Colors, Pigments and Traditions

(revised version in october 2008 – www.joaobarcelos.com.br)

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1. Basic Palette for Painters

It is usually seen in literature that the so-called **"basic artist's palette"** contains more or less the following colors [1]

- **Yellow**

- Cadmium Yellow (light, medium, deep)
- Yellow Ochre
- Raw Sienna
- Naples Yellow

- **Orange**

- Cadmium Orange

- **Red**

- Cadmium Red (light, medium, deep)
- Vermillion
- Alizarin Crimson

- **Blue**

- Cerulean Blue
- Cobalt Blue
- Ultramarine Blue
- Prussian Blue

- **Green**

- Viridian
- Emerald Green

- **Brown**

- Burnt Sienna
- Burnt Umber
- Raw Umber

The artist choose some colors of each set in order to form his palette, which leads approximately to 10 colors, plus black and white (flake, zinc or titanium).

[1] I will always refer to oil painting, but there is no significant differences with respect to others techniques. We are going to talk more about this soon.

Palettes formed with such colors reflect (even in an unconscious way) some concepts which are in old painting traditions, mainly in fine arts. There is certain dissemination among the artistic beliefs, also affirmed by many authors, that experienced painters do not use many colors. Of course, to use many colors at a time can be impracticable, but we are talking about using the same colors any time. Perhaps, this procedure is a vestige originated from the old masters palette (before Impressionism). We know they rarely used more than six colors (besides black and white).

We must have at least a little care in following traditions like that. Old masters did not have at their disposal the amount of pigments we have. More than that, It was themselves who made their own colors (let me, by way of illustration, mention that the first oil tube just appeared in 1841). In order to have an idea of this increasing number we mention it was registered about nine thousand dyes and six hundred pigments [2] in the 2000 Color Index international (a collection enclosing nine volumes). Five years later, the number of pigment increased to almost one thousand. It might be opportune to mention it is not the art world which dictates the research on new pigments (the quantity involved is very small). The research is mainly based on automobile and building industries.

[2] The difference between a dye (used in textile, graphical and food industries) and pigments is that the former react with the medium. Pigments do not. Now we can understand why some pigments are not compatible with all the painting techniques. What differentiates one technique from another is the binding medium where the pigment is immersed (oil – mainly linseed oil – for the oil painting; Arabic gum for watercolor; acrylic emulsion for acrylic painting etc.). Certain substance may works as pigment for a medium and as a dye for another.

The basic palette mentioned above has excellent, but very old pigments. The most recent are Titanium White and the Cadmium Red, produced in a commercial way starting from 1920. Cadmium Yellow is much older. Its commercial production dates from 1840. Excepting the Titanium White, which is still the best white we have (technically speaking), there are many others more interesting options for the remaining pigments. They come from the chemistry industry, mainly from the organic sector (based on the carbon atom and its chain property involving other atoms, mainly hydrogen, oxygen and nitrogen). In order to situate in time, we mention that the Organic Chemistry appeared in the middle of 19th century.

The only organic pigment which appears in the "basic palette" is the Alizarin Crimson, initially obtained from a plant called *madder*. Coincidently, Alizarin was one of the first pigments to be synthesized by the Organic Chemistry. The other pigments are mineral and many of them are obtained in a synthetic way. There are many people who still believe that earth colors (Naples Yellow, Yellow Ocher, Raw Sienna, Burnt Sienna, Row Umber and Burnt Umber) are extracted from natural sources. This might be actually true, but in a scale close to extinction [3]. Further, there are some pigments which do not exist anymore.

[3] To have an idea of this fact, let us mention that there are 169 manufactures of the synthetic Yellow Ocher and just two from natural sources, registered in the 2005 Color Index International.

2. On the Colors of the Basic Palette

Now, we start to discuss the colors mentioned in the basic palette with more details. We begin with Alizarin Crimson. It is a red with a beautiful violet shade, mainly known by its transparency. It is rare to find an artist who does not look for it. However, many are not conscious that Alizarin Crimson has little resistance to light, with a classification just **reasonable**, in a scale where the two levels above are **very good** and **excellent**. This means that its color will fade (around ten to twenty years with indoors light). So, we cannot think to use Alizarin Crimson in paintings which will be exposed outdoors.

Nowadays there exist much better alternatives to replace Alizarin Crimson. For example, the Winsor&Newton has been commercializing, both in artist and student lines, the so-called "Permanent Alizarin Crimson" (please see Fig. 1). It is made from a pigment also transparent, but with excellent lightfastness (something estimated in 150 years, or more, with indoors illumination). However, we must pay attention because the name given to this new product is a fantasy name. The pigment used in the "Permanent Alizarin Crimson" belongs to another family in the Organic Chemistry classification, with different characteristics of the old Alizarin Crimson (we are going to see more details soon).

It is not difficult to find other manufacturers that may use this same name but with another pigment or this pigment with another name. This can produce a great confusion. Further, there are many pigments today that can replace old pigments of the "basic palette" with advantages, in quality and price. These new pigments are commonly found with old names. Consequently, this may lead us to use modern pigments but keeping mind in the past. The worst of this procedure is that we may not figure out all the advantages that modern pigments may have.

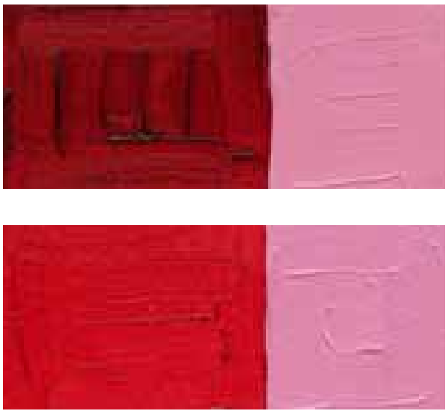


Figure 1: Comparison between Alizarin Crimson (PR83) and Permanent Alizarin Crimson (PR177) (we are going to talk on the codes used inside parenthesis more ahead). The clearer part of the figures correspond mixtures with white (titanium).

Let us now consider the Cadmium Yellow, Red and Orange. Contrarily to Alizarin Crimson, they are pigments of excellent lighfastness. There is no problem in using them and they are always welcome in any palette. However, they become relatively expensive and usually appear in series 4 of artist lines (how bigger is the series higher is the price [4]).

[4] This does not necessarily mean that how bigger is the series better is the quality. There are pigments or which are difficult to be synthesized or are processed form expensive substances. In these cases, prices become higher. Nowadays, pigments based on cadmium and cobalt (mainly this) are among the most expensive.

It is difficult to have confidence in cheap colors containing cadmium or cobalt pigments. Probably they also contain some extender (an inert substance to save pigment - usually calcium carbonate). After some experience we may know if certain color contains little pigment or not because we have to use a reasonable amount to mix with other colors, especially white. This may occur with student lines. Good colors are usually found in artist lines [5].

[5] Student lines usually contain half of the pigment found in the corresponding artist lines. It is common to hear that artist colors contain 50% of pigment and 50% of medium (generally linseed oil) and no extender. Concerning the extender, it is good if it is actually not there. However, the proportion between medium and pigment depends on its characteristic. There are cases where the amount of pigment reaches 80% and there are others with less than 50%.

