INDUSTRIAL HYGIENE REPORT

Homestake Mining Company
Lead, South Dakota

DATE OF SURVEY:
July 12-23, 1977

REPORT WRITTEN BY:
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FINAL REPORT
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CLASSIFICATION OF PLANT: 1041

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ABSTRACT

In 1976, the National Institute for Occupational Safety and Health (NIOSH) reported on a retrospective cohort mortality study of individuals who had worked at the Homestake Gold Mine in Lead, South Dakota. The study indicated an excess of both nonmalignant and malignant respiratory diseases. To determine the possible etiologic agents responsible for the observed excess in mortality, NIOSH initiated a comprehensive environmental assessment of this mining population.

An industrial hygiene study was conducted to assess both current environmental conditions, and also attempt to determine the magnitude of previous underground exposures. Approximately 170 workers encompassing 90% of the various job titles were sampled for an entire work shift to determine time-weighted average (TWA) exposures. Industrial hygiene survey methods included breathing-zone air sampling for airborne fibrous minerals with analyses to determine fiber identification, concentration and fiber size distributions (optical and electron microscopy), and airborne arsenic and trace metal concentrations (atomic absorption). Likewise, a general airborne area sample was collected at each worksite for the determination of radon daughter levels. In addition to the environmental evaluation, samples of crushed ore were collected from the mills for analyses of free silica, arsenic, fibers, and trace metals. To assist in the evaluation of past exposures, midget impinger samples were collected to compare the current dustiness with similar historic exposure data collected by the company.

Exposure data was grouped by job title, for areas underground, and within the ore crushing mills. TWA exposures to arsenic for all underground workers ranged from 0.10 to 11.62 $\mu g/m^3$, and for workers in the crushing mills 0.60 to 6.45 $\mu g/m^3$. Airborne exposures to trace metals for all workers were found only in trace amounts. When airborne samples were evaluated by optical microscopy for asbestos, TWA fiber concentrations for all underground workers ranged from 0.02 to 4.01 fibers >5 µm in length/cm^3, and for workers in the crushing mills ranged from 0.12 to 5.34 fibers >5 µm in length/cm^3. Electron microscopy characterization of airborne fiber samples indicated that 84% of the fibers observed were amphibole asbestos while the remaining 16% were either unidentified or non-asbestos minerals. Most of the fibers observed (70 to 80%) were shorter than 5 µm with a geometric mean fiber length of 3.2 µm and a geometric mean diameter of 0.4 µm. Radon daughter levels varied within the mine depending on the source of make-up air; levels ranged from non-detected to 0.169 working level.

Impinger dust sampling data collected during the study was correlated with the fiber and arsenic exposure data; this extrapolation was used with the Company's past impinger data for estimation of past arsenic and fiber concentrations. Likewise, free silica exposure data collected in past years by the

Bureau of Mines and the Mine Enforcement and Safety Administration was correlated with impinger data for estimation of past exposures. When assessing exposures during the past 25 years, exposure to asbestos fibers would have the greater potential for exceeding current health standards. However, before approximately 1952 there was an additional risk of over exposure to free silica because of elevated dust concentrations caused by underground blasting procedures and the lack of efficient dust suppressive techniques. Based on current exposure data collected during this study, mean exposures for free silica, radon daughter, arsenic, and asbestos fibers are within Occupational Safety and Health Administration and Mine Safety and Health Administration health standards for most of the job classifications.

CONTENTS

FIGURES

TABLES

TABLES (continued)

ACKNOWLEDGMENTS

Collection of samples for airborne particulates used for this study and the laboratory fiber identification and characterization are the results of many hours of effort from NIOSH personnel with the Industrial Hygiene Section, Industry-wide Studies Branch, Division of Surveillance, Hazard Evaluations and Field Studies. Special appreciation is extended to Terry Boyle and Robert Phillips for their help with the optical microscopy analyses, Dennis Roberts who performed optical and electron microscopy analyses, and James Carter who completed the majority of the electron microscopy fiber characterization.

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INTRODUCTION

In 1976, the National Institute for Occupational Safety and Health (NIOSH) reported on a retrospective cohort mortality study of 440 individuals who, in 1960, had worked underground at least 5 years at the Homestake Gold Mine in Lead, South Dakota (1). The study indicated an excess of both nonmalignant and malignant respiratory diseases. The mortality pattern (see Table 1) showed a significant excess of nonmalignant respiratory disease in general (8 observed vs. 2.56 expected, $p<0.01$), and of pneumoconiotic disease specifically (5 observed vs. 1.57 expected, $p<0.05$), to have occurred after 20 years since onset of underground mining. No such excess of nonmalignant respiratory disease risk was noted during the first 19 years after beginning underground mining. However, a significant excess of respiratory tract cancer was demonstrated at each of the time intervals since onset of underground mining: 3 observed vs. 0.56 expected ($p<0.05$) at less than 20 years, and 7 observed vs. 2.18 expected ($p<0.01$) at 20 or more years since onset of such employment.

In assessing what possible etiologic agent(s) contributed to the observed excess of deaths due to malignant and nonmalignant respiratory disease in this population, the environmental exposures of these miners were examined. Using the results of three previous environmental studies at the mine--Bureau of Mines in 1960 (2), Mining Enforcement and Safety Administration (MESA) in 1973 (3), and MESA in 1974 (4)--it was concluded that exposures did not exceed ambient residential levels for radon daughters and were negligible for the three other known carcinogens in the mine: arsenic, chromium, and nickel. In addition, asbestos exposures were studied during the 1974 MESA survey (4). The average fiber concentration of the 200 personal samples collected was 0.25 fibers greater than 5 micrometers (μm) in length per cubic centimeter of air (fibers/cm^3); the highest concentration found was 2.8 fibers/cm^3. NIOSH analyzed 25 of the MESA air samples using electron microscopy (5). This analysis indicated that 80 to 90% of the observed fibers were amphiboles. Of these fibrous amphiboles, 61 to 72% were in the cummingtonite-grunerite series (e.g., amosite asbestos). In addition, 94% of the total fibers observed were less than 5 μm in length. Based on the three previous environmental studies and the NIOSH electron microscopy analysis, the 1976 mortality study attributed the observed excess of malignant respiratory disease to asbestos, singly or in combination with cigarette smoke; the excess of nonmalignant respiratory disease was attributed to asbestos, with a possible additive role from low-level exposures to free silica dust (1).

Subsequent to the NIOSH mortality study, McDonald et.al., in 1978, reported a mortality study of 1321 men (underground and surface workers) who were members of the Homestake Veterans Association (HVA), which was founded in 1905 (6). All employees automatically became members of the HVA after completing 21 years of service with the Homestake Mining Company. Therefore, the entire cohort had at least 21 years of employment; the cutoff date for the study was 1973. The impetus of this study was to determine whether long-term exposure to cummingtonite-grunerite carried a carcinogenic risk. The mortality pattern (see Table 2) showed an excess in overall deaths (631

Table 1. Observed and expected deaths due to malignant and nonmalignant respiratory disease among white males who achieved 5 or more years of underground mining experience by April 1960 at Homestake Gold Mine, Lead, South Dakota.

Cause of death	Number of years since onset of underground employment					
	5–19 Years			≥ 20 Years		
	Observed (O)	Expected (E)	O/E	Observed (O)	Expected (E)	O/E
Malignant neoplasms	4	2.14	1.87	11	7.59	1.45
Respiratory system	3	0.56	5.36*	7	2.18	3.21**
Other	1	1.58	0.63	4	5.41	0.74
Nonmalignant respiratory diseases	0	0.59	--	8	2.56	3.13**
Influenza and pneumonia	0	0.31	--	3	0.99	3.03*
Other respiratory diseases	0	0.28	--	5	1.57	3.18*

* Significant difference between observed and expected deaths at $p<0.05$.
** Significant difference between observed and expected deaths at $p<0.01$.

From: Mortality patterns among hard rock gold miners exposed to an asbestiform mineral. Gillam, J.D., J.M. Dement, R.A. Lemen, J.K. Wagoner, V.E. Archer, and H.P. Blejer. Annals of the New York Academy of Sciences. 271:336-344, May 1976.

Table 2. Number of observed and expected deaths by cause according to South Dakota rates for various causes at the Homestake Gold Mine, Lead, South Dakota from 1937-1973.

Cause of death	1937-1973		
	O	E	O/E
Malignant neoplasms			
Total	93	90.5	1.03
Respiratory	17	16.5	1.03
Gastrointestinal	39	35.1	1.11
Other	37	38.9	0.95
Vascular lesions of the CNS	64	63.0	1.02
Diseases of the heart	264	232.5	1.14
Pneumoconiosis	37	-	-
Respiratory tuberculosis (including silico-tuberculosis)	39	3.6	10.83
Accidents	19	28.3	0.67
All other causes	115	131.8	0.87
Total	631	549.7	1.15

Definition of abbreviations: O = observed; E = expected

From: Mortality after long exposure to cummingtonite-grunerite. McDonald, J.C., G.W. Gibbs, F.D.K. Liddell, and A.D. McDonald. American Review of Respiratory Disease. 118:271-277, August 1978.

observed vs. 549.7 expected). For specific causes of death, the highest excesses were found for pneumoconiosis (37 observed), respiratory tuberculosis (39 observed vs. 3.6 expected), diseases of the heart (264 observed vs. 232.5 expected), and gastrointestinal tract cancer (39 observed vs. 35.1 expected). It was concluded that the pattern of mortality found was characteristic of hard rock mining with a severe silicotic risk (6). The differences in the findings between the mortality studies could be explained by the different criteria used for inclusion in the two cohorts and/or other differences in study design.

Since the original NIOSH study was limited to 440 workers, and there was a need for a more comprehensive environmental assessment for this mining population, NIOSH initiated a more definitive study of the Homestake Gold Mine in 1977. This new investigation included an expanded retrospective mortality study, a sputum cytology study among a selected group of current or retired underground workers, and a comprehensive industrial hygiene survey. This report describes the industrial hygiene survey and discusses the results. In addition, a model for extrapolating previous underground exposure levels is derived.

HISTORY OF THE HOMESTAKE MINE (7,8,9)

In 1876, mining for gold started in Lead, South Dakota, at a small surface working site. In 1877, the Homestake Mining Company was incorporated and, by the end of 1878, the first underground levels were being opened using the square-set method of mining with large timbers. The mining at that time was done by hand; it was not until the early 1900's that pneumatic drills began replacing hand-drilling operations and compressed-air locomotives replaced horses and mules underground. All pneumatic drilling was performed dry until about 1915; all drilling was done wet by 1926. Primary crushing of the ore was done underground until the mid-1930's when the operation was transferred to the surface. As underground mining became more extensive with increasing mining depths, the installation of the Ross Shaft in 1934 and the Yates Shaft in 1941 increased the mining capabilities down to the 4850-foot level. Between 1955 and 1970, deeper level mine development began with a winze (underground shaft) sunk from the 4850-foot level to the 6800-foot level, and a new ventilating shaft sunk from the surface extending down to the 6200-foot level. Deeper level mining development has continued to the present with two new winzes: one from the 4550-foot level to the 8000-foot level, and the other from the 6800-foot level to the 8000-foot level. A schematic cross-section of the mine is illustrated in Figure 1.

In the geologic formation at Lead, South Dakota, gold ore occurs in a number of different ore bodies contained in a folded rock strata called the Homestake Formation. This formation was originally a sedimentary rock containing the mineral sideroplesite, an iron-magnesium carbonate. The metamorphism of this rock has converted some of the formation to the iron-magnesium silicate minerals of the cummingtonite- grunerite series (e.g., amosite asbestos). This highly folded and cross-folded rock stratum is further intertwined with deposits of igneous rock in a series of rhyolite dikes. The ore formation also contains quartz and arsenopyrite. Since most of the gold ore is heterogeneously deposited in certain folds in the Homestake Formation, the gold is selectively mined in stopes located in ledges or major folds which are traversed by the mining levels. This is illustrated in Figure 2. In some instances, two or more ledges may occur and be ore-bearing on a given level.

The total amount of ore mined has remained fairly constant since 1937, with between 1 and 2 million tons mined each year except for 1943 to 1948 (see Table 3). The percentage of ore production from each ledge continues to change as the older ore bodies (9 and Main Ledges) are mined out, along with the opening of new ledges (11, 12, 19, and 21 Ledges). However, except for 1945, at least 55% of the ore milled since 1937 has come from the 9 and Main Ledges.

The number of workers underground has fluctuated greatly since 1920, with a low of 151 during 1943 to 1945, when no active mining took place, to a high of 1138 workers in 1941. However, the percentage of workers in each job

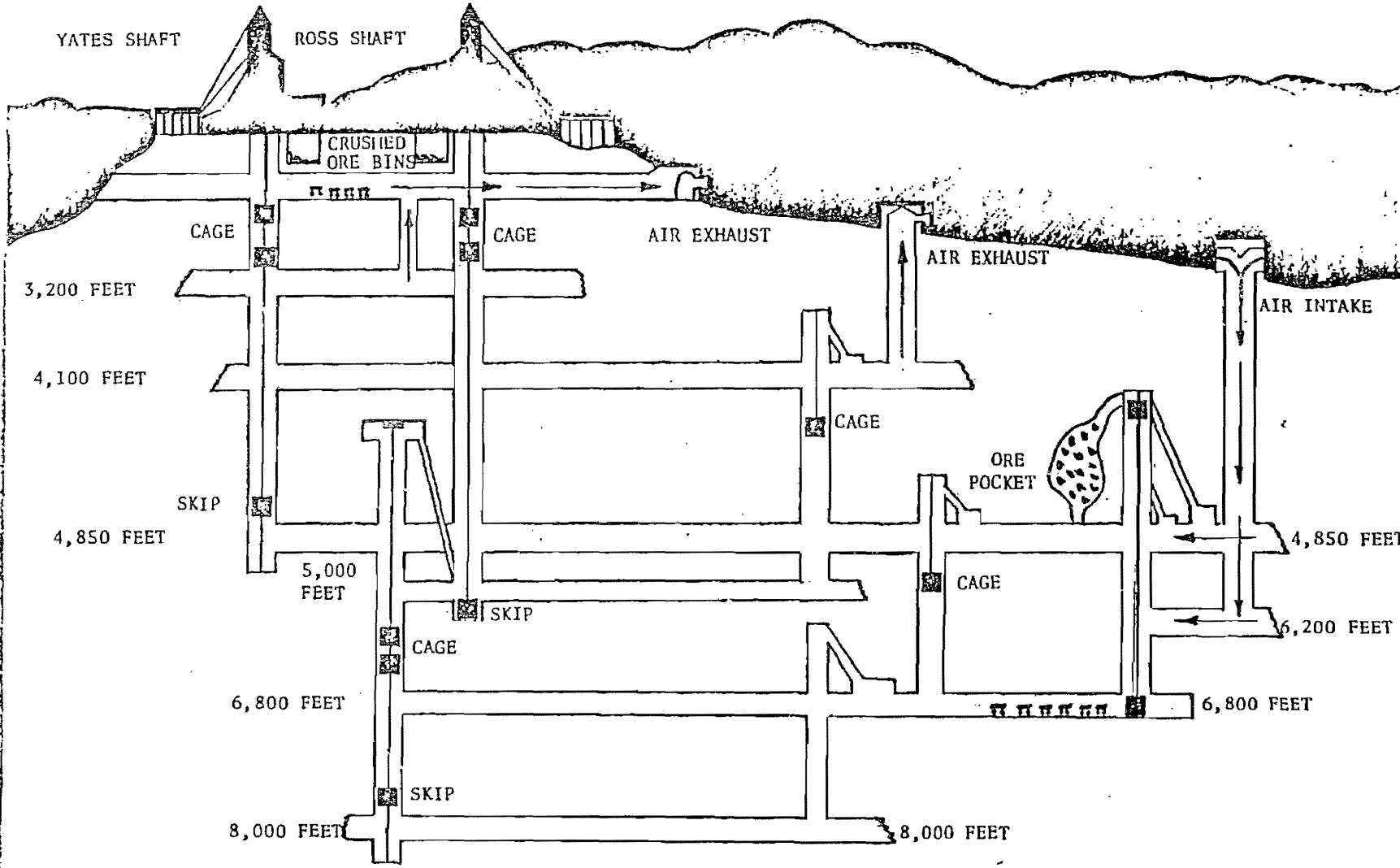


Figure 1. Cross section of Homestake Gold Mine, Lead, South Dakota

Figure 2. Selective mining of ledges
Homestake Gold Mine, Lead, South Dakota

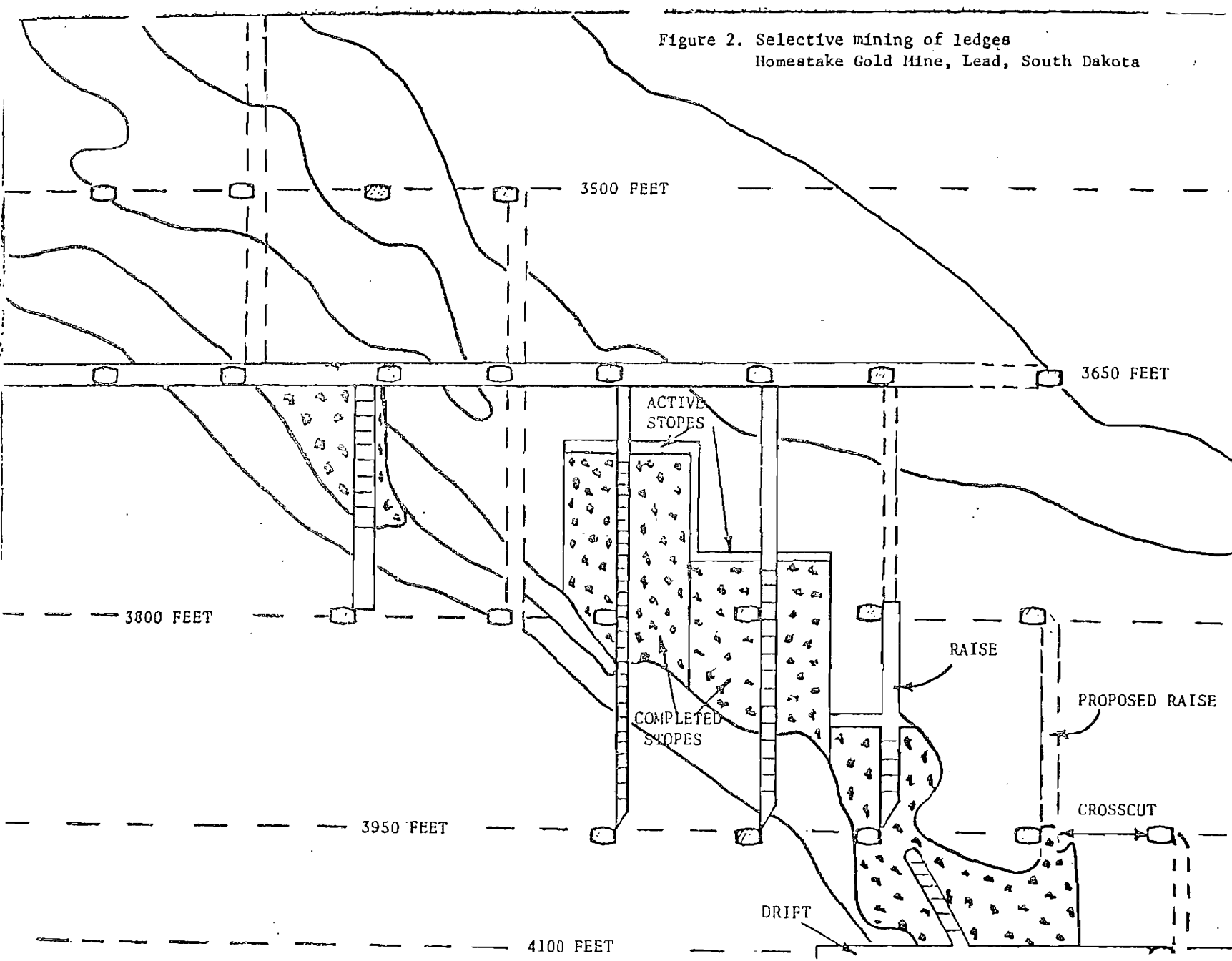


Table 3. Tonnage of ore mined by ledge from 1937 to 1976
Homestake Gold Mine, Lead, South Dakota

Year	Main Ledge Tonnage	%	5 Ledge Tonnage	%	7 Ledge Tonnage	%	9 Ledge Tonnage	%	11 Ledge Tonnage	%	13 Ledge Tonnage	%	19 Ledge Tonnage	%	21 Ledge Tonnage	%	Draw Hole Tonnage	%	Total Tonnage
1976	143,287	8.68	-	-	12,888	0.78	782,895	47.44	494,204	30.00	36,858	2.24	179,310	10.86	-	-	-	-	1,650,442
1975	160,551	10.80	-	-	37,273	2.50	747,694	50.25	399,502	26.85	29,482	1.98	113,456	7.62	-	-	-	-	1,488,072
1974	231,984	14.87	-	-	39,439	2.53	712,450	45.68	450,334	25.99	38,425	2.46	132,139	8.47	-	-	-	-	1,559,770
1973	242,341	15.36	-	-	5,642	0.36	785,488	49.78	347,237	22.00	62,846	3.98	134,450	8.52	-	-	-	-	1,578,021
1972	287,796	19.76	-	-	13,370	0.92	718,940	49.35	233,383	16.02	47,133	3.23	156,093	10.72	-	-	-	-	1,456,715
1971	347,290	19.56	-	-	46,787	2.63	946,804	53.32	262,314	14.77	53,035	2.99	119,470	6.73	-	-	-	-	1,775,700
1970	318,834	16.11	-	-	48,151	2.43	1,119,663	56.55	266,710	13.47	83,176	4.20	143,423	7.24	-	-	-	-	1,980,007
1969	359,925	18.83	-	-	74,313	3.89	1,131,776	59.20	195,084	10.20	65,754	3.44	85,073	4.44	-	-	-	-	1,911,925
1968	496,279	25.05	-	-	131,195	6.62	1,128,194	56.94	150,596	7.60	23,742	1.20	51,246	2.59	-	-	-	-	1,981,252
1967	498,310	26.25	288	0.02	118,536	6.24	1,152,972	60.72	88,890	4.68	1,535	0.08	38,168	2.01	-	-	-	-	1,898,699
1966	412,656	20.99	8,654	0.44	195,837	9.96	1,264,813	64.32	74,906	3.81	82	-	9,425	0.48	-	-	-	-	1,966,375
1965	541,598	26.60	-	-	224,420	11.02	1,248,148	61.30	19,607	0.96	-	-	2,526	0.12	-	-	-	-	2,036,294
1964	480,963	23.59	-	-	201,146	9.87	1,344,778	65.95	11,435	0.56	-	-	645	0.03	-	-	-	-	2,038,972
1963	310,057	16.20	-	-	213,744	11.16	1,390,181	72.63	-	-	-	-	161	0.01	-	-	-	-	1,914,143
1962	300,261	16.10	-	-	231,364	12.40	1,333,908	71.50	-	-	-	-	-	-	-	-	-	-	1,865,533
1961	289,593	16.27	-	-	181,225	10.18	1,309,517	73.55	-	-	-	-	-	-	-	-	-	-	1,780,335
1960	383,253	21.68	-	-	171,412	9.69	1,213,252	68.63	-	-	-	-	-	-	-	-	-	-	1,767,917
1959	447,131	25.59	-	-	170,673	9.77	1,129,554	64.64	-	-	-	-	-	-	-	-	-	-	1,747,358
1958	551,686	32.02	-	-	113,618	6.59	1,057,823	61.39	-	-	-	-	-	-	-	-	-	-	1,723,127

Table 3 (continued)

Year	Main Ledge Tonnage	%	5 Ledge Tonnage	%	7 Ledge Tonnage	%	9 Ledge Tonnage	%	11 Ledge Tonnage	%	13 Ledge Tonnage	%	19 Ledge Tonnage	%	21 Ledge Tonnage	%	Draw Hole Tonnage	%	Total Tonnage
1957	505,748	30.43	-	-	67,857	4.08	1,088,378	65.49	-	-	-	-	-	-	-	-	-	-	1,661,983
1956	447,735	27.47	-	-	66,737	4.09	1,115,700	68.44	-	-	-	-	-	-	-	-	-	-	1,630,172
1955	398,782	25.71	-	-	14,188	0.92	1,137,781	73.37	-	-	-	-	-	-	-	-	-	-	1,550,751
1954	483,492	32.46	-	-	18,856	1.27	986,836	66.27	-	-	-	-	-	-	-	-	-	-	1,489,184
1953	459,207	33.75	-	-	-	-	901,434	66.25	-	-	-	-	-	-	-	-	-	-	1,360,641
1952	452,025	37.00	-	-	-	-	770,370	63.00	-	-	-	-	-	-	-	-	-	-	1,222,395
1951	448,154	42.80	-	-	-	-	598,367	57.20	-	-	-	-	-	-	-	-	-	-	1,046,521
1950	538,154	42.70	-	-	-	-	721,074	57.30	-	-	-	-	-	-	-	-	-	-	1,259,228
1949	531,135	47.60	-	-	-	-	585,462	52.40	-	-	-	-	-	-	-	-	-	-	1,116,597
1948	449,915	49.60	-	-	-	-	457,326	50.40	-	-	-	-	-	-	-	-	-	-	907,241
1947	458,647	54.00	-	-	-	-	390,001	46.00	-	-	-	-	-	-	-	-	-	-	848,675
1946	324,181	41.21	-	-	-	-	324,617	41.27	-	-	-	-	-	-	-	-	137,814	17.52	786,632
1945	40,587	12.56	-	-	-	-	61,651	19.09	-	-	-	-	-	-	-	-	220,781	68.35	323,019
1944	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	None
1943	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	None
1942	726,988	55.37	-	-	-	-	309,846	23.60	-	-	-	-	-	-	-	-	276,182	21.03	1,313,016
1941	1,015,843	67.29	-	-	-	-	310,912	20.58	-	-	-	-	-	-	-	-	183,058	12.13	1,509,713
1940	1,040,341	72.63	-	-	-	-	145,071	10.20	-	-	-	-	-	-	-	-	245,920	17.17	1,432,332
1939	1,090,525	74.83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	366,797	25.17	1,457,332
1938	1,278,147	92.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	99,167	7.20	1,377,314
1937	1,216,242	87.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	178,531	12.80	1,394,773

From: July 11, 1977, memo from J.K. Waterland to D.T. Dalicata.
Homestake Mining Company, Lead, South Dakota

classification underground has remained fairly constant through the years. The working hours and average number of shifts worked per year are shown in Table 4. The amount of time per shift has been either 7 or 8 hours. These 7- or 8-hour shifts represent time spent at the worksite and do not take into account the 30 to 60 minutes spent before and after each shift in transit between the surface and the underground worksite. The average work week has ranged from a high of 52 hours from 1920 to 1933, to a current low of 40 hours. At the time of the survey, there were two 8½-hour shifts, including ½ hour for a meal underground.

