramarine" The Concise Oxford Dictionary of English Etymology. Retrieved June 12, 2022 from Encyclopedia.com; Margulies, 2015). The modern production of *'ultramarine'* utilized common cheap raw materials such as kaolin, feldspar, diatomaceous, earth, zeolite, sodium carbonate, sodium sulphate and sulphur among other minerals (Nečas, et al., 2017, 115; Finlay, 2004, 281) (Figure 4: a) & b) Beneath)



a) b)

Figure 4 a) Daniel Smith water-colour French Ultramarine; b) Sennelier oil colour French Ultramarine

4.1 Lapis lazuli Mining

Sar-e-Sang, is in Badakhshan, in the North-East of Afghanistan (Fig 1: a) & b) Above), which lies in the centre of the Hindu-Kush massif, along the right bank of the Kokcha river which cuts from north to south, an anticline with summits reaching 3500-5500 metres above sea level. The Kokcha results from the confluence of the Anjuman and Munjan rivers and empties into the Amu Dar'ya (the Oxus River of the ancients), which demarcates the border with Tajikistan and Uzbekistan to the north. The rock in its natural stage is very hard to break up, early miners used great wood fires to fracture the limestone (Wyart, et al., 1981, 189). The rock of this series are carbonate schists intercalated with biotite, amphibole, and rare pyroxene which are associated with the migmatites gneisses (Faryad, 1999, 225). This region in Badakhshan was mentioned in Chinese writings as early as the sixth century. From the village of Jarm, situated about 150 kilometres north of the mines, a commercial route following the corridor of Wakhan leads to Tibet; it connects China with the valley of the Amu Dar'ya and the city of Bokhara. Thus, lapis-lazuli has been used by the Chinese since antiquity. It is known that Marco Polo (c, 1254-1324) visited this region of Afghanistan in the 13th century, and speculating about this colour 'blue' said: *"there are mountains likewise in which are found veins of 'lapis lazuli', the stone which yields the azurite colour of 'ultramarine', here the finest in the world. It is a cold country"* (Finlay, 2004. 282), although he never saw it himself. *'Azure'* is a variation of 'blue' that is often described as the colour of the sky on a clear day. 'Lapis' stone, was first used as a pigment known as 'ultramarine' in the 7th century, and was described as 'illustrious, beautiful and most perfect, beyond all other colours' in painting treatise (Eastaugh, 2007). At the beginning of the 13th century, Cennino Cennini reported in the '*Il libro dell'arte,* probably written in the late 1390s and

first published in 1859, a method for its fabrication in stages as follows: a) the separation process of 'lazurite' from other accessory minerals, which is grounded to a fine powder; b) the powder is then blended and melted with a mixture of pine rosin, gum mastic, and beeswax, producing a dough known as 'pastello' which is divided into little dried cakes called, 'dried pans'; c) the 'pastello' is stored for a week at room temperature and kneaded once per day; and d) then massaged in a warm solution of ash (diluted potassium hydroxide, KOH) which preferentially separates the blue pigment particles. Repeated several times, this process produces several grades of pigment, each less saturated in colour than the one before (Ganio, et al., 2017) (Figure 5. Beneath). Until the late 18th century, the only source of *'lapis lazuli'* in Europe, Asia and Africa was the remote Sar-e-Sang valley, where it has been mined for more than six millennia (Morris, 2015).

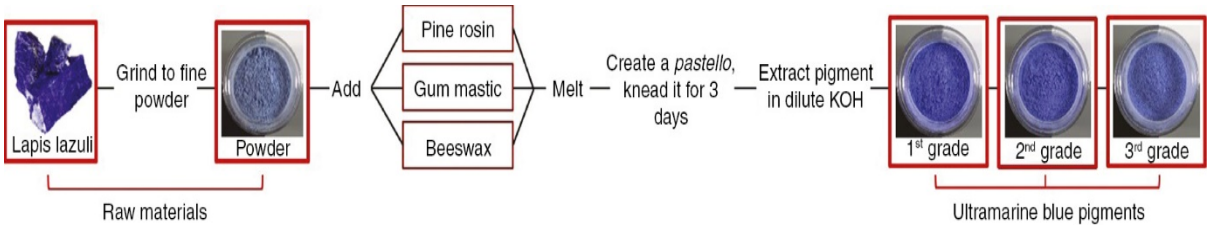


Figure 5 Cennino Cennini, process to produce *'Ultramarine blue'* from *'Lapis Lazuli'*

