ARSENIC

"Arsenic" - the poison that made the Borgias famous (not really...)
known to Dioscorides as "spodos", 1st C. AD

Found in nature as:
Realgar, AsS (orange to red sulfide), insoluable in water. period pigment

Orpiment As_2S_3 (yellow sulfide), insoluable in water, period pigment, oxidation product of realgar

both are poisonous, both were used (rarely) as poison, fatal in doses less than a tsp

D. Thompson mentions the use in Ren. Italy of the As sulfides as preservatives

Arsenic the poison is arsenious acid aka white arsenic aka sublimed arsenic, As_2O_3 (arsenic trioxide)

recipe to make: roast arsenopyrite (AsFeS) or one of the arsenic sulfides to make arsine gas, then collect the sublimate as it condenses, which will then be As_2O_3

If the arsenic sulfides are (according to everyone from Dioscorides to Argicola) roasted too long, you get the metallic form of arsenic, for which they had little use (metallic arsesnic is insoluable in water and therefore not useful as a poison or as a ancient or period medicine - it was considered worthless in period).

Fatal Dose for arsenic trioxide: between 5 to 50 mg/kg
Blyth documents fatal doses of 0.13 grams (~ 1/4 tsp)

Acute symptoms:
first symptoms show up in first 1/2 hour, death occurs after an hour to up to several days.

"Gastric Fever" symptoms common, i.e. gastric distress, esophageal pain, vomiting, bloody diarrhea, cold clammy skin, drop in BP, convulsions, coma , death via circ. failure

Chronic symptoms: jaundice, headache, dizziness, paralysis, conjunctivitis, burning extremities, numbness, rashes, hair loss, liver damage, weight loss, GI problems (see acute).

Secondary mode of poisoning: skin adsorption
symptoms -
acute: skin dematitis and ulceration, bleeding stomach lining
chronic: ulceration, GI problems, skin and stomach cancer

A cut or scratch that gets orpiment or realgar in it will not heal quickly, is subject to necrosis and ulceration (something to be aware of if you are thinking of using either as a pigment)

Arsenic Wierdnesses:

1. Arsenic has been given to horses on and off in history, to make them foam at the mouth (considered fashionable at times) and to make their coats glossy

2. arsenic used to be eaten by people in Styria (eastern Austrian Alps) for their health, to the tune of a quarter to a half a gram a day (ie, twice to four times greater than Blyth's estimated fatal dose (arsenious acid is a CNS stimulant - analogous to a poisonous pick-me-up)

LEAD

Lead, Pb   Latin: "plumbum"
NOT a common medieval poison, but was a known and acknowledged occupation hazard

PbO "litharge", also "massicot", fatal in doses less than 50 mg/kg

PbS Galena, common ore of lead, fatal in doses less than 50 mg/kg

$Pb(C_2H_3O_2) \cdot 3(H_2O)$, "lead acetate", also "sugar of lead" Tastes Sweet - which is why lead acetate-based white paint is so attractive to kids. Fatal in doses less than 50 mg/kg. Lead sulfate has a similar estimated fatal dose. Used to be common in white house paints, by itself or as an adulterant in lead white (lead carbonate)

$2PbCO_3 \cdot Pb(OH)_2$ "basic" lead carbonate, ; "lead white" This is the modern artists' white lead pigment; fatal in doses less than 50mg/kg

50 mg = ~ one to two "pinches of salt" in volume; 1 kg is 2.2 lbs - so if you do the math (and even if you don't), that's ~22.7 mg/lbs. A woman of small statute and bone structure weighing 100 lbs (45 kg) would have to consume ~2 grams (~4 tsp) of lead acetate, lead carbonate or lead sulfate to effectively commit suicide...

Acute symptoms of most lead poisoning: intestinal and liver inflammation and damage, convulsions, pale to white skin, CNS degradation (the exceptions to this rule are the lead arsenate compounds, which are very rare so we aren't really worrying about them as period poisons). Almost no one dies of acute lead poisoning accidentally, even during ancient and medieval periods - because you'd really have to go out of your way to get 4 or more tsp in you

People who get lead poisoning almost always get it from chronic exposure, which means exposure on the job, or exposure environmentally due to natural or man-made sources. As an occupational poison, the effects of lead poisoning were known to Dioscorides, Pliny, Agricola, etc.