Table 4. Employment and average number of hours worked from 1920 to 1974 at the Homestake Gold Mine, Lead, South Dakota.

Year	Average employees underground	Average no. shifts worked per employee year	Hours in shift	Average no. hours in workweek
1920	641	333	8	52(a)
1921	852	326	"	"
1922	842	327	"	"
1923	781	326	"	"
1924	790	318(b)	"	"
1925	723	336	"	"
1926	695	330	"	"
1927	665	333	"	"
1928	642	327	"	"
1929	723	320	"	"
1930	810	306(c)	"	"
1931	780	322	"	"
1932	783	335	"	"
1933	830	328(d)	"	52 & 48(d)
1934	957	304	"	48
1935	965	298	"	"
1936	1,037	299	"	"
1937	988	299	"	"
1938	1,044	299	"	"
1939	1,103	296	"	"
1940	1,085	297	7 & 8(e)	48 & 42(e)
1941	1,138	293	7	42
1942	850(f)	306(f)	"	"
1943	162(f)	289(f)	"	"
1944	151(f)	280(f)	"	"
1945	267(f)	283(f)	"	"
1946	614	276	"	"
1947	676	279	"	"
1948	684	273	"	"
1949	948	274	"	"
1950	993	286	"	"
1951	726	314	"	"
1952	739	290(g)	"	42 & 48(g)
1953	803	291	8	48
1954	887	291	"	"
1955	889	290	"	"
1956	914	292	"	"
1957	943	293	"	"
1958	925	294	"	"
1959	890	294	"	"
1960	970	292	"	"

Table 4 (continued)

Year	Average employees underground	Average no. shifts worked per employee year	Hours in shift	Average no. hours in workweek
1961	892	294	8	48
1962	939	288	"	"
1963	1,036	289	"	"
1964	1,046	290	"	"
1965	1,022	290	"	"
1966	983	288	"	"
1967	1,006	280	"	"
1968	1,002	272	"	"
1969	990	280	"	"
1970	993	282	"	"
1971	954	294	"	"
1972	900	254	"	48 & 44(h)
1973	960	249	"	44 & 40(i)
1974	963	249	"	40

Note:

(a) Alternating 56- and 48-hour workweeks. Calculated from record of total hifts worked and assuming 333 shifts per employee from the 1920 figures.

(b) Assumed figure. Data available for year are unreliable.

(c) Fire in Ellison shaft headframe caused a short shutdown of underground mine operations.

(d) Workweek changed from alternating 56- and 48-hour weeks to 48-hour weeks on September 1, 1933.

(e) Workweek and workday changed to 42 and 7 hours respectively on October 20, 1940.

(f) Production operations shut down during World War II from October 8, 1972, to July 1, 1945, by War Production Board Order L-208.

(g) Workweek and workday changes to 48 and 8 hours, respectively, on March 2, 1952.

(h) Workweek changed from 48-hour week to alternating 48- and 40-hour weeks on August 28, 1972.

(i) Workweek changed from alternating 48- and 40-hour weeks to 40-hour week on April 20, 1973.

From: Swent, L.W., G.R. Herrin, J.K. Waterland, and R.F. Bell. Mortality patterns among hard rock gold miners exposed to an asbestiform mineral - A Critique. Amer. Ind. Hyg. Conf. New Orleans, LA., May 16-21, 1976.

CURRENT

Extractive operations in Lead, South Dakota, have always used hard rock mining methods, with gold and silver being recovered after milling, processing, and refining. At the time of the July 1977 survey, the Homestake Gold Mine employed 968 employees underground with about 900 working on the 35 levels spaced at 150-foot intervals from the 1700-foot level down to the 6800-foot level, inclusive. A few employees worked on the remaining levels down to the 8000-foot level.

There are over 200 miles of workings on the various ledges with small crews of one to three workers scattered throughout. These crews are mainly composed of workers with job classifications of Miner 1st, 2nd, 3rd, and 4th who are responsible for drilling and blasting in stopes, drifts, cross-cuts, and raises, as well as the removal of ore by mucking and slushing. About 70% of the underground workers are "Miners"; others are carpenters, motormen, mechanics, skippers, etc.

Prior to large-scale, systematic ore removal, development work is required to outline each of the ore bodies within the mine and to provide access. This consists of driving drifts and cross-cuts (horizontal openings 7' x 7' in cross-section, or 7½' x 7½' as found on the lower levels of the mine), driving or boring raises, and boring diamond drill holes, all to outline the gold-bearing rock, and cutting ditches to carry water to the pumps. Once the development work has been accomplished, the breaking down and withdrawal of the ore (called stoping) begins. Stoping starts at the bottom of an ore body and proceeds upward from level to level. Nearly all of the ore between levels is mined by horizontal cut-and-fill stoping. Most of the stopes mined are without timber and are called "open" cut-and-fill. In 1975, 83% of the ore was produced from open cut-and-fill stopes. The majority of the remaining stopes are mined with timber or square sets, which are also later filled, and are called "timbered" cut-and-fill stopes. Shrinkage stoping and blast-hole stoping techniques are also employed.

In cut-and-fill stoping, the ore body is mined in successive 11-foot slices. With this method of stoping, a sand fill is used as a floor from which the miners begin to drill and blast a new slice of ore 11 feet high. The broken ore is then removed by scraping or slushing into an ore pass and dropped through a chute to the level below, where it is then drawn and loaded into cars. After the ore is drawn from the stope chutes into the cars, it is hauled to the shaft ore raises into which it is dumped before being drawn off through a loading cartridge of measured capacity (9 to 10 tons) into the ore skips (rectangular buckets). The ore is then hoisted to the surface where it is crushed to ½-inch size and conveyed to the mill bins.

After a "slice" of ore has been removed, most of the stope is back-filled with sand obtained from the tailings of the mill. This sand base provides both support and a floor upon which the next slice is broken. To prepare the stope for the next slice, air-powered drilling machines are set up and holes about 12 feet deep are drilled into the walls and roof. When drilling is completed, the holes are packed with explosives and blasted at the end of the work shift. On the following workday, the ore is slushed to a chute on the level below and the mining process is repeated.

PAST

In contrast to current mining methods, dry drilling techniques were employed until 1919 when wet drilling was initiated. Up until about the late 1930's, the practice was to blast the blockholes (secondary drilling) in large boulders with dynamite after miners temporarily left the work area. Miners would then return to the work area through the smoke and dust and charge the primary blast holes drilled during their shift. This primary blasting was normally done at the end of the work shift so that the dust could be allowed to clear. The boulder blockhole blasting procedure was changed in 1939 to blast them at the same time as the primary blast holes.

Prior to 1950, blasting was permitted at any time throughout the mine. This practice probably contributed greatly to the amount of dust and smoke present at the worksites during the shift. Procedures were changed in 1950 to permit blasting only at lunchtime and quitting time in square set (timbered) stopes and only at quitting time in open (untimbered) stopes, drifts, and raises. These changes helped to reduce the dust and smoke during working hours.

Until the early 1950's, the holes drilled to advance a "drift" (a horizontal tunnel-like excavation) or a "raise" (a vertical tunnel-like excavation) were both blasted in a two-step sequence. The first holes to be blasted were the "cut holes" (the holes which determine how far from the face the rock will be broken by the blast). A few minutes after blasting with dynamite, the miners re-entered the work area to inspect the results of the blast. If the cut holes had not broken to the desired depth, they were reblasted until the desired depth was achieved. This practice of multiple blasting in drifts and raises was changed in 1951-1952 so that all blasting was accomplished with single blasting step at the end of the work shift using electric delay blasting caps.

In 1950, drills began being equipped with automatic water valves that turned the water on when the compressed air was turned on. Older drills had separate air and water valves and miners tended to begin most of the holes they drilled by using only the compressed air without using any water for dust suppression. The conversion of drills was completed in 1953.

In 1963, wheeled carriage mounts for drills were developed for use in ore-breaking areas. Their use resulted in a much longer drilling cycle enabling miners to drill over a period of a week and then blast all the holes at once. Previously, the miners on each shift blasted the holes they drilled that shift. Using a single large blast helped to reduce the workers' exposure time to dust and smoke.

VENTILATION (8,9)

Ventilation in the mine, as measured by the exhaust air rate, was estimated at 77,000 cubic feet per minute (cfm) from 1918 to 1923, and was increased to 225,000 cfm in 1923 when a fan was installed in the No. 1 air raise (see Table 5). An additional fan was installed in 1933 at the No. 2 air raise, increasing the total ventilation to 475,000 cfm. The amount of air exhausted increased with the addition of more fans until a maximum of 867,000 cfm was attained in 1966. In 1975, the exhaust ventilation rate was 720,000 cfm.

Before 1945, small fans and ventilation ducts were used only to a minor extent to deliver clean air to the worksites within the mine and to help carry the airborne dust into the main exhaust ventilation systems. From 1945 to 1963, this secondary ventilation system consisted primarily of 5-horsepower (hp) distribution fans with a capacity of 2500 cfm and 12-inch diameter ventilation ducts. After 1963, 10- or 15-hp fans using 16-, 20-, or 30-inch diameter ventilation ducts gradually replaced the smaller fans; the change-over was completed in 1975. The larger fans delivered 2 to 3 times as much air to the worksite and, consequently, provided a greater potential for reducing airborne dust exposures. As shown in Table 5, the use of ventilation has proved to be important in the control of dust underground as reflected by the decline in dust concentrations (mppcf) observed since 1937. However, irrespective of the volume of air exhausted from the mine, a contributing factor in reducing worker exposures would be the proper positioning of the ventilation duct openings at the worksites.

Table 5. Ventilation and average dust concentrations from 1923-1975 at the Homestake Gold Mine, Lead, South Dakota.

Year	Average dust concentration (mppcf)	Ventilation into mine (cfm)
1923	ND	225,000 - Installed #1 air raise fan
1924	ND	225,000
1925	ND	225,000
1926	ND	225,000
1927	ND	225,000
1928	ND	225,000
1929	ND	225,000
1930	ND	225,000
1931	ND	225,000
1932	ND	225,000
1933	ND	475,000 - Installed #2 air raise fan
1934	ND	475,000
1935	ND	475,000
1936	ND	475,000
1937	11.0	475,000
1938	25.5	475,000
1939	15.3	475,000
1940	11.1	475,000
1941	13.3	547,000 - Installed Oro Hondo fan & shut down #1 air raise fan
1942	24.6	547,000
1943	ND	547,000
1944	ND	547,000
1945	ND	547,000
1946	24.3	547,000
1947	24.3	547,000
1948	12.0	547,000
1949	15.5	547,000
1950	12.6	547,000
1951	18.4	547,000
1952	9.7	547,000
1953	6.9	547,000
1954	5.9	547,000
1955	5.1	547,000
1956	5.2	547,000
1957	4.1	547,000
1958	4.3	547,000
1959	4.0	600,000 - Ellison shaft fan installed
1960	4.4	600,000 - Oro Hondo shaft stripped and #5 shaft completed.
1961	3.3	600,000
1962	ND	619,000
1963	ND	650,000

Table 5 (continued)

Year	Average dust concentration (mppcf)	Ventilation into mine (cfm)
1964	ND	800,000 - Two 750 hp fans on Oro Hondo Crosscut to Ellison Shaft
1965	4.2	829,000
1966	3.5	867,000
1967	3.1	864,000
1968	5.0	830,000
1969	4.0	802,000
1970	4.4	800,000
1971	2.4	815,000
1972	2.8	780,000 - Change to 1250 hp fan on Oro Hondo Shaft.
1973	2.5	780,000
1974	2.0	775,000
1975	ND	720,000 - Ellison Shaft caved

mppcf = millions of particles per cubic foot of air.
ND = No Data
cfm = cubic feet per minute

From: May 27, 1976, memo from J.K. Waterland to D.T.Delicate. Homestake Mining Company, Lead, South Dakota.

DESCRIPTION OF SURVEY METHODS

APPROACH (RATIONALE)

Since the purpose of the comprehensive industrial hygiene survey was to support the retrospective mortality study, not only was a current environmental assessment performed, but, in addition, an attempt was made to determine the magnitude of previous underground exposures. To this end, past exposure data compiled by the Homestake Mining Company and from inspection surveys by the U.S. Bureau of Mines and MESA were incorporated into the overall assessment of occupational exposures.

The sampling strategy was developed from information on the mineral composition of the geologic formation as well as exposure data previously collected during past surveys by the Bureau of Mines and MESA. Personal airborne samples (filters) were collected for analysis of fibrous minerals, arsenic, and trace metals including beryllium (Be), chromium (Cr), cobalt (Co), iron (Fe), lead (Pb), manganese (Mn), molybdenum (Mo), nickel (Ni), vanadium (V), and zinc (Zn). Each personal filter sample collected was cut in half. One of the halves was counted optically for fibers and further analyzed for fiber identification and characterization using electron microscopy techniques. The other half of each filter was used to determine trace metal and arsenic exposures. Since trace metals and arsenic were known to be present in small quantities, it was decided to combine the various personal airborne samples from a worksite to increase the probability of detecting them during analysis; one half were analyzed for trace metals, and the other half for arsenic. The combined filter halves for arsenic and trace metals were assigned an appropriate Job Code and a new sample number. A general airborne area sample was collected at each worksite and radon daughter concentrations were determined. Bulk ore samples collected from a composite mixture of ore coming from the crushing mills were analyzed for asbestos, arsenic, trace metals, and free silica. Personal air samples for free silica were not collected since there were data available from a 1976 MESA survey (10) and because of difficulties in collecting simultaneous samples. Because of the heavy physical demands normally encountered underground (drilling operations, climbing into and out of stopes, etc.) and the fact that a battery pack for the mining light and a self-rescuer were already strapped to the worker's belt, it was felt that two sampling trains would have been burdensome.

Since there was a work force of about 1000, including a small number involved with the crushing of ore on the surface, an attempt was made to collect samples from a representative group of employees. Therefore, approximately 170 employees encompassing 90% of the job titles were sampled for the entire work shift to determine short-term and time-weighted average (TWA) exposures. The different job titles that had exposures determined were representative of 95% of the mine employees.

About 70% of the samples were collected on workers who had a job title of Miner 1st, 2nd, 3rd, or 4th, with the remaining samples being collected on other underground workers or those employed in the surface crushing mills. In addition, most of the sampling was done on the Main Ledge and 9 Ledge since these were the oldest and most active ore ledges (see Table 3).

The sampling results were statistically analyzed to ascertain any differences in exposures between job titles and to determine if exposures varied significantly from ledge to ledge. To aid in this data treatment, a "Job Dictionary" was developed that consisted of current job titles with accompanying job descriptions. All job titles were assigned a four digit job code (see Appendix A). The first two digits using the following nomenclature represent the areas in which samples were collected: 01 - all underground operations, 02 - surface ore crushing, 09 - 9 Ledge, 10 - Main Ledge, 11 - 11 Ledge, 13 - 13 Ledge, 19 - 19 Ledge, and 21 - 21 Ledge. The last two digits of the job code correspond to the specific job title and job description such as Miner 1st, 2nd, 3rd, or 4th, Carpenter 1st, 2nd, or 3rd, Skipper, etc. Although each job title has a different job description, potential exposures within a job title grouping (i.e., Miner 1st and Miner 2nd) would be similar.

All locations within the mine where samples were collected are shown in Appendix B. The type of sample collected along with the appropriate sample numbers are indicated at each sampling site.

Since there were past dust exposure data, available from the Homestake Mining Company, which were determined with midget impingers midget impinger samples were also collected during the survey to compare the current "dustiness" with past exposures. Assuming a relationship could be found, it would thus be possible to make an estimate of the magnitude of other environmental contaminants such as arsenic and asbestos that had not been documented historically.

SAMPLING

Five or six teams of one or two NIOSH industrial hygienists spent an entire work shift with different mine crews each day for 2 consecutive weeks collecting samples and documenting work practices. Full-shift personal airborne samples for arsenic, trace metals, and asbestos were collected on each worker monitored. An open-face filter collection method was utilized with a Millipore AA cellulose ester 0.8-micrometer (μm) pore size filter at a flow rate of 2.0 liters per minute (lpm) using calibrated Mine Safety Appliance Model G pumps. The filters were changed periodically four to six times during the work shift to prevent overloading of dust for asbestos counting and to determine exposure levels for specific operations during a shift. At the end of each work shift, a radon daughter sample was collected by each team at the worksite on an open-face Millipore AA cellulose ester 0.8-μm pore size filter

for 5 minutes at a flow rate of 2.5 to 3.0 lpm using calibrated Bendix Model C-115 pumps. During a work shift, four to six midget impinger samples were collected at random intervals near the breathing zone of a worker and the type of work being performed was documented. Impinger samples were collected in 10 milliliters of ethyl alcohol at a flow rate of 2.8 lpm for 20 to 30 minutes using calibrated Bendix Model C-115 pumps.

AIR SAMPLE ANALYSIS

Arsenic and Trace Metals

Airborne samples for arsenic were analyzed by neutron activation using a germanium-lithium detector with a neutron flux of about 10^{14} neutrons/cm^2/second with a detection limit of 1.0 nanogram per sample (11). Airborne samples for trace metals were analyzed by air-acetylene atomic absorption for the metals Co, Cr, Fe, Mn, Ni, Pb, and Zn; by nitrous oxide-acetylene atomic absorption for Be; and by flame emission spectroscopy for V and Mo (12).

Radon Daughters

Radon daughter samples were analyzed for alpha radiation using a Millipore Scintillation Counter Model SPA-1 and an Eberline Portable Scaler Model PS-1. Alpha counts were made on the filters 40-90 minutes from the time of sample collection. Filters were checked for self-absorption by counting alpha activity on the filter face, counting the back side of the filter, and covering the face with an unused filter of the same type, and recounting the front side (13).

Fibers

All 448 personal airborne samples collected were analyzed for fibers using the NIOSH phase-contrast optical microscopy counting technique for asbestos (14). Fibers greater than 5 μm in length were counted at 450X magnification utilizing 45X (0.65 NA) phase contrast objective and 10X Huygenian eyepieces. A fiber was defined as any particle which had a length to diameter aspect ratio of 3:1 or greater. Fiber concentrations were reported as fibers >5 μm in length per cubic centimeter of air sampled (fibers/cm^3).

Fifty-one samples from the 448 were chosen for transmission electron microscopy (TEM) to characterize and identify the fibers (15). These 51 samples were randomly selected from two groups, samples with fiber concentrations as determined by optical microscopy that were >2.0 fiber/cm^3 and those <2.0 fiber/cm^3. This selection procedure was to assure that a representative number of both high and low fiber concentrations were characterized by TEM.

Duplicate sample preparations were made for TEM from each of the 51 filter samples to ascertain if particulate loss had occurred during the preparation method. If no particulate loss was observed, then one of the sample preparations was chosen for analysis. All fibers were sized by diameter and length and identified utilizing selected area electron diffraction (SAED) and energy dispersive spectroscopy X-ray analysis (EDS) and tabulated on a data sheet as illustrated in Figure 3. A maximum of 100 fibers or a minimum of 10 fields (grid openings) were analyzed on each filter sample at magnifications of 10,000-17,000X. The deposited particulates on the filter were assumed to be Poisson distributed.

To determine an "index" of dust exposures, 25 to 30 impinger samples were collected daily and counted the following day by two NIOSH counters using bright field optical microscopy at 100X magnification (16). A sample preparation was made for each counter from each impinger and allowed to stand for 30 minutes before counting. If particle counts, in millions of particles per cubic foot of air (mppcf), from each impinger sample preparation differed more than 10% between the two counters, another sample preparation was made and recounted.

BULK ORE SAMPLE ANALYSIS

The composite ore samples that were collected from the crushing mills on 3 different days were analyzed for trace metals, arsenic, free silica (quartz and cristobalite), and fibers. Trace metals and arsenic were analyzed as previously described. The percentage of free silica was determined by weighing out a portion of each ore sample and performing X-ray diffraction analysis (17). Fibrous amphiboles were identified and characterized by TEM (SAED and EDS) and compared to reference minerals obtained from the Smithsonian Institution.

Figure 3. Electron mic[illegible]copy data sheet

Sample Data

Sample #: _____

Study: _____

Date: _____

Analyst: _____

Filter Type: _____

Mounting Tech: _____

Operating Conditions

Mode: _____

Beam Current A: _____

Sample Tilt°: _____

Magnification: _____

Av. Grid Area, mm^2: _____

No. of Grids Counted: _____

Fiber #	Diffraction Pattern					Possible EDXRA ID	Fiber Size, mm		Picture Taken?
	Positive Amphibole	Positive Chrysotile	Non Asbestos	Ambiguous Pattern	No SAED Pattern		Dia.	Length	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
Total						Comments:			

ARSENIC

The arsenic concentrations for the combined filter halves from the various worksites are reported in Appendix C. In addition, samples are grouped in Appendix C, to give exposure results by job classification and to indicate exposures within the various ore ledges and the surface crushing mills. All Miner job classifications are grouped in Table 6 to observe possible differences in TWA exposures between ledges. The geometric mean TWA exposures to arsenic for the six ledges ranged from 0.24 micrograms per cubic meter ($\mu g/m^3$) for the 21 Ledge to 1.86 $\mu g/m^3$ for the 11 Ledge. When Miners from all ledges were grouped together, a geometric mean TWA exposure of 1.17 $\mu g/m^3$ resulted with lower and upper 95% confidence levels of 0.77 and 1.77 $\mu g/m^3$, respectively.

A summary of arsenic results is presented in Table 7 for all other job classifications underground (excluding Miners). The lowest concentration was observed for a Hoist Operator (0.10 $\mu g/m^3$) and the highest for a Boring Machine Helper (5.79 $\mu g/m^3$). A geometric mean TWA concentration of 0.81 $\mu g/m^3$ was determined for these non-Miner job classifications underground with 95% confidence levels of 0.42 and 1.57 $\mu g/m^3$.

A summary of TWA arsenic exposures for the four employees monitored in the surface crushing mills is presented in Table 8; the arsenic exposures ranged from 0.60 to 6.45 $\mu g/m^3$. A geometric mean TWA arsenic concentration of 1.33 $\mu g/m^3$ with 95% confidence levels of 0.24 and 7.42 $\mu g/m^3$ was determined for these surface employees.

The average (arithmetic mean) arsenic exposure calculated from the 47 TWA samples (grouped by worksite) for all underground employees was 2.03 $\mu g/m^3$ (see Table C-3, Appendix C), which is approximately half of the average exposure previously found in the 1974 MESA survey (93 samples with an average concentration of 4.4 $\mu g/m^3$). This finding is possible since the NIOSH results present samples collected during the entire work shift, during periods of both peak and minimal work activity; whereas the samples collected by MESA represent individual short-term samples collected during specific work activities. In most instances, the MESA samples did not take into account the lower concentrations expected to be found away from the active worksites.

Based on the NIOSH sampling, only one worksite had a concentration above the OSHA TWA arsenic standard of 10 $\mu g/m^3$ (18). The NIOSH-recommended arsenic standard of 2 $\mu g/m^3$ for any 15-minute period (19) was exceeded in 16 of the 51 composite samples (31%); however, comparing full-shift time-weighted data to a 15-minute standard will tend to underestimate short-term exposure levels.

Table 6. Time-weighted average (TWA) airborne arsenic exposures of underground employees with job titles of Miner 1st, 2nd, 3rd, or 4th at the Homestake Gold Mine, Lead, South Dakota.

Location	Number of TWA samples*	Arsenic $\mu g/m^3$							
		Range	Arith. mean	Std. dev.	Std. error	Geometric mean	Geometric std. dev.	LCL**	UCL**
9 Ledge	16	0.22–11.62	3.18	3.54	0.89	1.58	3.76	0.78	3.21
Main (10) Ledge	7	0.36– 1.80	0.83	0.50	0.19	0.72	1.72	0.44	1.20
11 Ledge	3	0.48– 7.25	3.19	3.58	2.07	1.86	3.89	0.06	54.34
13 Ledge	2	0.29– 4.62	2.46	3.06	2.17	1.16	7.08	0.00	1000
19 Ledge	4	0.50– 1.86	0.97	0.61	0.31	0.85	1.76	0.35	2.08
21 Ledge	1	0.24	0.24	–	–	0.24	–	–	–
Total	33	0.22–11.62	2.28	2.89	0.50	1.17	3.20	0.77	1.77

* 1 to 10 filter halves from personal samples collected at a work site during a shift were combined (see Appendix C).

** LCL and UCL are the lower and upper 95% confidence limits based on the geometric mean and geometric standard deviation of the individual estimates of daily TWA concentrations.

Table 7. Time-weighted average (TWA) airborne arsenic exposures of underground employees (excluding Miner classification) at the Homestake Gold Mine, Lead, South Dakota.

Job title underground	Number of TWA samples*	Arsenic $\mu g/m^3$							
		Range	Mean	Std. dev.	Std. error	Geometric mean	Geometric std. dev.	LCL**	UCL**
Motorman	2	0.53-2.11	1.32	1.12	0.79	1.06	2.66	0.00	1000
Skipper & Skipper Head	3	0.43-2.13	1.42	0.88	0.51	1.16	2.37	0.13	9.91
Cager	1	0.85	0.85	-	-	0.85	-	-	-
Hoist Operator	2	0.10-0.53	0.32	0.30	0.22	0.23	3.25	0.58	1000
Carpenter	1	0.26	0.26	-	-	0.26	-	-	-
Shaftman	1	0.47	0.47	-	-	0.47	-	-	-
Sandman	1	0.55	0.55	-	-	0.55	-	-	-
Diamond Drill Helper	1	2.33	2.33	-	-	2.33	-	-	-
Boring Machine Helper	1	5.79	5.79	-	-	5.79	-	-	-
Total	13	0.10-5.79	1.37	1.54	0.43	0.81	2.98	0.42	1.57

* 1 to 7 filter halves from personal samples collected from worker(s) with the same job title were combined (see Appendix C).

