Department of Conservation
California Geological Survey
Mineral Resources and Mineral Hazards Mapping Program

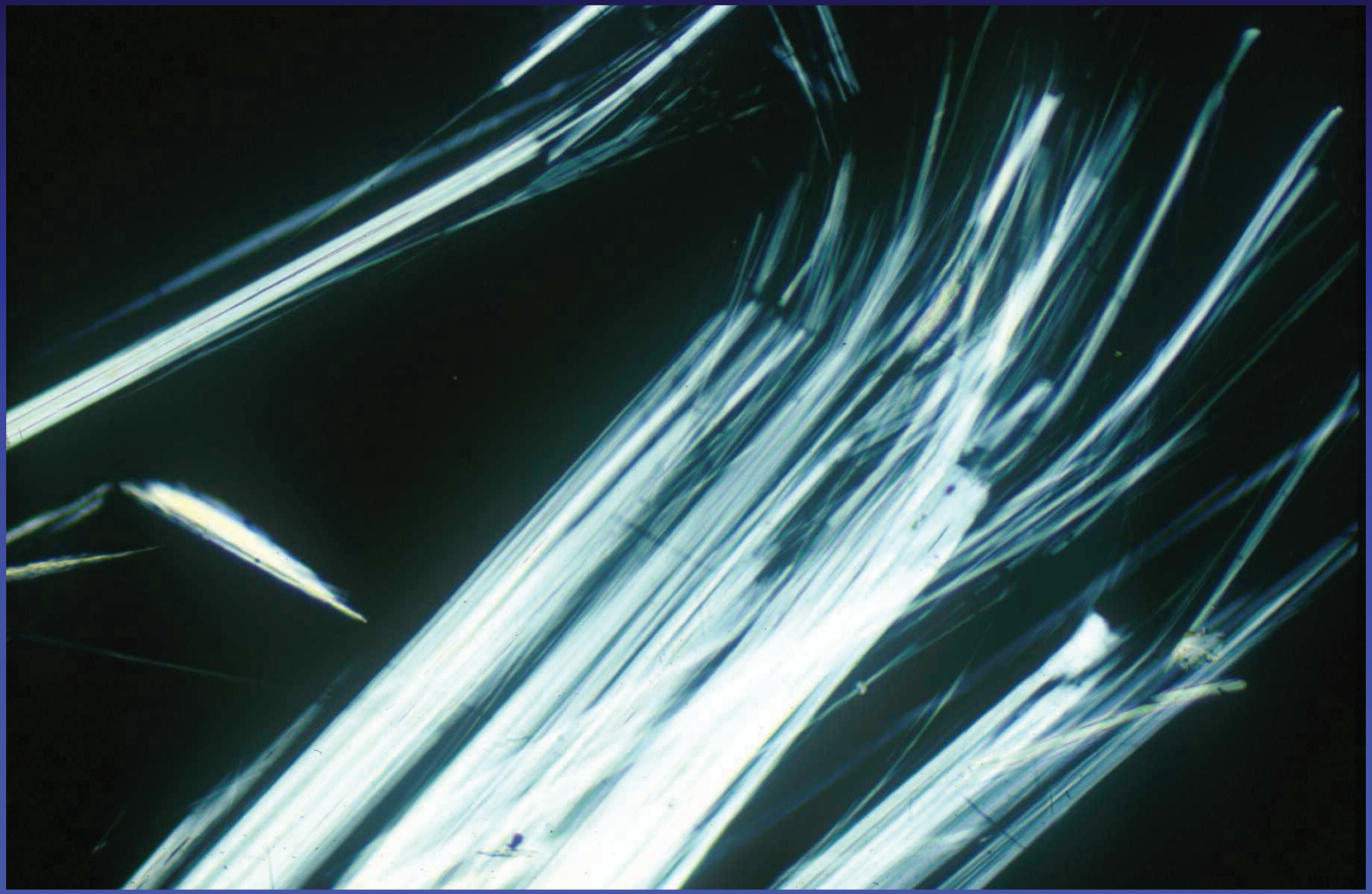
NATURALLY OCCURRING ASBESTOS IN CALIFORNIA

- Background
- NOA in California
- Maps

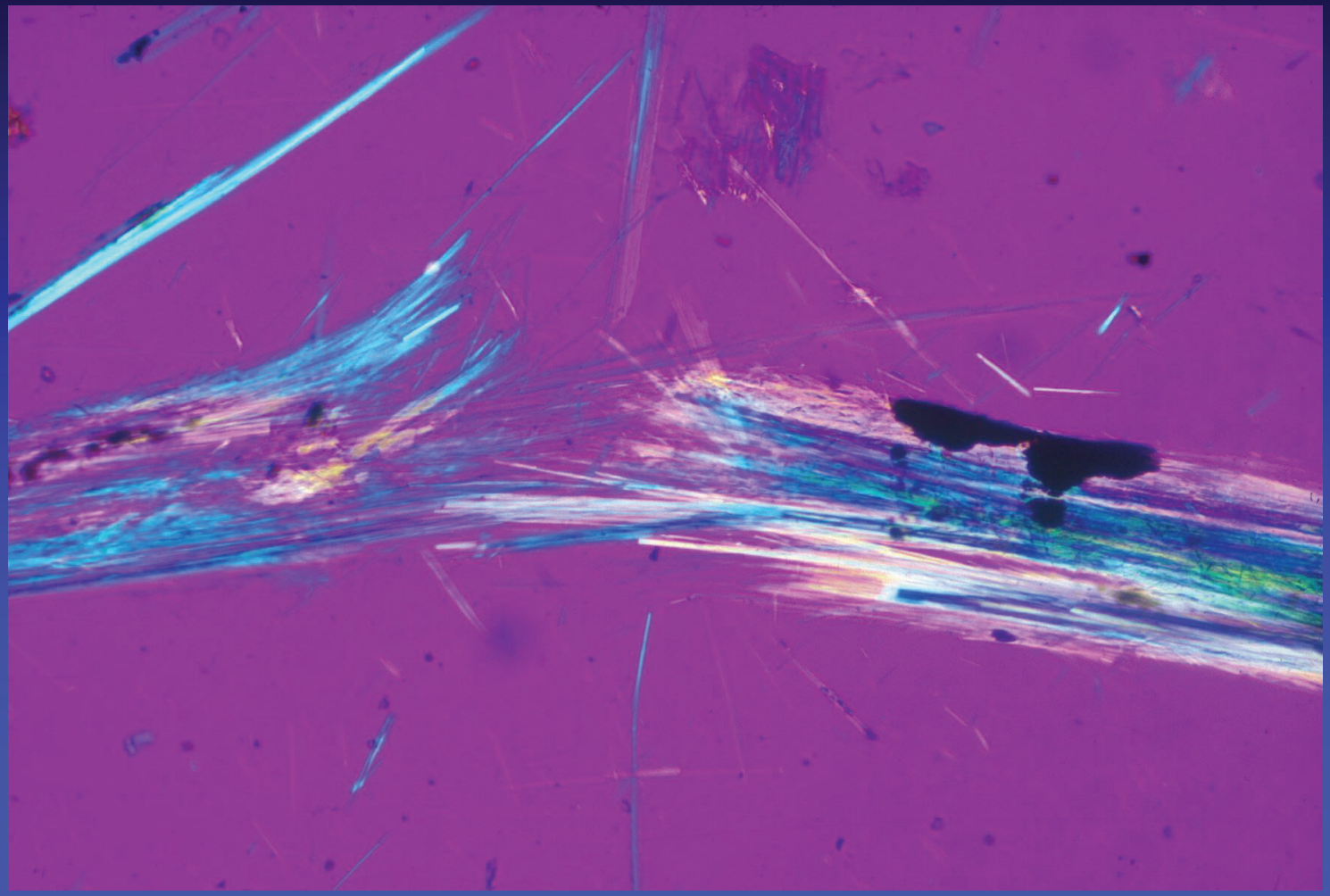
What Is Asbestos?

- Asbestos is a term used to identify the fibrous or asbestiform habits of six minerals.
- The six types of asbestos are:
  - Chrysotile (serpentine asbestos).
  - Crocidolite, Amosite, Tremolite, Actinolite, and Anthophyllite (amphibole asbestos).

Chrysotile (~35X)



Tremolite (~35X)



Health Effects (Inhalation)

- Asbestosis - a diffuse fibrous scarring of the lungs.
- Lung cancer - a malignant tumor in the lungs.
- Pleural plaques - localized fibrous scars lining the space around the lungs.
- Mesothelioma - a rare malignant cancer of the membranes lining the lungs, chest, and abdominal cavity.

Regulations Exist To:

- Limit worker exposure to asbestos;
- Minimize emissions of asbestos from industrial, construction, and waste handling activities;
- Control asbestos containing materials in schools and buildings;
- Limit the level of asbestos in water; and
- Restrict or prohibit the use of asbestos in certain products and applications.

What Is Naturally Occurring Asbestos (NOA)?

Naturally occurring asbestos (NOA) is the term applied to the natural geologic occurrence of any of the six types of asbestos.

How Does NOA Occur In The Field?

