

THE STUDY OF COLOR

We first created our watercolor map in 1995. Since that time, we have developed many new colors and received numerous requests for a reprint of this article. Thank you all for your support and interest.

In making our color wheel we found ourselves faced with the same question entertained by artists, scientists, professors and colorists for the last two and a half centuries, "Which color wheel?"

Explanations for color have been put forth in the form of triangles, charts, spheres, circles, wheels and graphs. Sir Isaac Newton in the early 1700s demonstrated that white light is made up of all the spectral colors and created a color wheel that placed the pure hue of the spectrum on the outside and shaded them to gray at the center. The Three Component Theory, first advanced by physicist Thomas Young and the later expanded upon by J. C. Maxwell and H. von Helmholtz, suggests that nature had three basic sensations which respond to red, green and violet light.

The color printer Jakob LeBlon found he could represent all visible objects with three colors—yellow, red (crimson) and blue. Albert Munsell, an American painter, arranged his color wheel by hue, chroma and value, while Ostwald's system defined pure hue and classified colors according to the amount of white

and black they contained. Ewald Hering published his theory which suggested that three pairs of opposing sensations produce all colors—blue and yellow, red and green and black and white.

We finally decided, after considerable research, to base the DANIEL SMITH color wheel on color vision, the measured evaluation of what we see, "colorimetry."

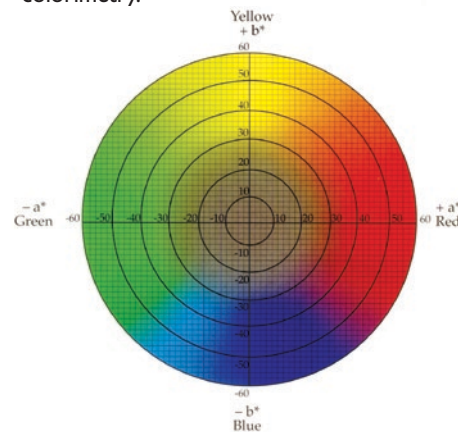


Fig. 1 Based on the manner in which we actually see color, the $L^*a^*b^*$ Color Chart contains the a^* axis, running left and right, showing red and green, the b^* axis shows yellow and blue.

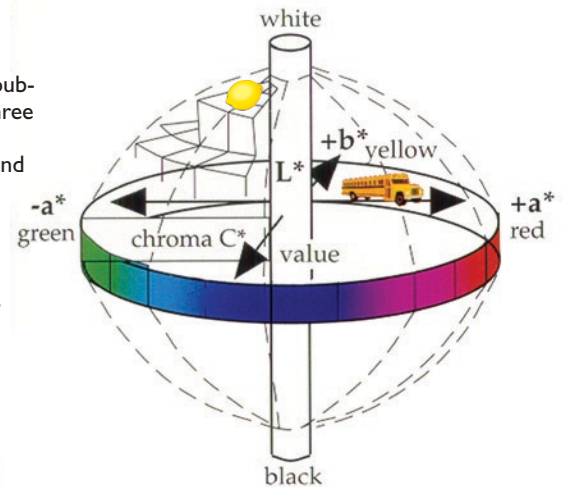


Fig. 2 The color sphere showing the white to black L^* axis, and the value and the chroma placements within red, green, blue and yellow. The school bus represents Cadmium Yellow Deep; the lemon represents Hansa Yellow Light.

How to Read Our Color Map

Color theory, color mixing and color vision are three very different subjects of study. Our color map is based on color vision or *colorimetry*, the measured evaluation of what we see. The science of color vision, which explores the appearance and related optical properties of materials, has greatly advanced from Sir Isaac Newton's first look through a prism. Color manufacturers require specific language and precise, reproducible methods for evaluating color. With *color measuring* or *color mapping*, color is mathematically reduced to reliable tables of numbers that correlate with the way the human eye actually sees color.

The language of color and its measurement consists of *Value* (light/dark) and two chromatic attributes, *Hue* and *Chroma*. Hue, the most obvious characteristic, is the distinction of one color from another—red, yellow, green, blue, and so forth. Chroma is the intensity, strength or saturation of color. Terms such as depth, vividness and purity help describe color differences.

The *spectrophotometer* is used to measure and map the relationships of color. It is a color measuring instrument made up of integrated sphere sensors and a multi-element lens system. A color's light energy is dispersed into wavelengths and sent into detectors which convert the light energy into separate electrical signals, producing numeric data. Finally, specialized computer software prints out the information on the color being analyzed.

This is an $L^*a^*b^*$ reading

L^* = light and dark (value)

Hue and chroma make up the a^* and b^* reading

- + a = redder (or less green)
- a = greener (or less red)
- + b = yellower (or less blue)
- b = bluer (or less yellow)

Here's how Cadmium Yellow Deep, the color of a school bus, and Hansa Yellow Light, the color of a lemon, are mapped.

Cadmium Yellow Dp (#37 on the color map)
 $L^* = 84.63$ $+a^* = 14.12$ $+b^* = 54.07$

Hansa Yellow Light (#07 on the color map)
 $L^* = 92.19$ $-a^* = -11.47$ $+b^* = 67.47$

Think of our map as a series of platforms or discs (a^* and b^*) placed around a center pole (L^*). The top or north pole is $L^*(100)$, white, and the south pole is $L^*(0)$, black. The series of platforms or discs have two linear intersections—an a^* plus to a^* minus plot line and a b^* plus to a b^* minus plot line. With this information about the hue, chroma and value, each color can be precisely mapped, all in relation to each other.



The Character of COLOR

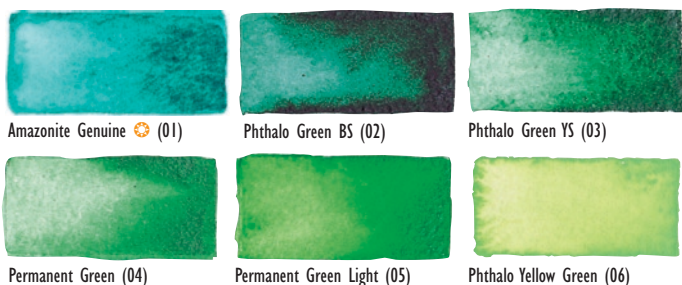
The unique personalities found within green, yellow, red and blue

Moving through the color spectrum of DANIEL SMITH Extra Fine™ Watercolors, we'll look at the different chroma changes and the positions of color ranges from pure hue to gray, and explore the characteristics of individual pigments.