Chronic symptoms:
"lead line" - blue line in gums just below teeth
"lead palsy" aka "wrist drop"
Gout
CNS effects, which are ***permanent***, children most susceptible; residence time in kidneys, 7 yrs; residence time in bones and liver, 32 yrs. Occupational lead hazards are fumes from foundry operations, smelting and assay; and fumes and dusts from making lead white pigment, or from removing lead white house paint. The classic example of environmental poisoning of toddlers is from eating sweet-tasting lead white paint chips which are flaking off in an old building.

(Blyth (1907) documents case of a man who died after working 4 days making lead white - which is really really fast for a lead-poisoning death)

MERCURY

Mercury, Hg greek: hydragyros "living silver" aka "quick silver" (as in the quick and the dead)

NOT a medieval criminal poison, was a known ancient and period occupation hazard

HgS - cinnabar - common ore of mercury (named so by Theophrastus in *On Stones*, the western world's first mineralogy text)

both elemental Hg and HgS are water and lipid insoluble - not considered to be really very toxic (if ingested, they tend to exit the other end in less than 2 days usually)

How to die of Hg poisoning in period: inhalation of Hg fumes (mining, smelting, metalworking and jewelry making, pigment production)

Acute symptoms: metallic taste, stomach upset, salivation, respiratory problems, death by resp. failure

Chronic symptoms: gingivitis, loose teeth, blue line in gums, CNS (permanent)

The blue line along the gums is a classic symptom for both chronic mercury and lead poisoning. But before you think that this is the case for the heavy metals, chronic copper poisoning causes a green line instead.

Poisoning by skin contact with fumes and Hg compounds:
chronic: depression (CNS effect), insomnia, weight loss, headache, loose teeth, tremors - so even if you could avoid breathing the fumes, you'll still get poisoned by absorbing the fumes through your skin.

fatal dose, less than 5 mg/kg for soluble mercury compounds (ingestion); lethal inhalation dose is even smaller

TARTAR EMETIC

$KSbC_4H_4O_7H_2O$ - Tatar emetic, aka antimony potassium tartrate (this is its modern name, period name ??? This really isn't an inorganic, but it was well know in period and was made from the common inorganic ore of antimony. I haven't had the chance to figure out which chemical described in Basil Valentine's *Triumphal Chariot of Antimony* is the tartar emetic)

Tartar emetic was a favorite of Catherine di Medici; it's also attributed to the di Borgias

To make tartar emetic (likely process): roast stibium (modern stibnite, SbS) [in period this was almost always done to stibnite in order to purify it, ie to drive of impurities by sublimation, since Hg and Pb and As can all be present in the raw ore], then mix with the "lees of wine" (the tail end product of wine making) and cooked [the "lees of wine" are made up of a large proportion or tartaric acid, which occurs naturally in grape vines]

accute symptoms: metallic taste in mouth, otherwise see symptoms for "gastric fever"; i.e., tatar emitic is an arsenic copycat in symptomology

Cadmia,

Cadmia candidates are:
1. zinc blende or calamine (smithsonite, zinc carbonate)
2. zinc sulfate pentahydrate, aka (modern) goslarite, "white vitriol"
3. combination of zinc and copper sulfate hydrates
4. a combination of zinc, cobalt and/or cadmium sulfides ???

Few words are as confused in period as cadmia, which was recognised as an occupation poison in the mining and chemical trades in period. The soluable salts (ie the sulfates) were known to eat clothes and shoes, and also to cause lung disease; cadmia "dusts," likely the sulfides, were also ecognized to cause lung disease.

Cobalt

Cobelt, Kobalt (spelling varies by time and place)
Kobalten (pl.; orig. is Germ.) were evil spirits in the mountains, also name attached to arsenical cobalt sulfides

Modern cobalt was the period "zaffre" used to make cobalt blue (a ceramic and glass color). "Venice glass" in the Renaissance was made with zaffre.

