**Potentially Hazardous Mine Products in Close Proximity to Some Arizona Highways**

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The cumulative effects of abandoned underground mines in Arizona occurs in both direct and indirect manners. For the highway geologist and civil engineer the first order of concern is normally the relative position of the abandoned underground workings in relation to the proposed infrastructure and there current condition. However the effects of the mining process sometimes are not fully understood at the time of design or construction or are only discovered through the environmental or right of way acquisition process that occurs after the geotechnical investigation is well underway. Occasionally unrecognized conditions are revealed well after construction is started.

Potentially hazardous unidentified mine products in close proximity to construction can inadvertently be incorporated into roadway fill or be exposed in side-hill cuts. Therefore it is suggested that when performing alignment studies in regions that have been previously mined that a closer look into the indirect effects mining on the highway construction process.

The following examples of highway construction demonstrate these types of indirect impacts that occurred well after construction was completed.

**Former Mercury Mining and Reduction Site along SR 51, Phoenix, Arizona**

Mining in the Squaw Peak area developed late in the 20th century in a belt of Precambrian schist and slates that occupies a low mountain pass through the Phoenix Mountains. At that time the nearest community was more than 5 miles away.

The City of Phoenix has gone through exponential growth throughout the past 55 years. It now lays claim to being one of the largest (in square miles) communities of the United States. This modern metropolis had its humble beginning as a farming and merchant community. Rapid expansion of the population base after World War II and the development of the Sunbelt as a desirable retirement destination have led to sprawling commercial and residential growth.

In order to relieve inner city traffic congestion in the early 1990's the Squaw Peak Parkway (SR 51) was constructed north through the central corridor of Phoenix, traversing the Phoenix Mountain Preserve. A four lane divided highway and traffic interchange overpass was constructed in the immediate vicinity of a former mercury mine.
and reduction facility on the western flank of Squaw Peak. This new route now passes through the same mountain pass, which is now named Dreamy Draw. This name is a relic reference to the apparent appearance of a person with intense exposure to vaporized mercury. Today thousands of daily commuters utilizing this route have very little knowledge of the site’s former activities.

**Brief Mining History of the Rico Mercury Property**

Although mercury deposits in the western United States had been exploited for some time, the arid climate and inconsistent metal prices tended to discourage development in the Phoenix Mountains to well after 1916. It was at that time that Samuel Hughes and a few associates located the Rico Group of lode claims on a promising outcrop of cinnabar on the southwestern flank of Squaw Peak. According to Schrader (1918), at the time of his visit to the mine the Rico shaft was open to a depth of “60 feet and a crosscut at this depth showed the principal part of the lode to be 7.5 feet in width.” By 1924 the shaft was 115 feet deep with a crosscut of 100 feet to the west and a 59-foot drift to the south. Most of the excavation work was performed by Mr. Hughes, himself without the use of timber reinforcement. In 1927 Mineral Survey No. 4047 was conducted as a prerequisite to patenting the property. The surveyors’ notes indicated the Rico shaft had approximately the same dimensions as had been excavated by Mr. Hughes.

A transfer of ownership occurred about this time as the property was now reportedly owned by the Quicksilver Corporation of America. It was also reported that the mine workings were being deepened and improved. In 1930 E.W. Hartman confirmed development of the Rico Shaft to 300-foot depth and the erection of a Rotary Furnace and six-unit condenser. In an article published in the Mining Journal Mr. Hartman states:

“...The main shaft of the Rico has been sunk to a depth of 300 feet following the dip of the formation, the shaft has been newly timbered from top to bottom. Prospect drifts have been run on four different levels. On the 70 foot level there is a station cut. On the 100-foot level drifts have been run north and south, the north being 100 feet in length and the south drift 80 feet in length. A crosscut 125 feet into the hanging wall showed another
vein contains cinnabar. On the 200-foot level drifts have been run 40 feet to the north and 30 feet to the south with an east crosscut of 5 feet. On the 245 foot-level a drift has been run to the north for 70 feet and drift to the south for 80 feet in length with a west crosscut of 35 feet.”

“The present inclined working shaft is 300 feet on the vein, or about 135 feet vertically. The vein shows a varied width, five to six feet wide near the shaft collar, 35 feet wide on the 100 foot level, and 26 feet wide on the 200-foot level.”

