INDUSTRIAL MEDICINE

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This magazine is published to promote sound thought upon and concerning industrial medicine and traumatic surgery. To that end it will contain articles, news items, reports, digests, and other presentations, together with editors' comments. The editorial policy is to encourage frank discussion. On this basis contributions are invited. The editors will exercise care in checking on the accuracy of data printed but in all other respects articles and opinions of which expression is allowed are the opinions of their authors—the editors reserving in all cases the right to comment on the same in the current or any subsequent issues as they may be inclined.

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Silica Bearing Dust

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THE significance of silica bearing dusts in industry depends entirely on the degree of harmful exposure offered to workers during the course of their daily occupations. The most important consideration in any occupational hazard is, *"How does it affect the man?" The amount* of silica in a material used, the degree of contamination of the atmosphere or the percentage of silica in a dust sample, is of less consequence than the number of finely divided particles that actually reach the alveoli or small air sacs of the lungs.

Dusts produced from substances containing silica consist of particles of various size but only those below three microns in diameter (a micron is 1/25,000 of an inch) are believed to be dangerous. This means that most of the "visible" dust is not of as much concern as the particles which are not seen by the naked eye. With this in mind, an appraisal of the silica bearing dusts from the viewpoint of jobs which offer significant exposure or a potential hazard would appear to be more meaningful than a simple listing of dusts which contain silica.

Silica or silicon dioxide (SiO_2) is the most common ingredient (60%) of the rocks and minerals which make up the earth's surface. It exists in two forms, *free* and *combined. Free* silica means that the silica is not combined chemically with other substances. *Combined* silica means that the silica is united with certain mineral oxides to form silicates such as mica, clay, asbestos, etc.

As far as is currently known only free silica can cause silicosis but all dusts which contain silica are not necessarily harmful. Silicosis is likely to result only where there is sufficient exposure to dust which contains respirable sized particles of free silica (especially below three microns) over long periods of time (two to 25 years—average 10).

As generally applied, the term *free silica* means quartz but there are many varieties of quartz as well as other forms of free silica.

FORMS OF FREE SILICA

Crystalline (Definite crystal structure)	Cryptocrystalline (Crystal structure too fine to be easily distinguished)	Amorphous (Non-crystalline)
Cristobalite	Chalcedony	*Diatomite
Tridymite	*Flint	*Silica Gel
*Quartz	Jasper	*Vitreous Silica
	*Chert	Opal
	*Tripoli	

*Of greatest industrial importance

CRISTOBALITE: A crystalline form of silica (free), extremely hard and inert chemically, very resistant to heat. Not used as a raw material in industry, but refractory bricks made from quartz or quartzite are altered to cristobalite by high temperatures to which they are exposed.

TRIDYMITE: Similar to Cristobalite.

QUARTZ: The most common and important form of free silica—occurs as a primary constituent of igneous rocks such as granite and as chief component of sandstone and silica sands.

CHALCEDONY: A cryptocrystalline form of silica—heat resistant and chemically inert—differs from flint and chert in the manner in which it fractures. Used primarily as a decorative material.

FLINT: A cryptocrystalline form of silica similar to chalcedony but more opaque and granular. Usually occurs as pebbles or boulders or as thick beds. Dull white to black in color—used as abrasive flint, potters' flint, semi-precious flint (Agate).

CHERT: A cryptocrystalline form of silica known also as "Hornstone." An impure form of flint used in abrasives and tube mill linings in potteries.

JASPER: A cryptocrystalline form of free silica, similar to chalcedony. Very compact and opaque. Colored by impurities (clay and iron oxide)—polishes well and used primarily for decorative purposes.

TRIPOLI: Generally regarded as cryptocrystalline form of silica. Sometimes confused with "tripolite," a species of diatomite obtained from the island of Tripoli in northern Africa. Tripoli is derived from the decomposition of chert or from siliceous limestone from which the calcium carbonate has been leached. Used as an abrasive in soap and scouring powders, for polishing metals, as a filtering agent, wood and paint filler, foundry parting compound and in the pottery industry.