Period Sources (resources that period people would have used):

Albertus Magnus, *The Lapidary*, 13 Century (St. Albertus Magnus was St. Aquinas's mentor)

Basil Valentine, *The Triumphal Chariot of Antimony*, late 15th century. An extremely cool book. Valentine discusses beneficial medical doses vs. toxic overdoses - thus anticipating by 4 centuries one of the fundmental axioms of toxicology.

Dioscorides, 1st Century AD greek doctor, wrote book on medicines and poisons, first recognised As trioxide as a caustic, depilatory, poison; also recongised poisonous nature of copper sulfate pentahydrate, copper oxides, PbO

Georgius Agricola, early 16th Century, *De Re Metallica* Both Agricola's text and the Hoover&Hoover annotation of the text discuss the poisonous nature of cadmia and Kobalt.

Pliny's *Natural History* (commonly available in period after 1469, the date of the Venice edition). Pliny the Elder, *Natural History*, Volume 9 (Books 33-35), trans. By H. Rackham, 1958, Loeb Classical Library/Harvard University Press, 430 pp., ISBN 0-674-99433-7. Pliny was really into medicines, and discusses all sorts of medicines and poisons scattered throughout the text. Since these aren't gathered in one place, it is a pain in the you-know-what to find them

Theophilus, *On Divers Arts* (*De Diversis Artibus*), trans. by Hawthorne, J., and Smith, C., 1979, Dover Publications, 216 pp.

Theophrastus (a student of Aristotle), *De lapidibus*, trans. by Eichholz, D. E.,1965, Clarendon Press (Oxford), 141 pp.

Misc.:
Big period organic poisons: hemlock, aconite (yellow flower or blue flower around Mediterranean; assoc. with the medieval theatrical [ie, morality play] treatment of Pontius Pilate), nightshade, hensbane; mandrake; etc

Other Poisons Refs:

Half-way decent toxicology web site:atsdr1.atsdr.cdc.gov (it used to a lot better, but obviously someone at CDC decided to make it more user-friendly (i.e., to "dumb it down", with the result that the contents have been vastly diluted).

Blythe, 1907 and 1920 editions of *Poisons*, London, page count varies. Blythe was one of the pioneers of occupational and forensic medicine, and toxicology. His books are historically important enough that most med schools still keep Blythe on the shelf.

Gettens, R., Kuhn, H., and Chase, W., "Lead White," 1993, in: Roy, A., Ed., *Artists' Pigments, v. 2,* Oxford University Press, pp.67-81.

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Thompson, D. V., 1956, The Materials and Techniques of Medieval Painting, Dover Publications.

Paranoid About Pigments: Mercury-Based Colors

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this article originally appeared in Divers Ars (an A&S newsletter in the Midrealm), 1997. This a revision (really slight - I fixed some grammar, and have removed some of the discussion of cinnabar in Moslem Spain until I can hunt down the source of that information so I can cite it properly). Permission is granted to copy this article in its entirety for personal use or free distribution to members of the SCA and other historical living history groups; feel free to fix spelling mistakes; otherwise all rights are reserved.

Much has been written in the last few decades on the toxicity of various pigments, especially ones of historical interest. For the non-specialist, the information available is often confusing (to be charitable) or alarming (to be blunt). The technical literature of toxicology is incomprehensible to anyone without a background in science. The various "safety" publications for artists and other non-science professionals is often alarmist, non-specific, and implicitly condescending. In the art-safety literature, the lack of specific information on various "toxic" substances is annoying, especially when a reader could make a better evaluation of the hazards if a just little more honestly-presented material were available.

This is an article on the toxicology of mercury compounds in historical artists' pigments. And now I must make the usual sort of disclaimer, that regardless of what I write, what you do at home with your own choice of poisons is your own responsibility. I'm not going to tell anyone to handle their pigments other than safely. The smartest thing to do is NOT use mercury compounds in your home at all. Admittedly, real vermilion is one of the most fabulous colors ever made into paint, but the risks of handling mercury are quite real. Unlike a lot of art-safety publications, here is some specific information on how you can poison yourself and your family by painting with mercury pigments.

