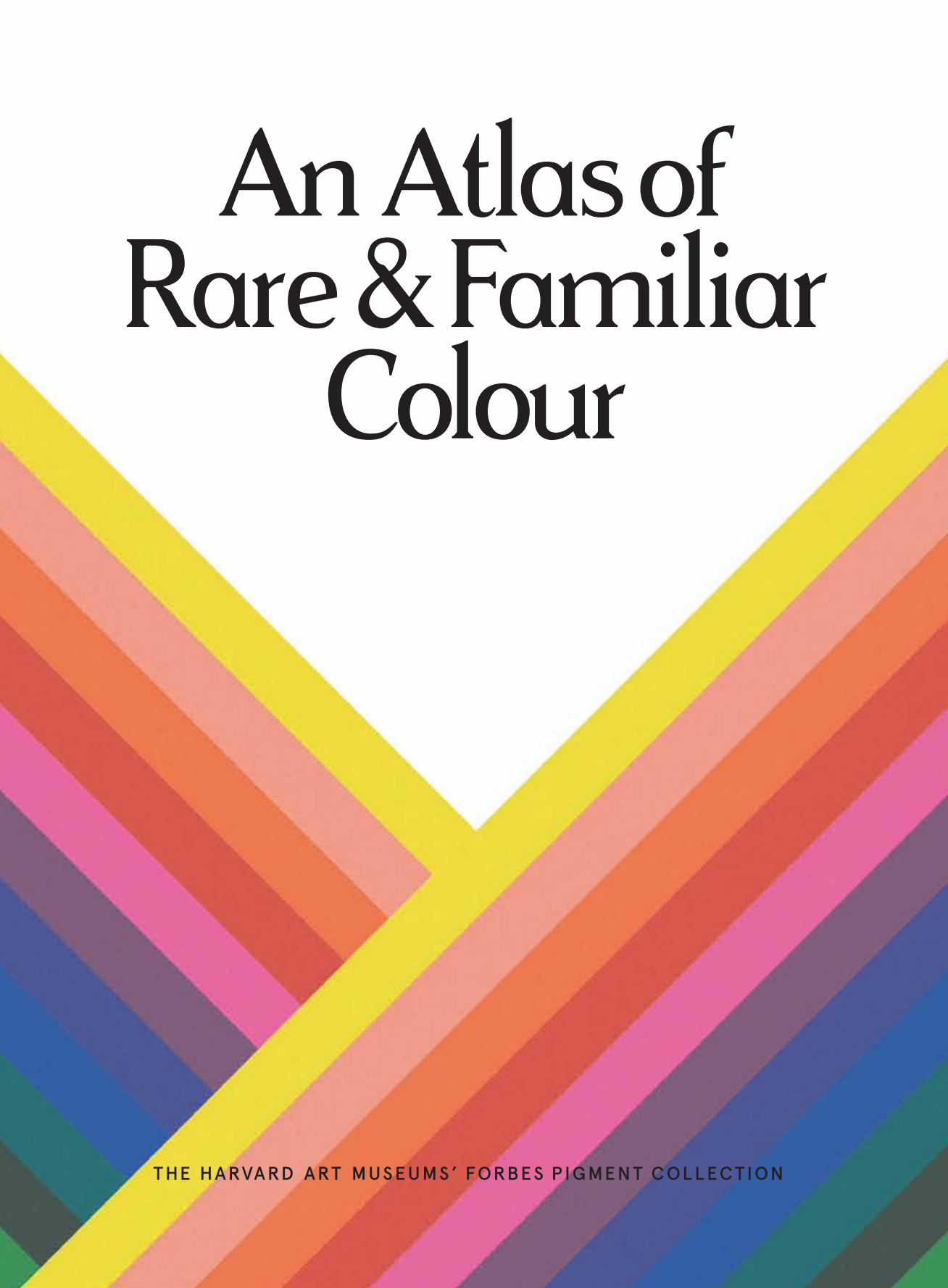
An Atlas of Rare & Familiar Colour



THE HARVARD ART MUSEUMS' FORBES PIGMENT COLLECTION

ATELIER ÉDITIONS

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FORBES PIGMENT COLLECTION

Yoko Ono

"If people want to make war they should make a colour war, and paint each others' cities up in the night in pinks and greens."

Foreword

You can see Harvard University's Forbes Pigment Collection from far below. It shimmers like an art display in its own right, facing in towards the glass central courtyard in Renzo Piano's wonderful 2014 extension to the Harvard Art Museums. The collection seems, somehow, suspended within the sky.

From the public galleries it is tantalising, almost intoxicating, to see the glass-fronted cases full of their bright bottles up there in the administrative area of the museum. The shelves are arranged mostly by hue; the blues are graded in ombre effect from deepest midnight to the fading indigo of favourite jeans, with startling, pleasing juxtapositions of turquoise (flasks of lightest green malachite; summer sky-coloured copper carbonate and swimming pool verdigris) next to navy, next to something that was once blue and is now simply, chalk.

A few feet along, the bright alizarin crimsons slake to brownish brazil wood upon one side, and blush to madder pink the other. This curious chromatic ordering makes the whole collection look like an installation exploring the very nature of painting. Which perhaps in a way it is.

It wasn't the original intention however, to create something of beauty, something that makes you happy just to look at it. Professor Edward Forbes – Harvard graduate, art historian and director of the Fogg Art Museum for 35 years until 1944 – actually began the pigment collection because he didn't want to be cheated. He wanted, during the 1920s to offer Harvard art students an equivalent experience to their contemporaries in Europe. He wanted them not just to be drawing plaster casts of ancient sculptures and copying prints of great paintings, but instead, to be seeing and copying real works.

But as he arrived in Europe with his dollars from the United States' oldest university, the antiquarians and art dealers saw him coming. He quickly realised that if he didn't know his French ultramarine from original ultramarine (the former was invented in France in 1828 after a 6,000 franc cash prize was offered; the latter was mined in northeast Afghanistan for 6,000 years and carried across country upon the backs of donkeys) or his lead white from the more recent titanium white – the latter less deliciously buttery but decidedly less toxic – he would waste the extraordinary financial resources with which he had been gifted.

So he started to learn about the materials, and as he learned he collected them, and as he collected them, he began to amass a resource of source material that is second to none. And is still very important to the world's knowledge of art.

Some of the items are absolutely no longer available. One of the ingredients in the watercolour Indian yellow – which until the early 20th century was sold in ochre-coloured balls the size of golf balls, and smelled of heat and dust and sweat and flowers – was the urine of cows or buffaloes fed with mango leaves. In 2001, I went to the only place we know for certain this Indian yellow was sourced: the village of Mirzapur in Bihar, India, which a Mr T. N. Mukharji of Calcutta had visited in 1883.

He told the Society of Arts he had seen the cows eating mango leaves and urinating on demand into buckets, and that the animals looked altogether unhealthy. By 2001, there was no yellow paint made in Mirzapur and people laughed until they wept at the very idea of making cows urinate to create colour. But there was, still, a mango orchard, a huge one with trees grown to wildness, where buffaloes wandered, and where, perhaps, the yellow crumbly ball of colour in the Forbes collection labelled "Indian Yellow" once was sent by train to the coast and thence to Europe or America.

Forbes was just in time too to obtain one of the more gruesome ingredients in 18th and 19th century paintings: mummy brown, made of real mummies, of Egyptians who had died two thousand years ago or more, and whose carefully preserved body parts somehow managed to make a thick dark paint resembling bitumen (good for shading, apparently, but terrible as a watercolour). The London colourman C. Roberson & Co. still had a few tubes on sale in the 1920s … and the Forbes collection has a couple of them, marked as "bituminous pigment from mummies embalmed with asphaltum."

Seeing them within the Forbes pigment archives, wrapped in plastic, I was reminded of the autobiography of the British writer Rudyard Kipling. When he was a boy sent to school in England from his home in India he used to stay for holidays with his uncle, the Pre-Raphaelite artist Edward Burne-Jones. And one day, when he was about 10 years old, his uncle appeared from his studio, shocked to have learned that Mummy Brown was in fact "made of dead Pharaohs." So he organised a funeral procession for his paint tubes, and they buried them beneath a tree in the garden. Even as an old man, Kipling wrote that he still remembered exactly where that tube of mummy brown lies.

Some of the pots of pigment, have faded on the outside with the interaction of light, so you have to open them to discern the original colour. This is a microcosm of the changes that occur over time to the artworks themselves.

Other items are reminders of just how poisonous art-making could be before health and safety regulations were systematised. Asbestine, a white powder made of magnesium silicate, is obtained by grinding waste asbestos. The sample in the collection comes from 1942. Meanwhile on the green shelves, there are several examples of emerald green and the closely related "Scheele's green" which gain their gleaming hues from the arsenic they contain. In the 19th century, they were so popular as wallpaper colours that even after it was known the colour could kill people, and animals, that came close, people still chose to buy them. That green was too beautiful, some people felt, not to be used.

The labels in the Harvard collection are things of history too, although this can scarcely have crossed the mind of the conservator, or apprentice conservator, whose job it was in 1926 to type "Cobalt Blue — ROBERSON" on a white label with red outlining. Or to scribble by hand in 1926 "Azurite Ground by Lamin Speciman [sic] E" in ink that has faded to sepia.

For years the collection scarcely changed. After all, it included samples of most historical colours, and there was plenty to be getting on with, plenty to keep conservators engaged; enough to share with other international conservators and art historians, engaged with their own precise enquiry into the stuff that makes painting marks on canvas into art.

But around 2005 that changed. A decision was made to bring the collection up to date, to find samples of the new colours and dyestuffs and pigment materials and binders that artists such as Mark Rothko, Jackson Pollock, Roy Lichtenstein and Jimmy Lee Sidduth were using, and the paint that laboratories were creating. At the same time there was a look to expand the collection of ancient and traditional paints, including from Australia (where orchid juice can act as a binding agent). Several hundred new phials and pots have been added since then, with labels that today look absolutely unremarkable, but which perhaps in a century's time might make someone smile, and wonder, as we do today, at the person who classified them so very long ago.

And some colours have only just been invented. In 2014, I was speaking as part of a panel at the Edinburgh Science Festival. Sitting beside me was a woman with synaesthesia (she would have seen these Forbes pigments as numbers and letters) and one of the scientists who had invented a new colour in Surrey in southern England. Such is called "Vantablack" – a colour name – but in fact it is the essence of no colour at all. Unlike other blacks, Vantablack absorbs every visible wavelength. Staring into such was like staring into visual deprivation, if visual deprivation can have a gentleness to it, like black velvet without the soft lights that let you see the pile, and is designed for stealth weaponry: for launching objects not to be seen.

The materials collection cabinets, containing the Forbes Pigment Collection, as seen from within the Harvard Art Museums.

The more recent sample in the Forbes collection (Vantablack 2.0) looks like a totally flat surface covered in black velvet. But in fact it is curved: you can see that from the side, however from the front there are no clues; it is fascinating. This is still a secret colour, trademarked, patented, and although the process is secret, such is grown on aluminium foil, and VANTA stands for "vertically aligned carbon nanotube arrays" which might be a clue. "Can I touch it?" I asked, when I saw that sample in Edinburgh. It was such an extraordinary surface I had to almost hold my hand down to prevent it reaching out. My fellow speaker looked terrified. "No!" he said.

"It costs thousands of pounds and is very delicate."

"What would it feel like then?" I asked.

"If you had real sensitivity to touch, then I suppose it would feel like touching thousands of tiny delicate tubes," he said.

Last month I visited the 1707 Marsh's Library in Dublin. The books were protected by glass but even just reading the titles you could be drawn into infinite worlds of the imagination. Nineteenth century explorations down the Niger and to the Pacific Islands; the first editions of the novelist Charles Dickens and the satirist Jonathan Swift (who was Dean of the Dublin cathedral at the time of Archbishop Marsh and disliked him intensely); a pharmacopoeia; books of plants and spells and stars. The titles and the cracked, worn leather of the bindings had the power to transport the visitor instantly to the worlds created and narrated by men and women of the past.

The Forbes Pigment Collection is similar. The bottles and flasks are like the spines of books that most of us cannot ever open. Yet it is enough to stand in front of them for a moment and gaze, or even see them from a distance from a gallery far below (next time I go to the Harvard Art Museums, even if I don't have another invitation backstage, I'm bringing binoculars) or see the stunning pictures in this very book to be transported instantly into a different shimmering place.

It brings you, in your mind, to places of beauty and creativity, of blue mountains, half-starved cows, poisonous walls and desert orchids. Places where scientists invent and miners mine and artists work and have ideas and create illusions. And most of all to places where you can know the world more keenly, through a tiny handful of its chromatic dust and create illusions. And most of all to places where you can know the world more keenly, through a tiny pinch of its dust.

Victoria Finlay, 2017

Author of *Color: A Natural History of the Palette* (Ballantine 2003) and *The Brilliant History of Color in Art* (Getty Publications 2015)

The Forbes Pigment Collection

From the very dawn of humanity, pigments have coexisted alongside ourselves, satisfying the impulses to express and create, a fundamental part of our species' nature. A pigment is a small particle of coloured material. Sometimes the pigment is used on its own, and inter-particle forces keep the pigment in place. More often, it is mixed with a binder (e.g. oil, egg tempera, gum Arabic) to make paint in the simplest form. A pigment is different from a dye in that dyes are not particles, but rather dissolved molecules that absorb into whatever material it colours, whereas a pigment is a solid particle and sits on top of whatever it colours. For example, the red from madder root, when extracted can be used as a textile dye. When the dye is absorbed, or mordanted by a process called laking onto an inert particle or base like alum, barite, or chalk (the refractive index of alum and chalk is close to that of oil, so the particle becomes invisible, giving a transparent red glaze), it can then be used as a pigment. Many organic pigments like madder and kermes started as dyes in a textile, and once the material no longer served its purpose, the dye was then extracted and laked into a pigment. Cave and rock paintings are made with pigments - naturally occurring, deeply coloured ores or ochres, and charcoal. In Europe and the United States, an ochre is an iron oxide brown, yellow or red. In Australia, where the single oldest continuous painting tradition dates back over 30,000 years, any pigment from the ground is called an ochre. There, red, yellow, black and white ochres are found. Similarly, the paintings in south-western France's Lascaux cave, dating from 17,000 years ago, used ochres and charcoal. In all cases, the ochres were finely ground and applied.

To understand colour, one must understand light. Visible light is a small part of the electromagnetic spectrum, a continuum of waves that cross one another. These waves are low frequency waves, radio waves, microwaves, infrared, red-violet visible light, ultraviolet, xrays and gamma rays. Humans see approximately between red at 400 nanometers to violet at 700 nanometers. White visible light contains all the visible wavelengths. For example, if it strikes a prism it refracts into its individual wavelengths, and we see all the colours separately. We see colours thanks to the wavelengths in visible light and the surfaces those wavelengths strike. When white light, strikes a pigment particle, some of the wavelengths are absorbed and others are reflected. For example, when white light strikes azurite, only the blue is reflected, which is what we see, with all other light absorbed.

Colour theory tells us that there are three primary colours, red, yellow and blue. These colours cannot be created by mixing colours together.

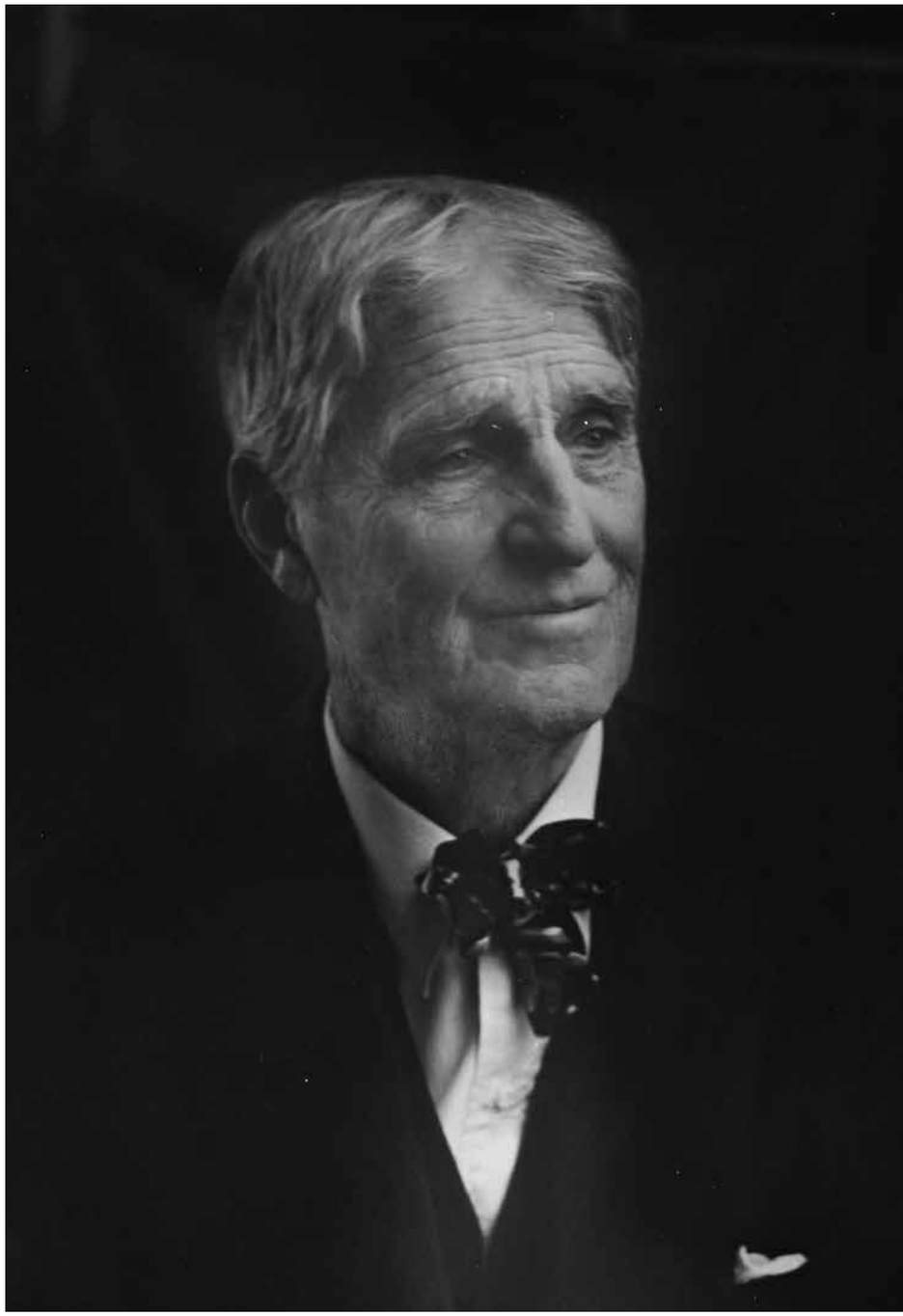
However, by combining these colours we can create any other colour, for example red and yellow together create orange, red and blue together create purple, blue and yellow create green. And if the three primaries are mixed they create brown, a tertiary colour. The primary and secondary colours can be arranged around a wheel, which is the basis of most colour theory. If you take a colour and cross the wheel to the opposite side, you find the complimentary colour: for example, the complimentary colour of red is the mixture of blue and yellow, green. This has been explored by artists, especially Impressionists, however Italian Renaissance painter Raphael is well known to have experimented with complimentary colours, notably in the application of a green background of his portrait of Julius II to offset the red drapery of the subject.

The cellular receptors in our eyes, the cones that receive colour information are sensitive to red, green and blue whereas rods receive light and dark information which plays a part in luminescence, and also impacts how we perceive colour. The cells lose their sensitivity to a colour if we stare at the same colour for a period of time. For example, if we look at green for some time, then stare at a white wall, we will see a red afterglow. This observation is an important part of Jasper Johns' green flag (*Flags*, 1968). The painting gives an afterglow of the real colours of the United States flag after staring at his green striped painting long enough.

Josef Albers also wrote extensively about how a colour is perceived not in its own, but relative to all the colours around it. The same colour can appear differently when surrounded by two different colours. Artists like Mark Rothko explored and wrote about the use of colour and what it meant. The play *Red* by John Logan is made up of quotes by Rothko bringing his thoughts about colour, especially red and back into the forefront of public consciousness. John Lahr wrote in the New Yorker, April 12, 2010:

> *For a month in 1949, Rothko went to the Museum of Modern Art to stand in front of Matisse's "The Red Studio," which the museum had newly acquired. Looking at it, he said, "you became that colour, you became totally saturated with it." Rothko turned his transcendental experience into an artistic strategy; his work demanded surrender to the physical sensation of colour. "Compressing his feelings into a few zones of colour," Rosenberg wrote, "he was at once dramatist, actor, and audience of his self-negation." Rothko escaped from the hell of personal chaos into the paradise of colour. "To paint a small picture is to place yourself outside your experience," he said. "However, you paint the large picture, you are in it."*

Edward Waldo Forbes, Fogg Director (1909-1944), portrait undated.



Forbes with students in gallery, 1944.

Rothko mixed his own paints, ladling in powdered pigments with the binding medium, often distemper or egg tempera, so his observations of colour were directly related to how he created his paint. By using pigments in the Forbes Pigment Collection and by synthesising additional pigments, we were able to determine that Rothko used a fugitive, calcium-salt of lithol red bound in animal skin glue for the background of the murals. When the murals were installed in the Holyoke Center, they were exposed to direct sunlight, despite Rothko's requests that the curtains be kept drawn. The paintings faded over the course of the fifteen years that they were installed, and were finally removed to dark storage in 1979. The 2014 exhibition of the murals faced a serious problem in that the restoration of the lost colour could not rely on traditional applications of glazes to the delicate unvarnished surface, as this would be irreversible. Instead, we used a projection of the missing colour calculated individually for over 2 million pixels per mural to restore the colour in a completely non-invasive way, returning Rothko's vision of the room. The viewer saw a mixture of the existing colour from the painting, combined with additional projected colour, giving the sensation of the original hue. Since then, we have found that Rothko used the same fugitive pigment on another painting. This finding informs us as to how we need to store and display that artwork, to avoid it suffering a similar fate as the murals. The pigment collection allows us to discover what choices the artist made when creating the works in the first instance. But also, it allows us to understand the changes that happen over time so that we can contextualise what we are seeing now, and how that is different to what may have been originally executed.