One can find excellent alternatives among organic pigments, with excellent or very good lighfastness, which replace the cadmium colors. Under certain circumstances, they may have advantages, because are transparent or semitransparent (a characteristic that cadmiums do not have). Another important aspect is that organic pigments lead to bright mixtures with white, usually much more radiant than the ones obtained from mineral pigments [6]. Thus, when the question of opacity is not important and when the subject of painting asks for transparent pigments, why do not use them? Why one has to be prisoner of old traditions, of a time whose boundary conditions are completely different of ours? Please see Fig. 2 where we can compare cadmium pigments (yellow and red) with two common organic ones.

[6] As illustration, I would like to mention that there exists a transparent mineral yellow pigment, processed from cobalt (please see the table at the end of this paper). It has very good lightfastness but, as any pigment processed from cobalt, it is too much expensive.

Figure 2: Comparison between yellow and Cadmium Red (PY35 e PR108) with organic pigments (PY74 and PR112).

To conclude this part let me say that one of the advantages of cadmium pigments, comparatively with the organics, is that they resist to higher temperatures, something around 1800 degree Fahrenheit. For the organics, the limit temperature is between 400 F and 600 F. In case of paintings on porcelain, this is an advantage that may be taking into account. However, for painting on paper, canvas and panels this of course is not so important.

Let us continue and talk about the two greens. Today, Emerald Green is just a name. The corresponding pigment does not exist anymore. It was poisonous (copper aceto-arsenite) and had a weak lightfastness. Its production was discontinued after the Viridian invention (before 1860). Viridian is transparent and inorganic, obtained from chromium oxide green (still much used), which is opaque, in an interesting hydration process (please see the two first examples of Figure 3).

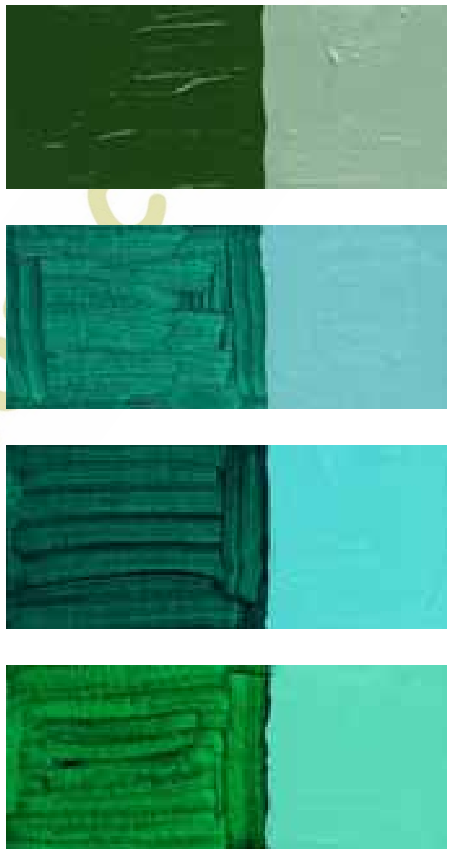


Figure 3: Chromium Oxide Green (PG17), Viridian (PG18) and Phthalo Greens (PG7 e PG36).

Currently, the Viridian cost is high (series 4) and has been replaced by one of the Phthalo Greens (there are two). These are organic pigments, more transparent than Viridian and with a very high tinting strength. Sometimes it is commercialized as a Viridian Hue o even as Emerald Green (in this case it is not necessary to use the word hue because Emerald Green is not manufactured anymore).

Phthalo Green is one of the most important pigments of ours days and is considered one of the highest legacy from the chemical industry for the artistic paintings [7]. It is a pity that a so important green is introduced in the art scenario as if it was the Viridian or even the deceased Emerald Green.

[7] To have an idea of its importance, we mention that among all pigments in the 2005 Color Index International, this phthalo has the biggest number of manufactures in the world, 368.

As it was said, there are two Phthalo Greens. The second one tends to yellow a little more (the phthalo we have talked about tends to blue) and, so, does not appear as a substitute of any older green (please see Fig. 3 above, where one can make a comparison with the previous phthalo and also with the Viridian). People believe if this phthalo had been invented first the importance of phthalos would be more appreciated.

Among the blues, one has that Cobalt Blue and Cerulean Blue (which is also made from cobalt) are very expensive (series 5 or 6). This is an interesting fact because Cobalt Blue was invented to be a cheaper alternative for the Ultramarine Blue, which was almost inaccessible for many painters. Ultramarine Blue was obtained from a semiprecious stone, called *lapis lazuli* (the commercialization of Cobalt Blue began around 1820 and Cerulean Blue fifty years later).

The synthesis of Ultramarine Blue (1828) is also considered another great legacy of the chemistry research. It allowed many artists have access to this beautiful and important pigment. Today, the relative position between Cobalt and Ultramarine Blue has changed. Many manufactures start from Ultramarine to simulate Cobalt Blue (in fact, both have a great similarity – Fig. 4). These blues, and also de Cerulean, are pigments of excellent lightfastness.

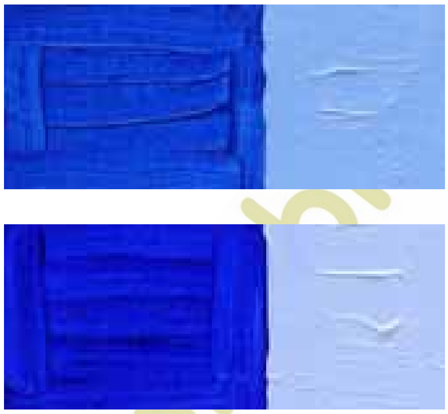


Figure 4: Cobalt (PB28) and Ultramarine (PB29) Blues

Concerning Prussian Blue, which dates back much earlier (1724), is also an excellent pigment. It is synthesized from iron (that is why the old name Iron Blue). It is transparent or semitransparent (it is not poison as someone believes). Although easily found and having a low price (series 1), it has been replaced for another pigments with similar characteristics, but with a more tinting strength, the Phthalo Blue (this name generically refers to a family containing seven pigments). Imitations of Cerulean Blue (or others, called Celestial Blue etc.) are done by starting from Phthalo Blue, sometime by just adding white. These resulting colors are very nice and can make us to forget the expensive Cerulean Blue. Please see Fig. 5.

In summary, Ultramarine and one (or more) of the Phthalos are good choices to appear in any palette, taking into account beautifulness, excellent quality and cost/benefit coefficient.

Finally, let us consider the "earth colors", which are Naples Yellow, Yellow Ochre, Raw Sienna, Burnt Sienna, Raw Umber and Burnt Umber. Although I have not included in the initial set, there is also the Venetian Red and Terra Verte. The former corresponding pigment also appears with many other names like Indian Red, Terra Rosa, English Red, Mars Red etc.). As the name "earth colors” indicates, these are pigments obtained from natural sources. In spite of some manufactures still appeal to these sources, the synthesis by the chemistry industry is more practical and economically advantageous. Further, one still has the control of quality because there is no problem related to changing of shades from one source to another. However, not all of them are synthesized. The most important are Yellow Ochre and Venetian Red. Sometimes this last one is directly sold as Burnt Sienna, for desperation of experienced painters who find it (with reason) too much red.

