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STUDY OF CANCER MORTALITY IN CHRYSOTILE ASBESTOS MINING COUNTIES

Final Report

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ABSTRACT

The purpose of this study was to implement key data gathering tasks of an epidemiological study protocol formulated as part of the intial program phase. These activities included the asbestos analysis of air and water samples and the identification and development of a study subject data base.

Initially, the ultimate objective of this program was formulated as the evaluation of the hypothesis:

> *Deaths due to respiratory tract cancer, mesothelioma, and cardiovascular disease are associated with the length of residence proximal to asbestos mining activities after controlling for the effects of cigarette smoking, occupation, and genetic susceptibility.*

California death record tapes were secured for the period 1969 through 1978 for the two counties with the most extensive deposits of asbestos bearing serpentine mineral formations. County residents were subdivided according to cause of death as given by the three and four digit ICDA codes. Case and control groups were defined in order to investigate whether the geographical distribution of residence associated with particular categories (case group) differed from that of the control causes. Three case groups were developed for males and females with two controls for each case. Causes of death known to be associated with occupational asbestos exposure were generally taken as case categories whereas controls were selected with precisely the opposing criterion. Case groups were digestive tract cancer, respiratory tract cancer and heart disease with hypertension. Control groups were reproductive cancers, heart disease without hypertension and general categories.

In order to asssociate an inhalation and ingestion exposure index with each individual's residential history, ambient concentrations of asbestos were determined for airborne and waterborne pathways. The California Air Resources Board made available their archive of cellulose high volume air sampler filters from the early 1970 time period. Twenty two filters were selected for electron microscopic analysis. These encompassed the

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geographical area of importance including the adjacent counties with areas outside the serpentine mineral formations. All samples were analyzed for chrysotile content by scanning electron microscope and several by transmission electron microscope as a quality assurance measure. In the serpentine area fiber counts all exceeded $1.0x10^5/m^3$ and ranged to $3.7x10^6/m^3$ (12 samples $6.7x10^5$ average). In the non-serpentine areas all fiber counts were less than $1.0x10^5/m^3$ and averaged $4.9x10^4/m^3$.

Water samples were gathered throughout the area and analyzed for chrysotile concentration. Eight samples contained chrysotile concentrations above the detectable limit of approximately $0.4x10^6$ fibers/liter. The highest concentration measured was approximately $20x10^6$ fibers/liter.

Examination of air and water asbestos concentration findings permitted the assignment of an air exposure index-high, medium, low- to each residence community. Water asbestos were insufficiently elevated and geographically coherent to support the definition of an exposure index.

Acknowledgements

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We further acknowledge the assistance of the local water districts throught out Calaveras and Tuolumne counties as well as the regional air quality managment district. Staff was provided quality assistance from the following individuals - Mr. Alan Miller and Richard Miller for data abstracting and coding, Mr. David Barsky for data base management and programming, Ms. Melanie Nelson for manuscript word processing.

Finally we extend our thanks to Dr. Carl Hayes for his assistance in project oversight during its final stages.

1.0 INTRODUCTION-HISTORY-SUMMARY

This report documents the second phase of a research effort concerning the association between ambient asbestos and cancer mortality. This segment was primarily a data gathering activity and consisted of air and water sampling for asbestos in the Calaveras and Tuolumne counties of California; collection and coding of certain categories of mortality data for the period 1969-1978; and asssignment of asbestos exposure indices to the study subjects. In addition standardized mortality ratios (SMR's) were calculated for somewhat broader mortality categories in the two counties for three years 1969-1971. These SMR values were compared with the expected number of deaths for each cause based upon three-year California rates.

In 1978 the U.S. Environmental Protection Agency performed an in-house study of age adjusted mortality rates in asbestos mining counties across the United States. The results showed increased mortality ratios for buccal and pharyngeal cancer, respiratory cancer, urinary tract cancer and deaths from hypertensive heart disease. Relative risks for these causes of death ranged from 1.2 and 5.6.

One of the limitations of this study was that the exposure to asbestos was defined not on the basis of environmental measurements in the communities, but by census information on mining. The investigators concluded that further investigation was needed and EPA decided to contract (competitively) to fund a case/control study that would include measurements of ambient asbestos exposures. SAI was awarded the procurement in September 1979. The first steps of the program included selecting the most suitable counties for study (resulting in Calaveras and Tuolumne), designing the epidemiological protocol, and developing an air and water sampling and analysis plan. Calaveras and Tuolumne counties were selected for several reasons: A rich and extensive asbestos bearing serpentine formation traverses the western portion of both counties. These counties are rural and individuals tend to be exposed to fewer confounding hazardous emissions. The exposure of this population to asbestos was hypothesized to be significantly elevated in localized portions of the counties while at low background levels in other parts of the counties.

Computer tapes of mortality data were obtained from the office of the State Registrar of Vital Statistics for the two counties for the time period 1969-1978. The data were sorted into computer files according to cause of death (ICDA code), sex, age, and county of residence.* The epidemiologic protocol design was to identify three case groups each of males and females. Each case group consisted of a selected set of causes of death known or suspected of being associated with occupationally related exposure to asbestos. Two control groups were identified for each case group with their selected causes of death categories known to be unrelated to asbestos exposure.

The overall approach thus for each case subject is to identify by age and sex matching, two control group members and associate with each an asbestos exposure index based upon their residence location.

In order to investigate whether air and water ambient levels of asbestos were elevated and to determine their gradients across the county a sampling and analysis approach was designed based upon knowledge of the water distributuion systems, populations, and air quality monitoring stations. It was predicted that roughly half the population in these two counties might have been exposed to elevated concentrations of asbestos in the air and/or water.

In September 1980 EPA approved the study protocol and SAI was issued a new contract to collect the mortality and exposure data. This report documents that contract.

The California Air Resources Board provided assistance to SAI in this study phase by making available their archives of high volume air sampler filters for the earliest time period still retained i.e. 1972 through 1974.* Twenty-two cellulose filters were selected for electron microscopic analysis. These encompassed all geographical areas of importance. Results were clear-cut. In the serpentine area fiber counts <u>all exceeded</u> 100,000 fibers/m^3, ranged to 3,700,000 and averaged 675,000 for 12 samples. In the non-serpentine areas <u>all</u> samples (10) had fiber counts <u>less</u> than 100,000

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* As opposed to county of death.

* It is most desirable to obtain past asbestos concentration information since this more closely reflects the exposure the subject popuation recieved

fibers/m^3 and averaged 49,000. Blanks and duplicates were run as quality assurance measures.

Since no archived water samples were available, twenty four were gathered from throughout the two counties in order to comprehensively characterize the asbestos content in each distinct water distribution system. Eight samples contained chrysotile concentrations above the detectable limit of approximately 400,000 fibers/liter. The highest concentration value measured was approximately 20 x 10^6 fibers/liter which may have been a local phenomenon associated with cement asbestos pipe transport. Unlike the airborne case, waterborne levels were neither significantly elevated nor geographically coherent to support the development of an exposure index.

In summary the airborne levels of asbestos found in communities in the serpentine formation areas are significantly elevated over non-serpentine areas and are more illustrative of occupational environments although the fiber sizes distribution is biased toward the fines. Importantly, of course, those exposed is a non-occupational population which is typically less hardy.

The following case and control groups with identifying cause of death codes (ICD, 8th revision) are being utilized for males and females:

Case Groups	Corresponding Control	Groups
1. Trachea,Bronchus and Lung Cancer (ICD 162.0-162.9)	General Causes (various ICD numbers)	Reproductive Cancers (ICD 174, 185-187.9)
2. Digestive Tract Cancer (ICD 150.0-159.9)	General Causes	Reproductive Cancers
3. Hypertensive Heart Disease (ICD 400.0-404.9, 410.0, 411.0, 412.1-412.2)	General Causes	Non-Hypertensive Heart Disease (ICD 410.9, 411.9, 412.3-412.4)

The total study population is 1382 individuals.

The study group was developed from the State computer tapes discussed above. In order to obtain the information necessary to support the mortality analysis, the death certificate hard copy was located, information abstracted, coded and placed on tape. The death certificate abstract form is shown as Figure 2.1-2. All necessary information has been coded to initiate the tracing of the surviving spouse or informant if that is ever needed.

Subsequent effort for this research would begin at this point. It would be appropriate to perform the analysis of this data base and test for associations between cause of death and the area of residence within the counties. Specifically the correlation between a case group, e.g. the 85 males deceased from the categories of hypertensive heart disease, and their airborne asbestos exposure based on residence history would be statistically contrasted with the 85 age matched males deceased from general causes and finally the 85 who died of non-hypertensive heart disease.

This approach was formulated as the most cost-effective procedure to determine if any categories of mortality correlated with asbestos exposure and to prioritize them.

The master plan for completion of the study, as envisioned by EPA, would be to perform a next of kin survey to improve upon the information base coded from the death certificate. A questionnaire was developed in the initial EPA sponsored contract which primarily obtains or verifies information on smoking, drinking and residence and occupational history. Next of kin interviews would only be considered later for specific case group categories where a convincing association with exposure was found.

2.0 BACKGROUND REVIEW

2.0.1 Health Risks

Health effects due to the occupational exposure to asbestos has been studied particularly in the mining, milling, textile, and construction industries. In their review of findings, EPA researchers (Acquavella, et al. 1979) cited studies* of human cohorts implicating asbestos as a factor in increased mortality from several types of malignancy: mesothelioma, lung and laryngeal cancer (especially for smokers), and possibly GI cancer. Mortality from non-cancerous conditions of the respiratory and possibly cardiovascular system has also been related to chronic occupational exposure (Mancuso, 1967; McDonald, 1971).

Studies have examined the risk of increased mortality among residents in neighborhoods proximal to asbestos processing faciltiies, in areas with natural asbestos deposits, and in communities having identifiable asbestos fibers in public drinking water. Historically such studies have been equivocal. However, recently with the emergence of two key factors (electron microsopy and cancer incidence registries) several studies undertaken have identified and quantified a risk factor among communities with elevated asbestos exposure to airborne and/or waterborne concentrations.

Specifically Graham (1977) demonstrated, through use of tumor registry data, residents in several Quebec communities had risks from 1.5 to 8.1 times higher than control communities for 10 different cancer sites among males and for seven sites among females. The most prominent excesses were found for cancer of pleura, small intestine, salivary gland, peritoneum, lip and tongue for males; and lip and pleura, salivary gland, kidney and melanoma for females.

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* Kleinfield, 1967; Mancuso, 1967; McDonald, 1971; McDonald, 1974; Miller, 1978.

Kanarek et al. 1980, analyzed the asbestos content in the water distribution systems supplying the San Francisco-Oakland Standard Metropolitan Statistical Area (SMSA). The dependent variable of interest was cancer incidence adjusted for age, sex and race. The major independent variable was chrysotile asbestos fiber content. Kanarek showed elevated mortality from cancers of the esophagus, stomach, gall bladder, and pancreas.

Acquavella et al., 1979 investigated the hypothesis that cancer as well as respiratory and cardiovascular disease mortality would be in excess in chrysotile asbestos mining counties across the country. Although national in scope, California figured large in this study since it accounts for over 70% of total U.S. asbestos production. Mortality data from the years 1969-1971 were obtained from the POPATRISK data base. Unfortunately this data base coarsely groups respiratory and digestive tract cancers and does not allow their subdivision into sub-groupings of more specific occupationally asbestos-related sites. Two critical features of the study protocol were that the county level was the smallest population breakdown and in a related limitation a localized source of emissions such as a plant or region of natural asbestos deposits could not be expected to affect the ambient air of an entire county. Thus the study would overestimate the population at risk and therefore dilute potential associations. The study protocol had no mechanism for considering occupational exposure. Control counties were matched according to population density. The results showed increased mortality ratios for buccal and pharyngeal cancer, respiratory cancer, urinary tract cancer, and deaths from hypertensive heart disease. Relative risk for these causes of death ranged from 1.2 to 5.5.

2.0.2 Determination of Air and Water Ambient Asbestos Levels

SAI undertook research to follow-up on the EPA effort discussed above. The purpose of the work was to design and execute an epidemiologic study protocol to further evaluate the hypothesis that asbestos related health effects have been observed among populations without occupational exposure. Two distinct California areas with extensive asbestos bearing serpentine formations were researched. One is associated with a deposit running through the junction of Fresno and San Benito counties (New Idria Deposit). The second is located throughout the western sections of Calaveras and Tuolumne counties (herein referred to as the Calaveras Deposit). The preferable study area was determined to be that associated with the Calaveras Deposit. Selection criteria were three-fold: greater population base, evidence of elevated airborne and waterborne concentrations of asbestos, and the existence of archives (CARB) of useful ambient air sampler filters dating back over seven years.

Figure 2.0-1 illustrates the asbestos deposits in California. The New Idria and Calaveras Deposits are among the richest and most extensive in the state and contain the only active commercial sities. Figure 2.0-1 depicts the general area of Calaveras and Tuolumne counties.

The oldest measured ambient levels of airborne asbestos taken in the western county area was reported by the California Department of Health in 1965-1967 (California Department of Public Health, 1967). Ambient (upwind) asbestos concentration was measured by dust sample collection through impingers. Quantification was by optical microscopy. Ambient levels on two separate occasions were made and ranged between 0.1 and 2 million particles per cubic foot of air (mppcf). A federal study at about the same time of the area "Environmental Survey of Asbestos Mining and Milling in California " (December 1966, Public Health Service Division of Occupational Health) suggests the equivalence 10 total fibers/cc = 1 mppcf by impinger. In the cited ambient concentrations (from the NIOSH Recommended Asbestos Standards) the levels across the country are summarized as generally $<10 ng/m^3$ with occasional peaks as high as 100 ng/m^3 (by electron microscopy). Using optical microscopy, ambient levels are generally less than 0.01 fibers > 5 μm/cc with peak values as high as 0.03 fibers >μ5 m/cc. Using the Public Health Service equivalence 6 fibers > 5 μm/cc, 1 mppcf by impinger yields the mine area ambient (upwind) concentration range 0.6 - 12 fibers/cc.* Further using the NIOSH suggested equivalent 20 fibers > μ5 m in length (as determined by optical microscopy) per nanogram of asbestos yields the mine ambient range 12 - 140 ng/m^3. Thus the ambient levels detected at upwind locations in the vicinity of a Calaveras mine/mill are at the extreme high end of surveyed range. A number of subsequent studies of the general area have confirmed that quite elevated concentrations of airborne asbestos exist. The most recent, of course, being the comprehensive analysis done of the area performed by SAI for EPA in 1980.

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* Note the current NIOSH recommended standard is 0.1 fiber/cc for an 8 hour time-weighted average (as detected by optical microscopy).