Many artists have ascribed emotions to colours. For example, Paul Gauguin combined emotion with subject matter and the aesthetic concerns of line, colour and form. This association was developed further by artists like Franz Marc and Wassily Kandinsky from the Blue Rider School, who wrote extensively about specific emotions associated with colours and applied those very same colours to evoke certain emotions. The theories were highly individualised, with the same colours of course not evoking the same emotions for each artist; presumably each viewer too has their own emotional response to each colour.

When I met abstract painter Ellsworth Kelly in his studio, he told me that he can tell when a colour is right; it's as if there were a needle upon a meter that moves as he is mixing a colour (he moved his arms to demonstrate) and at a certain point a signal goes off in within his mind that tells

him to stop. Kelly was very finely attuned to colour, but it is clear that to humans, colour and emotions have always been connected. In some way, colours tells us what is right and what is harmful; ripe fruit has a certain colour, red meat is edible, green meat less palatable. And colours must also release chemicals in our brain that catalyse these responses. So when we see jars of pigments, the receptors in our brain are flooded and we experience many different senses, which can go some way to explaining why shelves of pigments are so popular and endlessly fascinating to a great many people.

Edward Waldo Forbes started his collection of pigments as an educational exercise. He worked at the Fogg Art Museum (now part of Harvard Art Museums), for most of his career and was committed to bringing students face to face with art of good quality. His largest acquisitions were in the areas of Italian paintings and classical sculpture. When he started acquiring the collection, there were few original works of art, so he would travel to Europe, swiftly learning that he required connections and knowledge to make good purchases, in addition to requiring substantial funds of course. Many dealers were selling heavily restored, composite or forged works to wealthy American collectors in the early 20th century, and although Forbes bought cautiously and carefully, he was on occasion nevertheless, misguided. This lead him to consider ways to avoid such deceptions, and he eventually landed upon the idea that the best way to understand a work of art is from its composite parts; for example support, varnish, binding medium and pigments. Like A. P. Laurie before him, Forbes began to seriously investigate the pigments used by artists, collecting pigments as reference material directly from the people who prepared them, colourmen.

As Forbes travelled to Europe, he incrementally added to his growing collection of pigments. 1914 was a year of major expansion with a large purchase from the London based colourman, Charles Roberson and Co. This was made up of many pigments and source materials, such as a ball of Indian yellow, dragon's blood in native reed, mummy paint, and the fragments of the source mummy, a paint bladder and its ivory stick-pins from the late 18th, early 19th century. Much of the early collection was focused upon European and American pigments. As the collection's reputation grew, groups of pigments would be donated, such as those from Persia given by Mrs Schroeder, the wife of renowned Islamic art historian Eric Schroeder, as well as the collection of modern Persian pigments from Myron Smith; both dating from the mid-1930s. In 1931, Edward Forbes

travelled to Japan, where his brother Cameron was the appointed United States ambassador at the time. Cameron was instrumental in adding important Japanese pieces to the Fogg's collection, and Edward returned with a large group of pigments, inks and artists tools. In 1933, a significant number of studio materials from John Singer Sargent (1856-1925) were added, including paint tubes, a palette, brushes and a palette knife. The collection grew considerably further still, while Forbes remained at Harvard, as a driving force. He retired in 1944, and the accrual slowed down, with a collection of around 2000 pigments at the time. It continued in fits and starts until approximately 2007, when a budget was allocated for the addition of new materials. Since them, almost 1000 new samples have been added, starting with a group from Tate Britain museum in London and then directly from the manufacturers such as BASF, EC Pigments, Sun Chemicals, Kremer Pigments, and when needed, from local artist supply shops.

Forbes and his colleague Paul Sachs reshaped the museum profession in the United States, and part of that process was to impose transparency upon the field of conservation. Furthermore, Forbes employed the first scientist in an American museum, Rutherford John Gettens, as well as a researcher and conservator, George Leslie Stout. They studied the pigment collection and compiled their findings as a section in their seminal, and yet to be bettered volume, *Painting Materials: A Short Encyclopaedia*, in which they outline the history, chemistry and uses of pigments. This made the Forbes pigment collection a well-documented and studied reference collection for the profession, and it was in great demand. The collection was also widely shared with museums. A comprehensive list of these institutions can be found on the Boston Museum of Fine Arts database. In addition, Forbes kept a collection of pigments at his home subsequently donated to the Institute of Fine Arts, at New York University, which has similarly been shared. The pigments have been studied and spectra collected and added to databases, such as the infrared and Raman users group, used globally by conservation scientists.

Pigments can come from a variety of sources. There are those that are mineral derived, some of the world's oldest in fact, such as ochres and umbers. These minerals can be treated with heat to change the colour, by altering the hydration in their crystal structures: raw umber brown changes to a chocolate brown when heated, while raw sienna changes from yellow to red. Semiprecious stones can also be used as a pigment: azurite and malachite, blue and green copper carbonates respectively

have been ground into fine powders and used as pigments for centuries. Lapis lazuli, originally only mined in Afghanistan, can be ground and the blue material extracted to yield ultramarine, a pigment that was as expensive as gold until the early 19th century, when a synthetic analogue was prepared. Some mediaeval commissions would contain resource allocations specifically for the purchase of ultramarine; the price and quality of the materials indicated the piety of the donor. Other minerals can be used such a purple fluorite, which has been be ground to create a not entirely successful purple in the Middle Ages (for example, *Coronation of the Virgin* by Barthel Bruyn, 1515, Smith College of Art). Some artists will use precious stones as a pigment, for example diamond dust has been used by Andy Warhol, Vik Muniz, Peter Blake, Shepard Fairey, as well as on a custom automobile by George Barris.

Pigments can also be derived from plant sources. Often, a coloured organic material within the plant is extracted. For example, red from madder root (*rubia tinctorum*); red from brazilwood (any of several tropical trees of the senna genus, *Caesalpinia: C. brasiliensis, C. crista, C. echinata, C. sappan*); gamboge, a yellow-orange gum-resin produced by several species of Garcinia tree found in India, Thailand, Cambodia, Vietnam, and Ceylon ; dragon's blood, a transparent, red, resinous exudation from the fruit of several types of palms found throughout Southeast Asia (*Calamus draco, Daemonorops draco, Daemonorops propinquus, Dracaena draco and Dracaena cinnabari*) and South America (*Pterocarpus draco*); weld, a yellow dye extracted from the flowers, leaves and stems of the dyer's rocket plant, *Reseda luteola*. Bitumen and coal are also plant derived (on a geological tine-scale) and are used as pigments, sometimes described as Van Dyck brown, Cassel brown and asphaltum. Another well-known plant derived pigment is indigo. Originating in India, after the 17th century, it provided an alternative to woad which although chemically similar was the only other blue dye available in Europe. The finest denim from Japan is still dyed with natural indigo.

Pigments can additionally be derived from animal or insect sources. Kermes, a red dye from the dehydrated bodies of the female insects, *Kermes vermilio Planchon* and *Kermes ilicis* (formerly *Coccus ilicis*); cochineal, a bright red dye obtained from the body of the female insects *Dactylopius coccus Costa* (formerly *Coccus cacti*) that live on the nopal cactus (*Cactus oputia* or *C. coccinilifera*) in Mexico, the Canary Islands, and in Central and South America; lac dye a deep red colourant extracted from the crude shellac resin excreted by the lac insect, *Laccifer (Tachardia) lacca* (formerly *Coccus lacca*), indigenous to Southeast Asia; Indian yellow, which was originally made from the urine of cows fed exlclusively with mango leaves, and is a pigment composed of magnesium euxanthate; mummy brown, which is made from parts of Egyptian mummies that had been embalmed in bituminous material. This material apparently made a transparent brown glaze and was used until the supply of mummies became extremely scarce with the early 20th century. Tyrian purple is derived from the murex mollusc and was the only natural purple, dibromo-indigo. Approximately 10,000 molluscs are required to make one gram of pigment. Highly valuable, it was used on Roman senator's robes as well as imperial gowns. The Greek mythology surrounding its discovery recounts how Herakles' (Hercules) dog ate mulluscs on the beach turning his snout red and purple. No doubt something to do with the kitchen played a part in the introduction of the artists material (there are many examples of this; eggs for tempera, gelatine for binding medium, wheat starch to line canvases, linseed, walnut and heated oils as a patina on bronze, like one would season a cast iron skillet). I have only encountered Tyrian purple on one painting, *The Virgin and Child by the Master of St Cecilia* in the J. Paul Getty Museum, Los Angeles. It is an extremely rare pigment to find on a painting.

First reported in China, vermilion is probably the oldest synthetic pigment, and was imported to Europe in the 8th Century. Smalt is a blue glass that is ground up and used as a pigment and which dates from the mid-16th Century. Lead-tin yellow is another early synthetic pigment that was used extensively in Europe until the mid-18th century, after which it was lost. It was rediscovered in 1940 at the Doerner Institute in Munich. Prussian blue is important as it is the first synthetic pigment with a fully recorded history and was reported as a pigment in 1704 in Berlin. Many synthetic pigments arrived with the 19th century onwards as the understanding of chemistry evolved. The brighter colours of emerald green, cadmium yellow, cobalt blue, viridian, and chrome yellow had an enormous impact on painting through the Impressionists, Post-Impressionists, and Fauvism who exploited the possibilities of these newly available colours. From the late 19th century, organic chemistry has also played an increasingly important role in the production of pigments. Alizarin was used for British military uniforms after its discovery in 1868. Lithol red, one of the most important printing colours, was synthesised in 1899. When preparing to restore Rothko's famed Harvard murals of American painter Mark Rothko, we studied the materials he used, while working with the university's chemistry department, synthesising different salts of lithol red to use

(top)
Unrolling Rothko murals, Fogg Museum courtyard, 1985.

(bottom)
Marjorie B. Cohn, Gregory Smyrlian, Rhoda Burden, and Jean Lampton hanging Panel One, Rothko Mural Installation, Holyoke Center, January 1963.

(top)
Rothko Mural Installation, Holyoke Center, 1963.

(bottom)
Narayan Khandekar, senior conservation scientist, Straus Center for Conservation and Technical Studies, Harvard Art Museums, holding up a white card which shows the digital projection on Mark Rothko's Panel Four in the exhibition Mark Rothko's Harvard Murals, on display at the Harvard Art Museums November 16, 2014 – July 26, 2015.

as standards, discovering Rothko used both the calcium and sodium salts. Mauve, a substitute for Tyrian purple was synthesised from coal tar by William Perkins in 1856, realising a latent desire for purple in the late Victorian period. Many pigments that are manufactured now originate with organic chemistry and the distribution of atoms around a conjugated system. New inorganic pigments are, however, far less frequent, with some notable additions being mica and pearlescent pigments. Amongst these inorganic pigments are squares of anodised aluminium 'glitter' which can be considered mega-pigments. They are well known in hot-rod paints, which were popularly used by artists such as Americans Ed 'Big Daddy' Roth and George Barris from 1959 onwards. British painter Richard Hamilton used such pigments in his Guggenheim friezes; American artist Robert Grosvenor used metal flake paint on his sculptures, as did American Minimalist John McCracken, in the 1960s at the same time they were being used on custom automobiles.

Seeing as they are developed or discovered quite frequently, new pigments are acquired for the collection on a regular basis, in the same fashion as when it was first developed – there is a selection we seek out, and one we are mandated. We purchase pigments from colourman Kremer Pigments regularly. For example, we recently needed some unfaded dragon's blood (we have many samples of it that have faded), and some kermes lice from which is extracted the red kermes dye. We also purchased a sample of Vantablack from Surrey Nanosystems (Vanta being an acronym for: vertically aligned nano-tube arrays). This is more of a surface coating than a pigment as it is nanotubes that are grown in place, and is 99.965% light absorbing. Staring at Vantablack is like looking at the deepest velvet black hole; currently it is the 'blackest black'. Indian-born British sculptor Anish Kapoor has an exclusive license on the use of this material in art, which has caused some controversy, leading artist Stuart Semple to produce the 'pinkest pink', which is available to all except Kapoor. Naturally, we hastened to acquire a sample of Semple's Pinkest Pink. Surrey NanoSystems have produced a version of Vantablack that uses nanotubes as a pigment, as has Massachusetts based NanoLab with its Singularity Black. One major difference is that Singularity Black's distribution is not bound by a licensing agreement.

Another interesting example of how the collection grows through conservation needs dates to 2016, when we were examining the pigments used in a painting of John the Baptist and Saint-Barbara by Spanish artist Lluís Borrassà (1380-1424). We found that a blue pigment used in

the green architecture did not match any of the spectra in our database. The conservator suggested from her experience that it could be aerinite, which has been reported in 12th century murals in the Pyrenees. We then purchased a sample to use as a standard. However, it was not the pigment in the painting, but we did acquire through such enquires, an additional pigment for our database. On another occasion, we were examining three paintings attributed to American artist Jackson Pollock. We needed to acquire many standard materials to use as a reference, 250 samples in fact, which London's Tate Gallery kindly shared; allowing us to identify pigments that were not available during Pollock's lifetime, calling the previous attribution into doubt.

A recent project that examined the materials used to make bark paintings by Aboriginal Australian artists, lead us to travel to art centres in the northern reaches of the country, collecting ochres directly from a traditional gathering site, with permission from the artists. We collected 25 ochre standards that we elementally characterised using LA-ICP-MS (laser ablation inductively coupled plasma mass spectrometry), then adding the results to an ochre atlas being compiled in Flinders University in Adelaide, Australia. These were the first pigments from the Australian continent to have been added to the Forbes Pigment Collection. Since then, Steven Patterson of Australian colour supplier Derivan, has sent paints that they have made using ochres from Indigenous Australian art centres such as Buku-Larrnggay Mulka at Yirrkala, Northern Territory. An unexpected find from this project was that Aboriginal artists on the region's Groote Eylandt used not just black manganese ore (for which the island is well known), and charcoal, but also manganese dioxide from a dry cell battery. Naturally, an opened dry cell battery has been added to the collection - something I was told repeatedly not to experiment with when I was a young boy.

Often, we are approached by people who want to donate pigments to the collection. For example, Edwin B. Faulkner, who worked for Sun Chemicals, and is editor of the 2nd edition of *High Performance Pigments*, developing pigments for over 40 years donated samples from the 1970s he'd found in his garage. Or, Porfirio Gutiérrez, a master weaver from Oaxaca, who contacted us regarding the dyes his family use for dying yarns. In the same way that the ochres from Australia were collected at very specific locations, these colourant sources were collected from around Porfirio's village. The colourants are: cochineal insect, anil, huizache, pericon and marush. In addition, he sent samples of dyed

(top)
Rutherford J. Gettens in laboratory, circa 1950

(bottom)
View from the northeast of Hunt Hall ("Old Fogg" Museum), undated

fabric as supporting reference, showing the colours. Also, Keith Edwards, who is an historic pigment expert based in Nottingham, United Kingdom, sent us samples of Egyptian blue and blue verditer, that he manufactured himself in 2016. In April 2017, he sent five more: Cheddleton ochre, Gradbach ochre, and Doglow mine umber; Indian lake made from lac insect and Florentine brown, based on the formula for Prussian blue where the iron centre has been replaced with copper. Aslı Çavuşoğlu, a Turkish artist who was visiting Boston, invited me to participate in a performance piece, and donated Armenian cochineal made by Dr. Armen Sahakyan, who has revived the production of this colourant after it had ceased in 1915. A sample of Dutch process lead white dating from 1908 had made its way to the Museum of Fine Arts in Boston over the years, and was returned to Harvard Art Museums in 2016, along with five other samples of lead white dating in the 1920s-30s.

In recent discoveries, a new, highly saturated, inorganic pigment was developed at Oregon State University by Professor Mas Subramanian, dubbed YInMn Blue, after the metallic core of the molecule Yttrium, Indium and Manganese. It was an accidental discovery; he was developing products related to electronics. We are very fortunate to have an example of YInMn Blue directly from Professor Subramanian's laboratory. Should the ratio of metals change, or some metals be substituted for others, then a whole gamut of very bright colours can be synthesised. This particular discovery of a new inorganic blue hue has been widely reported, culminating in the May 2017 announcement that Crayola would add a new blue to their range in its honour named Bluetiful. The pigment has been manufactured by the Shepherd Colour Company, and it not only has a beautiful ultramarine hue, it also is able to reflect infrared light, meaning that it has significant heat reducing properties with applications in roofing and automotive finishes, Derivan Paints has made some into paint; the inclusion of YInMn Blue within the collection is, naturally, eagerly anticipated.

The pigment world constantly intersects and the individuals involved are equally as enthusiastic about colour in the same way that the pioneers like Forbes, Gettens, Stout and Laurie were. And, through the spread of the reputation of the collection, it has found use beyond those of technical art history, continually fascinating visitors to the Harvard Art Museums now, and for many years to come.

Narayan Khandekar, 2017
Director of the Straus Center for Conservation and Technical Studies at The Harvard Art Museums and author of *Collecting Colour* (ArtEZ Press 2017)

Cadmium Scarlet
English Vermilion
Geranium Lake
Ultramarine Red
Dragon's Blood
Imperial Red
Madder Lake
Venetian Red
Cochineal
Pure Indian Red
Chinese Vermilion
Red Ochre
Cinnabar
Kermes Lake

Mark Rothko

"There is only one thing
I fear in life, my friend;
One day, the black will
swallow the red."

Intoxicating ardour and carnal lust, wanton sensuality and rapacious power, gloried martyrdom, and celebrated valour, the colour red, the oldest known within our species' palette, has entranced humanity for millennia.

Naturally occurring ochre for example, a red-hued clay coloured by iron oxide and earth's most common pigment, appears to have been ground for symbolic bodily anointment by our Middle Pleistocene, Stone Age ancestors some 165,000 to 50,000 years ago; the evidence of such found within several coastal archaeological sites, such as the caverns of South Africa's Mossel Bay. Whilst north-west Spain's Cave of Altamira possesses a majestic, long-extinct steppe bison rendered with red ochre, and dating between 15,000 and 16,500 BC. Another natural pigment, red haematite or mineral iron oxide, was recovered from a grave site within China's Beijing Zhoukoudian cavern complex, evidencing habitation from between 700,000 and 200,000 years ago. Archaeologists conjecture haematite usage at Zhoukoudian may illustrate symbolic blood offerings to the sacred dead.

Rubia tinctorum or common madder, an herbaceous plant found throughout Africa, Asia and Europe, whose long roots, when crushed, produces a richest red hue, rose madder or Turkey red, has been utilised for aeons; cotton dyed with madder, drawn from India's Mohenjo-daro archaeological site, for example, dates to the third century BC. Another botanical pigment, dragon's blood, preferably of apothecary grade, is created from that brilliant ruby resin drawn from the wounded trunks of several plant genera; *Dracaena draco* and *Dracaena cinnabari*, found respectively upon Spain's Islas Canarias, and the Yemeni island of Socotra. Believed to possess medicinal properties, dragon's blood was known to the Ancient Greek, Roman and Arabic worlds as radiant pigment, and an effective palliative.

Kermes, another scarlet dye, made from the dessicated carcasses of the female *Kermes Vermilio* scale insect. A species found throughout the Mediterranean, kermes saturated the garments of Ancient Greece and Rome, the decadent Sicilian silks of the Middle Ages, and the luxurious woollen textiles of 14th and 15th century Western Europe. Superseded by cochineal, a crimson-hued dye extracted from the cochineal insect, *Dactylopius coccus*, cochineal, long employed by the Aztec and Mayan peoples of North and Central America, went exported by Spain from Mexico across Europe, eastward to India and the Far East, after Hernán Cortés' conquest of the Aztec Empire in 1521.

Accompanying the Renaissance were several innovative, varieties of red pigment, transported to Europe in the 15th and 16th centuries by way of trade routes established throughout Asia, the New World and the Middle East; devoured wholeheartedly by enraptured artists and artisans. Master Venetian painter Titian garbed the Virgin Mary, several awestruck apostles, and ascendant God himself in incandescent vermilion cloaks for his 1518 illuminated altarpiece, *Assumption of the Virgin*. According to Titian, "A good painter needs only three colours: black, white and red." Vermilion, a pigment originally created by milling cinnabar, the scarlet mineral form of mercury sulphide, once rouged the cheeks of Ancient Rome's women; coloured the royal possessions found within the sarcophagus and tomb of the Mayan Red Queen at Palenque, southern Mexico, between 600 and 700 AD. And went utilised in the Far East; found throughout architecture, ceremonial textiles, and as a colourant of carved lacquerware, during China's Song Dynasty, 960–1279 AD.

Carmine, formulated through the crushing of Armenian and Polish cochineal insects, *Porphyrophora hameli* and *Porphyrophora polonica,* went employed by the painters of the Dutch Golden Age. Baroque painter Johannes Vermeer's 1656 work, *The Procuress,* reveals a young courtesan grasped by an apparent suitor, garbed in carmine doublet. Whilst the subject of fellow Dutchman, Rembrandt Harmenszoon van Rijn's painting known as *The Jewish Bride* of 1667, appears enveloped by swathes of decadently brocaded, carmine-hued cloth. However, with the Industrial Revolution, such natural red pigmentations went rendered wholly obsolete, superseded now by a succession of synthesised chemical compounds, such as alizarin in 1869. Alizarin, the organic colouring element of the madder root, was the inaugural natural pigment to be duplicated synthetically. Economical and sustaining, contrary to organic-sourced red colourations, the advent of alizarin and other synthetic pigments, saw, with the 19th century's end, Europe's madder plantations, and Latin America's cochineal exports to Europe, nearly cease altogether.

Synthetic pigment advancements went accompanied with nascent understandings of colour theory, and complementary colour; the interrelationship between the colours red and green for example, proving of particular fascination to that aptly redheaded Dutch Impressionist painter, Vincent van Gogh. "I sought to express with red and green the terrible human passions," wrote van Gogh of his vivid 1888 work, *The Night Café,* to brother Theo that September. "The hall is blood red and pale yellow,

with a green billiard table in the centre, and four lamps of lemon yellow, with rays of orange and green. Everywhere it is a battle and antithesis of the most different reds and greens."