** LCL and UCL are the lower and upper 95% confidence limits based on the geometric mean and geometric standard deviation of the individual estimates of daily TWA concentrations.

Table 8. Time-weighted average (TWA) airborne arsenic exposures of surface employees in crushing department, at the Homestake Gold Mine, Lead, South Dakota.

Job title	Number of TWA samples*	Arsenic $\mu g/m^3$ Range	Mean	Std. dev.	Std. error	Geometric mean	Geometric std. dev.	LCL**	UCL**
Surface Workers Crushing (i.e. Crusher/ Feeder, Laborer, Mechanic, Belt/Chip Picker)	3	0.77-6.45	2.76	3.20	1.88	1.75	3.13	0.10	29.88
Motorman (Surface)	1	0.60	0.60	-	-	0.60	-	-	-
Total	4	0.60-6.45	2.22	2.83	1.41	1.33	2.94	0.24	7.42

* 1 to 7 filter halves from personal samples collected from worker(s) with the same job title were combined (see Appendix C).

** LCL and UCL are the lower and upper 95% confidence limits based on the geometric mean and geometric standard deviation of the individual estimates of daily TWA concentrations.

To determine if differences in exposure levels existed within and between ledges, an analysis of variance (ANOVA) was used to compare geometric mean exposures to airborne arsenic by ledge for all Miners (20). The results shown in Table 9 indicate a fluctuation of exposure levels in which the concentration variance within ledges was just as great as the concentration variance between ledges. Based on the samples collected, it could not be concluded that differences in exposures to arsenic existed between ledges for the Miners 1st, 2nd, 3rd, and 4th.

TRACE METALS

The remaining filter halves from the personal airborne samples, which were combined in the same manner (i.e., by worksite) as those for arsenic, were analyzed for trace metals, and are reported in Table 10. All TWA concentrations were within both NIOSH-recommended and current OSHA standards. The metals Be, Co, Ni, V, Pb, and Mo were not detected. The metals Fe, Zn, Cr, and Mn were detected in trace amounts with TWA concentrations ranging from 1.6 to 567.4 $\mu g/m^3$ for Fe, 0.2 to 19.5 $\mu g/m^3$ for Zn, 0.4 to 3.4 $\mu g/m^3$ for Cr, and 0.2 to 13.5 $\mu g/m^3$ for Mn.

FIBERS

Optical Microscopy

Concentrations of fibers >5 µm in length (fibers/cm^3) were determined for all personal air samples and are reported in Appendix D. All fibers >5 µm in length and with an aspect ratio $\geq$ 3:1 were counted and assumed to be asbestos. TWA asbestos fiber exposures in excess of the current OSHA TWA standard of 2.0 fibers/cm^3 (21) were observed for individual workers in the following job categories:

(1) Boring Machine Operator (2.44 fibers/cm^3)
(2) Boring Machine Helper (2.57 fibers/cm^3)
(3) Miner 1st - drilling (2.78 fibers/cm^3)
(4) Miner 2nd - drilling (3.42 fibers/cm^3)
(5) Miner 4th - ore removal (4.01 fibers/cm^3)
(6) Mechanic 3rd - Mill (2.48 fibers/cm^3)
(7) Belt/Chip Picker - Mill (2.03 fibers/cm^3)
(8) Laborer 2nd - Mill cleanup (3.09 fibers/cm^3)
(9) Laborer 1st - Mill cleanup (5.34 fibers/cm^3)

These elevated fiber exposures represented 5 percent (5 of 96) of the underground employees studied and 33 percent (4 of 12) of the surface employees monitored.

Table 9. One-way analysis of variance (ANOVA) comparing geometric mean TWA exposures of Miners 1st, 2nd, 3rd, and 4th to arsenic on the six ledges at the Homestake Gold Mine, Lead, South Dakota.

Source of variation	Degrees of freedom (df)	Sum of the squares (SS)	Mean of the squares (MS)	Fs
Among the Ledges	5	412,463	82,493	0.99
Within the Ledges	27	2,275,317	82,604	
Total	32	2,669,780		
F.50 (5, 27) = 0.89		F.25 (5, 27) = 1.41		

Note: There is no significant added variance component among ledges for exposures to arsenic. Based on the number of samples collected, it could not be concluded that differences in exposures to arsenic existed between ledges.

Table 10. Time-weighted average (TWA) airborne trace metal exposures at the Homestake Gold Mine, Lead, South Dakota.

Composite sample number	Samples combined*	Trace metals $\mu g/m^3$			
		Fe	Zn	Cr	Mn
600	79,75,89,87	74.9	2.9	0.5	2.7
601	49,40,45	124.6	3.9	0.7	2.6
602	53	68.8	2.5	1.3	0.6
603	61,69,70,67	87.0	4.6	0.4	1.8
604	28,32,93,50	188.3	4.5	0.6	4.2
605	83,84,120,119,33,16,37	256.0	6.4	2.0	4.0
606	110,62,116,106	108.3	1.7	0.4	3.8
607	23,13,9,76,12	22.5	1.3	1.2	0.8
608	189,152,179,177,191,170	90.3	3.5	2.6	2.6
609	138,135,136,128,125,129, 143	91.4	4.8	2.0	2.0
610	155,139,132,108,105,154	87.1	7.6	2.8	2.2
611	242,224,238,240,230,241	192.5	6.7	2.7	4.0
612	169,166,156,172,183	15.7	6.5	1.1	0.2
613	20,24,57,207	7.0	2.3	1.2	0.2
614	261, 265,268,266,255	278.9	0.2	1.1	2.9
615	38,21,11,19	81.3	1.4	0.5	2.4
616	221,216,203,197	314.4	7.8	1.2	4.7
617	284,319	24.3	3.4	1.0	0.5
618	325,313,277,335	26.3	3.3	1.1	0.2
619	334,320,309	57.9	4.5	0.8	1.2
620	46,64,74,59,35	52.9	3.3	0.5	1.3
621	194,178,185,193	151.0	4.3	0.6	3.7
622	114,118	90.0	8.1	0.9	2.4
623	297,298,296	104.4	2.4	0.5	3.2
624	314,200,317	88.9	4.8	0.6	2.5
625	259,247,254,258,270	174.3	5.1	0.5	4.8
626	71,187,184,196	325.8	2.7	1.1	6.7
627	153,211,174,160	208.8	2.6	1.8	4.0
628	95	137.3	2.0	1.3	2.0
629	329,322,141,130,99,324 256,333,338,126	272.9	4.5	1.2	4.8
630	204,229,55,245,73	49.6	2.6	0.5	1.9
631	377,369,345,367,362 355,370,379,376	244.3	8.6	3.4	6.7
632	140,175,195,200,281,212 269,199	218.9	3.2	0.7	4.9
633	408,411,404,412	113.6	6.9	1.2	3.2
634	306,282,278,305,217,225	89.3	2.5	1.2	2.6
635	399,394,384,392,393,332	68.3	3.5	1.2	1.9

Table 10 (continued)

Composite sample number	Samples combined*	Trace metals $\mu g/m^3$			
		Fe	Zn	Cr	Mn
636	425,426,300	66.3	5.C	1.1	1.7
637	354	113.0	7.8	1.7	2.6
638	479,453,474,437,480,459, 430,367,481,475	567.4	4.0	1.5	13.5
639	455,457,458	1.6	3.8	1.4	0.3
640	235,341,358,368,210	197.9	4.0	2.1	3.5
641	477,491,490,489,486,487, 488	62.4	4.0	1.2	1.2
642	438,432,440,434,431,442	58.7	5.7	0.9	1.4
643	421,415	91.4	2.9	1.1	1.7
644	365,447,443,435	42.1	4.0	1.8	1.1
645	417,90,405,205,418	254.4	19.5	1.8	5.5
646	41,343,228,347	88.6	3.9	1.4	1.4
647	403,316,381,414	254.9	3.9	1.2	8.5
648	253,398,371,360,397	88.8	2.2	0.8	2.0
649	380,390,427	72.2	3.5	0.6	1.5
650	299,407,465	3.2	0.3	0.6	9.6
651	436,201,94	79.4	0.3	0.6	1.5

* 1 to 10 filter halves from personal samples collected at a work site during a shift were combined.

Note: Be, Co, Mo, Ni, Pb, and V were not detected in any composite sample. The lower limits of detection were:

Beryllium (Be)	0.3 µg/sample
Cobalt (Co)	1.0 µg/sample
Molybdenum (Mo)	5.0 µg/sample
Nickel (Ni)	1.0 µg/sample
Lead (Pb)	3.0 µg/sample
Vanadium (V)	0.5 µg/sample

The following two job classifications had individual worker exposures in excess of the current OSHA allowable ceiling value of 10 fibers >5 μm in length/cm^3:

(1) Miner 1st - putting in track (15.48, 12.77 fibers/cm^3)
(2) Laborer 1st - cleanup in Mill (10.07, 15.72, 16.20 fibers/cm^3)

These concentrations were determined from individual samples collected from 3 employees (2 Miners and 1 Laborer) over time periods of 12 to 36 minutes. The samples in excess of the current OSHA ceiling standard represented about one percent of all the samples collected.

Individual samples were grouped to observe differences in exposures between job classifications as well as between the various ore ledges and the surface crushing mills. As shown in Table 11, when all Miner job classifications were grouped by ledge; the geometric mean TWA exposures ranged from 0.17 fibers/cm^3 (21 Ledge) to 0.54 fibers/cm^3 (Main Ledge). When Miners from all ledges were grouped together, a geometric mean TWA exposure of 0.44 fibers/cm^3 resulted with 95% confidence levels of 0.35 and 0.53 fibers/cm^3.

A summary of TWA fiber exposures is presented in Table 12 for all job classifications underground excluding Miners. The lowest geometric mean TWA concentrations were observed for the Diamond Drill Operators and Hoist Operators (both 0.05 fibers/cm^3), and the highest for Boring Machine Operator/Helpers (2.50 fibers/cm^3). The geometric mean TWA concentration for all these job classifications was 0.24 fibers/cm^3 with 95% confidence levels of 0.14 and 0.45 fibers/cm^3.

A summary of TWA exposures for employees in the surface crushing mills is presented in Table 13; concentrations ranged from 0.12 fibers/cm^3 (Motorman) to 5.34 fibers/cm^3 (Laborer 1st). A geometric mean TWA concentration of 1.16 fibers/cm^3 with confidence levels of 0.59 and 2.28 fibers/cm^3 resulted after combining the data from all job classifications in the crushing mills.

To determine if differences in exposure levels existed within and between ledges, ANOVA was used to compare geometric mean TWA concentrations of airborne fibers >5 μm in length/cm^3 by ledge for all Miners. The results of the analysis shown in Table 14 indicate a fluctuation of fiber exposure levels in which the concentration variance within ledges was just as great as the concentration variance between ledges. Based on the samples collected, it could not be concluded that differences in exposures to fibers >5 μm in length existed between ledges.

Portions of 61 randomly chosen filters were shared with the Homestake Mining Company for a comparison of counting techniques; from these, five samples were subsequently voided by NIOSH due to filter loss, being used more than

Table 11. Time-weighted average (TWA) airborne fiber exposures (optical microscopy) of underground employees with job titles of Miner 1st, 2nd, 3rd, or 4th at the Homestake Gold Mine, Lead, South Dakota.

Location	Number of samples counted	Number of TWA exposures*	Fibers greater than 5 μm in length/cm^3							
			Range	Mean	Std. dev.	Std. error	Geometric mean	Geometric std. dev.	LCL**	UCL**
9 Ledge	168	38	0.08–4.01	0.68	0.80	0.13	0.47	2.22	0.36	0.62
Main (10) Ledge	49	13	0.10–2.79	0.73	0.69	0.19	0.54	2.23	0.33	0.87
11 Ledge	40	9	0.08–1.46	0.63	0.48	0.16	0.45	2.58	0.22	0.93
13 Ledge	16	4	0.17–0.98	0.64	0.38	0.19	0.52	2.26	0.14	1.91
19 Ledge	31	7	0.09–0.97	0.31	0.31	0.12	0.22	2.38	0.10	0.49
21 Ledge	6	2	0.11–0.25	0.18	0.10	0.07	0.17	1.79	0.00	30.55
Total	310	73	0.08–4.01	0.63	0.68	0.08	0.44	2.33	0.35	0.53

* A TWA exposure was calculated for each miner from the 3 to 5 samples collected during a shift.

** LCL and UCL are the lower and upper 95% confidence limits based on the geometric mean and geometric standard deviation of the individual estimates of daily TWA concentrations.

Table 12. Time-weighted average (TWA) airborne fiber exposures (optical microscopy) of underground employees (excluding Miner classification) at the Homestake Gold Mine, Lead, South Dakota.

Job title	Number of samples counted	Number of TWA exposures*	Fibers greater than 5 μm in length/cm^3							
			Range	Mean	Std. dev.	Std. error	Geometric mean	Geometric std. dev.	LCL**	UCL**
Diamond Drill Operator and Helper	10	2	0.04-0.06	0.05	0.01	0.01	0.05	1.33	0.00	0.64
Boring Machine Operator and Helper	10	2	2.44-2.57	2.50	0.09	0.06	2.50	1.80	1.80	3.48
Motorman (Underground)	11	3	0.12-0.92	0.63	0.44	0.25	0.45	3.16	0.03	7.86
Sandman	13	3	0.11-0.43	0.27	0.16	0.09	0.23	1.99	0.04	1.31
Skipper and Skipper Head	12	3	0.23-0.91	0.55	0.34	0.20	0.47	1.99	0.08	2.61
Shaftman	7	2	0.06-0.07	0.065	0.007	0.005	0.06	1.12	0.02	0.17
Carpenter	13	3	0.52-1.06	1.18	0.29	0.17	1.03	1.47	0.31	2.11
Hoist Operator	12	3	0.02-0.11	0.06	0.05	0.03	0.05	2.37	0.01	0.44
Cager	4	1	0.08	0.08						
Pipeman, Master	3	1	0.29	0.29						
Total	95	23	0.02-2.57	0.55	0.71	0.15	0.24	3.94	0.14	0.45

* A TWA exposure was calculated for each employee from the 3 to 5 samples collected during a shift.

** LCL and UCL are the lower and upper 95% confidence limits based on the geometric mean and geometric standard deviation of the individual estimates of daily TWA concentrations.

Table 13. Time-weighted average (TWA) airborne fiber exposures (optical microscopy) of surface employees in crushing department at the Homestake Gold Mine, Lead, South Dakota.

Job title	Number of samples counted	Number of TWA exposures*	Fibers greater than 5 μm in length/cm^3							
			Range	Mean	Std. dev.	Std. error	Geometric mean	Geometric std. dev.	LCL**	UCL**
Crusher-Feeder	7	2	1.23-1.64	1.44	0.29	0.21	1.42	1.23	0.23	9.12
Mechanic 3rd	4	1	2.48	2.48	-	-	-	-	-	-
Belt/Chip Picker	11	3	0.24-2.03	1.21	0.91	0.52	0.87	3.12	0.05	14.71
Laborer 2nd	11	3	0.74-3.09	1.78	1.28	0.69	1.51	2.04	0.26	8.94
Laborer 1st	7	1	5.34	5.34	5.34	-	-	-	-	-
Motorman	6	2	0.12-0.83	0.48	0.50	0.36	0.32	3.93	0.00	1000
Total Surface Workers Crushing	46	12	0.12-5.34	1.72	1.43	0.41	1.16	2.89	0.59	2.28

* A TWA exposure was calculated for each surface employee from the 3 to 7 samples collected during a shift.

** LCL and UCL are the lower and upper 95% confidence limits based on the geometric mean and geometric standard deviation of the individual estimates of daily TWA concentrations.

Table 14. One-way analysis of variance (ANOVA) comparing geometric mean TWA exposures of Miners 1st, 2nd, 3rd, and 4th to asbestos on the six ledges in the Homestake Gold Mine, Lead, South Dakota.

Source of variation	Degrees of freedom (df)	Sum of the squares (SS)	Mean of the squares (MS)	Fs
Among Ledges	5	13,367	2,673	0.55
Within Ledges	66	319,232	4,837	
Total	71	332,599		
F.75 (5, 66) = 0.534		F.50 (5, 66) = 0.870		

Note: There is no significant added variance component among ledges for exposures to asbestos fibers >5 μm in length. Based on the number of samples collected, it could not be concluded that differences in exposures to asbestos existed between ledges.

once for collection, or loss of data. The results of the comparisons presented in Table 15 indicate that sample concentrations determined by NIOSH exceeded those determined by the company in all but three of the samples. This observed difference could be attributed to the handling of the filter samples prior to counting, differences in counter experience, preparation of samples, and/or the optical microscope resolution.

Electron Microscopy

A total of 740 fibers from 51 filter samples were sized, identified, and then categorized using electron microscopy techniques at 17,000X magnification into one of the following four mineral groups:

(1) Cummingtonite-Grunerite (asbestos amphibole)
(2) Tremolite-Actinolite (asbestos amphibole)
(3) Hornblends (nonasbestos amphiboles, aluminum detected in the elemental composition)
(4) Ambiguous or Nonasbestos

The last group includes those fibrous minerals which did not give a discernible SAED or EDS spectrum for identification or were identified as nonasbestos fibrous minerals such as gypsum, brucite, calcite, etc. Results of airborne fiber size determinations (diameter and length) are shown in Tables 16 and 17 with appropriate summary statistics. For all four mineral types the median and geometric mean fiber dimensions were almost identical. Those fibers identified as the mineral cummingtonite-grunerite had a geometric mean diameter of 0.43 μm with a geometric mean length of 3.3 μm. In comparison, those fibers identified as tremolite-actinolite had a geometric mean diameter of 0.27 μm and a mean length of 4.1 μm. Combining the results of the analyses for all four mineral groups indicated a geometric mean fiber diameter of 0.40 μm and a geometric mean length of 3.2 μm. As indicated in Table 18, 24% of the identified cummingtonite-grunerite fibers and 32% of the tremolite-actinolite fibers had lengths >5 μm, and as a composite, they accounted for 83% of all fibers >5 μm in length.

A summary of airborne fiber types as determined by TEM (SAED and EDS) are shown in Table 19. Eighty-four percent of the airborne fibers were identified as amphibole asbestos, while the remaining 16% were either unidentified (ambiguous) or nonabestos minerals. Sixty-nine percent of the amphiboles were characterized as cummingtonite-grunerite, 15% as tremolite-actinolite, with the remaining 16% identified as fibrous hornblend minerals. Typical photomicrographs of airborne fibers, SAED patterns, and EDS spectrums for cummingtonite-grunerite and tremolite-actinolite are shown in Figures 4 and 5, respectively.

Table 15. Comparison of NIOSH and Homestake optical microscopy fiber counting (fibers greater than 5 μm in length per cubic centimeter of air).

Sample Number	NIOSH	Homestake
H4	0.11	0.06
H5	0.36	0.11
H16	2.44	0.52
H18	0.05	0.01
H28	0.06	0.08
H32	0.81	0.17
H37	1.79	0.46
H39	2.44	0.06
H50	12.77	0.86
H55	0.24	0.01
H58	0.37	0.18
H63	0.17	0.01
H73	0.33	0.02
H80	0.26	0.06
H88	0.54	0.01
H93	0.01	0.01
H97	1.29	0.01
H125	1.58	0.05
H128	0.29	0.10
H135	0.13	0.01
H136	0.07	0.03
H138	0.21	0.05
H143	0.18	0.05
H173	0.72	0.04
H204	2.72	0.03
H205	0.21	0.01
H208	1.69	0.05
H219	3.15	0.53
H229	0.68	0.02
H235	0.19	0.04
H245	0.02	0.01
H247	0.64	0.07
H250	0.55	0.04
H254	0.05	0.02
H258	0.39	0.05
H259	0.05	0.06
H270	0.33	0.08
H274	0.28	0.01
H275	0.60	0.06
H294	0.08	0.08
H295	3.58	1.20
H301	0.53	0.02
H302	0.17	0.01
H303	0.30	0.01
H306	0.67	0.02

Table 15 (continued)

Sample number	NIOSH	Homestake
H308	0.08	0.01
H320	0.35	0.03
H334	0.08	0.04
H341	2.01	0.04
H352	0.44	0.04
H357	0.48	0.04
H358	0.38	0.03
H381	0.25	0.28
H387	0.09	0.02
H414	1.36	0.31
H418	0.12	0.03

Table 16. Fiber size determination by diameter analysis (electron microscopy) of airborne samples collected at the Homestake Gold Mine, Lead, South Dakota.

Type of fibrous mineral	Micrometers (μm)								
	Median	Range	Mean	Std. dev.	Std. error	Geometric mean	Geometric std. dev.	LCL*	UCL*
Cummingtonite-Grunerite	0.4	0.1-8.0	0.63	0.75	0.04	0.43	2.31	0.39	0.47
Tremolite-Actinolite	0.3	0.1-1.1	0.33	0.21	0.03	0.27	1.82	0.23	0.32
Hornblends	0.4	0.1-3.1	0.64	0.58	0.06	0.47	2.14	0.40	0.44
Ambiguous Determination or Non-Asbestos	0.3	0.1-2.5	0.42	0.43	0.07	0.31	2.12	0.25	0.40
Total	0.4	0.1-8.0	0.58	0.67	0.03	0.40	2.25	0.38	0.43

* LCL and UCL are the lower and upper 95% confidence limits based on the geometric mean and geometric standard deviation of the individual fiber diameters.

Table 17. Fiber size determination by length analysis (electron microscopy) of airborne samples collected at the Homestake Gold Mine, Lead, South Dakota.

Type of fibrous mineral	Micrometers (μm)								
	Median	Range	Mean	Std. dev.	Std. error	Geometric mean	Geometric std. dev.	LCL*	UCL*
Cummingtonite-Grunerite	3.0	0.5-38.5	4.5	4.5	0.26	3.3	2.1	3.0	3.6
Tremolite-Actinolite	3.8	1.3-23.8	4.9	3.6	0.47	4.1	1.8	3.5	4.8
Hornblends	2.8	0.7-21.0	3.9	3.9	0.43	2.9	2.0	2.5	3.4
Ambiguous Determination or Non-Asbestos	1.9	0.6- 7.0	2.3	1.4	0.21	1.9	1.8	1.6	2.3
Total	3.0	0.5-38.5	4.2	4.2	0.19	3.2	2.1	3.0	3.4

* LCL and UCL are the lower and upper 95% confidence limits based on the geometric mean and geometric standard deviation of the individual fiber lengths.

Table 18. Percentage of fibers greater than 5 micrometers (μm) in length by electron microscopy of airborne samples collected at the Homestake Gold Mine, Lead, South Dakota.

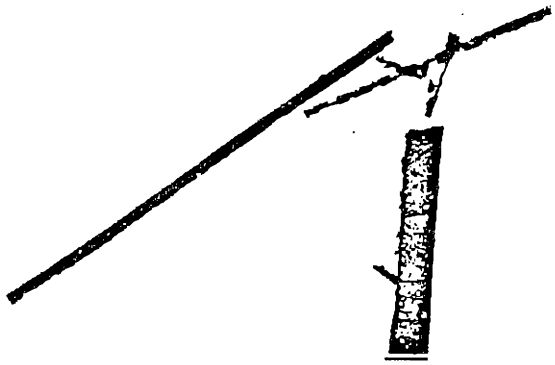
Type of fibrous mineral	Mean diameter μm	Mean length μm	Percent fibers >5 μm in length
Cummingtonite-Grunerite	0.63	4.5	24
Tremolite-Actinolite	0.33	4.9	32
Hornblends	0.64	3.9	23
Ambiguous Determination or Non-Asbestos	0.42	2.3	9
Total	0.58	4.2	23

Note: Cummingtonite-grunerite and tremolite-actinolite fibers >5 μm in length accounted for 83% of all fibers >5 μm in length.

Table 19. Electron microscopy identification of airborne fibers by selected area electron diffraction and energy dispersive x-ray analysis at the Homestake Gold Mine, Lead, South Dakota.

Percentage of total fibers identified		Percentage of amphibole fibers identified		
Amphiboles	Ambiguous determination or non-asbestos	Cummingtonite-grunerite	Tremolite-actinolite	Hornblends
84	16	69	15	16

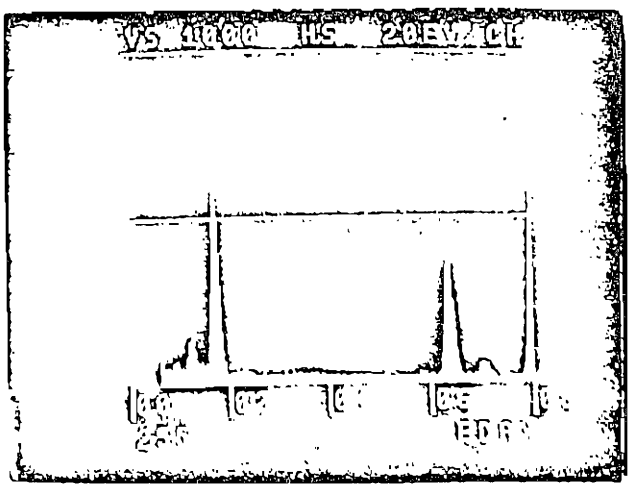
Figure 4. Fibrous cummingtonite-grunerite electron microscopy analysis Homestake Gold Mine, Lead, South Dakota.



Photomicrograph

1 micrometer

Selected Area Electron Diffraction



Energy Dispersive X-Ray Spectrum
Mg-Si-Fe

(variation in elemental ratios observed)

To help characterize and identify the fibrous amphiboles observed on the airborne samples, composite ore samples collected from the surface mills were analyzed by TEM (SAED and EDS). Photomicrographs of SAED patterns were made of typical fibrous particulates (aspect ratio $\geq$ 3:1) which were tilted into a preferred zone-axis orientation. Subsequently, d-spacings of the fiber's c-axis were measured from the photomicrographs. Likewise, EDS was also performed with elemental ratios tabulated for each of the fibrous mineral types. In addition, as a reference standard, minerals of cummingtonite, grunerite, tremolite, and actinolite were obtained from the Smithsonian Institution and were characterized in the same manner as the ore samples. Those fibers which demonstrated an amphibole electron diffraction pattern and indicated aluminum in their elemental composition were classified as hornblends.

To determine the relative aspect ratios (length to diameter) for each of the four fibrous mineral types, a frequency fiber size distribution was performed with each mineral type classified into three size groups (i.e., aspect ratios $\geq$ 10:1, $\geq$ 5:1, and $\geq$ 3:1). As indicated in Table 20, the observed aspect ratios for all fiber types were basically the same, except for tremolite-actinolite, which demonstrated a greater portion (68%) of the fibers being $\geq$ 10:1. As an average for all four mineral typee, 79% of the fibers had aspect ratios $\geq$ 5:1 with 33% $\geq$ 10:1.