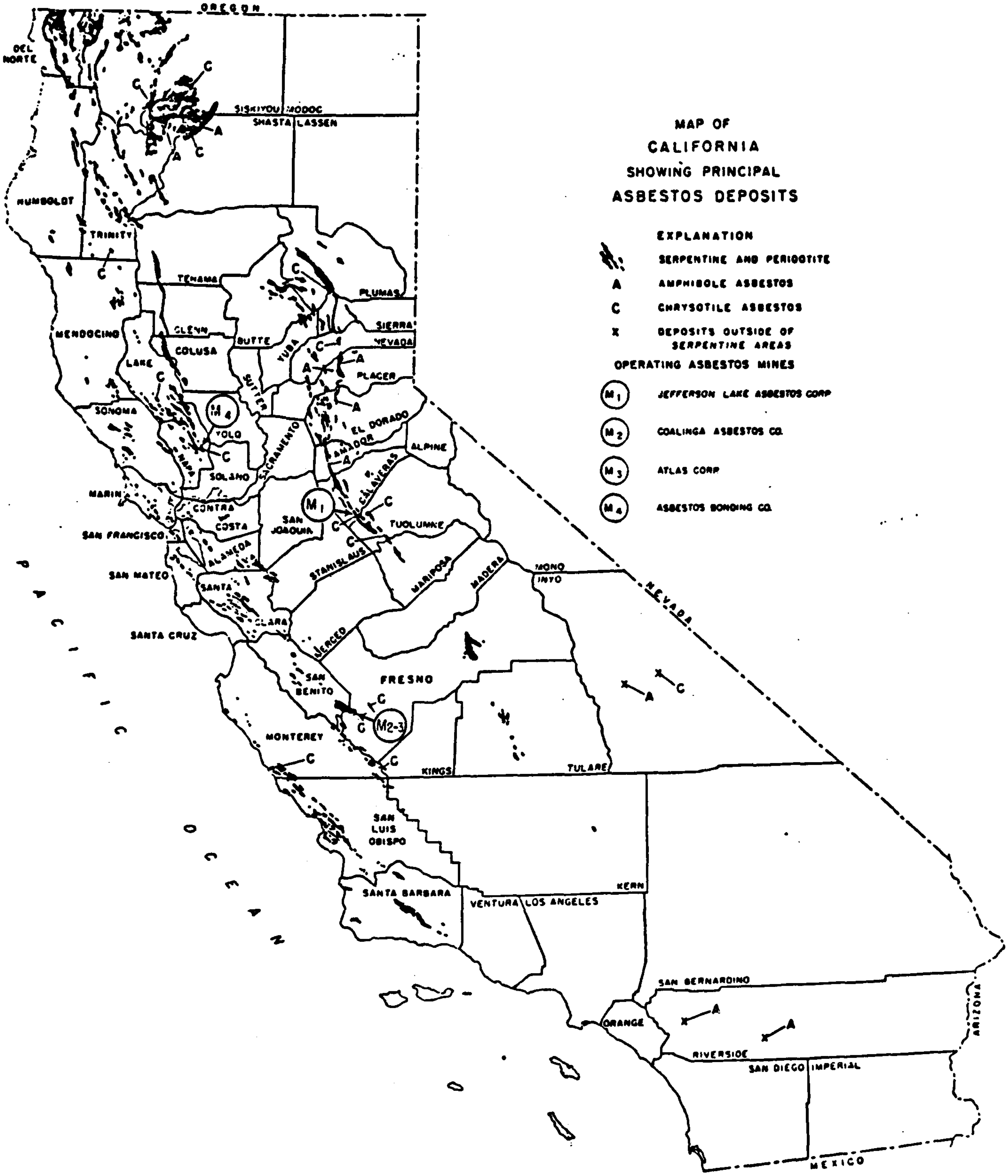

Figure 2.0-1 Asbestos Deposits of California.

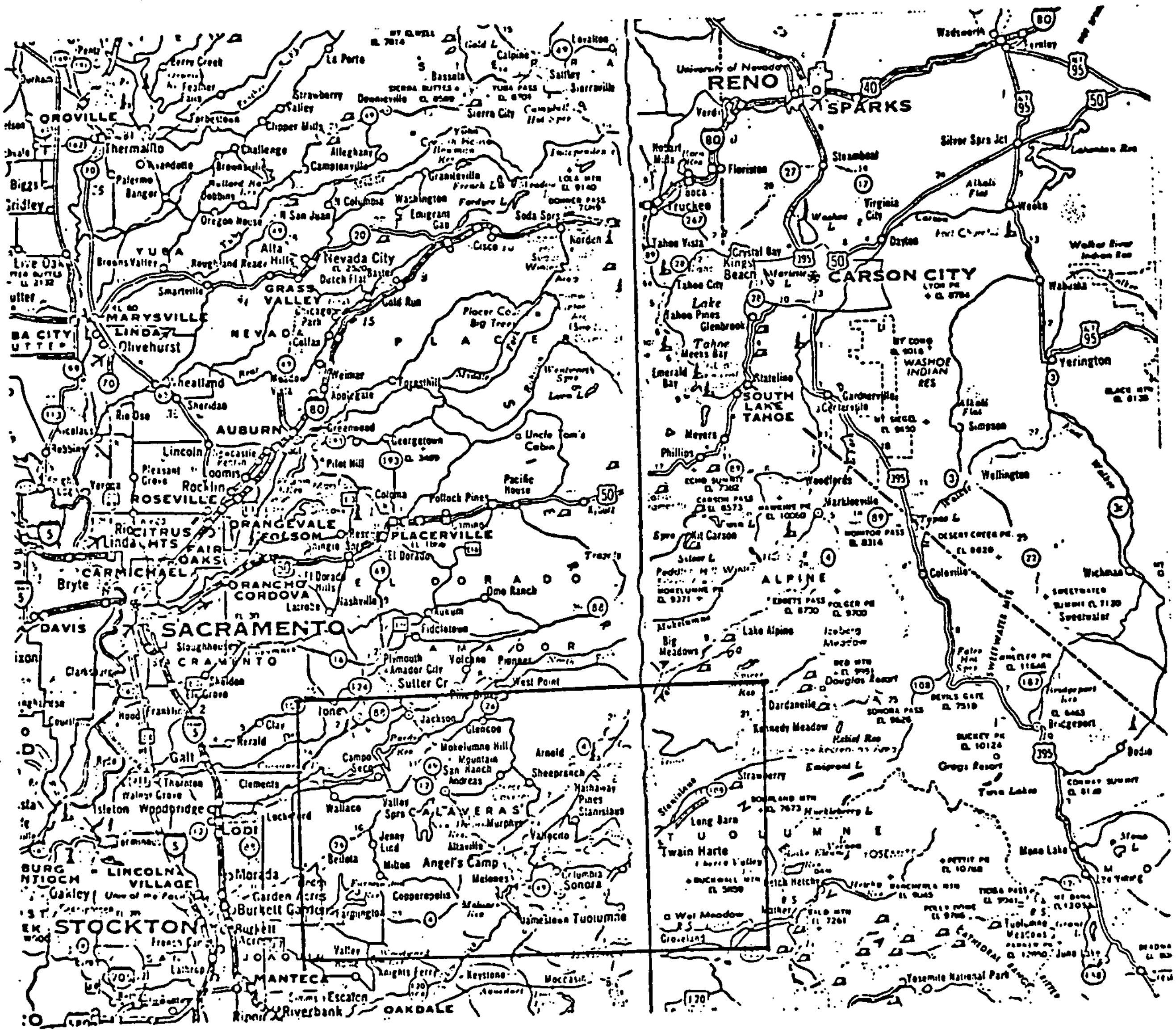

Figure 2.0-2 Serpentine Areas of Calaveras and Tuolumne Counties.

The California Air Resources board provided hi-vol sampler filters from geographical areas of interest. Available samples went back to 1972. Analysis of these filters provided an important basis for the determination of airborne asbestos exposure to the study population.

Filter selection procedure was to obtain 22 filters accounting for seasonal variation at significant single locations, coverage of the entire geographical region, and representation of suspected high and low suspended particulate values. In addition, all hi-vol filter flow traces were inspected to confirm that regular flow rates occurred throughout the collection period and that no data tampering was evidenced.

Table 2.0-1 summarizes the results of the scanning electron microscope analyses. Fiber counts and other data should be read as follows for SAI number 81-1101 there were 3,251,00 fibers/m^3 in the fiber size range of less than 5 microns length. Figure 2.0-3 and Table 2.0-2 can be used to explicitly interpret all sample locations. As can be readily seen from Table 2.0-1 the first twelve readings (sites 55922, 55921 and 22741) are significantly elevated over the remainder. i.e. serpentine deposit sites compared to non-serpentine. Furthermore the serpentine area concentrations must be assessed as extremely high by any measure and would be of note even in an occupational environment.

In addition to analysis by scannning electron microscopy several analyses were performed by TEM (transmission electron microscope) as a quality assurance procedure. TEM Analysis was conducted using a Hitachi Model H-500 Scanning Transmission Electron Microsope equipped with both SAED and Dispersive X-ray capabilities. Two grids for each sample were counted at a magnification of 10,000X and the diameter measurements were made at magnifications of 100,000X or 200,000X. The magnifications were calibrated using a carbon grating replica. Chrysotile fibers were identified according to morphology and/or selected area electron diffraction. Comparison of TEM and SEM analysis for 81-1116-2 (Sonora 55922 9/20/74) and 81-1235 (Van401ELD 09001 8/14/73) are summarized in Table 2.0-3.

The fiber counts for the TEM analysis are slightly higher due to the higher resolving power of the TEM.

Table 2.1-1

SUMMARY ASBESTOS ANALYSIS BY ELECTRON MICROSCOPY OF STUDY AREA HI-VOL FILTERS

SAI Number	Location	Site	Collection Date	fibers/m^3 ≤5μm (10^{-3})	fibers/m^3 >5μm (10^{-3})	mass/m^3 ≤5μm (10^{-3})	mass/m^3 >5μm (10^{-3})	Surface area/m^3 ≤5μm (10^{-3})	Surface area/m^3 >5μm (10^{-3})
81-1101	Sonora	55922	08-08-73	3251	448	221	147	2513	1578
81-1097	Sonora	55922	10-25-73	232	24	118	15	379	127
81-1116	Sonora	55922	09-20-74	704	12	46	18	456	105
^81-1094	Sonora	55922	12-30-73	247±145	44±23	37±21	24237±33748	234±130	5205±6243
81-1120	Sonora	55922	06-28-74	106	8.4	13	380	89	333
81-1099	Sonora	55922	09-25-73	388	38	43	16	332	185
81-1121	Sonora	55922	04-05-74	231	26	31	27	201	122
81-1118	Sonora	55922	07-22-74	153	9.5	86	1461	204	752
81-1102	Sonora	55921	07-15-73	378	73	73	202	401	526
*81-1106	Sonora	55921	05-24-73	1031±253	79±60	268±130	435±214	1305±106	2100±183
81-1110	Sonora	55921	03-23-73	86	14	3.8	103	45	216
81-1092	Mariposa	22741	07-11-72	417	31	44	7.2	360	104
81-1231	Camino	09663	04-10-73	7.5	0.0	0.4	0.0	4.5	0.0
81-1232	Placerville	09664	04-10-73	29	13	1.6	7.5	15	61
81-1235	Van 401 ELD	09001	08-14-73	14	0.0	0.5	0.0	6.3	0.0
81-1199	Modesto	50557	07-26-72	66	16	10	160	59	232
81-1204	Stockton	39252	07-25-72	29	0.0	5.1	0.0	40	0.0
81-1213	Leevining	26772	09-20-72						
81-1217#2	Madera	20001	11-20-72	46	1.9	1.3	11	21	37
81-1218	Madera	20002	03-13-73	79	8.3	3.1	2.8	38	23
81-1197	Bridgeport	26773	04-07-73	10	3.4	0.1	39	2.0	74
81-1196	Van 201 ELD	09301	06-15-73	18	0.0	11	0.0	33	0.0
Sample blank #29 (same ashed blank dilution as sample filters)				0.0	0.0	0.0	0.0	0.0	0.0
Sample blank #2 (10 fold ashed blank dilution as sample filters)				7.0	0.8	0.3	3.4	4.4	9.6
Sample blank #2 (10 fold aerosol O.T. and filtered water blank)				0.0	0.0	0.0	0.0	0.0	0.0

*denotes filter variation within one sample filtration

^denotes sample variation between two separately filtered samples

Figure 2.0-3 Site Locations of Samples Analyzed for Asbestos

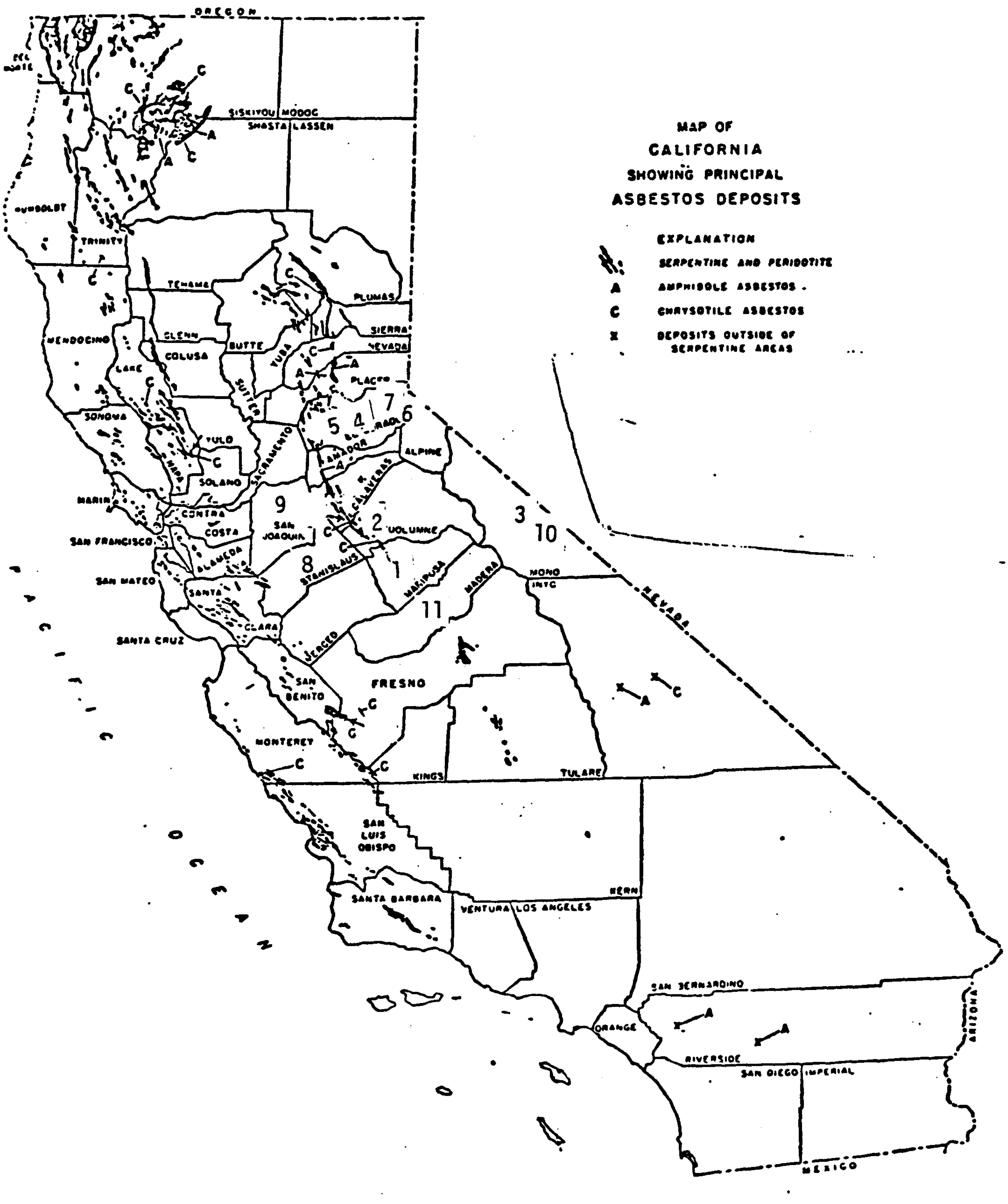

Table 2.0-2 Ambient Asbestos Samples-Site Designations

Site Designation	Site Location	Sample Date
1	Mariposa	7/11/72
2A	Sonora Location #1	3/23/73, 5/24/73, 7/15/73
2B	Sonora Location #2	8/8/73, 9/25/73, 10/25/73, 12/30/73, 4/15/74, 6/28/74. 9/20/74
3	Bridgeport	4/7/73
4	Camino	4/10/73
5	Placerville	4/10/73
6	Van 201	6/15/73
7	Van 401	8/14/73
8	Modesto	7/26/72
9	Stockton	7/25/72
10	Lee Vining	9/20/72
11A	Madera #1	11/20/72
11B	Madera #2	3/13/73

The surface area and mass values are slightly higher in the SEM analysis which is probably due to the apparently larger fiber diameters which result either from gold coating the filters or problems with resolution above magnifications of 50,000X.