Any work of art is not only a sense-datum; it is also and primarily a vehicle of sensibilities, of values and of ideas, and these have not yet proven capable of being treated phenomenologically or quantitatively (Gage, 2000, 12). In the fifteenth century in the Netherlands, where oil painting was first developed in its modern form, the valuable materials such as *'lapis lazuli'* was less frequently used due to its high cost and manufacturing time. However, it was used for specific garments portraying special meanings. The goal was understanding this complex relationship of colour, psyche, and emotions that enable the artist to produce an effective work of art (Bleicher, 2005, 37). This knowledge also empowers artists to intentionally create a work that will elicit the specific desired response from the audience. Michelangelo would have to wait for his patron to purchase 'ultramarine' for his works. Durer wrote a furious letter from Nuremberg in 1508 complaining that 100 florins barely bought a pound of 'ultramarine' (Finlay, 2004, 283). Michelangelo could have used a cheaper 'blue' mineral, called 'azurite' which sometimes was called 'il blu citramarino' like 'ultramarine' (Finlay, 2004, 287). The Price of good quality *'lapis lazuli'* was remarkably stable for hundreds of years, an ounce of it typically costing around the equivalent of an ounce of gold. Even though when new sources of the stone were found in Siberia, and Chile for example, the purest product remained extremely costly (Morris, 2015).

4.2 Blue and the meaning in the works of Giotto

It is easy to turn any artist into a legend for our own amusement and sense of adventure. In Western culture, the colour 'blue' dates to 431AD, when the Christian church began to associate it with saints and religious figures to bring the history of the Bible to life. Giotto di Bondone was known as magnanimously as Giotto, the painter and architect, who was born at Colle, a little village belonging to the Commune of Vespignano in the beautiful valley of the Mugello, not many miles to the north of Florence. No authenticated evidence has been handed down regarding the exact date of his birth (c, 1265/70 - 1337). He is renowned for his naturalistic and realistic works on tempera and fresco, these two techniques which pre-date the invention of oil paint, although some early attempts may have occurred (Berrie, et al., 2016. 1). As to authentic notices concerning his life and work, there is the unsatisfactory legacy of a few scattered documents, which afford little evidence or connected dates with certain periods of his artistic activity and cast no light whatsoever upon the personality of the man himself (Perkins, 1902). Giotto used a technique for painting on wood in the 14th century, similar to those described by Cennino Cennini. The artist used an inky wash to lay in the shaded parts of the flesh and mantle. (Figure 6. Beneath)

Figure 6 Giotto, Madonna, and Child (c, 1310-1315), Samuel H. Kress Collection. National Gallery of Art Washington, D.C. (1939.1.256)

Then, he proceeded to work in egg tempera, applying overlapping strokes of thin paint to model the forms. For the most part, the pigments he used are part of the typical early fourteenth century palette, minus the expensive blue pigment lapis lazuli, which is often found in early fourteenth century panels and frescos (Berrie, et al., 2016, 2). There is no substantial evidence of where artists such Giotto obtained their colours, either from international trade of colour or whether pigments were obtained locally. Cennini alluded to artists' making some pigments themselves, but purchasing others that were troublesome to synthesize at an apothecary, and he noted that azurite, associated with silver, came from Germany or Siena (Cennini, 1954). The pigment used in 'Madonna and Child, c, 1310-1315' (Figure 6. Above), and other Florentine artists' works likely came from the ceramicists or glassmakers who would have used something similar for a colourant in their own work. It is of interest that there is no evidence for Giotto using 'ultramarine' made from *'lapis lazuli,'* particularly in this work (Berrie, et al., 2016, 2). The 'blue' paint used for the Virgin's mantle is not the deep 'blue' of *'lapis lazuli'* or 'ultramarine' but rather, it is coloured predominantly by azurite, which in this work is very pure and does not contain any detectable transition elements, impurities, or substitutions, such as zinc or manganese, which are sometimes found in azurite or malachite. In addition to azurite, there are some smaller green and green–blue particles in the paint. Raphael used 'azurite' for the robe of Christ in the oil on panel "Procession to Calvary" made between 1503 - 1505. Very often this 'azurite' was used as a base to reduce costs; however, 'ultramarine blue' was more expensive, and it is characterized by a deep, purple shade, and it looks even more beautiful. The trouble with colour symbolism or perhaps the joy of it, is that it is not constant, and it may change due to life events or other standards. It was the Pope Pius V, who standardized liturgical colour coding in the 16th century, whereas 'blue' has always been reserved for 'Queen Mary', the 'Mother of Christ', and not for the men who serve her (Finlay, 2004, 293). Another fruitful example is the vault of the Scrovegni Chapel, or Cappella degli Scrovegni (known as Arena Chapel), a small church adjacent to the Augustinian monastery in Padua, in the region of Veneto, Italy. Giotto di Bondone and his workshop was commissioned to paint and decorate the vault and walls of the church by the affluent Paduan banker, Enrico Scrovegni, as it was to serve two purposes: 1) to serve as a family private oratory; and 2) as a funerary monument for himself and his wife [Figure 7: a) & b) Beneath]