Individual airborne sample results, as determined by TEM, were compared to their respective optical microscopy counts and are shown in Table 21. The fiber concentrations determined from TEM analysis for both total fibers and fibers >5 μm in length represent "positively identified asbestos" in which identification was confirmed by either SAED or EDS. Therefore, the reported TEM fiber concentrations represent minimum estimates of true total airborne asbestos concentrations since they do not take into account the number of asbestos fibers that gave ambiguous results.

The TEM concentration of asbestos fibers (>5 μm in length) were higher than most of the respective optical microscopy determinations. As noted in Table 16, a significant portion of the observed fibers had diameters <0.3 μm, and consequently would not have been observed using the standard optical microscopy method due to the presence of fiber sizes below the resolution capabilities of the microscope optical system. As expected, when all fibers (asbestos, hornblend, and unidentified) >5 μm in length were counted by TEM, fiber concentrations exceeded those determined by optical microscopy.

RADON DAUGHTERS

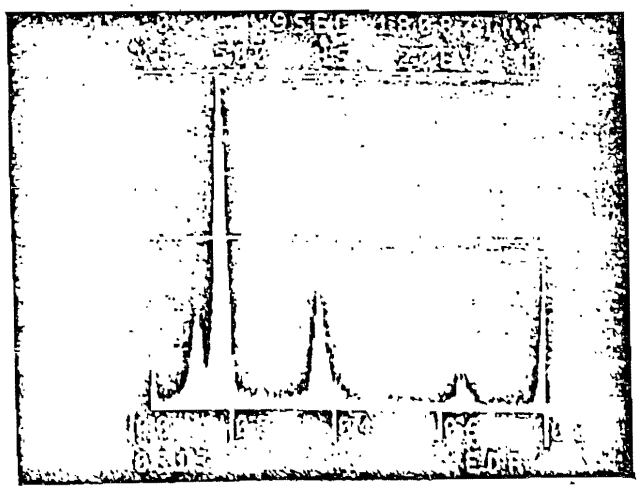
The radon daughter measurements (alpha decay), as shown in Table 22, were assigned to one of three different ventilation systems which supply air to the mine. The assignment of measurements to the three ventilation systems was

Figure 5. Fibrous tremolite-actinolite electron microscopy analysis
Homestake Gold Mine, Lead, South Dakota.

Photomicrograph

1 micrometer

Selected Area Electron Diffraction



Energy Dispersive X-Ray Spectrum
Mg-Si-Ca-Fe
(variation in elemental ratios observed)

Table 20. Fiber size distribution by aspect ratio (length to diameter) electron microscopy analysis at 17,000X magnification of airborne samples collected at the Homestake Gold Mine, Lead, South Dakota.

Types fibrous mineral	Cummulative frequency (%)		
	≥10:1	≥5:1	≥3:1
Cummingtonite-Grunerite	30	77	100
Tremolite-Actinolite	68	92	100
Hornblends	19	74	100
Ambiguous Determination or Non-Asbestos	26	83	100
Total	33	79	100

Table 21. Comparison of optical and transmission electron microscopic (TEM) fiber concentrations of air samples collected at the Homestake Gold Mine, Lead, South Dakota.

Sample number	Job title	Fibers/cm^3		
		Optical fibers >5 μm	TEM *fibers >5 μm	TEM *total fibers
H-003	Miner 4th	0.9	1.0	3.6
H-007	Miner 1st	2.8	17.6	78.3
H-016	Miner 1st	2.4	2.2	6.5
H-021	Miner 3rd	2.0	3.6	7.2
H-041	Miner 1st	0.8	1.3	6.5
H-042	Miner 1st	15.5	15.8	110.8
H-044	Miner 3rd	0.8	2.1	2.1
H-048	Miner 2nd	0.5	1.0	2.7
H-056	Miner 2nd	5.0	3.0	19.6
H-074	Miner 1st	0.6	0.5	1.0
H-086	Miner 2nd	1.6	0.7	4.8
H-109	Miner 1st	1.2	5.2	20.9
H-118	Motorman-Underground	0.2	0.6	1.3
H-139	Miner 1st	3.8	1.4	4.1
H-166	Diamond Drill Operator	0.2	0.8	3.1
H-178	Miner 1st	0.2	0.0	0.0
H-187	Miner 1st	0.4	0.4	5.8
H-191	Miner 1st	3.3	0.6	1.2
H-204	Miner 1st	2.7	2.4	2.4
H-211	Miner 1st	0.7	1.2	3.6
H-216	Miner 1st	1.7	2.1	25.6
H-217	Miner 4th	1.1	0.9	0.9
H-219	Miner 1st	3.1	4.1	46.8
H-239	Motorman-Underground	1.6	1.0	11.0
H-241	Miner 3rd	4.9	2.5	22.6
H-255	Boring Machine Operator	5.2	7.1	77.2
H-260	Miner 1st	1.5	1.2	3.8
H-269	Miner 4th	9.8	16.4	44.6
H-272	Miner 1st	0.5	1.1	3.1
H-295	Skipper Head	3.6	44.3	118.8
H-301	Miner 1st	0.5	0.5	0.9
H-304	Shaftman	0.1	0.5	0.9
H-318	Miner 1st	2.1	2.6	11.2
H-327	Cager	0.2	1.1	3.6
H-336	Skipper	0.7	1.4	6.3
H-341	Miner 1st	2.0	1.3	10.8
H-335	Miner 1st	6.6	1.8	3.5
H-396	Crusher-Feeder	2.6	2.9	10.8
H-401	Crusher-Feeder	1.7	2.1	17.3
H-409	Miner 1st	0.9	1.1	2.2
H-415	Mine Shift Boss	1.1	1.6	6.9
H-416	Miner 1st	4.9	25.2	73.9
H-417	Miner 1st	1.5	0.6	6.9
H-425	Skipper	0.4	0.7	2.9

Table 21 (continued)

Sample number	Job title	Fibers/cm^3		
		Optical fibers >5 μm	TEM *fibers >5 μm	TEM *total fibers
H-436	Motorman-Surface	1.9	0.7	11.3
H-440	Miner 1st	0.6	0.9	2.3
H-443	Carpenter 1st	1.7	1.1	23.2
H-455	Hoist Operator	0.1	0.8	1.6
H-462	Miner 1st	1.1	3.7	11.8
H-467	Laborer 2nd	4.3	2.0	5.4
H-477	Sandman	0.8	0.5	5.5

*Note: Includes only those fibers identified as asbestos using selected area electron diffraction and/or energy dispersive X-ray analyses.

Table 22. Radon daughter measurements grouped by ventilation systems at the Homestake Gold Mine, Lead, South Dakota.

Ventilation system	Sample number	Sample location	Working level (WL)
	1	6500, Main Ledge, 90 pillar, Drift north	0.000
	2	6050, 13 Ledge, 47c stope	0.004
	3	6800, 93 & 94c stopes	0.007
	4	6050, Main Ledge, 89e stope	0.003
	5	6050, 13 Ledges, 54 drift	0.000
	6	5450, 11 Ledge, 49 & 51 stopes	0.000
#1	8	5600, 11 Ledge, 55 pillar	0.000
	9	5750, 11 Ledge, 57c stope	0.000
	10	5750, 9 Ledge, 67 & 68d stopes	0.007
	11	5450, 9 Ledge, 66 & 67c stopes	0.000
	12	5750, 9 Ledge, 68c stope	0.000
	13	6050, Main Ledge, 90 pillar	0.001
	16	4850, #4 Hoist Room	0.004
	17	5450, 9 Ledge, 64 & 65d stopes	0.009
		Avg.	0.003
	14	6200, 19 Ledge, 27 chute	0.022
	15	5900, 19 Ledge, 28 & 29f stopes	0.041
	19	4850, 19 Ledge, 46 x cut	0.026
	21	#4 shaft	0.005
	22	6200, 21 Ledge, 50 & 52 stope	0.032
	28	4400, 9 Ledge, 31 & 32 stope	0.018
	29	4850, skip pocket, Yates	0.024
#2	30	4100, Main Ledge, 58e stope	0.022
	31	3650, 9 Ledge, 27d stope	0.044
	32	3800, 9 Ledge, 18b stope	0.045
	33	4850, Skip pocket	0.019
	35	4250, 9 Ledge, 36 & 37 stopes	0.014
	38	4550, #6 Hoist Room	0.007
	39	3950, 9 Ledge, 24 & 25 stopes	0.064
	40	4100-4250, Main Ledge	0.032
	41	4250, Main Ledge, 70 x cut	0.012
	42	4250, Main Ledge, 71c stope	0.034
	50	4700, 9 Ledge, 37F stope	0.036
	52	4100, Main Ledge, 61 x cut	0.020
	53	2000, Ross Station - Ross Shaft	0.024
		Avg.	0.027
	18	1700, 9 Ledge, 24a stope	0.040
	24	2150, 9 Ledge, 51 stope	0.163
	25	2000, 9 Ledge, 45 & 51 stope	0.165
	26	2150, 9 Ledge, Motor Barn	0.142
	27	2150, 9 Ledge, 49 x cut	0.154
#3	34	1700, 8 x cut - air from open cut area	0.111
	54	1700, 8 x cut - air from open cut	0.101
	55	2000, 9 Ledge, 50 x cut	0.169
	56	4850, return air from bent drift	0.036
	57	4850, intake from vent drift - Yates	0.027
		Avg.	0.111

based on discussions with Homestake Mine personnel. The measurements are reported in terms of a working level (WL) which is defined as any combination of the short-lived radon daughters in 1.0 liter of air which will result in an ultimate 1.3×10^5 million electron volts of potential alpha energy (22). Radon daughter levels ranged from 0 (below level of detection) to 0.169 WL. As can be seen in Table 22, there is a significant difference in levels among the worksites supplied by the different ventilation systems. However, the assignment of the three ventilation systems to the various mine locations did not take into account possible air mixing between systems. Results of radon daughter sampling from a subsequent MESA survey in September 1977, appear to approximate these observed measurements (22). The results from that survey indicated a range of levels from 0.010 to 0.130 WL, with average exposures of 0.036 and 0.073 WL determined for ventilation systems #2 and #3, respectively. No sampling was performed in the areas of the mine which were supplied air from the #1 ventilation system, since previous sampling had indicated negligible levels. Both the NIOSH and MESA 1977 surveys indicated higher levels in the areas of the mine which were supplied air from the #3 ventilation system which draws its intake air through old surface and underground workings, many of which are caved or cracked. These workings are in a part of the mine which was thought to have higher alpha activity due to the presence of rhyolite and phonolite dikes.

In the 1960 Bureau of Mines survey (2), five samples were collected for radon daughters with an average level of 0.006 WL found. Other surveys by MESA observed levels generally around 0.01 WL, with maximums of 0.015 WL in 1968 (23) and 0.02 WL in 1975 (24). These earlier surveys, which indicated levels lower than those observed by NIOSH and MESA in 1977 studies, did not attempt to identify levels by ventilation systems and, therefore, did not completely characterize the potential for exposure throughout the mine.

DUST

Impinger dust sample concentrations in millions of particles per cubic foot of air (mppcf) were calculated by job type for each 15- to 30-minute sampling period. In addition, TWA values were calculated from the four to six samples collected in the breathing zone of the observed worker during a shift; average TWA values for the different ledges were also calculated. All impinger sample results are reported in Appendix E. A summary of the impinger results grouped by surface (crushing) and underground ledge is shown in Table 23 and indicates that the individual dust sample concentrations ranged from 0.0 to 16.6 mppcf. If the dust is assumed to be inert (i.e., <1% quartz), then the current OSHA standard for impinger samples would be 15 mppcf for the respirable fraction and 50 mppcf for total dust; likewise, if the quartz content is >1%, then the formula $\frac{250}{\% SiO_2 + 5}$ would be applicable (25). It was noted

Table 23. Airborne dust exposures as determined by impinger samples collected at the Homestake Gold Mine, Lead, South Dakota.

Location*	Number of individual samples collected	Range mppcf	Mean mppcf	Median mppcf	Time-weighted average (TWA)
Crushing (surface)	10	0.07- 5.96	2.0	1.3	2.1
9 Ledge	85	0.03-13.22	1.5	0.7	1.2
Main Ledge	37	0.04-16.60	1.9	1.0	1.3
11 Ledge	22	0.00- 4.12	1.1	0.8	1.1
13 Ledge	12	0.37-12.47	2.6	1.3	2.4
19 Ledge	15	0.04- 5.46	0.7	0.2	0.5
21 Ledge	6	0.13- 1.63	0.7	0.6	0.8
Total	187	0.00-16.60	1.5	0.9	1.3

* Includes all job types working in these locations.

mppcf - millions of particles per cubic foot of air.

during impinger dust counting that over 95% of the dust particles observed were less than 10 μm in diameter and were therefore considered to be potentially respirable. In addition, it was determined by the analysis of ore samples and airborne collected samples that the quartz content was >1%.

The highest dust concentrations were found during the work activities of dumping waste (16.6 mppcf), filling ore cars (13.2 mppcf), putting in track (12.5 mppcf), and blast hole drilling (10.7 mppcf). These elevated concentrations were due mainly to inadequate local ventilation and/or lack of water as a dust suppressant. Moderate concentrations were observed during drilling in stopes (8.7 mppcf), blast hole slushing (8.1 mppcf), clean-up in the crushing mill (6.0 mppcf), pulling chute (5.1 mppcf), and borehole drilling (4.2 mppcf). Most of these activities, except for clean-up in the crushing mill, represented isolated instances where insufficient amounts of water were being used to suppress airborne dust. In most instances, the work practices utilized, such as amount of water used for dust suppression and positioning of ventilation ducts, determined the relative dustiness of the work environment.

Although individual sample results were sometimes high, average (arithmetic mean) TWA exposures by ledge or surface location were always substantially lower, as shown in Tables 24, 25, and 26. The geometric mean TWA exposures to dust for the six ledges ranged from 0.11 mppcf (19 Ledge) to 2.40 mppcf (13 Ledge), as shown in Table 24. When Miners from all ledges were grouped together, a geometric mean TWA exposure of 0.85 mppcf was calculated with 95% confidence levels of 0.55 and 1.34 mppcf. The lowest TWA exposure over a shift for a Miner was 0.06 mppcf; this particular Miner was involved in the installation of water pipes on the 4850 Level, 19 Ledge. The highest TWA exposure for a Miner was 6.03 mppcf during dumping waste, mucking, and unloading equipment on the 6500 Level, Main Ledge.

In Table 25, a summary of TWA exposures to dust is presented for all other underground job classifications (excluding Miners). Both the lowest (0.18 mppcf) and highest (2.68 mppcf) TWA exposures over a single shift were observed for the Skipper job classification, with a geometric mean concentration of 1.07 mppcf. The geometric mean TWA concentration for these nonminer underground job classifications was 1.03 mppcf with 95% confidence levels of 0.57 and 1.86 mppcf.

A summary of TWA exposures to dust for the two workers monitored in the surface crushing mills (see Table 26) indicated mean concentrations of 0.27 mppcf for a Belt/Chip Picker and 3.82 mppcf for a Laborer 1st. Individual sample concentrations ranged from 0.07 to 5.96 mppcf, with the highest levels found for the Laborer 1st during cleanup in the crushing mill.

Table 24. Time-weighted average (TWA) airborne dust exposures (impinger samples) of underground employees with job titles of Miner 1st, 2nd, 3rd, or 4th at the Homestake Gold Mine, Lead, South Dakota.

Location	Number of samples counted	Number of TWA exposures*	Millions of particles per cubic foot of air (mppcf)							
			Range	Mean	Std. dev.	Std. error	Geometric mean	Geometric std. dev.	LCL**	UCL**
9 Ledge	80	14	0.12-4.06	1.48	1.25	0.33	0.95	2.91	0.51	1.77
Main (10) Ledge	27	6	0.29-6.03	1.71	2.23	0.91	0.91	3.34	0.26	3.23
11 Ledge	16	3	0.42-1.82	1.15	0.70	0.41	0.98	2.13	0.15	6.42
13 Ledge	12	2	2.09-2.75	2.42	0.47	0.33	2.40	1.21	0.42	13.71
19 Ledge	9	2	0.06-0.20	0.13	0.10	0.07	0.11	2.34	0.00	228.36
21 Ledge	6	1	0.75	0.75	-	-	0.75	-	-	-
Total All Miners Underground	150	28	0.06-6.03	1.42	1.40	0.26	0.85	3.12	0.55	1.34

* A TWA exposure was calculated for each miner from the 3 to 7 samples collected during a shift.

** LCL and UCL are the lower and upper 95% confidence limits based on the geometric mean and geometric standard deviation of the individual estimates of daily TWA concentrations.

Table 25. Time-weighted average (TWA) airborne dust exposures (impinger samples) of underground employees (excluding Miner classification) at the Homestake Gold Mine, Lead, South Dakota.

Job title	Number of samples counted	Number of TWA exposures*	Millions of particles per cubic foot of air (mppcf)							
			Range	Mean	Std. dev.	Std. error	Geometric mean	Geometric std. dev.	LCL**	UCL**
Skipper and Skipper Head	17	3	0.18-2.68	1.81	1.41	0.81	1.07	4.69	0.02	49.97
Carpenter	10	2	0.61-0.71	0.66	0.07	0.05	0.66	1.11	0.25	1.73
Hoist Operator	12	2	0.85-0.95	0.90	0.07	0.05	0.90	1.08	0.44	1.82
Motorman	6	1	1.46	1.46	-	-	1.46	-	-	-
Diamond Drill Operator	6	1	0.82	0.82	-	-	0.82	-	-	-
Boring Machine Operator	6	1	2.53	2.53	-	-	2.53	-	-	-
Total All Non-miners Underground	57	10	0.18-2.68	1.34	0.92	0.29	1.03	2.30	0.57	1.86

* A TWA exposure was calculated for each underground employee from the 3 to 6 samples collected during a shift.

** LCL and UCL are the lower and upper 95% confidence limits based on the geometric mean and geometric standard deviation of the individual estimates of daily TWA concentrations.

Table 26. Time-weighted average (TWA) airborne dust exposures (impinger samples) of surface employees in crushing department at the Homestake Gold Mine, Lead, South Dakota.

Job title	Number of samples counted	Number of TWA exposures*	Millions of particles per cubic foot of air (mppcf)							
			Range	Mean	Std. dev.	Std. error	Geometric mean	Geometric std. dev.	LCL**	UCL**
Belt/Chip Picker	5	1	0.27	0.27	-	-	0.27	-	-	-
Laborer 1st	5	1	3.82	3.82	-	-	3.82	-	-	
Total Surface Workers Crushing	10	2	0.27-3.82	2.05	2.51	1.78	1.02	6.51	0.00	1000

* A TWA exposure was calculated from the 5 samples collected on each of the Crushing Department employees monitored.

** LCL and UCL are the lower and upper 95% confidence limits based on the geometric mean and geometric standard deviation of the individual estimates of daily TWA concentrations.

Nineteen impinger samples were randomly chosen from those collected during the survey and were simultaneously counted by the Homestake Mining Company as a comparison of counting methodologies. These sample comparisons are presented in Table 27 and indicate no significant difference ($p<0.05$) between NIOSH and Homestake counts.

BULK ORE SAMPLES

Three composite ore samples collected from the crushing mills during the survey were analyzed for trace metals, free silica (quartz and cristobalite), arsenic, and asbestos in an effort to help substantiate the characterization of airborne contaminants in the mine. The trace metal, arsenic, quartz, cristobalite results are presented in Table 28. All trace metals except for iron (14-15%) were either not detectable or were found in negligible quantities. Quantities of arsenic ranged from 0.26 to 0.31% using both atomic absorption and neutron activation analysis techniques, and free silica determinations indicated the presence of 22-24% quartz and 0.9% cristobalite. Asbestos fiber characterization was performed by TEM as previously described; this analysis confirmed the types of fibers observed in the airborne sample exposure data collected in both the mine and mill.

Table 27. Comparison of NIOSH and Homestake impinger counts.

Sample number	Concentration (mppcf)	
	Homestake count	NIOSH count
H2	1.33	1.44
H5	0.69	1.02
H12	2.91	3.67
H16	0.35	1.27
H18	0.47	0.29
H20	0.22	0.37
H21	2.22	3.73
H26	0.83	1.40
H27	0.89	1.30
H119	0.83	0.13
H122	1.35	1.12
H123	1.91	1.05
H125	2.06	0.95
H126	0.59	0.25
H129	2.47	0.97
H131	3.19	1.48
H137	1.13	0.26
H141	0.89	0.76
H148	4.79	3.97

No significant difference ($p>0.05$) between NIOSH and Homestake counts.

Table 28. Composite ore sample analysis.

Sample number	% Be	% Co	% Cr	% Fe	% Mn	% Mo	% Ni	% Pb	% V	% Zn	% Quartz	% Cristobalite	% Arsenic*	% Arsenic**
1	N.D.	N.D.	N.D.	14	0.2	N.D.	N.D.	N.D.	N.D.	0.01	22	0.9	0.27	0.27
2	N.D.	N.D.	N.D.	15	0.3	N.D.	N.D.	N.D.	N.D.	0.01	24	0.9	0.27	0.29
3	N.D.	N.D.	N.D.	15	0.3	N.D.	N.D.	N.D.	N.D.	0.01	23	0.9	0.26	0.31
Limit of Detection	0.01%	0.01%	0.005%	0.01%	0.01%	0.03%	0.01%	0.01%	0.01%	0.01%	0.03mg	0.03mg	0.005%	0.001%

N.D. - None Detected

* Atomic absorption spectrophotometry

** Neutron activation

COMPARISON OF PRESENT AND PAST EXPOSURES

As part of the overall study at the Homestake Gold Mine, which includes the mortality study, the industrial hygiene survey was conducted not only to characterize current exposures but to be able to combine the current results with pertinent data such as historic exposures data, changes in work practices and mining techniques, etc., to postulate types and extent of prior exposures underground.

RADON DAUGHTERS

The first industrial hygiene survey conducted at this mine was by the Bureau of Mines in 1960 (2). During that survey, five radon daughter measurements were made and indicated an average exposure of 0.006 working level (WL). Since the radon daughter levels were considered to be low, no attempt was made to locate sources. Subsequently, other studies were conducted in 1968 (23) and 1975 (24) substantiating these low levels (<0.02 WL); likewise, identification of the sources of radon daughters was not attempted. It was not until this study and the MESA study in 1977 (22) that some sources were identified. As indicated in Table 22, substantial differences in exposure levels were observed for the different ventilation systems. The highest exposures were found in that part of the mine which had make-up air drawn through the old mine workings (designated as the #3 ventilation system), which was the major source of fresh air ventilation before 1941. To determine radon daughter sources, air samples were collected during the NIOSH survey near the air intake points of the #3 ventilation system, and near rhyolite and phonolite dike formations which are found throughout the mine.

These air samples indicated the presence of alpha activity throughout the mine, and especially around the dikes and near the openings of the old mine workings. The alpha activity found near the rhyolite and phonolite dikes could account for the exposures found at the worksites that were supplied air from the #3 ventilation system since many of these dike formations are located in these areas of the mine. Sources of radon daughters around the air intakes of the old mine workings were impossible to locate since much of the air is drawn through numerous rock crevices which probably contain rock fragments from rhyolite and phonolite dikes dispersed throughout. The presence of alpha activity is assumed to be caused by Radium-226 based on MESA's radiometric analysis of different Homestake rock types. As shown in Table 29, radiometric determinations substantiated the results of the NIOSH survey which found higher airborne levels of alpha activity near rhyolite and phonolite dikes.

In assessing past exposures to radon daughters, a possible approach would be to assume that higher exposures occurred in the upper levels of the Main and 9 Ledges during the years in which fresh air was drawn from the old mine

Table 29. Radiometrically determined Radium-226 content of different rock types at the Homestake Gold Mine, Lead, South Dakota.

Formation	Level	Radium-226 content picocuries/gram of rock	
		Individual sample	Average
Poorman	800	1.2	
Poorman	2000	3.4	
Poorman	2150	2.2	
Poorman	4850	1.0	
Poorman	6800	1.1	
Poorman	Average		1.8
Homestake	800	0	
Homestake	2000	0	
Homestake	4850	0.5	
Homestake	6800	0.4	
Homestake	Average		0.2
Ellison	800	0.2	
Ellison	2000	0.3	
Ellison	2000	0.4	
Ellison	4850	0.3	
Ellison	6800	2.9	
Ellison	6800	2.0	
Ellison	6800	1.5	
Ellison	Average		1.1
Rhyolite dike	800	2.9	
Rhyolite dike	800	2.3	
Rhyolite dike	800	2.3	
Rhyolite dike	2000	3.1	
Rhyolite dike	2150	3.7	
Rhyolite dike	4850	3.3	
Rhyolite dike	6800	2.5	
Rhyolite dike	Average		2.9
Phonolite dike	800	9.5	
Phonolite dike	2000	5.9	
Phonolite dike	5450	4.2	
Phonolite dike	Average		6.5

Note: Collected samples were about 3 pounds each. All were pulverized to about 200 mesh, then blended and packaged in plastic bags for shipment to Technical Support Center of MSHA in Denver, Colorado, for radiometric determination of Radium-226. The lower limit of detection for Radium-226 is approximately 0.2 picocuries/gram and the accuracy for the levels measured is plus or minus 20%.

From: October 12, 1979 correspondance with L. Swent, Homestake Mining Company.

workings, and that average exposures have gradually decreased with the addition of the other two ventilation systems. With the addition of these systems, an average radon daughter exposure level could be calculated since work crews have always worked periodically in all areas of the mine. Another factor to take into account is the length of time spent underground (see Table 4). Work hours per week have steadily decreased from a high of 52 hours in 1920 to the present low of 40 hours, and should be factored in when determining employee working level months (WLM). When all these conditions are assessed, employee WLM's in the past would most probably be at least equivalent to, and most likely higher, than those observed for the current workforce.