- NOA may be found:
  - In veins
  - On slip surfaces in rocks and between rock units
  - As mass fiber
  - As loose fibers or fiber bundles in soil and sediment

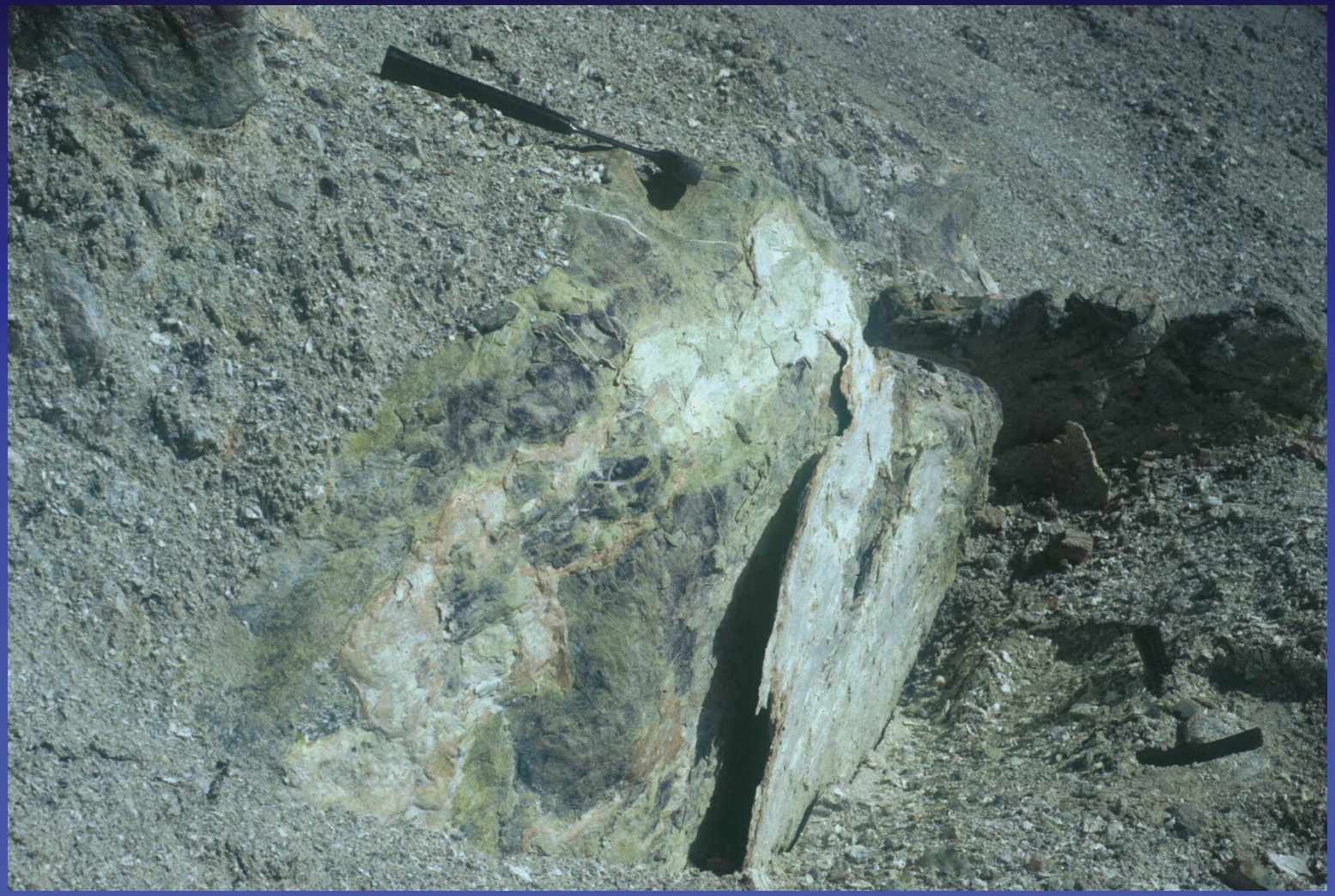
Cross Fiber Asbestos

Cross Fiber Asbestos

Slip Fiber Asbestos

Slip Fiber Asbestos

Mass Fiber Asbestos



Mass Fiber Asbestos

Why Is NOA A Concern To CalTrans ?

- Worker Safety / Public Safety
- Regulatory Compliance
- Hazmat Issues
- Public Relations

Public Relations

Sacramento Bee 8/16/01 ★★ B3

Asbestos found at site of Auburn multiplex

By Art Campos
BEE STAFF WRITER

Testing of soil from a construction site for a 10-screen multiplex in Auburn has confirmed the presence of naturally occurring asbestos.

Grading work on the Nevada Street site by Cinecon Group Inc. was voluntarily halted last week after Placer County health officials discovered serpentine rock, which often yields the cancer-causing fibers.

Cinecon officials have ordered the area to be kept wet to reduce dust being blown into the air. They also have submitted a mitigation plan describing other measures being taken to eliminate risk to their workers and to the community.

Dr. Richard Burton, county public health officer, said Cinecon is complying with all requirements.

"Typically, they would submit this plan now and a more comprehensive plan later to describe how they will complete the construction while they continue to mitigate any health risks," Burton said.

In the meantime, there is no increased risk to the community, he said, and Cinecon, which specializes in the building of movie theaters, has been authorized to continue doing trenching work.

"But anything beyond trenching would require them to submit the more comprehensive site assessment and mitigation plan," Burton said.

Such a plan would identify the extent of asbestos on the site and would address the remainder of work to be done, he said.

Officials for the Chico-based Cinecon could not be reached for comment.

Last week, Rick Huffman, president of Cinecon, said his company intended to deal with the situation quickly.

Nevada Street remains open to traffic, but the construction site, just north of Palm Avenue, is closed to the general public.

The proposed 10-screen project is within the city limits of Auburn and was approved by the city. An Auburn official said last week that Cinecon's geotechnical reports did not show the presence of the serpentine rock.

Grading work began earlier this month, but a complaint of excessive dust prompted county officials to investigate.

□ □ □

The Bee's Art Campos can be reached at (916) 773-2825 or acampos@sacbee.com.

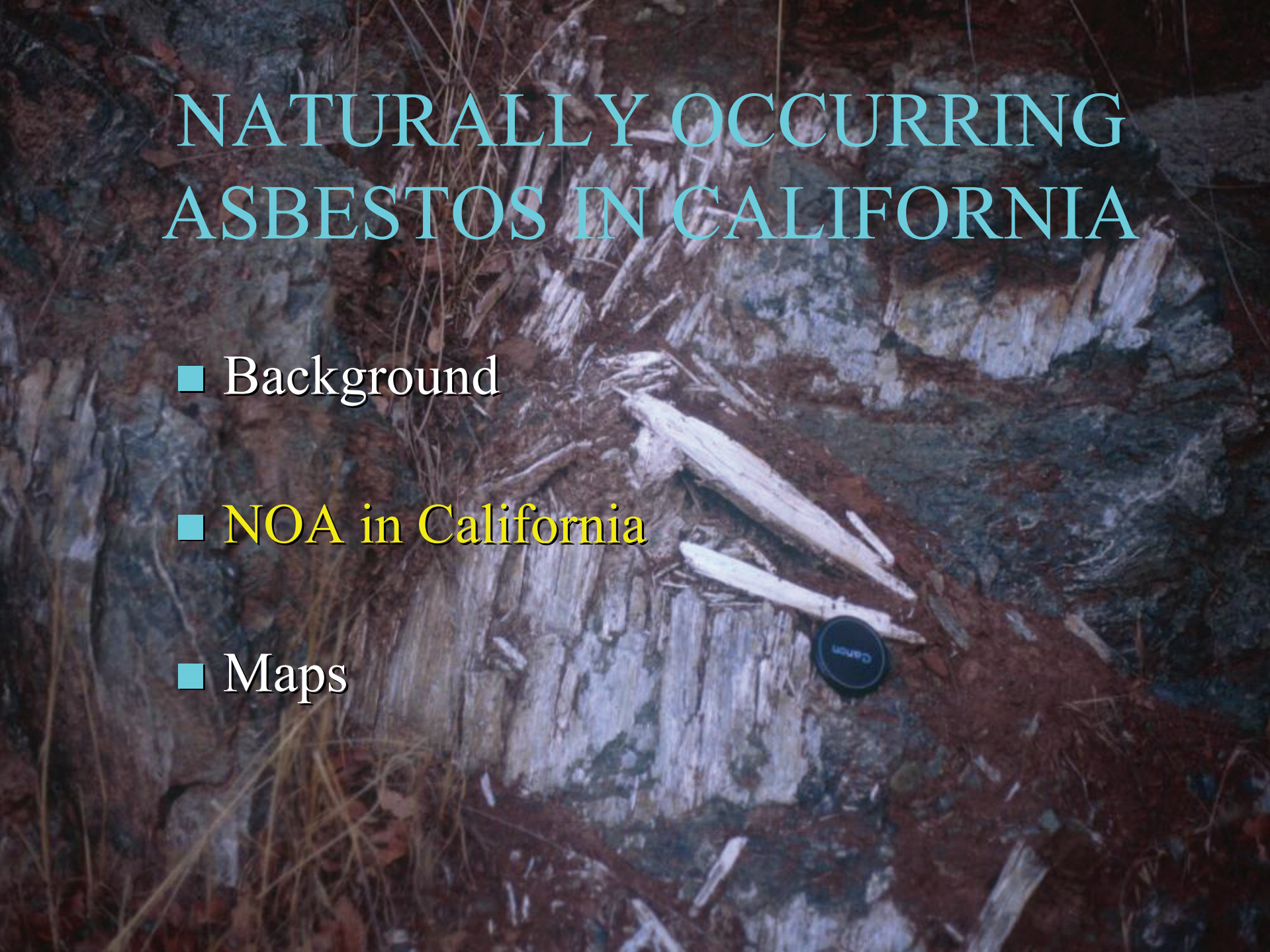
Project's asbestos stirs up concerns

An El Dorado Hills school construction site yields fibers.