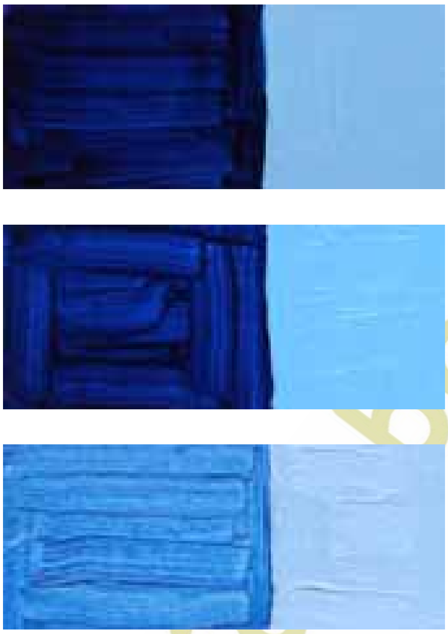


Figure 5: Prussian (PB27), Phthalo (PB15:3) and Cerulean (PB35) Blues

Unfortunately, it seems that some artists are not aware of the transparent versions of these two pigments, which have slightly different shades. These are commercialized with their own characteristic names (or with few modifications), i.e., Transparent Yellow and Transparent Red Iron oxides.

The red version has a shade much closer to the old Burnt Sienna (in my opinion still more beautiful). Please see Fig. 6 for comparisons. In Fig. 7 we find the Natural Yellow Ochre and both versions (opaque and transparent) of the synthetic case.

Figure 6: Natural Burnt Sienna (PBr7), Venetian Red (PR101) and Transparent Red Iron Oxide (PR101).

The transparency and shadow of these iron oxide versions are due to the relative small size of the pigment granulation. Other earth colors are obtained directly from mixings.

With respect to Naples yellow, it is found in literature as a very dangerous pigment because contains lead. This is actually true for the old Naples yellow, extracted from natural sources. Today, the colors which appear in the stores with this name are imitations (there is no term “hue” because the old Naples yellow does not exist anymore). It is lead free and can be used without problems. Your shadow is usually matched by mixing yellow ochre (transparent or not) with white.

Figure 7: Natural Yellow Ochre (PY43), Synthetic Yellow Ochre (PY42) and Transparent Yellow Iron Oxide (PY42).

I have not included any violet into the "basic palette" because, by tradition, one says that violet is nothing more than a mixing of blue and red. Roughly speaking it is true as it is also true that green is just a mixing of blue and yellow [8]). However, by mixing blue and red one may reach a violet with poor or not desired characteristics (as well as one does not get a green with the characteristics of a Phthalo Green by just mixing blue – cyan – and yellow). An excellent violet pigment of the past (and still in the present) is the Cobalt Violet. But, taking into account what we have seen on the high prices of pigments made from cobalt, this may not be a reasonable option. Actually, it is not. Also in this part there are options among organic pigments. One of the most distinguished is the Dioxazine, which is commercialized with this name (or others more attractive). Please see Fig. 8.

[8] If someone roughly identify magenta as violet will be in trouble, because magenta is a primary hue and, consequently, cannot be matched anyway. In the same manner, just cyan gives green when mixing with yellow. In case of mixing blue and yellow the result is black! Please, see my other paper "Color Mixing for the Artist – Part I"

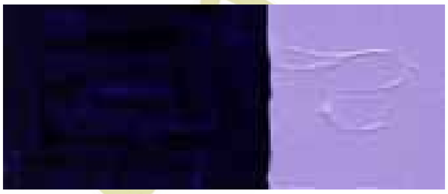


Figure 8: Dioxazine (PV23).

3. Today scenario evolved from Impressionism

The purpose of everything was said in the previous sections is to call our attention that old traditions cannot be sustainable in a near future (if it is not already today) and may become fictitious. The chemistry industry has given us a great number of new and interesting pigments. If it was not this development there would not have been technical conditions for the impressionist movement come out (in the middle of 19^{th} century). The naive information we usually hear is that Impressionism arose because oil tube was invented and painters could practice the *plein air*. Of course, this gave a contribution, but the Impressionism roots are much deeper and more interesting. Let us briefly discuss about them in order to be situated in time and become more conscious on the power that scientific discoveries can have on the quality of a piece of art. By the way, what we have at our disposal is incommensurably bigger of what the impressionists had (at the end we are going to talk on the impressionist palette).

Before the Impressionism there were two important currents, polarized by two great artists, Ingres and Delacroix. The former defended the valorization of form and the precise lines of drawing (Neoclassicism). In fact, this kind of attitude was a central idea of any current till that time. In other words, colors should continue to play the role of a co-star in the artistic scenario. For Delacroix, colors should play the principal role (Romanticism). Of course, this was an idea much ahead for his time. It is opportune to mention that landscapes, where colors naturally would have an important role, were not of relevant interest for painting.

There were many important events at that time, as in any other of the history of art, that create suitable conditions for appearing a new kind of painting, much more free and with colors playing the main role (that reached its apex not in the Impressionism, but in the next artistic period, known as Post-impressionism, mainly in the Van Gogh works). One of these events was the invention of photography and the quick access to cameras and films. Many popular artists, that painted small figures for a living, had their sustenance disappearing almost from night to day. For many artists, combination of painting and photos was considered to be impossible and an inconvenient task, a feeling that is still found today.

With no doubts the advent of photography changed the rigid form of painting and opened a door, such that colors could enter as the main stars. This is the principal characteristics of the impressionist movement.

The photography was used as an auxiliary tool for impressionists like Manet, Degas, Sisley, Toulouse-Lautrec, Sargent, among others. For them, photography facilitated the register of moving scenes, as well as to catch some details to late on complete the painting in the studio. They did not painting <u>from</u> photos, but <u>with</u> photos. This was a technique resource which allowed the imagination and creativity to start more ahead. In fact, these were almost the words said by Delacroix, one of the first user of photos as an auxiliary tool for painting.

It is also important to emphasize that the photography invention would not be sufficient alone to make the impressionist movement comes out. Almost at the same time there was the so called industrial revolution. This allowed, by means of the chemistry industry, an access to a wide variety of new pigments (but sometimes without much control of quality for the artistic paintings). Of course, the invention of the oil tube facilitates the *plein air* painting and the landscape theme could be explored in its plenitude. There were also the developments in Optics, first in the Maxwell electromagnetic theory. It was also due to Maxwell the idea that we just have three kinds of sensors in retina. Later on, Chevreul introduced the notion of complementary colors, which was much explored not only by impressionists, but by post and neoimpressionists also.

4. Identification of Pigments

A question I now place is how one gets a domain on colors, besides this high number of pigments, their mixings and a much higher numbers of names?