In order to approximate previous radon daughter levels, the dust exposure data, as determined by the company since 1937 (see Tables 30 and 31), could possibly be extrapolated and used as an exposure index for underground operations. The predicted radon daughter levels would then directly relate to the effectiveness of the ventilation in controlling dust at the worksite and to the changes which have occurred in work practices and production. Although the exposure to radon daughters has been shown to be more closely related to air changes than any other control factor (26), the exhaust air volume (see Table 5) is not directly related to air changes per unit time due to the constant changes in the volume of open area in the mine. While the period of 1924 to 1932 may have had only one-third the volume of exhaust air, as compared to later years, the rate of air changes may have been equal due to the lesser volume of open area in the mine. Since the effectiveness of the ventilation cannot be estimated by the increases in the volume of air exhausted from the mine, dust exposure data may be the only reasonable means of estimating past radon daughter exposures. However, additional simultaneous sampling of radon daughters and dusts is required to determine if a relationship exists between radon daughter measurements and changes in dust concentrations.

In the years prior to 1940, most of the mining was performed above the 3200-foot levels of the Main and 9 Ledges where radon daughter levels are currently found to be higher. In addition, dust exposures were a magnitude higher than those currently observed which could possibly reflect a similar increase in past radon daughter levels. It has been speculated that if radon daughter levels increase with respective dust exposures, the relationship would not be linear since radon daughters are constantly "growing in" even with an increase in air changes, and that the further one gets from radioactive equilibrium, the faster is the relative growth of the radon daughters (27).

OTHER EXPOSURES

If it is assumed that dust exposures (impinger samples) are acceptable indicators of relative exposures to other agents such as arsenic, asbestos,

Table 30. Approximate exposures to dust by type of work for surface and underground workers from 1937 through 1974 at the Homestake Gold Mine, Lead, South Dakota.

Millions of particles per cubic foot (mppcf)

Year	Sill (no mining)	Mining	Crusher crew	Motorman	Skipping	Caging	Diamond drill	Surface	Weighted yearly average # of samples	Weighted yearly average Conc.
1937	8.1	6.6	32.1	25.0	95.1	-	-	-	107	11.0
1938	9.3	34.7	42.7	26.8					216	25.5
1939	12.0	12.0	2.7	28.9	27.1				748	15.3
1940	9.1	13.0		21.0		2.6		2.9	1,056	11.1
1941	12.4	10.2	31.7	22.0	3.4	1.9			498	13.3
1942	12.8	49.8	9.2	31.9	2.8	1.1			184	24.6
1943										
1944										
1945										
1946										
1947	12.3	26.9		7.5					255	24.3
1948	11.3	11.6	17.9	18.7	23.6				178	12.0
1949	22.1	12.3	29.3						183	15.5
1950	4.1	14.0	2.3	10.0					297	12.6
1951	6.3	6.7	128.9	18.6		0.6			198	18.4
1952	3.6	7.1	44.0	9.2	9.5				247	9.7
1953	1.5	5.5	9.3	15.9	0.7				140	6.7
1954	2.0	8.1							22	5.9
1955	3.2	5.4		1.2					249	5.1
1956	1.4	5.4							104	5.2
1957	2.6	5.0							290	4.1
1958	2.2	4.7	5.7						121	4.3
1959	2.6	4.3							74	4.0
1960	2.4	4.2	5.7						24	4.4
1962										
1963										

Table 30 (continued)

Year	Sill (no mining)	Mining	Crusher crew	Motorman	Skipping	Caging	Diamond drill	Surface	Weighted yearly average # of samples	Conc.
1964	0.9	3.4	1.8	5.3	1.8		1.2	2.4	247	3.3
1965	0.9	4.5		4.4					86	4.2
1966	2.0	3.3	6.5	7.1	3.8			1.2	311	3.5
1967		3.1	2.4						261	3.1
1968	1.5	3.2		31.6	12.0			1.2	260	5.0
1969	1.5	2.9	2.5	6.7	9.8				228	4.0
1970	1.4	3.0	1.5	25.5	4.8				146	4.4
1971	0.7	2.5	1.8	2.1					195	2.4
1972		2.9	2.7	2.6				2.5	200	2.8
1973	0.8	2.9	3.7						180	2.5
1974	0.9	2.6	1.6	2.7	2.1			0.6	124	2.0
1975										

Note: Air sampling was performed by impinger in areas expected to have high dust exposures so that dust control measures could be initiated. If all samples taken in a given year were averaged, the exposures would be biased on the high side. Only samples which represented exposures of employees were used in obtaining the averages in this Table. Repetitive sampling in high dust concentration areas were not used in obtaining the averages.

From: May 27, 1976, memo from J.K. Waterland to D.T. Delicate. Homestake Mining Company, Lead, South Dakota.

Table 31. Approximate exposures to dust by type of mining operation from 1939 through 1974 at the Homestake Gold Mine, Lead, South Dakota.

Millions of particles per cubic foot (mppcf)

Year	Slusher operator	Chute puller	Stope miner	Power shovel operator	Drift miner	Raise miner	Bore hole operator	Yearly average conc.
1937								
1938								
1939		9.9	12.6					12.2
1940								
1941								
1942								
1943								
1944								
1945								
1946								
1947		6.5	5.8		52.7	26.5		26.3
1948		7.7	10.6		30.8	22.3		14.8
1949		7.9	9.2		18.4			9.8
1950		10.1	9.1		7.3	22.4		11.3
1951		11.7	5.9		2.6			7.3
1952		8.2	7.6					7.7
1953	10.8	10.3	2.6	2.5		20.0		10.9
1954			1.8			20.6		11.6
1955	9.0	6.3	2.4	8.8		19.7		8.1
1956	11.8		3.0	1.6		21.0		9.2
1957	7.9	3.2	3.4	2.2				5.6
1958	10.8	1.8	11.4					9.6
1959	7.5	2.6	3.6					5.9
1960	3.8		1.4					2.3
1961								
1962								
1963								
1964	8.2	2.4	1.5			6.1		3.6
1965	6.2	2.7	1.7	2.0				4.8
1966	6.3	3.8	1.4	3.4	1.8			2.1
1967	6.4	2.6	1.2	3.9	1.0			3.9
1968	6.6	4.7	1.5	6.3	1.6		22.9	5.5
1969	6.5	3.0	1.2		1.2		31.1	8.7
1970	7.3	3.1	1.0	2.6	2.4		14.6	6.0
1971	6.9	4.4	1.2		0.8		14.5	6.0
1972	6.3	4.4	1.2	3.9	1.7	6.8	8.6	4.4
1973	6.3	4.8	1.3	2.9	3.0			4.4
1974	6.5	5.5	1.4	2.9				5.2

From: May 27, 1976, memo from J.K. Waterland to D.T. Delicate. Homestake Mining Company, Lead, South Dakota.

etc., then historic concentrations can be predicted. This assumption can be supported by the statistical analyses performed on the arsenic and asbestos samples (Tables 9 and 14) in which exposures were not found to be statistically different between the mine ledges. Based on the uniformity found in the mine for arsenic and asbestos, it could be concluded that quartz is also uniformly dispersed throughout the mine and that concentrations would also be related to the observed dust exposure levels.

Although airborne samples for quartz were not collected during this study, analysis of composite ore samples from the mill indicated a consistent quartz content of 22-24%. Personal respirable airborne dust samples for quartz were, however, collected on 80 underground workers by MESA in 1976 (10). The results indicated that 80% of the exposures were within the current OSHA standard of $\frac{10}{\% SiO_2+5}$ mg/m^3 (25) and that 60% were within the NIOSH-recommended standard of 50 µg/m^3 (28). The percent quartz found in these samples ranged from none detected to 48%, with an average of 13%. Similarily, in the 1973 Bureau of Mines survey, the results from personal respirable samples showed an average quartz content of 13.1% (3). This consistent average ($\sim$13%) in quartz content appears to be a logical choice in determining average exposures since it represents the respirable quartz fraction detected in the airborne dust. By assuming a 13% quartz content, and using the formula $\frac{250}{\% SiO_2+5}$, dust exposures below 14 mppcf would be considered within the current OSHA standard as expressed in mppcf. As determined by the Homestake Mining Company (see Table 30), yearly average dust exposures by type of work have been considerably less than 14 mppcf since 1952, and have been exceeded only on six occasions between 1937 and 1952. Likewise, when compared to the yearly averages calculated by the Homestake Mining Company for mining operations (see Table 31), only during the years 1947 and 1948 was 14 mppcf exceeded.

To determine if a difference existed between NIOSH dust counting methodologies and those historically and still used by the Homestake Mining Company, impinger samples collected during this study were shared with the company. As indicated in Table 27, no significant difference was observed and it was concluded that dust exposure data collected in previous years by the company represented a good indicator of the relative dustiness of exposures by job type. However, air sampling data were collected by the company in the past for purposes of identifying "dusty" operations; consequently, the reported mean dust exposure concentrations in Table 30 and 31 could be biased on the high side.

Since company average dust exposure data were available for underground workers, an attempt was made to predict past exposures to arsenic and asbestos. The arithmetic mean of the TWA dust exposure data for all under-

ground workers (see Tables 24 and 25) collected during this study were used with the respective arsenic (see Tables 6 and 7) and asbestos (see Tables 11 and 12) data to develop an exposure relationship. This included a total of 7 data points comprising the job types of Miner (total), Skipper, Carpenter, Hoist Operator, Motorman, Diamond Drill Operator, and Boring Machine Operator. The arithmetic mean of the TWA concentrations for each job type were used and weighted with respect to the total number of samples collected. A regression analysis was performed and prediction equations were developed for arsenic and asbestos.

As illustrated in Figure 6, a correlation of $R^2 = 0.84$ was achieved for arsenic with the prediction equation:

$$\text{Exp. Arsenic } \overline{X} = -94.77 + 30.17 \text{ (Exp. Dust } \overline{X})$$

Exp. Arsenic $\overline{X}$ = Exponential transformation of the arsenic mean
Exp. Dust $\overline{X}$ = Exponential transformation of the dust mean

Likewise, for asbestos (see Figure 7), a correlation of $R^2 = 0.85$ was achieved with the prediction equation:

$$\text{Exp. Asbestos } \overline{X} = -1.72 + 1.00 \text{ (Exp. Dust } \overline{X})$$

Exp. Asbestos $\overline{X}$ = Exponential transformation of the asbestos mean
Exp. Dust $\overline{X}$ = Exponential transformation of the dust mean

By using the average dust exposure data collected by the company (Tables 30 and 31), the estimation equations can be used to determine approximate exposures to arsenic and asbestos. As an example, if the mean dust concentration determined for all underground workers in 1971 (2.4 mppcf from Table 30), is selected an arsenic concentration can be determined as follows: since the exponential value of 2.4 is 11.0, using the arsenic estimation equation yields a value of 1810.6. By taking the natural log of 1810.6, a mean concentration of 7.5 $\mu g/m^3$ for arsenic is predicted. Likewise for asbestos, again using 2.4 mppcf as an example, using the asbestos estimation equation yeilds a value of 7.9. By taking the natural log, a mean concentration of 2.1 fibers >5 μm in length/cm^3 is predicted for asbestos.

Based on the data presented and the assumptions made, average exposure levels to quartz, arsenic, and radon daughters for the past 25-30 years probably have been within the current OSHA standards. However, average exposures to asbestos fibers (>5 μm in length) appear to have had a greater probability of exceeding the OSHA standard of 2.0 fibers/cm^3 on numerous occasions during this same time period. In fact, from the derived asbestos estimation equation, dust exposures which exceeded 2.2 mppcf had the potential for exceeding

Figure 6. Regression analysis [illegible] dust and arsenic
Homestake Gold Mine, Lead, South Dakota

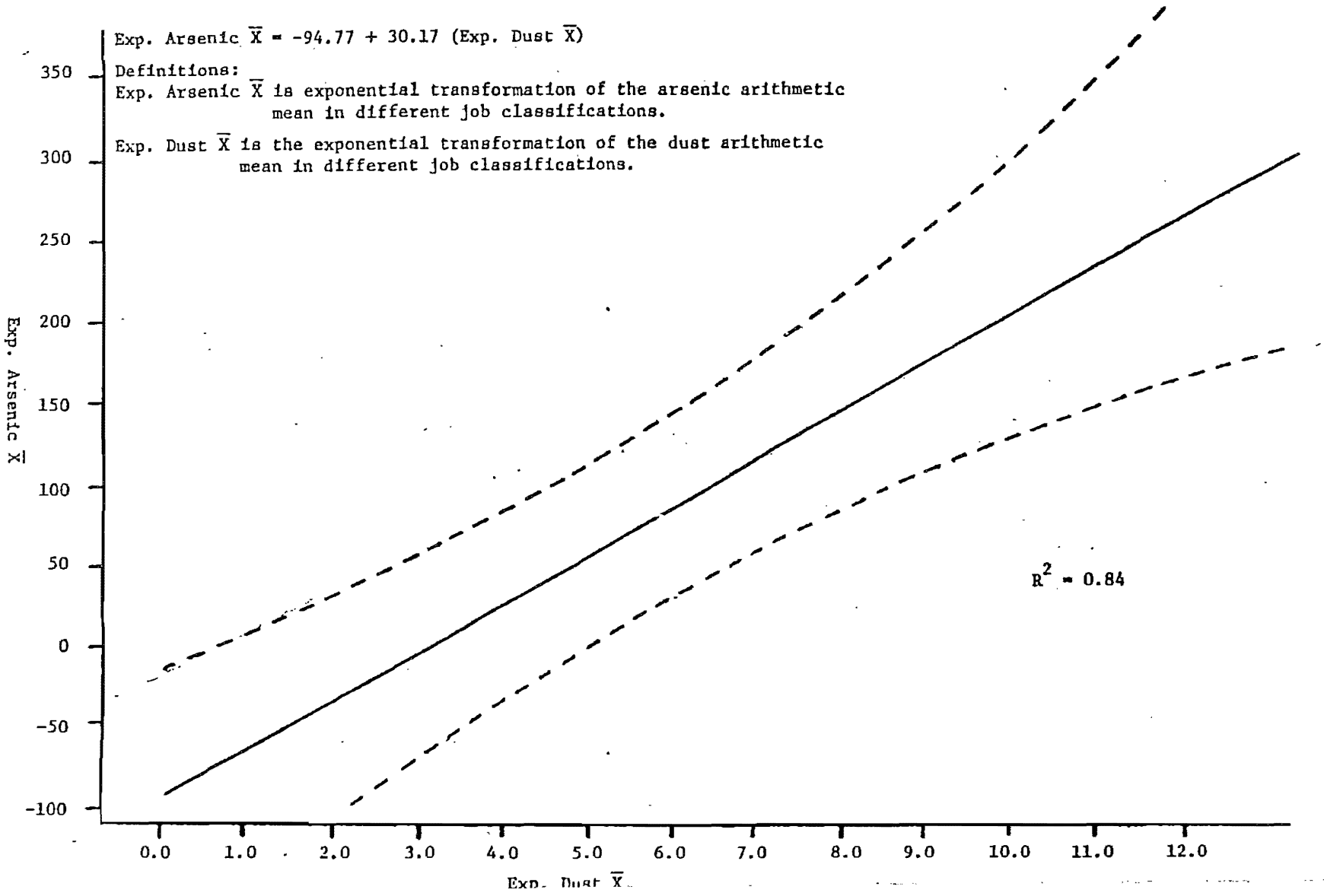
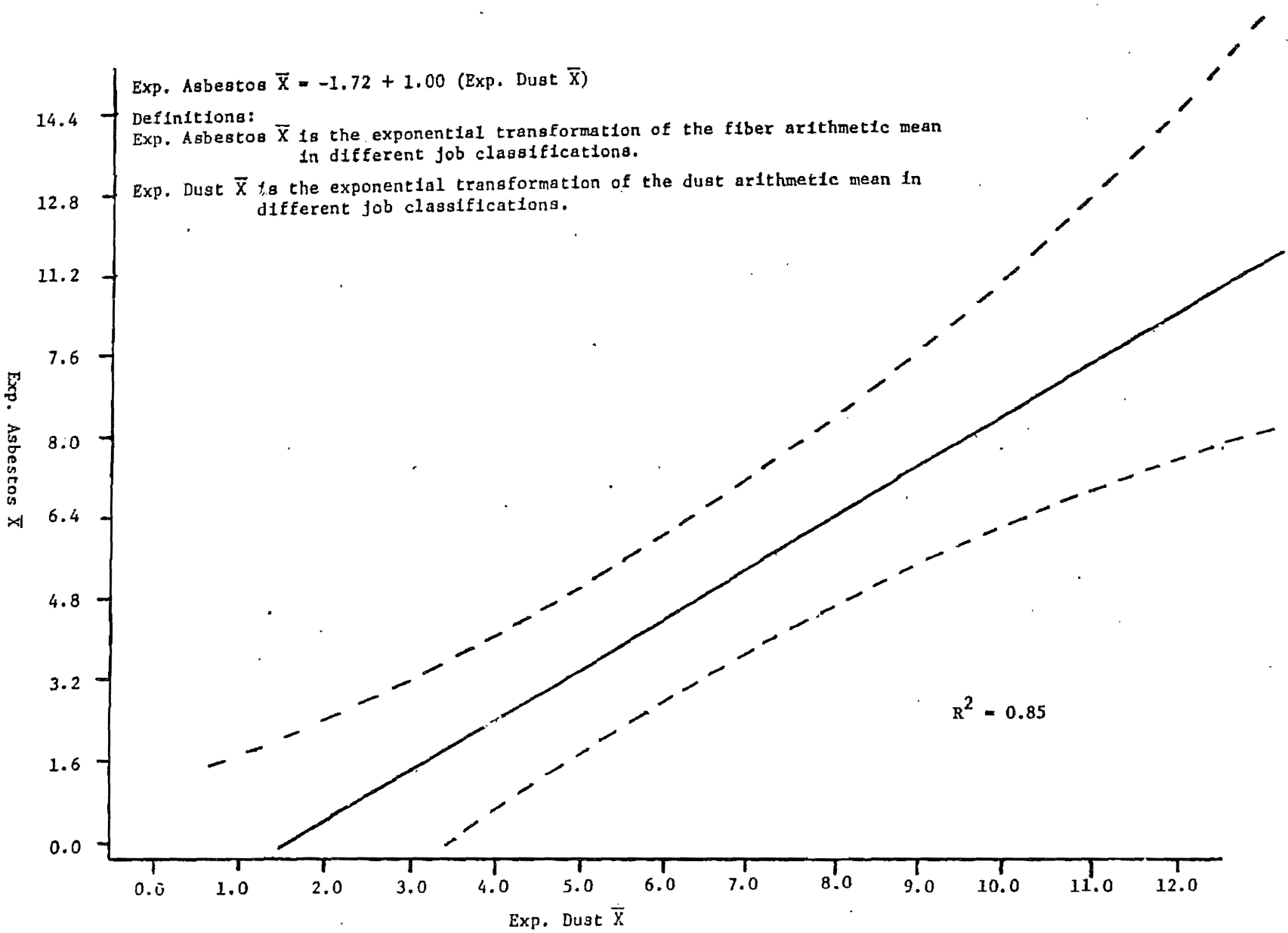


Figure 7. Regression analysis f dust and asbestos
Homestake Gold Mine, Lead, South Dakota



2.0 fiber/cm^3. It should be noted that when determining past arsenic and asbestos exposures using the estimation equations, that the 95% confidence interval increases with the respective increase in exposure. Therefore, it is prudent to use only those exposure values which fit the regression equation plot in Figures 6 and 7.

DISCUSSION

The results of the present industrial hygiene study and past Bureau of Mines and MESA surveys have demonstrated multiple environmental contaminants in both the mine and the mill. The observed exposures to quartz, arsenic, asbestos, and radon daughters are thought to have the greatest potential for causing adverse health effects. However, other airborne contaminants such as trace metals, carbon monoxide, carbon dioxide, methane, nitrogen dioxide, hydrocarbons, benzo(a)pyrene, and aldehydes have been identified, but were detected in negligible quantities (10).

QUARTZ

Epidemiological studies demonstrating adverse health effects of airborne free silica (quartz) have been compiled since the early 1900's. Most of these studies, including those conducted in the hard rock mining industry (29, 30,31), have shown an excess of respiratory disease in workers exposed to airborne dust containing >30% quartz. The documentation of silicosis in the Barre, Vermont granite sheds has been a major source of data for establishing permissible dust exposure levels since the types of operations observed have been typical of other uncontrolled operations found in the mining, foundry, and ceramic industries (32,33, 34). Based on the impinger-count dust concentration data, the granite shed studies have indicated an exposure limit of 5 mppcf to be an effective control for the prevention of silicosis in workers exposed to airborne dust containing 25–35% quartz. A recent medical study performed in the Vermont granite industry (35) reported no cases of silicosis among workers whose span of employment began after the implementation of dust controls in 1937, resulting in an average exposure of about 3 mppcf. These findings confirmed an earlier medical study which showed a similar absence of silicosis in granite workers exposed over an 18-year span from 1937 to 1955 to an average concentration of 5 mppcf (36). Quartz content of the airborne granite dust in both studies was reported to be approximately 25%.

In view of the epidemiological data available for workers exposed to mineral dust containing <25% quartz, the occurrence of silicosis in the Homestake Mine for underground workers who started employment within the past 25 years would not be expected. This assumption is based on an average quartz content of 13% found in the airborne dust and from the use of yearly average dust exposure data tabulated by the company. Even if a higher free silica content of up to 25% is assumed, silicosis probably would not have manifested itself during the last 25 years since most of the average dust exposures for underground mining have not exceeded 8.3 mppcf (see Table 30). However, these assumptions are based on the absence of other environmental contaminants which are found in this mine and may act in an additive or synergistic manner with quartz.

ARSENIC

There have been numerous reports on arsenic-induced occupational cancer, with most of the epidemiological data collected from smelter workers exposed to arsenic trioxide (37,38,39,40). Other studies have shown an increase in respiratory cancer mortality of workers in sheep-dip factories (41,42), and among workers exposed to arsenates and arsenites in pesticide plants (43). There is one reported epidemiological study of workers exposed to arsenopyrite which demonstrated a high degree of association of skin arsenism and lung cancer (44,45). These study data, which were collected from a group of Rhodesian gold miners, identified 37 cases of lung cancer during the period from 1957 to 1963. This represented a six-fold increase in lung cancer for adult males when matched to the population in the Gwanda region of Rhodesia. Although no exposure data or quantification of arsenic content were documented for this mine, there was, however, a reported increase of skin keratoses in the mine workers. Similar studies on vineyard and sheep-dip workers have reported characteristic hyperpigmentation and keratoses with chronic arsenic exposure (46,47). It was reported that a high risk of lung cancer exists when the exposure to inorganic arsenic dust is high enough to cause keratoses. No documented cases of skin hyperpigmentation or keratoses have been observed for employees at the Homestake Gold Mine.

ASBESTOS

Asbestos is the generic name used for a group of naturally occurring mineral silicate fibers of the serpentine and amphibole series. The most common types found in occupational environments are the fibrous serpentine mineral chrysotile and the fibrous amphiboles which include crocidolite, anthophyllite, the tremolite-actinolite group, and amosite (part of the cummingtonite-grunerite group).

Approximately 50 years after the introduction of asbestos into industry, the first suspicion of an assoication between asbestosis and lung cancer was recognized in 1935 (48,49). Since then, mortality studies of workers employed in the manufacturing of asbestos products, and the installation and removal of asbestos in shipyards have provided the most concrete evidence concerning an association between lung cancer, pleural, and peritoneal mesotheliomas and exposure to asbestos. Although most of the epidemiological data have been collected on workers exposed to chrysotile, other studies on workers exposed to fibrous asbestos amphiboles have demonstrated similar malignant respiratory diseases (50,51,52,53,54).

The predominant type of asbestos observed in the Homestake Gold Mine in Lead, South Dakota is the cummingtonite-grunerite mineral group. One particular fiber type in this mineral group, commercially referred to as amosite, has

been documented in two epidemiological studies to cause lung cancer. In a study of workers exposed to amosite while making insulation materials, 10 mesotheliomas were found along with an increased risk of lung cancer after 20 years from onset of exposure (55). The excess lung cancer risk in the amosite workers was shown to increase with duration of employment. In addition, there was a 3.87-fold increase in lung cancer among those workers with less than 3 months employment. In another study, 914 men who worked for various periods of time during 1940 in a plant manufacturing amosite insulation materials, including 65 men who had worked for less than 1 month, had an excess mortality from lung cancer but not from all cancers or from all causes (56). This observed excess became discernible only after 30 years from onset of exposure. An excess of mortality from lung and from all cancers showed up after progressively shorter intervals from onset of exposure when the duration of exposure increased.

The type of amosite used by the workers in these two studies, which is typically found in other industrial applications, is considered fibrous both on a macroscopic and a microscopic scale. This differs from the amosite observed in the Homestake Gold Mine since it forms in a nonfibrous mineral habit, but through attrition by the various mining processes, fragments into respirable fibers. Most of these fibers, as demonstrated by the electron microscopy characterization, are identical to airborne fibers observed in the industrial environment.

It has been demonstrated that fibrous particulates with the morphology ($\geq$ 3:1 aspect ratio) like those observed in this study have the potential for producing tumorigenic effects in animal injection and inhalation studies (57). These studies concluded that the physical morphology (size dimensions), and to a lesser degree chemical and surface characteristics of a fiber are the determining factor for inducing a biological effect. The precise fiber dimensional characteristics required for these observed pathologic responses have been difficult to determine experimentally because of the difficulties encountered in producing fibers of specific size dimensions. However, the results from some of the studies suggest that long, thin fibers play an important role in eliciting a biological response. In one particular fiber implantation study, it was concluded that fibers less than 1.5 μm in diameter and longer than 8.0 μm in length may be the most important for production of pleural sarcomas (58).

When the Homestake fiber size data (see Table 16 and 17) are compared to the fiber dimensional characteristics which are thought to produce biological responses in animals, only the small diameter fibers (<1.5 μm) appear to match the criteria. Most of the observed fibers had lengths less than 5.0 μm and, when compared to the animal study results, they would be considered to have a lesser potential for creating a biological response. However, in a toxicologic study in which asbestos retention in the human respiratory system

was measured, it was concluded that smaller fibers (diameter and length) than those demonstrated in the animal studies had a greater probability of being retained (59). In this toxicologic study, size measurements of chrysotile and amphibole asbestos fibers were made from lung washing fluid obtained by broncho-alveolar lavage, sputum collected on alive individuals, and respiratory tissues (lung parenchyma, parietal pleura, and mediastinal lymph nodes) sampled at autopsy. All individuals studied had been diversely exposed to asbestos dusts and affected by various asbestos-related diseases. The results indicated that most of the fibers retained in lung tissues were less than 0.20 μm in diameter and shorter than 5 μm. The intra-alveolar fibers were shorter (mean 3.3 μm) than fibers found in lung parenchyma (mean 4.9 μm). Fibers encountered in mediastinal lymph nodes were shorter (mean 2.5 μm) and of amphibole type, whereas fibers encountered in the parietal pleura were the shortest (mean 2.3 μm) and had the smallest diameters (mean 0.06 μm). All fibers encountered in the different sites of the respiratory system were found to have diameters less than 0.25 μm and with mean lengths less than 8 μm. These data strongly suggest that the fibers observed in the Homestake Gold Mine would have a high probability of being transported within the body. Research to date has not been able to establish a fiber length below which there exists no carcinogenic potential by inhalation; this is true because of the unavailability of specifically sized fibers for study (60).