a)  b) 

Figure 7 Giotto, a) Scrovegni Chapel (Cappella degli Scrovegni, consecrated in 1305); b) Church centre vault.

One of the most important devices that Giotto uses to convey this thematic interplay is through symbolic use of colour. Using colour, he not only creates aesthetic beauty, but also creates moral and thematic connections between characters and scenes. The realistically painted architectural details create a *trompe-l'oeil* effect of surface material and 3-dimensional projection (Gage, 1995, 64; McGregor, 2015) [Figure 8: a) & b) Beneath]

a) 

b) 

Figure 8 Giotto, a) Scrovegni Chapel (Cappella degli Scrovegni, consecrated in 1305); b) Church side-walls

Here, the mind accepts a virtual reality of illusory yet ordinary space. Giotto painted these figures expressively in three-dimensional settings, creating a sense of believable realism, yet ordinary life is transcended through brightly saturated colour. Medieval aesthetes such as Abbot Suger (1081-1151), a French abbot, statesman and historian, believed that 'sensory impressions derived from bright colours drew the onlooker from the material to the immaterial, bringing the divine into human life' (Gage, 1995. 64). The fresco cycle is organized along four tiers, each of which contains episodes from the stories of the various protagonists of the Sacred History. Each tier is divided into frames, where each forming a scene. The chapel is asymmetrical in shape, with six windows on the longer south wall, and this shape determined the layout of the decoration. The first step was choosing to place two frames between each double window set on the south wall; secondly, the width and height of the tiers were fixed in order to calculate the same space on the opposite north wall. Cycles of scenes showing the Life of Christ and the Life of the Virgin were the grandest form of religious art in the period, and Giotto's cycle is unusually large and comprehensive, showing the ambition of the commission. Allowing for this, the selection and iconography of the scenes are broadly comparable to other contemporary cycles; Giotto's innovation lies in the monumentality of his forms and the clarity of his compositions.

A hundred years later, Tiziano Vecellio di Gregorio, known in English as Titian (c, 1488/90-1576), was an Italian painter from Venice and considered the most influential member of the 16th century Venetian School. He was recognized by his contemporaries as "The Sun Amidst Small Stars." He was the most versatile of painters, equally adept with portraits, landscapes, mythological and religious subjects. During the course of his life the method and technique of painting and the application of colour exercised a profound influence not only on painters of the late Italian Renaissance, but on future generations of Western artists. His artistic style changed drastically, but he retained a long-life interest in colours, which defied convention with his work of "Bacchus and Ariadne." (Figure 9: D). Beneath). Appreciating this painting from the top right to bottom left with a diagonal line dividing the painting, it can be seen that it is 'blue', which may have cost a fortune to make. This is not a biblical theme, instead, it is a mythological subject and Ariadne is wearing the Virgin's colours of 'blue' robes (Figure 9: A). Beneath). The painting was commissioned by Alfonso I d'Este, Duke of Ferrara, for the Camerino d'Alabastro – a private room in his palazzo in Ferrara decorated with paintings based on classical texts. Originally, the painting was commissioned to Raphael Sanzio da Urbino (1483-1520) and Fra Bartolommeo (1472-1517) to work on it, but both died before they could start the work, leaving only some drawings. He then decided to give it to Titian (Figure 9: A), B), C) & D). Beneath)

