

**Amphiboles at New Idria, California**  
Part One, Preliminary Report on Field Observations  
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Summary

This report is a summary of field observations made during a field trip to the New Idria District, a.k.a. CCMA, from May 10-17, 2010. The purpose of this field trip was to identify and characterize amphiboles within and immediately adjacent to the New Idria serpentinite, the largest known body of chrysotile asbestos. As part of this work, over 60 georeferenced samples were taken. The observations and conclusions in this preliminary report relate solely to field observations and may be modified or corrected after analysis of samples in the laboratory.

One of the goals of this study was to address certain limitations of the EPA 2008 study that led to the BLM emergency closure order for the CCMA. Some of these limitations include sampling methods that made it impossible to ascertain specific sample locations in the District, extremely limited spatial coverage with the 23 km x 8 km serpentinite body, the possibility of cross-contamination by repeated vehicle runs over the same road and trail network, and the lack of control samples taken at a substantial distance from the District, with resulting lack of reliable background levels of mineral dusts.

Several types of amphiboles were found in hard rock samples from various points in the District. These amphiboles were massive and non-asbestiform. Specific minerals observed were glaucophane, crossite, hornblende, kaersutite, tremolite and actinolite. The occurrence of these minerals relates to specific geologic settings, the distribution of which is highly irregular in the District. In addition to hard rock samples, dust samples were obtained by digging at specific locations spread across the District. Finally, insulation material of industrial origin was observed. This insulation material appears to contain long-fiber asbestos of an unknown type. This occurrence relates to numerous industrial artifacts that lie abandoned at various places in the District, a legacy of over a century of mining. Artifacts include brick kilns, iron or steel furnaces and smelting equipment associated with mercury mining. Specific artifacts may or may not retain preserved insulation material.

Background

New Idria, California, contains the largest known deposit of chrysotile asbestos in the world, featuring rugged slopes of extremely short fiber ( $<5\mu$ ) fibers occurring in a mountainous oval area approximately 23 x 8 km in size, located at the southern end of the Diablo Range of California. This historic area is known as the New Idria District, and will be referred to in this document simply as the District, unless BLM regulatory matters are under discussion. An EPA 2008 study reported the presence of tremolite asbestos at

New Idria, which was a new mineral occurrence at that locality. Citing concerns about increased health risks to visitors due to the presence of amphibole asbestos, BLM issued an emergency closure order on May 1, 2008.

While the health risks of incidental (non-occupational) exposure to chrysotile asbestos remain controversial, there is general consensus in the medical community that exposure to amphibole asbestos carries a higher level of risk than chrysotile asbestos. For this reason, the BLM adopted a conservative position and issued its emergency closure order for CCMA upon learning of the results of the EPA 2008 study.

Recognizing that there is no evidence of morbidity and mortality in exposed populations of CCMA visitors, the EPA relied on activity-based sampling to simulate exposure to visitors. This simulated exposure was then related through computer models to a projected health risk. The dose-response relationship in these models is based on extrapolation from occupational exposure data (e.g. Van Baalen, 2010). Due to the activity-based sampling method used by EPA, it is not clear where the reported amphibole asbestos occurs within the District.

### Field Methods

Addressing the above issues required on-the-ground geological fieldwork, which was made possible by a CCMA special access permit issued to the writer by BLM in the Spring of 2010. Accordingly, the writer visited the New Idria District during the period May 10-17, 2010, traveling by 4-WD vehicle as well as substantial foot travel to reach specific localities. All localities sampled were georeferenced with a handheld Garmin GPS, with positions recorded as degrees, minutes and hundredths of minutes. Hard rock samples were obtained in the traditional manner with hammer and cold chisel from outcrops, and were labeled on the spot. In addition, several stream boulders were sampled from the immediate vicinity of outcrops. Finally, dust samples were taken using a simple sampling methodology: at each chosen locality, generally on a road, a trowel cleaned by a tissue was used to scoop up 50-100 gram samples from the center of the road, and the sample was stored in a ziplock bag. A companion sample was taken approximately 50 feet from the road in otherwise undisturbed serpentinite soil. The purpose of the twin samples from chosen localities was to address the issue of cross-contamination by vehicles. It is possible that analysis of the twin samples will reveal systematic differences resulting from such contamination. The widest distribution of sample localities was chosen consistent with physical access on the deteriorating road network and time limitations in the field. In the end, over 40 dust samples were taken from localities throughout the serpentinite in the District, as well as control samples taken from spots 20 miles or more distant.