By Chris Bowman
BEE STAFF WRITER

Construction crews at an El Dorado Hills high school carved into rock rich with asbestos of the most hazardous kind and created athletic fields with contaminated soil while school was in session last month.

Tests commissioned by The Bee found asbestos fibers in dust on the campus parking lot, on the fields under construction and in veins of rock exposed from excavation.



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NOA In California

- Chrysotile is the most common type of asbestos.
- Chrysotile is primarily associated with serpentinite or serpentinized ultramafic rock.
- Tremolite is probably the most common type of amphibole asbestos.

NOA In California

- Amphibole asbestos may occur in and adjacent to serpentinite and ultramafic rock and in other geologic settings such as:
  - Contact metamorphosed carbonate rocks (limestones or dolomites).
  - Other metamorphic rocks.
  - Sedimentary rocks or in soils derived from asbestos-containing parent materials.

Ultramafic Rocks / Serpentinite

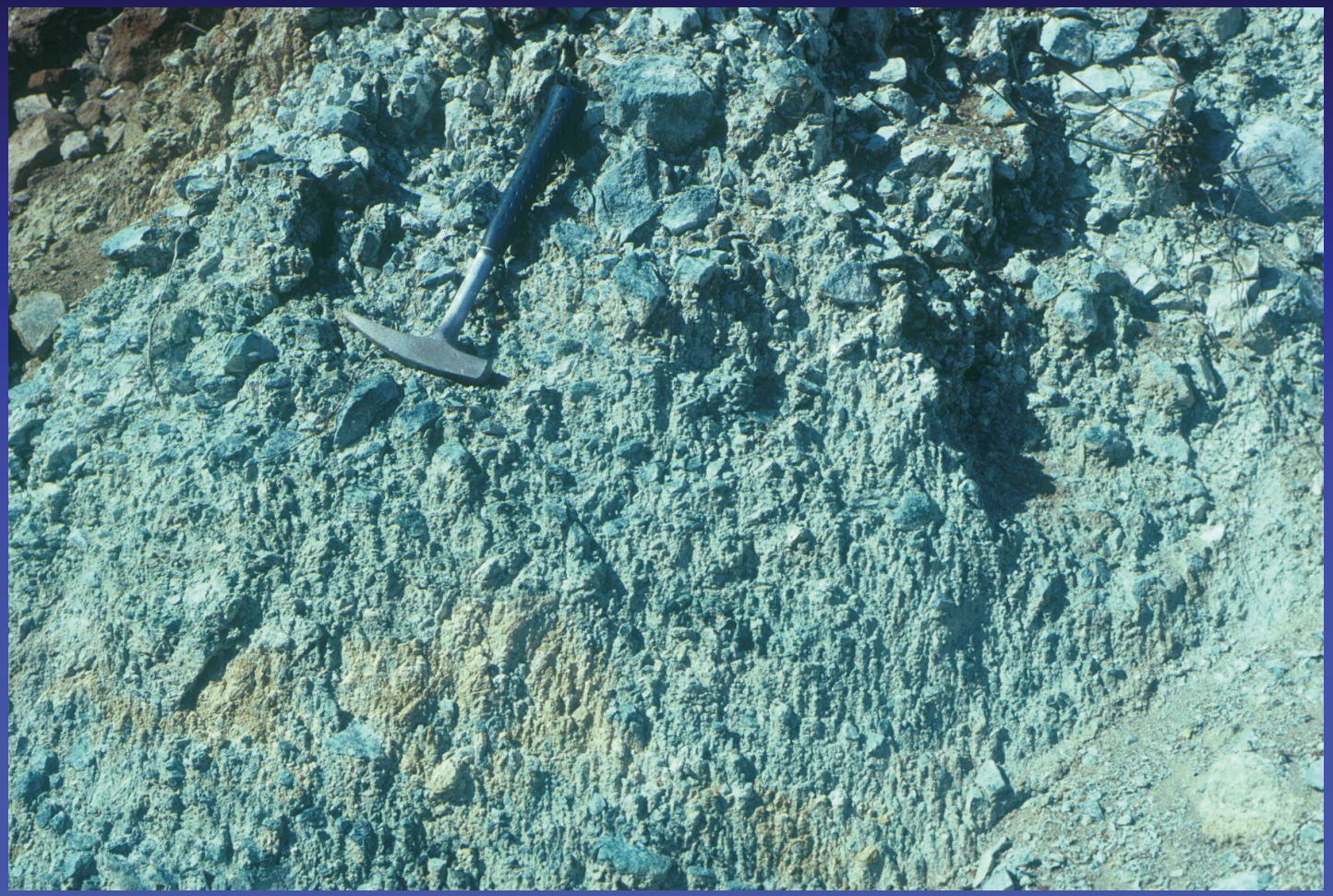
Ultramafic Rocks / Serpentinite

Ultramafic Rocks / Serpentinite

Ultramafic Rocks / Serpentinite

Ultramafic Rocks / Serpentinite

Weathered Serpentinite



Ultramafic Rocks / Serpentinite

Geologic Contacts

Dikes or Inclusions

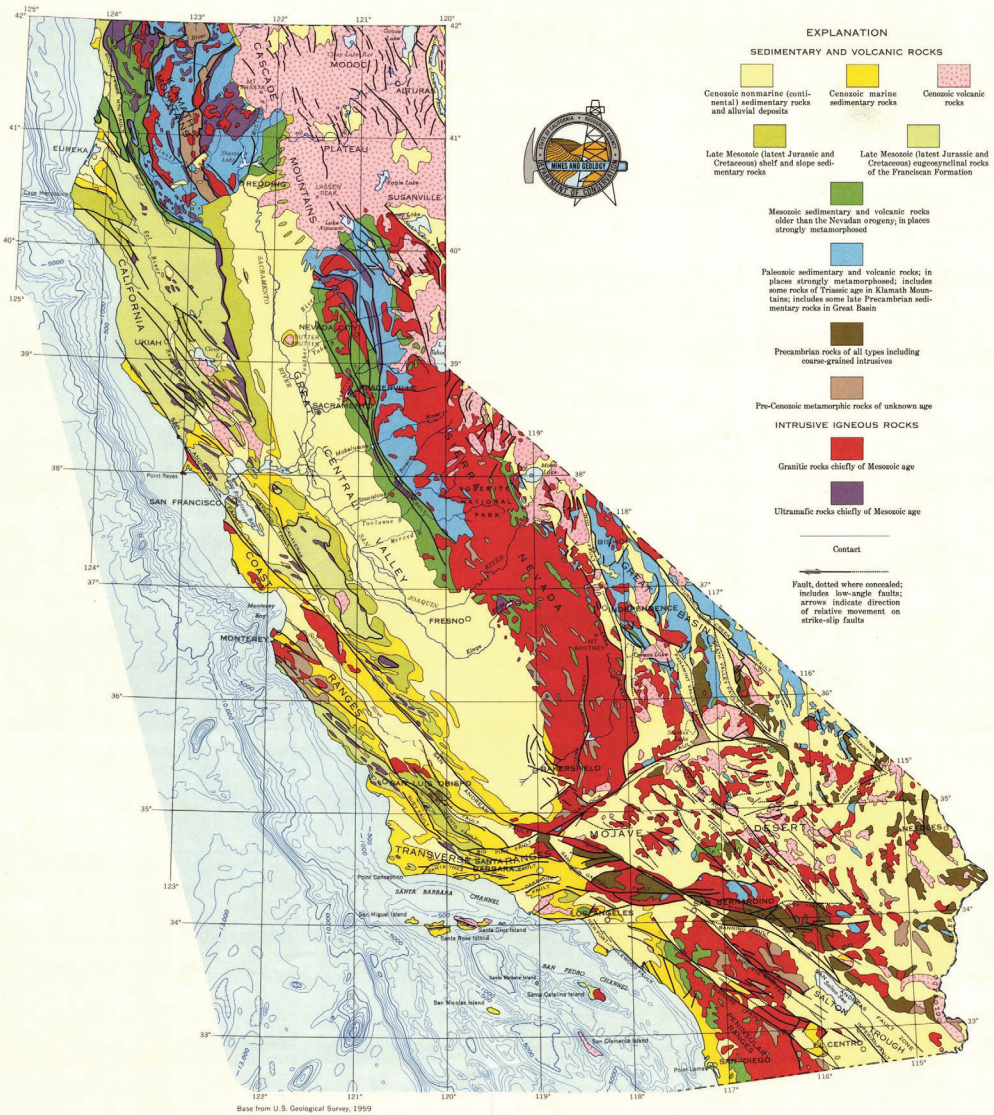
Where Is NOA Found In California?