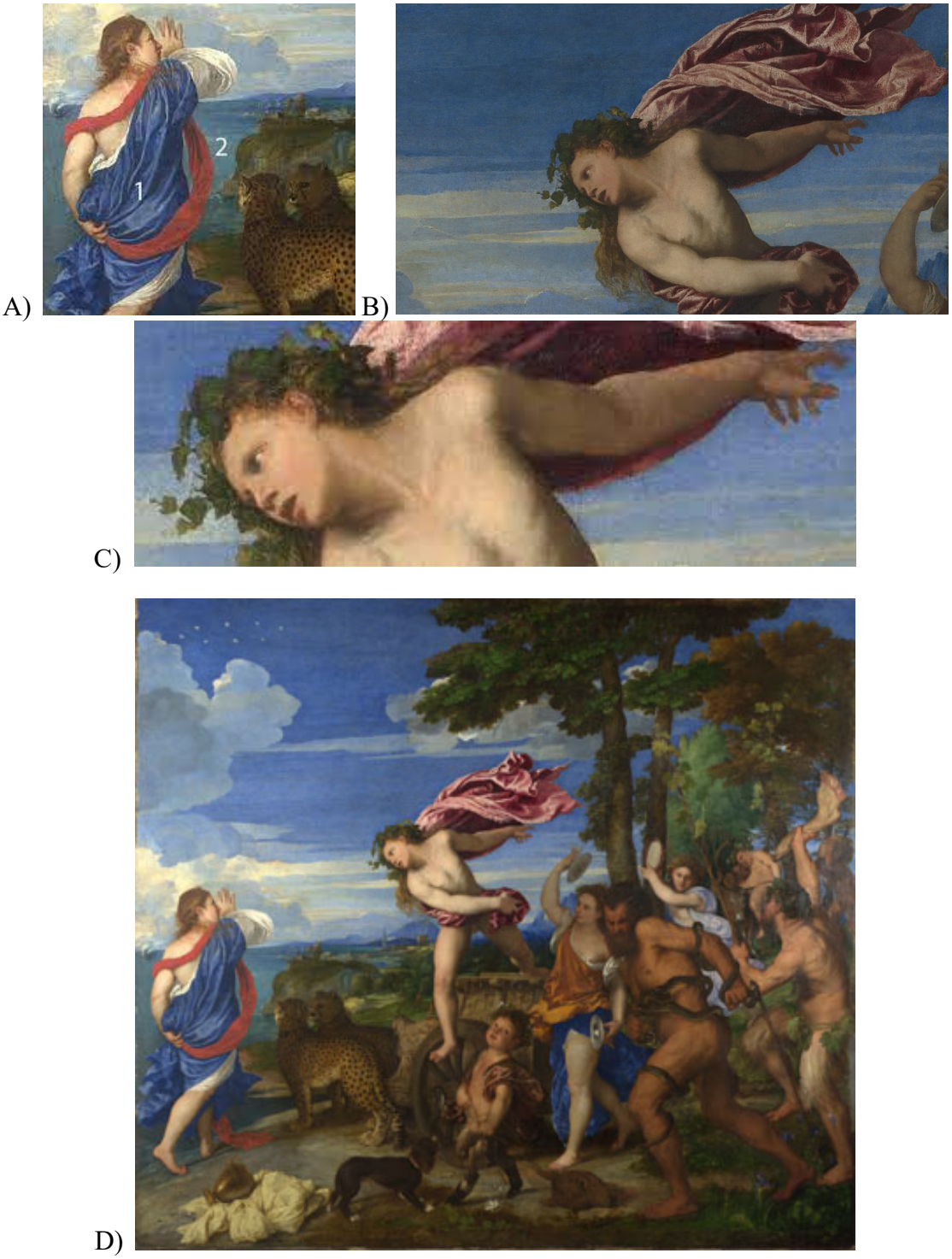


Figure 9 Titian, A), B), C), & D). 'Bacchus and Ariadne'. 175cm x 190 cm. Oil paint on canvas 1520-1523. (Source from, https://www.glennis.net/post/colour-arena-chapel)