The Face of Modern Mercury Poisoning

The scariest photograph I've ever seen is in a monograph on mercury hazards published by the World Health Organization. In it, a Japanese family is gathered in their best clothes, western suits and kimonoes, for the coming-of-age ceremony of a young woman born with Minamata disease. The family members, 30 or so people, stand or sit for the photo, smiling for the camera. In the center of this group, the patriarch of the family sits with the teen-aged Minamata victim on his lap. He is beaming as if this were the happiest day of his life. His arms circle the girl, holding her up. Her bones are malformed and it is obvious in the photo that she can not sit in his lap without his help. Her hands have the appearance of late-stages of chronic rhumatoid arthritis, stiff and claw-like. Her eyes do not meet the camera because she can not turn her head. Her facial structure is deformed so her face is a cypher. No sign of emotion or intelligence is here to be read: Minamata disease robs its victims of most voluntary motion. In Japanese culture, this is one of the most important days of her life; and here she is, in her silk kimono, physically unable to smile. This is the worst of what chronic mercury poisoning looks like.

In general, there are two flavors of mercury: organic and inorganic. The organic methylated mercury compounds are mostly a product of modern industrial chemical plants. The chlorine-chemical and pulp-paper industries have discharged methylmercury into rivers, lakes and oceans as part of their waste. This practice is now illegal in many places, like the United States and Sweden, but remains a common practice in other industrial countries.

Bacteria in the bottom muds of bodies of water can also methylate mercury, though other bacteria can break it back down. Where both exist together, the rate of methylation is approximately three times faster than its breakdown by bacterial organisms. Since the methylation reaction is faster, methylmercury will accumulate in underwater environments.

Methylmercury is stable in most biological environments (e.g., your stomach) and is also fat (lipid) soluble. Fat-soluble means that body fat will suck it up and hold onto it, just like other unwelcome squatters in your body like pastries and ice cream. Unlike the latter, however, methylmercury is highly toxic and can persist in an organic host (e.g., you) for months to years before breaking down. Methylmercury was the causative agent involved in the Ontario, Sweden, Niigata and Minamata poisonings. When people worry about mercury in fish, it's organic methylated mercury they're worrying about.

Inorganic Mercury Compounds

Methylmercury poisoning, also known as Minamata disease, is not what we worry about when handling mercury-based pigments. The mercury in vermilion, mercuric sulfide, is inorganic and insoluable in just about everything except aqua regia. Mercury in the geochemical processes of the earth's surface occurs either as elemental mercury in liquid or vapor form, or as mercuric sulfide, the solid we use as a pigment; other natural mercury compounds are vanishingly rare. Mercuric sulfide and elemental mercury are the least toxic mercury chemicals when ingested, though there are documented cases where people have died after swallowing large amounts of elemental mercury in suicide attempts.

Elemental mercury and mercuric sulfide are highly insoluble, and unlike other inorganic mercury compounds, they are inert in your digestive system when ingested in small amounts. In a matter of days, most of that mercury will exit via the colon. Historically, mercury never had the bad reputation it has today. In fact, in the nineteenth century, mercury compounds were very popular as both patent and prescription medicines. (My very favorite prescriptions are mercury suppositories and enemas; incidentally, Hitler used mercury enemas quite frequently - a classic case of too much roughage).

The true danger of mercury in any form is from mercury vapor. Mercury vapor is the common cause of most inorganic mercury poisoning. Inhaling mercury vapor in amounts greater than 1 microgram per 10 cubic meters is not good for you, especially over a long period of time. One microgram in ten cubic meters of air is 82 parts per trillion by weight; that's not much. Even if you could smell mercury, your nose can not identify that small of an amount. Over a lifetime of painting, that's probably enough to give you chronic mercury poisoning. The death-causing symptoms of both acute and chronic mercury poisoning are basically the same, i.e., kidney failure, often gastrointestinal tract damage and always CNS dysfunction.