The identification of colors by names, something natural till the middle of 19^{th} century (or a little more), when the majority of colors of the “basic palette” were discovered, become impracticable nowadays (just few can be done in this way). I find opportune to say again on the procedure adopt by respectable manufactures, following many times the legislation of their countries. The name of the color in the tube should be the official name related to the corresponding pigment (for mixings, there is no rule). For example, we know that Cobalt Blue is among the most expansive colors. However, it can be matched by mixing some pigments (usually starting from ultramarine). In this case, the name "Cobalt Blue" should not appear alone in the tube. What is done by these manufactures is to add the term "hue" after "Cobalt Blue". This means that tube may contain the color of "Cobalt Blue", but not the pigment characteristic of the Cobalt Blue.

Until almost the end of 19th century this procedure gave a control on names and pigments. Today it is obsolete, because the high number of new pigments. Further, their names are so strange that manufactures usually have no interest in using them. The number of pigments that grows more is in the organic sector, where they are organized in families (characterized by certain structures of the carbon atom). Today we have the following principal families:

- Azo
- Isoindolinone
- Phthalocyanine
- Quinacridone
- Anthraquinone
- Diketo Pyrrolo Pyrrole
- Oxazine
- Triarylcarbonium
- Methine and Polymethine

Inside each one of these families, there are many pigments, whose specific names are not much attractive either. Thus, we in fact realize that manufactures are right in avoiding these names. What they generally do is trying to find more pleasant ones. Sometimes, old names are resuscitated, as Emerald Green, Vermilion, Indian Yellow etc. The similarity is just in the hue, because they are very different with respect to lightfastness, toxicity, opacity etc. When an organic pigment is sold as a mineral one, the artist may be induced to believe in a completely different kind of product. More than that, he may not realize all the features that the new pigment could give to him. Another interesting point is that new pigments, used as an imitation, can be much better than those they are replacing (an unusual thing when one talks on imitation).

As it was said, there is a great diversity of names given by manufactures. It is possible to find colors with the same name and made from different pigments and, what it is much common, colors with the same pigment but having different names (we are going to see more details in the next section). In case of mixings, the number of different names increases much more. In order to have an idea, I look at the artist charts of 16 manufactures, and isolate the main pigments they used. I could see that this number is around forty. These appear in almost six hundred mixtures with the most different names. Of course, this number would increase much more if I look at the charts of student lines.

In summary, it is practically impossible to identify a color and its characteristics just by its commercial name. For this reason, a kind of code with letters and numbers (or just numbers) was created to identify pigments. This is a standard procedure used in all world, called "Color Index", or CI for short. We list below the letters used in these codes

PB	Pigment Blue
PBk	Pigment Black
PBr	Pigment "Brown"
PG	Pigment Green
PO	Pigment Orange
PR	Pigment Red

PV Pigment Violet

PY Pigment Yellow

PW Pigment White

As examples, we mention that Cobalt Blue is classified as **PB28**, Prussian Blue as **PB27**, Ultramarine Blue as **PB29**, Cerulean Blue as **PB35** etc.

This kind of identification is more common and appears in tubes of colors. There is another one containing just numbers. As illustration we mention that, for the same pigments above, we have: Cobalt Blue, **77346**; Prussian Blue, **77510**; Ultramarine Blue, **77007**; Cerulean Blue, **77368**. Looking at these numbers, it might appear that the two first numerals, **77**, characterize the blue. This is not true. For example, cadmium yellow (**PY35**) has also the code **77205** and the first phthalo blue (**PB15**), **74160**.

A certain pigment has some characteristics which are inherent to its structure, independent of manufacturer name. The most important are **lightfastness** and **transparency**. The only factor which may depend on the manufacturer is the series, but, as we have seen, this is not necessarily related with the quality of the pigment. We just mention that lightfastness and transparency may vary for one medium to another. For example, in watercolor, pigments may become more transparent and with less lightfastness.

A problem we have to deal with the CI numbers is that they are written in a very small size. To whom that do not use the same colors at all times (like me) this may lead to some difficulties. The way I found to circumvent this problem is to put a label in tubes and write the CI numbers in a large size (I do not care about the fantasy name). Please see Fig. 9. I take this opportunity to suggest the manufactures to adopt a procedure like that.

Figure 9: CI numbers in a large size

5. Table with some of the main pigments

In the table which follows, I am going to mention the main pigments used in the artist's oil colors of the following manufactures (alphabetic order): Blockx, Da Vinci, Fragonard, Gamblin, Grumbacher, Holbein, Lefranc, Maimeri, M. Graham, Mussini, Norma, Old Holland, Permalba, Rembrandt, Sennelier and Winsor&Newton. I will just refer to tubes containing one pigment (no mixings) and use the convention

Opacity Rating:

□ Transparent
□■ Semi-transparent
■ Opaque

Lightfastness Rating:

I Excellent
II Very Good
III Moderate

MINERAL (NATURAL)

These are pigments obtained from natural sources. Most of them have a synthetic counterpart, but almost all manufactures still use the natural case. In spite of this, the tendency is to opt just for synthetic pigments in a near future (where the problem of different hues for different sources does not exist). In the examples below, pigments will be just mentioned in a general way. For more details on mineral pigments (natural or synthetic) please see my article entitled "Inorganic Pigments".

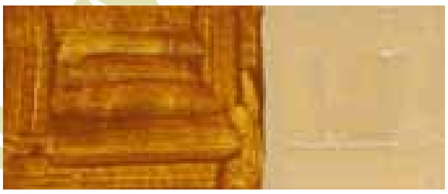
PY43 – Natural Hydrated Iron Oxide ■ I

This is the well-known **Yellow Ochre**, one of the oldest pigments. It has been replaced by the corresponding synthetic version **PY42**.

PR102 – Natural Red Iron Oxide ■ I

This pigment is rarely used today. It has been almost totally replaced by the synthetic version **PR101**.

PBr7 - Natural Iron Oxide □ I



This is the natural pigment which is still much used, besides its hue can be matched starting from the transparent version of **PY42**. It also appears in three other forms:

Calcined Natural Iron Oxide □ I

This is still found, it is the well-known **Burnt Sienna**. Sometimes it has been replaced by the transparent version the **PR101** (also sold as burnt sienna).

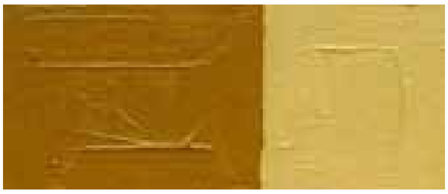
Calcined Natural Iron Oxide with Manganese □■ I

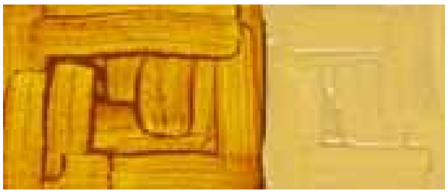
Natural Iron Oxide with Manganese □■ I

MINERAL (SYNTHETIC)

Today, there are much more synthetic organic than mineral pigments (a very different scenario from the Impressionist time), but they still play an important role in any palette. Let us start with the ones we have mentioned above.