We'll begin our journey through the color map with Green to Yellow, then Yellow to Red, Red to Blue, and Blue to Green to complete the circle. I've divided each section into distinctive chroma groups, beginning with the bright shades (the outer edge of the map), and moving inward to less saturated colors.

From Green to Yellow

Within this group there are three distinctive chroma groups. The first contains **Amazonite Genuine** (01), **Phthalo Green-BS** (02), **Phthalo Green-YS** (03), **Permanent Green** (04), **Permanent Green Light** (05), **Phthalo Yellow Green** (06), **Hansa Yellow Light** (07), **Lemon Yellow** (08), **Bismuth Vanadate Yellow** (09) and **Green Gold** (10).



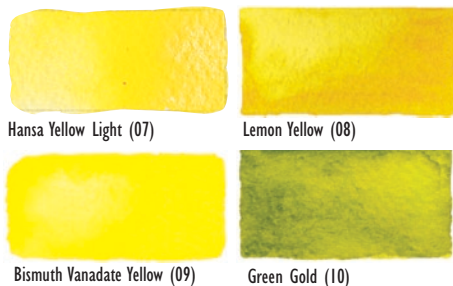
Amazonite Genuine, a DANIEL SMITH exclusive, is a member of the PrimaTek Series of artists' colors. PrimaTek paints are created from authentic mineral pigments and were developed by DANIEL SMITH'S resident chemist to

offer new options in hue and paint properties to artists. PrimaTek® pigments each have a unique signature with effects that range from extreme granulation to smooth and transparent washes. Amazonite Genuine, a non-staining color, offers the artist a transparent teal hue that has become a favorite of watercolorists seeking the clarity of Phthalo pigments without the staining quality. This shade of feldspar microcline, a precious mineral, shares the name of the Amazon basin where it is found.

Phthalo greens are clean, clear pure hue colors that wash from deep, rich, almost black green to transparent bottle green. Phthalo Green-BS (blue shade)—called Winsor Green, Monestial Green, Thalo Green and Armor Green by other manufacturers—and Phthalo Green-YS (yellow shade) are both powerful, transparent, staining pigments.

Staining transparents have a tendency to overpower other colors when mixing. Always start with the weaker color, and add very small amounts of these staining pigments until you reach the desired mix.

Permanent Green, Permanent Green Light and brilliant lime-green Phthalo Yellow Green are mixtures of Phthalo Green-BS.



There are three clean, vivid yellows; cool, lemony Hansa Yellow Light (arylide yellow) has a very slight green undertone. Lemon Yellow, a highly lightfast yellow, has less dense pigment particles because it is an organic pigment. These two yellows are clean, bright semi-transparent colors that yield beautiful, vibrant color mixtures. Bismuth Vanadate Yellow, the third yellow in this range, has very dense and heavy pigment resulting in an extremely opaque and brilliant hue. Note on the color map, page 22-23, how bright the color chroma is for these colors.

Green Gold, another hue with an extremely bright color chroma, differs from the brighter mixing yellows in that it poses a dark green masstone. This blend of Nickel Azo, Hansa Yellow Light and Phthalo Green replicates the obsolete pigment PY10 and is a remarkable bright yellow in washes, giving it this placement on the color map.

The second level of colors, mid-range Greens and Yellows are less concentrated—colors that have less green and yellow and contain more of their color complements, red and blue. **Viridian** (11), **Cobalt Green** (12), **Hooker's Green** (13), **Sap Green** (14), **Aureolin/Cobalt Yellow** (15) and **Cadmium Yellow Light** (16) are mid-range.



Viridian, an excellent glazing pigment, dates back to 1838. Ours is pure pigment, unenhanced with the phthalo green found in many of today's viridians. Cobalt Green, used as an artist's pigment since 1835, is a mid-range green-yellow that disperses very evenly for glazing. Our Hooker's Green is a blended color with significantly better lightfastness than most competitors. Moving towards yellow is Sap Green. Ours has great color and rates extremely permanent in lightfastness. While the formulations used by many manufacturers of Sap Green contain PG8, which fades readily, ours mixes PG7 (phthalo green) and P049 (quinacridone deep gold) to create a lightfast paint. Aureolin (Cobalt Yellow) is more transparent, more granular and less yellow than Cadmium Yellow Light, which is semi-transparent and moves evenly through water. Both are inorganic, slightly green, and are used extensively in watercolor palettes.

The final Green to Yellow group, made up of all inorganic pigments, is **Kingman Turquoise Genuine** (17), **Fuchsine Genuine** (18), **Terre Verte** (19), **Malachite Genuine** (20), **Cobalt Green Pale** (21), **Bohemian Green Earth** (22), **Zoisite Genuine** (23), **Chromium Green Oxide** (24), **Buff Titanium** (25), **Undersea Green** (26), **Naples Yellow** (27), **Olive Green** (28) and **Nickel Titanate Yellow** (29).





Zoisite Genuine (23)

Chromium Green Oxide (24)

Buff Titanium (25)

These colors contain smaller amounts of green and yellow, are lighter in value, and range from low to moderate tinting power. Natural mineral or earth colors are not high chroma, pure hue colors. Leaning optically towards their color complements, they mix less cleanly than colors in the other two groups, but have nature's subtlety.



Undersea Green (26)



Naples Yellow (27)



Olive Green (28)



Nickel Titanate Yellow (29)

Kingman Turquoise Genuine, made from the classic blue-green turquoise mined in Arizona, is a low-staining paint with exquisite gradations of light and color. Fuchsite Genuine is created with the pearly-green mineral Fuchsite. Ours comes from Russia and, when ground into pigment, produces a paint that retains the shimmer and luminous qualities resulting from the mineral's mica-like qualities.