- In serpentinites and serpentinized ultramafic rocks, which are common in the foothills region of the Sierra Nevada, the Coast Ranges, and northwestern California.
- Tremolite asbestos has been found in most of the counties in the Sierra Nevada and the Klamath Mountains.
- NOA may occur more frequently in fault or shear zones.

CALIFORNIA DIVISION OF MINES AND GEOLOGY
IAN CAMPBELL, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

GEOLOGIC MAP OF CALIFORNIA
SCALE 1:2,500,000



Base from U.S. Geological Survey, 1959

GEOLOGIC MAP OF CALIFORNIA

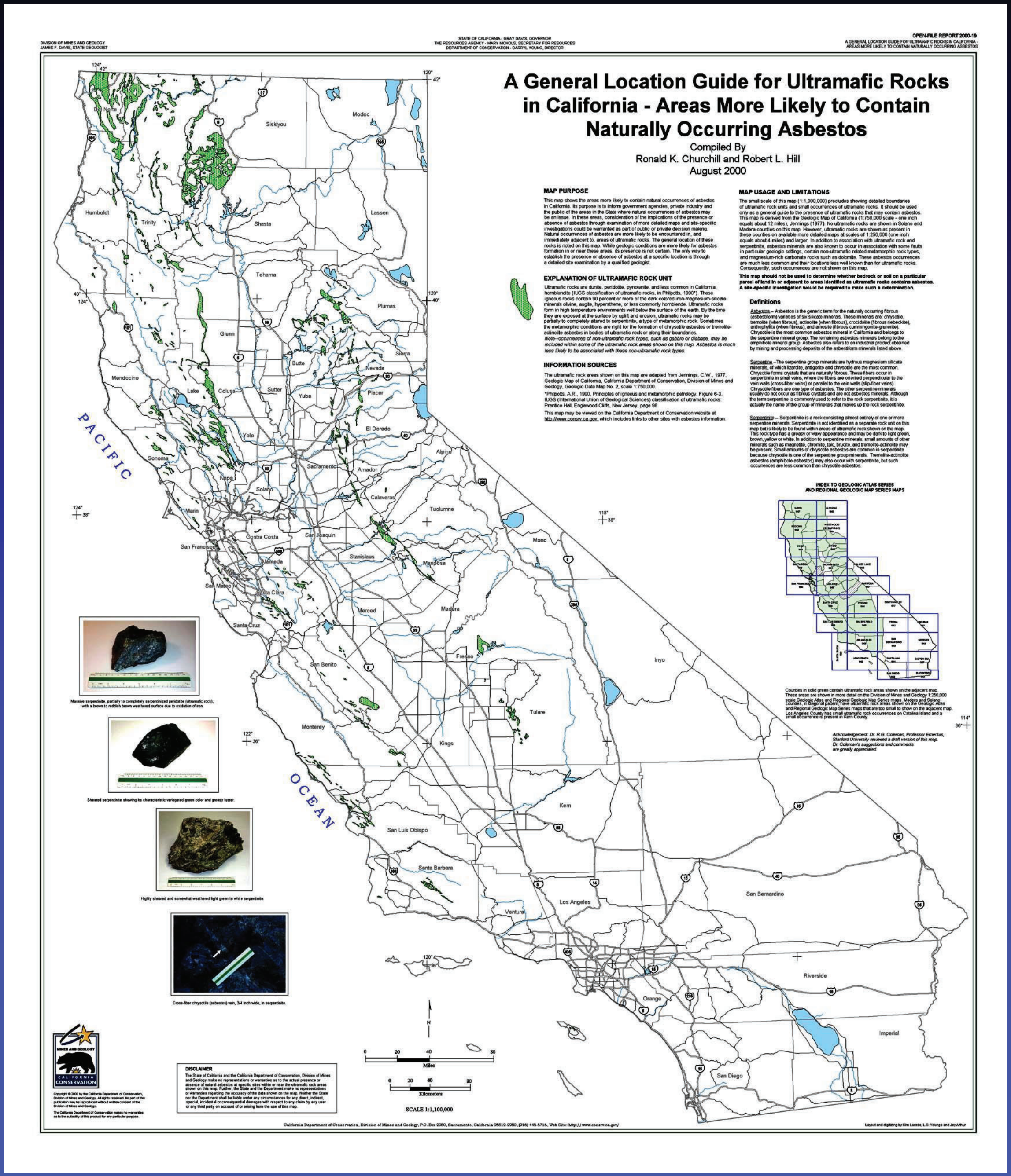
COMPILED BY U.S. GEOLOGICAL SURVEY
AND CALIFORNIA DIVISION OF MINES AND GEOLOGY

SCALE 1:2 500 000

0 50 100 MILES

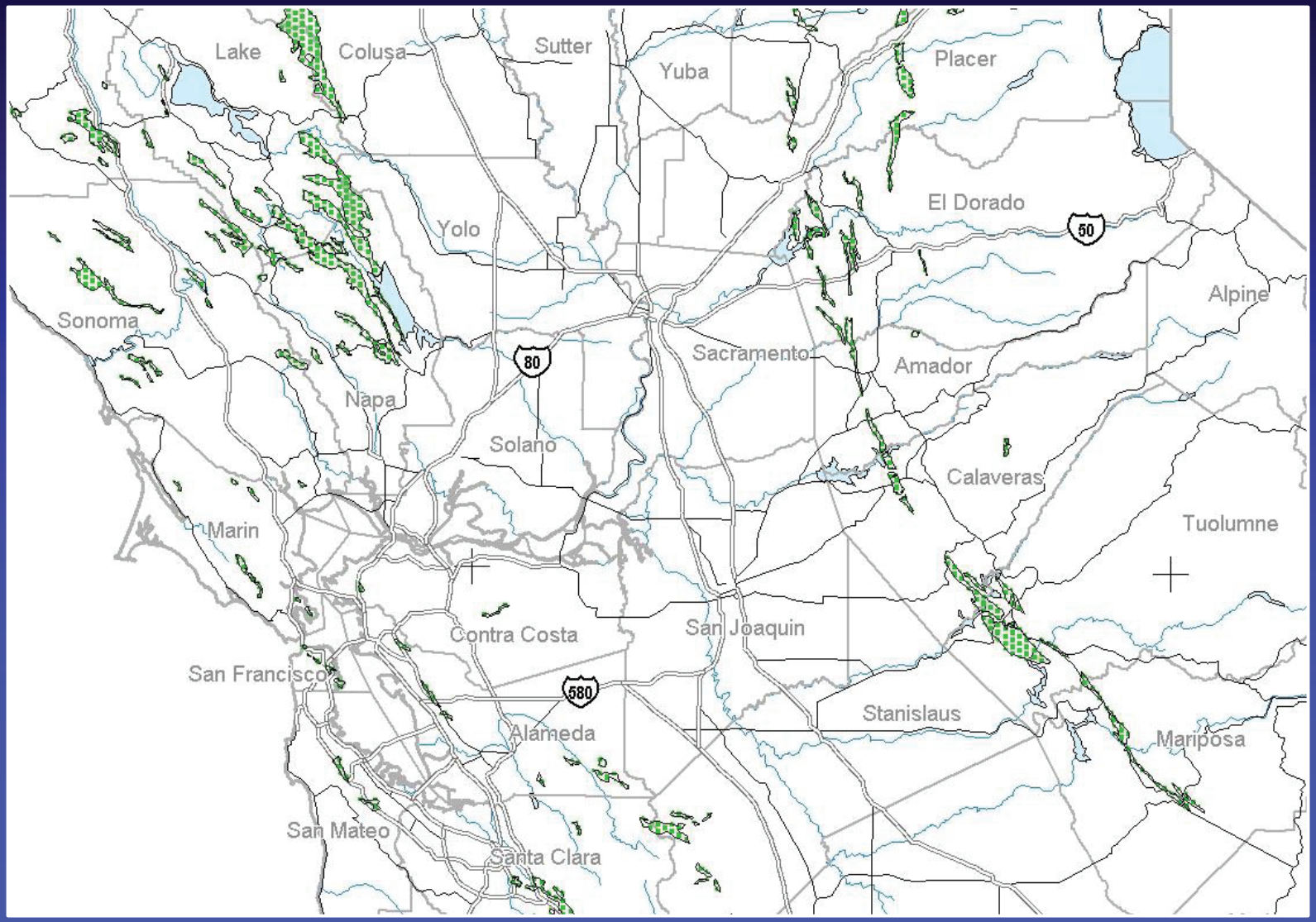
SUBMARINE CONTOUR INTERVALS 500 AND 1000 FEET; DATUM IS SEA LEVEL

1966



A General Location Guide for Ultramafic Rocks in California - Areas More Likely to Contain Naturally Occurring Asbestos
Compiled By
Ronald K. Churchill and Robert L. Hill
August 2000
MAP PURPOSE
This map shows the areas more likely to contain natural occurrences of asbestos in California. Its purpose is to inform government agencies, private industry and the public of the areas in the State where natural occurrences of asbestos may be an issue. In these areas, consideration of the implications of the presence or absence of asbestos through examination of more detailed maps and site-specific investigations could be warranted as part of public or private decision making. Natural occurrences of asbestos are more likely to be encountered in, and immediately adjacent to, areas of ultramafic rocks. The general location of these rocks is noted on this map. While geologic conditions are more likely for asbestos formation in or near these areas, its presence is not certain. The only way to establish the presence or absence of asbestos at a specific location is through a detailed site examination by a qualified geologist.
EXPLANATION OF ULTRAMAFIC ROCK UNIT
Ultramafic rocks are dunite, peridotite, pyroxenite, and less common in California, hornblendite (IUGS classification of ultramafic rocks, in Philpotts, 1990*). These igneous rocks contain 90 percent or more of the dark colored iron-magnesium-silicate minerals olivine, augite, hypersthene, or less commonly hornblende. Ultramafic rocks form in high temperature environments well below the surface of the earth. By the time they are exposed at the surface by uplift and erosion, ultramafic rocks may be partially to completely altered to serpentinite, a type of metamorphic rock. Sometimes the metamorphic conditions are right for the formation of chrysotile asbestos or tremolite-actinolite asbestos in bodies of ultramafic rock or along their boundaries.
Note--occurrences of non-ultramafic rock types, such as gabbro or diabase, may be included within some of the ultramafic rock areas shown on this map. Asbestos is much less likely to be associated with these non-ultramafic rock types.
INFORMATION SOURCES
The ultramafic rock areas shown on this map are adapted from Jennings, C.W., 1977, Geologic Map of California, California Department of Conservation, Division of Mines and Geology, Geologic Data Map No. 2, scale 1:750,000.
*Philpotts, A.R., 1990, Principles of igneous and metamorphic petrology, Figure 6-3, IUGS (International Union of Geological Sciences) classification of ultramafic rocks: Prentice Hall, Englewood Cliffs, New Jersey, page 96.
This map may be viewed on the California Department of Conservation website at http://www.consrv.ca.gov, which includes links to other sites with asbestos information.
MAP USAGE AND LIMITATIONS