Alizarin's synthetic substitution of cochineal and madder root with the 19th century, went repeated with the dawning 20th century's replacement of cinnabar and vermilion, with cadmium red. Cadmium, a naturally occurring, highly-ductile silver metal, was rendered into several pigments; yellow, orange and red, through smelting, then immersion within either a chloride or sulphate solution, before heating once more to produce powdered cadmium sulphide. Necessitating the addition of selenium, cadmium red first became commercially available in 1919, and was immediately adulated by the bespectacled French painter, Henri Matisse. "A certain blue penetrates your soul," he once declared, having rendered an entire composition first in blue, then red. Now enraptured with his beloved cadmium red, 1908's *Harmony in Red* being emblematic of such. "A certain red affects your blood pressure."

Abstract expressionist, Russian-American painter Mark Rothko's enduring fascinations with both Matisse; 1911's *L'Atelier Rouge* was of significant influence, as well as the colour red, is illustrated best perhaps by 1958's *Four Darks in Red*. Four vast rectangular, irregular swathes of red, burgundy and saturated black command his monumental composition, engulfing viewers with ever-transforming fields of depth. Such abstracted, intimated forces had the capacity to summon "the basic emotions—tragedy, ecstasy, and doom." Of the colour red itself, French multidisciplinary artist Louise Bourgeois, renowned for her exploratory, sexually explicit works centred about domesticity, childhood trauma, and physicality, declared, "Red is affirmation at any cost - regardless of the dangers in fighting - of contradiction, of aggression. It's symbolic of the intensity of the emotions involved." "Red, of course, is the colour of the interior of our bodies," observes British artist Anish Kapoor, famed for his colossal biomorphic sculptures, paralleling, in many ways, Bourgeois' visceral relationship to the hue. "In a way it's inside out, red."

Cadmium Scarlet
Straus.1689
F. Weber Co., USA, n.d.
In 1907, commercial production of synthetic pigment cadmium red began. It quickly became the standard red of important 20th century painters such as Henri Matisse.

(top left)
Fluorescent
Pigment Brick Red,
Tages-Leucht-Farbe
Ziegelrot,
Schwarzlichtfarbe
Straus.8541
Kremer Pigments,
USA, 2013

(top right)
FD&C Red #4
Aluminium Lake
Yet to be catalogued
Allied Chemical Corp.,
USA, 2016

(bottom)
Toluidine Toner 16 T 01
Straus.1657
Ansbacher-Siegle Corp.,
USA, n.d.

Pigment from
Persia, Red
Straus.3415
Persia, 1935
Colour bought in Persia by
Mrs Eric Schroeder. Eric
Schroeder was the Keeper
of Islamic Art, Fogg Art
Museum, Harvard University,
1938-1970.

(top)
Indantherene Fast Pink
Straus.1640
H. Kohnstamm & Co.,
USA, n.d.

(bottom)
Laque Fine
Straus.1585
Lefranc & Cie, France, n.d.

English Vermilion
Straus.2202
A synthetic pigment developed in China in the 8th century. Vermilion was the primary red pigment used by European painters from the Renaissance until the 20th century, and was almost wholly replaced by a new synthetic pigment, cadmium red.

Geranium Lake, Laca Geraneo
Straus.1598

Rose Toner
Straus.1635
Imperial Paper & Color Corp., USA, 1934

Ultramarine Red
Straus.1682
Castlefranco, Italie, n.d.

(top)
Red PR-49:2 (Calcium Salt of Lithol Red)
Straus.2433
For his 1960s Harvard murals, American painter Mark Rothko employed lithol red. This highly fugitive pigment was more commonly associated with the printing industry than with artists' paints. Exposure to high levels of light led to dramatic fading of Rothko's murals, and they were removed from display in 1979, and only recently, in 2014, were they restored (using a carefully calculated projection of coloured light instead of pigment) and redisplayed.

(bottom)
Dragon's blood, Resina Dracaena from Sumtra, Powdered
Yet to be catalogued
Kremer Pigments, USA, 2016

(top)
Toner Light,
Lithol Red Medium
Straus.1639
Imperial Paper & Color
Corp., USA, 1941
Lithol red (PR 49) is most commonly associated with the printing industry, where it is still used for low-cost printing inks, and was especially popular in 1950s printing.

(bottom)
Madder Lake
Concentrate
Straus.1590
Imperial Paper & Color
Corp., USA, 1940

Venetian Red
Straus.1521
F. Weber Co., USA, n.d.

Cochineal
(Carmine Lake)
from female insect
Coccus Cacti
Straus.106
F. Weber Co., USA, 1941
British soldiers, who were known as "red coats" got this name when the red military uniform was adopted by the British Army in 1645. Ordinary soldiers wore red coats dyed with madder, while officers wore scarlet coats dyed with the more expensive cochineal.

Pure Indian Red
Straus.2046
Reichard-Coulston Inc., USA, n.d.

Chinese Vermilion
Straus.145
F. Weber Co.,
USA, 1927
Collected by E. W. Forbes.

(top)
Brazil Wood Cuttings
(Lign. Pernambuco)
Straus.1616

(bottom)
Red Ochre
Straus.1004

Cinnabar

Straus.576

A very poisonous substance. Occurring in many forms, the volcanic substance was sometimes highly fugitive, turning black when exposed to sunlight (and moonlight). This discolouration did not happen with all cinnabar-based paints, rather only those containing traces of chlorine.

Cochineal beetles

Straus.725

A natural, non-toxic dye traced back to the Aztec and Maya peoples of Central and North America, still used as a natural dye to this day. The female insects are crushed to extract carminic acid, which is treated to produce carmine, yielding shades of red. The body of the female cochineal is composed of roughly one fifth carminic acid.

Armenian Cochineal
(Stored in the dark)
Yet to be catalogued
Mesrop Mashots Institute
of Ancient Manuscripts,
Armenia, 2016

Dragon's Blood in
native reed
Straus.566
Charles Roberson & Co.,
United Kingdom, 1914
Bright red resinous material
that forms as an exudate from
a variety of plant species
belonging primarily to the
Daemonorops and Dracamea
genuses. Used for millennia
as medicine, incense, dye,
and varnish.

(top left)
Specimens of Kermes `Berries', Probably Kermes Ilicis
Straus.569
Courtauld Institute of Art, United Kingdom, 1937
Used by Professor O. Dinaroth of Universitat Wurzburg in his studies of kermesic acid (1910-13).

(top right)
Kermes Lake "Lacca di Cimatura"
Straus.728
Courtauld Institute of Art, United Kingdom, 1938
Used by Professor O. Dinaroth of Universitat Wurzburg in his studies of kermesic acid (1910-13).

(bottom left)
Madder Root
Straus.3545
Grown in E.W. Forbes' garden in the 1920s. A notable physiological effect of madder is that of colouring red the bones of animals fed upon it, as also the claws and beaks of birds. This appears to be due to the chemical affinity of calcium phosphate for the colourant.

Kidney Haematite
Straus.615

Cadmium Orange
Cadmium-Barium
Orange
Sirinj
Rex Orange
Tanager Red
Japanese
Bright Red
Powdered Coral
Kidney Haematite
Jan
Saffron
Madder Root
Cadmium Orange

Wassily Kandinsky

"Orange is red brought
nearer to humanity
by yellow."

Sweetest clementines and divine illuminations, transformation, jubilant gaiety, and flamboyance, Dionysian ecstasy and deepest empathy, the colour orange entrances with red's vivacity; yet pacifies with yellow's serenity.

Upper Palaeolithic artworks, such as those found within north-west Spain's Cave of Altamira betrays evidence, alongside red ochre, of natural orange ochre, coloured by iron oxide. Orange however, in her purest colour incarnation, arose only with the excavation and milling of noxious ruby-hued realgar; a natural, arsenic mineral sulphide, often discovered alongside yellow relative, orpiment. Supplying radiant orange, ground realgar went utilised within the elaborate tomb paintings of Ancient Egypt, and as a cosmetic by the Akkadians, those of Bronze Age Mesopotamia; whilst a vessel of realgar was excavated from the fourth century BC ruins at Corinth, Greece.

Drawn from heated lead oxide, minium produces a brilliant coral hue; one which embellished the illuminated manuscripts of the Byzantine Empire. *Crocus sativus*, a flower native to Southwest Asia, possesses scarlet styles and stigmas, which, when dried, produces saffron; a chromatic orange colourant, and the world's most expensive spice. Cultivated throughout ancient Assyria, Greece and Persia; 50,000 year old cave artworks, unearthed in modern Iraq, contain magnificent beasts illustrated with a saffron-based pigment. Turmeric, another botanical pigment drawn from the dried rhizomes of the *Curcuma longa* plant, yields a yellow-orange hue. Renowned for some 4000 years throughout the Indian subcontinent and Southeast Asia for medicinal and colourant properties, turmeric was used for the dying of resplendent saris, ceremonial monk's robes, and later, from the dawning 19th century, turmeric paper; colour-transforming paper suffused with turmeric to indicate the presence of alkalis.

Renaissance Venice's *vendecolori,* colour merchants, assuaged that age's fascinations with never before seen pigments; luminous orange amidst such. Popularising realgar and cousin orpiment for luminaries such as painter Tiziano Vecellio, Titian, the hue would prove wholly indispensable to realising the famed Venetian *colorito* technique. Romantic *colorito*, contrary to classic Florentine *disegno's* emphases upon rationalism, preparatory drawing, design and erudition, instead employed colour in pronounced fashion, accentuating sensuality, expression, and composition. Titian, a somewhat synonym of orange's nomenclature, employed the hue throughout much of his celebrated œuvre. 1523's monumental

work, *Bacchus and Ariadne*, reveals Greek goddess Ariadne, mistress of the labyrinth, abandoned now upon the island of Naxos by her deserting lover Theseus. She is discovered by the god of wine, revelry, and ecclesiastical ecstasy, Bacchus himself. Ecstatically wielding high two silver cymbals, one of Bacchus' several accompanying bacchantes is garbed with realgar cloak. Realgar appears within 1510's *The Holy Family with a Shepherd*, and later, 1555's *Venus and Adonis*. Enduring across the works of Italian contemporaries Giovanni Bellini and Jacopo Tintoretto, harmful realgar's usage occurred intermittently throughout Dutch 17th century, and British 17th and 18th century painting. Such went rendered obsolete at last by the introduction of chrome orange, a lead chromate in 1809. Originally discovered in 1797 by French chemist Louis Nicolas Vauquelin, chrome orange is drawn from Siberian red mineral crocoite.

Pleasantly symmetrical, as is yesteryear's way, the 17th century also saw the invention of the *orangerie*; warmed greenhouses allowing oranges themselves to appear throughout the larders of northern Europe, the hue somewhat more ubiquitous, ascendant within our collective consciousness. However, it was the liberation of painters from within, by the invention of the metal paint tube in 1841 to create out-of-doors, *en plein air*, that orange went broadly utilised by artists, eager to replicate nature's entrancing chiaroscuros; the vagaries and gradations of sunlight and shadow. Authored by the father of French Impressionism, Claude Monet, 1872's *Impression, Sunrise* reveals Normandy's port city of Le Havre by dawn. An orange sun, haloed by luminescent Titian light, rises over several sail and steamboats, refracting across kindling cloud, and greyest sea. "Impressionism is only direct sensation," declared Monet, imploring artists "to forget what object you have before you," to "paint just as it looks." Evocations of an impression remained paramount for he and fellow Impressionists, not the objective encapsulation of subject or scene. Named for *Impression, Sunrise*, Impressionism encompassed the equally sensorial works of several fellow French adherents; Paul Cézanne, Camille Pissarro and Pierre-Auguste Renoir, many of which are now found within Paris' Musée de l'Orangerie. Fascinated by natural landscapes, radiant sunlight, and vivacious colour, the Post-Impressionists also possessed a marked affection for orange; Paul Gauguin's appreciation perhaps, foremost amidst such. Journeying to that far-flung Pacific island of Tahiti by sailboat with 1891, after authoring such impressionist works as 1881's *Still Life With Oranges*, Gauguin would author several celebratory works of that South Sea's

idyll, frequently resplendent with incandescent orange. 1892's *Arearea* for example, portrays two cross-legged Tahitian maidens seated behind a prominent orange hound, whilst another of that same year, *Pastorales Tahitiennes* reveals another orange hound kneeling before two other Tahitian maidens; all framed by an orange-swathed landscape. Tahiti and elsewhere, brilliant orange elements appear throughout Gauguin's work. "An orange and a side-glance," he wrote within his *Intimate Journals*, ostensibly referencing the citrus fruit, but perhaps also the hue; "nothing more is necessary."

Bacon and oranges, an improbable tryst upon first glance, nevertheless remains one of modern art's most enduring love affairs; that between colossus of British figurative painting Francis Bacon, and his several varieties of orange. Infamously macabre, Bacon's renowned triptych, 1944's *Three Studies for Figures at the Base of a Crucifixion*, draws catalyst from the Eumenides or Furies of Aeschylus's *The Oresteia*, a sorrowed Greek trilogy. As well as Picasso's sketches, an image of materialised ectoplasm, and of course, the Crucifixion. Possessing three gruesome, anthropomorphic gargoyles, howling beneath an unexecuted cross, Bacon's Furies, rendered with oil and pastel, writhe across an unmistakable crucifixion orange background; a garish hue he employed throughout several works. Such was created largely with brilliant cadmium orange, developed earlier that century alongside another synthetic hue, quinacridone orange, and depthless black. "Some paint," he once declared, "comes across directly onto the nervous system and other paint," conceivably imagining his indelible crucifixion orange, "tells you a story in a long diatribe through the brain."

Assorted infatuations with orange, Bacon's aside, are also to be found within the respective œuvres of American industrial designers Charles and Ray Eames, Spanish painter Pablo Picasso, and throughout the joyous compositions of activist American street muralist, Keith Haring. Illustrating the various perils of crack cocaine usage, 1986's fluorescent orange work *Crack Is Wack* reveals black-line winged skulls, flaming banknotes and various fantastical saw-toothed beasts, one of which is about to devour an unfortunate human sacrifice. Another work, 1983's *Untitled*, reveals a crucified figure rendered with black line and orange, dying upon a television screen, itself centred upon a cross before an audience, whilst 1989's colossal orange work, *The Last Rainforest*, portrays a vast, labyrinthine mass of nightmarish beasts, human figures and entwining boughs, representative of nuclear armament, environmental collapse and the AIDS virus epidemic. Haring had by then created dozens of provocative murals, screen-prints, sculptures and paintings, often exploring, in vibrant orange hues, sexuality, warfare, death, addiction and AIDS awareness, before his own death from the virus in 1990.

Cadmium Orange
Straus.1408
Charles Roberson & Co.,
United Kingdom, n.d.

(top)
Cadmium-Barium
Orange
Straus.131
The Harshaw Chemical Co.,
USA, 1927

(bottom)
Modern Persian
Pigment, Scarlet
(Vermilion), "Sirinj"
Straus.3382
Made in Russia from red
lead, collected in Isfahan,
Iran, 1935

(top left)
Pigment from Persia, Orange
Straus.3410
Persia, 1935
Colour bought in Persia by Mrs Eric Schroeder. Eric Schroeder was the Keeper of Islamic Art, Fogg Art Museum, Harvard University, 1938-1970

(top)
Rex Orange (Molybdate Orange)
Straus.1409
Imperial Paper & Color Corp., USA, 1941

(bottom)
Tanager Red Toner
Straus.1650
Imperial Paper & Color Corp., USA, 1941

Japanese, Bright Red
Straus.3555
Japan, 1931
Pigment collected by E. W. Forbes during his 1931 travels in Japan.

Powdered Coral
Straus. 3595

Kidney Haematite
Straus.1502

Jan
Straus.806
Japan, n.d.

Saffron

Straus.526

One of the more flavourful pigments in the collection, it is commonly described as "the world's most expensive spice". The documented history of saffron cultivation spans more than three millennia, with it's use as a dyestuff predominant through history across the globe. Important in medicinal uses throughout history, it was famously used by Cleopatra to infuse her bathwater, by Alexander the Great to treat his battle wounds, and in the 14th century it was used to combat bubonic plague.

Madder Root

Straus.571

In very light concentrations on natural fibres, the red madder root dyes a rich apricot orange.

Lemon Yellow
Cobalt Yellow
Naples Yellow
Strontium Yellow
Cadmium-Barium Yellow
Hansa Yellow di Aquila
Chrome Yellow Irox
Persian Berries
Zafferano
Persian Berries
Lemon Yellow

Vincent van Gogh

"How lovely yellow is! It stands for the sun."

Radiant sunflowers and sallow, jaundiced flesh, wanton frivolity, and enlightened wisdom, intoxicating avarice and loathsome cowardice, the colour yellow has, from antiquity, remained an exercise of the contrary.

Incandescent yellow ochre, a natural earth pigment coloured by hydrated iron oxide or limonite, went employed within the Upper Palaeolithic, late Stone Age by the extraordinary painters of south-western France's Lascaux caverns. Executed some 17,300 years ago, here amidst the aurochs, a long-extinct variety of colossal wild cattle, the bison, bear, deer and ibex, one finds an astounding horse, rendered resplendent with yellow ochre. Long before Lascaux however, Indigenous Australians had, at Madjedbebe, a sandstone rock shelter in western Arnhem Land, the site of earliest Australia's human occupation, employed red and yellow ochre within morturary rites and throughout cavern paintings, some 60,000 years ago.

Within the land of the pharaohs, the Ancient Egyptians believed yellow was synonymous with that mineral which has entranced all humanity for millennia: gold. Colour of the sun, considered equal with all that remains eternal, imperishable, indestructible and immortal, the very flesh and bones of the gods themselves were believed to be made from gold. Yellow ochre, massicot, a lead oxide, and harmful orpiment, an arsenic sulphide mineral, went utilised as pigmentation throughout Ancient Egypt's elaborate tomb paintings; indeed fragments of suspected, lemon-hued orpiment were recovered from the tomb chapel of Metjetji, believed to date from 2400 BC. Orpiment, fascination of Roman would-be alchemists, went employed across the murals of Pompeii, and was, notwithstanding the mineral's well-known harmful nature, nevertheless ingested in Ancient China both as a medication, and as a pesticide within rice-fields.

Naples yellow, superseded noxious lead-tin yellow, once formed by firing powdered lead and tin oxide, with the 15th century. Adulated by landscape painters, famed for its utility when credulously rendering vagaries of sun and sunlight, Naples yellow, drawing name from the large natural deposits of lead antimoniate found at Mount Vesuvius, upon the Bay of Naples, went created from non-toxic chromium titanate pigment, and appears, often alongside lead-tin yellow and yellow ochre, in several notable works of the era.

Flemish painter Hieronymus Bosch's fantastical triptych *The Garden Of Earthly Delights*, circa 1503–1515, for example possesses vast swathes of assorted lemon hues; colouring the landscape of the work's central panel, within which appear dozens of unclothed human and animal forms satisfying every imaginable desire. Rembrandt, a synonym for Dutch Golden Age painting, rendered his 1636 work, *Belshazzar's Feast*, from the Old Testament's Book of Daniel, with an array of yellows, Naples amidst such. King of Babylon, blasphemous Belshazzar, garbed in brocaded golden cape, had orchestrated an ornate banquet for assembled nobles. Serving wine drawn from sacred vessels looted by his father Nebuchadnezzar from the Temple in Jerusalem, a divine hand appeared before the astounded revellers. And authored an illuminated Hebrew inscription in which Belshazzar's kingdom's end is foretold; legend tells, he was slain that very evening.

Belshazzar's last supper aside, yellow's more ruinous associations have endured throughout the centuries. Europe's non-Christian faithful Jews and Muslims were mandated, from as early as 1215, by several nations, Britain, France, Italy, and Spain amidst them, to mark themselves, often with yellow peaked hats, felt medallions, coloured bands, and Stars of David. Exacerbated by long-held implications of treachery, and usury, gold lending, anti-Semitism would from then forth possess an unmistakable yellow hue; one that would endure well into the 20th century. Repentant Cathars, those of an outlawed, Gnostic faith originating in the middle of the 12th century, were commanded by the Roman Catholic Church to wear forever, two yellow crosses. Whilst Spain's 16th century heretics were impelled to appear before the Spanish Inquisition in capes of yellow cloth. Judas Iscariot was from the Middle Ages garbed with yellow, as was Mary Magdalene from the Renaissance forth; on account of Venetian prostitutes' entrancing yellow dress, from the late 14th century onwards.

Excavated from altogether-inhospitable Siberia, incandescent mineral crocoite, a natural form of lead chromate was discovered in 1762. Possessing chromium, a new element identified by French chemist Louis Nicolas Vauquelin in 1797, such went employed to create brilliant marigold chrome yellow. Obtainable from the early 19th century forth, chrome yellow went employed alongside another saturated hue, Indian yellow, created from the urine of cow or buffalo, nourished exclusively with mango leaves, in the ethereal, incandescent landscapes of celebrated British Romantic painter, J. M. W. Turner. 1844's *Rain, Steam, and Speed, the Great Central Railway*, Turner's radiant impressionist work for example, reveals an early Great Western Railway locomotive, obscured almost entirely by a yellowed miasma as it crosses the River Thames over the Maidenhead Railway Bridge. Turner's adoration of yellow was such that contemporary detractors maligned his works as "afflicted with jaundice," an artist of wholly distorted vision. Another artist long consumed by yel-

low infatuations was the French Post-Impressionist painter, Paul Gauguin. Several works, such as 1889's *The Yellow Christ*, Christ yellow upon the cross, and 1888's *Self-Portrait Dedicated to Vincent van Gogh* (*Les Misérables*) reveals a contemplative Gaugin, now as Jean Valjean, the chief character of Victor Hugo's novel, *Les Misérables*, against a vivid yellow interior. "Oh yes! He loved yellow, did good Vincent, the painter from Holland," observed Gaugin of another yellow devotee, sunflower worshipping Vincent van Gogh, "gleams of sunlight warming his soul, which detested fog." Chrome and, blessedly perhaps, ammonic Indian yellow, were both superseded altogether by synthetic cadmium yellow, first introduced in 1820, with the end of the 19th century.