Appendix A contains information on the procedures used for the preparation and analysis of the electron microscopy effort. The microscope facilities are described and additional remarks are made pertaining to the results and conclusions.

Analysis of the turbidity and asbestos content of water samples was conducted by the Exposure Evaluation Branch of the Epidemiology Division, Health Effects Research Laboratory, EPA Cincinnati: Twenty three water samples were gathered by SAI staff encompassing the population centers and water distribution systems. Table 2.0-4 delineates the sampling sites and Table 2.0-5 summarizes the analysis results. The water distribution system location and types - both historic and current were discussed in the final report from the initial contract (Ziskind, 1980). Ten samples contained statistically significant amounts of chrysotile asbestos with three samples over 1 million fibers per liter. The highest concentration measured was at Groveland (20 x 10^6 fibers/liter) and appears to be due to aggressive water transport through asbestos cement pipe (Personal Communication B. Beaudreau, General Manager, Groveland Commercial Services District). The pH in the Groveland system decreases to approximately 6.0 after gas chlorination. Lime treatment is planned to raise pH to greater than 9 which should reduce the asbestos content in the water. In any event the system is localized and fairly recent (16 years).

It was concluded that asbestos concentration in water was neither particularly elevated nor distributed with a sufficient gradient to warrant creating an exposure index for use in the epidemiologic protocol. It was decided, on the other hand, that airborne concentration of asbesto fulfilled both criteria (sufficiently elevated levels and geographic gradient) and exposure indices were formulated. Categories of asbestos concentration areas in the two counties were defined as either high, medium and low according to whether they were less than 5 miles from deposits, between 6 and 10 miles, or greater than 10 miles. Deposits were readily located on the area geological maps and each community was labeled and coded for incorporation into the

Table 2.0-4 ASBESTOS WATER SAMPLING SITES

57303	-	Residency 270 High School Street San Andreas (Utility Sink)
57304	-	Residency 151 Chestnut Street Valley Springs (Garden)
57305	-	Residency 8288 West Main Mukelumne Hill (Garages)
57306	-	Residency Main Street West Point (Garden)
57307	-	Haags Store (Also Residency) R.R. Flats Rd. (Well Water) R.R. Flats (Bathroom Sink) (No Filter)
57308	-	Residency 429 Church Murphys (Kitchen Sink - No Filter)
57309	-	Murphy's Hotel Murphy's (Bathroom Sink - No Filter)
57310	-	Jackpot Gas Main Street Angels Camp (Bathroom Sink - No Filter)
57311	-	Residency 1280 Bush Angels Camp (Garden)
57312	-	Gold Rush Mobile Homes Parrott's Ferry Road Columbia (Bathroom)
57313	-	Old Tuolumne County Court House Yaney Street Sonora (Bathroom)
57314	-	Residency 33 Bradford W. Sonora (Garden)
57315	-	Residency 514 Stewart Sonora (Garden)

57316		Residency 18415 Gardner Ave. Tuolumne (Garden) (A little murky brown)
57317	-	Residency (Apt. Bldg.) 22771 Twain Harte Drive Twain Harte (Garden)
57318	-	Strawberry Store (Gen. Store and residency) Hwy 108 Strawberry (Garden)
57319	-	The Square Nail Restaurant 18376 Bay Ave. Tuolumne (Bathroom)
57320	-	Yosemite Bank Hwy 120 Groveland (Bathroom)
57321	-	Residency 121 (The Main Street) Copperopolis (Garden)
57322	-	Same as 57321
57323	-	Same location as 57320
57324	-	Same location as 57306
57325	-	Black Bart Inn - Garden Faucet 55 St. Charles Street (Hwy 49) San Andreas

Samples 57303 - 57322 were taken in October 1980
Samples 57323 - 57325 were taken in March 1981

Table 2.0-5 Turbidity and Asbestos Results for California Samples

Sample No.	Description	Turbidity (JTU)	Chrysotile Concentration Millions of Fibers/liter Conc.	95%Confidence Limits Upper	Lower
57303	San Andreas	0.6	NSS (0.3)*	0.5	0.05
57304	Valley Springs	2.1	BDL (0.1)**	-	-
57305	McKellumme Hill	3.3	0.4	0.8	0.05
57306	West point	1.6	5.5	6.9	4.0
57307	Railroad Flats	2.5	NSS (0.1)	0.4	0.09
57308	Murphys	1.4	0.6	1.1	0.1
57309	Murphys	2.5	0.6	0.9	0.3
57310	Angels Camp	0.3	NSS (0.1)	0.3	0.02
57311	Angels Camp	0.7	0.7	1.0	0.4
57312	Columbia	0.6	BDL (0.05)	-	-
57313	Sonora	0.3	0.5	0.8	0.2
57314	Sonora	0.2	NSS (0.2)	0.4	0.01
57315	Sonora	0.5	BDL (0.06)	-	-
57316	Tuolumne	10.0	NSS (0.4)	1.0	0.3
57317	Twain Harre	0.3	NSS (0.3)	0.5	0.05
57318	Strawberry	0.9	NSS (0.06)	0.2	0.05
57319	Tuotumne	0.7	BDL (0.07	-	-
57320	Groveland	0.5	3.2	4.2	2.3
57321	Copperopolis	1.3	BDL (0.3)	-	-
57322	Copperopolis	5.5	BDL (0.3)	-	-
57323	Groveland	-	20.1	-	-
57324	West Point	-	0.4	-	-
57325	San Andreas	-	0.5	-	-
2551A	Blank	0.2	NSS (0.05)	0.2	0.05
2551E	Blank	0.2	BDL (0.05)	-	-
2552E	Blank	0.2	NSS (0.15)	0.4	0.09
2562E	Blank	0.2	BDL (0.05)	-	-
2561E	Blank	0.2	BDL (0.05)	-	-
2581A	Blank	0.2	NSS (0.05)	0.2	0.05
2601A	Blank	-	BDL (0.05)	-	-

* NSS - Non-significant. While concentrations based on less than five fibers may show the presence of asbestos in the water, the actual value is not considered very reliable.

** BDL - Below the detectable limit shown. No fibers were seen in the analysis.

coding of the mortality data base. The flexibility was retained to assign numerical values of fiber concentration to each area. In the serpentine areas fiber counts exceeded 100,000 fibers/m^3, ranged to 3,700,000 and averaged 675,000. In the non-serpentine area (all greater than 10 miles distance) all samples had fiber counts less than 100,000 fibers/m^3 and averaged 49,000. In addition to the residence of the deceased individual being recorded on the death certificate their length of stay in the county and in the state are recorded as denoted in Figure 2.0-3. Although without further investigation it would not be possible to verify their residence history in the county during that period, it does facilitate the elimination from the study of individuals with less than a minimal period of residence in the county. Furthermore it is thus possible to define an exposure index equal to the product of length of stay in the county and average fiber concentration in the area of residence.

2.0.3 Case and Control Selection

The study group was defined as those individuals who died in Calaveras and Tuolumne Counties during the ten year period 1969 and 1978. Approximately 4300 individuals, nearly all white, were found to be in that population. It was predicted that approximately one half of the population would have resided in the serpentine formation areas and therefore the counties would provide a useful distribution of residence (exposure index) for contrast among ICDA categories.

Both cases and controls were identified from the California state death tapes. The tapes are compiled monthly alphabetically by county of death. Thus it was necessary to obtain the complete tapes from Calaveras and Tuolumne counties and those entries from throughout the state of residents of Calaveras and Tuolumne counties who died elsewhere. These tapes have coded the basic information from the death certificate including the full name, date of death, sex, race, birthplace, date of birth, age, county of death and residence cause of death (4 digit) and local (county) file number.

The listings were sorted into groups according to the International Classification of Diseases (ICD) code for the underlying cause of death. A ten year time interval (1969-1978) was selected in order to gain a sufficient statistical base while not proceeding into the more distant past thereby complicating the study by introducing earlier revisions of the ICD codes.

Causes of death hypothesized as linked to asbestos exposure (primarily based upon the occupational literature) were delineated and case groups formed as follows:

CERTIFICATE OF DEATH

STATE FILE NUMBER — STATE OF CALIFORNIA—DEPARTMENT OF PUBLIC HEALTH — LOCAL REGISTRATION DISTRICT AND CERTIFICATE NUMBER

DECEDENT PERSONAL DATA

1A NAME OF DECEASED—FIRST NAME	1B. MIDDLE NAME	1C LAST NAME	2A DATE OF DEATH—MONTH, DAY, YEAR	2B HOUR M
3. SEX	4 COLOR OR RACE	5 BIRTHPLACE (STATE OR FOREIGN COUNTRY)	6. DATE OF BIRTH	7. AGE (LAST BIRTHDAY) YEARS / IF UNDER 1 YEAR: MONTHS, DAYS / IF UNDER 24 HOURS: HOURS, MINUTES
8 NAME AND BIRTHPLACE OF FATHER		9 MAIDEN NAME AND BIRTHPLACE OF MOTHER		
10. CITIZEN OF WHAT COUNTRY	11. SOCIAL SECURITY NUMBER	12. MARRIED, NEVER MARRIED, WIDOWED, DIVORCED (SPECIFY)	13. NAME OF SURVIVING SPOUSE (IF WIFE, ENTER MAIDEN NAME)	
14. LAST OCCUPATION	15. NUMBER OF YEARS IN THIS OCCUPATION	16 NAME OF LAST EMPLOYING COMPANY OR FIRM (IF SELF EMPLOYED, SO STATE)	17. KIND OF INDUSTRY OR BUSINESS	

PLACE OF DEATH

18A. PLACE OF DEATH—NAME OF HOSPITAL OR OTHER IN-PATIENT FACILITY	18B. STREET ADDRESS—(STREET AND NUMBER, OR LOCATION)		18C INSIDE CITY CORPORATE LIMITS (SPECIFY YES OR NO)
18D. CITY OR TOWN	18E. COUNTY	18F. LENGTH OF STAY IN COUNTY OF DEATH YEARS	18G. LENGTH OF STAY IN CALIFORNIA YEARS

USUAL RESIDENCE (IF DEATH OCCURRED IN INSTITUTION, ENTER RESIDENCE BEFORE ADMISSION)

19A. USUAL RESIDENCE—STREET ADDRESS (STREET AND NUMBER OR LOCATION)		19B. INSIDE CITY CORPORATE LIMITS (SPECIFY YES OR NO)	20. NAME AND MAILING ADDRESS OF INFORMANT
19C. CITY OR TOWN	19D. COUNTY	19E STATE	

PHYSICIAN'S OR CORONER'S CERTIFICATION

21A. CORONER: I HEREBY CERTIFY THAT DEATH OCCURRED AT THE HOUR, DATE AND PLACE STATED ABOVE FROM THE CAUSES STATED BELOW AND THAT I HAVE HELD AN INVESTIGATION OR INQUEST ON THE REMAINS OF DECEASED AS REQUIRED BY LAW	21B. PHYSICIAN: I HEREBY CERTIFY THAT DEATH OCCURRED AT THE HOUR, DATE AND PLACE STATED ABOVE FROM THE CAUSES STATED BELOW AND THAT I ATTENDED THE DECEASED FROM (ENTER MONTH, DAY, YEAR) TO (ENTER MONTH, DAY, YEAR) AND LAST SAW THE DECEASED ALIVE ON (ENTER MONTH, DAY, YEAR)	21C. PHYSICIAN OR CORONER—SIGNATURE AND DEGREE OR TITLE ▶	21D. DATE SIGNED
		21E. ADDRESS	21F. PHYSICIAN'S CALIFORNIA LICENSE NUMBER

FUNERAL DIRECTOR AND LOCAL REGISTRAR

22A SPECIFY BURIAL, ENTOMBMENT OR CREMATION	22B. DATE	23. NAME OF CEMETERY OR CREMATORY	24. EMBALMER—SIGNATURE (IF BODY EMBALMED) LICENSE NUMBER
25. NAME OF FUNERAL DIRECTOR (OR PERSON ACTING AS SUCH)	26. IF NOT CERTIFIED BY CORONER, WAS THIS DEATH REPORTED TO CORONER? (SPECIFY YES OR NO)	27. LOCAL REGISTRAR—SIGNATURE ▶	28. DATE ACCEPTED FOR REGISTRATION BY LOCAL REGISTRAR

MEDICAL AND HEALTH DATA

CAUSE OF DEATH

29. PART I. DEATH WAS CAUSED BY: ENTER ONLY ONE CAUSE PER LINE FOR A, B, AND C

IMMEDIATE CAUSE (A)

CONDITIONS, IF ANY, WHICH GAVE RISE TO THE IMMEDIATE CAUSE (A), STATING THE UNDERLYING CAUSE LAST

DUE TO, OR AS A CONSEQUENCE OF (B)

DUE TO, OR AS A CONSEQUENCE OF (C)

APPROXIMATE INTERVAL BETWEEN ONSET AND DEATH

30. PART II: OTHER SIGNIFICANT CONDITIONS—CONTRIBUTING TO DEATH BUT NOT RELATED TO THE IMMEDIATE CAUSE GIVEN IN PART I	31. WAS OPERATION OR BIOPSY PERFORMED FOR ANY CONDITION IN ITEMS 29 OR 30? (SPECIFY OPERATION AND OR BIOPSY)	32A. AUTOPSY (SPECIFY YES OR NO)	32B. IF YES, WERE FINDINGS CONSIDERED IN DETERMINING CAUSE OF DEATH? (SPECIFY YES OR NO)

INJURY INFORMATION

33 SPECIFY ACCIDENT, SUICIDE OR HOMICIDE	34 PLACE OF INJURY (SPECIFY HOME, FARM, FACTORY, STREET, OFFICE BUILDING, ETC.)	35 INJURY AT WORK (SPECIFY YES OR NO)	36A DATE OF INJURY—MONTH, DAY, YEAR	36B HOUR M
37A. PLACE OF INJURY (STREET AND NUMBER OR LOCATION AND CITY OR TOWN)		37B. DISTANCE FROM PLACE OF INJURY TO USUAL RESIDENCE (ITEM 19) MILES	38. WERE LABORATORY TESTS DONE FOR DRUGS OR TOXIC CHEMICALS? (SPECIFY YES OR NO)	39 WERE LABORATORY TESTS DONE FOR ALCOHOL? (SPECIFY YES OR NO)

40. DESCRIBE HOW INJURY OCCURRED (ENTER SEQUENCE OF EVENTS WHICH RESULTED IN INJURY. NATURE OF INJURY SHOULD BE ENTERED IN ITEM 29)

STATE REGISTRAR

A	B	C.	D.	E.	F.