The importance of Tiziano Vecellio di Gregorio (Titian), lies in his ability to paint expressively, embodying sensible materiality in the representation of light and colour. The pictorial corporeality in Titian, manifested in the 16th century of the Venetian Academy through the search for enlightened knowledge (Gómez, 2020), was based on the transfiguration of the vigorous strokes of his colourful brush in support of his works, in whose action, the observable reality, which the authors wish to outline, was configured in an expressive and suggestive way. Titian efficiently executed free and precise brushstrokes on the canvas and demonstrated technical solvency and mastery as a genuine

quality of his creative conception. Likewise, Titian creatively resolved pictorial representation in the field of painting itself; not necessarily, he captured the ideation of his work with the intention of capturing a mimetic reality, therefore, he expressed the creative construction of the environment of sensible reality through light and colour with excellence. The verisimilitude with which he embodied his characters in painting was devoted to the study of nuances of colours in his palette, and he was even able to paint the intangible, the ethereal in the atmosphere of his paintings. At the beginning of his career, the example to follow of artistic performance in the paintings of his time was Giovanni Bellini (1433 - 1516) and in Titian's later years, the creative personality lying in him, manifested his imprint through brushstrokes and pictorial stains, splendid in Titian. This attitude was integrated into the creative act of painting, relating to the intrinsic and sincere experience of the "elementary stage of all true knowledge" (De Luelmo, 2018, 33). For this reason, Titian sought a transcendental reference in the representation of nature, guided by the perception of light and the transfiguration of the intangible in the pictorial atmosphere, glimpsed consecutively in rhetorical eloquence by Giorgio Vasari (1511-1574) in the constant musings about the dichotomy of natural and artistic beauty (Ventura, 2012). Titian's brushstrokes shaped the fundamental meaning of the mere act of painting; he investigated the application of colour, the materiality of the pigment and the interrelation of nuances that he executed in his palette, significantly engaging with the observer of his paintings to conclude that, what was captured in painting was real and true. It should be noted that Titian not only displayed the tools and utensils of painting, but also at the end of his days, he even painted with his fingers. This last action, which allowed him to blur the contours of his main characters or figures, and in view of this fact, to approach the representation of the intangible in the atmosphere and light.

In the work of 'Bacchus and Ariadne' (1520-1523) (Figure 9: D) Above), Titian correctly composed the symbolic interpretation of one pigment, in particular the colour *'Ultramarine'*, used lavishly in the coruscating sky and in 'Ariadne's' drapery (Figure 9: A) Above) since it provided in the general composition of the painting, the particular condition of integrating the nuances of warm temperatures that significantly represented the agency of the god 'Bacchus' [Figure 9: B) & C)] (Roman equivalent of the Greek Olympian god Dionysus). The motif that produced the mythological representation in his painting, was based on classical texts. The Roman poetic text created by Catullus (87 BC – 54 BC) and Oviedo (43 BC – 17 AD), was adapted by Titian's imagination and successfully represented through an iconographic synthesis of the fantastic encounter of those mythological characters. In the course of the scene, the central representation of its creatures was pictorially illustrated, exemplifying the beauty inspired by the literary resource behind the painting (Mucznik, 2017). Princess 'Ariadne', the daughter of Minos, King of Crete, had assisted Theseus in his successful quest to kill the Minotaur deep within the labyrinth, but then she was abandoned by King Theseus, her beloved on the island of Naxos. The appearance of 'Bacchus' transformed the sorrowful event of separation from the beloved into a sacred encounter, since 'Bacchus' was captivated by the beauty of 'Ariadne' and she was snatched away to Olympus to be his wife. He gave her a seven-starred crown and ensured her immortality by converting the crown into a constellation after her death. A fundamental characteristic of feminine beauty in Titian's work, pictorial voluptuousness (Perea, 2016), is close to performing a historiography in the ideation of beauty from a symbolic perspective (Palacios, 2018). Titian, when representing this event, developed the various compositional elements of his work, combining them through an image related to the exceptional colour. The vibration of the colour pigments in said work expressed the balance of the technical trade of the colour blue: *"Ultramarine"* a revealed chromaticism (Doerner, 2005). It is important to be clear that Titian's interaction in the corpus of patronage characterized the commercial transactions in his profession as a painter and led to the patronage of the various European imperial houses (André, 2021), consolidated in Venice and surroundings (Munari, 2017).