Dutch abstractionist, De Stijl painter Piet Mondrian, famed for his minimalist, geometric compositions of black-line and primary coloured shape, alighted at New York City from Paris in September 1940. And whilst many of Mondrian's works encompass all three brilliant primary hues, 1937-1942's *Composition with Yellow, Blue and Red* emblematic of such, for yellow, seemingly, he reserved greatest affection. Several compositions completed soon after settling in Manhattan illustrate such; 1942's *New York City I*, and 1942-1943's whimsically titled *Broadway Boogie Woogie*, reveal Manhattan's ordered street alignment from above. Rendered with thickest acid yellow line, yet drawing influence from Boogie Woogie, an American variety of syncopated jazz, jubilant *Broadway Boogie Woogie* went accompanied by 1942-1944's *Victory Boogie Woogie*, created in anticipation of an Allied war victory; yellow's predominance synonymous perhaps with the incandescence of triumph. "I wish to approach truth as closely as is possible" Mondrian observed, "and therefore I abstract everything until I arrive at the fundamental quality of objects."

Conceptual artist twosome, Bulgarian Christo and Moroccan Jeanne-Claude's expansive swathes of saffron cloth parallel Mondrian's abstraction of object, in pursuit of fundamental elements, and appreciation of yellow. Illustrated by their monumental environmental cloth-encasing works such as 1985's *The Pont Neuf Wrapped*, whereby Paris's oldest bridge went entirely encased by some 450,000 square feet of golden sandstone cloth. And 1991's *The Umbrellas, Japan-USA*, 1984-91 which saw some 1,760 colossal yellow umbrellas installed across Tejon Pass, California, Christo's 2016 work, *Floating Piers* once more encompassed yellow; 75,000 square feet of sunflower yellow fabric causeway in fact, floated across Italy's Lake Iseo to the island of San Paolo.

Fluorescent Pigment
Lemon Yellow,
Tages-Leucht-
Farbe Zitronengelb,
Schwarzlichtfarbe
Straus.8549
Kremer Pigments, USA, 2013

Cobalt Yellow
Straus.1305
Castlefranco, Italie, n.d.
Cobalt yellow is also known as aureolin. The name is derived from the Latin *aureus*, meaning "golden".

(top)
Naples Yellow
Straus.1236
Lefranc & Cie, France, n.d.

(bottom)
Naples Yellow, "Chrome"
Straus.1248
Ansbacher-Siegle Corp., USA, n.d.

(top left)
Lemon Yellow
Straus.2230

(top right)
Strontium Yellow
Straus.56
Ross, further research
required, 1941

(bottom)
Cadmium-Barium
Yellow
Straus.129
The Harshaw Chemical Co.,
USA, n.d.

(top)
Hansa Yellow
Straus.1275
Fezandie & Sperrle Inc,
USA, n.d.

(bottom)
Indian Yellow
Straus.1314
Geo. Rowney & Co.,
United Kingdom, n.d.

(top)
Chrome Yellow Medium
Straus.1252
Fezandie & Sperrle Inc,
USA, 1936

(bottom)
Chrome Yellow, Lead Chromate
Straus.57
Ansbacher-Siegle Corp.,
USA, 1941

"Irox" Yellow Orange
Straus.2051
Reichard-Coulston Inc.,
USA, n.d.

Ball of Raw Indian Yellow
Straus.529
Charles Roberson & Co., United Kingdom, 1914
Indian yellow is produced from the urine of cows exclusively fed a diet of mango leaves. Also called piuri, puree, euxanthin or euxanthine, it is a xanthonoid.

Indian Yellow, water purified
Straus.530
Charles Roberson & Co., United Kingdom, 1914

(top left)
Modern Persian Pigment, Indian Yellow, "iarat" or "usara shireh daraght-i rivand"
Straus.3386
Made in India from the sap of the China rhubarb, collected in Isfahan, Iran, 1935

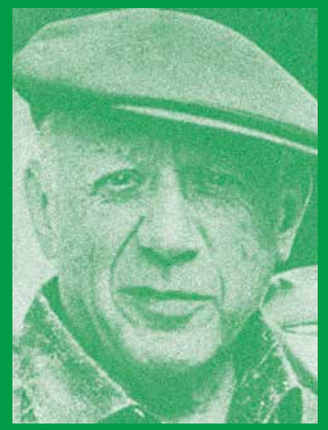
(top right)
Orpiment
Straus.1138
n.l., 1916

(bottom)
Zafferano di Aquila. Purissimo
Straus.1242
Farmacia Dr. Comotti, Milan, Italy, n.d.
Saffron is a natural, golden-yellow colourant obtained from the flower stigmas of the Crocus sativus plant, native to the Middle East.

(top)
Weld
Straus.574
Common names for weld include dyer's rocket, dyer's weed, woold and yellow weed. This dye was used from the first millennium BC, dating back perhaps further than the use of either woad (blue) or madder (red).

(bottom)
Persian Berries
Straus.727

Malachite
Terre Verte
Byaku Roku
Garland Green
Chrome Green
Chromic Oxide
Marie Collart
Emerald Green
Green
Turquoise
Rokusho
Verdigris
Zinnober Green
Ultramarine Green



Pablo Picasso

"They'll sell you thousands of greens. Veronese green and emerald green and cadmium green and any sort of green you like, but that particular green, never. "

Verdant vegetation and healthful vitality, contrary illness and consuming envy, environmentalism, Quranic exaltation and wholesale liberty, the colour green intoxicates with yellow's incandescence, then allays with blue's equilibrium.

Neolithic cave artworks remain wholly absent of identifiable green pigmentation, yet the northern European inhabitants of that age nevertheless fabricated an approximate green dye from the leached leaves of birch trees. Originating with the enterprising Ancient Egyptians, an unmistakeable green hue arose originally by way of finely ground malachite; a copper carbonate hydroxide mineral extracted from the mines of the West Sinai, from 4000 BC. Representing regeneration and rebirth, reflected through the annual flooding of the Nile, and the resultant fertility, malachite adorned the tomb paintings and papyri of the Pharaonic Kingdom. Indeed, a paintbox containing malachite pigment was discovered within the Valley of the Kings' 14th century BC tomb of the youthful pharaoh, King Tutankhamun. Salubrious both to the deceased and the living, malachite was worn about the eyes in warding away malevolent spirits, or formed scarab amulets, with which to revitalise the dead. Osiris, lord of the underworld went regularly illustrated with malachite visage, whilst the very afterlife itself was known to all, as the Field of Malachite.

Yielding subdued hues, *terre verte*, green earth, a natural pigment employed by antiquity's Romans, was drawn from clay coloured by, variously, iron oxide, magnesium, aluminium silicate, or potassium. Symbolic of Venus, the goddess of gardens, vegetables and vineyards, *terre verte* appeared throughout 1st century AD frescoes excavated at Pompeii, Herculaneum, and Dura-Europos in modern Syria. Such went accompanied by another Roman colour innovation, that of verdigris, *viride graecum*, or the green of Greece. Created by steeping warmed plates of brass, copper or bronze within vast vats of fermenting wine, later vinegar, the resultant copper carbonate accretions were removed from said plates and dried, to form the pigment's base. Verdigris' preparation appears within Roman naturalist philosopher Pliny the Elder's encyclopedic *Naturalis Historia* of 77 AD; he himself expiring alas with Mount Vesuvius' cataclysmic eruption of 79 AD.

Malachite and verdigris' usage persevered throughout the Middle Ages, illuminating medieval manuscripts, or illustrating the vestments of merchants, bankers, and gentry. Lamented by that Italian Renaissance polymath Leonardo Da Vinci for the pigment's notorious ephemerality, verdigris nevertheless went utilised to longstanding effect within Dutch-Flemish Northern Renaissance painter Jan van Eyck's monumental 1434 oil oak-panelled work, *The Arnolfini Portrait*. Revealing the wealthy Italian merchant Giovanni di Nicolao Arnolfini, arranged alongside his wife within a well-appointed interior; the latter garbed in cascading gathered gown. Remarkable for the hue's unmistakable vibrancy, wholly eclipsing van Eyck's eclectic composition, verdigris also appears throughout the œuvre of another enthusiast; Italian Renaissance painter Paolo Veronese. Enveloping a scarlet-bonneted cameleer with verdigris within 1573's ecclesiastical work, *The Adoration of The Kings*, he rises centre, flaying away at his charge as the three kings prostrate themselves before the Child Jesus, Veronese also deployed verdigris within 1575's tetraptych, the *Four Allegories of Love; Unfaithfulness, Scorn, Respect and Happy Union*; the latter two portraying figures resplendent in vestments of varicoloured green. Paralleling verdigris' ephemeral constitution, the pigment would vanish altogether with the development of Scheele's Green in 1778 by German-Swedish chemist, Carl Wilhelm Scheele.

Drawing source from wholly fatal copper arsenate, Scheele's Green, known also as Schloss Green, went highly sought after by 19th century paint manufacturers and interior decorators. Rather lamentably however, all these alluring shades of forest, sage and willow contained arsenic, which, with time, would leach quietly forth from the ornate, decorative wallpapers that invariably adorned Victorian chambers and parlours, hastening many to their deaths. Accompanied by another arsenic-compound pigment, Emerald or Paris green, developed in 1814 by German chemist Wilhem Sattler, amidst numerous other varieties of arsenic-derived dyes; the Victorians being rather partial to the hue. Arsenic-coloured Scheele's Green wallpaper would stand accused of expediting the death of Napoleon Bonaparte himself; several of the exiled emperor's chambers upon the south Atlantic island of St. Helens were originally papered with such.

Napoleon's death notwithstanding, 19th century green hues, conversely, were also to enliven the sylvan compositions of several extraordinary artists; one of whom being that synonym of English Romantic landscape painting; John Constable. Idyllic evocations of Golden Age Albion, the pleasant pastures of William Blake's *Jerusalem*, Constable's 1816 *Wivenhoe Park* reveals the country estate of one Major-General Rebow, executed in green's variegations. Languorous livestock arrange themselves about

a sage millpond within which anglers sail, whilst stands of majestic oak and willow suffuse pleasantly undulating Suffolk meadow; all enveloping grand, russet-hued Rebow manor. 1819's *The White Horse* reveals the work's eponymous tow-mare voyaging across Suffolk's River Stour, the banks of such garlanded with elms and willows. Whilst 1821's photorealist *Study of the Trunk of an Elm Tree*, likely painted at Hampstead, replicates with astounding exactitude, all the majesty of a towering elm's trunk. "Nothing can exceed the beautiful green of the meadows which are beginning to fill with buttercups," he would observe for April of that year. "How delightful is the country." Across the English Channel, verdurous compositions went authored by another, more daring painter; Post-Impressionist Paul Cézanne. Withdrawing from Paris for the Arcadian landscapes of Provence, Cézanne would complete, from 1882 forth, several progressively abstracted oil works, all illustrating Montagne Sainte-Victoire. 1887's iteration reveals the peak rising omniscient over the sage tapestry of the Arc River Valley, and framed by a colossal pine bough. 1895's work portrays the very same peak, Post-Impressionist now, the Arc River Valley clouded with amorphous green foliage. Cézanne's abstractionism reaches apex however, with his Cubist masterwork, 1906's *Le Jardin des Lauves*. Illustrating such with dozens of apple, chartreuse, forest and willow rectangles, framed from above by spiralling clouds of lilac and leaden grey. Several vanitas containing skulls aside, greened hues would enliven many of Cézanne's Provencal panoramas. "A touch of green, believe me, is enough to give us a landscape," he once observed, "Art has a harmony which parallels that of nature."

Encompassing blackest bowler hats, and enormous smoking pipes, the eclectic oeuvre of 20th century Belgian surrealist painter René Magritte also bears dozens of enigmatic greenest apples. Notoriously pedestrian by nature, bowler-hatted Magritte's green apple fascination first manifested itself with 1952's *La Chambre d'Écoute*. Here, within an archetypal windowed, objectless room, a colossal green apple entirely consumes the interior. Succeeded by 1960's *La Carte Postale*, whereby an omniscient green apple levitates above a backwards gazing figure, and 1961's *Le Prêtre Marié*, where two colossal, masquerade-masked apples nestle against one another beneath blue-clouded heavens; the impossible anthropomorphism of these enormous apples paralleling perhaps, that of the priest's matrimony. Margritte's fixation finds memorable apex nevertheless within the impossible imperceptible of 1964's surrealist masterwork, *Ceci n'est pas une pomme*. Here a sumptuous blossoming painted green apple, is famously declared, not in fact, to be an apple; a contrarian practice first undertaken with 1928's *The Treachery of Images*.

Malachite (Hull)
Straus.2078
Charles Roberson & Co., United Kingdom, n.d.
Used as a mineral pigment in green paints from antiquity until the 19th century, malachite is moderately lightfast and varying in colour. It was replaced by more stable synthetic greens such as verditer.

Terre Verte
Straus.1930
Lefranc & Cie, France, n.d.
Translating to "earth green", this pigment is a natural earth. The most renowned terre verte, was mined near Verona in Italy until 1940, giving rise to the name Verona green.

Byaku Roku
Straus.803
Japan, 1931
Collected by E.W. Forbes during his 1931 travels in Japan, possibly malachite.

Pigment from Persia,
Turquoise
Straus.3411
Persia, 1935
Colour bought in Persia by Mrs Eric Schroeder. Eric Schroeder was the Keeper of Islamic Art, Fogg Art Museum, Harvard University, 1938-1970.

(top left)
Fluorescent Pigment
Green, Tages-
Leucht-Farbe Grun,
Schwarzlichtfarbe
Straus.8557
Kremer Pigments,
USA, 2013

(top right)
Emerald Green,
Copper Aceto-Arsenite
Straus.1986
Fezandie and Sperrle Inc,
USA, 1936

(bottom)
Modern Persian
Pigment, Green "jiva"
Straus.3381
Made from a metal (mercury, cinnabar) which comes from Russia, collected in Isfahan, Iran, 1935

Garland Green
L 57 T 22
Straus.2021
Ansbacher-Siegle Corp.,
USA, n.d.

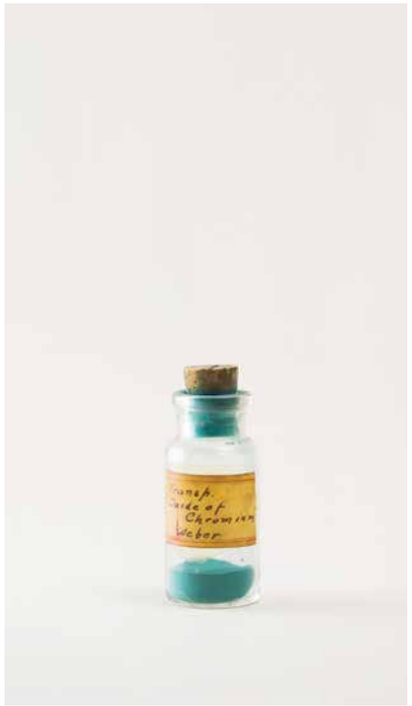
Chrome Green Medium
Straus.1993
Fezandie and Sperrle Inc,
USA, 1936

Chromic Oxide
(Anhydrous)
Straus.2014

CP Green,
Chromium Oxide
Straus.2016
Reichard-Coulston Inc.,
USA, n.d.

Marie Collart Green Light
Straus.3712
Blockx Fils, Belgium, n.d.
The pigment is named after the Belgian landscape and animal painter Marie Collart (December 6, 1842 – October 18, 1911). One of the pigments used by Lewis Rubenstein while assisting José Clemente Orozco in the painting of the fresco *Dive Bomber and Tank*, 1940, in the collection of the Museum of Modern Art, New York City.

Rokusho, A-0 No. 3
Straus.800
Japan, 1931
Collected by E.W. Forbes during his 1931 Japanese travels. Rokusho is described in literature as being natural malachite.



(top left)
Transparent Oxide of Chromium
Straus.2013
F. Weber Co., USA, n.d.

(top right)
Verdigris
Straus.1967
Buchner, further research required, n.d.

(bottom left)
Chrome Green, Zinnober Green
Straus.77
Made from Prussian blue & chrome yellow.

(bottom right)
Chrome Green House Paint
Straus.1994
n.l., 1927

Malachite (polished)
Straus.536

(top left)
Viridian, Emeraude Green
Straus.3699
One of the pigments used by Lewis Rubenstein while assisting José Clemente Orozco in the painting of the fresco *Dive Bomber and Tank*, 1940, in the collection of the Museum of Modern Art, New York City.

(top right)
Green Toner Y 62 T 04
Straus.2020
Ansbacher-Siegle Corp., USA, n.d.

(bottom)
Pieces of Copper Acetate, Verdigris
Straus.539
Verdigris has the curious property in oil painting of initially appearing bluish-green, before turning into a rich foliage green over the course of a few weeks.

Japanese, Turquoise
Straus.3551
Japan, 1931
Pigment collected by E. W. Forbes during his 1931 travels in Japan.

Ultramarine Green
Straus.2003
The Standard Ultramarine
Co., USA, 1941

(top left)
Ultramarine Green
Straus.2002
n.l., 1927

(top right)
Phthalocyanine Green
(Chlorinated Copper
Phthalocyanine)
Straus.70
Krebs Pigment Corp.,
USA, 1941
Made by chlorinating
phthalocyanine blue, which
was introduced in November
1935 by chemists from ICI
as monastral blue.

(bottom)
Verde a Calce
Straus.1747
Florence, Italy, 1923

Ultramarine
Ash Blue
Lapis Lazuli
Blue Verditer
Byaku Gunjo
Pompeian Blue
Egyptian Blue
Cerulean Blue
Manganese Blue
Cyanine Blue
Cobalt Blue
Gunjo
YInMn Blue
Smalt

Yves Klein

''I had left the visible, physical blue at the door, outside, in the street. The real blue was inside, the blue of the profundity of space, the blue of my kingdom, of our kingdom! ... the immaterialisation of blue, the coloured space that can not be seen but which we impregnate ourselves with.''

Heaven's tranquillity and ocean's infinitude, erudition, Homeric masculinity, quietude and richest imagination, unwavering authority and universal harmony, the colour blue is that of nature's leviathans; becalming and subsuming with equal measure.

Leaves of crushed *Isatis tinctoria*, a flowering plant from the family *Brassicaceae*, have, from antiquity, yielded an extraordinary blue dye, woad; the exclusive source of blue colouration for centuries. Kneading said leaves into globes, these were then ground into a fine powder, before being steeped within an aromatic concoction of water mixed with human urine; lightfast blue dye duly resulting. Originating within Turkey and the Middle East, woad seeds and blue-hued bast fibre, believed to be linen or hemp dyed with woad, went excavated from the Neolithic cavern of l'Audoste; found within south-east France's Bouches-du-Rhône region, and dated between 5000 and 10,000 BC. Rather partial to such woad hues too were those imaginative Ancient Egyptians; recovered woad dyed linens date from near 2500 BC. Nevertheless, for that beguiling, semi-precious mineral lapis lazuli reserved the Egyptians' true reverence. Drawn from the mines of the Sar-e-Sang valley, within the Badakhshan mountains of north-east Afghanistan, astronomically valuable lapis lazuli, mined from the 7th millennium BC, coloured the Kingdom of the Sun's funereal artefacts and sarcophagi. Scarcity, as ever, proved the mother of invention; the Egyptians, fatigued by the inaccessibility of lapis lazuli, went about, from near 2200 BC, formulating the world's inaugural synthetic pigment; imaginatively named, Egyptian blue. Alas, no recorded Egyptian methodology endures, however Roman architect and military engineer Vitruvius revealed such within his 1st century BC opus, *De architectura*. Limestone and sand, combined with copper from mineral azurite or malachite, and natron, a naturally occurring mixture of sodium compounds, were heated together at extraordinary temperatures, some 800–900°C, before the resultant opaque blue crystals were ground. Yielding deepest cerulean pigment, such would be lost beneath the sands of time until 1815 when, whilst excavating the Roman baths of Titus, and the frescoes of Pompeii, Egyptian blue would be rediscovered at last by the English chemist and inventor, Sir Humphrey David.

Beyond the Valley of the Nile however, eastward across the Arabian Sea, the Bronze Age inhabitants of the Indus Valley cultivated *Indigofera tinctoria*, another flowering plant, from the *Fabaceae* family; leaching richest blue dye, indigo, from the plant's leaves, from between 3300 and 1300 BC. Evidence indicative of even earlier indigo dyeing, from around 4000 BC, appears within cloth excavated at Huaca Prieta, within northern Peru's coastal Chicama Valley. Exported to Ancient Greece and Rome from India, rare Indigo, derived from the Greek word for the dye, *indikón*, literally, from India, was deployed as decorative pigment, cosmetic ingredient, and cloth dye from the 2nd millennium BC. Renowned as a rarest hue throughout successive centuries, appearing infrequently within European easel paintings from the Middle Ages forth, desirable indigo became altogether more accessible with daring Portuguese explorer Vasco de Gama's inaugural 1497 sea voyage to India. Establishing direct trade, and later, indigo plantations themselves across Europe's respective Caribbean, Central and South American colonies, and later still, South Carolina, *Indigofera tinctoria* succeeded woad at last, with the late 17th century.

Entranced as the Continent may have once been with indigo, another source of blue pigmentation, ultramarine drawn from near-priceless Afghan lapis lazuli, would wholly mesmerise Middle Age and Renaissance, artists, artisans, and worshippers. Drawn from the Latin "beyond the sea", "Ultramarine is a colour more noble, more beautiful, and perfect than any other colour," declared 15th century Italian painter Cennino Cennini within his *Il Libro dell'Arte, The Book of Art*, authored circa 1400. More beautiful, and more expensive than gold itself, enchanting ultramarine was traditionally reserved for the raiment of Christ and the Virgin Mary, often to radiant effect. Italian Renaissance painter Raphael's 1505 altarpiece *The Ansidei Madonna* reveals an enthroned Madonna with child, attired in a magnificent ultramarine, gilded robe, and accompanied by saints John the Baptist and Nicholas of Bari. However, the most famous example of ultramarine's usage remains undoubtedly Dutch painter Johannes Vermeer's circa 1665 celebrated oil on canvas *tronie*, a study of an imagined figured, *Girl with a Pearl Earring*. Garbed with exotic costume, magnificent oriental ultramarine turban and of course, the eponymous, improbably large pearl earring, Vermeer's subject is a young girl, more than likely his eldest daughter, the adolescent Maria. Revealed in profile gazing enchantingly back at the viewer, unadulterated ultramarine renders her cascading turban near luminescent; juxtaposed magnificently by the opacity of the enigmatic girl's porcelain flesh. Utilised throughout Vermeer's oeuvre, facilitated perhaps by patron Pieter van Ruijven's wealth, ultramarine would remain largely inaccessible over the succeeding centuries. Until 1824, when a savagely

contested reward of six thousand francs, and recognition of synthetic ultramarine's creation, saw French chemist Jean-Baptiste Guimet triumphantly declared the original creator. Thus Guimet's artificial hue is known now as French ultramarine.