The small scale of this map (1:1,000,000) precludes showing detailed boundaries of ultramafic rock units and small occurrences of ultramafic rocks. It should be used only as a general guide to the presence of ultramafic rocks that may contain asbestos. This map is derived from the Geologic Map of California (1:750,000 scale - one inch equals about 12 miles), Jennings (1977). No ultramafic rocks are shown in Solano and Madera counties on this map. However, ultramafic rocks are shown as present in these counties on available more detailed maps at scales of 1:250,000 (one inch equals about 4 miles) and larger. In addition to association with ultramafic rock and serpentinite, asbestos minerals are also known to occur in association with some faults in particular geologic settings, certain non-ultramafic related metamorphic rock types, and magnesium-rich carbonate rocks such as dolomite. These asbestos occurrences are much less common and their locations less well known than for ultramafic rocks. Consequently, such occurrences are not shown on this map.
This map should not be used to determine whether bedrock or soil on a particular parcel of land in or adjacent to areas identified as ultramafic rocks contains asbestos. A site-specific investigation would be required to make such a determination.
Definitions
Asbestos -- Asbestos is the generic term for the naturally occurring fibrous (asbestiform) varieties of six silicate minerals. These minerals are: chrysotile, tremolite (when fibrous), actinolite (when fibrous), crocidolite (fibrous riebeckite), anthophyllite (when fibrous), and amosite (fibrous cummingonite-grunerite). Chrysotile is the most common asbestos mineral in California and belongs to the serpentine mineral group. The remaining asbestos minerals belong to the amphibole mineral group. Asbestos also refers to an industrial product obtained by mining and processing deposits of the asbestiform minerals listed above.
Serpentine --The serpentine group minerals are hydrous magnesium silicate minerals, of which lizardite, antigorite and chrysotile are the most common. Chrysotile forms crystals that are naturally fibrous. These fibers occur in serpentinite in small veins, where the fibers are oriented perpendicular to the vein walls (cross-fiber veins) or parallel to the vein walls (slip-fiber veins). Chrysotile fibers are one type of asbestos. The other serpentine minerals usually do not occur as fibrous crystals and are not asbestos minerals. Although the term serpentine is commonly used to refer to the rock serpentinite, it is actually the name of the group of minerals that makes up the rock serpentinite.
Serpentinite -- Serpentinite is a rock consisting almost entirely of one or more serpentine minerals. Serpentinite is not identified as a separate rock unit on this map but is likely to be found within areas of ultramafic rock shown on the map. This rock type has a greasy or waxy appearance and may be dark to light green, brown, yellow or white. In addition to serpentine minerals, small amounts of other minerals such as magnetite, chromite, talc, brucite, and tremolite-actinolite may be present. Small amounts of chrysotile asbestos are common in serpentinite because chrysotile is one of the serpentine group minerals. Tremolite-actinolite asbestos (amphibole asbestos) may also occur with serpentinite, but such occurrences are less common than chrysotile asbestos.
INDEX TO GEOLOGIC ATLAS SERIES AND REGIONAL GEOLOGIC MAP SERIES MAPS
PACIFIC
OCEAN
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Glenn
Butte
Sierra
Nevada
Mendocino
Lake
Colusa
Sutter
Yuba
Placer
El Dorado
Yolo
Sonoma
Napa
Alpine
Sacramento
Amador
Solano
Calaveras
Marin
Tuolumne
San Francisco
Contra Costa
San Joaquin
Mono
Alameda
Stanislaus
Mariposa
San Mateo
Santa Clara
Santa Cruz
Merced
Madera
Fresno
San Benito
Inyo
Tulare
Monterey
Kings
Kern
San Luis Obispo
Santa Barbara
Los Angeles
San Bernardino
Ventura
Riverside
Orange
Imperial
San Diego
DISCLAIMER
SCALE 1:1,100,000

Ultramafic Rock Map Close-up



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What Do Geologic Maps Show?

- The distribution, nature, and age relationships of rock units.
- Structural features (faults, folds).
- Sometimes show distribution of surficial deposits.

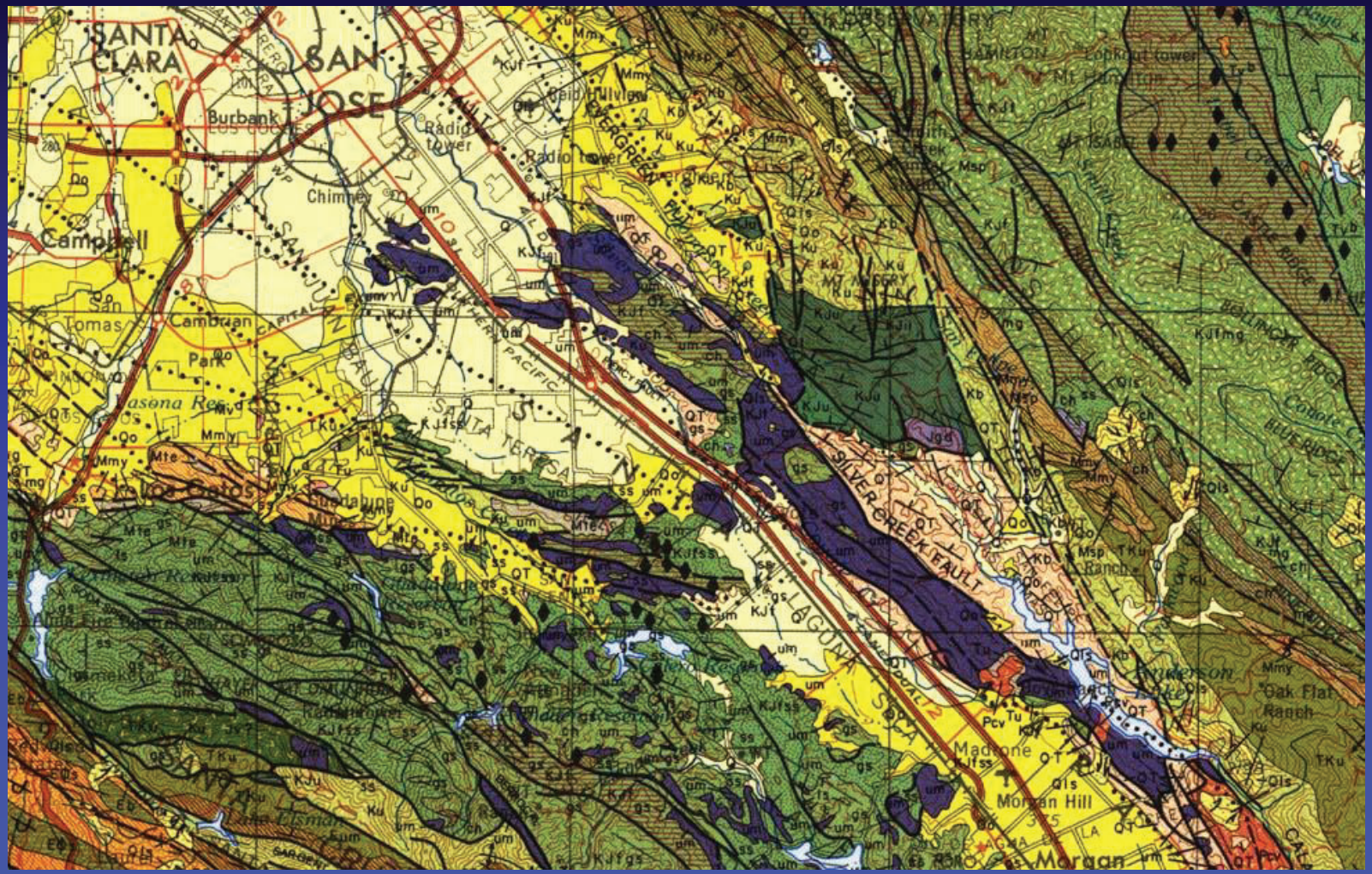
What Do Geologic Maps Tell You About NOA?