RADON DAUGHTERS

Radon and its daughter products, starting with Radon-222, have been documented to cause lung cancer in workers mining uranium ore (61). Typically, in mining operations, radon gas diffuses out from the rock into the mine atmosphere where it may be inhaled by the occupants of the mine. Some of the inhaled radon will decay in various parts of the respiratory system, producing its radioactive daughters there; some radon will pass the lung-blood barrier and enter the blood stream.

The primary radiation hazard arising from the inhalation of radon comes from the alpha-particle emission of the radon itself and its daughters. The daughter nuclides which are primarily involved are Po-218, Pb-214, Bi-214, and Po-214. Alpha emission from Bi-214 occurs in only 0.04% of the decays and can be neglected, as can the beta emissions from it and Pb-214. The buildup and decay of these nuclides are important, however, in determining the amount of the strong alpha emitter Po-214. The Po-214 daughter has a long half life and its concentration builds up slowly so that the subsequent alpha emissions from Po-210 need not be considered except for very long-term exposures (62).

Cancer risks from exposure to radon daughters are usually quantified relative to working level months (WLM), which is the cumulative exposure over a period of time. A WLM corresponds to 170 hours of exposure to a radon daughter concen-

tration of one working level. Although the lung cancers observed in uranium miners appear to have occurred most frequently at high levels (40-200 WLM), not all the clinical experience is based on heavily exposed persons. In particular, an epidemiological study of uranium miner populations in Czechoslovakia, where, on the average, radon daughter concentrations in mines are lower than the U.S.A., has provided a source for risk estimates at relatively low exposure levels. An excess mortality from lung cancer was observed for miners after exposure to less than 100 WLM (61,63). Some of these exposures extended over a 40-year period, indicating that effects may occur at exposure rates as low as 2.0 to 2.5 WLM per year.

Similarly, other studies have documented excess lung cancers for miners exposed to radon daughters in other hard rock mining operations. A study of miners who worked underground in fluorspar mines in Newfoundland, Canada has demonstrated a high risk of lung cancer (64). For those men who mined fluorspar for 5 to 10 years, the risk of lung cancer was only slightly higher than expected, whereas among those who mined fluorspar for more than 10 years, the risk was 9 times that of the general population. Based on the radon daughter measurements made in the fluorspar mine, it was estimated that levels probably ranged from 2.5 to 10.0 WL during the period when these miners were employed. Likewise, in an epidemiological study of cancer mortality among hematite miners, there was an observed excess of lung cancer (36 vs. 20.6 expected, $p<0.001$) among underground workers, but no excess was demonstrated for surface workers (65). Radon daughter concentrations were found to range from 0.15 to 3.2 WL underground.

A mortality analysis was performed on a group of hard rock metal miners who had completed a minimum of 15 years mining underground between January 1, 1937, and December 31, 1948. A total of 47 lung cancer deaths were found as compared with 16.1 expected (66). Measurements for radon daughters during the time of the study varied from 0.1 to 0.2 WL. Concentrations during the period of time when the deceased miners worked were estimated to be approximately 1.8 WL because of less effective ventilation. In addition, the ore from the mine was found to contain appreciable amounts of arsenic and traces of nickel, which were considered as possible contributors to the excess lung cancer.

In a recent study, exposure-response relationships were postulated by analysis of lung cancer among 15 different mining groups exposed to radiation from radon daughters (63). It was predicted that as the exposure rate of radon daughters (alpha) decreases, cancers per unit of radiation increase, and that the induction latent period (time from start of exposure to clinical cancer) is shortened by increased age at the start of mining, cigarette smoking, and by high exposure rates. In addition, the incidence increases with age at the start of mining, with the magnitude of exposure, and with the amount of cigarette smoking. However, it was speculated that the effect of cigarette smoking is primarily to accelerate the appearance of tumors and that low doses of radon

daughters increase the efficiency of alpha radiation to continually produce alterations in the chromosomal proteins (DNA) of the somatic cells. The more of these alterations there are in an individual's cells, the more likely it is that exposure to an additional carcinogen will result in a cancerous transformation.

CONCLUSION

Based on the data collected from the current industrial hygiene survey and past MESA and Bureau of Mines studies, mean exposures for free silica, radon daughters, arsenic, and asbestos fibers are within current OSHA and MSHA health standards for most of the job classifications. If the exposure estimation equations and the assumptions derived from the current exposure data are utilized, then exposures to asbestos for the past 25 years would have the greatest potential for exceeding current health standards. However, before approximately 1952 there is an additional risk of over exposure to free silica because of the elevated dust concentrations caused by underground blasting procedures and the lack of efficient dust suppressive techniques. Based on the current exposure data no one agent can be clearly implicated in promoting respiratory disease in the past 25 years. The potentiating effect of all or some of the observed contaminants may predispose workers to both malignant and nonmalignant diseases. Epidemiological evidence of exposures to arsenic, asbestos, and radon daughters has been documented to elicit pulmonary cancers, and although exposures to silica are not carcinogenic by themselves, a developed silicosis may be a temporal prelude to the development of malignant tumors in the presence of these other contaminants.

RECOMMENDATIONS

The results of the present industrial hygiene study indicate TWA exposures to arsenic and asbestos, for the most part, to be below current OSHA and MSHA standards. Likewise, exposures to quartz would probably be within the OSHA and MSHA standards if a 13% quartz content is assumed. There were, however, a few individual samples collected during underground work activities and at some ore milling operations which indicated exposures to arsenic and asbestos to be in excess of the OSHA standards. In particular, some of the underground operations, (e.g., filling ore cars, mucking, putting in track, and bore hole drilling) indicated periodic high asbestos fiber concentrations. In those instances where a concerted effort was made by the worker to keep the ore wet and maintain adequate ventilation directed to the worksite, exposure levels were kept to a minimum. However, a few of the operations do not lend themselves to these work practices and it would be advisable to furnish appropriate respiratory protection to those exposed employees.

Many of the employees in the surface crushing mills are subject to high dust concentrations during various work activities. At the time of the industrial hygiene survey, employees in the mills were wearing appropriate respiratory protection. To help reduce some of the dust exposures, it may be feasible to at least partially enclose some of the ore conveyor systems in the mill and install exhaust ventilation. In addition, an enclosed system would help to prevent spills and eliminate the need for subsequent clean-up.

A continuing educational program should be instituted to ensure that all employees have current knowledge of job hazards, proper maintenance procedures, and clean-up methods, and that they know how to correctly use respiratory protective equipment and protective clothing.

Even though radon daughter levels were relatively low, it would be appropriate to explore methods of reducing exposures. The reduction of dust levels at the worksites might help to alleviate radon daughter exposures. Also, the application of sealant materials to contain potential radioactive contaminants may be warranted. One method of utilizing sealant material is to apply it directly to the rock so that the radon transfer rate from the rock to the mine air is reduced. Another way would be to use the sealant as a coating on sealstoppings constructed to isolate radon and radon daughter contamination sources such as mined out stopes. Since the #3 ventilation system (designated by NIOSH) draws its intake air through the old surface mine workings, it may be worth exploring the possibility of using sealant materials for injection into the periphery of the mine openings; this would help to seal fractures and decrease rock permeability.

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Appendix A. Job dictionary for the Homestake Gold Mine in Lead, South Dakota.

Table A-1. Job dictionary for all job types underground at the Homestake Gold Mine, Lead, South Dakota.

Job Code	Job Title	Description of Duties
0100	Electrician	Electrical repair and installation, sometimes works underground.
0101	Cager	Hoist and lower men, equipment and supplies for underground use.
0102	Fork Lift Operator	Assist in loading cement timber, and supplies for underground use.
0103	Truck Driver 1 to 3 Ton	Haul men and supplies between Yates sawmill, shops, Ross and Yates Shafts.
0104	Lampman, Head	Charge and repair lamps and batteries at Yates and Ross.
0105	Lampman	Charge and repair mine lamps at Yates and Ross lamprooms.
0106	Powderman	Take care of book work and delivery of powder and caps.
0107	Hoist Operator, Underground	Operate hoist in underground hoist room. Assist in handling men and supplies. Located in Ross and Yates.
0108	Pipeman, Master	Install and repair air and water lines to air doors, chutes, pumps, coolers.
0109	Pipeman	Responsible for air door operation, repair of water lines, airlines.
0110	Carpenter, 1st.	Install pass gates, frame timber, install dumps.
0111	Carpenter, 2nd.	Layout chimneys, make switch stands, build air doors.
0112	Carpenter, 3rd.	Install borehole pads and drilling pads for anchor bolts, cement in bolts, frame timber.
0113	Carpenter, 4th.	Frame timber, build forms in mine for concrete, drill pinholes and anchor bolt holes.

Table A-1 (continued)

Job Codes	Job Title	Description of Duties
0114	Carpenter, Master	Act as Leadman in installation of pass gates, frame timber, install walls and dumps.
0115	Repairman, 1st.	Prepare and fill mine orders.
0116	Repairman, 2nd.	Help prepare and fill orders for mine; grease and oil cars.
0117	Repairman, 3rd.	Help oil and grease cars at ore and waste dumps.
0118	Mechanic, 1st.	Dept. 11:repair hand tools, sharpen saws.
0119	Mechanic, 2nd.	Dept. 11:repair and install all air doors.
0120	Mechanic, 3rd.	Dept. 11:feed crusher, check and lubricate all crushing equipment. Same Job Code as Area 02, Position 02.
0121	Shaftman	Shaft Maintenance, caging, handle long material, supervise shaft timbering.
0122	Shaftman, 2nd.	Ship, pull raises, blast rock, cage, handle long material, perform shaft repair.
0123	Mechanic Special	Same as Mechanic, 1st and Mechanic, 3rd.
0124	Skipper Head	Leadman on skip crew, pull raises, skip rock, handle long material.
0125	Skipper	Load Skips, extra caging and shaft work.
0126	Sampler Head	Take care of morl and dry drill samples, mark stope for back sampling.
0127	Sampler	Take care of mine sample (either morl or dry drill), mark stopes for back sampling.
0128	Sandman, Underground	Watch sandlines, drain stopes, back-fill stopes, repair broken sandpipe.

Table A-1 (continued)

Job Code	Job Title	Description of Duties
0129	Shopman, 2nd.	Underground drill and leg repair.
0130	Shopman, 3rd.	Assist in underground drill and leg repair.
0131	Motorman-Surface	Transport rock between Yates and Ross and South Mill, and haul supplies.
0132	Motorman, 1st.	Haul rock, men, and supplies, general clean-up.
0133	Motorman, 2nd.	Haul rock, men, and supplies, general clean-up.
0134	Helper, 1st.	Fill mine orders, Relief Man for oil, bit, and lamp room.
0135	Helper, 2nd.	Helper on 1½ ton truck, hauling supplies and materials between Sawmill, Shops, etc.
0136	Helper, 4th.	Relief Man for oil, bit, and lamp rooms.
0137	Pump Operator	Repair and maintain pumps.
0138	Mine Supervisor	Responsible for mine production, spends some time underground.
0139	Laborer, 1st. Underground	Clean skip pocket, help on cages and where needed.
0140	Laborer, 2nd. Underground	Clean-up, maintain water ditches, unload materials.
0141	Diamond Drill Operator	Set-up drill equipment, obtain drill samples for geological logging.
0142	Diamond Drill Helper	Assist in setting up drill and obtaining ore samples.
0143	Boring Machine Operator	Machine set-up, monitor boring of hole, completion of borehole raise.

Table A-1 (continued)

Job Code	Job Title	Description of Duties
0144	Boring Machine Helper	Assist in machine set-up, handling of drill rods, sill clean-up.
0145	Miner, Surface	Oilman, wash sample sacks, clean underground latrines, repair vent bags, janitorial work.
0150	Miner, 1st.	Shotcret, Load, Haul, Dump Operator, must be capable of drift and stope mining.
0151	Miner, 1st.	Drill and scrape in cage raises and regular raises.
0152	Miner, 1st.	Drill and scrape in shrinkage stopes.
0153	Miner, 1st.	Drill and scrape in sub-sill drifts.
0154	Miner, 1st.	Drill and scrape in 7 x 7 and smaller drifts.
0155	Miner, 1st.	Drill and scrape in 7½ x 7½ and larger drifts.
0156	Miner, 1st.	Open cut and fill stopes including blast hole, includes drilling and slushing.
0157	Miner, 1st.	Drill and scrape in timber cut and fill stopes.
0158	Miner, 1st.	Drill in bored raises.
0159	Miner, 1st.	Sinking, including drilling and slushing.
0160	Miner, 2nd.	General mine maintenance, install and maintain track, repair pipe.
0161	Miner, 2nd.	Drill and scrape in cage raises and regular raises.
0162	Miner, 2nd.	Drill and scrape in shrinkage stopes.
0163	Miner, 2nd.	Drill and scrape in sub-sill drifts.

Table A-1 (continued)

Job Code	Job Title	Description of Duties
0164	Miner, 2nd.	Drill and scrape in 7 x 7 and smaller drifts.
0165	Miner, 2nd.	Drill and scrape in 7½ x 7½ and larger drifts.
0166	Miner, 2nd.	Drilling and slushing in open cut and fill stopes including blast hole.
0167	Miner, 2nd.	Drill and scrape in timber cut and fill stopes.
0168	Miner, 2nd.	Drill in bored raises.
0169	Miner, 2nd.	Sinking, including drilling and slushing.
0170	Miner, 3rd.	Guniting stopes, timberline, helper in stope.
0171	Miner, 3rd.	Drill and scrape in cage raises and regular raises.
0172	Miner, 3rd.	Drill and scrape in shrinkage stopes.
0173	Miner, 3rd.	Drill and scrape in sub-sill drifts.
0174	Miner, 3rd.	Drill and scrape in 7 x 7 and smaller drifts.
0175	Miner, 3rd.	Drill and scrape in 7½ x 7½ and larger drifts.
0176	Miner, 3rd.	Drilling and slushing in open cut and fill stopes including blast hole.
0177	Miner, 3rd.	Drill and scrape in timber cut and fill stopes.
0178	Miner, 3rd.	Drill in bored raises.
0179	Miner, 3rd.	Sinking, including drilling and slushing.
0180	Miner, 4th.	Help Pipeman, change blanks for sandcrews, repair broken sand lines, install pipelines.

Table A-1 (continued)

Job Code	Job Title	Description of Duties
0181	Miner, 4th.	Drill and scrape in cage raises and regular raises.
0182	Miner, 4th.	Drill and scrape in shrinkage stopes.
0183	Miner, 4th.	Drill and scrape in sub-sill drifts.
0184	Miner, 4th.	Drill and scrape in 7 x 7 and smaller drifts.
0185	Miner, 4th.	Drill and scrape in 7½ x 7½ and larger drifts.
0186	Miner, 4th.	Drilling and slushing in open cut and fill stopes including blast hole.
0187	Miner, 4th.	Drill and scrape in timber cut and fill stopes.
0188	Miner, 4th.	Drill in bored raises.
0189	Miner, 4th.	Sinking, including drilling and slushing.
0190	Mine Shift Boss	

Note: The first two digits of the Job Code represent ledges of the mine (e.g. 01 - all workers on any ledge, 09 - 9 Ledge, 10 - Main Ledge, 11 - 11 Ledge, 13 - 13 Ledge, 19 - 19 Ledge, and 21 - 21 Ledge). The last two digits of the Job Code correspond to the specific Job Title and Job Description.

Table A-2. Job dictionary for all job types in the surface crushing mills at the Homestake Gold Mine, Lead, South Dakota.

Job Code	Job Title	Description of Duties
0200	Surface Operations	Crushing Department
0201	Crusher-Feeder	Maintain crusher, watch ore from feeder. Surface - Ross or Yates.
0202	Mechanic, 3rd.	Feed crusher, check and lubricate all crushing equipment. Surface - Ross or Yates.
0204	Belt/Chip Picker	Inspect ore on conveyor from crusher. Surface - Ross or Yates.
0205	Laborer, 2nd.	Cleanup around ore crusher and shovel spills from conveyor. Surface - Ross or Yates.
0206	Laborer, 1st.	Cleanup ore spills. Surface - Ross or Yates.
0231	Motorman, Surface	Transport rock between Yates and Ross and South Mill, haul supplies.

Appendix B. Sample locations for NIOSH survey at the Homestake Gold Mine, Lead, South Dakota.

Figure B-1. Level 170( ) Ledge.

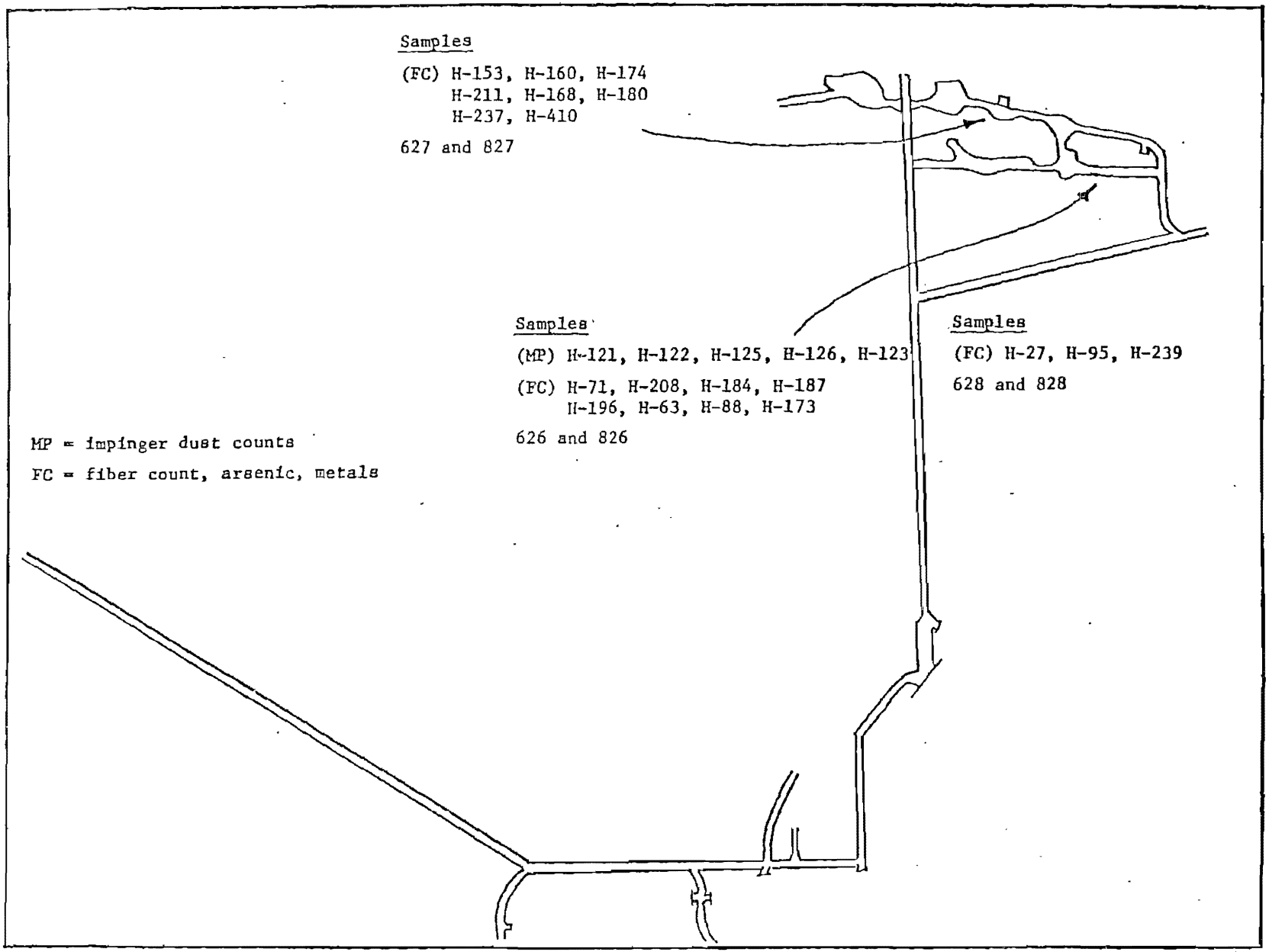


Figure B-2. Level 2000-215 9 Ledge (A).

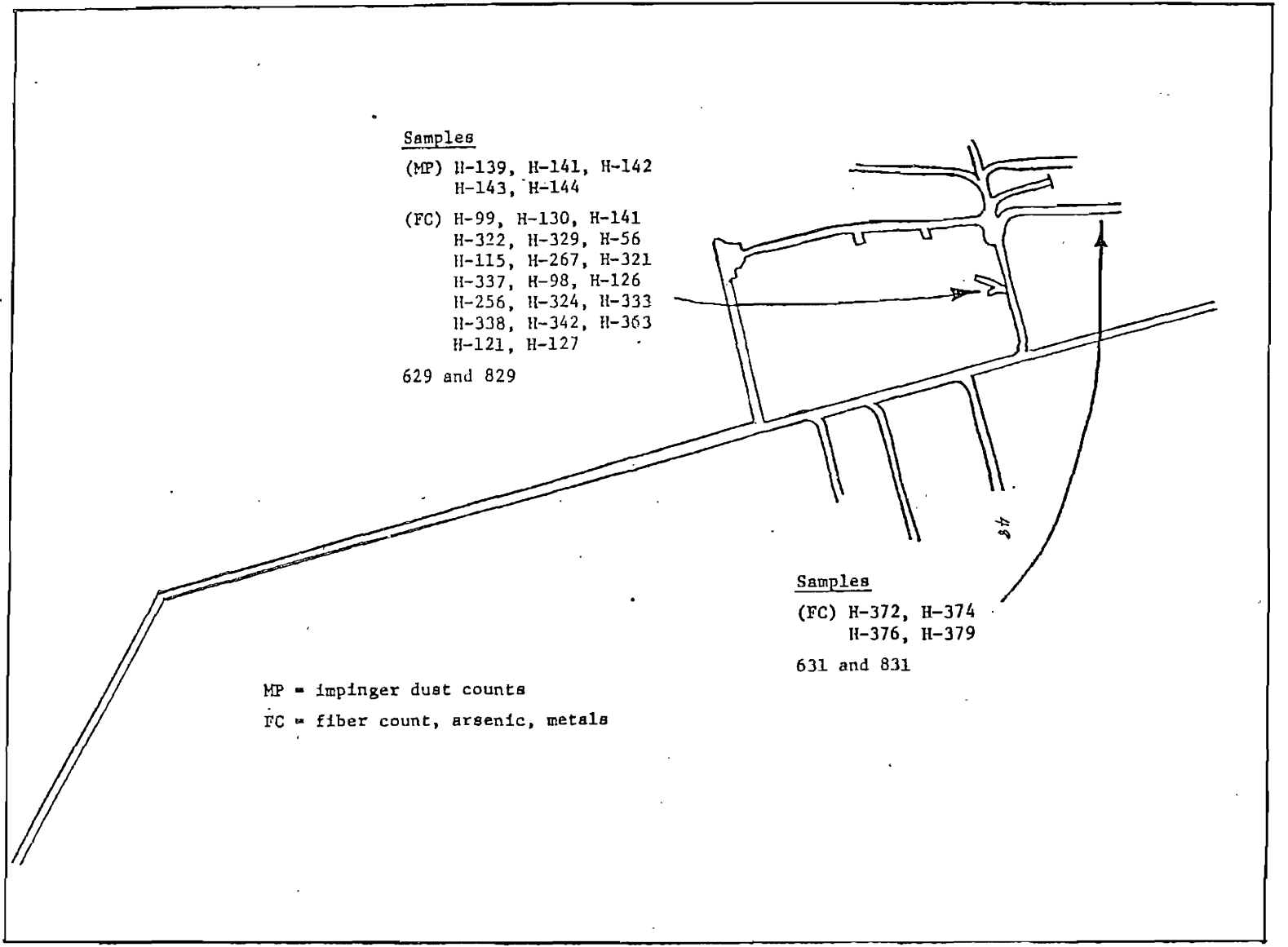


Figure B-3. Level 2000 - 30, 9 Ledge (B).