Terre Verte (green earth) mixes viridian and raw umber to imitate the classic underpainting color used by the Romans. Malachite Genuine, the best green available from ancient Egypt up through the Renaissance, is lightfast and transparent with low tinting strength. Cobalt Green Pale is by nature a very pale blue-green colorant. Bohemian Green Earth is another natural earth green, slightly yellower.

Zoisite Genuine is a dramatically granulating paint that creates interesting textures as it moves through water. Its granulation pattern ranges from an almost black hue to a dark, bottle green.

Chromium Green Oxide is a neutral, opaque flat green that can be used to soften other colors. Buff Titanium is a wonderful neutral sandy color. Surprisingly transparent, it layers well. Undersea Green, a mix of inorganic French ultramarine and organic quinacridone gold pigments, produces an atmospheric separation effect, even in light washes. In Naples Yellow, the mixture of cadmium yellow light and venetian red is neutralized by the opaque, milky character of zinc oxide, creating a warm golden yellow with a slight tint of orange. Olive Green gets its beautiful warm brown color from the raw umber and its clean green from a mixture of ultramarine blue and Aureolin. It is slightly granular and semi-transparent. Nickel Titanate Yellow is somewhat opaque in mass tone but lifts cleanly. It is a beautiful yellow-green others call Lemon Yellow Hue.



From Yellow through Orange and on to Red

This large section begins with the pure chroma colors from bright yellow to orange, and then from orange to red. The first half of the outer edge contains:

Cadmium Yellow Medium Hue (30), Hansa Yellow Medium (31), Hansa Yellow Deep (32), Nickel Azo Yellow (33), Rich Green Gold (34), Indian Yellow (35), New Gamboge (36), Cadmium Yellow Deep (37), Burgundy Yellow Ochre (38), Permanent Yellow Deep (39), Quinacridone Gold (40), Transparent Yellow Oxide (41), Permanent Orange (42), Pompeii Red (43),



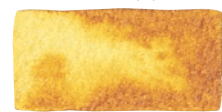
Cadmium Yellow Medium Hue (30)



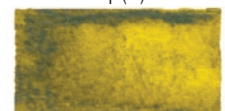
Hansa Yellow Medium (31)



Hansa Yellow Deep (32)



Nickel Azo Yellow (33)



Rich Green Gold (34)



Indian Yellow (35)



New Gamboge (36)



Cadmium Yellow Deep (37)



Burgundy Yellow Ochre (38)



Permanent Yellow Deep (39)



Quinacridone Gold (40)



Transparent Yellow Oxide (41)



Permanent Orange (42)



Pompeii Red (43)



Cadmium Orange (44)

Cadmium Orange (44) and Quinacridone Sienna (45).

The bright yellow to orange colors begin with Cadmium Yellow Medium Hue, developed as an alternative to the standard cadmium colors on the market today. This blend of pigments is an exact color replacement for our Cadmium Yellow Medium with slightly better color strength and cleaner mixing properties.

Hansa Yellow Medium and Hansa Yellow Deep are modern pigments developed in the 1950s. Note on the color map the relationship of these two colors to the cadmiums; Hansa Yellow plots out as the "perfect yellow" and both are more saturated colors. Nickel Azo Yellow has the warmth of Hansa Yellow, but is paler and somewhat more neutral. Rich Green Gold is a semi-transparent yellow green, wonderful for glazing and indispensable in landscapes. Our Indian Yellow and New Gamboge unlike many other brands' colors of the same names, have an excellent reputation and a lightfastness rating of II—Very Good. Both granulate slightly, and create nice golden-orange/brown puddled edges. Indian Yellow is made with anthrapyrimidine yellow, one of four new vat pigments we selected for our line.

Cadmium Yellow Deep (cp) is next. Semi-transparent and less pure than the Hansa Yellows, Cadmium Yellow Deep creates warm, slightly grainy mixtures.

Burgundy Yellow Ochre, an earthy ochre from Burgundy France, is a unique color with a higher chroma than standard Yellow Ochre.

Permanent Yellow Deep, a sunset color made with isoindolinone yellow, also has a lightfastness rating of II—Very Good. A rich, sedimentary near-orange in mass tone, it graduates to a glowing hot yellow in washes.

Quinacridone Gold, in a class of its own, has been our single most popular newcomer. Many watercolorists have replaced Raw Sienna with it, and as you'll note on the color map, it plots out as more vivid and cleaner than Raw Sienna. Quinacridone pigments (pronounced kwin ak' ri doan) range from gold, deep orange, coral and scarlet to rose, violet, magenta and maroon. They are "high-performance" transparent pigments that are lightfast, durable at all tinting levels, maintain outstanding clarity and color intensity, and are truly unequalled.

Transparent Yellow Oxide is earthy and leans towards brown, with handsome sedimentation in washes. Pompeii Red is a red-orange of unusually high chroma for a natural earth color. Two oranges, each with a slight bias towards yellow, are Permanent Orange and Cadmium Orange (cp). Though similar colors, the Permanent Orange is more yellow and slightly more saturated, and Cadmium Orange is redder. On the color map, our Quinacridone Sienna, like Burnt Sienna, plots right on the orange line. It is transparent and considerably brighter than Burnt Sienna, ideal for glazing.

The second half of bright colors, orange to red, contains:

Pyrrrol Orange (46), Perinone Orange (47),



Pyrrrol Orange (46)



Perinone Orange (47)

Pyrrrol Scarlet (48), Organic Vermilion (49), Perylene Scarlet (50), Permanent Alizarin Crimson (51), Cadmium Red Scarlet (52), Cadmium Red Medium (53), Pyrrrol Crimson (54), Pyrrrol Red (55), Perylene Red (56), Permanent Red (57), Permanent Red Deep (58), Carmine (59), Quinacridone Coral (60), Quinacridone Fuchsia (61) and Quinacridone Red (62). Out of this group the old familiar names are Cadmium and Permanent Red, but the newer pigments—pyrrols, perylenes, quinacridones and perinones—all plot out as cleaner, more vivid, higher chroma colors.