DIATOMITE (Diatomaceous Earth): An amorphous silica, composed chiefly of minute siliceous skeletons of marine or fresh water plants known as diatoms. It is a light, powdery, earthy material with a fine, uniform grain. Sometimes called "infusorial earth" but this is erroneous as infusoria (small animalcules) are seldom present. Used as a mild abrasive in metal polishes, scouring soaps, dentifrices, nail polishes, but principal use is for insulation, filtering, and a decolorizing agent in the manufacture of glues, metallurgical solutions, paints, varnishes, fruit juices and leather tanning.

SILICA GEL: An amorphous form of silica, it is a manufactured substitute for diatomite made from sodium silicate solution by the action of hydrochloric acid. It is a hard glossy material with the appearance of clear quartz and is used as a dehydration and filtration agent. It is used in refrigeration, oil refining and solvent recovery. Research thus far indicates that silica gel does not cause silicosis but until more is known, it should be considered potentially dangerous.

VITREOUS SILICA: An amorphous silica formed by melting quartz and found in nature only as a mineralogical curiosity (e.g., hollow tubes of vitreous silica formed by lightning striking a bank of sand.) Manufactured in two varieties, "fused silica" or "silica glass" (opaque), and "fused quartz" or "quartz glass" (transparent). The manufacturer's name for vitreous silica is "Vitreosil." It is used largely for laboratory and industrial chemical handling equipment. It may contain 99% of free silica.

OPAL: An amorphous form of silica occurring as the result of decomposition of silicate or siliceous rocks. Other than quartz it is probably the most common form in which free silica occurs. It occurs abundantly in the diatomaceous earths. Used as decorative material and to a limited extent as gems. As found in nature, it is usually high in free silica.

SANDSTONE: These are compacted sedimentary rocks of variable color and consistency. They range from friable to firm, according to the strength of the cement between the grains which are composed mostly or wholly of quartz. Used in abrasives manufacturing, building and construction, quarrying, paint, etc.

QUARTZITE: A metamorphic rock derived from sandstone in which the sand grains are cemented by silica. When a sandstone becomes so firmly cemented by deposition of silica that the fracture takes place *through* the grains of quartz sand instead of *around* them, it has become a quartzite. Used in abrasives manufacturing, filtering media, paint, mineral fillers, quarrying and building.

GRANITE: The most important intrusive (not appearing on the surface) igneous (formed from molten masses) rock. It is composed chiefly of quartz (35%) and feldspar but also contains flecks of mica and hornblende. Used extensively in building and construction work and in the monument industry. Also encountered in mining, excavating, drilling, quarrying, etc.

FELDSPAR: These are the most abundant group of minerals. They make up about 80% of the igneous rocks. They are silicates of alumina with lime, soda or potassium. They are very important economic minerals. Most of the annual output in the U. S. A. is consumed in the ceramic industries. On weathering, feldspar changes to clay (Kaolin).

TALC: A hydrous magnesium silicate. When it is mined it may be accompanied by other minerals such as serpentine, dolomite, and tremolite (see "Rubber Industry").

ASBESTOS: (See "Rubber Industry.")