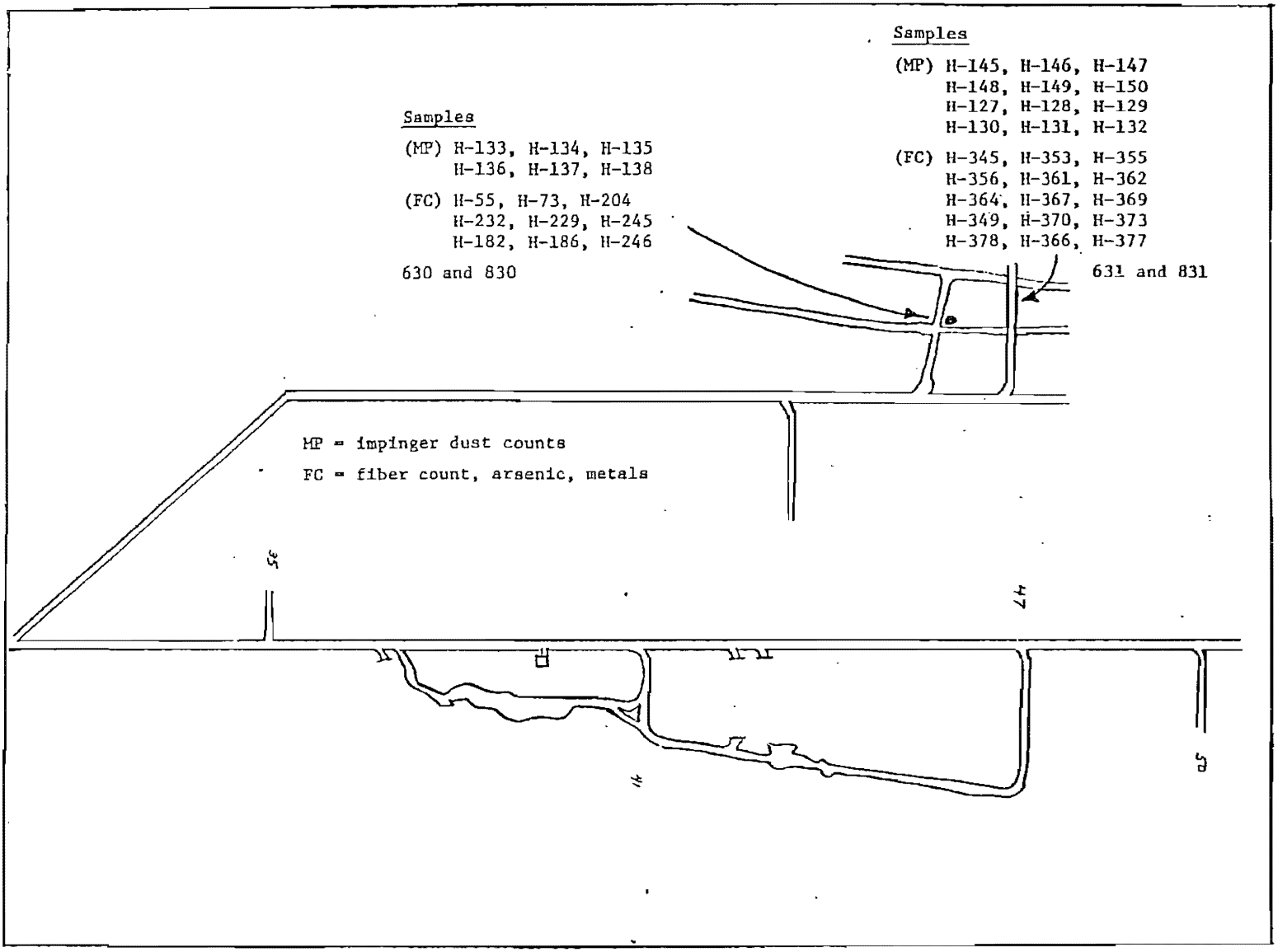


Figure B-4. Level

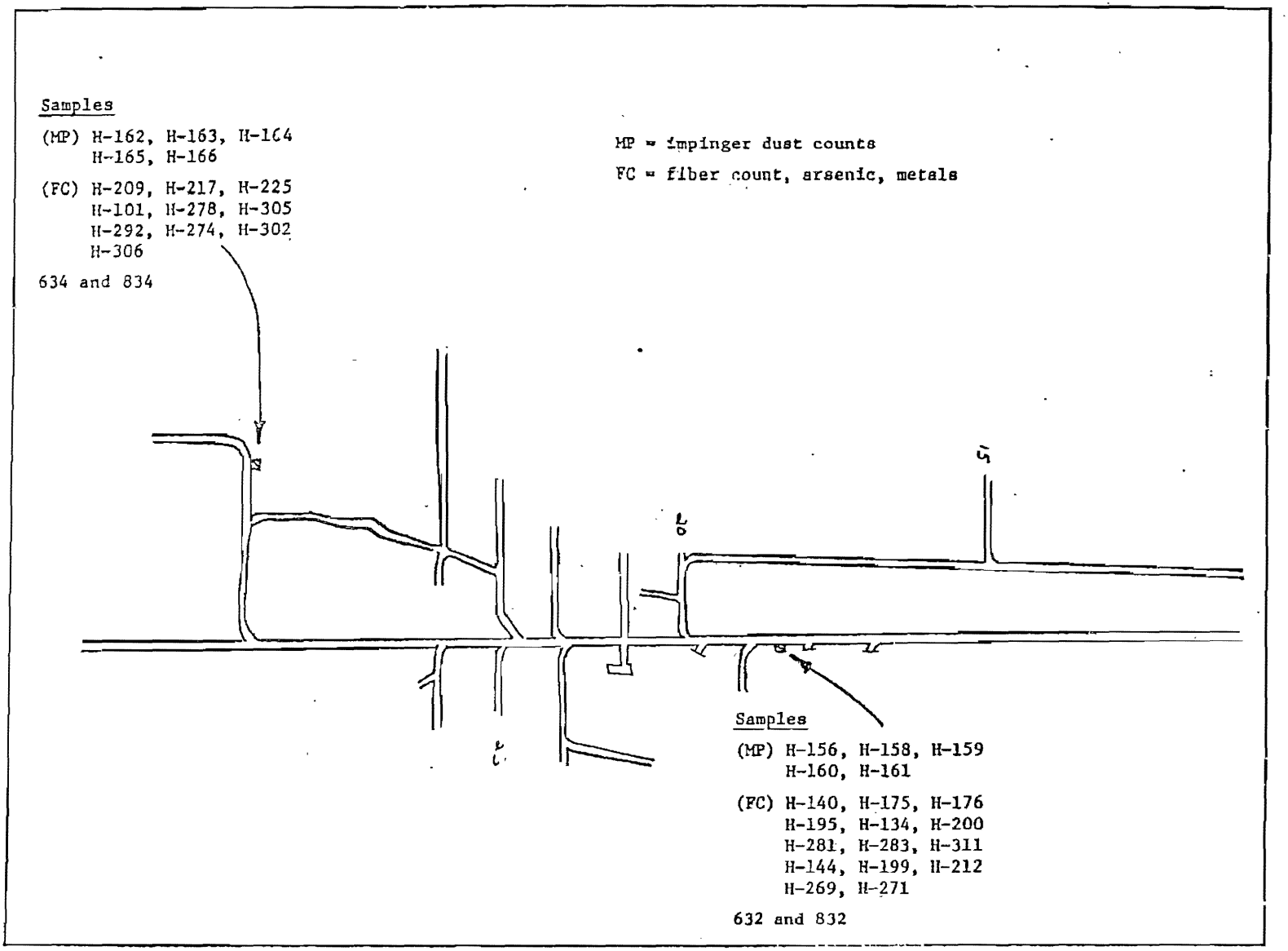


Figure B-5. Level 3[illegible], 9 Ledge (A).

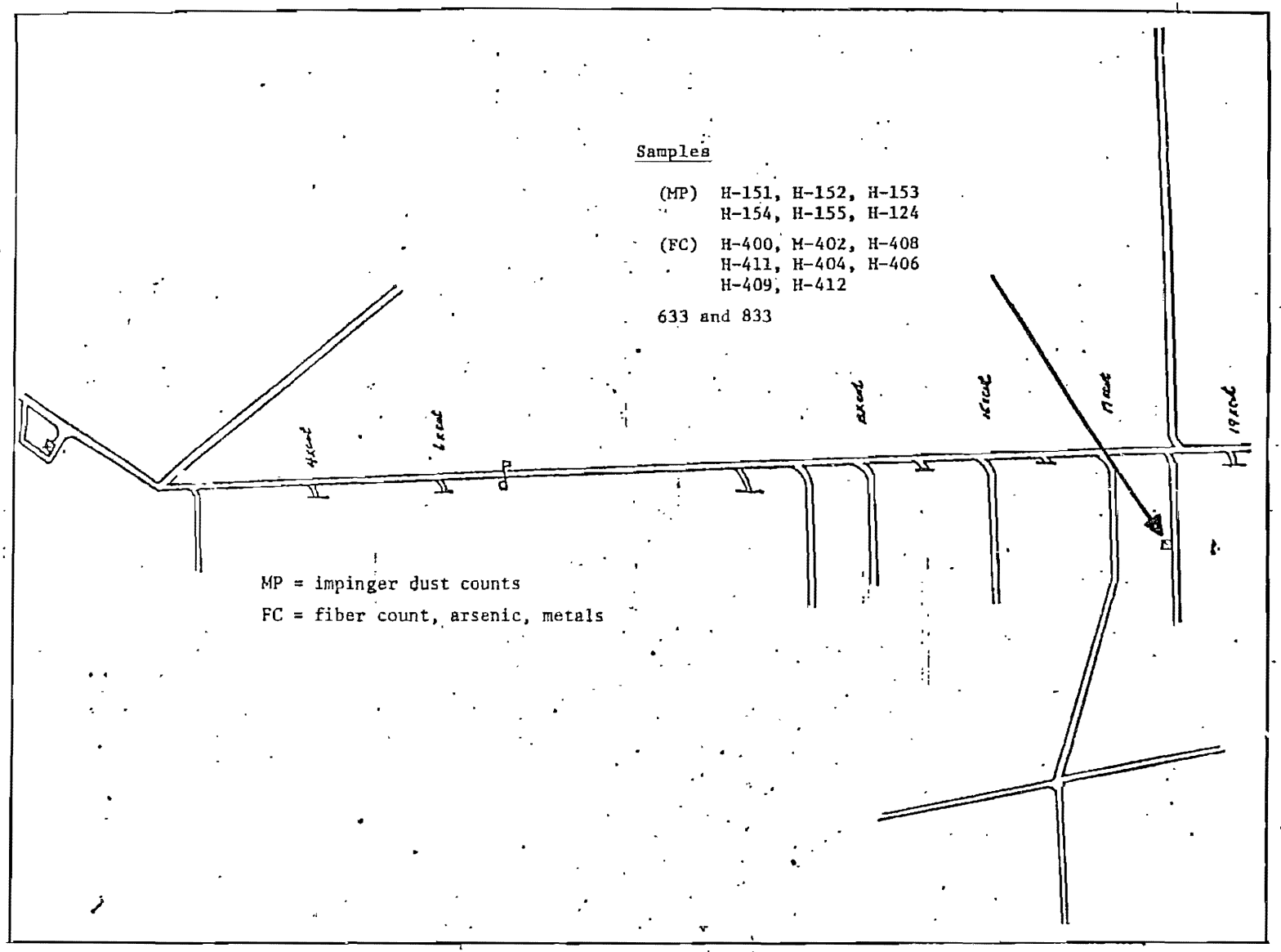


Figure B-6. Level 39 9 Ledge (B).

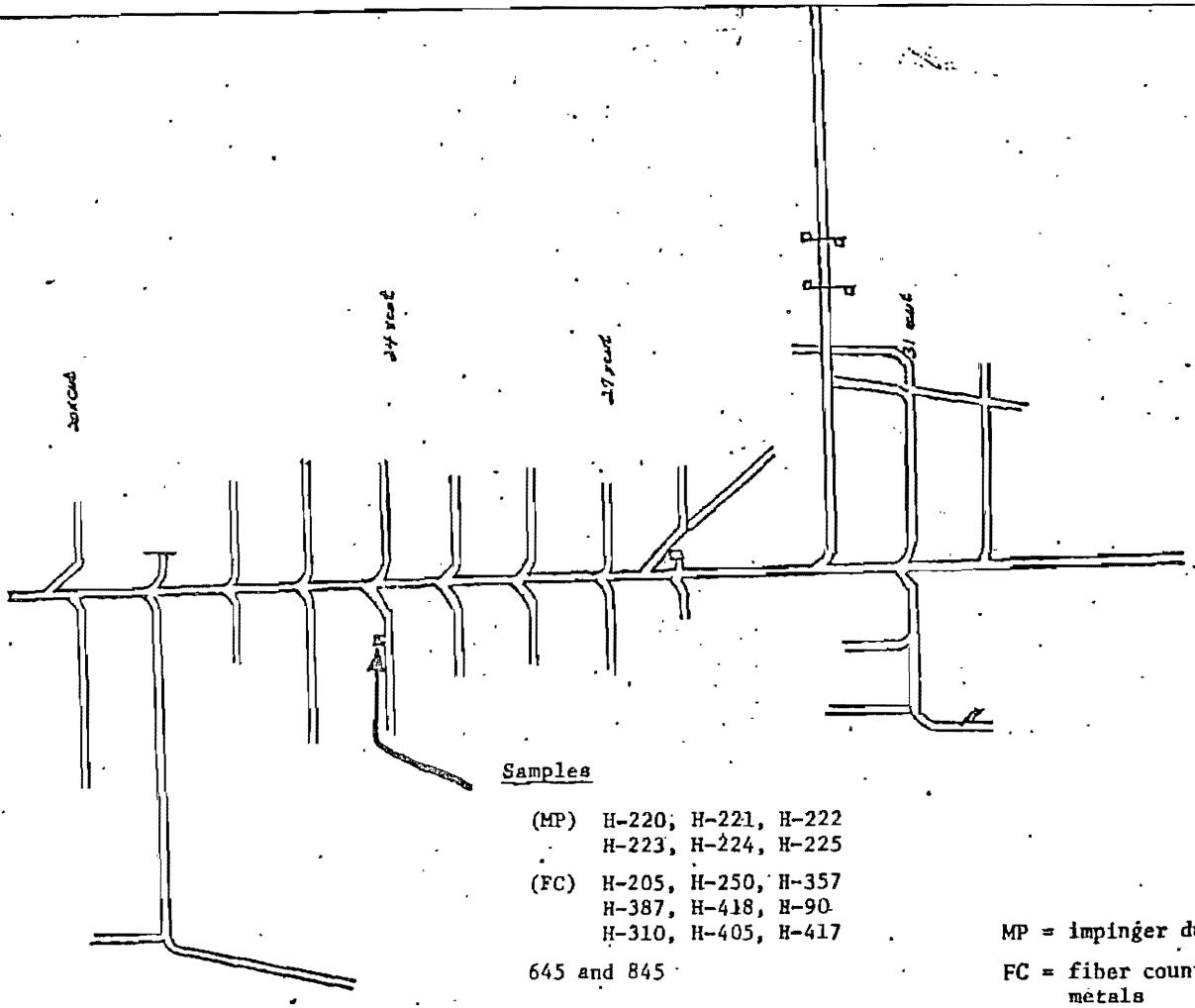


Figure B-7. Level 4 , Main Ledge.

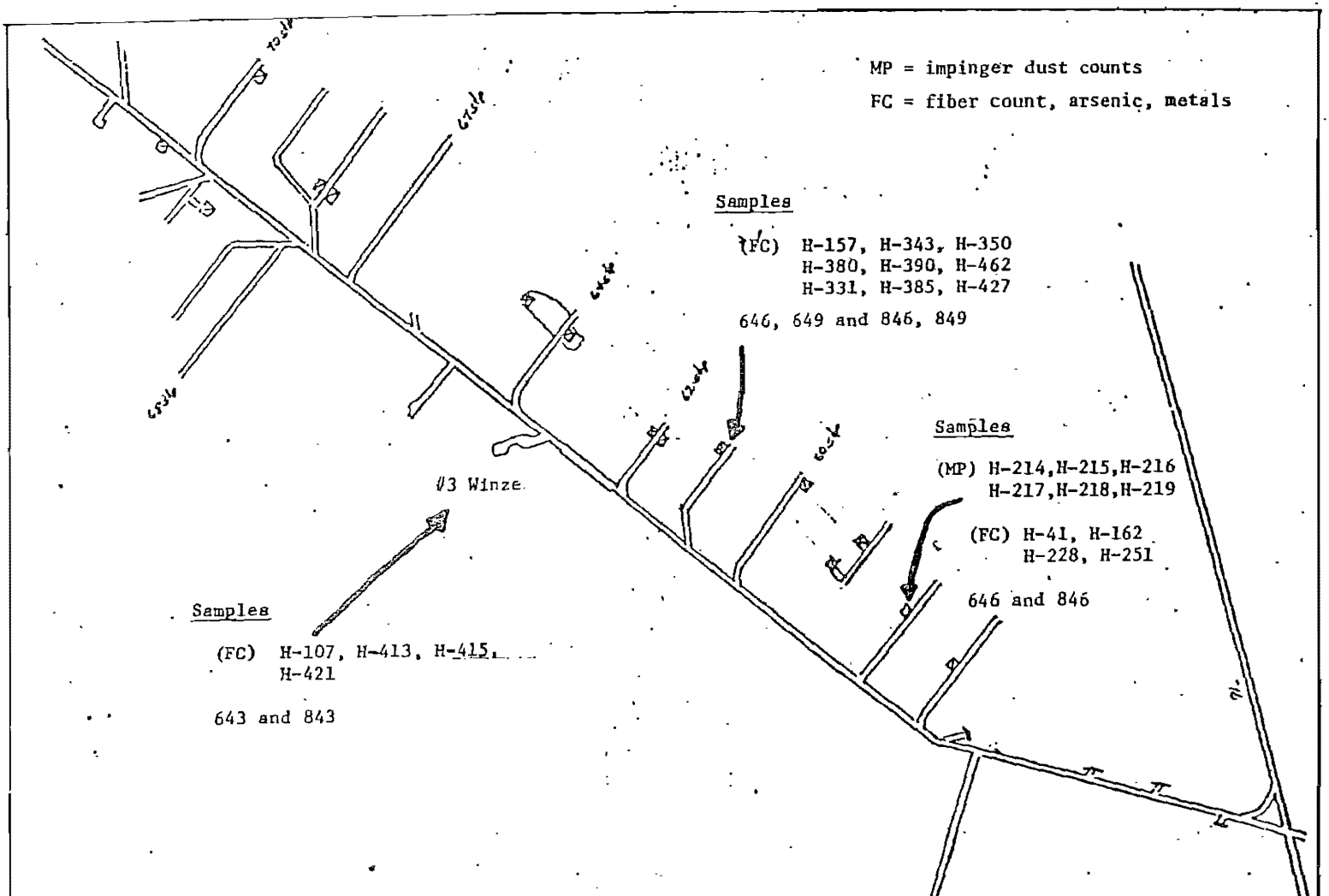
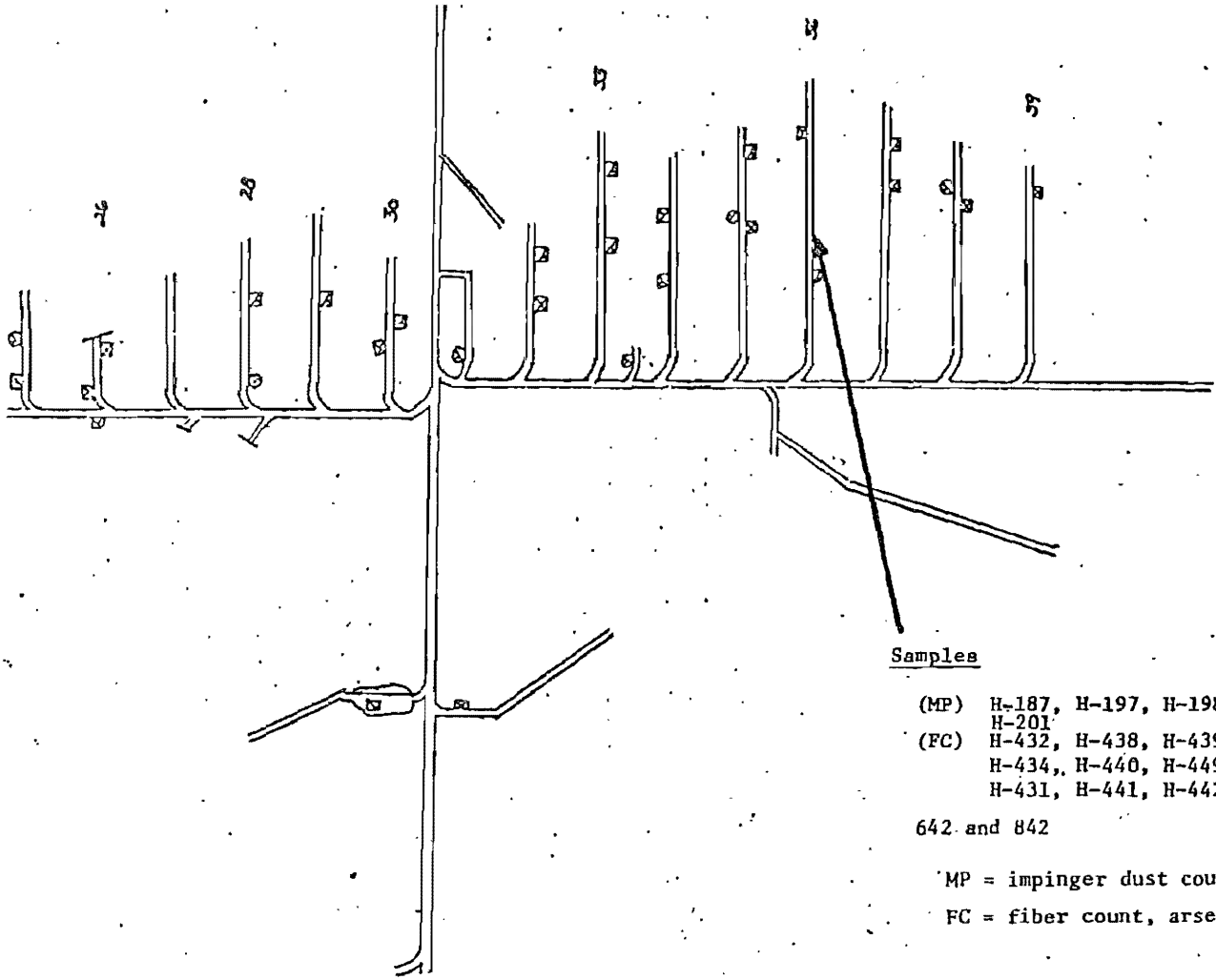


Figure B-8. Level 0, 9 Ledge.



Samples

(MP) H-187, H-197, H-198, H-199, H-200
H-201
(FC) H-432, H-438, H-439, H-445
H-434, H-440, H-449, H-451
H-431, H-441, H-442, H-444

642 and 842

MP = impinger dust counts

FC = fiber count, arsenic, metals

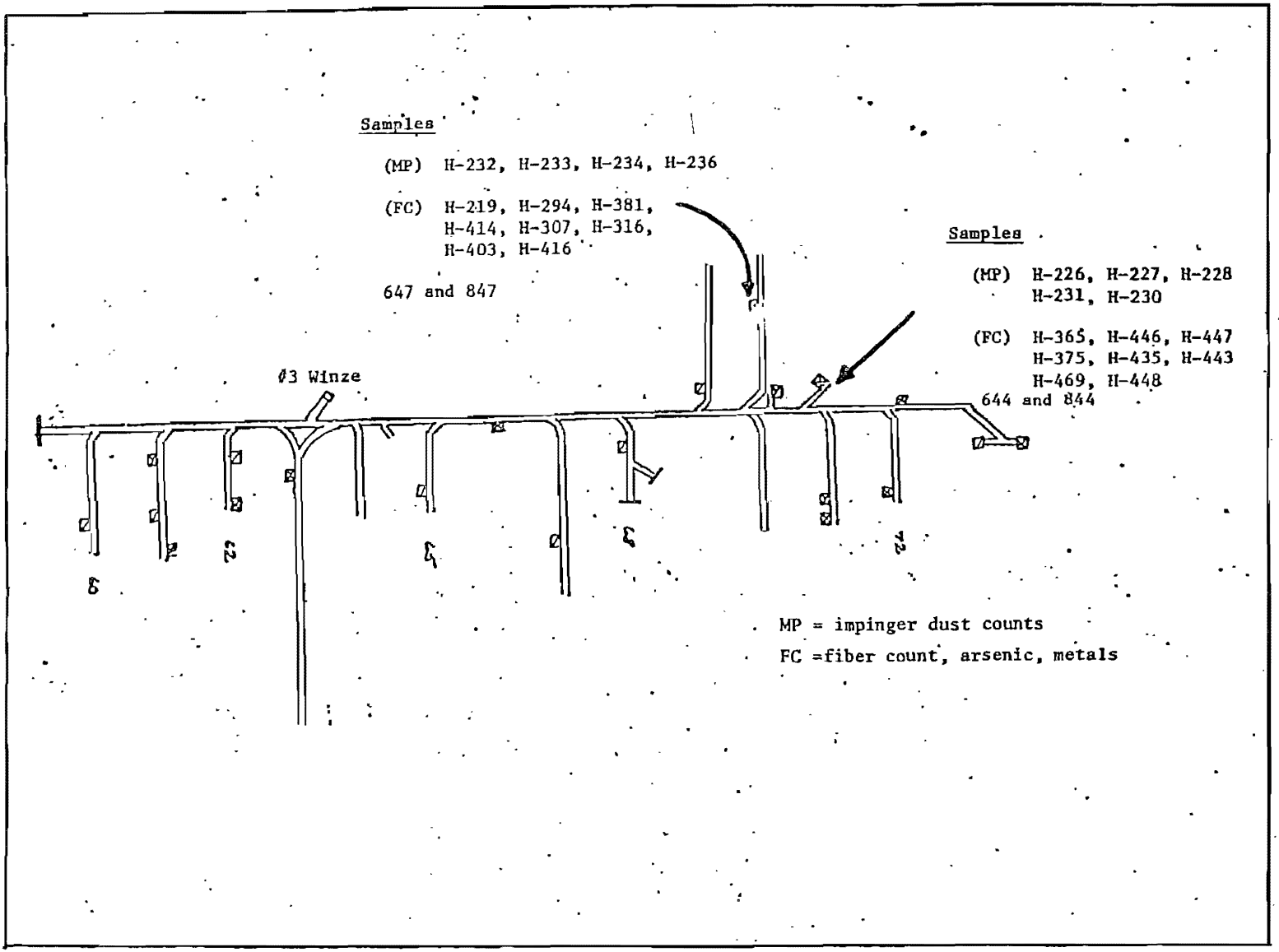

Samples
(MP) H-232, H-233, H-234, H-236
(FC) H-219, H-294, H-381, H-414, H-307, H-316, H-403, H-416
647 and 847
Samples
(MP) H-226, H-227, H-228 H-231, H-230
(FC) H-365, H-446, H-447 H-375, H-435, H-443 H-469, H-448
644 and 844
#3 Winze
MP = impinger dust counts
FC =fiber count, arsenic, metals

Figure B-10. Level 900, 9 Ledge.