This represents the last definitive comments on the limits of workings although excavation could have been continuing. In 1933 it was reported that the Rico Shaft and working at the 100 foot level had caved in and although an effort was made to stabilize the shaft it was ultimately beyond the capacity of the mine operators and the property was abandoned.

In an inspection report dated 1935, an adjoining property the Dolores Lode Claim consisted of several small workings and a 105-foot vertical shaft. This shaft referred to as the “Larsen Shaft” is approximately 250 north and 25 feet east of the Rico Shaft. At that time the first five sets of the timbering needed to be replaced.

In 1940 a mine owners report indicated renewed interest in the Rico Group. The new mine owner reported that the Rico shaft was presently only accessible down to 90 feet.

No further information regarding mine development has been discovered. The property apparently went into a state of disrepair and was essentially abandoned for many years. However ever increasing real estate values for commercial and residential property started to lay a new claim to the property. Luxury homes and vacation resorts began chipping away at the boundary of the claims. For many years two city routes, Northern Avenue and 19th Street bisected the mine property. It was at this time that the character of the property began to merge with the rest of the City of Phoenix. In 1991 a scattering of hillside mine openings and waste dumps associated with the concrete foundations for the former mercury processing equipment, punctuated the entrance to Dreamy Draw Park and the Phoenix Mountain Preserve.

An archeological investigation of the new state route documented the position of the former mining infrastructure and identified the position of the ore dumps that still were not completely processed nearly 60 years after they had been removed from the Rico.
and Larsen shafts. However the original claim boundaries and dimensions of the Mineral Survey have been preserved in the construction drawings for the new state highway.

**Some Properties of Mercury**
*Abstracted from the Handbook of Chemistry and Physics.*

Mercury is the only common metal liquid at ordinary temperatures. It only rarely occurs free in nature. The chief ore is cinnabar (HgS). The commercial unit of mercury is the flask that weighs approximately 75 pounds. The metal is obtained by heating cinnabar in a current of air and by condensing the vapor. There are many everyday products that use mercury. It has been used in thermometers, barometers and diffusion pumps. It is also used to make mercury vapor lamps and advertising signs, it is also used to make mercury switches such as temperature rheostats and temperature control devices. One of the most common uses of mercury is for dental amalgam. Mercurous chloride formally received wide use as the cathartic “calomel” in the medical industry and mercuric sulfide has been utilized as the vermilion coloring pigment of paint.

**Potential Hazard**

Outside of these common uses mercury can be virulent poison and is readily absorbed through the respiratory system. According to Rector (2003) The two types of mercury most likely to be found in the Dreamy Draw “today” are elemental mercury, (quick silver), and mercuric sulfide, (cinnabar). Elemental mercury may have been deposited as a result of the refining and transportation process during the early part of the 20th century. These deposits were probably short lived due to elemental mercury’s propensity to evaporate at temperatures greater than 77 degrees Fahrenheit. Elemental mercury also readily forms alloys (amalgamates) with most metals except for iron and readily combines with sulfur at room temperatures. Elemental mercury combined in this manner forms a tight bond and is essentially immobile in the landscape. Cinnabar is even less biologically available and environmentally mobile than elemental mercury, due largely to its low solubility in water. Cinnabar also does not emit mercury vapor under normal temperature conditions. However cinnabar dust can migrate from the area by wind or precipitation.

Bain (2003) reports that “Reconnaissance field sampling in Dreamy Draw, including the Mercury Mine School area, by the Arizona Department of Environmental Quality concluded that “Overall, what mercury that may be found at the old Dreamy Draw mine sites is most likely at a concentration and or is in a form that would render is unavailable to human uptake.”
**Conclusion:**

Although mercury mining was evaluated for archaeological purposes prior to design and construction, the potential impacts were probably never made clear to the geotechnical consultants investigating the alignment. Undoubtedly waste material containing cinnabar has been incorporated into the highway fill. However when the concentration of mercury was investigated some 10 years after the project was completed the relative impacts appeared to be negligible. The presence of an earthen fill over the mine site probably serves to cover much of the remaining waste rock and entrances to the underground workings. The lack of information and potential impact of the abandoned caved in underground workings associated with the Rico property that are in close proximity to the south bound on ramp of the Northern Avenue, is an issue that may require additional future investigation.