The feminine presence that beautifully represented the aspect of 'Ariadne', was placed on the extreme left of the work; thus, said configuration originated balance and at the same time compositional tension, in whose dichotomous quality of Titian's work was in common agreement with the vigorous brushstrokes in the use of colours. Titian's pictorial trade allowed him to execute licenses in the distribution of the elements that make up the painting, whose original intention reflects the unity of the image. Thus, it is appreciated that one of those leopards close to 'Ariadne', (Figure 9: A),

Above), reflects the mirror image of her that forms the driving force of 'Bacchus's chariot. It was in this aspect that Titian manifested the feeling of the Venice school, through mastery of the technique and the execution of the beautiful colours that make up the pictorial volumes between light and the contrast of chiaroscuro (Doerner, 2005). This attitude, which Titian revealed in his colouristic technique, exemplified the essential atmosphere of a metaphysical reality throughout the picture. The corporality of colour expresses the visible spirit in the excellence of the operative process of the vigorous nuances of colours. There had been no tradition of representing these bacchanalian subjects in painting before Titian but his evocation of a pre-classical -Arcadia- populated by gods and mythical beings is compelling and magnificently painted.

CONCLUSION

'Blue', nowadays is regarded, according to opinion polls, as people's favourite colour besides 'black', at least in Western society, but this has not been always the case. In antiquity, blue had little value and normally presented negative connotations, such as its chief association with the Celts of pre-Roman Britain, as they frequently painted their bodies blue, derived from the woad *(Isatis Tinctoria)* plant, and by doing so, they terrified their enemies. Another property it was used for, was for healing battle wounds; perhaps this was the main reason for decorating their bodies with this colour 'blue'. Simultaneously, red or purple in antiquity was regarded as high status colour, and this remained the case throughout the Middle Ages. What the history of the spectrum suggests, is that there are real difficulties in perceiving and identifying colours in complex arrays, especially when their edges are undefined, and that the relative poverty of colour-vocabularies reflects these difficulties and encourages representations to be far more concerned with ideas about colours than with the colour perception themselves. It has been suggested that in the case of both Western and non-Western societies, colour usage cannot always be understood in terms of colour-science, as it may have differed considerably. Blue is the deepest, most unimpeded of colours, the gaze plumbs the depths of infinity, forever escaping it. Blue is the most insubstantial of all colours, it seldom occurs in the natural world except as a translucency, that is to say as an accumulation of emptiness, the void of the heavens and the deep of the seas. Its substantial metaphysical significance can be appreciated as along with the limitations on its clinical uses. According to Kandinsky, blue has a solemn superterrestrial gravity. This gravity may evoke the sense of death, such as in the tombs in ancient Egypt. It may also have been considered to be the colour of truth, and this is why 'blue' in the sky is the threshold which separates mankind from its rules and from beyond its fate.

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REFERENCES

André, S. (2021). "La Junta de Patrimonio de Italia: un laboratorio político (1576-1596)". *Memoria y Civilización*. 24, 2021, 105 – 127. Source from, https://hdl.handle.net/10171/63492

Andreas Petzold, 2011. Book Reviews: Blue, The History of a Color. Visual Resource. Vol 19, No. 2. Pp 155-176. Source from, DOI: 10.1080/0197376031000107212

Andrew J. Elliot (2015). Color and Psychological Functioning: A Review of Theoretical and Empirical work. Front Psychol. Vol. 6. Pp 368. Source from, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4383146/

Barbara H. Berrie, Marco Leona, Richard McLaughlin. (2016). Unusual Pigments Found in a Painting by Giotto (c, 1266-1337) Reveal Diversity of Materials used by Medieval Artist. Heritage Science. SpringerOpen Journal. Vol. 4. Issue 1. Pp 1-9. Source from, DOI 10.1186/s40494-016-0070-9

Cennino Cennini. (1954). Il Libro dell'Arte. New York, Dover Publishing

David Margulies. (2015). Lapis Lazuli, Use as Pigment. Materials History. Source from, http://www.michaelharding.co.uk/lapis-lazuli

De Luelmo-Jareño, J., M. (2018). Desvelar lo visible. Merleau-Ponty y el aprendizaje por la pintura. *Arte, Individuo y Sociedad, 30*(1). Pp 29-41. Source from, https://doi.org/10.5209/ARIS.55396

Doerner, M. (2005). Los materiales de pintura y su empleo en el arte. Reverté.