Guimet's innovation in fact accompanied two other, preceding developments; that of German dye-maker Johann Jacob Diesbach, and French chemist, Louis Jacques Thénard. 1703's Prussian blue, inadvertently invented by Diesbach whilst developing cochineal red pigment, and employed to extraordinary effect within Japanese painter and printmaker Katsushika Hokusai's 1829 woodblock print, *The Great Wave off Kanagawa*, such went reconceived with 1842 by another serendipitous discovery; that of English astronomer, Sir John Herschel. Prussian blue, Herschel revealed, possesses an extraordinary sensitivity to light, which may be manipulated to create multiple facsimiles of single illustrations. Indispensable to architects, who were now able to author multiple reproductions of building plans, such were aptly named blueprints, on account of their Prussian blue hue. Whilst 1802's cobalt blue, long incorporated within Chinese porcelain, went independently discovered as an alumina-based pigment by Thénard. And later, employed to astounding effect within the blue-hued compositions of fellow French painters, Claude Monet, and Pierre-Auguste Renoir. Monet's 1877 impressionist work *Gare Saint-Lazare*, reveals a locomotive, enshrouded by voluminous smoked clouds, departing a platform within Paris' Saint-Lazare railway station; rendered variously, with cobalt blue, French ultramarine, and another blue pigment, cerulean blue, discovered with 1798 by Swiss pharmacist Johann Georg Albrecht Höpfner. Cobalt and ultramarine both appear too within Renoir's 1880-1886 oil painting, *The Umbrellas*. Another Parisian scene, several promenading, grey cast figures grasp assorted blue-hued parasols upraised against an afternoon's cascade; the canopies of such geometrically arranged beneath Paris' leaden heavens.

Der Blaue Reiter, The Blue Rider was an association of avant-garde artists and painters established in 1911 in Munich. Fundamental to the development of Expressionism, such went centred about two painters, Russian Wassily Kandinsky, believed now to possess synaesthesia, and German Franz Marc. *Der Blaue Reiter* took name from both artists' enduring equine and blue fascinations. And actualised by Kandinsky's 1903 abstracted work of the same name, within which a blue-cloaked horsemen canters rapidly across a meadow. Labouring to express spiritual revelations through modern art, colour symbolism and intuitive expression, *Der Blaue Reiter*'s members consolidated Cubism, Primitivism, and Fauvism as they evolved towards pure abstraction. Bluest hues and horses nevertheless endured; Kandinsky's metamorphosing œuvre illustrative of such. 1911's oil painting *Lyrical, (Lyrics)* reveals another horseman, now wholly abstracted, attended by organic blue forms, whilst 1925's *In Blue* stands as an abstracted work of illuminated geometric and amorphous forms, juxtaposed amidst swathes of clouded blue; 1940's *Sky Blue* reveals several biomorphic entities suspended within infinite blue heavens. "The deeper the blue becomes, the more strongly it calls man towards the infinite," Kandinsky declared, "awakening in him a desire for the pure and, finally, for the supernatural … Almost without exception, blue refers to the domain of abstraction and immateriality."

Colour wholly metamorphosed into human flesh and blood, the very synonym of blue herself, no respectable accounting of the hue's chronology is replete without mention of that consummate French painter and performance artist, Yves Klein. Fixated with the hue from the tender age of nineteen when he declared, "The blue sky is my first artwork," 1957's *Proposte Monocrome, Epoca Blu, Proposition Monochrome; Blue Epoch* saw Klein exhibit eleven identical, monochromatic blue canvases, all coloured with an especially formulated, brilliant pigment. Henceforth known, naturally, as Klein's Blue Period, the colour, International Klein Blue, IKB, became an artwork unto itself; colouring dozens of canvasses, globes, obelisks, plaster sculptures, 1962's multiples, *Venus* and *Victoire de Samothrace* foremost amidst such, supper plates, sponges, and tabletops. Even the nude forms of women went swathed with blue, living paintbrushes with which he authored 1960's *Anthropometry* compositions. Klein's œuvre characterised by ceaseless experimentation with medium and form, reserved unwavering reverence for blue's esoteric nature, declaring; "Blue has no dimensions; it is beyond dimensions, whereas the other colours are not ... All colours arouse specific associative ideas ... while blue suggests at most the sea and sky, and they, after all, are in actual, visible nature what is most abstract."

(top)
Ultramarine, Genuine
Straus.1826.
Hamilton, further research required, n.d.
During the Renaissance, patrons who commissioned artworks were often required to supply extra funds for ultramarine, due to its cost.

(bottom)
Ultramarine Ash Blue
Straus.82
Newman, United Kingdom, n.d.
Also known as mineral ash blue. Ultramarine ash is the lowest quality of natural ultramarine, but is highly valued for manufacturing blue glazes.

Lapis Lazuli, 40,000 per sq. in. screen (Genuine Ultramarine)
Straus.1815

Lapis Lazuli
Straus.710
Blue is extracted from ground lapis lazuli to produce ultramarine. Until synthetic ultramarine was invented in 1826 it was as expensive as gold, mined only in Afghanistan. Ultramarine was created by mining the lapis lazuli stone from quarries in Badakshan (now Afghanistan) in the Middle Ages, and remains available to this day as a pigment.

Blue Verditer
Straus.1788
Charles Roberson & Co., United Kingdom, 1927
An artificially prepared copper carbonate, very similar to azurite.

(top left)
Byaku Gunjo (189 grs)
Straus.1800
The weight is 189 grains (grs) [equivalent to 12.25grams]. Possibly azurite.

(top right)
Fluorescent Pigment Blue, Tages-Leucht-Farbe Blau, Schwarzlichtfarbe
Straus.8555
Kremer Pigments, USA, 2013

(bottom)
Pompeian Blue
Straus.1803
Lefranc & Cie, France, 1929
Also known as Eyptian blue or blue frit. Used in ancient times, it was manufactured by heating a mixture of silica, copper salts, and calcite in a sodium carbonate flux to 830 C.

Egyptian Blue
Straus.943
Label states "Egyptian blue (artificial calcium silicate)." Egyptian blue is possibly the first synthetic pigment, utilised by the Ancient Egyptians over 5000 years ago.

Cuprum Carbonicum
(Blue Verditer)
Straus. 2233

Usugun (Azurite)
Straus. 798
Japan, 1931.
Pigment collected by
E. W. Forbes during his
1931 travels in Japan.

(top left)
Genuine Ceruelean Blue
Straus.1853
Fezandie & Sperrle Inc,
USA, 1936
Although known in 1805,
it was however not used as
a pigment until 1860.

(top right)
Manganese Blue
Straus.89.
Stanley Doggett Inc.,
USA, n.d.
A synthetic green-blue
pigment made by fixing
barium manganate upon
a barium sulphate base.
Manganese blue was first
discovered in 1907
but not patented until 1935.
Rarely used as an artist's
pigment, it has found uses
in tinting cement.

(bottom left)
Cyanine Blue
Straus.1735
Newman,
United Kingdom, n.d
A mixture of Prussian
blue and cobalt blue

(bottom right)
Suco Turquoise Blue
Straus.1872
The Standard Ultramarine
Co., USA, n.d.

Cobalt Blue
Straus.1855
Charles Roberson & Co.,
United Kingdom, 1926
A stable blue discovered
in1802.

(top)
Ultra Marine
(Synthetic Ultramarine)
Straus.1807
Tizian Color Co., further research required, n.d. Although chemically identical to natural ultramarine, it is a synthetic pigment. A prize was awarded in 1828 to J. B. Guimet who first synthesised ultramarine in 1826.

(bottom)
Gunjo (100g)
Straus.1798

YInMn Blue
Yet to be catalogued
Crayola released a new colour based on YInMn blue in May 2017 at Oregon State University. Yttrium, Indium, Manganese blue was accidentally discovered by Professor Mas Subramanian in 2009.

Smalt
Straus.713
Smalt is a coarsely ground blue potassium glass containing small amounts of cobalt oxide, which is the source of the blue colour. Used in European paintings from the early 15th-century, probably first in Germany and subsequently in Italy, and became widespread in the 16th- and particularly, the 17th-centuries. Smalt loses its colour over time, leaving blue areas an ashy grey colour.

(top left)
Cobalt Blue
Straus.3703
One of the pigments used by Lewis Rubenstein while assisting José Clemente Orozco in the painting of the fresco *Dive Bomber and Tank*, 1940, in the collection of the Museum of Modern Art, New York City.

(top right)
Gunjo (Ultramarine)
Straus.3586
Japan, 1931
Pigment collected by E. W. Forbes during his 1931 travels in Japan. Gunjo is described in the literature as an azurite pigment with the colour of ultramarine blue.

(bottom)
Ultramarine Blue
Straus.1873
The Standard Ultramarine Co., USA, n.d.

(top left)
Azurite
Straus.2293
n.l., 1923
A. P. Laurie, mentioned on the label, is a well-known chemist and pioneer in the study of pigments and paintings. Azurite is the cheaper of the two early mineral blues (the other and more expensive being ultramarine). A basic copper carbonate, it often naturally occurs alongside malachite.

(top right)
Hon-Ai (Native Indigo)
Straus.811
Japan, 1931.
Pigment collected by E. W. Forbes during his 1931 travels in Japan.

(bottom)
Prussian Blue
Straus.6
Also known as Antwerp blue or Berlin blue. Prussian blue is the first synthetic pigment with a known history and date of first preparation; manufactured in Berlin in 1704.

Yo-Ai (Western Indigo)
Straus.809
Japan, 1931.
Pigment collected by E. W. Forbes during his 1931 travels in Japan.

Genuine Indigo from Indigofera Tinctoria

Yet to be catalogued

Kremer Pigments, 2016
True or genuine indigo, the dye from the Indigofera Tinctoria plant, is the main source of natural commercial indigo. Although synthetic indigo has taken place as a source for the shade, it is still frequently used as a cotton dye, namely in denim production.

Cascade Blue

Straus.97

Ansbacher-Siegle Corp., USA, 1942
Phosphotungstic toner manufactured by Ansbacher Siegle Co. Phosphotungstic pigments were first made in Germany circa 1910 and patented in 1914. They are made by precipitating a basic dye with phosphotungstic acid. This produces a pigment with good lightfastness, although some phosphotungstic pigments may bleed. Used in printing inks, paints, and enamels.

Rose Foncé
Madder Lake
Tyrian Purple
Murex Shell
Manganese Violet
Ultramarine Pink
Violet de Cobalt
Cobalt Violet
Magenta
Cerise
Mars Violet
Alizarin Violet
Mauve
Rose Foncé

Yayoi Kusama

"When I was a child, one day I was walking in the field, then all of a sudden, the sky became bright over the mountains, and I saw clearly the very image I was about to paint appear in the sky. I also saw violets, which I was painting, multiply to cover the doors, windows and even my body ... I immediately transferred the idea onto a canvas."

Aristocracy's rapture and thaumaturgy's synonym, pious adherence, entrancing femininity, sumptuous luxury and inescapable seduction, the colour purple tempers red's vivacity, with blue's equipoise.

Within the very deepest, twilit recesses of south-eastern France's Pech Merle cavern, our Neolithic ancestors once grasped masses of naturally occurring red ochre, haematite and mineral manganese oxide. And illustrated violet-hued visions of mammoths, coloured horses, aurochs, bison, bears, reindeers, handprints, and fellow hominoids. Executed between 16,000 and 25,000 BC, these antecedent, approximate purple pigmentations were originally created by combining ground haematite and manganese with fat or saliva, then applying such to both Pech Merle, and Lascaux's cavernous walls.

Drawn from the mucous secretions of that Mediterranean *Muricidae* variety shellfish known as Murex, Tyrian purple would serve as the inaugural example of a manufactured, unmistakable purple hue. Manufactured from the 15th century BC forth, such was named for the ancient Phoenician city of Tyre, modern-day Lebanon, where the luxurious dye's production occurred in vast, odious vats, within which thousands upon thousands of gathered murex quietly decomposed beneath the Mediterranean sunshine, labour-intensive Tyrian purple proved more expensive than gold. Wholly unobtainable by regular Phoenicians, Byzantines and later, Romans, ceremonial vestments, dyed with purple's opulence, remained the enforced, infatuated preserve of monarchs, aristocracy, and clergy for centuries. Julius Caesar, encountering Queen Cleopatra's sumptuous Tyrian purple raiment, sails and interiors whilst in Egypt with 48 BC, returned to Rome, entranced now with the wondrous hue, and forbade the attiring of any Roman citizen with Tyrian purple, excepting of course, himself. Paralleling the Roman Empire's very decline, Tyrian purple's reign would end at longest last with the fall of Constantinople, modern-day Istanbul, in 1453 AD.

Declaring with 1464 that Tyrian purple no longer colour the vestments of cardinals, Pope Paul II ordered scarlet substitute for such, variegated hues of purple would nevertheless persist within Renaissance devotional representations; a continuance of Middle Ages custom. French painter Philippe de Champaigne's 1656 work, *Christ In The House Of Simon The Pharisee* for example, reveals reclining Christ, enveloped in sumptuous purple robe, receiving anointment by Mary Magdalene. Later that century, the hue would also significantly influence the gestative field of optics.

English mathematician and physicist, Sir Isaac Newton's 1672 New *Theory about Light and Colors* first identified violet, purple's lightened cognate, as one of seven original colours within the visible colour spectrum. However, to another English chemist, the rather precocious Sir William Henry Perkin, went perhaps posterity's greatest renown. Adolescent Perkin had, with Easter of 1856, undertaken several chemical experiments by which to synthesise quinine, an effective anti-malarial. Rather than synthesise such however, Perkins found he had serendipitously created an intensely-hued, permanently silk-dyeing purple hue; naming such Tyrian purple, than mauveine, the violet mallow flower's French title. And finally mauve, by which the colour's name endures. Rapidly adopted then by both sartorial Empress Eugenie, wife of France's Emperor Napoleon III, as well as England's Queen Victoria, Perkin's patented, modestly-priced mauve caused an altogether sensation amidst those enviably fashionable Victorians. Catalysing an industry of further aniline dyes, British, German, and Swiss dye manufacturers would produce, from the mid-19th century forth, an astounding array of synthetic, chromatic dyes; fuchsine, later known as magenta, renamed such in 1859 to honour the French victory at the Battle of Magenta, the very same year cobalt violet, a cobalt phosphate went discovered by French chemist Alphonse Salvétat. As well as safranin, induline, imperial and Britannia violets amidst such.

Violet fixations weren't reserved however for rivalrous dye-manufacturers, or Victorian sartorialists. Rather, many of the later 19th and early 20th centuries' artists were equally enamoured with the hue's varieties; the Impressionist painters Paul Signac, Georges Seurat and Pierre-August Renoir notably so. Impressionism's famed Claude Monet executed numerous light and optical excavations with such; 1891's *Haystacks, Effect of Snow and Sun*, one of some thirty examinations, reveals pyramidal haystacks within Normandy's winter fields, rendered with delicate strokes of violet, lilac, iris and lightened purple. 1903's *The Houses Of Parliament*, Sunset portrays London's Westminster Palace viewed from the River Thames; Gothic spires outlined against a luminous sunset, one of some nineteen violet compositions Monet authored of Britain's celebrated edifice. Haystacks and Houses of Parliament however, floundered before the aesthetic pleasures offered forth by the serene water lily. "I have finally discovered the true colour of the atmosphere," Monet once declared. "It is violet. Fresh air is violet."

Modernist American painter Georgia O'Keeffe's fascination with flora paralleled that of Monet; now an enduring synonym of her œuvre. Painting large-scale, sensual examinations of the stamens, petals, styles and ovary of flowers, apparently representative of female anatomy, yet denied by O'Keeffe as ever representing such, her examinations regularly encompassed much of Monet's violet palette. 1923's *Grey Lines with Black, Blue and Yellow* possesses undulating, ever-deepening folds of abstracted iris and lilac petal flesh, centered about the flower's vulva-reminiscent interior. 1925's *Flower of Life II* reveals vast unfurled iris petals enveloping a glanced flower's intimate depths; sensuous hues gradating from lilac to blackened-purple, mauve, and finally scarlet. "I wish you could see what I see out the window—the earth pink and yellow cliffs to the north—the full pale moon about to go down in an early morning lavender sky…" O'Keeffe wrote awed from Ghost Ranch, New Mexico. "Pink and purple hills in front and the scrubby fine dull green cedars—and a feeling of much space—It is a very beautiful world."

Renowned more so perhaps for his scarlet fixation, rather than a purple predisposition, fellow American painter Mark Rothko's oeuvre possesses nevertheless, several notable examples of variegated purple's usage. Creating large, abstract expressionist, multiform works within which vast rectangular swathes of dense colour horizontally overlay and juxtapose one another from 1947 forth; Rothko's 1957 work, *White Cloud Over Purple*, and 1960's *No. 12 (Black on Dark Sienna on Purple)* prove wholly illustrative. Containing two rectangles, black above, sienna below, both encompassed within a darkened purple border, *No. 12* possesses that characteristic contemplative depth, and enveloping abstraction the artist remains renowned for. With 1964 however, and the commission by American philanthropists John and Dominique de Menil of several site-specific works to be housed within their non-denominational chapel in Houston, Texas, Rothko's reverence for purple would achieve fullest realisation. Completing fourteen monumental compositions, each a vast, meditative field of subdued colour constituted by textured layers of blackened purple, aubergine and nightshade, the artist's final works evoke the journeying infinitude of our innermost thoughts and visions.

Rose Foncé
Straus.1597
Newman, United Kingdom, n.d.

Madder Lake
Straus.1600
Fezandie & Sperrle Inc,
USA, 1936

6,6-Dibromoindigo,
Tyrian Purple
Straus.1003
Kremer Pigments, USA, 2010
Also known as Pheonician Purple, it is a bromine-containing natural dye, from a secretion produced by several species of predatory sea snails in the family Muricidae, originally known by the name Murex (see p. 141). Extracting this dye involved tens of thousands of snails and substantial labour; as a result, the dye was very highly valued.

Shell containing purple pigment
Straus.8815
One of nine sea shells with pigment, c. 2012. Gift of Maliha Noorani. This series of paint in shells is part of a research project carried out by Noorani at the Straus Center.

Murex Shell
Straus.730
Sidon, seaport town of ancient Phoenicia (now Sidon, Lebanon), n.d.
This shell is one of the species from which the ancients obtained their purple dye, known as Tyrian purple. An experiment in 1908 produced 1.4g of dye from 12,000 molluscs.

Manganese Violet
Straus.1761
F. Weber Co., USA, 1927

(top left)
Ultramarine Pink
Straus.1741
The Standard Ultramarine Co., USA, 1941

(top right)
Ultramarine Pink, (Hydrochloric Acid Gas)
Straus.2
The Standard Ultramarine Co., USA, n.d.

(bottom)
Violet de Cobalt
Straus.1749
Lefranc & Cie, France, 1927

Cobalt Violet #2
Straus.1744
Lefranc & Cie, France, n.d.

Genuine Cobalt Violet
(Cobalt Phosphate
R.J.G.)
Straus.1743
Fezandie & Sperrle Inc,
USA, 1936
RJG-Rutherford John Gettens

Fluorite
Straus.974
Made up of calcium fluoride. Remaining fluorite from the Bartel Bruyn project undertaken with the Smith College Museum of Art, Northampton, Massachusetts.

(top left)
Magenta Toner (Rhodamine)
Straus.1645
H. Kohnstamm & Co., USA, n.d.
Originally called fuchsine, it was renamed to celebrate the Italian-French victory of the Battle of Magenta (Italy). Said to be a part of the pigment known as Tuscan red in combination with an iron oxide. Also used as a primary in printing (CMYK).

(top right)
Rhodamine, Cerise Toner
Straus.113
Imperial Paper & Color Corp., USA, 1941

(bottom)
Mars Violet
Straus.1753
Charles Roberson & Co., United Kingdom, n.d.

Alizarin Violet
Straus.1740
F. Weber Co., USA, 1942

(top)
Mauve
Straus.1739
F. Weber Co., USA, 1942
Synthetic mauve was discovered accidentally by chemist William Henry Perkin as he attempted to create a cure for malaria in 1856. Originally called Tyrian purple, it was subsequently marketed as mauve in 1859. The 1890s are sometimes referred to in retrospect as the "Mauve Decade", because of the widespread popularity of the colour in Europe and the United States.

(bottom)
Alizarin Violet
Straus.7
F. Weber Co., USA, 1941

Jaune de Mars
Naples Yellow
Raw Sienna
Burnt Sienna
Mummy Brown
Van Dyke Brown
Raw Umber
Brazil Wood
Sepia
Jaune de Mars
Naples Yellow
Raw Sienna
Burnt Sienna
Mummy Brown
Van Dyke Brown
Raw Umber
Brazil Wood
Sepia
Jaune de Mars
Naples Yellow
Raw Sienna
Burnt Sienna
Mummy Brown

Georgia O'Keeffe

''All the earth colours of the painter's palette are out there in the many miles of badlands...''

Gathered from the natural world's minerals, raw sienna and yellow ochre, burnt umber and red oxide, terre verte, titanium white and vegetable black, the primeval colours drawn from earth endure emblematic of humanity's ceaseless want for expression, and remembrance.