- Geologic maps may help identify areas with a higher or lower likelihood of containing NOA.
- Geographic Ultramafic Rock Units (regulations).

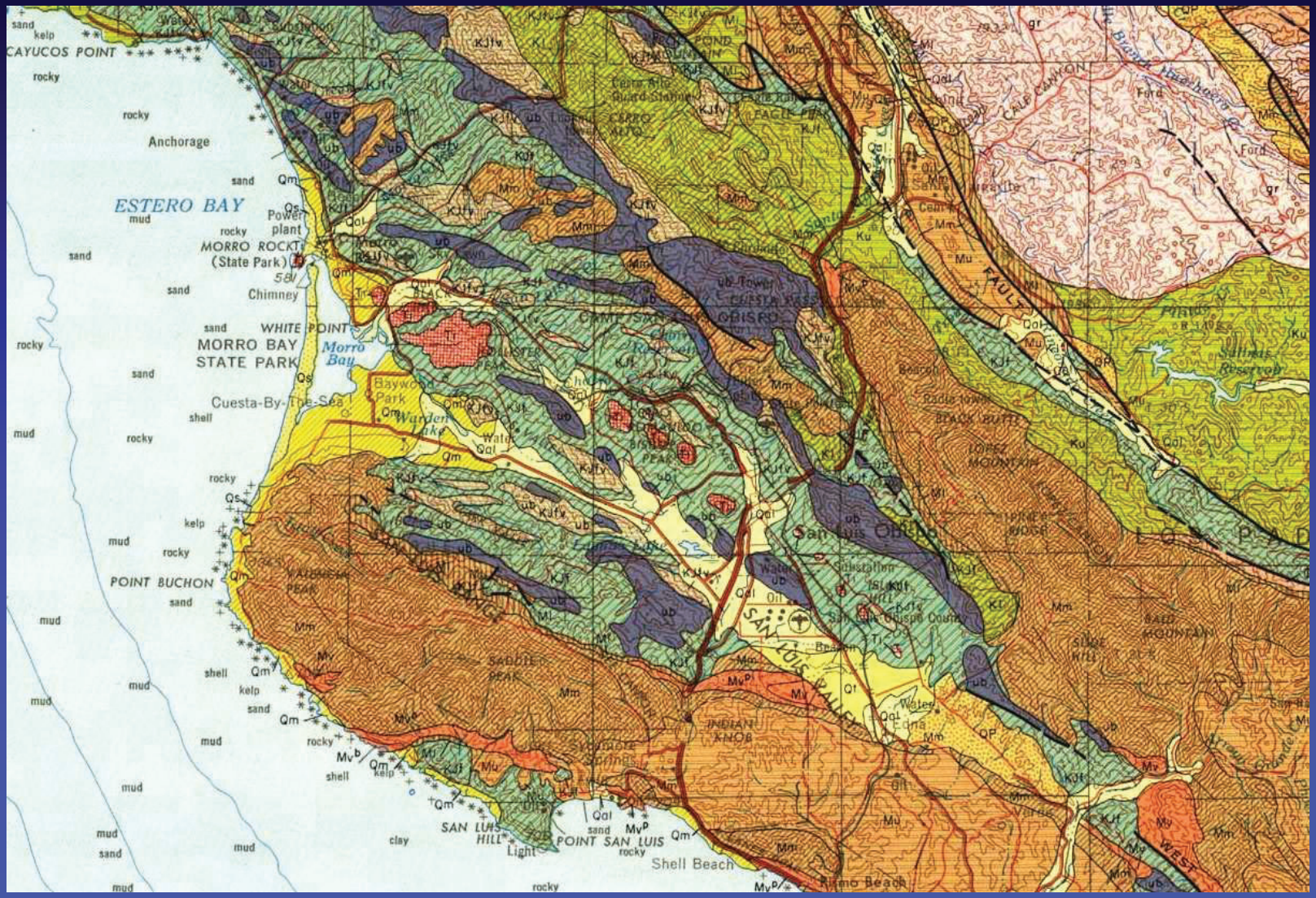
What Geologic Maps Don't Tell You About NOA?

- If NOA is present at a particular location.
- If NOA is absent at a particular location.