Pyrrrol Orange is a showstopper—warm, very intense and highly lightfast thanks to its modern synthetic organic pigment. To see another modern pigment in action, try two color mixtures: Permanent Green first mixed with Perinone Orange and then with Cadmium Orange. The Perinone mixture is brighter, and has a richer, less muddy glow. Perinone is another of our vat pigments. It is brilliant, transparent and staining and because the pigment is so saturated, the dried paint film gradates to rich, deep orange.

Stemming from vat dyes developed in the early 1900s for the textile industry, vat pigments date from only the 1950s. Of the 400-listed vat dyes, only about 10 have become commercially significant as vat pigments. The reasons are that vat pigments are inherently expensive products and are only used where exceptionally high lightfastness is required and cannot be obtained with cheaper alternate pigments. Anthrapyrimidine Yellow (used to make Indian Yellow), Perinone Orange, Anthraquinoid Red, and Indanthrone Blue (also used to create Indigo) are the four vat pigments we chose for our watercolor line.

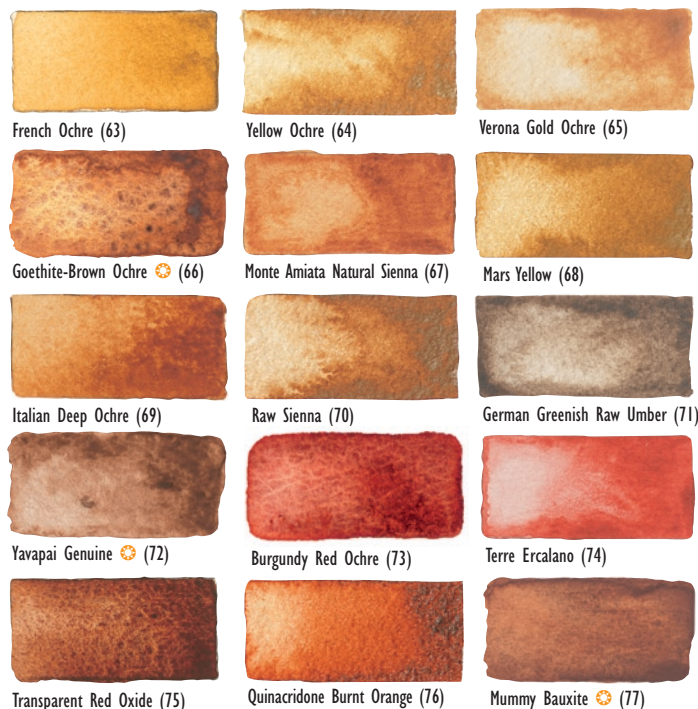
Pyrrrol Scarlet, Organic Vermilion, and Perylene Scarlet all plot out very closely to one another, yet when you paint them out they look very different. This is because our map is two-dimensional. If we could show the colors in a platform sphere as in Fig. 3 (pages 22-23), you would see how the values change. The pyrrol pigments, new colors made from a modern synthetic organic pigment, diketo-pyrrolo-pyrrol, disperse very evenly, while the perylenes are more sedimentary, leaving a dark granular wash. The individual perylene molecule gives off a brilliant orange hue that shines through these increasingly popular modern, metal-free red pigments. You may also know Organic Vermilion as Scarlet Lake or Rose Carthame (PR-pigment red 188).

Permanent Alizarin Crimson is a blended, bright rose hue. This brilliant and transparent color has the highest lightfastness rating and greater intensity than Alizarin Crimson but shares many of its properties, including high-staining and non-granulating characteristics.

Permanent Red and Permanent Red Deep are bright, strong reds made

from PR 170-naphthol red. They are semi-transparent and lightfast permanent. Carmine, a fugitive color in many brands, is rated II-Very Good in the Daniel Smith line due to the benzimidazolone carmine pigment used. It is very close to and slightly redder than Alizarin Crimson. The final two in this group, Quinacridone Coral and Quinacridone Red are unique colors that have no comparison. Quinacridone Coral is “the perfect match to the Tropicana Rose” and Quinacridone Red plots out as our truest Red. Quinacridone Fuchsia is equally vivid, but slightly cooler. Of all our colors, the Quinacridones rate first in popularity.

Moving in towards the center of the color map are the mid-level, less saturated yellows and reds: **French Ochre (63), Yellow Ochre (64), Verona Gold Ochre (65), Goethite-Brown Ochre (66), Monte Amiata Natural Sienna (67), Mars Yellow (68), Italian Deep Ochre (69), Raw Sienna (70), German Greenish Raw Umber (71), Yavapai Genuine (72), Burgundy Red Ochre (73), Terre Ercolano (74), Transparent Red Oxide (75), Quinacridone Burnt Orange (76), Mummy Bauxite (77), English Red Ochre (78), Transparent Brown Oxide (79), Italian Burnt Sienna (80), Italian Venetian Red (81), Sedona Genuine (82), Hematite Burnt Scarlet (83), Burnt Sienna (84), English Red Earth (85), Venetian Red (86), Minnesota Pipestone (87), Lunar Earth (88), Permanent Brown (89), Quinacridone Burnt Scarlet (90), Deep Scarlet (91), Indian Red (92), Cadmium Red Deep (93), Perylene Maroon (94), Anthraquinoid Red (95) and Alizarin Crimson (96).**



Yellow Ochre, one of the oldest known pigments, and Mars Yellow, a processed synthetic mineral version of ochre, are very close in value. Mars Yellow is darker and more transparent than the natural ochre due to the absence of clay. We offer several ochres from various European mines. Yellow Ochre is the most neutral. French Ochre is fairly bright, with a very slight greenish tone. Verona Gold Ochre has a golden-pink cast, while Italian Deep Ochre leans toward orange-brown. English Red Ochre is a warm, sedimentary reddish-brown. Goethite-Brown Ochre is a slightly warm natural brown ochre with more pronounced granulation than any ochre we offer. All are low tinting, a characteristic of earth pigments.

Raw Sienna and Burnt Sienna are ancient earth pigments with subtle beauty and extreme permanence. Monte Amiata Natural Sienna is made with very fine high-grade Italian pigments, giving it a more vibrant, surprisingly transparent look.