Ineffaceable red ochre, earth coloured by iron oxide, stencilled, during the Pleistocene, the outstretched palms of our enterprising ancient forebears; within Sulawesi Island, northern Indonesia's several Maros limestone caverns. Determined by Indonesian and Australian archaeologists as some 39,000 years old, Sulawesi's illustration is now believed to be the world's oldest known hand stencil, predating even those hand stencils found within northern Spain's Cave of El Castillo. Accompanied by another illustration, that of a female barirusa, a variety of wild Indonesian boar, such may in fact be the oldest known figurative depiction. More recent research however suggests that Mirrar Indigenous Australian artists expressed themselves with reflective pigments fashioned from ground ochre mixed with mica, at the Madjedbebe rockshelter in Kakadu, within Australia's Northern Territory, some 65,000 years ago.

Paleolithic cavern artworks, rendered by our Old Stone Age European ancestors, such as the dappled horses of south-eastern France's Pech Merle cavern, the aurochs and ibex of the country's south-western Lascaux caverns, and the bison of north-western Spain's Cave of Altamira, all possess evidence of red and yellow ochre, as well as charcoal, haematite and umber's usage. "After Altamira, all is decadence," Spanish painter Pablo Picasso once declared, Altamira's resplendent cavern artworks are wholly paralleled by those magnificent Neolithic rock paintings found upon the Horn of Africa, within the Laas Geel desert caverns of western Somaliland. Revealing assorted long-horned cattle, ceremonially garbed and accompanied by herders, antelopes, giraffes and jackals, these extraordinary illustrations, rendered with swathes of red, black and yellow ochre, went authored between 5,000 and 11,000 years ago. Encompassing the Neolithic, Bronze and Iron Ages, the caverns of Argentine Patagonia's Cueva de las Manos, possesses dozens of radiant, bone pipe-blown hand stencils, hunters, guanacos or native llamas, ostrich-like rhea birds, and felines, as well as geometric shape, and representations of the sun. Rendered with various hues of purple and red iron oxide, white from kaolin, yellow from mineral natrojarosite, and black drawn from manganese oxide, some 3,000 to 9,000 years ago, these, and the several other minerals that constitute our natural palettes, have actualised our human species' expressive yearnings for millenia.

Orange ochre, bound with Acacia tree sap, illustrates several extraordinary painted scenes within the Ancient Egyptian tomb chapel of Nebamun. Authored some 3,400 years ago, circa 1350 BC, Nebamun, possessing incandescent orange ochre flesh, hunts for waterfowl amidst the fecund marshes of the Nile; astride a narrow vessel and accompanied by wife Hatshepsut and youngest daughter. Yellow ochre, symbolic of both gold, and the sun, also went frequently utilised throughout Ancient Egypt; colouring the flesh of women, as well as that of those Mediterranean Libyans, Bedouin, Syrians and Hittites. Appearing in vast golden swathes throughout the several-chambered tomb of Ramses IV, yellow ochre, meticulously applied around 1156 BC, envelops serpents, falcons, courtesans, winged scarabs, beast-headed figures, as well as the gods Horus, Khum, and Re-Horakhthy. Ancient Greece admired red ochre, *sinopia*, drawing such from Sinope, coastal Anatolia for usage within chromatic architectural and sculptural paintings, and expansive frescoes. Sinopia's application persisted throughout the Middle Ages and into the Renaissance; utilised within preparatory drawings for frescoes, and known variously, as Venetian red, Sienna earth, or *ocra rosso*. Vivid Pompeian red however, found throughout that suffocated city's frescoes, was in fact, originally yellow ochre. Transformed by volcanic emissions following Mount Vesuvius' 79 AD cataclysmic eruption, with the sensational 18th century excavations of both Pompeii and Herculaneum, that regal scarlet hue became then, the favoured colour of sumptuous British dining halls.

Emblematic of peasantry and impoverishment, assorted taupe, burnt sienna, sepia, umber, sorrel and hazel hues garbed labourers and monastic orders throughout the successive centuries; colour enduring as a synonym of aristocracy and ostentatious wealth. With the dawning Renaissance however, and the expansion of artists' palettes through increasingly accessible, chromatic hues, purveyed by 15th century Venice's *vendecolori*, colour merchants, earth-derived pigments, understandably, went largely neglected in favour of these kaleidoscopic new pigments, drawn from throughout the world. Nevertheless, earth-derived hues would endure across the favoured palettes of numerous artists from the 16th century forth. Italian painter Giuseppe Arcimboldo's 1566 fantastical Mannerist work, *Earth* for example, reveals an elaborate human head, constituted entirely by several entwined stag, ram, lion, elephant, sheep, hare and horses' heads, all rendered with variegated natural hues of brown, ochre, taupe, and clay. An elaborate visual metaphor for the

natural world's ordering and wealth of mammals, Arcimboldo's partiality for earth hues was paralleled by that of another celebrated artist; Flemish Baroque painter Sir Anthony Van Dyck. Wholly besotted with earth's natural colours, he would utilise such throughout dozens of portraits; 1635's *Charles I at the Hunt*, 1637's *Duke of Richmond* are both of note, the latter rendering garments, stablehands, faithful hounds, horses and even the heavens themselves with assorted earthen hues. Van Dyck's unwavering usage of russet, Cassel earth, ochre and soil saw that darkest shade of brown synonymous with his oeuvre honourably entitled, Van Dyck Brown; an eponym that endures to this very day.

Fascinations with earth's hues reached an idiosyncratic apex perhaps with the 16th, and later the 19th century's macabre appetite for unmistakeable, Mummy brown. Created from the crushed remains of ceremonially embalmed, long-deceased Egyptians, such yielded a richest brown, bituminous pigment, beloved of artists, and available, astoundingly, well into the 20th century. French painter Martin Drölling's 1815 work, pastoral *Interior of a Kitchen*, betrays extensive usage of the infamous hue, whilst fellow countryman Eugene Delacroix's partiality for such is illustrated by 1830's long celebrated work, *Liberty Leading the People;* within which the triumphant goddess of liberty draws forth the liberated French over the likely Mummy brown-hued corpses of fallen révolutionnaires. The notorious pigment also appeared throughout his 1854 painting of the *Salon de la Paix*, within Paris' long-destroyed Hôtel de Ville. English Pre-Raphaelite painter Edward Burne-Jones' palette is also known to possess hues fashioned from Egyptian remains, as was the that of fellow Dutch-British classical painter, Lawrence Alma Tadema.

Such macabre endeavours were not however, the exclusive preserve of 19th century English and French painters. That German leviathan of 20th century painting, performance art, and sculpture, polymathic Joseph Beuys, wholly partial to earth-hues, created his very own signature substance; *Braunkruez*, brown cross. Fabricated from utilitarian brown household oil paint variously adulterated with rustproofing chemicals, fat and hare's blood, unmistakeable, ominous, decaying Braunkruez appears throughout Beuys' eclectic oeuvre. 1962's *Physico-Chem-Zeit-Konstellation 11:00 23:00* entwines pencilled references to physics, chemistry and astronomy, all partially obfuscated by vast arcing swathes of cascading *Braunkruez*. Whilst 1963's *Untitled Braunkruez 3* reveals several pages of newspaper annotated with painted images of a cross, and abstracted mechanical forms, all rendered with Beuys' unsettling hue. Abstraction finds

further expression within 1965's *Houses of the Shaman*, whereby suffocating *Braunkruez* asphyxiates page and audience equally. "My objects are to be seen as stimulants for the transformation of the idea of sculpture… or of art in general," Beuys observed. "That is why (the) nature of my sculpture is not fixed and finished. Processes continue in most of them: chemical reactions, fermentations, colour changes, delays, drying up. Everything is in a STATE of CHANGE."

Jaune de Mars
Straus.3707
Blockx Fils, Belgium, n.d.
One of the pigments used by Lewis Rubenstein while assisting José Clemente Orozco in the painting of the fresco *Dive Bomber and Tank*, 1940, in the collection of the Museum of Modern Art, New York City.

Naples Yellow
Straus.1237
Stone, further research required, 1949
Found in the studio of the late Professor A. P. Laurie, Chart, Surrey, England, 1949.

(top left)
Raw Sienna
Straus.680
Spain, 1933
Sienna is an earth pigment containing iron oxide and manganese oxide. In its natural state, it is yellow-brown and is called raw sienna. When heated, it becomes a reddish brown and is called burnt sienna.

(top right)
Burnt Sienna
Straus.679
Spain, 1933

(bottom)
Mummy, Egyptian Brown
Straus.17
Charles Roberson & Co., United Kingdom, n.d.
Mummy, or Egyptian Brown, was manufactured from the embalmed bodies of Ancient Egyptians, and can be seen in the context of a range of resinous, transparent brown pigments popular in British painting throughout the mid-18th and 19th centuries. The use of such was encouraged by the belief that it contained bitumen, an assumption apparently based on the earlier inclusion of both bitumen and ground mummy in medication. In the course of at least 300 years of trade, an unrecorded number of archaeological objects was destroyed in order to make pigment. Ethical and technical unsuitabilities as a raw material for paint was ignored by artists and colourmen alike until its use appears to have ended with the beginning of the 20th century.

Van Dyke Brown, Bituminous Earth
Straus.15
Also named Cassel or Cologne earth. Van Dyke brown oil paint was frequently used in American painter and educator Bob Ross' TV show, *The Joy of Painting*, as a base colour for trees, cabins, and basecoats.

Raw Umber
Straus.690

(top)
Brazil Wood
(lign. Pernambuco)
Straus.1589

(bottom)
Sepia 1/4 lb.
Straus.1131
F. Weber Co., USA, n.d.
Sepia is the black or brown ink from a cuttlefish or squid. Popular in the 18th century for use in drawing.

Graphite
Lamp Black
Black Oxide
of cobalt
Ivory Black
Blue Black
Charcoal
Raven Black
Mineral Black
Vine Black
Bitumen
Ivory Black
VantaBlack
Graphite

Louise Nevelson

"When I fell in love with black, it contained all colour. It wasn't a negation of colour. It was an acceptance. Because black encompasses all colours. Black is the most aristocratic colour of all."

Illumination's absence and malice's whereabouts, lamentation, savagery, darkest occultism, austere elegance and sinister obfuscation, the achromatic colour black entrances with fathomless depth, yet disarms with malevolence's allusion.

Elementary charcoal, drawn forth from the hearths of our Palaeolithic ancestors, constitutes one of the world's oldest black pigments. Appearing throughout south-western France's Lascaux caverns, in the assorted blackened forms of oxen, horses and steer, authored between 18,000 and 17,000 years ago. And within northern Spain's fabled Cave of Altamira, outlining steppe bison, horses, and deer, the oldest of such completed some 35,000 years ago, charcoal black would later be accompanied by other, more vivid blackened hues. Such were fabricated either with the charred bones of wild animals, known as carbon black or through the crushing of natural manganese oxide.

Fecund, nourishing blackened Nile Valley soil ensured the Ancient Egyptians regarded black as synonymous with regeneration and fertility. Anubis, that blackest jackal and the revered god of the underworld was believed to offer protection to the dead against assailment. Whilst Osiris, "the black one", god of the afterlife, resurrection, and the dead, administered to a blackened underworld within which the sun was believed to regenerate with each dusk. Gathered from the residue of oil lamps, thickest lampblack went utilised throughout Ancient Egypt's palette. Appearing across papyri, dated to before 2500 BC, throughout tombs and within blackened kohl, a protective variety of eye cosmetic worn against several malaises and made with mineral stibnite, Ancient Greece also utilised both lamp and carbon black; black being of symbolic significance. Separated from the land of the living by the blackened waters of the River Acheron, the Greek underworld was believed to be black, as was the ebony throne upon which Hades, king of the subterranean realm, reigned forth from. Essential to Ancient Greek expression, black pigmentation appears throughout the civilisations' celebrated black-figure pottery. Originally produced circa 700 BC at Corinth upon the Peloponnese peninsula, blackest figures, went rendered with clay slip, all markedly juxtaposed against the vases' richest terracotta hues with firing. Fabricated approximately 570 BC, the most renowned example of such, the *Francois Vase*, a vast Attic volute krater, a variety of earthenware vessel, went adorned with an astounding array of beasts, humans, mythological scenes and figures from Greek mythology; Olympian gods, centaurs, nymphs, sphinxes, griffins, panthers and bulls, Dionysus, Hephaestus,

and Ajax bearing the deceased Achilles.

Middle Ages' superstition saw black acquire more malign associations, synonymous now with misfortune, ill foreboding, and the devil; Europe's devastating Black Death epidemic, outbreaking with 1346, galvanising such. Medieval artworks betray evidence of bone black's usage, whilst black ink, an admixture of hide, resin, bone, carbon and lampblack invented within China from the 3rd century BC, India from the 4th, thus China and India ink. As well as Iron Gall ink, drawn from Oak galls, and revealed within the writing of monastic Middle Age scribes, fastidiously reproducing religious works upon parchment and vellum within the quietened scriptoria, a monastery's writing chambers. Synonym of innovation, German printer and publisher Johannes Gutenberg's revolutionary invention of the moveable-type Gutenberg press with 1436 however, constructed 1440, ensured not only the obsolesce of labouring scribes, but also the fabrication of a new printer's ink. Developed by Gutenberg himself to better adhere to the press's metal type, the lustrous, viscous oil-based ink, in fact a varnish, was constituted largely by carbon, amalgamated with copper, lead, and titanium. Sumptuary laws of the preceding 14th century, those regulations concerning appearance and consumption, saw merchants, bankers, and magistrates attire themselves with blackest garments, forbidden as they were from the chromatic finery garbing nobility. Possessing richest black hue, the culmination of several advancements within dye manufacture, one demanding, from the 17th century, Belizean logwood, darkest garments became, with succeeding centuries, the favoured hue of monarchs. Dutch Northern Renaissance painter Rogier van der Weyden's subdued portrait of Philip the Good, Duke of Burgundy, for example, completed after 1450, reveals said Duke enveloped wholly with black vestments. Nobility, clergy, pious Calvinists, Protestants and Puritans all too, went swathed with black; Italian baroque painter Michelangelo Caravaggio's œuvre serves wholly illustrative of black's now-assured predominance.

Fascinations with darkest hues endured across the 18th and 19th centuries; Spanish Romantic painter Francisco Goya's midnight works wholly emblematic of the latter. Authored between 1819 and 1823, fourteen ominous, raven compositions constitute *Las Pinturas Negras, The Black Paintings*. Executed originally upon the walls of Goya's last residence *Quinta del Sordo. Saturn Devouring his Son*, perhaps the most infamous of the fourteen works, reveals the myth of Titan Cronus, fearing overthrow by his several sons, devouring each upon their births. Goya's macabre,

rapacious Saturn, eyes gazing maniacally forth, savages a bloodsoaked, partially devoured headless torso. Enveloped almost entirely by blackest shadow, such darkest imaginings parallel another work; *Aquelarre, Witches' Sabbath*. Revealing a twilight witches' coven, grotesque figures all bowed before a colossal blackest goat, Satan, the artist's nightmare scene, rendered with sallow ochre and leaden charcoal, betrays Goya's fixations upon misanthropy, and mortality.

Mortality serves as a leitmotif throughout the works of French Realist-Impressionist painter, Édouard Manet. 1867's grave *The Execution of Maximilian* reveals Austrian Archduke Ferdinand Maximilian's death, and those of two generals, by firing squad; seven Mexican republican loyalist soldiers, all garbed in leaden charcoal and black. 1872's portrait, *Berthe Morisot with a Bouquet of Violets*, reveals the young French painter Morisot rendered exclusively with funereal hues; mourning dress, accompanying hat and scarf, even her eyes, originally green, are painted black; the eponymous violets themselves almost imperceptible against the obsidian blackness of her sorrowful chest. An anomalous work, for Manet's usual uniform light went substituted by side illumination, Morisot's visage appears an exercise in chiaroscuro, of black he would nevertheless declare, "black is not a colour."

American Abstractionist painting from the mid-20th century forth encompasses several artists notably of blackest fixations. Frank Stella's colossal 1959 enamel on canvas work, *The Marriage of Reason and Squalor, II*, one of a series of several *Black Paintings*, such as *Arundel Castle* and *Getty Tomb*. Revealing two vast symmetrical U-shaped forms, each comprised of twelve rectilinear black stripes, separated by unpainted white canvas interstices, *The Marriage of Reason and Squalor, II* evokes deepest infinitude, and a surrendering to optical ambiguity. One catalytic he revealed, to "emotional ambiguities", Stella's monochromatic compositions parallel those of another American Minimalist, Ad Reinhardt. Authoring an oeuvre progressively characterised by subtraction; forsaking narrative, palpable emotion, and colour, the remaining ten years of Reinhardt's life would see numerous works, described by he as "ultimate paintings", created exclusively with black's assorted hues. 1962, 1963 and 1964's several works, all variously titled *Abstract Painting*, appear at first glance to be uniform monochromatic fields of colour, absent of any content. However, meditative examination reveals Reinhardt's canvases in fact encompass several chromatic hues. Almost imperceptible, such optical subtleties signify obfuscated narratives, forgotten memories and nebulous visions;

the very elements he believed, frequently obscured by overt gesture, reference, narrative, and colour.

"I want to emphasise the idea of black as intellectuality and conventionality," Reinhardt observed, noting, "black is interesting not as a colour but as a non-colour and as the absence of colour."

Piece of naturally occurring Graphite
Straus.970
Graphite is consists of layered sheets of hexagonal carbon rings. This structure allows it to be used as a lubricant. Long been used for drawing, when combined with clay it is used in lead pencils.

Lamp Black
Straus.1099
R. R. Cameron, USA, 1928
Black soot condensed from the burning of mineral oil, tar, pitch or resin.

(top left)
Black oxide of cobalt
Straus.1129
J. D. Penberthy MPS.
E.S.M.G., USA, n.d.
Employed not as a black pigment, but rather as the colourant in blue glazes.

(top right)
Ivory Black
Straus.1114
Winsor & Newton,
United Kingdom, n.d.
Made from the charred off-cuts of ivory which are then ground and washed. Produces a slightly brown, warm tone. Currently the name ivory black is used for bone black.

(bottom left)
Maple Soot
Straus.1086

(bottom right)
Blue Black, Charcoal
Straus.1101
Madderton & Co,
United Kingdom, n.d.
Charcoal is made by heating wood in a sealed chamber.

Raven Black Oxide
Straus.1128
C. K. Williams & Co.,
USA, n.d.
A naturally occurring mineral used as a pigment in ancient cave paintings. Still used today by Australian Aboriginal artists, especially on Groote Island. Often used as a dryer for oil paint.

Mineral Black
Straus.2056
Reichard-Coulston Inc.,
USA, n.d.
Refers to powdered graphite or ground black slate. As the pigment is in a sealed container, its composition has not been determined yet.

Vine Black
Straus.3711
Made in the same way as charcoal, but using vine wood exclusively. It possesses a bluish tone. Chemically it is carbon. One of the pigments used by Lewis Rubenstein while assisting José Clemente Orozco in the painting of the fresco *Dive Bomber and Tank*, 1940, in the collection of the Museum of Modern Art, New York City.

Black made from
Calcined Pig Bones
Straus.1111
n.l., 1933

Bitumen
Straus.1393
Charles Roberson & Co.,
United Kingdom, 1929
Also known as asphaltum,
such was popular in the
18th and 19th centuries as a
transparent brown. Produces
a paint that never dries and is
well known to create serious
cracking (alligatoring), to run
and to crawl.

(top right)
Ivory Black
Straus.21
Geo. Rowney & Co.,
United Kingdom, n.d.

VantaBlack
(Anish Kapoor)
Yet to be catalogued
NanoSytems, United
Kingdom, 2016
Artist Anish Kapoor has the
exclusive licensing rights to
use this within a work of art.
Fellow artist Stuart Semple
protested and declared that
his eponymous pink pigment,
known as the pinkest pink, is
available to all, except Kapoor.

Gum Arabic
Talc
White Lead
Satin Spar
Zinc White
Bone Ash
Alabaster Gips
Antimony White
Lead White
Gum Arabic
Talc
White Lead
Satin Spar
Zinc White

Edmund de Waal

"I know the dangers of white.
I think I know the dangers of an
obsession with white, the pull
towards something so pure,
so total in its immersive
possibility that you are
transfigured, changed,
feel you can start again."

Radiant innocence and virtuous immaculacy, sacrifice, virginity, beatific spirituality and prostrate humility, ethereal purity and the enveloping sanctuary or achromatic colour white, black's obverse, absolves every trespass, and purifies each conscience.

Natural calcium carbonate, drawn from the compressed, calcareous skeletons and seashells thrust forth to the earth's surface within the Cretaceous Period, between 145 and 66 million years ago, offer the world's oldest source of natural white pigmentation. Named *creta*, Latin for chalk, such went revealed by our Upper Palaeolithic ancestors through engravings of assorted bears, horses, ibex and mammoths, upon the whitest limestone cavern walls of southern France's Chauvet-Pont-d'Arc cave, accompanied by lines of charcoal and ochre, approximately 37,000 years ago. Or grasped as crayons of chalk, and related mineral calcite by our Palaeolithic forebears as they adorned south-western France's Lascaux Caves with whitened oxen, horses and steer, some 18,000 years ago.

Goddess Isis, Ancient Egypt's divinity of motherhood, fertility, marital devotion, and sorcery, was believed synonymous with the colour white; a wall painting from circa 1360 BC reveals her white-winged, with whitest headdress. A sacred hue, one that garbed both Isis' devotees, as well as the deceased with whitest linen, whitest clay and bone went deployed within the Nile Valley's hieroglyphs, paintings and tomb illustrations. "White lead was held in estimation in the days even of the Trojan War," wrote Roman author and naval commander Pliny the Elder with 77 AD of the Ancient Greeks' appetite for *cassiteros*, white lead, utilised from the 4th century BC forth. Created by laying lead ingots and vinegar within earthenware jars, then enveloping such with layers of either tan bark or bovine excrement, the resultant lead carbonate went utilised as a white pigment, and applied as a harmful, flesh-whitening cosmetic.