**Asbestos Mining Areas along US 60, Gila County, Arizona**

US 60 transects the Historic Chrysotile Asbestos Mining Area of Gila County, Arizona for approximately 15 miles. Numerous waste dumps and mine workings are visible on the route as one travels north from the Town of Globe AZ, and passing through the Salt River Canyon. According to Harris (2004) there are 90 known occurrences of asbestos in a 100-square-mile area near this crossing of U.S. 60 with the Salt River Canyon.

Asbestos is generic name given to a group of fibrous mineral silicates found in nature. (Wilson, 1975). There are six different silicate minerals that have a fibrous form, which have this commercial designation. However the dominant asbestos mineral found in Arizona is chrysotile, which is part of the serpentine family. Arizona chrysotile fibers were mined for their ability to be chemically inert, fireproof, and as a high quality electrical insulator. They have also been extensively utilized as an additive to structural concrete. Approximately

Location of some known chrysotile asbestos mining areas adjacent to US 60 north of Globe, Arizona.

From: US Department of the Interior, 1952
90,000 tones of asbestos were mined in Arizona between the years 1914 to 1982. (Wrucke, 1986). Presently there is no asbestos mining in Arizona and all six asbestos minerals are generally avoided as a potential health hazard. The EPA has concluded that inhalation of any amount of asbestos is potentially hazardous, that a single asbestos fiber can be lethal. (Abelson, 1990)

**Geologic Occurrence**

The existence of chrysotile asbestos, in this area of Arizona has been assigned to a geologic process in which a series of diabase dikes and sills that selectively intruded and dilated an older Precambrian sequence of sedimentary strata, identified as the Apache Group. These intrusive bodies have effectively hoisted (elevated) and separated the formally conformably (flat lying) bedded lithologies. A sub unit of this group known as the Mescal Limestone is known to be a favorable host for the development of serpentine and chrysotile asbestos, when in contact with these intrusive diabase bodies. It is therefore generally believed that these “deposits originated through metamorphic action of the diabase intrusions upon Precambrian Mescal limestone” (Anthony, 1977), which form strata-controlled zones of serpentine and chrysotile at the diabase limestone contact margins. Wrucke, 1986, describes the asbestos in this area as “veins of cross-fiber chrysotile asbestos in tabular masses of serpentine, that replace meta-limestone during contact metamorphism.”

During the 1930’s excavation of the steep road cuts for U S 60, through Salt River Canyon contractors probably encountered naturally occurring serpentine and chrysotile. It is assumed that no special treatment of the material was given at that time. Construction records indicate that weathered diabase was the most desirable and routinely sought after borrow material. It can only be assumed that most of the deleterious asbestos material was incorporated into the roadway fills.

Records from the U.S. Bureau of Mines indicate that during the 1950’s attempts to develop underground asbestos mines in the immediate proximity to U S. 60 in Salt River Canyon. The two prospects were known as the Sorsen and the Roadside Mines. Some of the recorded
underground workings and waste material from these properties are reported to be within 200 feet of the highway. Wrucke 1986 reported, “Chrysotile mining in Arizona has been by small scale underground methods using room and pillar methods, and stoping with backfill.” Presently the two prospects did not appear to develop much further than that reported by the US Bureau of Mines but the ultimate size of underground workings are unknown.

**Potential Hazard**

This section of US 60 has been the site of several rock fall and road hazard elimination projects within the past 10 years. Fortunately these projects appear to have been constructed well away from the documented underground workings and the suspected asbestos waste material. However undocumented underground workings are known to occur in close proximity to the present alignment. The asbestos zone at the contact of the diabase intrusions and the Mescal limestone probably occurs in outcrop along the highway cuts but as of this date are not specifically identified.

There will probably be a time when a ground disturbing activity such as a roadway widening or rock slide will require special safety procedures to protect construction workers and motorists passing, through a construction zone, from airborne inhalation of asbestos fiber. Additionally significant efforts to dispose of roadway excavation containing chrysotile fibers will drive construction costs up. There may also be a problem of disposing of wastewater containing above normal levels of chrysotile fibers.

Mitigation of any undocumented underground working that contains chrysotile would also have to contain similar stringent requirements to protect the workers. However the engineering techniques would probably be the same as for other abandoned underground mines.
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