German Greenish Raw Umber, a natural earth pigment, is considerably paler than most raw umbers, with a characteristic yellow-green cast.

continued on page 7



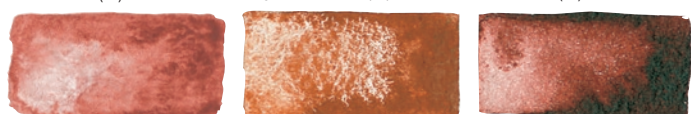
English Red Ochre (78) Transparent Brown Oxide (79) Italian Burnt Sienna (80)



Italian Venetian Red (81) Sedona Genuine (82) Hematite Burnt Scarlet (83)



Burnt Sienna (84) English Red Earth (85) Venetian Red (86)



Minnesota Pipestone (87) Lunar Earth (88) Permanent Brown (89)



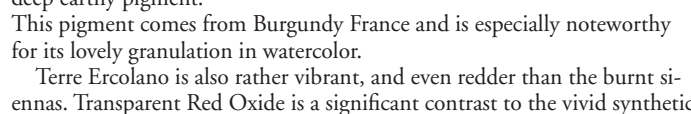
Quinacridone Burnt Scarlet (90) Deep Scarlet (91) Indian Red (92)



Yavapai Genuine (87) Cadmium Red Deep (93)



Burgundy Red Ochre Perylene Maroon (94)



Anthraquinoid Red (95) Alizarin Crimson (96)

Yavapai Genuine, made from earthy-brown stone, is a mellow pink-brown granulating paint.

Burgundy Red Ochre, a surprisingly transparent natural ochre, is a rich and deep earthy pigment.

This pigment comes from Burgundy France and is especially noteworthy for its lovely granulation in watercolor.

Terre Ercolano is also rather vibrant, and even redder than the burnt siennas. Transparent Red Oxide is a significant contrast to the vivid synthetic oranges. It is a rustier orange, completely lightfast, with beautiful granulation in washes. Transparent Brown Oxide is a rich, warm brown with the interesting granulating effects produced with iron oxide.

Notice on the color map how cleanly Quinacridone Burnt Orange plots in comparison to any of the Burnt Siennas—it's also more golden. Lunar Earth is a Daniel Smith exclusive—close in color to Burnt Sienna and made with iron oxide, it produces a fascinating separation effect in washes.

Mummy Bauxite is made from inorganic Bauxite, a mixture of aluminum and iron oxides. This warm cinnamon color granulates more dramatically than Burnt Sienna to resemble the look of rusted iron.

English Red Earth, Venetian Red and Indian Red are dense, flat, opaque inorganic colors. Venetian Red is redder and Indian Red is browner. English Red Earth falls between them and produces smooth, even washes.

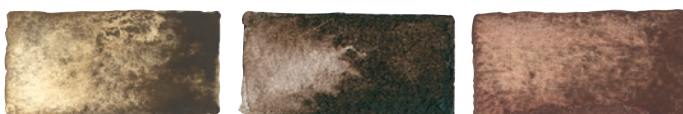
Italian Venetian Red is more granular and slightly browner. Italian Burnt Sienna is similar to our standard Burnt Sienna with a higher chroma and slightly warmer, brighter tone.

Sedona Genuine, Hematite Burnt Scarlet and Minnesota Pipestone, three of the PrimaTek® Series colors, are noteworthy for their remarkable working properties. Sedona Genuine matches the ruddy red rock from Arizona that it is manufactured from. Hematite Burnt Scarlet is created from authentic Hematite that has a higher red iron oxide content than our Hematite Genuine. It is a rich rusty-orange hue that granulates to create dark orange-brown areas. Minnesota Pipestone has become a favorite of portrait artists for its subtle brown-pink hue. Pipestone, or genuine Catlinite, creates a creamy and earthy paint with a warm undertone.

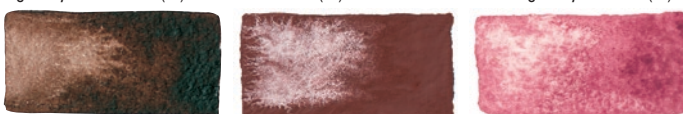
Higher-chroma Cadmium Red Deep is another of our low-soluble cadmium colors.

We now move on to four of my favorites: Quinacridone Burnt Scarlet, Permanent Brown, Perylene Maroon and Deep Scarlet—all unique new colors. They all are rich, saturated, high tinting colors that are sedimentary and move from very dark red-browns to glowing washes. Permanent Brown and Deep Scarlet are created from a small group of pigments called azo pigments, known for their outstanding lightfastness. Lastly, Anthraquinoid Red, a vat pigment, is a warm, granular violet-red, lightfast rated I—Excellent. For those interested in permanence, it is a good replacement for Alizarin Crimson, although it does not mix as cleanly.

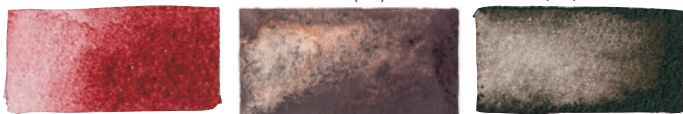
The last division within the yellow to red section contains the rich dark brown earth colors and three subtle natural pinks: **Tiger's Eye Genuine** (97), **Raw Umber** (98), **Burnt Tiger's Eye Genuine** (99), **Burnt Umber** (100), **Lunar Red Rock** (101), **Pinkcolor** (102), **Rose Madder Genuine** (103), **Hematite** (104), **Sepia** (105), **Van Dyck Brown** (106), **Hematite Violet** (107) and **Raw Umber Violet** (108).



Tiger's Eye Genuine (97) Raw Umber (98) Burnt Tiger's Eye Gen. (99)



Burnt Umber (100) Lunar Red Rock (101) Pinkcolor (102)



Rose Madder Genuine (103) Hematite (104) Sepia (105)



Van Dyck Brown (106) Hematite Violet (107) Raw Umber Violet (108)

The majority of today's brown pigments are still obtained from the earth. The principle color-producing agent is iron oxide, a material found in most rocks and earth.