Donkin, R. A. (1977). Spanish red: An ethnographical study of cochineal and the *Opuntia* cactus. *Transactions of the American Philosophical Society. Vol.* 67. Pp 1–84.

ELIZABETH KNOWLES "blue." The Oxford Dictionary of Phrase and Fable. Retrieved June 11, 2022 from Encyclopedia.com: https://www.encyclopedia.com/humanities/dictionaries-thesauruses-pictures-and-press-releases/blue

Ernesto Pujazon, Jose Domingo Elias. (2021). Newton's Spectrum Theory, The Color Indigo and Its Mystical Practices. International Journal of Creative Research Thoughts (IJCRT). Vol. 9, Issue No. 7. Source from, http://www.ijcrt.org/

Ernesto Pujazon, Mumtaz Mokhta, Jose Domingo Elias. (2022). The Significances of RED within the Pre-Columbian Funerary Rituals. Asian Journal of Behavioural Sciences. Vol. 4. No. 1. Pp 15-42. Source from, https://myjms.mohe.gov.my/index.php/ajbs/article/view/17368

F. Mason Perkins. (1902). Giotto, The Great Master in Painting and Sculpture. George Bell and Sons. Pp 2.

Ganio, M., Pouyet, E., Webb, S., Schmidt Patterson, C. & Walton, M. (2018). From lapis lazuli to ultramarine blue: investigating Cennino Cennini's recipe using sulfur K-edge XANES. *Pure and Applied Chemistry*, *90*(3), 463-475. https://doi.org/10.1515/pac-2017-0502

Glennis McGregor. (2015). Colour Symbolism in Giotto's Arena Chapel. (Blog) Source from, https://www.glennis.net/post/colour-arena-chapel

GÓMEZ LÓPEZ, S. (2020). Armonía Del Mundo Y Retórica Celeste en La Venecia Del Siglo XVI. *Endoxa*, Vol. *46*, Pp 357–382. Source from, https://doi-org.ezproxybib.pucp.edu.pe/10.5944/endoxa.46.2020.27417

Jan Wouters, Noemi Rosario-Chirinos. (1992). Dye Analysis of Pre-Columbian Peruvial Textiles with High-Performance Liquid Chromatography and Diode-Array Detection. Journal of the American Institute for Conservation. Vol. 31. No. 2. Pp 237-255. Source from, https://cool.culturalheritage.org/jaic/articles/jaic31-02-007.html

Jean Wyart, Pierre Bariand, Jean Filippi, Carol M. Stockton. (1981). Lapis-Lazuli from Sar-e-Sang, Badakhshan, Afghanistan. GEMS & GEMOLOGY. Vol. 17. Pp 184-190. Source from, https://www.gia.edu/doc/Lapis-Lazuli-from-Sar-E-Sang-Badakhshan-Afghanistan.pdf

John Gage. (2000). Colour and Meaning, Art, Science and Symbolism. Thames & Hudson Ltd. Pp 15.

Kingsley, K. Scarlett and Richard Parry, "Empedocles", *The Stanford Encyclopedia of Philosophy* (Summer 2020 Edition), Edward N. Zalta (ed.), URL = https://plato.stanford.edu/archives/sum2020/entries/empedocles/

Lynn Edwards, Julia Lawless. (2002). The Natural Paint Decorator. Kyle Cathie Limited. Pp 12-13.

Merriam-Webster. (n.d.). Blue. In *Merriam-Webster.com dictionary*. Retrieved June 14, 2022, from https://www.merriam-webster.com/dictionary/blue

Mucznik, S. (2017). Metamorfosis: algunos mitos y sus imágenes en el arte romano. *Gerión. Revista de Historia Antigua*, *35*(1). Pp 167-186. Source from, https://doi.org/10.5209/GERI.56961

Munari, I. (2017). [SPA] Quinientos Scudos. Tiziano En El Verano De 1553, Entre Carlos V y Felipe II // Quinientos Scudos. Titian In The Summer Of 1553, Between Charles V and Philip II. *Librosdelacorte.Es*, (13). Pp 86–104. Source from, https://revistas.uam.es/librosdelacorte/article/view/7046

N. Eastaugh, V. Walsh, T. Chaplin, R. Siddall. (2007) *Pigment Compendium: A Dictionary of Historical Pigments*. Routledge.