Soluble inorganic salts of mercury are highly toxic, as are many other salts of heavy metals. Prior to the invention of barbiturates, mercuric chloride was one of the preferred poisons for suicide. Mercuric chloride was also popular in the nineteenth century as a diuretic and antiseptic.

Mercuric nitrate is extremely toxic, and was the chemical used for making hat felts from the sixteenth through the nineteenth centuries. This compound was used to make felt from animal hairs. Straight hairs like beaver resisted felting, but after treatment with mercuric nitrate, they would curl up and felt easily. Felters were poisoned by the fumes released in the felting process, and the hatters from the fumes released during the blocking process (which uses steam, not mercury - the steam however would volatilize the elemental mercury out of the felt, which hatters then inhaled). Mercuric nitrate was also popular in the nineteenth century in topical medicines, notably in itching ointments and muscle liniments. Most of these medicines have thankfully vanished from the modern pharmacopia.

Mercury in Pigments

There are two different mercury compounds used in historic or modern pigments: mercuric sulfide (HgS) and mercury sulfate hydrate ($HgSO_4.2H_2O$). The latter was rare; it was extracted from the roots of an East Indies plant, Operculina turpethum. Bright yellow in color, it was a fugitive color in painting and turned black with little provocation. Mercury sulfate hydrate was sold as "turpeth mineral" or as "mercury yellow" during the nineteenth century, when most synthetic pigments were unpopular because of their impermanence. It was also overused in England as a veternary insecticide, where an overdose would kill the animal as well as the bugs. It is no longer used in art or veternary science.

Mercuric sulfide is the other mercury pigment. The Cathaginians mined the greatest mercury deposit on earth, at Almaden in modern Spain. After the Roman takeover of Carthage's colonies, the Romans continued to mine the deposit. They called both the river near the mine and the mercury ore found there "minium." "Minium" is the word the Romans used for both hematite red and mercury red. Back in Roma proper, in the 2nd century BC, mercuric sulfide as "minium" replaced iron oxide as the paint on the imperator's face in his triumphal parade. In those days, the grade of mercuric sulfide coming out of the ground at Almaden was still very red and easily seperated from its host rocks.

The christianized Visigoths who conquered Spain during Rome's decline continued to work the Almaden deposit. Other mercury deposits existed in the world, notably in Asia Minor, but Almaden was bigger, better, and well-linked by water to ports in the western Mediterranean, the Bay of Biscay, and north to Ireland. When Spanish mercuric sulfide was unavailable, however, artists substituted lower-grades of cinnabar from Brittany, Tuscany and Dalmatia. Lower grades of mercuric sulfide are often stained by tarry hydrocarbons which are ubiquitous at almost every mercury deposit in the world; the color of this ore tends toward a muddy brown-purple. This stuff is just fine for making quicksilver, but as a pigment it's a loser.

Illuminators began to adultrate their muddy-purple minium with the scarlet-colored lead oxide, Pb_3O_4. As the supply of pigment-worthy mercuric sulfide dropped and the price went up, red lead took up a larger percentage in the composition of minium. In the fullness of time, minium became the name for red lead. Sometime around the year 1000, someone had the bright idea to recombine the two elements of mercury ore, mercury and sulfur, back into a pure product without the impurities common to mined ore. The result hit the growing gothic art market as vermilion, which is still its name today.

The process of combining mercury and sulfur to make vermilion is described in Cennini, Theophilus, and many other medieval recipe books for pigments. Basically, you put the chemicals in a vessel and loosely cover it. Then you cook it over low heat. First, the sulfur will vaporize and exit the vessel as a yellow smoke; when this happens, you cover the vessel for real or you will oxidize the sulfur into SO_2 instead of combining it with the mercury. After a little more time, a red smoke will make its way out of the covered vessel. This is a fume of HgS, whose presence tells you that your vermilion is done. Take it off the fire, let it cool and then grind it up. Sometimes the finished product appears black on the surface: that's a small amount of metacinnabar, a rare black cubic form of mercuric sulfide. It is easily removed by rubbing it off prior to grinding.