Tiger's Eye and Burnt Tiger's Eye are made from the light-refracting gemstone. Layers of quartz containing iron oxides give this stone its characteristic glow and, in paint, produce heavy granulation that closely resembles the shades found in Tiger's Eye stones. Burnt Tiger's Eye Genuine is made with stones that have been baked, or calcined, before being ground into pigment, to create a warm reddish tone.

Dimonite, one type of iron ore, colors the ochres. Siennas have increased iron oxide content, while umbers have an increase in manganese oxide content. These pigments are not too far removed from the colors used by the cave painters. Our Van Dyck brown, a blend of siennas and umbers, is lightfast, unlike many others. One unique color, Raw Umber Violet, is a mixture of raw umber with quinacridone violet, which gives this earthy sedimentary color a slight hint of burgundy.

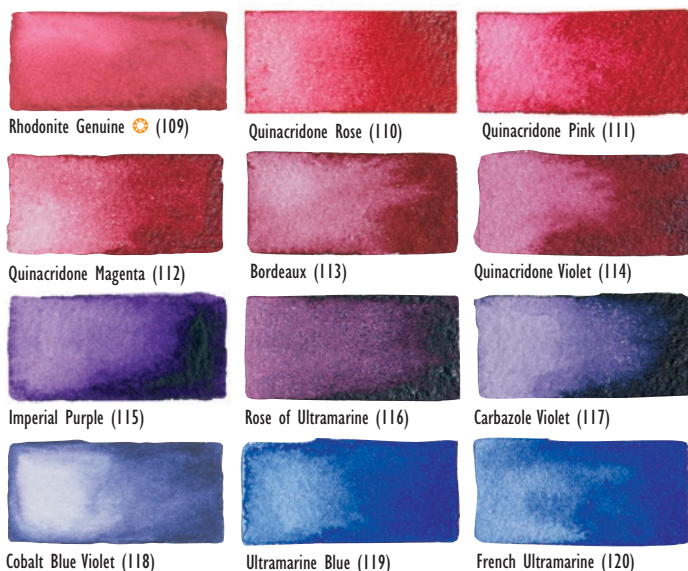
Lunar Red Rock is a DANIEL SMITH exclusive that is an extremely granulating red iron-oxide.

Rose Madder Genuine, a classic earthy pale pink, is derived from the roots of the madder plant. It remains popular despite low tinting strength and marginal lightfastness. Pinkcolor, a pale grayed pink, was a key color in 18th-century English watercolors and is lightfast.

Hematite and Hematite Violet are made from genuine Hematite but differ in hue due to the variety of mineral content that Hematite can contain. Hematite has a warm yellow undertone while Hematite Violet has a striking purple hue.

From Red to Blue

This section can be divided into two chroma groups. **Rhodonite Genuine** (109), **Quinacridone Rose** (110), **Quinacridone Pink** (111), **Quinacridone Magenta** (112), **Bordeaux** (113), **Quinacridone Violet** (114), **Imperial Purple** (115), **Rose of Ultramarine** (116), **Carbazole Violet** (117), **Cobalt Blue Violet** (118), **Ultramarine Blue** (119) and **French Ultramarine** (120) make up the bright chroma colors.



Violets, from Red to Blue, have historically been among the more fugitive colors, and were made from vegetable dyes and animal extracts. Many artists prefer to mix their violets but modern pigments are providing some sound alternatives.

Rhodonite Genuine is first on the color map. This neutral red is extremely intense and non-granulating. This brilliant color is derived, somewhat surprisingly, from the natural mineral Rhodonite found in Germany and typically used in jewelry.

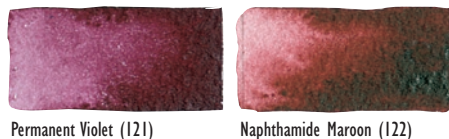
Next, the Quinacridone colors—Rose, Pink, Violet and Magenta—are beautifully transparent with high tint strength. Quinacridone Rose, a bright red-violet also called Permanent Rose, is one of those colors that is virtually impossible to mix. The similar Quinacridone Pink is equally strong, and yields even truer pinks. Quinacridone Violet (labeled Permanent Magenta and Permanent Violet in other brands) is slightly redder than Quinacridone Magenta. Both gradate from a deep red-violet to clean transparent washes.

Bordeaux, another of the azo pigments, is a scrumptious, velvety wine color. It is a high tinting, semi-transparent color you really must see to appreciate.

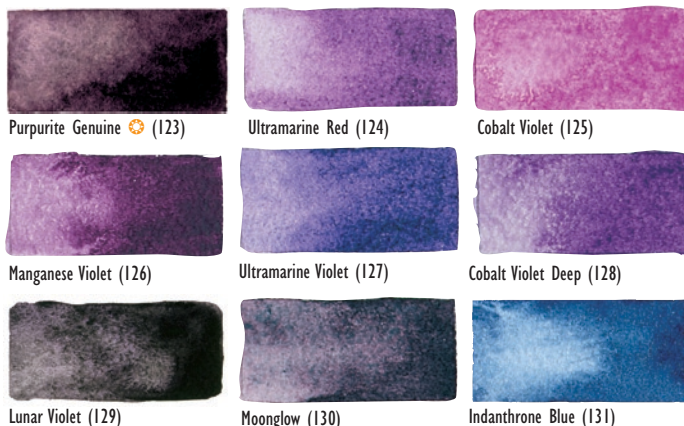
Imperial Purple is a mixture developed with DANIEL SMITH customers who requested a vibrant and granulating royal purple. This blended color is semi-transparent and granulates with surprising shades of violet and pink.

Rose of Ultramarine is a blend of Quinacridone Rose and Ultramarine Blue. In washes the blue sinks, creating a vivid violet with exciting separation. Carbazole Violet plots on the blue side of violet. It is slightly granular and goes from black-violet to a clean “classic” purple with good tinting strength and excellent lightfastness. Cobalt Blue Violet is a wonderful blend of cobalt blue and quinacridone violet. On the color map, Ultramarine Blue plots bluer and slightly less saturated while French Ultramarine is slightly redder and more saturated.