Synonymous with sacrifice, purity and virtue, Ancient Roman notions of white's symbolism endured throughout the succeeding centuries, colouring early Christian iconography, such as the white Lamb of God; the very centrepiece for example, of Flemish Renaissance painter Jan van Eyck's magnificent 1432 altarpiece, *Adoration of the Mystic Lamb*. Alongside white unicorns, and the garments of holy figures. The New Testament's Gospel of Saint Mark, in revealing Jesus Christ's transfiguration saw his "raiment became shining, exceeding white as snow; so as no fuller on earth can white them." Resplendent raiment that Italian Renaissance painter Fra Angelico sought to replicate with his illuminated fresco; 1442's *Transfiguration*. Fellow Italian painter Cennino Cennini mentions

the white pigment Angelico utilised for *Transfiguration*, was *Bianco di San Giovanni*; lime white pigment made with calcium carbonate and calcium hydroxide, within his *Il Libro dell'Arte*, *The Book of Art*, authored with 1400. 1490's magnificent oil painting, *Lady with an Ermine*, authored by that inimitable Italian Renaissance painter Leonardo Da Vinci, reveals the mistress of Ludovico Sforza, Duke of Milan and Da Vinci's patron, Cecilia Gallerani, tenderly grasping the eponymous ermine. That is, a stoat clad with winter's coat; an enduring synonym of nobility and purity, on account of the enduring conviction the ermine would rather perish than witness the sullying of their majestic white coat.

Noxious lead white remained the artist's exclusive source of white oil-colour throughout the succeeding centuries, until the 19th, with the advent of zinc white. A zinc oxide originally advanced by French chemist Guyton de Morveau in 1782 as a source for white pigment, then later developed into a watercolour, Chinese white by British manufacturer Winsor & Newtown with 1834, and a reliable oil colour by French manufacturer LeClaire with 1844; such rendered lead white largely obsolete. White's variegations went employed to spectacular effect within American Pre-Raphaelite influenced painter James Abbot McNeill Whistler's 1862 oil work, *Symphony in White no 1: The White Girl - Portrait of Joanna Hiffernan*. Revealing Hiffernan, Whistler's Irish mistress and the artist's model, he described her full-figure portrait, she standing upon the arctic white pelt of a polar bear, all executed with an extraordinary aray of whitest hues, within an early 1862 letter thus to French-English satirist, George du Maurier; "a woman in a beautiful white cambric dress, standing against a window which filters the light through a transparent white muslin curtain – but the figure receives a strong light from the right and therefore the picture, barring the red hair, is one gorgeous mass of brilliant white." Accompanied by two similar oil portraits, 1864 and 1867's *Symphony in White, No. 2* and *No. 3*, both of Hiffernan, Whistler's desire for white pigmentation went shared by French Impressionist painter, Gustave Caillebotte. Fascinated by the monochromatic hues of then-gestative photography, Caillebotte's 1877 oil-work *Paris Street in Rainy Weather*, said Paris street in fact, the Place de Dublin, a wholly pleasant parallel to Whistler's Irish model Hiffernan; reveals Parisian wayfarers with parasols held aloft, wandering beneath an opaque deluge, across whitened, cobbled boulevards. Undertaken largely with whitened hues of yellow, red, and blue, white nevertheless, remains the prevailing hue; Caillebotte's refracted light leaves one with the impres-

sion of ceaseless, omniscient white.

Titanium white, whitest of all whites, remains unequivocally, the 20th century's white. Originally discovered over a century earlier by amateur English mineralogist, Reverend William Gregor with 1791, titanium was not developed into a workable pigment until 1916, by both American and Norwegian manufacturers. Unrivalled in luminosity, and enduring opacity, such went employed, alongside zinc white, and white lead, throughout the œuvre of Russian Suprematist painter, Kazimir Malevich. 1915's *Suprematism*, reveals a imposing whitened cross, upon a whitened plain, whilst 1918's abstracted *Suprematist Composition, White on White*, reveals one whitened square, askew within another. Wholly absent of illusory depth, volume and colour, his vast expanse of white allows one's mind to descend deep introspectively within, down amidst unexamined recesses, unclouded by ornamentation or hue. "I have overcome the lining of the coloured sky…" Malevich declared rapturous. "Swim in the white free abyss, infinity is before you." Malevich's adoration for white's absolution went equated by Canadian born, American Abstract Expressionist painter, Minimalist Agnes Martin. Celebrated for her austere canvasses of serene colour fields, upon which dense, minute, ethereal, delineated grids went superimposed, such monastic applications betray her fascinations with Taoist philosophy and transcendence. Emblematic of such perhaps then, is 1964's oil and graphite on linen, *White Stone*. Encompassing a monochromatic, whitened plain, an abstraction of New Mexico's characterless desert terrain, upon which lays a grid of faintest intersecting graphite lines, Martin's quietened, contemplative works, 1965's *Morning*, 1979's twelve works, *The Islands*, and 1999's *Loving Love*, throughout which one's thoughts may voyage unobstructed deeply within, all sought to actualise our innermost, as she believed "awareness of perfection."

Gum Arabic, 2 oz.
Straus.3568
Japan, 1931
Binding medium collected by E. W. Forbes during his 1931 travels in Japan. The gum is produced by several species of Acacia tree; the most important for painting is Acacia Senegal. Gum arabic has been used as a binder since Ancient Egyptian times. Often used as a binding medium in watercolour.

Talc

Straus.180

Also known as steatite or French chalk. Talc is used as a filler in paper, ceramics, paint, plastics, rubber, soaps, plaster, crayons, and cosmetics.

White Lead, Dutch Process

Yet to be catalogued

The Dutch process of lead white manufacture involves suspending strips or buckles of lead white over vinegar, then covering them with tan bark and dung. The combination of acetic acid, heat and carbon dioxide from the fermenting bark produces the pigment.

Satin Spar, Gypsum
(Terra Alba)
Straus.603

(top left)
Zinc White
Straus.1049
Lefranc & Cie, France, n.d.
As a pigment it was first listed by Winsor & Newton in 1834, although naturally occurring zinc oxide was occasionally used earlier.

(top right)
Bone Ash
Straus.1034
Made by calcining bone.
Its traditional use is to prepare paper for metalpoint.

(bottom)
Alabaster Gips
Straus.954
A fine grained gypsum made from alabaster stone. Used for filling paper or as a pigment called mineral white or terra alba.

Antimony White
Straus.2227
Introduced as a pigment in 1920 under the name Timonox by Cookson Lead and Antimony Co. Often mixed with zinc white.

Lead White
Straus.590
Lead white is one of the earliest artificially produced pigments, and was the chief white pigment used by artists in the 19th century. Accelerates the drying of oil media.

Tin Powder
Aluminium Bronze
Gold Leaf
Mosaic Gold
Stannic Sulphide
Gold Ore
Venus Chrome
Yakikin
Gin
A-Okin
Metal Flake
Silver
Tin Powder
Aluminium Bronze

Andy Warhol

" It was the perfect time for silver. Silver was the future ... astronauts wore silver suits. And silver was also the past – the silver screen – Hollywood actresses photographed in silver sets."

Radiant opulence and exquisite elegance, luxury, rarity, ostentatious ornamentation and resplendent exaltation, the colours drawn from revered metals, bestow transcendence, and herald majesty.

August, lambent gold, so the ancient Egyptians believed, constituted the very flesh of the gods themselves. Enormously valuable gold leaf, fabricated over 5000 years ago by the hammering of gold into delicate sheets or leaves, went applied, with an organic adhesive, to various consequential surfaces and objects; sarcophagi, tomb paintings, illustrations of gods, nobles, and pharaohs. Gold pigmentation however, occurred in both the form of encaustic pigments, that is, ground pigment combined with liquefied beeswax, before application. And with tempera; an emulsion of water and oil or albumin from egg white, to which ground pigment is combined, to create pliable, coloured paints. Within the Fayum, a vast oasis region some 150 miles south of Alexandria, British archaeologist Sir William Matthew Flinders Petrie excavated, between 1887 and 1889, a cemetery dating from the 1st and 2nd centuries AD, when Egypt lay beneath Imperial Roman rule. Encompassing some 150 mummified figures, each possessed extraordinary portraits of the long-deceased, executed by anonymous Coptic artists upon attached wooden panels. Known as the Fayum Portraits, many of such reveal their naturalistic subjects adorned with elaborate golden headdresses, jewellery, and colliers, all rendered with gold leafing. Fayum's portraiture aesthetic, and gold leafing, endured forth across the bisection of the Roman Empire, and the successive centuries of the Byzantine Empire, influencing Christian icon painting and mosaics throughout. Another altogether extraordinary, kaleidoscopic mosaic for example, realised with 547 AD, adorns the vaulted interior of Ravenna, northeastern Italy's Basilica of San Vitale. Illustrating assorted Old Testament parables, flowers and peacocks, plants, landscapes and other animals, as well as portraits of Emperor Justinian I, and Empress Theodora with characteristic Hellenistic-Roman aesthetic, the mosaic's *tesserae*, coloured squares of glazed glass, many of which contain gold lead, suffuse the entire basilica throughout with radiant gold. Silver too was known to the Ancient Egyptians; often augmenting gold with such, and utilised alongside gold within the illuminated manuscripts of the Middle Ages, as well as the gold-ground panel paintings of the 13th century. However on account of ready oxidisation, such went less frequently employed. Early Italian Renaissance painter Paolo Uccello's enormous triptych *The Battle of San Romano*, begun approximately in 1435, was, for example, originally rendered with vast swathes of lustrous silver and gold

leaf. Astride magnificent stallions, dozens of armoured Florentine and Sienese knights, lances grasped in defiance, violently charge back and forth trampling the fallen beneath; their once-radiant silver armour, now blackened obsidian by the ravages of time, whilst their gold-embellished harnesses, pennants, and garb all remain astoundingly lambent.

Astronomically costly gold saw enraptured alchemists and artists both pursue alternate methods by which to effect that intoxicating mineral's creation. One such pigment, borne of these speculative explorations, was inexpensive Mosaic gold; a metallic yellow hue composed of stannic sulphide, utilised from the 13th century forth within illuminated manuscripts and gilding. Such went replaced with the 19th century and the advent of bronze-based pigments, composed of copper and zinc, aluminium-based pigments succeeding these in turn. Authentic gold's usage however, occurred unwavering from the Renaissance forth. Florentine painter Sandro Botticelli's remarkable tempera on canvas masterwork, *The Birth of Venus*, executed between 1482 and 1485, draws subject from Ovid's Metamorphoses. Revealing the goddess Venus porcelain and unclad, gently sailing to shore upon a half-scallop shell, sent thus by the breath of Zephyr and Aura. Awaiting Venus' landfall is the handmaiden of spring, Thallo, grasping an opulent, brocaded cloak with which to envelop her. Gold pigmentation appears throughout Botticelli's composition; within Venus' fulgent tresses, upon the wings of the gods, across textiles, gilding that enormous scallop shell, the laurel trees and grasses upon the shore; even the ocean's waves contain gold. Such partiality for the alchemists' hue may be accounted for by the fact that Botticelli himself had originally practiced as a goldsmith; indeed, his very name is likely drawn from the Italian, *Battigello*; one who beats gold.

Celebrated Italian Renaissance painter Titian's 1560 work, *Danae Receiving the Golden Rain*, reveals bare reclining Danae, daughter of Acrisius, impregnated with a cascade of golden rain by Zeus, now metamorphosed into a cloud, went executed with variegations of gold. Whilst nearly two centuries later, American Tonalist painter James Abbott McNeill Whistler would employ both gold and silver within several highly abstracted, so-named *Nocturne* compositions. With 1871's *Nocturne: Blue and Silver – Chelsea*, Whistler sought to encapsulate the tranquil quietude, and twilit loveliness of London's River Thames. Rendered with swathes of darkest grey, lent silver's luminosity by applying then partially erasing layers of transparent oil paint, his subdued dusk vista of Chelsea accompanied another, somewhat more incandescent work; 1875's *Nocturne in Black*

and Gold, the Falling Rocket. Illustrating the remarkable pyrotechnic displays then conducted each evening at riverside Chelsea's now-destroyed Cremorne Gardens, Whistler's painting evokes all the incendiary wonder of a Victorian fireworks spectacle; evanescent archipelagos, and constellations of scarlet, sulphurous yellow, and conflagrant gold all illuminate London's blackened night's sky.

Renowned Austrian symbolist painter Gustav Klimt's fabled Golden Phase, characterised by incalculable measures of gold leaf, encompassed two notable Byzantine, Art Nouveau-influenced works, both radiant with gold. 1907's *The Portrait of Adèle Bloch-Bauer I*, reveals the resplendent, golden-garbed wife of banker and sugar magnate, Ferdinand Bloch-Bauer. Alongside 1908's *The Kiss (Lovers)*, within which two saffron and gold enshrouded lovers, entwine rapturously now as one. "Truth is like fire," Klimt is once said to have observed; an impassioned lover himself, known for the incandescence of his palette, and the intensity of his ardours. "To tell the truth means to glow and burn." American Abstractionist painter and sculptor Robert Rauschenberg's monochrome explorations from 1951 forth, began with white, evolved to black, then red, and at last, with 1953, gold. That year's *Untitled, Gold Painting*, encompasses an abstract topography of fabric and adhesive; the palisades and valleys of such completely enveloped with gold leaf. Intended to collapse what he termed, "clichés of association", that is, standard expectations of symbolism and context, Rauschenberg's unhallowed, decontextualised application of gold leaf invoked several dialogues; perceived and imagined value, and conveyance of the artist's message, as well as re-examined orthodox hierarchies of material, colour, and hue. "I did a painting, or a couple of each," he revealed, "one in toilet paper collage, trying to duplicate it in gold leaf. And I studied both paintings very carefully and I saw no advantage to either. Whatever one was saying the other seemed to be able to be just as articulate."

Rauschenberg's successor in the dismantling of so-named clichés of association remains none other than fellow American artist, Jeff Koons. Celebrating kitsch ostentation, and pop-culture's garish iconography, Koons' eclectic, frequently provocative oeuvre encompasses for example, 1990-1991's *Made In Heaven*, a series of elaborate pornographic images featuring himself and then-wife, celebrity Cicciolina, 1988's *Michael Jackson and Bubbles*, a lavish gilded porcelain sculpture of the musician, grasping beloved chimpanzee. "He's a little like King Tut," observed Koons of the work. "The eyes; the way Michael would do his make-up. And if you look at his leg, it reminds me of the pyramids of Giza." The artist's metallica fascinations find further expression within 1992's *Celebration* series, which incorporated numerous, enormous, iridescent sculptures of novelty dogs, all made from the joyous forms of twisted balloons; gleaming metallic, voluminous sculptures, rendered in candy-coloured hues of magenta, orange, blue, scarlet, silver and gold. Deconstructions of assumed symbolism and accepted value, Koon's elevation of kitsch's iconography into high art, through the subversion of materials, contexts and subjects, sees traditional synonyms of decadence and refinement, gold and silver foremost amidst such, corrupted to a wholly contemplative, unsettling effect.

Tin Powder (RJG)
Straus.36
Further research required, n.d.
RJG-Rutherford John Gettens

Aluminium Bronze
Powder (RJG)
Straus.37
Baer Brothers, USA, n.d.
RJG-Rutherford John Gettens

(top left)
Finest French Gold Leaf Bronze
Straus.2099
Leo Uhlfelder Co., USA, n.d.

(top right)
Gold Leaf Powder
Straus.33
Baer Brothers, USA, n.d.

(bottom)
Mosaic Gold, Stannic Sulphide SnS2
Straus.734

Gold Ore
Straus.587

501 Venus Chrome Lining
Straus.2087

(top left)
Yakikin (Gold)
Straus. 504
Japan, 1931
Pigment collected by E. W. Forbes during his 1931 travels in Japan.

(top right)
Gin (Powdered Silver)
Straus. 505
Japan, 1931
Pigment collected by E. W. Forbes during his 1931 travels in Japan.

(bottom)
A-Okin
(Gold and Silver mixed)
Straus. 506
Japan, 1931
Pigment collected by E. W. Forbes during his 1931 travels in Japan.

(top)
Metal Flake Silver
automotive product
for use in clearcoat
Yet to be catalogued
Anodised aluminium squares, similar to the material used on hot rods (customised automobiles) in the 1960s and by Richard Hamilton on his large Guggenheim reliefs.

(bottom)
Metal Flake Blue
automotive product
for use in clearcoat
Yet to be catalogued
Anodised aluminium squares, similar to the material used on hot rods (customised automobiles) in the 1960s and by Richard Hamilton on his large Guggenheim reliefs.

Silver from Silver
Nitrate
Straus.2101

Appendix

Glossary

Achromatic colours
An achromatic colour is one that lacks a clear hue or saturation, such as black, white, and grey. See Hue, Saturation.

Aquamarine
The name aquamarine derives from the Latin *aqua marinus*, "water of the sea". Blue-green in colour, this transparent crystal is a variety of beryl. The name is also used to describe a pale blue to pale green blue shade.

Azurite
A soft, deep blue copper mineral produced by the weathering of copper ore deposits. Related to malachite, when ground, such creates a deep blue pigment possessed of a green tint. An important pigment for wall painting in ancient Egypt, it was, by the Renaissance, generally employed for under-painting costly ultramarine.

Black
The very darkest colour, black is achromatic, with conflicting categorisations as a colour or non-colour. Such results from the absence of light, or the absence of the reflection or transmission of light by a material. There is a wide range of blacks, generally produced by burning organic matter; blacks from bone tend to be warm; those from plants and woods such as vine tend to be cooler. Long equated with night, death, and mourning, black was always nevertheless, an inexpensive pigment, used regularly within artworks and interiors. Painters often mixed black with other pigments to produce darker shades. See Achromatic Colours.

Blue
A primary colour, for both pigments in painting as well as the light colour model RGB (red, green, blue). Historically associated with sky, heaven, peace and truth, blue is also symbolically associated with the earth. Within icon painting, convention saw portrayals of the Virgin Mary in blue garments. This was thought to be a continuation of a pagan belief that blue stones and glass could repel demons, including the witch known as the Evil Eye. See Primary.

Bole
An iron-rich, red clay with a slight yellow tint. Used in preparing a surface for gilding, such allowed gold leaf to result in a warmer, orange finish. Iznik ceramics painters from the late-sixteenth century employed Armenian bole, a rare source of red at the time, which retains traces of uranium. See Gilding.

Brazilwood
The wood of any tropical trees of the genus Caesalpinia, such yields a red dye by oxidizing into brazilin. A source of red and purple dye, brazilwood was used throughout and beyond the American Colonial period.

Brown
Considered the least specific colour. Browns vary from yellow to almost red, but are always characterised by a darkened cast. Solid and earth-hued, they have also had sophisticated applications, although it is now often associated with plainness, the rustic and poverty. Sources of brown pigments include burnt earths (see Earth Pigments), raw umber, peat (see Van Dyke Brown), and mixtures of pigments. Natural brown dyes are derived from plants such as catechu (a brown dye from the acacia tree), gambier (a yellow-brown dye from the leaves of the Uncaria gambier), and myrobalan (khaki made from the fruit of that tree).

Burnt Pigments
Calcined by heating within a kiln to make them darker, burnt pigments include burnt sienna, umber and ocher, and the burnt earth pigments. From the Renaissance forth to the present day, these have endured as important pigments within artists' palettes.

Cast
As a shadow cast upon an object, the term cast is used to describe the presence of another hue within a colour, subtly altering the characteristic of the latter, and lending such dimension; for instance, red with a blue cast (such as those approaching purple) has a cooler feel; with a yellow cast, such is warmer.

Calcination
See Burnt Pigments.

Celadon
A yellow green that is grey, somewhat more yellow than sage green. The colour is named for Céladon, a character in *L'Astrée*, Honoré D'Urfé's 17th century romance novel, who appears garbed with ribbons of grey green.

Cerulean
From the Latin carculeus, a deep blue colour like that of a clear sky. Whilst such retains an ancient colour name, it is a modern pigment made from oxides of cobalt and tin, with a gentle green cast.

Chroma
A term originated by Albert H. Munsell, of the Munsell colour system, to designate the purity of colour (such as how grey a hue is). Colourfulness and saturation are considered synonyms. See Hue, Saturation, Value.

Cinnabar
See Vermilion.

Cobalt
A bright, deep blue with a green cast, slightly more intense than cerulean. Cobalt blue was one of the first older pigments to be produced synthetically (1802). Originally named Thénard's blue after the inventor, such was introduced as an artist's pigment in the 1820s. Compounds of cobalt have been used to produce colours other than blue, such as violet and a bright yellow.

Cochineal
See Kermes.

Colorimetry
The science and technologies used to describe and quantify the human perception of colour.

Colorito
Roughly translated to "colouring", this term from Italian Renaissance painting is generally applied to Venetian painting in which colour is employed in a dominant manner; for sensual expressive purposes and as an important compositional element.

Colour Circle
The circular design arranges hues in their most saturated form, with colours blending consecutively into one another - red into orange, yellow, green, blue, purple, before returning cyclically back into red. Other representations are the triangle, and the subsequent sphere. Colour triangles show the primaries at the peaks, with the secondary and tertiary colours down each triangle's sides and interior. The fullest representation of colour space, the colour sphere, has the colour circle at its equator and black and white as the poles; with all the intermediate tones and shades completing the rest of the surface and interior.

Colour Temperatures
A quality of a colour to fall into one of two temperature categories: warm or cool. The division of the hue spectrum by temperatures is as follows: the purples, reds, oranges and yellows (warm colours) contrary to the greens and blues (cool colours). Neutrals (including white, black, greys and browns) and all tints, shades, and tones can also be classified as either warm (red or yellow-like) or cool (blue or green-like). Some also use

the temperature qualifier for a colour's cast. For instance, pinks with a blue cast are qualified as cool, whilst purples with a red cast are frequently qualified as warm.

Cool Colours
See Colour Temperatures.

Dye
A colouring agent that dissolves completely in a medium, usually water. Pigments, in contrast, are indissoluble. Important natural dyes, also known as dyestuffs, include yellow from rustic, saffron, or weld; blue from woad or indigo; red from kermes or madder, the delicate pink and yellow from safflower, and brown from catechu. Greens were generally made by mixing blue and yellow dyes.

Earth pigments
Pigments obtained from earths that are mineral-rich. Historically, the most readily available colours for painters, they are frequently named for the region from which they are drawn. Varieties include umber (from Umbria, Italy, a darker red-like brown), sienna, from Sienna, Italy, and ochre (both yellow brown). Colours vary widely from brightest reds to yellows and greens, for example Verona green, or terre verte, is a grey-green earth.