REV 1-1 GR Form VS-11

Figure 2.0-3
CERTIFICATE OF DEATH-California

A. Case Groups (hypothesized associations with asbestos exposure)

1. Malignant Neoplasms of Digestive Organs and Peritoneum
   ICD 150.0 to 159.9
2. Malignant Neoplasm of Trachea, Bronchus and Lung ICD 162.0 to 162.9
3. Hypertensive Heart Disease ICD 400.0 to 404.9, 410.0, 411.0, 412.1 to 2.2

B. Control Groups (no hypothesized association with asbestos exposure)

1. Reproductive Neoplasms (matched to digestive and respiratory cancer case groups)

   Males: ICD 185.0 to 187.9 (Prostate, Testes, Other and Unspecified)
   Females: ICD 174.0 to 174.9 (Breast)
2. Non-Hypertensive Heart Disease (matched to hypertensive heart disease case group) ICD 410.9, 411.9, 412.3 to 412.4
3. General Causes of Death (Matched to digestive, respiratory and hypertensive heart disease case groups). Includes all causes of Death, except:

   a) Tuberculosis ICD 10.0 to 19.9
   b) Malignant Neoplasms of Digestive Organs and Peritoneum
      ICD 150.0 to 159.9
   c) Malignant Neoplasms of Trachea, Bronchus and Lung
      ICD 162.0 to 162.9
   d) Malignant Neoplasms of Breast ICD 174.0 to 174.9
   e) Malignant Neoplasms of Prostate, Testes, Other and Unspecified
      Male Genital Organs ICD 185.0 to 187.9
   f) Malignant Neoplasms Without Specification of Site ICD 199.0 to 199.9
   g) Mental Disorders ICD 290.0 to 315.9
   h) Hypertensive Disease ICD 400.0 to 404.9
   i) Ischaemic Heart Disease ICD 410.0 to 412.9
   j) Cerebrovascular Disease ICD 430.0 to 438.9
   k) Diseases of the Respiratory System ICD 460.0 to 519.9
   l) Diseases of the Digestive System ICD 520.0 to 577.9
   m) Complications of Pregnancy, Childbirth and the Puerperium
      ICD 630.0 to 678.9
   n) Congenital Anomalies ICD 740.0 to 759.9
   o) Causes of Perinatal Morbidity and Mortality ICD 760.0 to 779.9
   p) Water Transport Accidents ICD 830.0 to 833.9
   q) Other and Unspecified Accidental Falls ICD 887.0 to 887.9
   r) Accidental Drowning and Submersion ICD 910.0 to 910.9
   s) Accident Caused by Firearm Missiles ICD 922.0 to 922.9
   t) Suicide and Self-Inflicted Injury ICD 950.0 to 959.9
   u) Homicide ICD 960.0 to 969.0
   v) Legal Intervention ICD 970.0 to 978.9
   w) Injury Undetermined Whether Accidentally or Purposely Inflicted
      ICD 980.0 to 989.9
   x) Injury Resulting from Operations of War ICD 990.0 to 999.9

These categories were eliminated from the general control causes of death because they included:

1. Other case or control categories (b, c, d, e, h, i)
2. Categories which could be associated with asbestos exposure and/or the three case categories (a, f, j, k, l)
3, Categories unlikely to contain records that would be age-matchable to case records (m, n, o)
4. Categories containing deaths due to recreational activities, which could be related to length of stay in the county, or place of residence within the county (p, q, r, s)
5. Categories containing deaths likely to present difficulties in obtaining information from survivors due to their sensitive nature (g, t, u, v, w, x)

All case and control subjects chosen were white, recorded as residents of either Calaveras or Tuolumne Counties, and died in years 1969 through 1978.

In summary, three case groups were selected which have been cited in the occupational or general epidemiologic literature as suspected of being asbestos related. We have selected specific concomitant cancer or heart disease control groups and a general control group. Table 2.0-6 provides the breakdown on the case and control group sizes.

The general control group included all categories except 1) those which could possibly be associated with asbestos exposure, e.g. digestive and respiratory diseases, 2) those likely to present difficulties in obtaining information from surviviors, e.g., suicides, 3) those likely to be poorly age matched with case groups, and 4) those heavily locale specific, e.g., drowning.

Table 2.0-7 illustrates the age and year of death breakdown of male case group II*. Each case subject was then age and year of death matched with two controls- one from control group VI and one from the appropriate designated analog control group which in this case is group IV.

After all case and control subjects were identified, each Certificate of Death was located, reviewed, abstracted, coded and placed on tape. Figure 2.0-3 shows the California Certificate of Death. Additional information abstracted from the Certificate includes material vital to assigning asbestos exposure, e.g. residence and length of stay in the county; assisting in identifying confounding exposures, e.g. last occupation; useful in locating surviving kin; and verifying critical data such as the ICD number.

Residence information was recorded and also coded according to the distance from high asbestos deposit areas. Coding of occupation was performed and occupations classified into asbestos exposure potential as: definite, probable, possible and probably no exposure. Subsequent analysis of these data will focus on residence in the area so the primary measure of exposure and will treat occupational category as a covariate which will be stratified or adjusted for. It is readily acknowledged that death certificate listing of occupation is a poor measure. These other such confounding factors such as

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* Numbers disagree with those above since a slightly different analysis was being performed which utilized somewhat different ICD categories.

Table 2.0-7

Male Deaths from Malignant Neoplasms of Respiratory System (ICD 160-163), by Year and Age at Death, Calaveras and Tuolumne Counties

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
LT 10	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0
15-19	0	0	0	0	0	0	0	0	0	0
20-24	0	0	1	0	0	0	0	0	0	0
25-29	0	0	0	0	0	0	0	0	0	0
30-34	0	0	0	0	0	0	0	0	0	0
35-39	1	0	0	0	0	0	0	1	0	0
40-44	0	1	0	0	0	0	0	0	0	0
45-49	0	0	1	0	0	1	1	0	0	1
50-54	0	3	0	1	0	2	5	1	2	1
55-59	3	2	2	1	0	2	2	3	3	1
60-64	1	1	2	0	5	5	4	4	2	1
65-69	2	2	3	2	5	3	4	3	6	2
70-74	2	1	1	1	3	0	4	5	1	3
75-79	4	2	2	0	1	4	0	1	2	2
80-84	2	1	1	1	0	2	4	2	0	1
GE 85	1	0	0	1	0	2	1	2	3	0
TOTAL	16	13	13	7	14	21	25	22	19	12

smoking and drinking could be accounted for at some future time by means of next-of-kin interviews if the proposed analyses identified specific case groups with a significant elevated risk and there was sufficient interest to minimize additional possible confounding factors.

Figure 2.0-4 shows (in photo-reduced size) the computer generated form developed to record the abstracted information. For each subject decedent, data from the death tapes are filled in when the form is generated. These data are:

- o Social security number
- o Name
- o Data of death
- o Birthplace and birthdate
- o Age at death
- o Marital status
- o Counties of death and of residence
- o Cause of Death
- o Whether or not an autopsy was performed
- o The qualifications of the certifier.

The data recorded by our abstractors from the hard copy death certificate were entered in the appropriate blanks. These are:

- o Identification Number
- o Father's name and birthplace
- o Mother's name and birthplace
- o Name of surviving spouse
- o Last occupation and years worked
- o Name and address of hospital

The format for the death certificate abstract corresponding to Figure 2.0-4 is described in Appendix B. Coding for birthplace, occupational classification, occupational asbestos exposure, city codes (for exposure indices), and county codes are all provided in Appendix B.

DEATH CERTIFICATE ABSTRACT

CARD NO 0 1 ID NO STATE FILE NO LOCAL REG NO SOCIAL SECURITY NO

01 02 03 04 05 06 07 08 09 10 11 12 13 14 15

NAME DATE OF DEATH

16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51

SEX RACE BIRTHPLACE BIRTHDATE AGE

52 53 54 55 56 57 58 59 60 61 62 63 64

CARD NO 0 2 ID NO FATHERS NAME BIRTHPLACE

01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

MOTHERS MAIDEN NAME BIRTHPLACE

29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

MARITAL STATUS NAME OF SURVIVING SPOUSE

51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

CARD NO 0 3 ID NO LAST OCC YRS COMPANY KIND

01 02 03 04 05 06 07 08 09 10 11 12

NAME AND ADDRESS OF HOSPITAL

CO OF DEATH LENGTH OF STAY IN CO IN CA USUAL RES CITY CO

13 14 15 16 17 18 19 20 21 22

NAME OF INF ADDRESS

23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59

CITY STATE CAUSE OF DEATH CODE . AUTOPSY CERTIFIER

60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76

PHYSICIAN/CORONER NAME, ADDRESS PHYSICIAN LICENSE NUMBER

IMMEDIATE CAUSE(A) DUE TO(B) DUE TO(C)

OTHER SIGNIFICANT CONDITIONS

AIR ASBESTOS X 10 WATER ASBESTOS

77 78 79 80

Figure 2.0-4 Death Certificate Abstract

2.0.4 Case and Control Matching System

The system for matching control records to case records was established as follows:

- o Controls were matched to cases of the same sex.
- o Cases were categorized into 5 year age groups (<5, 5-9, 10-14, 15-19...,80-84, $\leq$85), and listed by year of death (1969 through 1978)
- o For each case of given sex, 5 year age group, and year of death a control was chosen randomly from among all controls of the same sex, age group, and year of death. If there were no controls with the same year of death (or if the number of cases out-numbered the controls for a given year of death), a control was sought from the year of death nearest the case. All controls were chosen from the same age group as the case.
- o An effort was made to choose unused controls for each successive case group. But if all controls in a given age range and year (e.g. digestive cancer), controls were used again for another case group (e.g. lung cancer).

For the Reproductive Neoplasms control group, the pool of subjects was so small (only 115 decedents), nearly all had to be used twice to provide matches for the Digestive and Respiratory cancer case groups.

Among controls taken from the General Causes pool, approximately 12% of the male controls and 9% of the female controls had to be used for matches twice.

The Non-Hypertensive Heart Disease pool was large enough that no controls had to be used twice.

2.0.5 Quality Assurance of Death Certificate Abstraction and Coding

As each death certificate was abstracted, the certificate was quickly check for (1) internal consistency, and (2) consistency with the information as coded by the California Office of Vital Statistics on the computerized records. Because of time limitations, this check could not be exhaustive, but nevertheless several errors were detected.

1. Errors in the State Vital Statistics Coding of Residence.

We discovered several instances where the county of residence coded on the state death tape was incorrect. One type of error was to assign either the Calaveras code or the Tuolumne code to the county of residence when the city of residence actually lies in a different county. This error occurred fifteen times in our series.

Number	City of Residence	Actual County
3	Stockton	San Joaquin
2	Coulterville	Mariposa
1	Knight's Ferry	Stanislaus
1	Oakdale	Stanislaus
1	Berkeley	Alameda
1	Oakland	Alameda
1	Acampo	San Joaquin
1	Linden	San Joaquin
1	Sutter Creek	Amador
1	Santa Clara	Santa Clara
1	San Francisco	San Francisco

Since only decedents who were residents of Calaveras or Tuolumne Counties were to be used in this study, all of the aabove out of county residents were deleted.

Another error we discovered was the assignment of the Calaveras County code to five decedents who were actually residents of Tuolumne County.

Number	City Residence
3	Sonora
1	Columbia
1	Tuolumne City

We corrected the county of residence codes for these decedents, and kept them in the study.

We should not one feature of this miscoding in the state records. The decendents in our series were selected from the state tapes on the basis of their residence being coded as Calaveras or Tuolumne. However, any actual residents of Calaveras or Tuolumne who were miscoded as residents of other counties would not have been included. In view of the coding errors displayed above, this last type of misclassification probably did occur, although there were probably few of these since only 20 total errors were detected in roughly 1000 records.

We also found one instance where a coded age at death differed from the death certified age at death by one year, and so this correction was made.

2. Errors in Death Certificate Entries

There were only two errors detected on the death certificates themselves. One was an incorrect year of birth (inconsistent with the year of death), and the other was an inconsistency of the length of stay in the county with the length of stay in California. These erros could not be corrected, since we do not know what the actual entries should be.

3. Errors in Vital Statistics Coding of the Cause of Death

The information abstracted from the death certificate included the complete causes of death as well as the "other significant conditions". We checked the causes of death on the certificate against the Office of Vital Statistics 4 digit ICD code on a 10% sample. In a few instances, the death certificates themselves were vague, and so the given ICD codes were necessarily somewhat arbitrary. But no incorrect ICD codes were found, so we feel confident accepting the codes as given.

4. Errors in Coding the Abstracted Data

For quality control of our own effort--namely the coding of the death certificate data we abstracted--we recoded a 10% systemtatic sample of the certificates.

One hundred and two records were checked, and 14 coding errors were found. Since each certificate contains 6 variables to be coded*, this translates into a rate of 2 coding errors per 100 variables. This was judged to be acceptable, and the records were sent to be keypunched.

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* The birthplace of the decedent, the birthplaces of the parents, the occupation, the likelihood of occupational exposure, and the city of residence.

2.1 Determination of Standardized Mortality Ratios (SMR's)

Standardized mortality ratios were calculated as part of this study utilizing the California State mortality tapes. The purpose of this effort was to examine if the total observed number of deaths in the counties for particular categories of ICD codes were at variance with the expected numbers based on State of California rates. It should be noted that the exact residence of each individual within the counties was not factored into the analysis. Therefore the analysis does not bear directly upon the key study question of whether individuals living in the vicinity of serpentine deposits, i.e. experiencing elevated ambient airborne asbestos concentrations, have different mortality patterns. Rather it examines the gross incidence across the counties in comparison to the State of California. Since the counties are relatively rural in comparison to the significant state population centers many factors differ and remain uncontrolled in this analysis.

In order to compare the mortality of Calaveras and Tuolumne Counties to the experience of the State of California as a whole it is necessary to take into account the potentially confounding effects of age, race, and sex differences. We have calculated standardized mortality ratios (SMR's), adjusting for age, for whites only, separately for males and females.

The causes of death to be examined were grouped into six categories as follows:

A. Three categories of death from causes possibly associated with asbestos exposure:

-Malignant neoplasms of digestive organs and peritoneum (ICD 150-159*)

-Malignant neoplasms of the respiratory system (ICD 160-163)

-Hypertensive heart disease and hypertensive heart and renal disease (ICD 402-404)

B. In addition, two comparison groups of deaths were looked at, composed of deaths from causes that have no reported association with asbestos exposure:

-Malignant neoplasms of the breast (used for females only) (ICD 174)

-Malignant neoplasms of the genital organs (ICD 180-187)

C. Finally, we examined the total number of deaths from all causes.

The ICD codes included in these categories are broader than the ICD codes used to delineate the case and control groups. These categories had to be used because the only published source of age, sex, and race specific numbers of deaths for California is the United States Vital Statistics,** and the causes of death were tabulated in these broader categories. Ischaemic heart disease deaths (ICD 410 to 412) were not included in the SMR calculations because the published deaths were not separated into hypertensive and nonhypertensive.

The SMR is a ratio of an observed number of deaths to an expected number. The observed number of deaths for each cause is the sum of the deaths for that cause in Calaveras and Tuolumne Counties for three years, 1969, 1970, and 1971. The expected numbers of deaths for each cause were calculated by multiplying cause-specific three-year California rates (for whites, for each sex, and for each 5 year age group) by the corresponding 1970 subpopulation of Calaveras and Tuolumne Counties. The three year California rates used in the calculations were derived by summing the State deaths in 1969, 1970, 1971, and dividing by the 1970 population given by the U.S. Census.

The expected number of deaths in each 5 year age group were then summed over all ages to give the total number of expected deaths in Calaveras and Tuolumne counties for the three years in question.

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* International Classification of Disease, 8th Revision
* Table 7-6 "Deaths from 69 Selected Causes, By Age, Color, and Sex, Each State"

The 95% confidence limits of the SMR's were calculated as outlined in Rothman and Boice (1979), assuming the occurrence of events to be Poisson distributed. For observed numbers less than 30, the upper and lower limits were found from the table in Remington and Schork (1970) (p. 394). For SMR's with observed values greater than 30, Byar's approximation given in Rothman and Boice (1979) was used.

For males, all SMR's were less than 1.00, i.e., there were fewer observed deaths than expected, based upon the experience of white males in California. Even the mortality from all causes was depressed (686 deaths observed vs. 728 expected), indicating that (adjusting for age) white males in Calaveras and Tuolumne had a lower overall mortality than males in California for the years 1969 through 1971. The category of death that mosts nearly approached the expected figure was malignant neoplasms of the respiratory system.

None of the male SMR's was statistically significant at the &=0.05 level, since all confidence limits span the null value, 1.00.