PY42 – Synthetic Hydrated Iron Oxide I

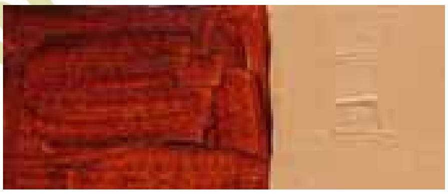




As it was mentioned, there are two versions of the synthetic hydrated iron oxide, one opaque and other transparent. Both have the same CI because the pigment is the same. The difference between them is due to the granulation size (the transparent case corresponds to the small size). There is no problem in identify these two cases. The transparent one is sold as **Transparent Yellow Iron Oxide** (or other similar name containing the word "transparent").

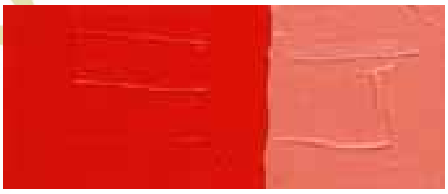
We take this opportunity to mention that this same characteristic appears in others pigments (but not too much). One of the oldest examples is the **Ultramarine Blue** (**PB29**), but the hues are not so different.

PR101 – Synthetic Red Iron Oxide I



The reason for two different colors with the same CI number is the same as in the previous case. The transparent version is sold as **Transparent Red Iron Oxide**, but due to its similarity with the old **Burnt Sienna**, it may be also commercialized with this name.

PY35 – PR108 – PO20 - Cadmium Yellow, Red and Orange Pigments ■ I



These pigments have their hues varying considerably depending on the degree of calcinations (the same as occurred with the PBr7).

It is not also difficult to identify a color with cadmium pigment because it is sold with the name cadmium. The problem we have with cadmium pigments is that they become much expensive. Today, there are many excellent pigments in the organic sector which can replace the cadmiums with advantages.

PY40 – Potassium Cobaltinitrite □ II

This is a famous mineral pigment, known as **Aureolin**. Oil colors with this name are sold by Blockx, Grumbacher, Holbein, Sennelier and Winsor&Newton. In Fragonard chart, it receives the name **Fragonard Aureoline**, and in Old Holland, **Cobalt Yellow Lake**.

This is a pigment synthesized from cobalt. As we have seen, pigments with this characteristic are among the most expensive. Today, we can find many other excellent and better options in the organic sector.

PBr24 – Oxides of Titanium, Antimony and Chromium ❑■ I

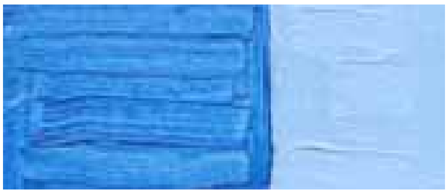
This is an excellent pigment which has been used by many manufactures. Since it resembles Yellow Ochre and also Naples Yellow, some manufactures adopt such names. We thus have.

- **Fragonard Earth Yellow** (Fragonard)
- **Chrome Titanate Yellow** (Grumbacher)
- **Naples Yellow Deep** (Mussini)
- **Naples Yellow Deep Extra** (O. Holland)
- **Yellow Ochre Light** (Rembrandt)
- **Light Yellow Ochre** (Sennelier)

PG17 – Chromium Oxide ■ I

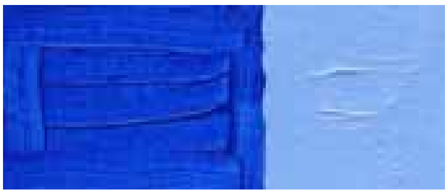
This is a good option of a opaque pigment. It is commercialized by almost all the manufactures, except M. Graham and Fragonard. There is no problem in identifying this color because it is sold as **Chromium Oxide Green** or small variations about this name. The only exception is Blockx that gives the name **Lamoriniere Green**.

PB35 – Oxides of Cobalt and Tin ■ I



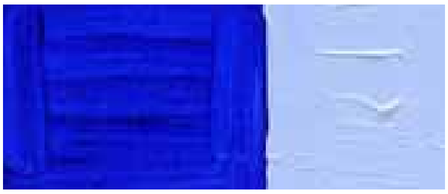
It is a very expensive color (contains cobalt). Only Da Vinci does not commercialize it. It is sold as **Cerulean Blue** or small variations around this name (sometimes the pigment **PB36** is used instead – Oxides of Cobalt and Chromium – it has a similar hue).

PB28 – Oxides Cobalt & Aluminum ❑■ I



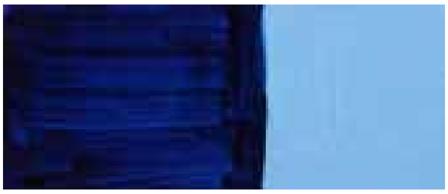
An expensive pigment and usually sold by all manufactures as **Cobalt Blue** or slightly variations around this name.

PB 29 – Complex Silicate of Sodium & Aluminum with Sulfur □ I



It is a much used pigment and sold with the name **Ultramarine**. It appears in a deeper version with small granulations. However the hue does not change considerably.

PB27 – Alkali Ferriferrocyanide □ I



It is a very common pigment and is commercialized with the name **Prussian Blue**.

ORGANIC

These are pigments based on the carbon rings. They are transparent or semitransparent and are characterized by a high tinting power. What much people do not know is that around 70% of pigments used by manufacturers are organic. Here resides the necessity of correctly identify them. They are usually sold with old names, generally related to mineral pigments. That is the reason why we are not conscious of this high number.

In the names in which follow, I will just mention the family which the pigment belongs.

YELLOWS:

PY3 – Monoazo □■ II

We observe that this pigment resembles the color of the lemon yellow. That is why it is much found with names containing these words.

- **Hansa Yellow Light** (Da Vinci)
- **Hansa Yellow Light** (Gamblin)
- **Japanese Yellow Lemon** (Lefranc)
- **Hansa Yellow** (M. Graham)
- **Lemon Yellow** (Mussini)
- **Lemon Yellow** (Norma)
- **Scheveningen Yellow Lemon** (O.H.)
- **Cadmium Yellow L. Hue** (Sennelier)
- **Winsor Lemon** (Winsor&Newton)

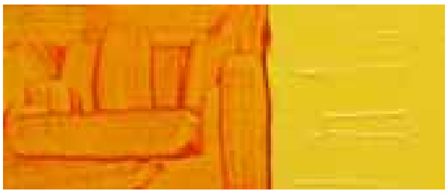
PY65 – Monoazo □■ I

- **Deep Chrome Yellow Hue** (Fragonard)
- **Diarylide Yellow** (Grumbacher)
- **Chrome Yellow Deep Hue** (Lefranc)
- **Sahara Yellow** (Lefranc)
- **Winsor Yellow Deep** (Winsor&Newton)

PY74 – Monoazo □■ I

- **Light Chrome Yellow** (Fragonard)
- **Hansa Yellow Medium** (Gamblin)
- **Japanese Yellow Light** (Lefranc)
- **Schev. Yellow Light** (Old Holland)
- **Winsor Yellow** (Winsor&Newton)

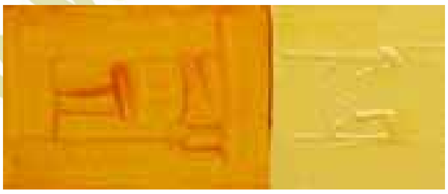
PY83 – Disazo □ I



This (as well as **PY110** and **PY153**) is sometimes sold as **Indian Yellow** because the similar hue of an old and fugitive organic natural pigment (made from urine of cows). However, these new ones have excellent lightfastness and, except the hue, do not have anything in common with the old **Indian Yellow**.