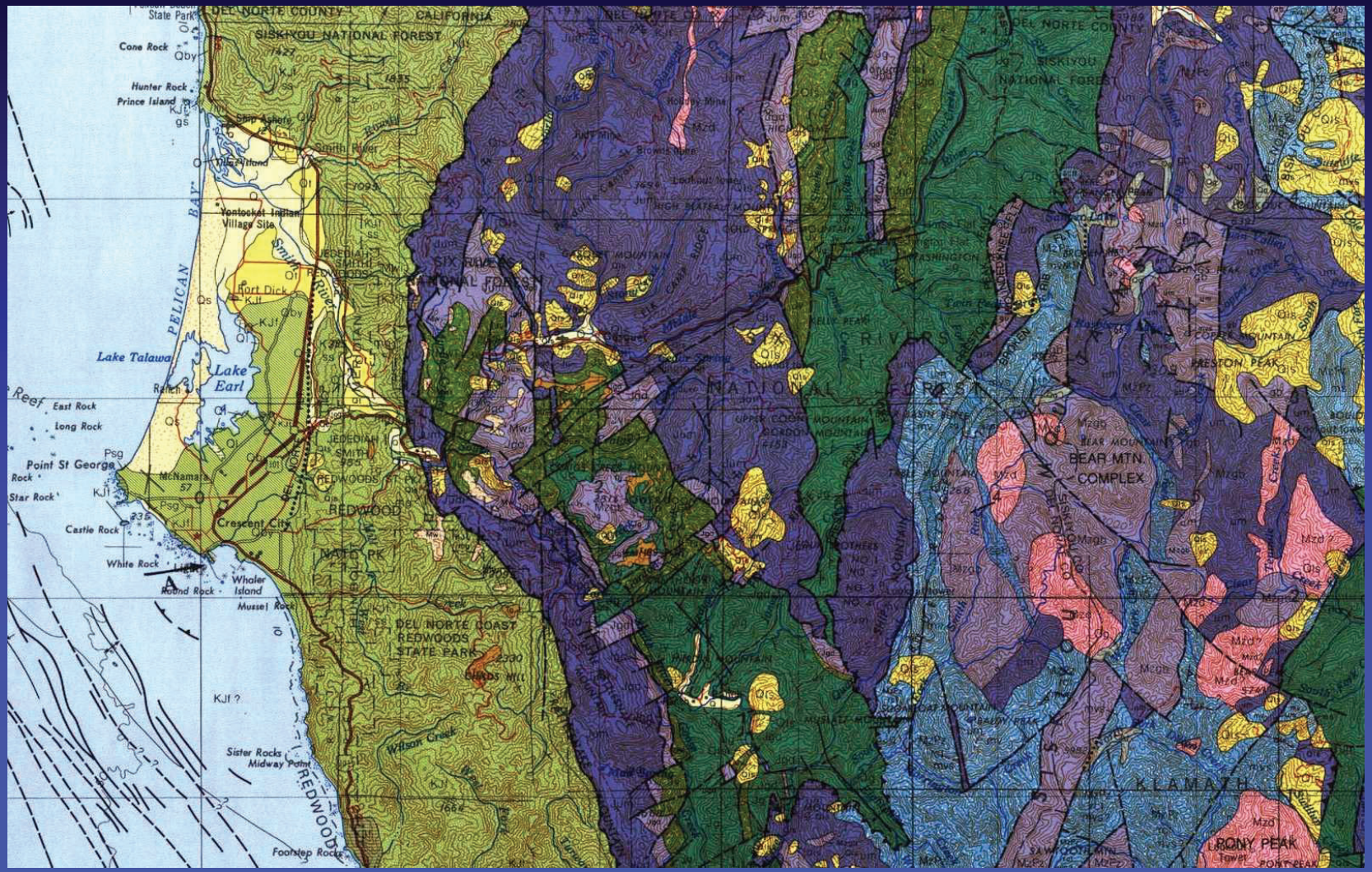
San Jose Area



San Luis Obispo Area



Crescent City Area

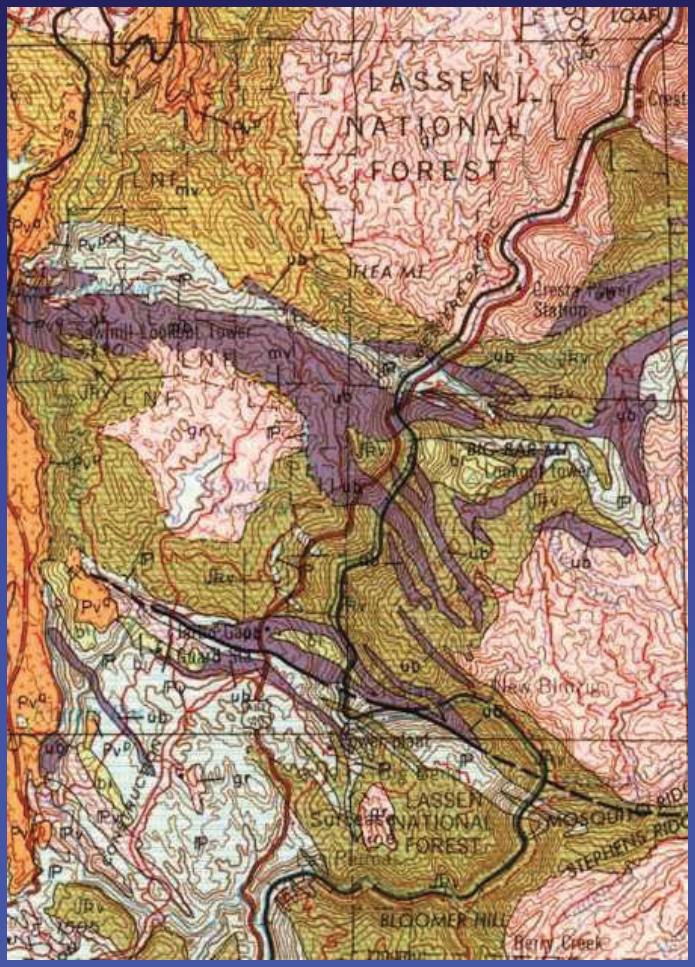


Using Geologic Maps

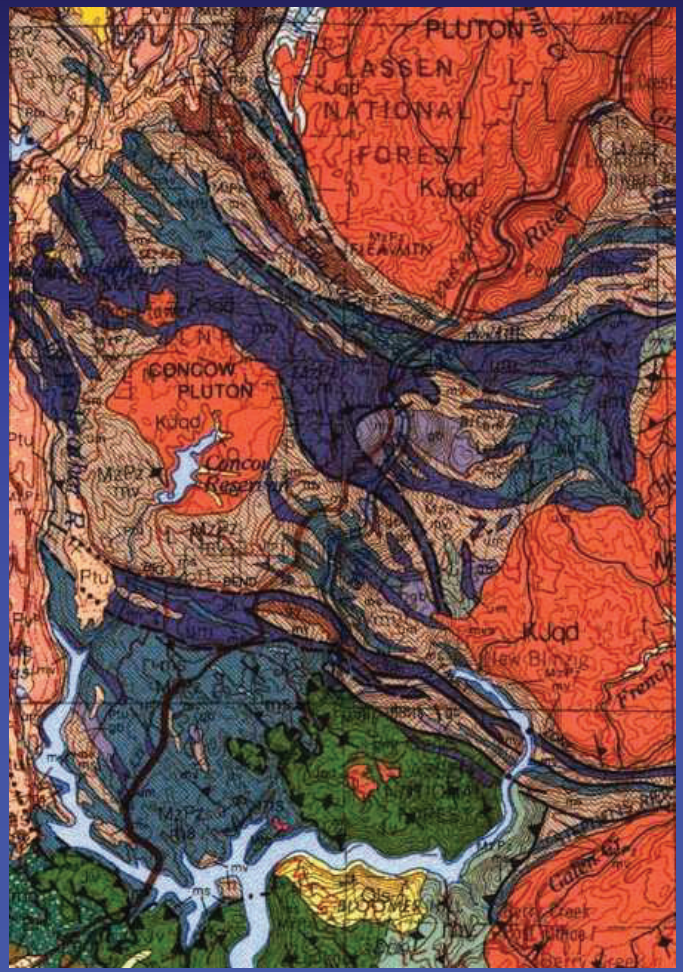
- Be aware of the date or version of the map. More recent maps are usually preferred.
- Use the largest scale (most detailed) maps appropriate for the project.
- Read the map legend to identify which patterns or colors indicate ultramafic or ultrabasic rock units.

Chico Sheet

1962

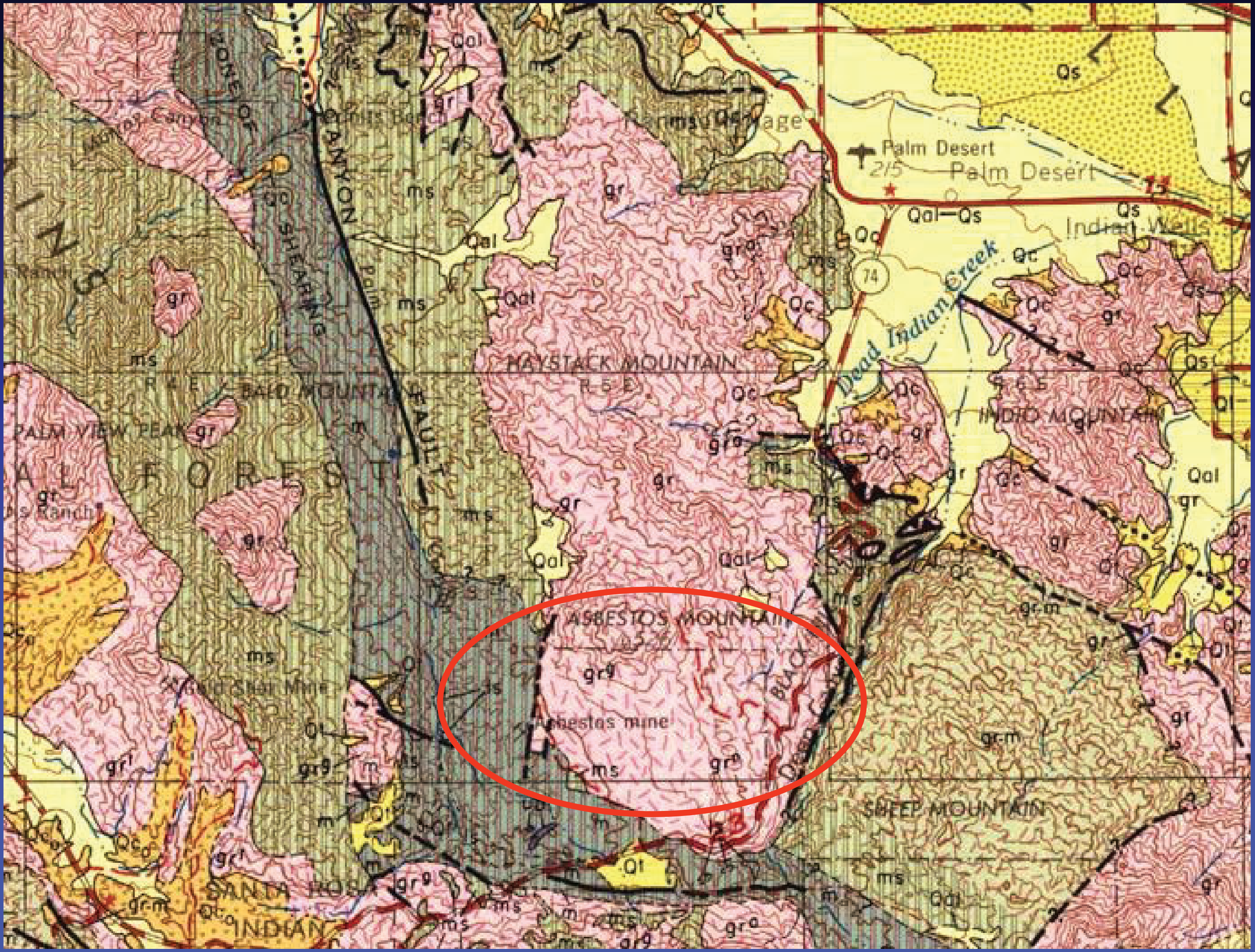


1992



Map Scales

Map Scale	1 Inch	1/20 Inch	1/20 Inch^2
1:1,100,000	17.4 miles	4,583 feet	480 acres
1:250,000	4 miles	1,042 feet	25 acres
1:100,000	1.6 miles	417 feet	4 acres
1:24,000	2,000 feet	100 feet	0.23 acres
1:240	20 feet	1 foot	1 sq. foot