As an exercise in paranoia, let us follow some mercuric sulfide from the mine to the painting and examine the hazards along the way. We'll assumed our mercury ore is hosted in carbonates, which is the case at some small mines in Arkansas and Nevada. The mineral calcite, calcium carbonate, is relatively soft: you can scratch it with a quarter or a penknife. The modern mineral cinnabar, our friend mercuric sulfide, tends to be very crimson when hosted in calcite. You can spot it easily - it's very heraldic, color on metal. We could make Roman minium easily by breaking the rock up into gravel-to-sand-sized pieces and then picking the cinnabar out. Once we had enough cinnabar to grind, we would do so and find that it changes color into a rich scarlet. This color change from crimson crystal to scarlet powder is one of the diagnostic properties of cinnabar, and every undergrad in my mineralogy section had better remember it for the lab final.

The hazard in breaking and grinding is the dust we'd make and the vapor we'd release. The dust isn't that big a deal if we swallow a little, though it'd be good to avoid doing so. But it is a problem if we breath it: HgS gets stuck on mucus where it can take its time and break down to S^{--} and Hg^{++}. Hg^{++} does not pass into the blood from the lungs as easily as elemental Hg, but it will do so eventually, if you haven't coughed it up first.

The vapor, of course, is the real problem. By breaking and grinding, we increase the surface area of exposed HgS, which can then produce more Hg vapor, and we provide the mineral with heat from friction, which encourages vapor production. We can reduce the heat of friction by grinding under water, but that doesn't solve the problem of first breaking the ore up into smaller, grindable pieces. To be truthful, it's a fact of life that just being near a mercury mine is a hazard, because mercury ore is always giving off vapor, crushed or not. All mercury deposits host some elemental mercury in the ore. There is no such thing as a mercury ore without identifiable native mercury in it. I have looked at hundreds of cinnabar samples under low magnification (typically 10X to 40X) and have seen beads of elemental mercury on almost every one of them. Here's the really bad news: cinnabar can release mercury vapor all by itself; all it needs is a warm sunny day in the summer. Cinnabar is one of the few minerals which is photosensitive; along with tourmalene, it will fade on a timescale of decades if exposed to light. Unlike tourmalene, cinnabar releases mercury vapor as it slowly fades in color from a bright red (assuming it's a quality sample) to a dull red-brown. There's another way we could separate the cinnabar from our calcite: we can dissolved the calcite in dilute (10%) hydrochloric acid. There's no indication that anyone did this historically, nor is this a modern method of processing mercury ore. But for small samples, it's quick and very easy. It also releases mercury vapor, and as an added bonus, chlorine gas too!

Now you know about making your own Roman minium, along with producing your own mercury vapor hazard while you work. It doesn't take a large brain to realize this isn't something you want to do in your kitchen. We haven't discussed the proper disposal of the acid, if you opt for the hydrochloric separation technique, but that's a whole new topic which really requires its own article. Trust me, you don't want to be doing this in your kitchen.

We've already discussed combining mercury and sulfur to make vermilion, but let's talk for a moment about making that vermilion "from the ground up." First we need some sulfur, which is actually relatively easy to find. It precipitates from vapor at many volcanically-heated hot spring deposits in the western USA, like the Sulphur Bank Mine Superfund Site in California; it forms on top of salt domes in Michigan, Oklahoma, and Texas, where it is hydraulically mined; and it is sold still in many drug stores as "flowers of sublimated sulfur, USP grade."

Now we need some mercury. We can make mercury by mining the ore, crushing it and then roasting it in a retort. The retort needs a condensing tube arrangement to collect the liberated mercury vapor and condense it into liquid which we can then collect. On a small scale, an alembec will do nicely.

Finding an alembec, however, is not exactly easy or cheap. Needless to say, making our own elemental mercury releases a lot of nasty vapors. We have previously discussed the process of making the vermilion, so we won't repeat that since you already know about the vapors produced there. The only thing left which we haven't discussed is painting with our pigment.