- **Indian Yellow** (Gamblin)
- **Shev. Yellow Deep** (Old Holland)
- **Indian Yellow Permanent** (Permalba)
- **Indian Yellow Orange** (Sennelier)
- **Bright Yellow** (Sennelier)

PY110 – Isoindoline □ I

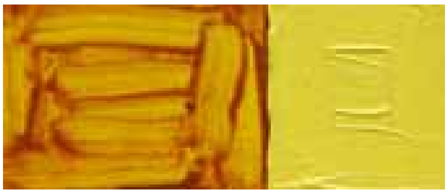


- **Indian Yellow** (M. Graham)
- **Stil de Grain Yellow** (Rembrandt)

PY129 – Methine and Polymethine □ I

- **Azo Green** (M. Graham)
- **Old Holland Golden Green** (O.H.)
- **Transp. Golden Green** (Rembrandt)
- **Golden Green** (Sennelier)

PY150 – Monoazo □ I



We observe that it has a similarity with the hue of **PY40** (Aureloline).

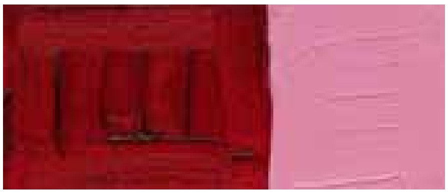
- **Translucent Yellow** (Mussini)
- **Aureoline** (Rembrandt)

PY153 – Methine and Polymethine □ I

- **Indian Yellow** (Mussini)
- **Indian Yellow** (Norma)

REDS:

PR83 – Anthraquinone □ III

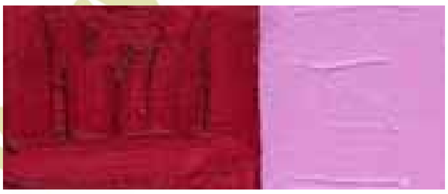


- **Alizarin Crimson** (Gamblin)
- **Alizarin Crimson** (Grumbacher)
- **Alizarin Crimson** (Holbein)
- **Alizarin Crimson** (Lefranc)
- **Alizarin Crimson** (M. Graham)
- **Alizarin Madder Lake** (Mussini)
- **Mad. (Crimson) Lake Deep Ex.** (O.H.)
- **Alizarin Crimson** (Sennelier)
- **Alizarin Crimson** (Winsor&Newton)

PR112 – Monoazo □■ II

- **Naphthol Red** (Gamblin)
- **Grumbacher Red** (Grumbacher)
- **Naphthol Red** (M. Graham)
- **Scheveningen Red Light** (O.H.)
- **Scheveningen Red Medium** (O.H.)

PR122 – Quinacridone □ I



- **Fragonard Pink** (Fragonard)
- **Quinacridone Magenta** (Gamblin)
- **Thio Violet** (Grumbacger)
- **Transparent Rose** (Holbein)
- **Permanent Violet** (Lefranc)
- **Verzino Violet** (Maimeri)
- **Translucent Magenta** (Mussini)
- **Ruby Red** (Norma)
- **Old Holland Magenta** (O.H.)
- **Quinacridone Magenta** (Sennelier)

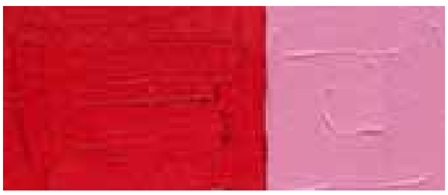
PR149 – Anthraquinone □ I

- **Rose Madder Pale** (Blockx)
- **Perylene Red** (Holbein)
- **Perylene Red** (Gamblin)
- **Bright Red** (Lefranc)
- **Perylene Red** (Permalba)
- **Scarlet** (Rembrandt)
- **Winsor Red Deep** (Winsor&Newton)

PR170 – Monoazo □■ II

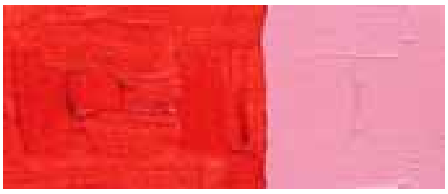
- **Lefranc Red** (Lefranc)
- **Cadmium Red Medium Hue** (Sennelier)

PR177 – Anthraquinone □ I



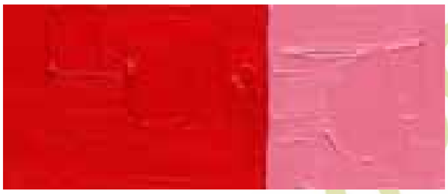
- **Crimson Lake Transp. Red** (Holbein)
- **Carmine Lake Hue** (Lefranc)
- **Anthraquinone Red** (M. Graham)
- **Ruby Madder** (Norma)
- **Burgundy Wine Red** (Old Holland)
- **Permanent Alizarin Crimson** (W&N)

PR209 – Quinacridone □ I



- **Tiziano Red** (Maimeri)
- **Quinacridone Red** (M. Graham)
- **Madder Lake Brilliant** (Mussini)
- **Crimson Lake** (Sennelier)

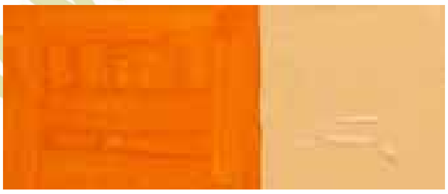
PR254 – Diketo Pyrrolo Pyrrole □■ I



- **Sandal Red** (Maimeri)
- **Permanent Red Deep** (Rembrandt)
- **Bright Red** (Winsor&Newton)

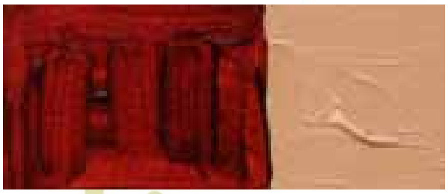
ORANGES:

PO62 – Monoazo □■ I



There are many alternatives in organic sector for replacing the cadmium orange. The example above is commercialized by Gamblin with the name **Mono Orange**.

PO48 – Quinacridone □ I

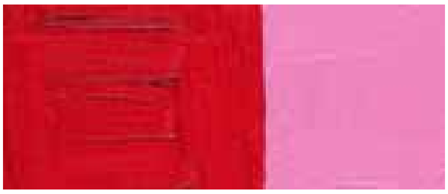


This may be an alternative in organic sector for the old burnt sienna.

- **Quinacridone Organge** (Grumbacher)

VIOLETS:

PV19 – Quinacridone □ I

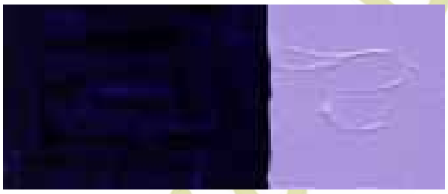


There are two versions for this pigment depending on the granulation size. The manufactures usually commercialized both and there is no mistake in finding one or another.