Nikolaos Lazaridis. (2015). Amun-Re, Lord of the Sky: a Deity for Travellers of the Western Desert. British Museum Studies in Ancient Egypt and Sudan. Vol 22. Pp. 43-60. Source from, http://www.britishmuseum.org/research/publications/online_journals/bmsaes/issue_22/lazaridis.aspx

Palacios Méndez, L. M. (2018). Belleza, "venustà" y virtud: De la "bella donna anonima" al retrato de la esposa virtuosa en la Venecia de inicios del Cinquecento. *Anales de Historia del Arte*, *28*. Pp 87-111. Source from, https://doi.org/10.5209/ANHA.61605

Pedro Lilienfeld. (2004). A Blue-Sky History. Optics & Photonics News. Optical Society of America. Source from, http://web.ist.utl.pt/berberan/ESP/artigos%20diversos/blue%20sky%20history.pdf

PEREA, H. (2016). Jaime Torres Bodet. Comentarista de las artes de Italia. *Literatura Mexicana*, *27*(1). Pp 99–117. Source from, https://doi-org.ezproxybib.pucp.edu.pe/10.19130/iifl.litmex.27.1.2016.904

Peter, Bancroft. (1984). Sar-e-Sang Mine, Jurm, Afghanistan. Fallbrook-California. Source from, http://www.palagems.com/lapis-lazuli-bancroft

Petru, S. (2006). Red, Black or White, The Dawn of Colour Symbolism. Documenta Praehistorica 33. Source from, DOI: 10.4312/dp.33.18

Radovan Nečas and Dalibor Všianský. (2016). International Conference on Ecology and new Building materials and products, ICEBMP 2016 Ultramarine – not just a pigment of traditional folk architecture plasters. Procedia Engineering. Vol 151. Pp 114-118. Source from, doi: 10.1016/j.proeng.2016.07.400

Roderick Conway Morris. (Aug 18, 2015). Lapis Lazuli and the History of 'The Most Perfect' Color. The New York Time. International Arts. Exhibition Review. Source from, https://www.nytimes.com/2015/08/19/arts/international/lapis-lazuli-and-the-history-of-the-most-perfect-color.html

Shah Wali Faryad. (1999). Metamorphic evolution of the Precambrian South Badakhshan Block. Based on mineral reactions in metapelites and metabasites associated with whiteschists from Sare Sang (Western Hindu Kush, Afghanistan). Pre-Cambrian Research. Vol. 98. Pp 223-241. Source from, DOI: 10.1016/S0301-9268(99)00051-0

Steven Bleicher. (2005). Contemporary Color, Theory and Use. Thomson Delmar Learning. Pp 37-50

Suleiman Wali. (2017). Afghanistan's Beautiful Link to Da Vinci's $450 Million 'Salvator Mundi'. HussPost. Source from, https://www.huffpost.com/entry/afghanistans-beautiful-link-to-da-vincis-450-million_b_5a132ac0e4b010527d677f42

T. F. HOAD "ultramarine." The Concise Oxford Dictionary of English Etymology. Retrieved June 12, 2022 from Encyclopedia.com: https://www.encyclopedia.com/humanities/dictionaries-thesauruses-pictures-and-press-releases/ultramarine-2

Ventura, R. M. B. (2012). Lodovico Dolce e uma crítica às Vite de Giorgio Vasari. *História Da Historiografia: International Journal of Theory and History of Historiography*, *5*(9). Pp 72–87. Source from, https://doi.org/10.15848/hh.v0i9.379

Victoria Finlay. (2004). Color a Natural History of the Palette. Random House Trade Paperback Edition. Pp 270-317

Yusuf Baqai. (2018). The Power of Amun-Ra. Student Scholar Symposium Abstract and Poster. 298. Source from, https://digitalcommons.chapman.edu/cusrd_abstracts/298?utm_source=digitalcommons.chapman.edu%2Fcusrd_abstracts%2F298&utm_medium=PDF&utm_campaign=PDFCoverPages