For females, the picture is somewhat different. The all causes mortality was increased to 1.05 times the expected. Among the conditions suggested to be related to asbestos exposure, the SMR's were elevated above unity for cancers of the digestive system (SMR=1.07) and hypertensive heart disase (SMR=1.75). However, the number of observed deaths for respiratory cancer was less than expected (6 to 10.18).

Among the "dummy" conditions not known to be related to asbestos exposure, the malignant neoplasms of the genital organs among women showed an elevated SMR of 1.34. This result was unexpected. However, the recent study by Kanarek et al (1980) of asbestos in drinking water and cancer incidence in the San Francisco-Oakland area found an elevated number of deaths from uterine cancer.

Although none of the female death ratios reached statistical significance at the α=0.05 level, the hypertensive heart disease SMR (1.75) had the largest excess of observed over expected.

One difficulty with a community study of an environmental exposure such as this one is that an observed excess mortality might not be caused by ambient environmental exposures, but by occupational exposures. Examining deaths among males and females separately is one way to check for this possibility. If asbestos related mortality were higher among men than among women, exposure in the workplace might be the cause. In our data, however, males have lower mortality ratios than females for most causes, including total mortality.

The lower than expected overall mortality for males deserves some comment. In studies of males in an occupational setting, this observation has been called the "healthy worker effect." Occupational groups tend to be selected for the healthier, more vigorous individuals in the population. Consequently, even when adjusting for age, the overall mortality of a specific industrial group may be less than expected, if the expected mortality is based on the experience of all males in the general population.

It may be that the occupational and recreational activities prevalent in these two rural counties (where timber and mining are dominant industries) exert a small selective pressure on males, which accounts for a male population with a lower than expected mortality. The fact that the observed mortality was not lowered for females indicates that an occupational selection might be involved. On the other hand, it may indicate the presence of a factor which puts females at a higher risk.

One method to "adjust" for a possible healthy worker effect in occupational studies has been suggested by Tabershaw and Gaffey (1974) , Kupper et al(1978), and others. This involves the calculation of a "relative" standardized mortality ratio (RSMR) by dividing the cause-specific SMR by the all causes SMR. This results in a measure of risk that takes into account the lower underlying mortality of the study popuation.

Since for males the all causes SMR was 0.94, the calculation of an RSMR increases all of the observed to expected ratios. All cause spcific RSMR's tend to be closer to 1 than the SMR's, except respiratory system cancers, where the RSMR=1.04. However, this adjusted SMR is not statistically significant.

One reason for the general lack of statistical significance in this analysis is that many of these SMR's are based upon small numbers. These two counties combined had a 1970 white population of only 17,000 males and 16,000 females. Consequently, the number of deaths accruing in just three years is not large. Our data set contains all deaths from 1969 through 1978. However, we have elected to use only deaths from 1969 to 1971, spanning the censal year, in order to use the 1970 census population as a denominator. The lack of age, sex, and race specific population figures during the middle and late part of the decade prevents us from making full use of our mortality data.

In order to use all of the observed county deaths during the 1970's, it would be necessary to get population estimates for these years. This would be possible by using the forthcoming 1980 census data. Intercensal populations can be estimated using the 1970 annd 1980 figures and estimation procedures, such as those given by Shryock, Siegel, et al (1976).

Finally, we must discuss the choice of a comparison population. The indirect standardization technique measures the experience of the two counties against the experience of the entire state of California. We have restricted the analysis to whites, compared males and females separately, and adjusted for differences in age distribution between the counties and the state by standardization. But there may be other factors that confound the mortality comparisons. The expected values were derived from the death rates of the state of California as a whole. The state death rates include deaths from urban areas such as Los Angeles and San Francisco. These urban areas may have increased cancer mortality over rural areas by virtue of greater air polluation, pollution of drinking water, occupational exposures, and smoking levels in the population. In short, asbestos related mortality in Calaveras and Tuolumne Counties may have been masked by comparing these counties to the state population, which is composed of subpopulations exposed to several other environmental insults that can produce the same effects.

A better comparison would be to use rural California counties near Calaveras and Tuolumne, with similar population densities and industries, but without serpentine deposits. This is not possible at this point in our study, however. Such a comparison would require mortality data from the comparison counties that are age, sex, race and cause specific. Data this detailed are not available from the published California vital statistics. We would have to identify selected comparison counties and access Calfornia death tapes the same way the Calaveras and Tuolumne data were acquired.

Table 2.1-1 and 2.1-2 present the SMR results for males and females respectively. Appendix C provides the age specific mortality data for Calaveras and Tuolumne counties from which the three year study interval, 1969-1971 was taken.

Table 2.1-1

STANDARDIZED MORTALITY RATIOS - MALES

Observed deaths reflect Calaveras and Tuolumne County experience (1969-71)
Expected deaths are based upon rates for California (1969-71)

	Males			
	Observed Deaths	Expected Deaths	SMR (O/E)	SMR 95% Conf. Limits
Malignant Neoplasms of Digestive Organs and Peritoneum (ICD 150-159)	33	36.53	0.90	(0.62, 1.27)
Malignant Neoplasms of Respiratory System (ICD 160-163)	42	42.98	0.98	(0.70, 1.32)
Hypertensive Heart and Renal Disease (ICD 402,404)	1	3.06	0.33	(0.01, 1.82)
Malignant Neoplasms of the Genital Organs (ICD 180-187)	11	13.12	0.84	(0.42, 1.50)
Mortality from All Causes	685	723.03	0.94	(0.87, 1.02)

Table 2.1-2

STANDARDIZED MORTALITY RATIOS - FEMALES

	Observed Deaths	Expected Deaths	SMR (O/E)	SMR 95% Conf. Limits
Malignant Neoplasms of Digestive Organs and Peritoneum (ICD 150-159)	27	25.32	1.07	(0.70, 1.55)
Malignant Neoplasms of Respiratory System (ICD 160-163)	6	10.18	0.59	(0.22, 1.28)
Hypertensive Heart and Renal Disease (ICD 402, 404)	6	3.42	1.75	(0.64, 3.82)
Malignant Neoplasms of the Breast (ICD 174)	13	18.18	0.72	(0.38, 1.22)
Malignant Neoplasms of the Genital Organs (ICD 180-187)	18	13.43	1.34	(0.79, 2.12)
Mortality from All Causes	488	464.04	1.05	(0.96, 1.15)

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Appendix A

Description of Electron Microscopy

A-1 Description of Whatman #41 Cellulose Filters

The filters shipped to Science Applications, for analysis by Scanning Electron Microscope were contained individually in glassine negative storage envelopes and appeared to be in good condition. Some filters appeared to have lost some material or were unevenly dispersed. These filters were excluded from the analysis.

The filter dimensions were 8" x 10" with an effective filter surface of 7" x 9" or 63in^2 (406.5 cm^2).

A-2 Laboratory Procedures for Asbestos Measurement of Air Samples Collected Collected on High Volume Whatman 41 Cellulose Filters

Cleaning of glassware and utensils

All utensils and glassware are cleaned in a sonic bath (Bransonic model 220) using 2 rinses of Milli-Q water (.2 μm filtered) and a final sonicated rinse of reagent grade acetone. After cleaning, the glassware and utensils are stored in sealed plastic bags. All water is prescreened using the Scanning Electron Microscope to avoid any asbestos contamination.

Procedure for ashing the filter samples:

Sections of filters no greater than 2" x 2" (1" x 2" is optimum) are excised from the original 8" x 10" Whatman 41 high volume filter using precleaned scissors and transferred into engraved precleaned glass vials (70 mm x 30 mm). For almost all samples a 1" x 2" sample is excised. Each filter is placed in the vial with the top surface of the filter against the inner surface of the glass vial.

No more than 2 sample vials are ashed at the same time. The vials are placed into the Low Temperature Asher (International Plasma Corp. Model PM 104C) side by side and lying down with the top of the vial facing the door of the ashing chamber. This will minimize any effect of sample cross-contamination. After the samples are placed in the Low Temperature Asher, the power is turned on and the chamber is placed in the slow evacuation mode. In approximately 5 minutes the vacuum will reach 1 torr; at this time the chamber is switched into the fast vacuum mode and will pump down to less than .1 torr in a matter of minutes. At this point, the RF generator and oxygen flow are turned on and the ashing of the filter begins.

The filters are ashed for 4 hours at a vacuum of 1 torr, oxygen meter flow of 200, and an RF forward power of 20 watts. The reflecting power is kept below 1 watt by the fine tuning on the instrument console. Once ashing is complete the RF power and oxygen are turned off and the vacuum value on the instrument is turned to the off position. The purge for the sample chamber is opened to allow the chamber to return to atmospheric pressure over a period of 30 minutes (any shorter time could result in sample loss or contamination). Before the samples are removed from the chamber, the power to the entire instrument must be turned off to avoid turbulence caused by the instrument cooling fans. The samples are removed carefully and capped.

Sample dilution procedures:

All filter handling and filtration were performed in a laminar flow bench with a particle concentration at $\geq$.5μm of less than 100 particles/cu. ft. A Climet Model 208 particle counter was used to monitor particle levels.

The capped samples containing the ashed filter are transferred to the laminar flow bench and the initial dilution is performed with the air fan turned off so that the dry ashed sample is not blown out of the vial during the first addition of aerosol O.T. dispersant. Exactly 20 ml. of .2μm millipore filtered .1% Aerosol O.T. is carefully pipetted into the sample vial. The vial is capped, shaken gently and then placed in a ultrasonic bath (Bransonic Model 220) for 5 minutes. The sample is removed from the sonic bath and exactly 2.00 ml of the solution is withdrawn 1 cm from the bottom of the vial and transferred to a clean plastic 15 ml. test tube with a screw top cap. Approximately 5 ml. of .2μm filtered deionized water is added to the test tube and gently shaken for approximately 1 minute before pouring into the filter assembly.

The 25 mm filter assembly (Nuclepore stock #410200) is made of borosilicate glass with a sintered glass support and has a funnel volume of 20 ml. and an effective filtered area of 2.14 cm^2.

The asbestos samples are collected on a .2μm pore size nuclepore filter which is backed by a .45μm pore size millipore filter which aids in a more even dispersal of particles.

The sample contained in the plastic test tube is poured into the filter assembly after 1 ml. of deionized water has been filtered through the funnel to saturate the filter media. The test tube and cap are rinsed twice with 5 ml of deionized water into the filter funnel and a light vacuum is applied to the filter to allow complete filtration within 30 seconds. When the sample solution approaches approx. 1 cm in depth, the walls of the filter funnel are carefully rinsed with 2-3 ml of filtered deionized water and allowed to totally filter. 15 seconds after the sample solution has finished filtering the pump is turned off and the filter is allowed to air dry for 30 minutes before removal from the funnel assembly. The sample filter and the backing filter are removed together with clean polyethylene forceps and transferred to a clean plastic petri dish with a depth no less than 1 cm and taped in place. The filter is ready for sectioning for the Scanning Electron Microscope or the Transmission Electron Microscope analysis.

FILTER PREPARATION FOR THE SCANNING ELECTRON MICROSCOPE

Using a clean razor blade, excise a portion of the taped filter section from the filter by pressing evenly downward on the filter and backing filter (it is not advisable to pull the blade across the filter as this may result in particle loss and filter distortion). Carefully remove the cut section and transfer to a clean sheet of 2" x 2" leucite or plexiglass (keeping the backing filter in place aids in transferring the filter section without warping). The backing filter is removed by carefully sliding the nuclepore sample filter laternally off the backing filter using a sharp needle. 4 mm x 4 mm sections are cut using a new razor and pressing with a downward motion only. The softness of leucite or plexiglass provides for a very even undisturbed cut. The razor blade and the 2" x 2" plastic are discarded after each filter is cut. The filter sections are transferred to aluminum specimen mounts backed with #465 scotch transfer tape and only the edges of the filter are gently pressed down and evened out using a sharp needle.

The samples are coated with gold using an ISI P-SI Sputter Coater Set at 40 ma, 2.5 kV, a vacuum of .1 torr, and coated for 2.5 minutes.

FILTER PREPARATION FOR THE SCANNING TRANSMISSION ELECTRON MICROSCOPE

The filters sections remaining in the petri dishes after SEM sample preparation are transferred to a vacuum evaporator and coated with 40 to 50 mm of carbon in bursts on the order of 5 seconds to avoid polymerization of the nuclepore filter.

3 mm x 3 mm sections are excised from the filter pad as described in the SEM filter preparation procedure and placed carbon side down over a carbon stabilized formvar coated copper grid (200-300 mesh).

The copper grids to be extracted by the Jaffe wick method (EPA 600/2-77-178) are placed on top of a section of Whatman #42 ashless filter paper that is over a square of polyethylene foam that has been triple washed and ultrasonicated in acetone. The entire extraction arrangement is contained in a precleaned 100 mm x 15 mm precleaned glass petri dish. Four grids for each sample are prepared in the following manner. Approximately 10 μℓ of reagent grade chloroform is pipetted onto each 3 mm x 3 mm filter section using a syringe and the petri dish is carefully filled with chloroform to a level approaching the top of the foam support. The petri dishes are covered and placed inside a bell jar to maintain a high chloroform atmosphere and reduce evaporation. Each filter grid is allowed 48 hours for dissolution of the nuclepore filter. The grids are then transferred to a clean covered petri dish to dry before analysis by the Transmission Electron Microscope.

FILTER ANALYSIS BY SCANNING ELECTRON MICROSCOPY

The total counts of two separate filter areas of each sample are analyzed at a magnification of 10,000X in the slow scan rate mode with a beam current of 15 kV. The resolution of the ISI Super III-A Scanning Electron Microscope is checked prior to each sample analysis using an asbestos standard sample containing many fibrils with diameters of .02 to .03μm. Actual sample analysis proceed only when fibrils of .03μm in diameter can be clearly resolved using the slow scan rate at a magnification of 20,000X.

Each sample filter section (two for each sample) is analyzed for a minimum total of 50 fields or 50 fibers (100 total) and the results are combined and totaled in the computer analysis. Chrysotile asbestos fibers are confirmed by morphology and the presence of magnesium and silicon using a Kevex 5100c dispersive X-ray system.

Fiber analysis for the purpose of this survey were placed into four categories; chrysotile, amphibole, ambiguous, and non-asbestos. Confirmation for chrysotile required both morphology and X-ray identification. Very small fibers (<.1 μm diameter) which do not readily yield strong X-ray peaks were confirmed when their fiber diameters and length were very well defined or when they were found in the same field as another larger fiber confirmed to be Chrysotile by both morphology and X-ray spectra.

Amphiboles when present were confirmed by morphology and X-ray spectra. X-ray spectra typical of an amphibole must be well defined otherwise the particle will be listed as ambiguous.

The ambiguous classification contains all the fibers which have a questionable morphology or an ambiguous X-ray spectrum. The most common example in this category is a fiber which exhibits a silicon peak but no magnesium peak.

The non asbestos fiber category includes all fibers defined as having an aspect ratio of 3:1 but not having an asbestiform morphology. The second criterion includes all fibers greater than .1μm in diameter that exhibit no X-ray spectrum or no silicon peak.

The final reporting of data includes fibers/meter^3, mass/meter^3 (nanograms) and surface area/meter^3 (μm^2) expressed as total fibers, fibers $\leq$5μm, and fibers >5μm.

It is very important to emphasize the instrument parameters used in the analysis.

The accelerating voltage on the SEM was set at 15 kV for a number of reasons. Beam penetration at a higher kV range is much greater and decrease the ability to resolve individual fibers with diameters below .1 m. 15 kV is also the optimum energy range for X-ray analysis. The peak to background ratio for Magnesium Aluminum and Silcon is much higher at 15 kV than 20 kV or 25 KV also due to beam penetration (less area below the fiber is being excited). The working distance of the SEM was calibrated and maintained at a working distance of 8 mm and a stage tilt of 15^{o}. This provided for maximum resolution without compromising X-ray yield. The samples were prepared on .2 m pore size Nuclepore filters (particles on the shiny side) primarily because of their smooth background as compared to .1 m pore size or even the .45 m pore size filters.