SILICEOUS DUSTS

Industry	Siliceous Materials Used	Occupations Offering Possible Hazard	Remarks
ABRASIVES			Recent investigation has disclosed a new chest condition known as "Shaver's Disease" in the artificial abrasives industry. The principal exposure is from fumes generated in the processing of bauxite in electric furnaces. The fume contains, among other things, a high (25%) percentage of silica, but the condition is not similar to silicosis and is not thought to be due to silica. The actual causative agent has not yet been determined. Practically all grinding wheels are now free of significant amounts of free silica and hence do not offer a silicosis hazard as is still frequently claimed.
Natural			
Scouring Soaps Polishing Powders Sand Paper Sand Blasting Metal Buffing Polishing	Flint, chert, quartz, quartzite, sandstone, sand, tripoli, diatomaceous earth — finely ground.	Abrasive making, bed rubbing (Stone), sand blasting, buffing, sanding, planing (Stone), mixing, packing, metal polishing.	
Artificial			
Grinding Wheels, etc.	Traces of silica only from vitrified clay in wheels. Most common artificial abrasives are emery (aluminum oxide) and carborundum (silicon carbide).	Bonding department, periodic kiln unloading.	
CERAMIC			Most of the raw materials used in pottery contain silica in the form of silicates and may in addition contain a little quartz. The slip house, clay shop and bisque departments have the greatest silica hazard, with frit makers and glost kiln workers only slightly less.
Potteries Refractories Brick Manufacturing	Feldspar, clay, sand, flint (includes any form of quartz used in ceramic bodies), tripoli, chert, and other amorphous silica.	Making chinaware, earthenware, stoneware, compounding and mixing native clays, grinding and mixing raw materials, crushing, handling, unloading and weighing, glazing, finishing, fettling, kiln operations, making fire brick, silica brick, etc., brick sawing and cutting—furnace operating.	
Glass (ordinary and optical) Tile Electrical Insulators	Pure quartz sand—massive quartz for optical apparatus.		
CEMENT			While the cement industry is a definitely dusty one, investigation thus far has not shown that actual silicosis is a problem. Lung changes as revealed by x-ray show only increased linear markings similar to that caused by other inert dusts.
Portland	Contains 19.86% of silicon *dioxide* (SiO_2) but less than 1% of this is free silica.	No specific silicosis hazard.	

SILICEOUS DUSTS (Continued)

Industry	Siliceous Materials Used	Occupations Offering Possible Hazard	Remarks
CHEMICAL Acid Tower Linings	Massive quartz or quartzite.	Maintenance, lining.	While there is always a possibility of silicosis developing in workers in this group, the incidence is not high as compared to other industries known to have greater exposures. Cases are apt to be more sporadic. They are included however because of the possible hazard.
Filtering Media	Massive diatomaceous earth and tripoli, sand, finely granular quartz or quartzite, finely ground tripoli.	Quarrying, mining (open pit), handling, packing, mixing.	
Manufacture of Sodium Silicate	Pure pulverized quartz sand, pure tripoli, diatomaceous earth.	Charging, slagging, and various manufacturing processes.	
Manufacture of Silicon Carbide	Pure quartz sand.		
Paint	Finely ground crystalline quartz, quartzite, flint, sandstone, sand, tripoli.		
Mineral Fillers (as wood and rubber)	Finely ground crystalline quartz, quartzite, flint, tripoli, and other types of ground silica.		
Fertilizers Insecticides			
CONSTRUCTION	Rock dust, sand, gravel.	Rock drilling, crushing, handling, road surfacing, tunneling, excavating, sand blasting of stone buildings.	Most of this work is done outdoors so that there is less danger of producing silicosis. However, in confined work such as tunneling and rock drilling, the hazard can be great, particularly where operations are conducted in highly siliceous rock.
DIATOMACEOUS EARTH	Crude material obtained from large deposits over centuries, of diatoms or small aquatic plants whose skeletons or shells contain silica. The "needle-like" forms of diatoms have commercial value because of their light weight and fluffiness.	Quarrying, open pit mining, making filters, fillers, absorbents, manufacture of fire proofing material, insulators, packing. Used in paint, rubber, plastic moulding and as absorbent for acids, water and impurities.	Workers exposed to straight diatomaceous earth (not calcined) may show evidence of exaggerated linear markings in chest x-rays similar to that of other inert dusts. This is not true silicosis. In those workers exposed to the calcined diatomaceous earth, fibrosis of the lungs is present but this also differs from the nodular shadows seen in silicosis as nodules are not present. Further investigation is indicated.
FOUNDRY Steel Iron Non-ferrous	Sand used in molds, dust from siliceous parting compounds, mold wash, etc.	Molding, shaking out, cleaning castings, sand blasting, sand conditioning, cupola patching, ladle lining, mulling, sand handling, crane men, gate burning.	Contrary to popular belief, the incidence of silicosis in the foundry is not particularly high. Certain operations such as shaking out and cleaning castings may produce dangerous concentrations of free silica if not adequately controlled. While molding sand may contain as much as 70% free silica, the sand is moist and contains other materials such as sea coal and various binders so that moulding need not be a dusty operation. Parting compounds which used to consist largely of silica flour have been practically eliminated in foundry operations today and replaced by mineral facing materials which are silica free. Sandblasting, once an extremely hazardous operation, is now carried out under hygienic and safe conditions so that it is no longer a dangerous procedure. There is good evidence to show that the nodular x-ray shadows seen in grinders in the foundry industry, while closely simulating those of silicosis, are really due to "siderosis" or the deposition of iron pigment in the lungs. Iron dust of this type is inert, does not cause silicosis, and does not produce disability.
GLASS	See Ceramics.		
GRANITE	See Stone.		
INSULATION	Massive and ground diatomaceous earth. Rock wool.	Manufacture of heat insulation for pipes, boilers, furnaces, kilns, etc. and also of sound insulation in walls and between floors.	See remarks on "Diatomaceous Earth."