Egyptian blue
A copper silicate considered to be the first synthetic pigment, such was fabricated in Egypt from at least 3000 BC. Also known to Ancient Romans by the name caeruleum – from which the English word cerulean derives. See Cerulean.

Encaustic
A method of painting whereby pigments are combined with molten beeswax or resin. The liquid or paste is then applied to a surface, usually prepared wood. Encaustic painting was notably used within the Egypto-Roman portraits of Fayoum, all executed upon wooden panels.

Film colour
Described by German painter and colour theorist Josef Albers as "a thin transparent, translucent layer between the eye and the object, independent of the object's surface colour." Film colour is a layer of colour that appears to overlay another, but is not in fact, part of the surface. For example, the reflection of a coloured item onto a white wall, the blue cast of far away mountains, or the shining red of the rising sun at sunset.

Fluorescent or UV Fluorescent
UV fluorescent paint (black light fluorescent paint) is luminous paint that glows under a black light. Such is based upon pigments that respond to light in the ultraviolet segment of the electromagnetic spectrum. When exposed to ultraviolet radiation, some materials used within paintings become fluorescent, emitting visible light. In particular, traditional natural resin varnishes, such as mastic and dammar, emit a characteristic green-yellow colour. By viewing a picture under UV light to see how much light such emits, it is therefore possible to monitor the removal of old varnishes. While most paints emit very little fluorescence, some pigments and dyes used in paint do in fact emit characteristic colour. This can be useful to identify the presence of a particular pigment. For example, the dyestuffs in different red lake pigments emit several different colours, from bright orange to pink.

Fugitive
Used to describe the impermanence of coloured dyes or pigments which tend to fade when exposed to light, air, water or another corrosive substance. Colours from natural, plant-derived, dyes, indigo for example, are all extremely fugitive.

Gesso
White mineral gypsum is generally referred to as gesso, from the Italian for chalk. Such is used as a ground or preparatory layer to ensure a smooth surface for painting or gilding upon wood, or to prime canvas. The common practice was to apply a coarse lower layer (gesso grosso), followed by a finer upper layer (gesso sottile), which would be scraped and sanded to ensure such was completely smooth.

Gilding
The term gilding is used to describe a technique whereupon delicate layers of gold leaf are applied. A relatively affordable method of producing solid gold backgrounds, such was essential to the use of colour icons. As gold leaf needs to be applied to a smooth surface and is slightly translucent, gilding on wood is usually preceded by the applications of gesso, followed by a layer of green or red earth pigments that give characteristic green or red casts to the overlaid gold.

Gradation
A term used in colour to describe a gradual change in hues, such as the lightening or darkening of a particular hue at predictable intervals. Wilhelm Ostwald's colour work on grey scales was essential to artists and designers in the 20th century, showing that even progression of shades from light to dark relies upon adding black in proportionate increments; 1, 2, 4, 8, 16, and so forth.

Green
A secondary colour in pigments, green is a primary of light alongside red and blue in the RGB colour model (red, green, blue). Such is also a psychological primary in that green is viewed as a basic hue, alongside red, yellow, and blue. Commonly associated with growth, youth, and fertility, green has established itself within the 20th century as the pre-eminent colour of banking. Natural sources of green pigments were verdigris, malachite, and green earth (see Earth Pigments); often also created by combining blue and yellow.

Gouache
Gouache is a French term used to describe a type of watercolour paint that is opaque. Pigments are ground in water and mixed with gum. The opaque results of using gouache appear markedly different from those achieved with washes of watercolour.

Hue
The term hue describes the basic, characteristic colour of a tint, shade or tone. Such can also be defined as one of the pure colours of the spectrum, as opposed to white, black, or grey shades. Used as one of the three dimensions in the Munsell colour system. See Chroma, Value.

Indigo
A medium to dark blue originally obtained from the woad plant but largely replaced by Asia-sourced indigo (also called Indian blue) which contains approximately thirty times the amount of the dyeing substance, indicum. Indigo is a fugitive dye; the fading qualities of such are popular with textile manufacturers. Synthetic indigo, which fades similarly to the natural extract, is now used for blue jeans. Occasionally used by artists beneath azurite pigments, indigo lake would deepen blue mineral colours. Included by Newton within the colour spectrum, between blue and violet, to match the number of colours in the spectrum to those of French philosopher and mathematician

Rene Descartes' seven-tone music scale, indigo's position in the spectrum is still contested.

Iridescence
Named for Iris, the Greek goddess of the rainbow, iridescence describes the appearance of spectral colours due to interference of light in delicate films such as mother of pearl, or soap bubbles. Such can also describe the shifting colour in certain fabrics or surfaces depending upon one's viewing angle.

Kermes
From the Arabic qirmiz (which gave crimson), such is the oldest red dyestuff known. Obtained from the crushed and dehydrated bodies of the female scale insect (genus Kermes), which inhabits the kermis oak of the Mediterranean. A much stronger red, cochineal, draws origin from the cactus-dwelling insect (Dactylopius coccus) of Central America.

Lake
Pigment made from a dyestuff, which has been precipitated through evaporation, often onto a bearing substance such as ground eggshell or marble. Painters employed these to mix composed colours and to darken, or brighten a colour.

Lampblack
Black pigment made from soot, collected from the inside surface of a lamp blackened by an oil-lamp wick or burning candle.

Lead
Source of two significant pigments invented by the Greeks, lead white and red lead, these have been utilised both in art and for painting interiors. Lead-tin yellow, which has an acidic yellow tint, was an important new paint in Renaissance art. Highly toxic, lead-based paints have been withdrawn from most countries since the late 20th century.

Lücher Colour Test
Swiss psychologist Max Lüsher devised this test in 1947 to allow analyses of character and mental state through a subject's selection of colour samples and ordering by preference. Classical theories of colour association were applied within Lüsher's analysis: the choice of red, blue green and yellow indicated activity, tranquillity, tenacity, and radiant release respectively, although the signifance of such were modified by the order within which the colours were placed.

Lustre
A luminous glow or dimension of colour realised with metallic paints or oil paints.

Madder
Produced from the root of the plant Rubia tinctorum, madder is one of the most common historical sources of reds, pinks, and purples employed predominantly for textile dying. Madder lake was originally a pigment precipitated from madder dye; such is now a vivid red created from alizarin and a compound of aluminium.

Malachite
A moderate, yellow green pigment from the ground mineral of the same name, such is slightly deeper than verdigris. One of the few natural sources of green pigment, malachite is a copper carbonate similar to azurite, regularly extracted from the same mineral deposits.

Massicot
Occurring naturally in crystalline form, this lead monoxide is ground to produce a yellow pigment. Such has been employed since the classical period (1750-1820).

Monochromatic
A colour scheme or palette that is based around one hue (including tints, tones, and shades of that hue) or that of very closely related colours.

Muted
A quality of a colour that has faded, lightened, or greyed.

Neon
Describing an exceptionally bright vivid colour that appears to glow. Named for the form of coloured lighting made by exposing Neon and other Noble gases sealed with an electrically charged glass tube. Such are distinguished from fluorescent paints, which react to specific light. See Fluorescent.

Ochre
A yellow to deep orange or brown earth pigment containing hydrated iron oxide. Another variety of ochre containing large amounts of haematite, a dehydrated iron oxide, possesses a red hue and is known therefore, as red ochre.

Oil paint
Oil paints are created by mixing pigment with the medium of oil. Used in Northern Europe in the 13th and 14th centuries for panel painting, the paint's properties were further employed by Flemish painters; subsequently introduced to Italy with the early 15th century. Oils of different varieties may be used as a medium: linseed, walnut and poppy. Such dries slowly and is a more flexible medium than egg tempera, allowing a wide range of optical effects, and a broader and more detailed application of paint, subsequently extending the range of new expressive possibilities for artists.

Off-White
Also known as a shade of white, off-white describes white possessing the intimation of another colour. The eye is very sensitive to subtle variations in white (contrary to black); therefore off-whites theoretically number in the tens of thousands. Titanium white is generally considered the purest white.

Opalescence
Named for the mineral, opal, such describes materials possessing a clouded iridescence, or exhibiting the interplay of colours, in the very same fashion of the polychromatic mineral itself. See Iridescence.

Opaque
Possessing the quality of not transmitting light. An opaque pigment is neither transparent nor translucent, and has high concealing power, thus revealing nothing of the underlying surface or colours. See Translucent, Transparent.

Orpiment
A deeply coloured arsenic sulphide mineral from the decay of realgar, orpiment is a source of a yellow to medium orange. Utilised within Ancient China, Egypt and Greece, the usage of such was less common by the Renaissance. Although extremely toxic and incompatible with other pigments, including lead and copper-based, orpiment remained one of the few clear, bright-yellow pigments available to artists until the 19th century.

Paint
A mixture of colourant or pigment with a binding medium such as oil or egg, which after application upon a surface, transforms into a solid film.

Pigment
The pigment is the element in paint or in a substance that provides colour. Produced from a wide variety of materials, such as minerals, natural and synthetic dyestuffs, and other human-made compounds. Paint consists of pigment bound within a medium. The ratio of pigment to medium affects the malleability, colour and drying time of the paint. Pigments tend to deteriorate over time in

varying fashions and rates; the advent of new more lightfast or permanent pigments proved historically significant.

Polychrome
Denoting many coloured. For example, a statue, which is described as polychrome, is usually constructed of wood, terracotta or stone that has been painted either for decorative effect, or to impart a more realistic impression.

Primary
The three to five basic colours from which all the colours of the spectrum can theoretically be created. Primaries of pigments are red, yellow, and blue. Black and white are added to make a complete range of colours, but remain contested as authentic colours unto themselves. Primaries of light are red (R), green (G), and blue (B), from which the digital colour profile RGB is composed. Printers today employ CMYK printing, with cyan (C), magenta (M), and yellow (Y) together with black (K) as primary colours.

Prussian blue
A dark blue pigment first manufactured in 1704 within Berlin, the then-capital of Prussia, Prussian blue is one of the most important interior colours of the 18th century, such being the first enduring and affordable blue pigment. Also known as Berlin blue, Prussian blue was the first modern synthetic pigment, varying in intensity from moderate to dark, but always possessing a greener cast than "oriental" blues, drawn from cobalt or indigo lake. Prussian blue could also be calcined (such as heated) to create Prussian brown, a red brown ochre colour.

Realgar
Also known as ruby sulphur, realgar is an orange-red mineral consisting of toxic arsenic sulphide. Realgar yellow is better known as orpiment; realgar orange, a moderate to strong orange yellow is also known as Dutch orange.

Red
A primary colour, for both pigments in painting as well as the light colour model RGB (red, green, blue). Visually the most prominent colour with a complex symbolic history, red is associated with fire, passion, the devil, blood and violence. Notable historical examples of the use of such include Pompeian wall paintings and the "flashed red" of medieval stained glass. Important sources of red encompass cinnabar, mercuric sulphide (vermilion), dyes and lakes of madder, kermis or cochineal, and red lead.

Saturation
The relative strength or purity of a colour. Defined by some as the intensity of a colour or the amount of pigment or dye penetration upon a support or material. Also known as chroma in the Munsell colour system. See Chroma.

Secondary
A colour created by mixing two primary colours. In pigment colours, the term refers to green, orange, or purple, the hues obtained by mixing two of the primary colours, red, blue, and yellow, in approximately equal quantities. Tertiaries, on the other hand, are intermediates of primaries and secondaries on the colour circle, such as violet and turquoise. See Primary.

Sfumato
One of the four canonical painting methods of the Renaissance. The term derives from the Italian, to evaporate as smoke, describing the technique for blurring the edges of colours, or a fine shading meant to soften the transition between colours; a gradation without lines or borders from areas of light to those of dark, creating rich atmospheric effects. Such blossomed with the development of oil paints, which could be applied in delicate glazes; Leonardo da Vinci was one of the first great masters of the sfumato technique.

Shade
A graded colour. Also defined as a colour combined with black. Intermittently, but not altogether accurately, such is used interchangeably with tint and tone, as in "shade variations." See Tint, Tone.

Sienna or Siena
See Earth Pigments.

Simultaneous contrast
First analysed by Michel Eugène Chevreul in the early 19th century, this optical illusion describes the influence of one adjacent colour on another, such as the mutual enhancement of complementary colours. Simultaneous contrast effects encompass the heightening or the dulling of certain colours in their combination; the effects of contrast have utilised by painters throughout history.

Smalt
Cobalt glass is known as smalt when pulverised. This deep blue glass is prepared with cobalt oxide or cobalt carbonate. Popular because of its low cost, the manufacture of such became a Dutch and Flemish specialty in the 17th century. Historically, artists regularly employed cobalt glass as a base layer for more expensive blue pigments.

Subtractive colour
Describes the mixing of a limited set of pigments, inks or dyes to create a wider range of colours. Subtractive colour systems start with white light. Coloured inks, paints, or filters between the observer and the light source or reflective surface “subtract” wavelengths from the light, imparting perceived colour. Subtractive primaries are blue, red, and yellow in painting, or cyan, magenta, and yellow (CMY) within printing. See also Primary.

Tempera
Also known as egg tempera, such is a permanent, fast drying water-soluble paint medium (usually a glutinous material such as egg yolk) to which finely ground pigments are then combined. Tempera was used from ancient Egypt into the Renaissance, when it was gradually replaced by oil-based paint, as such could be applied in delicate glazes, allowing the artist to achieve better colour gradations. Tempera, unlike linseed and other natural oils rapidly dries and, does not tend to yellow nearly as significantly with age.

Tertiary
See Secondary.

Tint
A variation of a colour characterised by low saturation and lightening, either through the addition of white (pigments) or from sparse application (dyes).

Titanium white
Introduced in 1921 as an artist’s pigment, this cool, non-poisonous white largely replaced highly poisonous lead white and zinc white. The strongest, most brilliant white available to artists, such is also popular for it’s concealing power, possessing twice the opacity of pure lead white.

Tone
A darkened or desaturated colour achieved by the addition of grey, or by both tinting and shading. Occasionally, but not strictly accurately, used interchangeably with tint and shade, as in "tonal variations." See Shade, Tint, Tonal.

Tonal
In painting, used to describe when an artwork is one that relies upon changes of lightness and darkness rather than on changes of colour for effect. See Tone.

Translucent
A quality of a substance that allows light to pass through, often suggesting depth and richness, and the intimation of undertones. An example of translucent colour occurs when oil paints are applied in many thin layers of glazes.

Transparent
A quality of a substance such as watercolours, varnishes or very delicate oil glazes which allow underlying colours to appear beneath. However, German colour theorist Josef Albers' contests such within his seminal book Interaction of Colour, wherein he describes how to create the illusion of transparency through the usage of opaque colours.

Ultramarine
A brilliant blue with a red cast, the name of such is drawn from the Latin ultramarinus, "beyond the sea”. Made with ground lapis lazuli, the source of the finst ultramarine was from a single mine in Afghanistan, the name was lent by the Venetians, who remained the mineral’s chief importers. In the 15th century, a technique to further purify ultramarine into a deep blue appeared; grinding such finely, then heating with kaolin, soda ash, sulphur, and charcoal, before collecting the precipitate, making such even more expensive. Ultramarine was first synthesised in 1828.

Underdrawing
The preliminary outlining of a composition on a primed support. The underdrawing provides a guide or outline for the artist during the application of the paint layers. Sometimes such remains visible intentionally or not, or later reappears after the work is completed.

Umber
Named after Umbria, umber is a natural brown or reddish-brown earth pigment that contains iron oxide and manganese oxide. Naturally occurring, such is known as raw umber; when calcinated, the colour becomes deeper and is termed burnt umber.

Value
Describes the relative lightness of a colour compared against the grey scale occurring between pure white and black. Used as one of the three dimensions in the Munsell colour system. See Chroma, Hue.

Van Dyke Brown
A pale brown to brown-black pigment, such was an important artist's colour from the 17th throughout the 19th centuries. Named for the Flemish painter, Anthony van Dyck, on account of his extensive usage of the colour, the hue was first made from peat and soil, but is now made from a combination of black asphalt-like pigment and iron oxide. Also known, variously, as Cassel, Cologne or Verona brown, showing that it had no fixed source or recipe.

Varnish
A coating applied to the surface of a painting as a finishing. Such serves a dual function; visually affecting the painting’s appearance by providing a uniform surface for the reflection of light, and also acting as a protective coating. A variety of materials have been employed as varnishes: waxes, tree resins, fossil resins, oil/resin mixtures and synthetic preparations. Varnishes tend to darken and discolour over time, regularly necessitating removal and replacement.

Verdigris
From the French, "green of Greece"; a slightly blue-green pigment made by removing the patina from oxidised copper exposed to air or seawater over a period of time, after the application of acetic acid. One of the oldest manufactured pigments, such was introduced by the ancient Greeks. Until the 19th Century, verdigris remained the most vibrant green pigment available, frequently employed within painting. Lightfast in oil paint, but not in other media, verdigris darkens into brown’s hues with time’s passage.

Vermilion
A bright red or scarlet pigment made from cinnabar, a naturally occurring form of mercuric sulphide, such is also the name of the resultant colour. An important pigment in pre-classical times, vermilion rendered a bright red. Also produced synthetically by heating mercury and sulphur (beginning c. 1785), such tended to discolour to a purple-black, yet remains relatively stable within oil paints.

Volume colour
The appearance of colour penetrating a medium, as in coloured transparent liquids or plastics. Watercolours are considered such on account of the fact that they possess the appearance of being transparent, deepening in tone as more layers are applied, as are tinted resins.

Warm Colours
See Colour Temperatures.

Woad
A European flowering plant of the mustard family whose leaves yield a blue dyestuff. A primary natural source of dark blue colouring, woad was known to the ancient Britons of the first century, who utilised such as a war paint with which to stain their flesh blue. Such was eventually replaced by the stronger Indigofera tinctoria (true indigo), and eventually, synthetic indigo.

Yellow
One of the primary colours, yellow is also one of the most visible. Often used as a substitute for gold, long before such was synonymous with assorted sun gods, yellow came to signify warmth and vitality in medieval stained glass. Also known as the colour of jealousy, yellow, from ochre, has always been a naturally available pigment; the prevalence of such widening in the 18th century with the development of the lemon yellow chrome-based pigments, notably Turner's yellow. Important yellows include cadmium yellow (1817), antimony, orpiment, lead-tin yellow, and aureolin (see Cobalt). See Primary.

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p. 10 — The materials collection cabinets, containing the Forbes Pigment Collection, may be seen from many levels within the Harvard Art Museums. Photo: © Nic Lehoux.

p. 15 — Portrait of Edward Waldo Forbes, undated. Photographs of the Harvard Art Museums (HC 22), folder 3.185. Harvard Art Museums Archives, Harvard University, Cambridge, Massachussetts. Photo: Imaging Department © President and Fellows of Harvard College.

p. 16 — Edward Waldo Forbes with students in gallery. Photograph by George S. Woodruff, 1944. Fogg History Photographs, International News Photos, folder 1. Harvard Art Museums Archives, Harvard University, Cambridge, Massachusetts. Photo: Imaging Department © President and Fellows of Harvard College.

p. 22 — *(top)* Unrolling Rothko murals, Courtyard, Fogg Museum, 1987. Photographs of the Harvard Art Museums (HC 22), folder 1.636. Harvard Art Museums Archives, Harvard University, Cambridge, Massachussetts. Photo: Imaging Department © President and Fellows of Harvard College. Artwork: © 1998 Kate Rothko Prizel & Christopher Rothko / Artists Rights Society (ARS), New York.

(bottom) Marjorie B. Cohn, Gregory Smyrlian, Rhoda Burden, and Jean Lampton hanging Panel One, Rothko Mural Installation, Holyoke Center. Photograph by Elizabeth Jones, January 1963 © 2009 Kate Rothko Prizel and Christopher Rothko / Artists Rights Society (ARS), New York. Photo: Elizabeth H. Jones, © President and Fellows of Harvard College. Photographs of the Harvard Art Museums. Harvard Art Museums Archives, Harvard University, Cambridge, Massachussetts. Photo: Imaging Department © President and Fellows of Harvard College. Artwork: © 1998 Kate Rothko Prizel & Christopher Rothko / Artists Rights Society (ARS), New York.

p. 23 — *(top)* View of the triptych, Rothko Mural Installation, Holyoke Center. Photograph by Elizabeth Jones, January 1963 © 2009 Kate Rothko Prizel and Christopher Rothko / Artists Rights Society (ARS), New York. Photo: Elizabeth H. Jones, © President and Fellows of Harvard College. Photographs of the Harvard Art Museums. Harvard Art Museums Archives, Harvard University, Cambridge, Massachussetts. Photo: Imaging Department © President and Fellows of Harvard College. Artwork: © 1998 Kate Rothko Prizel & Christopher Rothko / Artists Rights Society (ARS), New York.

p. 23 — *(bottom)* Narayan Khandekar, senior conservation scientist, Straus Center for Conservation and Technical Studies, Harvard Art Museums, holding up a white card which shows the digital projection on Mark Rothko's Panel Four in the exhibition Mark Rothko's Harvard Murals, on display at the Harvard Art Museums November 16, 2014–July 26, 2015. © 2014 Kate Rothko Prizel and Christopher Rothko / Artists Rights Society (ARS), New York. Photo: Peter Vanderwarker, © President and Fellows of Harvard College. Artwork: © 1998 Kate Rothko Prizel & Christopher Rothko / Artists Rights Society (ARS), New York.

p. 26 — *(top)* Rutherford John Gettens in conservation lab, Fogg Museum, circa 1950. Conservation Department History Collection, box 9. Harvard Art Museums Archives, Harvard University, Cambridge, Massachussetts. Photo: Imaging Department © President and Fellows of Harvard College.

p. 26 — *(bottom)* View from the northeast of Hunt Hall ("Old Fogg"), undated. Photographs of the Harvard Art Museums (HC 22), folder 2.46 [1/7]. Harvard Art Museums Archives, Harvard University, Cambridge, Massachussetts. Photo: Imaging Department © President and Fellows of Harvard College.

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ABOUT THE BOOK'S DESIGN

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