A-3 Microscopy Facilities

SAI's electron microscopy lab contains a scanning electron microscope equipped with a dispersive X-ray spectrometer and a dedicated microcomputer for rapid and tailored data reduction of particle field counts, particle density and size distributions, and elemental abundances. The microscope is equipped with both a high angle back-scatter detector for atomic number contrast and a low angle back scatter detector for high resolution surface detail.

Adjacent to the SEM laboratory is a trace particle clean room which has been tailored for the handling and preparation of ambient air samples for asbestos and trace metals (see Figure A-1). The room is equipped with a HEPA filtered air system producing a variable laminar flow inside the room as well as a positive pressure throughout both the main lab and the anteroom. This eliminates any possible outside contamination for trace metal or asbestos samples. In addition to the ceiling HEPA filter system, the room is equipped with a laminar flow bench.

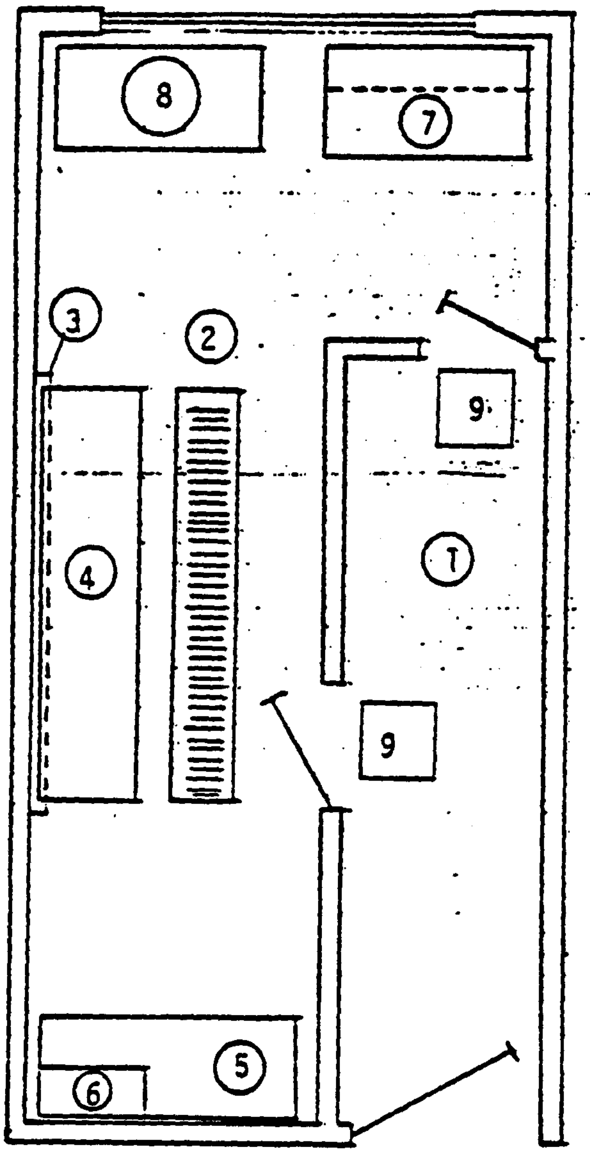
Through a formal agreement with Scripps Institution of Oceanography, SAI utilizes the scanning transmission electron miscroscope facility located less than 2 miles away. This instrument is an Hitachi Model H-500 with a magnification range of 500,000x and a resolution of 1.4 A^o, and is equipped with both Selected Area Electron Diffraction and computerized dispersive X-ray capabilities.

Instrumentation

SAI:

Model ISI Super IIIA Scanning Electron Microscope 70A^o resolution

magnification range 12-200,000x



1. Semi-clean transfer room (positive pressure to the outside exit).
2. Ceiling Hepa filter.
3. Floor exhaust with dampered control for variation in laminar flow over bench #4 and the positive pressure of the room.
4. Clean work table.
5. Bench for Jaffe-Wick preparation of filters.
6. Vented clean box for chloroform extraction of filters.
7. Laminar flow bench for filter sectioning and filtration.
8. Polyethylene sink.
9. Particle tac mat.

FIGURE A-1 TRACE PARTICULATE CLEAN ROOM.

- Standard secondary electron detector
- High backscatter detector for atomic number contrast
- Low angle backscatter detector (low loss) for high resolution surface imaging and elevation measurement with a resolution of 500A^{o}. (Detector is used for measuring particle volume and photographing biological and low atomic number surfaces.)

PS-I Sputter Coater

AuPd and Au target

Kevex 5100 c Dispersive X-ray System

30mm^2 detector area

1.49 ev/channel resolution

Motorola 6800 Computer System with dual floppy disc

Scripps Institute of Oceanography:

Model Hitachi H-500 Scanning Transmission Electron Microscope

Transmission Mode - resolution 1.4A^{o}, magnification range to 500,000x equipped for Selected Area Electron Diffraction

Scanning Mode - resolution of 30A^{o}; magnification range of 1000-300,000 equipped with a Model 6230 Ortec dispersive X-ray system which includes the computer and dual floppy disc.

Denton Carbon Evaporator

A-4 Results & Conclusions

Viewing the concentration summaries for Sonora and Mariposa sites (Table 2.0 - 1) reveals a minimum of at least one order of magnitude differental in concentration for fibers/m^3, mass/m^3, and surface area/m^3 in contrast to other sites assumed to be very low in concentration (Van 201 ELD, Van 401 ELD, Camino).

Depending upon which parameter is viewed, large differentials can occur in concentration when comparing two samples. For example, comparison of Sonora sample 12-30-73 (SAI #81-1094) with Camino sample 04-10-73 (SAI #81-1231) yields the following conentration effects:

	Total fibers/m^3	Chrysotile Total mass/m^3	Total surface area/m^3
81-1094 Sonora	291	24200	5450
81-1231 Camino	7.5	0.4	4.5
Ratio: Sonora / Camino	39	60500	1200

The fiber concentration in Sonora (81-1094) is 39 times higher, the mass concentration is 60500 times higher and the surface area is 5450 times higher This wide variation in concentration data should be considered carefully when relating to any epidemiological data.

The usual reporting of data includes fiber and mass concentration without reporting surface area. Theoretically mass and surface area do not differ in ratio only when the size distribution of the asbestos population does not change.

In the real world situation the size distribution changes greatly in chrysotile source rock areas with changes in meteorologic conditions. The percent of chrysotile fibers >5μm in the Sonora County samples varied from 1 to 19 percent (Table A-1). This variation in the size distribution is responsible for poor correlation between fibers/m^3 and mass/m^3.

In actuality, the correlation between fibers/m^3 and surface area/m^3 is a much better correlation (Table A-2). The correlation of all parameters ≤5μm is fairly consistent with the correlation between fibers/m^3 and surface area/m^3 (.98) being extremely good. Above 5μm <u>none</u> of the parameters correlate and it is important to note how poor the correlation is between fibers/m^3 and mass/m^3. It is recommended that some further investigation of surface area/m^3 as an included parameter in the reporting of asbestos data be considered.

TABLE A-1

Sample Variation in the Percentage of "Occupational" Chrysotile Fibers (<5μm) in Eleven Sonora County Samples

SAI Sample #	Collection Date	%Chrysotile fibers ≤5μm	%Chrysotile fibers >5μm	%Ratio of Chrysotile fibers >5μm
81-1101	08-08-73	86	12	14%
81-1097	10-25-73	71	7	10%
81-1116	09-20-74	74	1	1%
81-1094	12-30-72	49	9	18%
81-1120	06-28-74	39	3	8%
81-1099	09-25-73	56	5	9%
81-1121	04-05-74	79	9	11%
81-1118	07-22-74	61	4	6%
81-1102	07-15-73	57	11	19%
81-1106	05-24-73	82	6	7%
81-1110	03-23-73	54	9	17%

TABLE A-2

Correlation of Fibers/m^3, mass/m^3 and Surface Area/m^3 for Sonora sites

Compared parameters	Coefficient of Correlation $\leq 5\mu m$	$>5\mu m$	total distribution
Fibers/m^3 (excluding 81-1094) mass(ng)/m^3	.70	-.13	-.002
mass(ng)/m^3 (excluding 81-1094) surface area (μm^2)/m^3	.83	.30	.22
Fibers/m^3 (excluding 81-1094) surface area μm^2/m^3	.98	.59	.96

Appendix B

DEATH CERTIFICATE ABSTRACT FORMAT

Variable Number	Column Location	Field Type	Description
1	01-02	F2.0	Card Number, 01
2	03-06	F4.0	Identification Number
3	07-15	F9.0	Social Security Number:999-99-9999-blan
4	16-45	7A4,A2	Decedent (Last, First, Middle)
5	46-47	F2.0	Date of Death, Year (last two digits)
6	48-49	F2.0	Date of Death, Month
7	50-51	F2.0	Date of Death, Day
8	52	F1.0	Sex: 1-Male , 2-Female
9	53-54	F2.0	Birthplace (see State and Country Codes
10	55-57	F3.0	Date of Birth, Year (last three digits)
11	58-59	F2.0	Date of Birth, Month
12	60-61	F2.0	Date of Birth, Day
13	62	F1.0	Age Code: 0-100 years or over,1-years
14	63-64	F2.0	Age, years

DEATH CERTIFICATE ABSTRACT

Variable Number	Column Location	Field Type	Description
15	01-02	F2.0	Card Number, 02
16	03-06	F4.0	Identification Number
17	07-26	5A4	Father's Name (First, Middle, Last if different from decedent)
18	27-28	F2.0	Father's Birthplace (see State and Country Codes)
19	29-48	5A4	Mother's Maiden Name (First, Middle, Las
20	49-50	F2.0	Mother's Birthplace (see State and Country Codes)
21	51	F1.0	Marital Status: 1-Married; 2-Single, Never Married; 4-Divorced; 5-Widowed; 9-Unknown/Not Stated
22	52-80	7A4,A1	Name of Surviving Spouse(First, Middle, Last)

DEATH CERTIFICATE ABSTRACT

Variable Number	Column Location	Field Type	Description
23	01-02	F2.0	Card Number, 03
24	03-04	F4.0	Identification Number
25	07-09	F3.0	Last Occupation (see Occupational Codes): 999-blank
26	10-11	F2.0	Number of Years in Last Occupation: 99-blank
27	12	F1.0	Kind of Occupation: 1-Definite Asbestos Exposure; 2-Probable Exposure; 3-Possible Exposure;4-Probably No Exposure; 9-No Occupation (see exposure codes)
28	13-14	F2.0	County of Death (see County Codes)
29	15-16	F2.0	Length of Stay in County, years: 99-blank
30	17-18	F2.0	Length of Stay in California, years: 99-blank
31	19-20	F2.0	Usual Residence, City (see City Codes)
32	21-22	F2.0	Usual Residence, County (see County Codes)
33	23-40	4A4,A2	Name of Informant (First, Last, Middle)
34	41-59	4A4,A3	Address of Informant
35	60-68	2A4,A1	City of Informant
36	69-70	A2	State of Informant
37	71-74	F4.1	Cause of Death, ICD 8th Revision Code
38	75	F1.0	Autopsy: 1-No Autopsy; 2-Autopsy, results used; 3-Autopsy, results not used; 4-Autopsy, unknown if results used; 5-Unknown if an autopsy
39	76	F1.0	Certifier: 1-Coroner; 2-M.D. or D.O.; 3-D.C.; 4-Unknown before 1975, Military after 1975; 5-Unknown

BIRTHPLACE

STATE CODES

01 - Alabama
02 - Alaska
03 - Arizona
04 - Arkansas
05 - California
06 - Colorado
07 - Connecticut
08 - Delaware
09 - District of Columbia
10 - Florida
11 - Georgia
12 - Hawaii
13 - Idaho
14 - Illinois
15 - Indiana
16 - Iowa
17 - Kansas
18 - Kentucky
19 - Louisiana
20 - Maine
21 - Maryland
22 - Massachusetts
23 - Michigan
24 - Minnesota
25 - Mississippi
26 - Missouri
27 - Montana
28 - Nebraska
29 - Nevada
30 - New Hampshire
31 - New Jersey
32 - New Mexico
33 - New York
34 - North Carolina
35 - North Dakota
36 - Ohio
37 - Oklahoma
38 - Oregon
39 - Pennsylvania
40 - Rhode Island
41 - South Carolina
42 - South Dakota
43 - Tennessee
44 - Texas
45 - Utah
46 - Vermont
47 - Virginia
48 - Washington
49 - West Virginia
50 - Wisconsin
51 - Wyoming
52 - Virgin Island
54 - Outlying Possessions
55 - United States, Place Unknown

BIRTHPLACE

FOREIGN COUNTRY CODES

56 - Asia (inc. India, Israel, Korea, Lebanon, Pakistan
other Asia)

57 - Austria

58 - Belgium

59 - Central America (inc. British Honduras, Costa Rica, El Salvedor,
Guatemala, Honduras, Nicaragua, Panama)

60 - Canada

61 - China

62 - Czechoslavakia

63 - Denmark

64 - Eire (inc. Ireland, Northern Ireland)

65 - England

66 - Finland

67 - France

68 - Germany

69 - Greece

70 - Hungary

71 - Italy

72 - Japan

73 - Mexico

74 - Netherlands

75 - Phillippine Islands

76 - Poland

77 - Portugal

78 - Rumania

79 - South America (inc.Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador,
Paraguay, Peru, Uraguay, Venequela, other South American)

80 - Scotland

81 - Spain

82 - Norway, Sweden

83 - Switzerland

84 - USSR (inc. Russia, Ukrania)

85 - Wales

86 - West Indies (inc. Cuba, Dominican Republic, Haiti, Jamaica, West Indies
Federated, other West Indies)

FOREIGN COUNTRY CODES

87 - Yugoslavia

88 - All others (inc. Africa, Australia, Azores Islands, New Zealand, other Pacific Islands

89 - Unknown Nativity

OCCUPATIONAL CLASSIFICATION SYSTEM

Occupation Code:

Professional, Technical, and
Kindred Workers

Code	Occupation
001	Accountants
002	Architects
	Computer specialists
003	Computer programmers
004	Computer systems analysts
005	Computer specialists, n.e.c.
	Engineer
006	Aeronautical & astronautical eng.
007	Eng. not specified (4 yrs.college)
010	Chemical engineers
011	Civil Engineers
012	Electrical & electronic engineers
013	Industrial engineers(incl: gas plant engineers)
014	Mechanical engineers
015	Metallurgical & materials eng.
020	Mining engineers
021	Petroleum engineers
022	Sales engineers
023	Engineers, n.e.c
024	Farm management advisors
025	Foresters and conservationists
026	Home management advisors
	Lawyers and judges
030	Judges
031	Lawyers
	Librarians,archivists,and curators
032	Librarians
033	Archivists and curators
	Mathematical specialists
034	Actuaries
035	Mathematicians
036	Statisticians
	Life and physical scientists
042	Agricultural scientists
043	Atmospheric and space scientists
044	Biological scientists
045	Chemists
051	Geologists
052	Marine scientists
053	Physicists and astronomers
054	Life and physical scientists,nec
055	Operations & systems researchers and analysts
056	Personnel & labor relations workers
	Physicians, dentists, & related Practitioners
061	Chiropractors
062	Dentists

Occupations Code:

Professional, Technical, and
Kindred Workers - continued

Code	Occupation
063	Optometrists
064	Pharmacists
065	Physicians, medical and osteopathic
071	Podiatrists
072	Veterinarians
073	Health Practitioners, n.e.c.
	Nurses, dieticians, & therapists
074	Dieticians
075	Registered nurses
076	Therapists
	Health technologists & technicians
080	Clinical laboratory technologists technicians
081	Dental hygienists
082	Health record technologists & technicians
083	Radiological technologists & technicians, n.e.c.
084	Therapy assistants
085	Health technologists & technicians n.e.c.
	Religious workers
086	Clergymen
090	Religious workers, n.e.c.
	Social Scientists
091	Economists
092	Political scientists
093	Psychologists
094	Sociologists
095	Urban & regional planners
096	Social Scientists, n.e.c.
	Social & recreation workers
100	Social workers (incl. juvenile counseling)
101	Recreation workers
	Teachers, college & university
102	Agriculture teachers
103	Atmospheric, earth, marine & spac teachers
104	Biology teachers
105	Chemistry teachers
110	Physics teachers
111	Engineering teachers
112	Mathematics teachers
113	Health specialities teachers
114	Psychology teachers
115	Business & commerce teachers
116	Ecomonics teachers
120	History teachers

Occupation Code:
Professional, Technical, and
Kindred Workers - continued

121 Sociology teachers
122 Social science teachers, n.e.c.
123 Art, drama, & music teachers
124 Coaches & physical ed. teachers
125 Education teachers
126 English teachers
130 Foreign language teachers
131 Home economics teachers
132 Law teachers
133 Theology teachers
134 Trade, industrial & technical
135 Miscellaneous teachers, college & university
140 Teachers, college & university, subject not specified (incl. grad. assistant)

Teachers, except college & university

141 Adult education teachers
142 Elementary school teachers
143 Prekindergarten teachers
144 Secondary school teachers
145 Teachers, except college & university, n.e.c.
146 Teachers, not specified

Engineering and science technicians

150 Agriculture & biological technicians, except health
151 Chemical technicians
152 Draftsmen
153 Electrical & electronic engineering technicians
154 Industrial engineering technicians
155 Mechanical engineering technicians
156 Mathematical technicians
161 Surveyors
162 Engineering & science technicians, n.e.c. (includes trainee)

Technicians, except health & engineering & science

163 Airplane pilots
164 Air traffic controllers
165 Embalmers
170 Flight engineers
171 Radio operators
172 Tool programmers,numerical control
173 Technicians, n.e.c.
174 Vocational & educational counselors

Writers, artists, & entertainers

175 Actors
180 Athletes & kindred workers
181 Authors
182 Dancers
183 Designers
184 Editors & reporters
185 Musicians & composers
190 Painters & sculptors
191 Photographers
192 Public relations men & publicity writers
193 Radio & television announcers
194 Writers, artists, & entertainers, n.e.c.
195 Research workers, not specified (incl. research director)

Management and Administrators, Except Farm

201 Assessors, controllers & treasurers; local public administration
202 Bank officers & financial managers
203 Buyers & shippers, farm products
205 Buyers, wholesale & retail trade
210 Credit men
211 Funeral directors
212 Health administrators
213 Construction inspectors, public administration
215 Inspectors, except construction, public administration
220 Office managers, n.e.c.
221 Officers, pilots & pursers; ship
222 Officials & administrators; public administration, n.e.c.
223 Officials of lodges, societies &
224 Postmasters & mail superintende
225 Purchasing agents & buyers, n.e.c.
226 Railroad conductors
230 Restaurant, cafeteria & bar manager
231 Sales managers & department heads, retail trade
233 Sales managers, except retail trade
235 School administrators, college
240 School administrators, elementary & secondary
245 Managers & administrators, n.e.c. (film producer, self employed)
246 Management trainee

Sales Workers

260 Advertising agents & salesmen
261 Auctioneers
262 Demonstrators
264 Hucksters & peddlers
265 Insurance agents, brokers & underwriters (incl. insurance coordina
270 Real Estate agents & brokers
271 Stock & bond salesmen
280 Salesmen & sales clerks, n.e.c. (i medical distributer, drugstor cl
281 Sales associate

Clerical and Kindred Workers

301 Bank tellers (incl. banking,proofer)
302 Budgetary control
303 Billing clerks
305 Bookeepers (incl. accounting, auditing clerk)
310 Cashiers
311 Clerical assistants, social welfare
312 Clerical supervisors, n.e.c. (incl. det. head - office work, office manager)
313 Collectors, bill & account
314 Counter clerks, except food
315 Dispatcher & starters, vehicle
320 Enumerators & interviewers
321 Estimators & investigators, n.e.c. (incl. costomer's representative)
323 Expediters & production controllers
325 File clerks (incl. filers, book store sorting)
330 Library attendants & assistants (incl. library clerk)
331 Mail carriers, post office
332 Mail handlers, except post office (incl. mail clerk)
333 Messengers & office boys
334 Meter readers, utilities

Office machine operators

341 Bookeeping & billing machine operators
342 Calculating machine operators
343 Computer & peripheral equipment operators
344 Duplicating machine operators
345 Key punch operators
350 Tabulating machine operators
355 Office machine operators, n.e.c.
360 Payroll & timekeeping clerks
361 Postal clerks (incl. postal service)
362 Proofreaders
363 Real estate appraisers
364 Receptionists

Secretaries

370 Secretaries, legal
371 Secretaries, medical
372 Secretaries, n.e.c.
374 Shipping & receiving clerks
375 Statistical clerks
376 Stenographers
379 Administrative assistant
381 Stock clerks & storekeepers (incl. inventory)
382 Teacher aides, exc. school monitors (incl. school aide)
383 Telegraph messengers
384 Telegraph operators
385 Telephone operators
390 Ticket, station & express agents (incl. railroad station clerk)
391 Typists
392 Weighers
394 Miscellaneous clerical workers (incl service rep; general office worker)
395 Not specified clerical workers (incl Volt, Kelly)
396 Other clerical

Craftsmen and Kindred Workers

401 Automobile accessories installers
402 Bakers
403 Blacksmiths
404 Boilermakers
405 Bookbinders
410 Brickmasons & stonemasons
411 Brickmasons & stonemasons, apprenti(
412 Bulldozer operators (incl. tractor driver)
413 Cabinetmakers
415 Carpenters
416 Carpenter apprentices
420 Carpet installers
421 Cement & concrete finishers
422 Compositors & typesetters
423 Printing trades apprentices, exc. pressmen (incl. print shop helper)
424 Cranemen, derrickmen, hoistmen
425 Decorators & window dressers
426 Dental laboratory technicians
430 Electricians
431 Electricians apprentices
433 Electric power linemen & cablemen
434 Electrotypers & stereotypers
435 Engravers, exc. photoengravers
436 Excavating, grading & road machine operators, exc. bulldozer
440 Floor layers, exc. tile setters
441 Foremen & hammermen
442 Forgemen and hammermen
443 Furniture & wood finishers
444 Furriers
445 Glaziers
446 Heat treaters, annealers, & tempere(
450 Inspectors, scalers, & graders; log and lumber
452 Inspectors, n.e.c. (incl. telephon(investigation)
453 Jewelers & watchmakers (incl. jewe work)

Operatives, Except Transport - cont'd

656	Punch & stamping press operatives
660	Riveters & fasteners
661	Sailors & deckhands
662	Sawyers
663	Sewers & stichers
664	Shoemaking machine operatives
665	Stationary firemen
	Textile operatives
670	Carding, lapping & combing operatives
671	Knitters. loopers & toppers
672	Spinners, twisters & winders
673	Weavers
674	Textile operatives, n.e.c. (incl. miller)
680	Welders & flame-cutters
681	Winding operatives, n.e.c.
690	Machine operatives, miscellaneous specified (incl. pottery worker)
692	Machine operatives, not specified
694	Miscellaneous operatives (incl. miscellaneous handywork)
695	Not specified operatives (incl. baker's assistant, paper miller, pie factory, auto factory, jewelry factory, box assembler, aluminum window plant, factory worker, made barricades)
701	Boatmen & canalmen
703	Busdrivers
704	Conductors & motormen, urban rail transit
705	Deliverymen & routemen
706	Fork lift & tow motor operatives
710	Motormen; mine, factory, logging camp, etc.
711	Parking attendants
712	Railroadbrakemen
713	Railroad switchmen
714	Taxicab drivers & chauffeurs
715	Truck drivers

Laborers, Except Farm

740	Animal caretakers, exc. farm
750	Carpenters' helpers
751	Construction laborers, exc. carpenters' helpers
752	Fishermen & oystermen
753	Freight & material handlers (incl. furniturs mover)
754	Garbage collectors
755	Gardeners & groundskeepers, exc. farm
760	Longshoremen & stevedores
761	Lumbermen, raftsmen & woodchoppers (incl. lumber)

Laborers, Except Farm - continued

762	Stock handlers (incl. box boy, g[illegible]er clerk, stock girl)
763	Teamsters
764	Vehicle washers & equipment cleaners
770	Warehousemen, n.e.c.
780	Miscellaneous laborers
785	Not specified laborers (incl. factot[illegible]
786	Sanitation man, sanitizer
787	Maintenance man, n.s.

Farmers and Farm Managers

801	Farmers (owners and tenants)
802	Farm managers

Farm Laborers and Farm Foremen

821	Farm foremen
822	Farm laborers, wage workers (incl. farm hand, farm work)
823	Farm laborers, unpaid family workers
824	Farm service laborers, self-employed
825	Civilian Conservation Corp

Service Workers, Exc. Private Household

	Cleaning service workers
901	Chambermaids & maids, except priv[illegible] household
902	Cleaners & charwomen
903	Janitors & sextons (incl. custodi[illegible]
	Food service workers
910	Bartenders
911	Busboys
912	Cooks, except private household ([illegible] cook, director, chef)
913	Dishwashers
914	Food counter & fountain workers
915	Waiters (incl. barmaid)
916	Food service workers. n.e.c., exc private household
917	Restaurants, n.s.
918	Hostess
	Health service workers
921	Dental assistants
922	Health aides, exc. nursing (incl asst., nuclear research lab work
923	Health trainees
924	Lay midwives
925	Nursing aides, orderlies & attenc
926	Practical nurses
927	Health spa worker

Craftsmen and Kindred Workers - cont'd.

454	Job & die setters, metal
455	Locomotive engineers
456	Locomotive firement
461	Machinists
462	Machinist apprentices
	Mechanics & repairmen
470	Air conditioning, heating & refrig.
471	Aircraft
472	Automobile body repairmen
473	Automobile mechanics
474	Automobile mechanic apprentices
475	Data processing machine repairmen
480	Farm implement
481	Heavy equipment mechanics (incl. diesel, factory mech, meter)
482	Household appliance & accessory installers & mechanics (incl. repairmen)
483	Loom fixers
484	Office machine
485	Radio and television
486	Railroad & car shop
491	Mechanic, exc. auto, apprentices
492	Miscellaneous mechanics & repairmen
495	Not specified mechanics & repairmen
501	Millers; grain, flour & feed
502	Millwrights
503	Molders, metal
504	Molder apprentices
505	Motion picture projectionists
506	Opticians, & lens grinders & polishers
510	Painters, construction & maintenence (incl. contract)
511	Painter apprentices
512	Paperhangers
514	Pattern & model makers, exc. paper
515	Photoengravers & lithographers
516	Piano & organ tuners & repairmen
520	Plasterers
521	Plasterer apprentices
522	Plumbers & pipe fitters
523	Plumber & pipe fitter apprentices
525	Power station operators
530	Pressmen & plate printers, printing
531	Pressmen apprentices
533	Rollers & finishers, metal
534	Roofers & slaters
535	Sheetmetal workers & tinsmiths
536	Sheetmetal apprentices
540	Shipfitters
542	Shoe repairmen
543	Sign painters & letterers
545	Stationary engineers
546	Stone cutters & stone carvers

Craftsmen and Kindred Workers - cont'd

550	Structural metal craftsmen (incl. ir worker)
551	Tailors
552	Telephone installers & repairmen
554	Telephone linemen & splicers
560	Tile setters
561	Tool & die makers
562	Upholsterers
571	Specified craft apprentices, n.e.c.
572	Not specified apprentices
575	Craftsmen & kindred workers, n.e.c.
580	Former members of the Armed Forces

Operatives, Except Transport

601	Asbestos & insulation workers
602	Assemblers
603	Blasters & powdermen
604	Bottling & canning operatives
605	Chainmen, rodmen, & axmen; surveying
610	Checkers, examiners & inspectors; manufacturers
611	Clothing ironers & pressers
612	Cutting operatives, n.e.c.
613	Dressmakers & seamstresses, except factory
614	Drillers, earth
615	Dry wall installers & lathers
620	Dyers
621	Filers, polishers, sanders & bugger
622	Furnacemen, smeltermen & pourers
623	Garageworkers & gas station attenda
624	Graders & sorters, manufacturing
625	Produce graders & packers, except factory & farm
626	Heaters, metal
630	Laundry & dry cleaning operatives, n.
631	Meat cutters & butchers, exc. manufacturing
633	Meat cutters & butchers, manufactur
634	Meat wrappers, retail trade
635	Metal platers
636	Milliners
640	Mine operatives, n.e.c.
641	Mixing operatives
642	Oilers & greasers, exc. auto
643	Packers & wrappers, except meat & produce
644	Painters, manufactured articles
645	Photographic process workers
	Precision machine operators
650	Drill press operatives
651	Grinding maching operatives
652	Lathe & milling machine operative
653	Precision machine operatives, n.e.

Service Workers, Exc. Private Household, cont'd

Personal service workers

931 Airline stewardesses
932 Attendants, recreation & amusement
933 Attendants, personal service, n.e.c.
934 Baggage porters & bellhops
935 Barbers
940 Boarding & lodging house keepers
941 Bootblacks
942 Child care workers, exc. private household (incl. n.s., juvenile detention)
943 Elevator operators
944 Hairdressers & cosmetologists
945 Personal service apprentices
950 Housekeepers, exc. private household
952 School monitors
953 Ushers, recreation & amusement
954 Welfare service aides

Protective service workers

960 Crossing guards & bridge tenders
961 Firemen, fire protection
962 Guards & watchmen
963 Marshals & constables
964 Policemen & detectives (incl. railroad traffic officer)
965 Sheriffs & bailiffs
966 Military
980 Child care workers, private household (incl. baby sitter)
981 Cooks, private household
982 Housekeepers, private household
983 Laundresses, private household
984 Maids & servants, private household

996 Occupation not specific enough to code
998 DK

840 - DISABLED

850 - RETIRED

860 - UNEMPLOYED

890 - HOMEMAKER, HOUSEWIFE

999 - BLANK, MISSING, NOT REPORTED

Occupational Asbestos Exposure Codes

Code	Category
1	Definite asbestos exposure - decedent employed by asbestos company
2	Probable exposure - including building, house construction, plasterer, automobile mechanic, cement worker
3	Possible exposure - including steel or metal worker railroad workers, house painter, longshoreman, PG & E laborer
4	Probably No exposure - including Farmer, Rancher, lumber worker, office or clerical, food service, health services.