SILICEOUS DUSTS (Continued)

Industry	Siliceous Materials Used	Occupations Offering Possible Hazard	Remarks
DECORATIVE MATERIALS Gems Vases Tabletops Statues	Rock crystal, amethyst, rose quartz, citrine quartz, smoky quartz, chrysoprase, agate, chalcedony, opal, onyx, sardonyx, jasper, etc.	Dry cutting, polishing, crushing, grinding.	Semi-precious varieties of siliceous minerals have but *little* industrial use. The increasingly extensive employment of grindstones made of carborundum, copper, iron, box wood, etc., and enforced hygienic measures for eliminating dust through wet polishing and exhaust ventilation, now makes the danger of silicosis comparatively insignificant in this industry.
METAL GOODS AND MACHINERY	Siliceous materials in dust from abrasives, polishing materials, etc.	Grinding, polishing, dressing grindstones (old types).	The hazard from these operations is not great. Most of the comments under "Foundry" and "Abrasives" apply in this instance.
METALLURGICAL	Moderately pure sand, massive crystalline quartz, sandstone, quartzite, chert.	Making silicon, ferrosilicon and silicon alloys of other metals such as copper. Used as a flux in smelting basic ores.	A potential hazard exists in these operations but the industry is not noted as a silicosis producer.
MINING Hard Rock (All types)	Ore-bearing rock having significant percentages of silica. Seams of siliceous rock in ore bodies, or rock (quartz, chert, jasper) containing veins of metal such as gold.	Drilling, blasting, handling, loading, tunneling.	Mining has long been recognized as possibly the greatest source of silicosis of any of the dusty industries. "Miner's Disease" has been known for centuries. Its association with tuberculosis is well established. The degree of hazard is governed by several factors. These include the percentage of free silica in the dust or rock, the number of respirable sized particles of free silica at the breathing level of the worker, the amount of time actually spent in the various dust concentrations. This is true for all highly siliceous dusts regardless of the industry or operation which produces them. As in other industries where a dust hazard exists, modern hygienic control measures have greatly reduced the risk of silicosis in mining.
POTTERY	See Ceramics.		
QUARRYING	See Stone.		
REFRACTORY	See Ceramics.		
RUBBER	Various silicates such as talc, asbestos, kaolin, etc., which may contain some free silica.	Mixing, measuring, weighing, compounding, coating wires, etc.	Silicates other than asbestos are not thought capable of producing fibrosis of the lungs. Asbestos does not cause silicosis as only free silica is responsible for this disease. Asbestos is a hydrated magnesium silicate which may cause an occupational condition known as "Asbestosis" through a more or less mechanical plugging of the small terminal bronchioles and air sacs of the lungs by asbestos fibres. Talc is also a hydrated magnesium silicate and cases of pneumoconiosis or "dust in the lungs" have been reported in the rubber industry from the use of this material. Generally speaking, however, the problem of actual silicosis is not a significant one in the rubber industry.
SMELTING AND REFINING	Various ores containing siliceous material—slag.	Crushing, mixing, furnace charging, handling.	In the iron and steel manufacturing industries, according to a U. S. Public Health survey in 15 states, 11.6% of the workers were exposed to silica dust. This does not necessarily indicate the severity of the hazard but does point out the need for investigation and control.
STEEL MANUFACTURING	Silica containing brick.	Removing ladle linings, repairing furnace walls.	The number of cases of silicosis in proportion to the number of workers in the industry is small. Many cases discovered in routine examinations are found to have resulted from previous occupations such as mining, refractories, etc. Most of the cases which do occur are among masons lining ladles and repairing furnace walls with silica brick.