- **Magenta** (Blockx)
- **Rose Lake** (Blockx)
- **Quin. Alizarin Crimsom** (Da Vinci)
- **Rose Madder** (Da Vinci)

- **Red Rose Deep** (Da Vinci)
- **Solid Madder Lake Rubine** (Fragonard)
- **Garnet** (Fragonard)
- **Quinacridone Red** (Gamblin)
- **Quinacridone Violet** (Gamblin)
- **Quinacridone Red** (Grumbacher)
- **Thalo Red Rose** (Grumbacher)
- **Alps Red** (Holbein)
- **Ruby Red** (Lefranc)
- **Lefranc Crimsom** (Lefranc)
- **Primary Red** (Maimeri)
- **Rose Lake** (Maimeri)
- **Quinacridone Rose** (M. Graham)
- **Quinacridone Violet** (M. Graham)
- **Caesar Purple** (Mussini)
- **Sheveningen Rose Deep** (Old Holland)
- **Sheveningen Violet** (Old Holland)
- **Quinacridone Red** (Permalba)
- **Quinacridone Violet** (Permalba)
- **Quinacridone Rose** (Rembrandt)
- **Quinacridone Violet Med.** (Rembrandt)
- **Magenta** (Magenta)
- **Permanent Rose** (Winsor&Newton)
- **Permanent Violet** (Winsor&Newton)

PV23 – Oxazine □ I

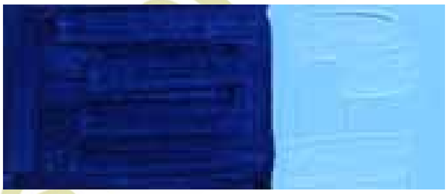


This pigment and the violet version of the **PV19** are excellent suggestion to replace the expensive mineral violet comes from cobalt.

- **Dioxazine Mauve** (Blockx)
- **Deep Oriental Violet** (Fragonard)
- **Dioxazine Purple** (Gamblin)
- **Dioxazine Purple** (Grumbacher)
- **Permanent Violet** (Holbein)
- **Violet (Blue Shade)** (Le Franc)
- **Violet Lake** (Maimeri)
- **Translucent Violet** (Mussini)
- **Dioxazine Mauve** (Old Holland)
- **Dioxazine Purple** (Permalba)
- **Dioxazine Violet** (Sennelier)
- **Winsor Violet** (Winsor&Newton)

BLUES:

PB15 – Phthalocyanine □ I



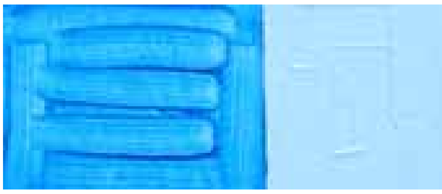
This has almost the same hue as **PB15:1** and differs just a little from the **PB15:3** (the second pigment where there are more producers in the world – the first one is the **PG7**)

- **Blockx Blue** (Blockx – PB15:1)
- **Manganese Blue Hue** (Da Vinci)
- **Phthalo Blue** (Da Vinci)
- **Phthalo Blue** (Gamblin)
- **Hydranger Blue** (Holbein)
- **Oriental Blue** (Holbein)
- **Transparent Blue** (Holbein)
- **Hortensia Blue** (Lefranc)
- **Berlin Blue** (Maimeri – PB15:1)
- **Old Holland Blue** (Old Holland)
- **Sheveningen Blue Deep** (Old Holland)
- **Blue Lake** (Old Holland)
- **Phthalo Blue** (Permalba)
- **Phthalo Blue** (Sennelier – PB15:1)
- **Winsor Blue** (Winsor&Newton)

PB15:3 – Phthalocyanine □ I

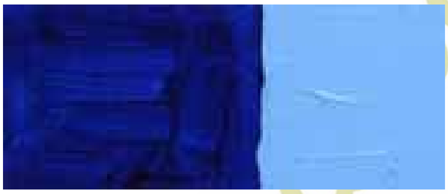
- **Primary Phthalo Blue** (Fragonard)
- **Thalo Blue** (Grumbacher)
- **Phthalo Blue** (Lefranc)
- **Primary Blue – Cyan** (Maimeri)
- **Translucent Cyan** (Mussini)
- **Phthalocyanine Blue** (M. Graham)
- **Helio Blue** (Norma)
- **Sheveningen Blue** (Old Holland)
- **Phthalo Blue Green** (Rembrandt)
- **Alizarin Blue Lake** (Sennelier)

PB15:4 – Phthalocyanine □ I



- **Manganese Blue Hue** (Gamblin)
- **Manganese Blue Phthalo** (Rembrandt)

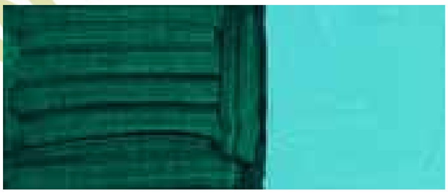
PB15:6 – Phthalocyanine □ I



- **Translucent Oriental Blue** (Mussini)
- **Phthalo Blue Red** (Rembrandt)

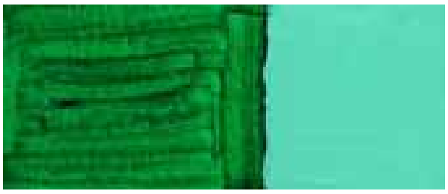
GREENS:

PG7 – Phthalocyanine □ I



- **Blockx Green** (Blockx)
- **Phthalo Green** (Da Vinci)
- **Phthalo Green** (Gamblin)
- **Thalo Green(Blue Shade)** (Grumbacher)
- **Viridian Hue** (Holbein)
- **Oriental Green**(Holbein)
- **Transparent Green** (Holbein)
- **Armor Green** (Lefranc)
- **Cupric Green Deep** (Maimeri)
- **Helio Green Deep** (Mussini)
- **Phthalocyanine Green** (M. Graham)
- **Viridian Tone** (Norma)
- **Scheveningen Green Deep** (O.H.)
- **Phthalo Green** (Permalba)
- **Phthalo Green Blue** (Rembrandt)
- **Phthalo Green Cool** (Sennelier)
- **Winsor Green** (Winsor&Newton)

PG36 – Phthalocyanine □ I



- **Phthalo Green** (Blockx)
- **Phthalo Emerald** (Gamblin)
- **Thalo Green (Yellow Shade)** (Grumb)
- **Phthalo Armor Green** (Lefranc)
- **Cupric Green Light** (Maimeri)
- **Helio Green Light** (Mussini)
- **Phthalo Green Yellow** (Rembrandt)
- **Phthalo Green Warm** (Sennelier)
- **Scheveningen Green** (Old Holland)
- **Winsor Green (Yellow Shade)** (W&N)

For more details on organic pigments, please see my paper entitled “Organic Pigments”.

WHITES:

PW1 (inorganic) **Flake White ■ I**

It is almost not produced anymore. It is very toxic, because contains lead. In the 2005 Color Index International there is no registration of any producer of this pigment, while for Zinc and Titanium Whites there are 7 and 188 respectively.