Calaveras and Tuolumne Counties
City Codes

I High Asbestos Areas: less than 5 miles from deposits

Calaveras County

11 - San Andreas
12 - Altaville
13 - Angels Camp, Carson Hill
14 - Melones
15 - Valley Springs, Double Springs
16 - Copperopolis, Salt Spring Valley
17 - Burson
18 - Calaveritas
19 - Campo Seco

Tuolumne County

20 - Sonora
21 - Chinese Camp
22 - Jamestown
23 - Groveland
24 - Jacksonville
25 - Tuttletown
26 - Big Oak Flat, Moccasin

II Medium Asbestos Areas: 6 to 10 miles from deposits

Calaveras County

31 - Milton
32 - Jenny Lind
33 - Telegraph City
35 - Mokelumne Hill
36 - Mountain Ranch
37 - Murphys
38 - Douglas Flat
39 - Vallecito

Tuolumne County

40 - Columbia

III Low Asbestos Area: More than 10 miles from deposits

Calaveras County

51 - West Point
52 - Railroad Flat
53 - Arnold, White Pines
54 - Camp Connell
55 - Avery, Hathaway Pines
56 - Sheep Ranch
57 - Glencoe
58 - Wilseyville

Tuolumne County

60 - Twain Harte
61 - Tuolumne, Bodenhamer
62 - Strawberry
63 - Long Barn, Sierra Village
64 - Soulsbyville
65 - Standard
66 - Mi-Wuk Village, Sugar Pine

CALIFORNIA COUNTY CODES

01 - Alameda
02 - Alpine
03 - Amador
04 - Butte
05 - Calaveras
06 - Colusa
07 - Contra Costa
08 - Del Norte
09 - El Dorado
10 - Fresno
11 - Glenn
12 - Humboldt
13 - Imperial
14 - Inyo
15 - Kern
16 - Kings
17 - Lake
18 - Lassen
19 - Los Angeles
20 - Madera
21 - Marin
22 - Mariposa
23 - Mendocino
24 - Merced
25 - Modoc
26 - Mono
27 - Monterey
28 - Napa
29 - Nevada
30 - Orange
31 - Placer
32 - Plumas
33 - Riverside
34 - Sacramento
35 - San Benito
36 - San Bernardino
37 - San Diego
38 - San Francisco
39 - San Joaquin
40 - San Luis Obispo
41 - San Mateo
42 - Santa Barbara
43 - Santa Clara
44 - Santa Cruz
45 - Shasta
46 - Sierra
47 - Siskiyou
48 - Solano
49 - Sonoma
50 - Stanislaus
51 - Sutter
52 - Tehama
53 - Trinity
54 - Tulare
55 - Tuolumne
56 - Ventura
57 - Yolo
58 - Yuba
98 - Out of State, Out of Country

Appendix C

SMR Data Base for Calaveras and Tuolumne Counties

Male Deaths from Malignant Neoplasms of the Digestive Organs and Peritoneum (ICD 150-159), by Year and Age at Death, Calaveras and Tuolumne Counties

AGE \ YEAR	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
LT 10	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0
15-19	0	0	0	0	0	0	0	0	0	0
20-24	0	0	0	0	0	0	0	0	0	0
25-29	0	0	0	0	0	0	0	0	0	0
30-34	0	0	0	0	0	0	1	0	0	0
35-39	0	0	0	0	1	0	0	0	0	0
40-44	0	0	1	0	0	0	0	0	0	0
45-49	0	0	0	0	3	0	0	1	1	1
50-54	0	0	1	0	2	1	0	3	0	0
55-59	1	1	0	0	1	2	1	0	0	2
60-64	1	0	0	4	2	2	2	4	0	3
65-69	1	2	1	5	2	0	0	3	3	6
70-74	3	2	4	1	2	2	1	2	3	4
75-79	3	2	2	1	0	1	0	0	1	2
80-84	1	1	3	1	0	2	2	4	1	2
GE 85	1	1	1	0	0	1	1	0	2	0
TOTAL	11	9	13	12	13	11	8	17	11	20

Male Deaths from Malignant Neoplasms of Respiratory System (ICD 160-163), by Year and Age at Death, Calaveras and Tuolumne Counties

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
LT 10	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0
15-19	0	0	0	0	0	0	0	0	0	0
20-24	0	0	1	0	0	0	0	0	0	0
25-29	0	0	0	0	0	0	0	0	0	0
30-34	0	0	0	0	0	0	0	0	0	0
35-39	1	0	0	0	0	0	0	1	0	0
40-44	0	1	0	0	0	0	0	0	0	0
45-49	0	0	1	0	0	1	1	0	0	1
50-54	0	3	0	1	0	2	5	1	2	1
55-59	3	2	2	1	0	2	2	3	3	1
60-64	1	1	2	0	5	5	4	4	2	1
65-69	2	2	3	2	5	3	4	3	6	2
70-74	2	1	1	1	3	0	4	5	1	3
75-79	4	2	2	0	1	4	0	1	2	2
80-84	2	1	1	1	0	2	4	2	0	1
GE 85	1	0	0	1	0	2	1	2	3	0
TOTAL	16	13	13	7	14	21	25	22	19	12

Male Deaths from Hypertensive Heart and Renal Disease (ICD 402, 404), by Year and Age at Death, Calaveras and Tuolumne Counties

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
LT 10	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0
15-19	0	0	0	0	0	0	0	0	0	0
20-24	0	0	0	0	0	0	0	0	0	0
25-29	0	0	0	0	0	0	0	0	0	0
30-34	0	0	0	0	0	0	0	0	0	0
35-39	0	0	0	0	0	0	0	0	0	0
40-44	0	0	0	0	0	0	0	0	0	0
45-49	0	0	0	0	0	0	0	0	0	0
50-54	0	0	0	0	0	0	0	0	0	0
55-59	0	0	0	0	0	0	0	0	0	0
60-64	0	0	0	0	0	0	0	0	0	0
65-69	0	1	0	0	0	0	0	0	0	0
70-74	0	0	0	0	1	0	0	0	0	0
75-79	0	0	0	0	0	0	0	0	0	0
80-84	0	0	0	0	0	0	0	0	0	0
GE 85	0	0	0	0	0	2	1	0	0	0
TOTAL	0	1	0	0	1	2	1	0	0	0

Male Deaths from Malignant Neoplasms of the Genital Organs (ICD 180-187), by Year and Age at Death, Calaveras and Tuolumne Counties

AGE	YEAR 1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
LT 10	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0
15-19	0	0	0	0	0	0	0	0	0	0
20-24	0	0	0	0	0	0	0	0	0	0
25-29	0	0	0	0	0	0	0	0	0	0
30-34	0	1	0	1	0	0	0	0	0	0
35-39	0	0	0	0	0	0	0	0	0	0
40-44	0	0	0	0	0	0	0	0	0	0
45-49	0	0	0	0	0	0	0	0	0	0
50-54	0	0	1	0	0	0	0	0	0	0
55-59	0	0	0	0	0	0	0	0	0	0
60-64	0	0	0	0	0	0	0	0	2	2
65-69	0	0	0	1	4	0	1	1	1	4
70-74	0	1	1	0	0	2	0	1	2	1
75-79	1	0	1	0	3	1	3	0	1	0
80-84	0	0	2	1	1	3	1	0	2	2
GE 85	1	1	1	0	1	0	2	0	0	2
TOTAL	2	3	6	3	9	6	7	2	8	11

Male Deaths from All Causes,
by Year and Age at Death,
Calaveras and Tuolumne Counties

AGE	YEAR 1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
LT 10	6	3	8	3	6	1	7	2	4	5
10-14	0	0	0	1	1	1	0	1	2	2
15-19	4	3	3	5	1	2	1	4	2	7
20-24	3	5	5	5	7	5	5	8	6	4
25-29	0	4	1	1	3	2	4	7	4	2
30-34	1	3	2	3	3	0	4	4	2	7
35-39	2	0	5	3	2	2	4	3	7	1
40-44	6	1	5	4	3	7	2	1	6	3
45-49	4	4	12	8	16	7	8	8	5	6
50-54	9	11	9	10	10	10	12	16	7	13
55-59	22	16	13	22	12	16	15	16	17	12
60-64	23	16	25	27	29	27	24	37	26	34
65-69	28	34	38	33	42	28	45	42	33	45
70-74	43	29	31	42	39	25	40	46	36	40
75-79	42	29	26	32	21	30	23	31	30	30
80-84	22	22	32	26	24	37	22	25	28	34
GE 85	22	28	26	22	26	24	20	16	38	29
TOTAL	237	208	241	247	245	224	236	267	253	274

Female Deaths from Malignant Neoplasms of the Digestive Organs and Peritoneum (ICD 150-159), by Year and Age at Death, Calaveras and Tuolumne Counties

AGE	YEAR 1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
LT 10	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0
15-19	0	0	0	0	0	0	0	0	0	0
20-24	0	0	0	0	0	0	0	0	0	0
25-29	0	0	0	0	0	0	0	0	0	0
30-34	0	0	0	0	0	0	0	0	0	0
35-39	0	0	0	0	0	0	0	0	0	0
40-44	0	0	0	0	0	0	0	0	0	0
45-49	1	2	0	0	0	0	0	0	0	0
50-54	0	0	0	0	0	1	0	1	2	1
55-59	1	0	1	1	1	0	2	2	0	0
60-64	2	1	0	1	1	0	2	3	1	1
65-69	0	0	0	0	2	1	4	1	0	1
70-74	3	2	1	0	4	2	5	1	1	0
75-79	2	2	1	1	1	1	4	1	0	1
80-84	1	0	3	0	0	1	0	1	2	3
GE 85	3	1	0	2	2	1	0	2	1	1
TOTAL	13	8	6,	5	11	7	17	12	7	8

Female Deaths from Malignant Neoplasms of Respiratory System (ICD 160-163),
by Year and Age at Death,
Calaveras and Tuolumne Counties

AGE	YEAR 1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
LT 10	0	0	0	0	0	0	0	0	0	0
10-14	0	0	1	0	0	0	0	0	0	0
15-19	0	0	0	0	0	0	0	0	0	0
20-24	0	0	0	0	0	0	0	0	0	0
25-29	0	0	0	0	0	0	0	0	0	0
30-34	0	0	0	0	0	0	0	0	0	0
35-39	0	0	0	0	0	0	0	0	0	0
40-44	0	0	0	0	0	0	1	0	1	0
45-49	0	0	0	0	0	1	1	0	1	0
50-54	0	0	0	1	0	0	0	0	0	1
55-59	0	2	1	1	0	0	2	0	2	2
60-64	0	0	0	0	2	0	0	0	1	5
65-69	0	0	1	0	3	0	0	0	1	1
70-74	1	0	0	0	1	0	2	2	1	1
75-79	0	0	0	1	0	1	2	0	0	2
80-84	0	0	0	0	0	0	1	1	0	1
GE 85	0	0	0	0	0	0	0	1	0	0
TOTAL	1	2	3	3	6	2	9	4	7	13

Female Deaths from Malignant Neoplasms of the Breast (ICD 174), by Year and Age at Death, Calaveras and Tuolumne Counties

AGE	YEAR 1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
LT 10	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0
15-19	0	0	0	0	0	0	0	0	0	0
20-24	0	0	0	0	0	0	0	0	0	0
25-29	0	0	0	0	0	0	0	0	0	0
30-34	0	0	0	0	0	0	0	0	0	0
35-39	0	0	0	1	1	0	0	0	0	0
40-44	0	0	1	0	0	0	0	0	0	0
45-49	0	1	0	0	1	1	1	0	1	1
50-54	1	0	0	0	1	1	1	0	1	3
55-59	0	1	0	1	0	1	1	1	2	1
60-64	0	0	3	0	1	1	1	1	0	0
65-69	0	1	0	0	0	1	1	1	1	1
70-74	0	0	1	1	0	0	2	0	3	2
75-79	1	0	0	0	1	0	0	0	0	0
80-84	0	0	0	1	0	1	0	0	0	0
GE 85	1	1	1	0	1	0	1	0	1	1
TOTAL	3	4	6	4	6	6	8	3	9	9

Female Deaths from Malignant Neoplasms
of the Genital Organs (ICD 180-187),
by Year and Age at Death,
Calaveras and Tuolumne Counties

AGE	YEAR 1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
LT 10	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0
15-19	0	0	0	0	0	0	0	0	0	0
20-24	0	0	0	0	0	0	0	0	0	0
25-29	0	0	0	0	0	0	0	0	0	0
30-34	0	0	0	0	0	0	0	0	0	0
35-39	0	0	0	0	0	0	0	0	0	0
40-44	0	0	0	1	0	1	0	0	1	0
45-49	0	0	1	0	0	0	0	0	0	1
50-54	1	0	0	0	1	1	2	0	0	1
55-59	1	1	0	0	0	1	0	2	0	0
60-64	0	2	2	2	0	2	1	0	0	0
65-69	1	1	0	1	0	0	0	2	1	2
70-74	0	1	1	0	0	0	0	0	1	0
75-79	1	0	2	2	0	0	0	0	0	0
80-84	1	1	1	0	0	0	0	1	1	0
GE 85	0	0	0	0	0	1	0	0	0	0
TOTAL	5	6	7	6	1	6	3	5	4	4

Female Deaths from Hypertensive Heart and Renal Disease (ICD 402, 404), by Year and Age at Death, Calaveras and Tuolumne Counties

AGE	YEAR 1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
LT 10	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0
15-19	0	0	0	0	0	0	0	0	0	0
20-24	0	0	0	0	0	0	0	0	0	0
25-29	0	0	0	0	0	0	0	0	0	0
30-34	0	0	0	0	0	0	0	0	0	0
35-39	0	0	0	0	0	0	0	0	0	0
40-44	0	0	0	0	0	0	0	1	0	0
45-49	0	0	0	0	0	0	0	0	0	0
50-54	0	0	1	0	0	0	0	0	0	0
55-59	0	0	1	0	0	0	0	0	0	0
60-64	0	0	0	0	0	0	0	0	0	0
65-69	2	0	0	0	0	0	0	0	0	0
70-74	0	0	0	0	0	1	0	0	0	0
75-79	0	0	0	0	0	0	0	0	0	0
80-84	0	0	1	0	0	0	0	0	0	0
GE 85	1	0	0	0	1	1	0	0	0	0
TOTAL	3	0	3	0	1	2	0	1	0	0

Female Deaths from All Causes,
by Year and Age at Death,
Calaveras and Tuolumne Counties

		YEAR									
		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE	LT 10	4	7	5	0	6	5	2	3	2	6
	10-14	3	0	1	0	0	1	0	0	0	0
	15-19	1	2	0	2	0	1	2	1	4	3
	20-24	1	1	1	5	1	0	2	1	2	3
	25-29	0	0	3	2	3	0	0	0	1	1
	30-34	0	0	0	0	0	1	0	2	0	1
	35-39	0	2	1	2	2	1	1	1	4	1
	40-44	0	1	6	4	1	3	4	6	5	2
	45-49	3	6	5	4	6	4	5	5	6	3
	50-54	5	5	10	6	8	8	9	9	5	11
	55-59	11	11	12	8	7	12	11	10	10	6
	60-64	10	13	15	14	17	15	18	16	9	14
	65-69	18	18	10	9	18	19	23	20	14	16
	70-74	18	19	20	10	23	21	25	15	21	21
	75-79	22	19	22	20	21	24	23	20	20	23
	80-84	24	28	21	11	25	27	26	22	29	23
	GE 85	35	34	35	36	38	33	41	31	37	52
	TOTAL	155	166	167	133	176	175	192	162	169	186

Female Deaths from All Causes,
by Year and Age at Death,
Calaveras and Tuolumne Counties

		YEAR									
		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE	LT 10	4	7	5	0	6	5	2	3	2	6
	10-14	3	0	1	0	0	1	0	0	0	0
	15-19	1	2	0	2	0	1	2	1	4	3
	20-24	1	1	1	5	1	0	2	1	2	3
	25-29	0	0	3	2	3	0	0	0	1	1
	30-34	0	0	0	0	0	1	0	2	0	1
	35-39	0	2	1	2	2	1	1	1	4	1
	40-44	0	1	6	4	1	3	4	6	5	2
	45-49	3	6	5	4	6	4	5	5	6	3
	50-54	5	5	10	6	8	8	9	9	5	11
	55-59	11	11	12	8	7	12	11	10	10	6
	60-64	10	13	15	14	17	15	18	16	9	14
	65-69	18	18	10	9	18	19	23	20	14	16
	70-74	18	19	20	10	23	21	25	15	21	21
	75-79	22	19	22	20	21	24	23	20	20	23
	80-84	24	28	21	11	25	27	26	22	29	23
	GE 85	35	34	35	36	38	33	41	31	37	52
	TOTAL	155	166	167	133	176	175	192	162	169	186