Moving towards the center of the map, colors containing less red and blue and more of their complements, we find **Permanent Violet** (121), **Naphthamide Maroon** (122),



Purpurite Genuine (123), **Ultramarine Red** (124), **Cobalt Violet** (125), **Manganese Violet** (126), **Ultramarine Violet** (127), **Cobalt Violet Deep** (128), **Lunar Violet** (129), **Moonglow** (130) and **Indanthrone Blue** (131).



Permanent Violet, made from thioindigoid pigment, is a rich, strong, reddish violet with very even dispersion. Naphthamide Maroon, the last of the new azo pigments, is a deep brown-violet; it's semi-transparent, low staining, and slightly sedimentary.

Purpurite Genuine is derived from a violet mineral of the same name. Ours comes from the most intense quality mined in South Africa. Purpurite is a naturally occurring manganese phosphate that, when ground into pigment, contains a small amount of the hematite. Purpurite's earthy hue and remarkable granulation is the result of this combination.

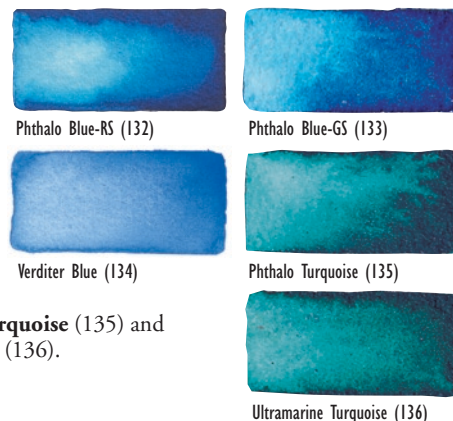
Next we have five inorganic violets, beginning with Manganese Violet, also known as permanent mauve. A more pure form of manganese phosphate than our Purpurite Genuine, it is a good mid-range violet best used by itself, as it tends to create muddy mixtures. The next groups of violets are ultramarines and cobalts. Chemically heating Ultramarine Blue produces Ultramarine Violet; further heating produces Ultramarine Red. Both are transparent, disperse evenly and have moderate to low tinting strength. Cobalt Violet and Cobalt Violet Deep are low tinting compared to the Ultramarine Violets and by nature allow more of the gum arabic binder to show through. Good glazing pigments, they are characteristically weak and light-bodied.

Lunar Violet is a deep and intense combination of two pigments noted for their granulating properties – Mars Black and Ultramarine Violet.

Moonglow, a blended color first developed in our oil line, creates the most unusual violet-gray, blue-red color separation. The blue-green from ultramarine blue and viridian sinks and allows the red of anthraquinoid red to float to the surface, creating fascinating light and dark washes. Indanthrone Blue, another DANIEL SMITH original, is the last of our high tinting strength vat pigments. This beautiful, very dark transparent blue ranges from a slightly reddish blue-black to rich denim blue wash. It is an interesting alternative to French Ultramarine.

From Blue to Green

Our journey began with two Phthalo Greens, and as we move from Blue to Green we find four final bright chroma pigments, **Phthalo Blue-RS** (132), **Phthalo Blue-GS** (133), **Verditer Blue** (134), **Phthalo Turquoise** (135) and **Ultramarine Turquoise** (136).



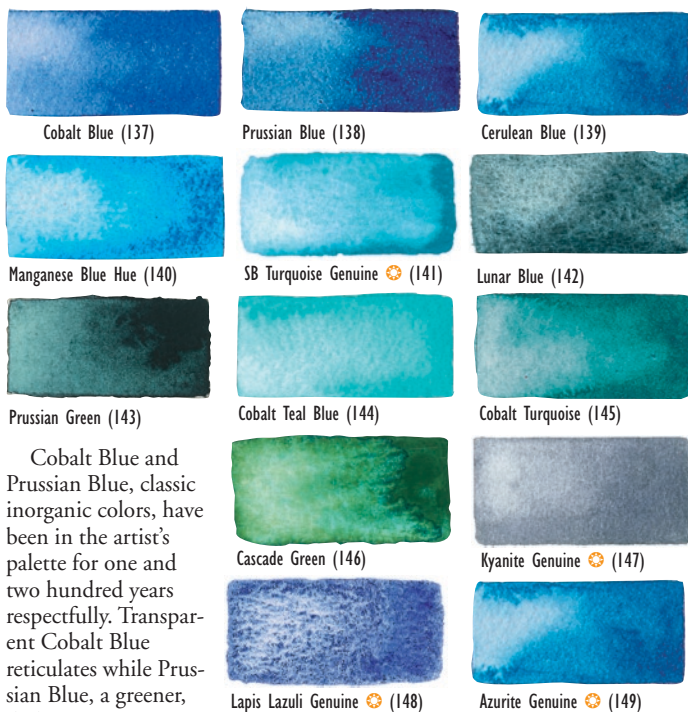
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Phthalo Blue-RS (red shade) obviously leans toward red, while Phthalo Blue-GS (green shade) leans toward green. Phthalo Blue-GS, known as Winsor Blue and Monestial Blue among other names, is a widely used bright blue pigment valued for its transparency and color saturation.

Verditer Blue is a lovely mixed blue with a high chroma, like the [hthalo blues, but without the high staining, transparency and saturation of the powerful phthalos. The addition of zinc white to a blend of cobalt and cerulean blues give this color its unique placement on the color map and its slightly soft, creamy finish.

Phthalo Turquoise washes from a strong deep teal to a beautiful clear turquoise. Made only at **DANIEL SMITH**, it is similar in color but brighter than Prussian Green. Also bright in chroma is our Ultramarine Turquoise, a blend of ultramarine blue and phthalo turquoise that creates an exciting separation in washes.

Moving in toward the center are the mid-range blue-green pigments: **Cobalt Blue** (137), **Prussian Blue** (138), **Cerulean Blue** (139), **Manganese Blue Hue** (140), **Sleeping Beauty Turquoise Genuine** (141), **Lunar Blue** (142), **Prussian Green** (143), **Cobalt Teal Blue** (144), **Cobalt Turquoise** (145), **Cascade Green** (146), **Kyanite Genuine** (147), **Lapis Lazuli Genuine** (148) and **Azurite Genuine** (149).