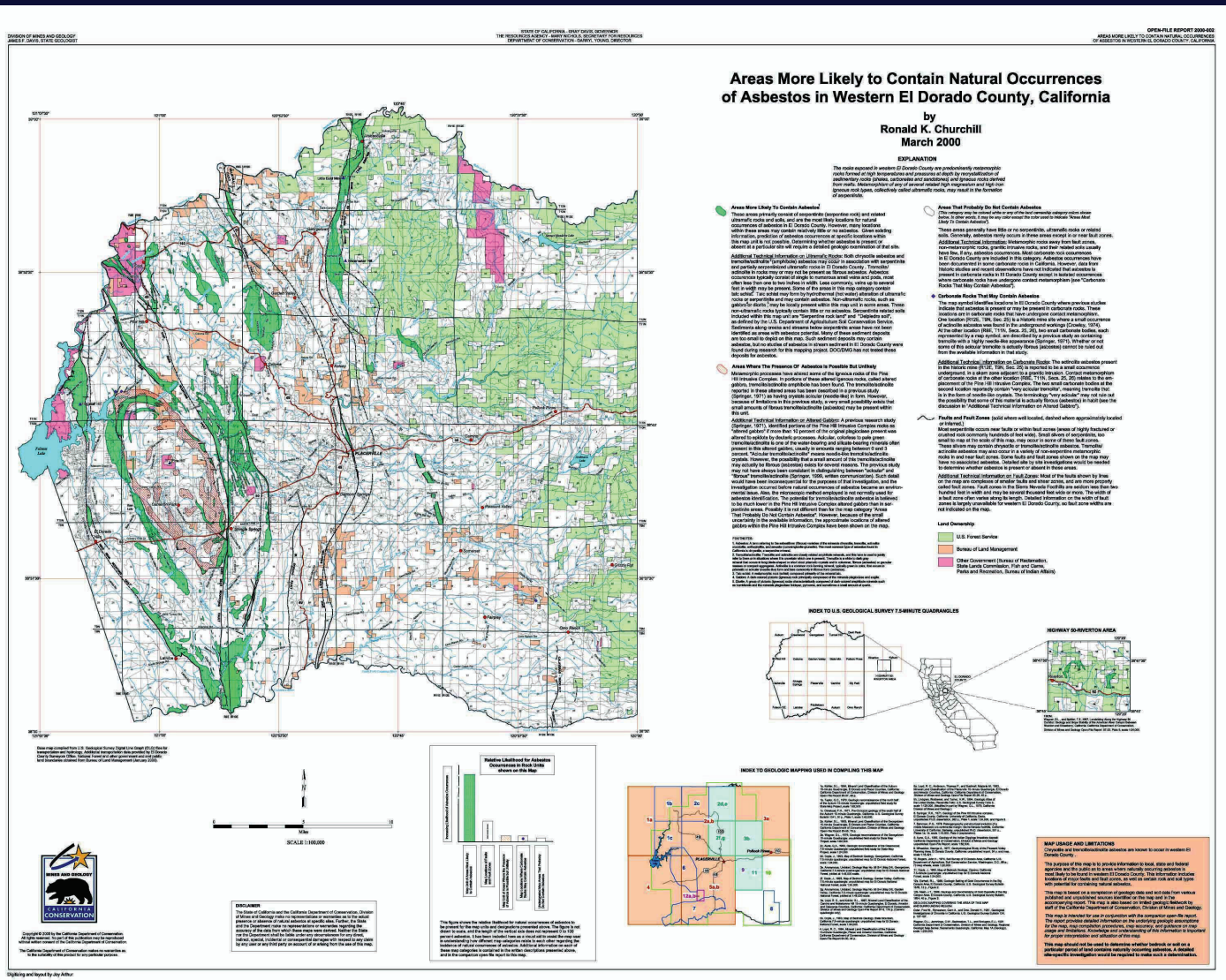


HAYSTACK MOUNTAIN
ASBESTOS MOUNTAIN
Asbestos mine
BALD MOUNTAIN
PALM VIEW PEAK
INDIO MOUNTAIN
SHEEP MOUNTAIN
Palm Desert
Indian Wells
Dead Indian Creek
CANYON
FAULT
SHEARING
ZONE OF
SANTA ROSA
INDIAN

What Is A NOA Map And What Does It Show?

- Compilation of more detailed geologic maps, soils maps, and other geologic information related to NOA.
- Areas likely to contain NOA are identified rather than geologic units.
- Intended for use by non-geologists.

NOA Map


DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST
STATE OF CALIFORNIA - GRAY DAVIS, GOVERNOR
THE RESOURCES AGENCY - MARY NICHOLS, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION - DARRYL YOUNG, DIRECTOR
OPEN-FILE REPORT 2000-002
AREAS MORE LIKELY TO CONTAIN NATURAL OCCURRENCES OF ASBESTOS IN WESTERN EL DORADO COUNTY, CALIFORNIA
Areas More Likely to Contain Natural Occurrences of Asbestos in Western El Dorado County, California
by
Ronald K. Churchill
March 2000
EXPLANATION
Areas More Likely To Contain Asbestos
Areas That Probably Do Not Contain Asbestos
Carbonate Rocks That May Contain Asbestos
Areas Where The Presence Of Asbestos Is Possible But Unlikely
Faults and Fault Zones
Land Ownership
U.S. Forest Service
Bureau of Land Management
Other Government (Bureau of Reclamation, State Lands Commission, Fish and Game, Parks and Recreation, Bureau of Indian Affairs)
INDEX TO U.S. GEOLOGICAL SURVEY 7.5-MINUTE QUADRANGLES
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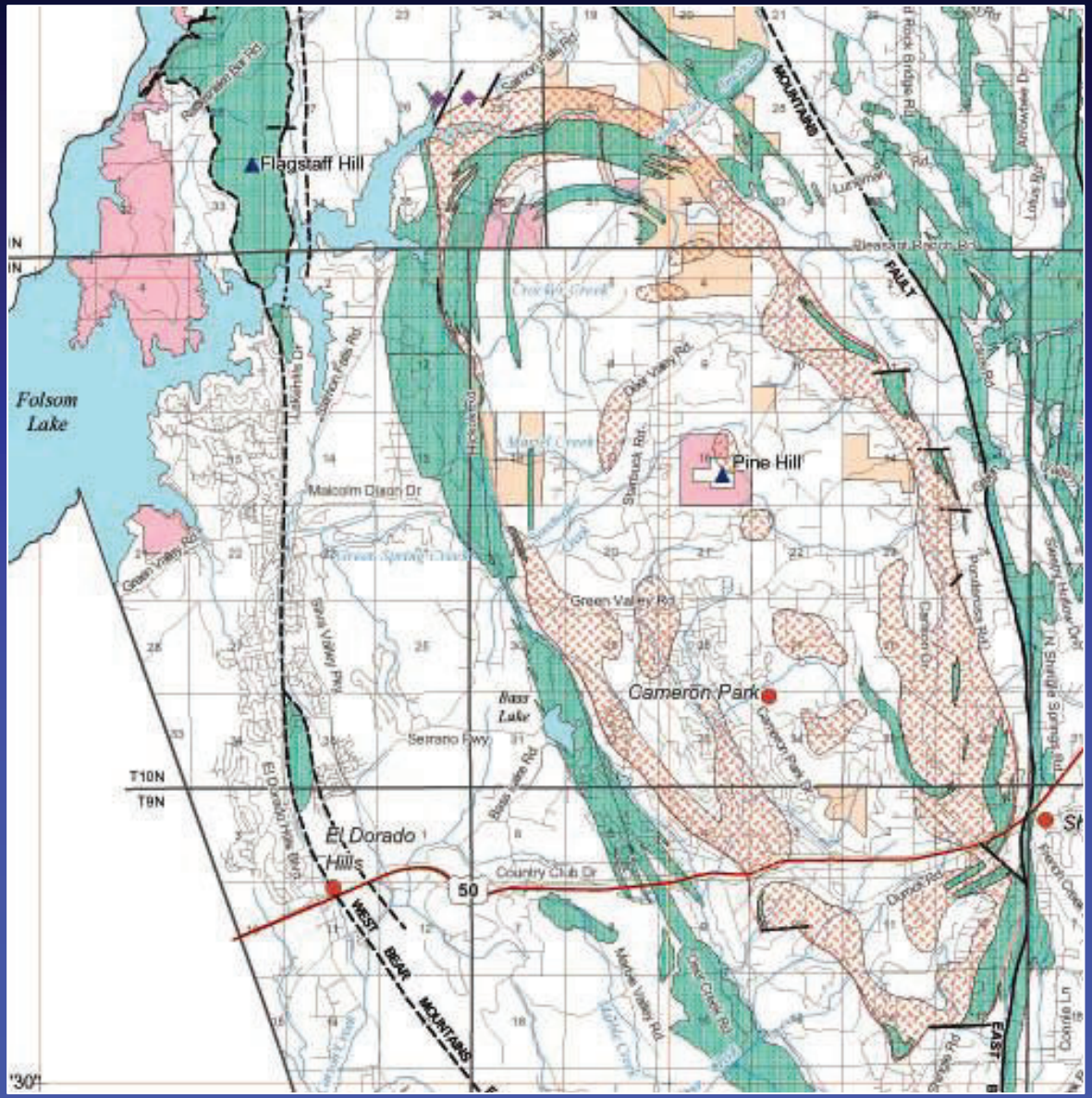
INDEX TO GEOLOGIC MAPPING USED IN COMPILING THIS MAP
Relative Likelihood for Asbestos Occurrences in Rock Units shown on this Map
MINES AND GEOLOGY
CALIFORNIA CONSERVATION
DISCLAIMER
MAP USAGE AND LIMITATIONS
SCALE 1:100,000

NOA Map (detail)



CGS / Caltrans Agreement

- CGS will assist Caltrans by:
  - Providing maps of geographic ultramafic rock units to the Caltrans districts.
  - Providing an index to geologic maps and soils reports for the districts.
  - Providing reports summarizing the potential for NOA in the districts.
  - Assist in training Caltrans staff
  - Other (e.g. detailed NOA maps)