### Results

The working hypothesis for this study is that naturally occurring amphiboles within or adjacent to the District are associated with tectonic blocks of distinct lithology, generally of the Jurassic and Cretaceous Franciscan Formation, a widespread unit in the California

Coast Ranges. Such tectonic blocks were shown by Coleman (1957) to be associated with the physical emplacement of the serpentinite diapir that forms the core of the New Idria District. In some areas, Franciscan rocks are also in fault contact with the serpentinite at its margins and amphibole mineralization at these contacts is a possibility. The distribution of tectonic blocks within the District is highly irregular, with a greater concentration at the northwestern end than at the southeastern end, as shown on the Eckel & Myers (1946) map and on later maps derived from it.

Another anomalous rock type occurs in the District, the red weathering silica-carbonate rocks that form the host rock for mercury deposits in the form of cinnabar. Within the serpentinite, the silica-carbonate rocks form resistant towers that are positive weathering features. Many of these towers are associated with small abandoned mercury mines of unknown age. At the Eastern margin of the serpentinite, in the vicinity of the Idria ghost town, large amounts of heavily mineralized silica-carbonate rock became the host rock for the historic mercury mines established beginning in 1853. The silica-carbonate rocks are not known to contain amphiboles, and none were observed in this study.

### Non-asbestiform Amphiboles

Amphiboles form a family of common rock-forming minerals, occurring in a variety of geologic settings. Their crystal structure allows for a wide variation in chemical composition and physical properties. Typically amphiboles occur in equant, bladed, or needle-like shapes. In certain specific environments, amphiboles may crystallize in asbestiform fibers, although this is relatively rare. Tremolite and actinolite, mentioned in the EPA study, require calcium as an essential constituent. At New Idria, the dominant mineral is magnesium-rich chrysotile, while calcium is in short supply relative to other elements. This is due to the nature of the geology, and this means that tremolite and actinolite should be rare and isolated.

**Glaucophane** is a Mg-rich sodic amphibole with a blue color that gives Franciscan blueschist its characteristic hue. At New Idria, glaucophane is associated with tectonic blocks of Franciscan Formation that have been mechanically emplaced within the serpentinite body. Glaucophane schists are easily recognized by their distinctive blue color. Glaucophane occurs in these rocks as 0.1 - 1.0 mm equant grains associated with albite and other silicate minerals. The country rock immediately to the west of the District is also Franciscan Formation, and blueschists may be seen here as well. It is important to realize that not all Franciscan rocks are blueschists, as greywackes and greenstones are also found.

**Crossite** is an Fe-rich analogue of glaucophane that has a similar appearance and occurs in similar settings. It is generally not possible to distinguish crossite from glaucophane in the field, and so both may occur within the District, in similar geologic settings. The name crossite has been discredited by the IMA amphibole subcommittee, but the historic literature on the New Idria District frequently refers to this mineral, hence the name is retained in this study. Note that Van Baalen (1995) described crossite from the Gem Mine locality, which features not one but two Franciscan tectonic blocks.

**Kaersutite**, formerly known as barkevikite, occurs in the District as an essential constituent of the Miocene stocks of soda syenite that crop out in the southeastern portion of the District. Coarse-grained kaersutite syenite boulders may occasionally be found in streambeds in that region as well. Some kaersutite crystals are as large as 175 mm in length.