Cobalt Blue and Prussian Blue, classic inorganic colors, have been in the artist's palette for one and two hundred years respectfully. Transparent Cobalt Blue reticulates while Prussian Blue, a greener, darker staining pigment, disperses more evenly.

Next are two mid-range blues, Cerulean Blue, whose name is derived from the Latin *caeruleum* meaning "sky blue." They are inorganics that create nice granular or settling washes.

Manganese Blue Hue, made with phthalo blue pigment, captures the vivid clarity and textural interest of real Manganese Blue, which can no longer be made.

Sleeping Beauty Turquoise Genuine is created from gem-grade turquoise from the Sleeping Beauty Mountain in Arizona. This pigment is slightly stronger and more blue than our other PrimaTek turquoise, the blue-green Kingman Green Turquoise Genuine.

Lunar Blue is a blend of Mars Black and Manganese Blue Hue, a granulating Phthalo Blue. The unique patterns created in water are a result of the combination of these two granulating pigments.

Prussian Green is a lightfast blended dark teal, made with Prussian Blue and Cadmium Yellow Light which produces intriguing, textural washes.

Cobalt Teal Blue, a "classic '50s color" is a bright, light green-blue aqua and Cobalt Turquoise is a pastel inorganic turquoise-gray.

Cascade Green is a blend of Phthalo Blue and Raw Sienna. Surprising movement and granulation occurs in water as the heavier Raw Sienna sinks and the lighter Phthalo Blue floats and finally settles around and on top.

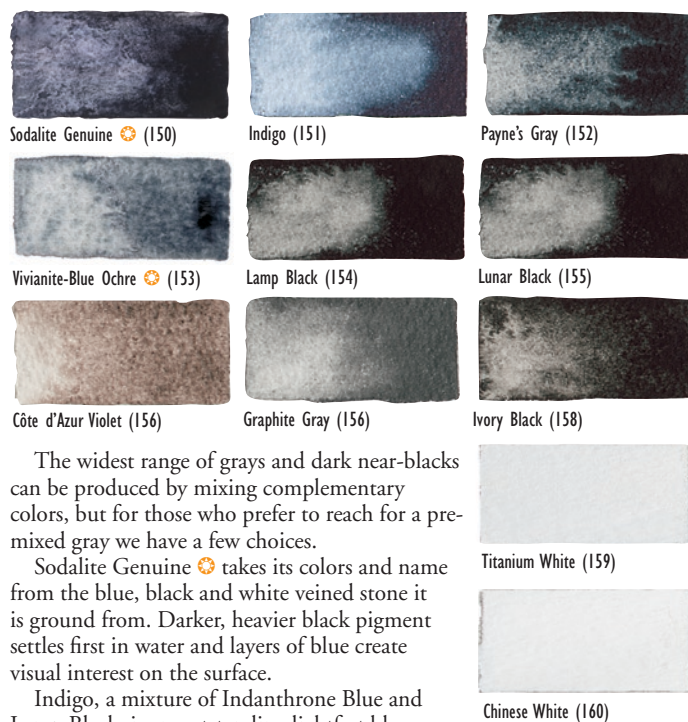
Three natural Prima Tek® colors finish out our blues.

Kyanite Genuine, perhaps one of our most interesting colors, comes from a blue-colored mica with flat thin layers of deep blue, shimmering silver and lighter blue tones. When ground into pigment and dispersed in water, the darker blue colors granulate and sink into the paper. The lighter, sparkling mica settles on top of this granulated blue ground.

Lapis Lazuli Genuine and the slightly greener Azurite Genuine, both derived from semi-precious stones, are non-staining, low-tinting blues widely used during the Renaissance. Lapis Lazuli Genuine, a sensational granulating color, has a distinctive mineral luster and a bright ultramarine hue. Azurite Genuine exhibits variations in green and blue. This pigment granulates well in mixtures and is wonderful when combined with less dense pigments, like quinacridones, as remarkable color separation is displayed.

Black to White

The center of the map contains all the black to white hues: **Sodalite Genuine** (150), **Indigo** (151), **Payne's Gray** (152), **Vivianite-Blue Ochre** (153), **Lamp Black** (154), **Lunar Black** (155), **Côte d'Azur Violet** (156), **Graphite Gray** (157), **Ivory Black** (158), **Titanium White** (159) and **Chinese White** (160).



The widest range of grays and dark near-blacks can be produced by mixing complementary colors, but for those who prefer to reach for a pre-mixed gray we have a few choices.

Sodalite Genuine takes its colors and name from the blue, black and white veined stone it is ground from. Darker, heavier black pigment settles first in water and layers of blue create visual interest on the surface.

Indigo, a mixture of Indanthrone Blue and Lamp Black, is an outstanding lightfast blue-black. Payne's Gray and Vivianite Genuine are blue-gray, Ivory Black has a red-brown cast and Graphite Gray plots into the center with a slight bias towards green.

Vivianite-Blue Ochre is a smoky, natural blue from Russia. Made from iron phosphate, this clay-like mineral brushes out like an ochre and its subtle quality does not overwhelm in mixes.

Made from a synthetic graphite pigment, Graphite Gray produces a well-dispersed color that has some of the characteristic sheen of graphite pencil lead—ideal for value studies and illustrations.

Côte d'Azur Violet is another of our PrimaTek® Colors, a soft gray-violet made from slate found in southern France.

Our last two blacks plot on the blue and green side of center. Lamp Black, the soot given off from burning mineral oil or tar, is high in tinting strength, a rich transparent pigment that has been used for thousands of years. Lunar Black, our own creation, is a very unusual reticulating color. Add a drop of water to a wash, and let it dry for fascinating marbled or stone-like effects.

Chinese White or Zinc White, first produced in the 1830s, will not darken upon exposure to the atmosphere like flake white or lead white. It is a semi-transparent pure white that effectively lightens other colors. Titanium White, slightly more opaque, is especially useful for corrections and overpainting. ■