PW4 (inorganic) **Zinc White □■ I**

It is the most transparent of the whites.

PW6 (inorganic) **Titanium White ■ I**

This is the most opaque white and has the best approximation of the ideal white. It reflects more than 97% of the incident light (the ideal case would reflect 100%). The lead white reflects 95% and the zinc white 91%.

BLACKS:

Like the whites, there are no much difficulties in identifying the color with respect their names. The most common are **PBk7** (Carbon Black) and **PBk11** (Mars Black).

6. A summarized view of the subject

In the beginning of these notes, I have said that there were 900 pigments registered in the 2005 Color Index International. In the table above, we have displayed some of the main pigments used by 16 manufactures in the artists' lines. If we count them, we find 3 natural and 12 synthetic inorganic (except black and whites) plus 26 synthetic organic pigments. We have also seen that manufactures use many different names to identify them, mainly for the organic sector. I could also verify that these 41 pigments appear in around 600 mixtures and almost all of them also have different names (in student lines the number of mixtures increases much more). So, identification of pigments and mixtures by their commercial names is almost an impossible task.

Our initial intention, mainly discussed in Section 1, was to show that the use of colors of the basic palette might be fictitious and/or obsolete. Some of those pigments do not exist anymore and we have today excellent synthetic alternatives, mainly the organic sector.

I consider myself the above data as facts. To go against them is the same as to ignore all the technological developments in these almost last two hundred years. However, what I am going to say in which follows is a point of view, it is just a suggestion that can give us a better control concerning everything has been presented.

It is possible to have an excellent set of colors at our disposal and avoid those ones which are very expensive (mainly originated from cadmium and cobalt).

Among the blues, we mention the Ultramarine (**PB29**) and the Phthalos. A good choice would be the **PB15:3** (or **PB15** and **PB15:1**). I would also include the nice **PB15:4**. Even though Prussian Blue (**PB27**) is an excellent and cheap pigment, nowadays it is better replaced by one of the Phthalos.

For the greens, we mention the two Phthalos, **PG7** and **PG36**. I suggest keep both, because they have peculiar characteristics. The inclusion of the opaque Chromium Oxide Green (**PG17**) might also be important, in order to have an equilibrium between opaque and transparent colors. In my particular choice, there is a predominance of transparent and semitransparent colors (with two or three opaque ones).

Concerning the "earth colors", two good options are the synthetic red and yellow iron oxides (**PY101** and **PY42** respectively), both transparent and opaque versions.

For the oranges, there are excellent pigments in the organic sector. Many of them can be a good choice (for example, the **PO62** we have showed above).

Among violets, one can avoid the (almost) fugitive Alizarin Crimson (**PR83**). There are excellent choices among the Quinacridores. For example, **PV19** (both red and violet versions) is an excellent choice. It would also be good to include the nice **PR122** (also a Quinacridone) and the Dioxazine **PV23**.

For yellows and reds the number of options is much wider. Two suggestions for yellows are **PY74**, a familiar hue, and **PY83** (or **PY110** and **PY153**) a stronger one. Concerning the reds we mention **PR149** (or **PR254**).

If one counts the pigments above, we have 18 colors. It is not necessary to use all of them at the same time, but any palette we form with them contains an excellent set of pigments.

Finally, it is also good to be actualized with news pigments that manufactures are frequently introducing. If a new color replaces an old one with advantages, we cannot lose the opportunity to get a better and more actualized set. On the other hand, if it has new characteristics, we may also include it as a new element of the set. This occurs much frequently with my palette.

In order to have confidence in replacing any old pigment or to include a new one, please see my other article entitled "A Comparative Study of Some Pigments".

7. With respect the mixtures

In all previous examples, we have considered colors with just one pigment. This simplifies the control in manipulating them. However, it may occur we frequently use some particular mixing in wide extensions. If this is the case, it might be practical to take this mixing already done. In my case, I use very much a mixing called **Sap Green** in landscape foliages. Of course, since it is a mixing, Sap Green of one manufacturer is not the same Sap Green of the other. In this particular case, I have never found the same pigments in two of all Sap Greens.

Once, I made my own **Sap** Green, by mixing **PG7** and **PY83**. I had too much work to do that. So, I look for a **Sap Green** closer to mine among the manufactures. I found that Rembrandt has one made with **PG7** and **PY110**. That is the one I use today.

8. The impressionist palette

To conclude, let us mention the impressionist palette (extracted from Philip Ball book – please see references).

- **Zinc White**
- **Lead White** (no longer exists)
- **Lemon Yellow** (barium chromate – no longer exists)
- **Chrome Yellow** (lead chromate – no longer exists)
- **Cadmium Yellow**
- **Naples Yellow** (lead antimonate – natural and very toxic – no longer exists)
- **Yellow Ochre** (PY43 – mineral natural)
- **Chrome Orange** (basic lead chromate – no longer existing)
- **Vermilion** (mercuric sulfide – almost no longer exists)
- **Red Ochre** (natural iron oxide)

- **Natural Madder Lake** (natural version of Alizarin Crimson – PY83 – much more fugitive)
- **Crimson Lake (cochineal)** (natural and made from an insect – very fugitive)
- **Scheele's Green** (copper arsenite – very toxic and no longer exists)
- **Emerald Green** (copper acetoarsenite – very toxic, fugitive and no longer existing – but its name remains)
- **Viridian** (PG18 – hydrated chromic oxide – replaced the two previous greens)
- **Prussian Blue** (PB27)
- **Chrome Green** (Prussian Blue + Chrome Yellow)
- **Cerulean Blue** (cobalt stannate)
- **Cobalt Blue** (cobalt aluminate)
- **Ultramarine Blue** (PB29 – synthetic)
- **Ivory Black** (boné black)

I have doubts about the presence of the cerulean blue in the impressionist palette. Its register is more appropriate for neo and post-impressionists. It might be that the cerulean blue mentioned above is a previous version, a kind of residue obtained from the cobalt blue synthesis.

As one observes, the reality of that time was much different of ours. The impressionist palette was almost opaque. Few exceptions were the Viridian (we are not considering the two other fugitives and toxic greens replaced by the Viridian), Prussian and Ultramarine Blues, as well as the natural violets (with bad reputation). The Alizarin Crimson (PR83) appeared just after and was much used by neo and post-impressionists. Almost in the same time other organic pigments were synthesized (with very poor lightfastness).

Our current resources are incommensurably higher. One can form many palettes, balancing excellent opaque and transparent pigments, organic and mineral. We can also find transparency, luminosity and tinting power very superior of what the impressionist had. Now I mention the question put by Robert Gamblin, artist and manufacturer of Gamblin products,

What the impressionists wouldn't have been done if they had these pigments at their disposal.

References

1. Ralph Mayer, *The artist's handbook of materials and techniques*, 5ª Edição.

2. Philip Ball, *Bright Earth – The invention of colour.*

3. François Delamare e Bernard Guineau, *Colour – Making and using dyes and pigments.*

4. Elisabeth West Fitzhugh (Editor), *Artists' pigments – A handbook of their history and characteristics* – Volumes 1, 2 e 3.

5. www.gamblincolors.com

6. www.handprint.com