Compared to mining, milling and producing Roman minium or medieval vermilion, painting with mercuric sulfide is a breeze. The hazards are dust production when mixing the pigment with its medium, and vapor production while the powdered pigment is exposed to warm air in its opened container. The recommended medium for mercuric sulfide pigment is glair. Glair forms a film impervious to air when it dries, so mercuric sulfide paint made with glair is not a vapor hazard. Glair can be a such good sealant around mercuric sulfide that in some medieval illuminations, the hexagonal-structured red HgS has altered in place to the isometricly-structured black HgS polymorph called metacinnabar. If there had been exchange with the atmosphere, the color would have browned, not blackened.

How much exposure is harmful? That's a hard question - most toxicity ratings are based on statistical studies. Here are some numbers which might give you a clue:

The United States Occupational Health and Safety Agency ("OSHA") lists a permissible 8-hour time-weighted average ("TWA") exposure to mercury in the workplace (assuming a 40-hour work week) of 1 microgram per 10 cubic meters.[1] By comparison with other toxic heavy-metal fumes, OSHA 8-hr TWA's for cadmium, inorganic tin, and copper are 100 micrograms per cubic meter, 2 milligrams per cubic meter and 0.11 milligrams per cubic meter respectively (these number are always subject to change).

Mercury vapor is obvious a lot more potent. In the bad old days before modern mining safety, the average career of a nineteenth-century Californian mercury miner was five years before his health was ruined. The California state mineralogist noted in the 1880's that the only people who would work in the mercury mines were Mexicans, Chinese, drunks and a few Irish who didn't know any better.[2] In the modern world, mining safety is a priority at the nationalized Almaden mine in Spain, still in production and still dominating the world mercury market for the last 2500 years. The average career of a Spanish mercury miner is fifteen years, even with occupational health monitoring and modern safety equipment.

Inhalation is the primary hazard when working with mercuric sulfide, but ingestion shouldn't be entirely discounted. Here's

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[1] These are 1997 numbers. These sorts of regulated numbers can and do change all the time. Check with your favorite environmental agency if you really want the most recent figures…

[2] Any state employee making a statement like that today would get instantly fired!

some data from known mercury poisonings involving a selection of ingested mercury compounds. Mercuric chloride is lethal in doses as small of 0.19 grams. Mercury nitrate is lethal in doses as small as 1.9 grams. Turpeth, the mercury yellow pigment no longer in use, is lethal in doses as small as 2.6 grams. One reported case of elemental mercury poisoning happened when a pregnant "girl" swallowed 4.5 ounces of the liquid metal in an attempt to induce abortion. (Remember that there are 28.4 grams in an ounce.) I'm sure there are cases of people killing themselves from swallowing mercuric sulfide, but I've not found any documented - this doesn't mean that there aren't some, it merely means I haven't found them yet. I suspect that lethal doses for mercuric sulfide are even larger than elemental mercury, since it has to break down first and the mercury ionized to Hg^{++} or it won't go anywhere other than out the body's back door.

Ingesting insoluble elemental mercury and soluble mercury already dissolved in drinking water are two different things. It is very very very hard for mercury to go into solution in water; but once it does so, it's then available to invade your body through your digestive system, just like the mercury in the soluble mercury salts. The most sensitive maximum contaminant level ("MCL") enforced by the United States EPA is for dissolved mercury in drinking water. This MCL is 2 parts per billion.[3] In terms of drinking water supplies, however, dissolved mercury really wants to be mercury vapor instead, and given half a chance will escape its watery prison into the atmosphere. The good news is that mercury in drinking water wants to be elsewhere; the bad news is that the place it really wants to be is in the air we breath.

Now it's time for last words, and these you should pay attention to, especially if you have pets or children. It is a well-known fact in toxicology that what's not toxic for an adult can be lethal for infants, children, and small pets. This is poignantly true for the heavy metals, which include lead, arsenic and mercury. If you want to be stupid and poison yourself with toxic chemicals in own your studio, that's your business; but don't do it to your loved ones at home - that's just plain wrong.

My advice about vermilion? Buy a reputable brand of non-mercury-based red paint in a tube instead.

References available upon request

Original version published 1997
Revision 2001

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[3] Again, these are 1997 numbers