SILICEOUS DUSTS (Continued)

Industry	Siliceous Materials Used	Occupations Offering Possible Hazard	Remarks
STONE Quarrying Building Excavating Mining Cutting	Granite, sandstone, ganister (quartzite rock) grindstones.	Rock drilling, crushing, sawing, grinding, polishing, handtool cutting, sand blasting, machine surfacing, blasting, handling, tunneling, granite cutting, monuments, carving, masonry.	Like mining, this industry was one of the most prolific producers of silicosis. The introduction of pneumatic tools (1892) greatly increased the exposure to dusts rich in free silica. A number of these operations are carried on outdoors so that dust concentrations are smaller. However, an incidence of silicosis of 25% has been reported from a granite quarry industry. Modern dust control methods now in use are expected to greatly reduce this figure.
TOBACCO	Quartz.	Processing tobacco leaf, hanging, blending, stemming, cleaning.	Recent studies indicate that the inhalation of free silica and insecticide dust may be of significance in this industry. The free silica content of dusts found in processing plants ranged from 22 to 58%. Further investigation is required.
VITREOUS	Dust from siliceous materials used, e.g., quartz, flint, feldspar, finely ground silicates.	Mixing, spray coating, sand blasting.	In the glaze department in potteries, the glaze making is an intermittent operation which exposes a few men to heavy dust concentrations for a few hours a week. Automatic spraying machines and exhaust ventilation are now coming into general use so that this hazard will be eventually controlled.

Industries Using Silica Bearing Materials

Abrasives (Manufacturing)
(Users of Abrasives)
Brick and Tile (Brick Cutters—Sawing)
Bed Rubbers (Stone)
Bisque Kiln Workers
Blasters—Foundry and Steel
Buffers—Polishing
Burners (Foundry)
Burn Filers
Casting Cleaners (Foundry)
Cement Workers (?)
Ceramic Workers (See Pottery Workers)
Furnace Chargers
Charger (Smelting and Refinery)
Chasers (Steel)
Shippers
Clay and Bisque Makers (*Pottery*)
Clay Product Workers (Pottery)
Concentrating Mill Workers
Construction Workers
Core Makers (Foundry)
Crane Men (Iron steel—non ferrous)
Crushermen (Clay and Stone)
Cutlery Makers
Diatomaceous Earth Workers
Drillers (Rock—Stone)
Excavation Workers (Construction)
Fertilizer Makers
Flint Workers
Foundry Workers (Assemble)
Fused Quartz Workers
Glass Furnace Workers
Glass Mixers
Glaze Mixers (Pottery)
Grinders
Grinding Wheel Makers
Insecticide Makers
Insulation Workers
Jute Workers
Masons
Miners
Planer Men (Stone)
Polishers and Cleaners
Pneumatic Tool Workers (Quarry and Mining)
Porcelain Makers (Pottery)
Pottery Workers
Pouncers (Felt Hat)
Quarry Men
Quartz Workers
Road Repairing
Rubber Workers
Sand Blasting
Sanders
Sandpaper Makers
Sand Pulverizing
Surveyors (Stone)
Scouring Powder Makers
Scrapers (Foundry)
Silicon Alloy Makers
Slate Workers
Smelters
Soap Abrasive Workers
Sodium Silicate Makers
Stamp Mill Workers
Statuary Workers
Stone (Artificial) Makers
Stone Masons
Stone Workers
Street Repairers
Subway Construction Workers
Tile Makers
Tumbling Barrel Workers
Tunnel Workers
Zinc Smelters and Refiners

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