**Hornblende**, the most common of all amphiboles, occurs in a strange way in the District. At numerous road crossings of Clear Creek by the road network, riprap of hornblende granite has been brought in to improve the road. This hornblende occurrence is therefore exotic and unrelated to the local geology. Specifically, hornblende crystals in these granites were estimated at several mm in size.

**Tremolite** is an Mg-rich calcic amphibole that occurs in metamorphic rocks from a variety of settings. At New Idria, Yoder & Chesterman (1951) and Coleman (1961) described tremolite as a rind or selvage around jadeite-bearing pods of Franciscan rocks found in the Clear Creek drainage. In the present study, the writer found one such pod as a stream boulder near the Coleman locality, but the occurrence contains several minerals that could not unambiguously be identified in the field. In addition, the writer found a stream boulder in the vicinity of the Victor Claim that contains massive tremolite with crystals of centimeter scale. No other tremolite was observed.

**Actinolite** is a calcic amphibole closely related to tremolite, but containing a higher proportion of Fe than tremolite. Actinolite occurs in a wider variety of geologic settings than tremolite. In the present study, the write found a stream boulder near the Victor Claim that appears to be Franciscan schist with a centimeter-wide crosscutting vein of massive actinolite (see photo). No other actinolite was observed in this study.



## Asbestiform Minerals

As mentioned in the introduction, the District is a world-class deposit of short-fiber chrysotile asbestos, and so the dust samples gathered as described above likely contain large amounts of chrysotile. However, the impetus for this study was the question of whether or not amphibole asbestos occurs, and if so, how and where. Future analysis of the dust samples will reveal the answer to this question.

Finally, insulation material of industrial origin was observed. This insulation material appears to contain long-fiber asbestos of an unknown type. This occurrence relates to numerous industrial artifacts that lie abandoned at various places in the District, a legacy of over a century of mining. Artifacts include brick kilns, iron or steel furnaces and smelting equipment associated with mercury mining. Specific artifacts may or may not retain preserved insulation material. One such artifact, the remains of a rotary furnace at the Clear Creek mine (see photo) appears to have asbestos-bearing insulation spilling out from a rusted-out area of the furnace wall, as well as potentially asbestos-bearing material that may be a seal related to the rotational mechanism. Both of these materials were sampled and await laboratory analysis. The writer is indebted to E.J. Fowkes and R. Iddings (2008) for providing the location of this equipment. Note that the position of this abandoned equipment is approximately ten feet off a road which was one of the main sampling routes used by the EPA 2008 study.



## Conclusions

The preliminary results of this study generally support the premise that naturally occurring amphiboles in the New Idria District are spatially and genetically related to the tectonic blocks of mainly Franciscan Formation that are included within the serpentinite body. An exception to this premise is the kaersutite syenite that is not a tectonic block, but an igneous intrusion of Miocene age.

As shown on the Eckel & Myers (1946) map, the distribution of Franciscan tectonic blocks is highly irregular within the serpentinite body, with a greater number to the north and west and a smaller number to the south and east. This observation helps to explain the complete lack of amphibole asbestos contamination from the now-closed commercial asbestos mines that lie in the southeastern portion of the District. Repeated studies have shown no such contamination (e.g. Van Baalen & Pooley, 2009). The most likely reason for this is that the asbestos mines themselves were located and positioned by prospectors and engineers in the 1950s and 1960s, who were interested in the highest possible economic ore grade with the minimum amount of contamination.

If it is true that the naturally occurring amphiboles are related to the tectonic blocks, then it is also likely true that there are large amphibole-free regions of the District, an observation that may have land management implications.

Exotic occurrences of amphibole, whether asbestiform or not, appear to be related to industrial processes that have taken place over the years, and are not derived from the local geology. These processes include mining, especially mercury mining, and road maintenance. The possible use of amphibole asbestos for insulation purposes in mining apparatus cannot be ruled out and must be investigated further. Sampling techniques used by the EPA in its 2008 study leave open the possibility that reported amphibole asbestos is related to industrial sources.

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