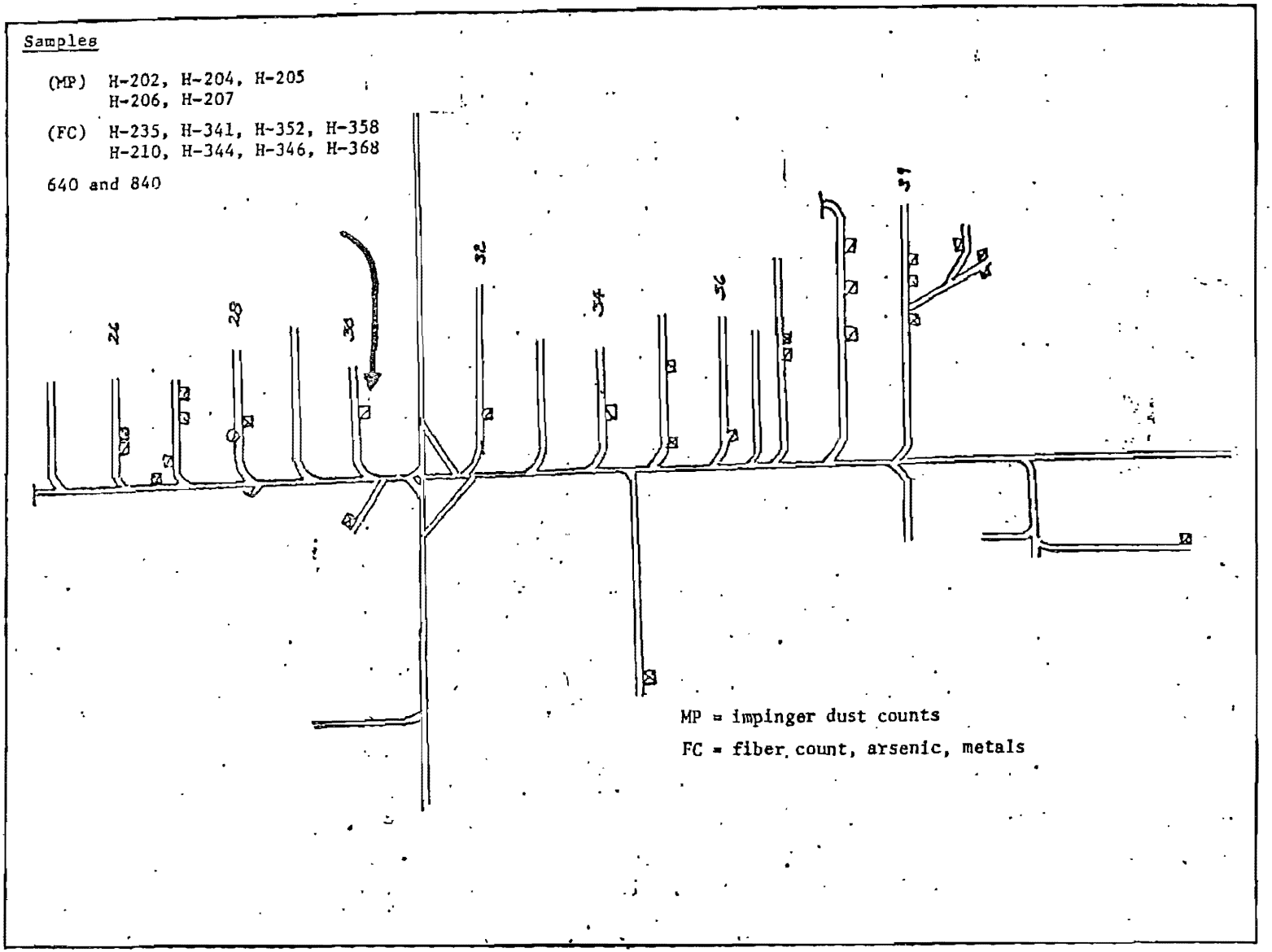


Figure B-11. Level 0, Ross Shaft.

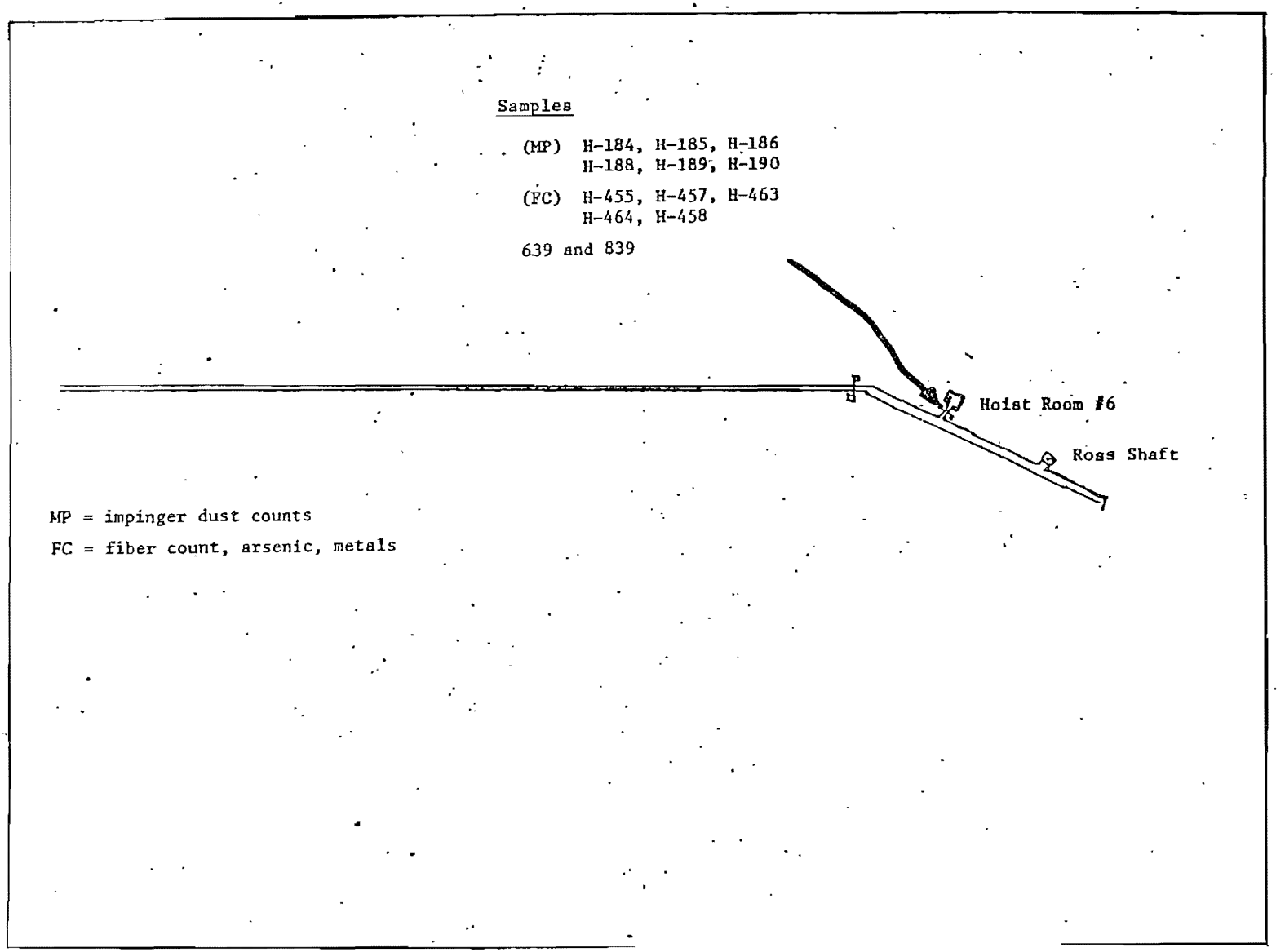
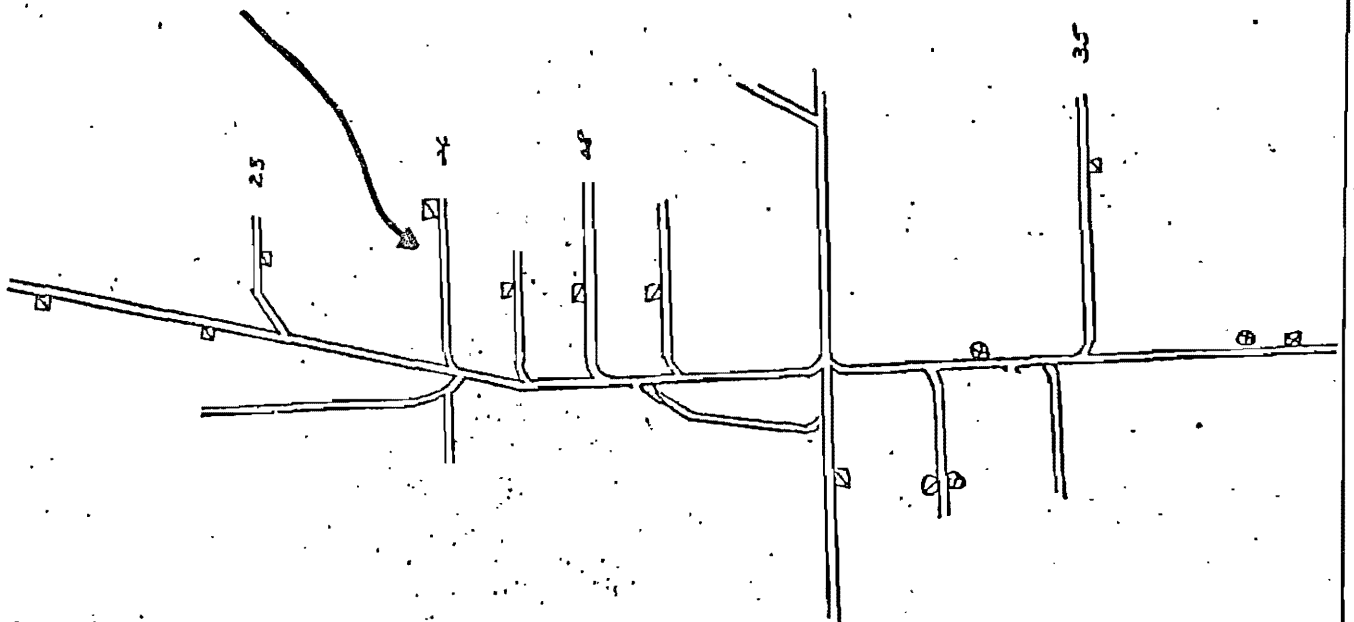


Figure B-12. Level 0, 11 Ledge.

Samples

(FC) H-477, H-478, H-482, H-491
H-473, H-483, H-486, H-489
H-471, H-484, H-485, H-487, H-488

641 and 841



MP = impinger dust counts

FC = fiber count, arsenic, metals

Figure B-13. Level 4700, [illegible]dge and 11 Ledge.

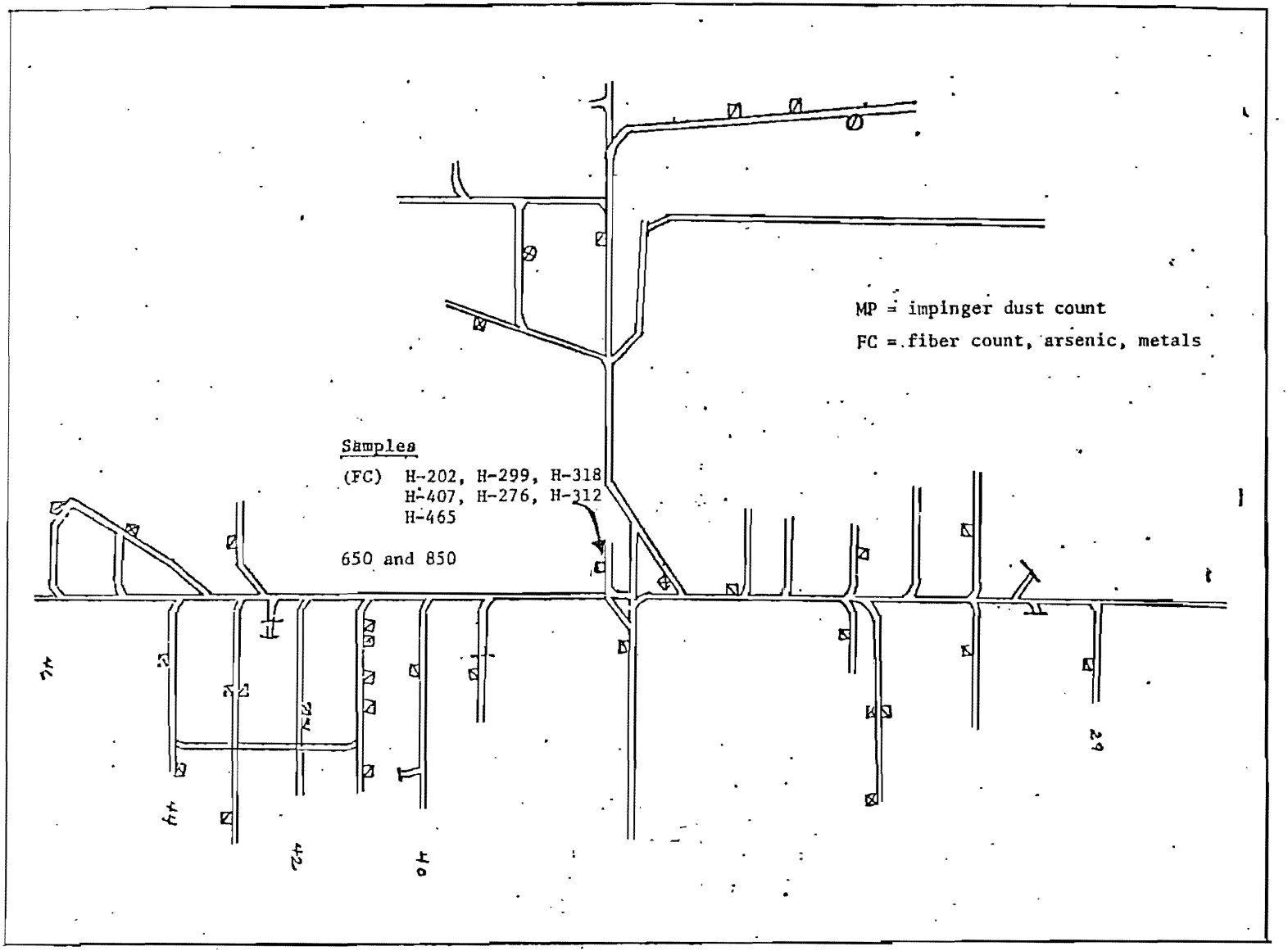


Figure B-14. Level 4850, Ross Sh. ; Surface Crushing (Ross).

Crushing on Surface (Ross)

Samples

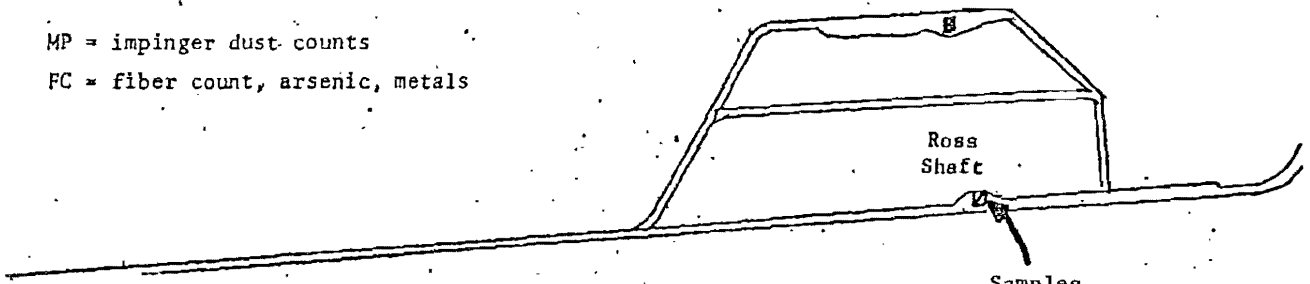
(MP) H-179, H-180, H-181, H-182, H-183

(FC) H-359, H-430, H-467, H-459, H-466, H-470
H-480, H-262, H-456, H-475, H-481, H-437
H-452, H-453, H-472, H-474, H-476, H-479
H-468

638 and 838

MP = impinger dust counts

FC = fiber count, arsenic, metals



Samples

(MP) H-191, H-192, H-193
H-195, H-194

(FC) H-167, H-336, H-354

637 and 837

Figure B-15. Level 4850, Yates Shaft; Surf Crushing (Yates); Surface Tramway.

Crushing on Surface (Yates)

Samples

(MP) H-167, H-168, H-169, H-170, H-171

(FC) H-293, H-253, H-398, H-360, H-397, H-420
H-218, H-371, H-401, H-382, H-384, H-389
H-392, H-388, H-391, H-394, H-399, H-332
H-383, H-393, H-396

635, 648 and 935, 848

Tramway on Surface

Samples

(MP) H-419

(FC) H-201, H-419, H-436
H-94, H-249, H-290

651 and 851

MP = impinger dust counts

FC = fiber count, arsenic, metals

Samples

(MP) H-183, H-174, H-175
H-176, H-177, H-178

(FC) H-300, H-423
H-424, H-425
H-428, H-429

636 and 836

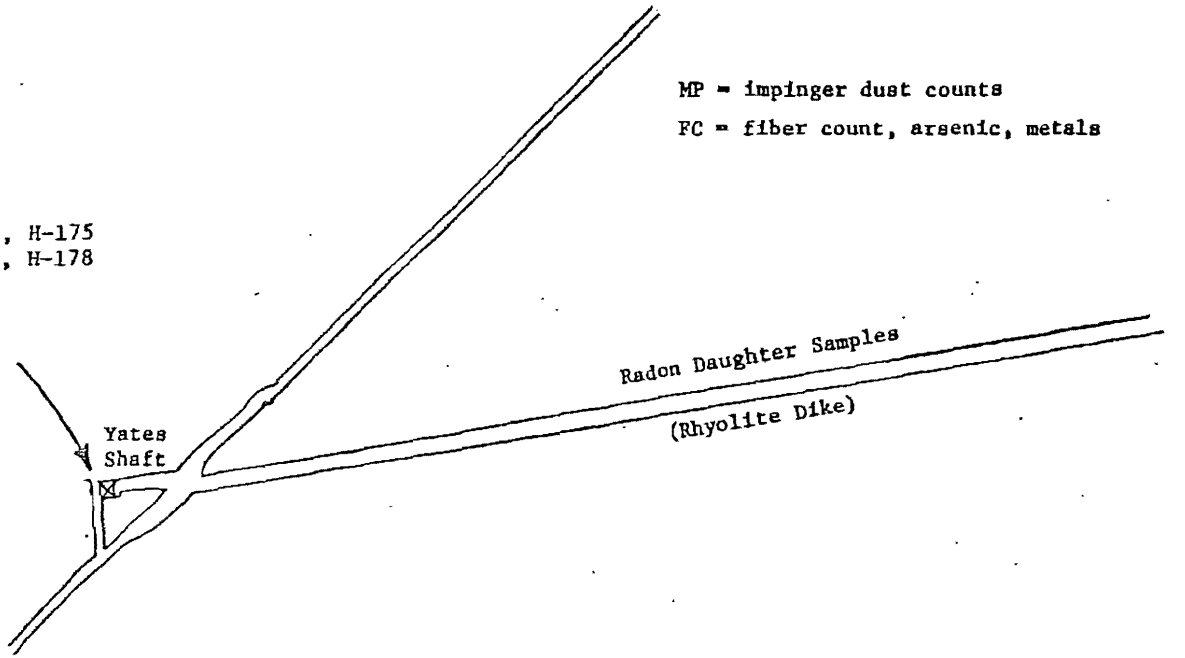
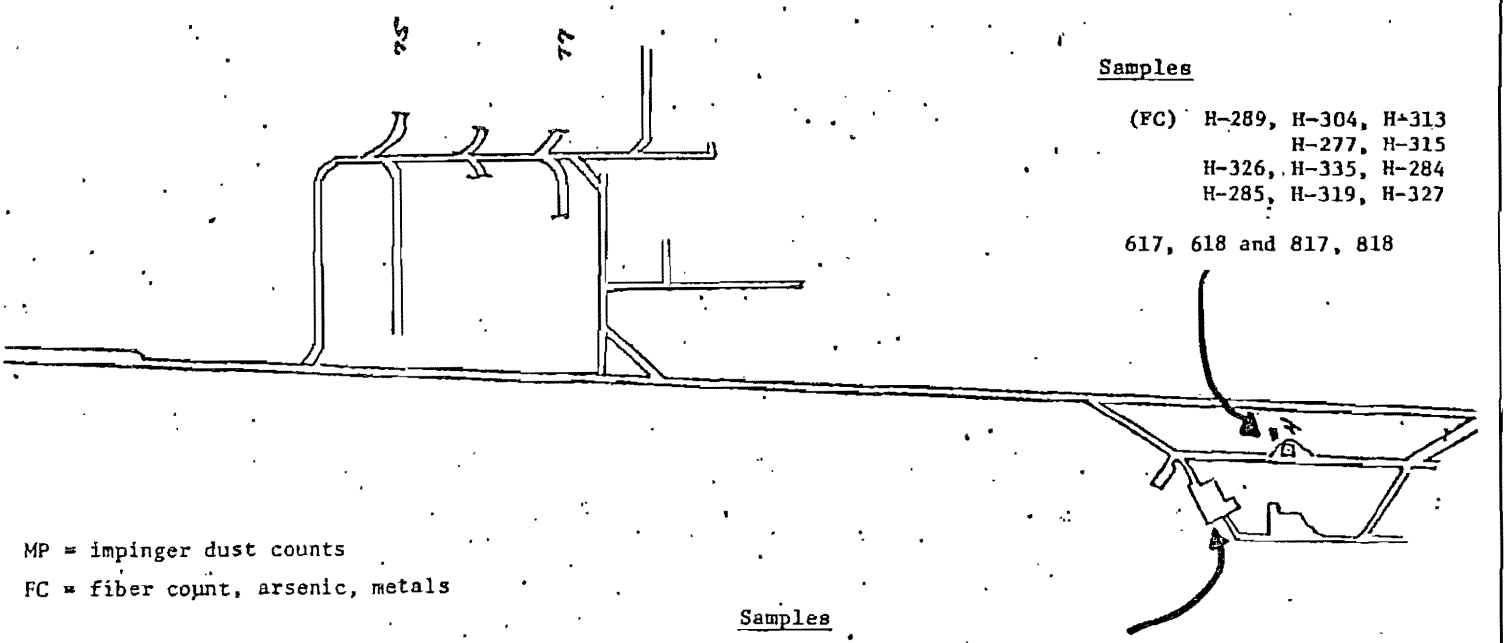


Figure B-16. Level 48' Main Ledge.



Samples

(FC) H-289, H-304, H-313
H-277, H-315
H-326, H-335, H-284
H-285, H-319, H-327

617, 618 and 817, 818

MP = impinger dust counts

FC = fiber count, arsenic, metals

Samples

(MP) H-73, H-74, H-75
H-76, H-77, H-78

(FC) H-20, H-24, H-57, H-207
H-2, H-66, H-68, H-213

613 and 813

Figure B-17. Level 0, 19 Ledge.

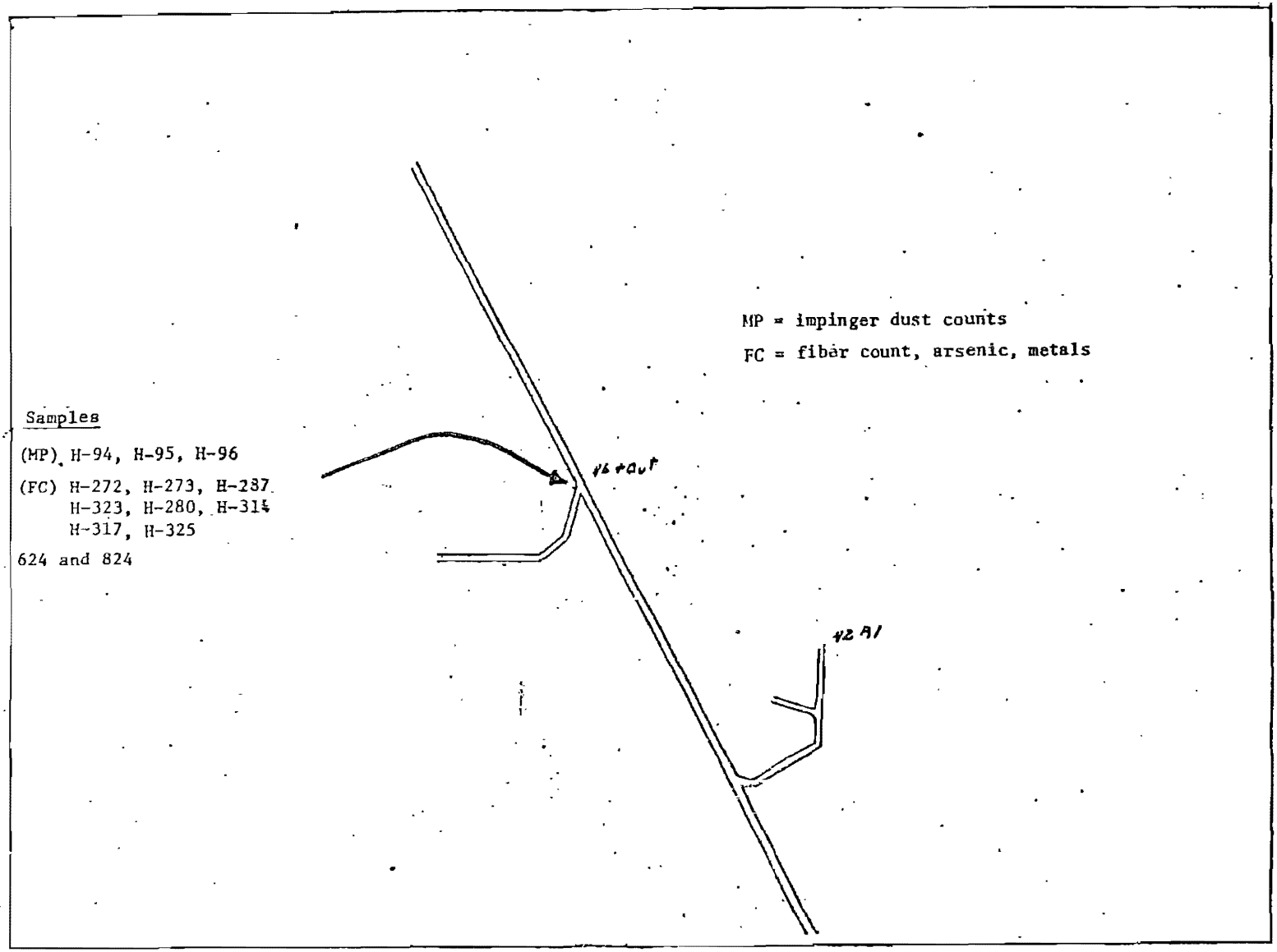


Figure B-18. Level JO, 11 Ledge.

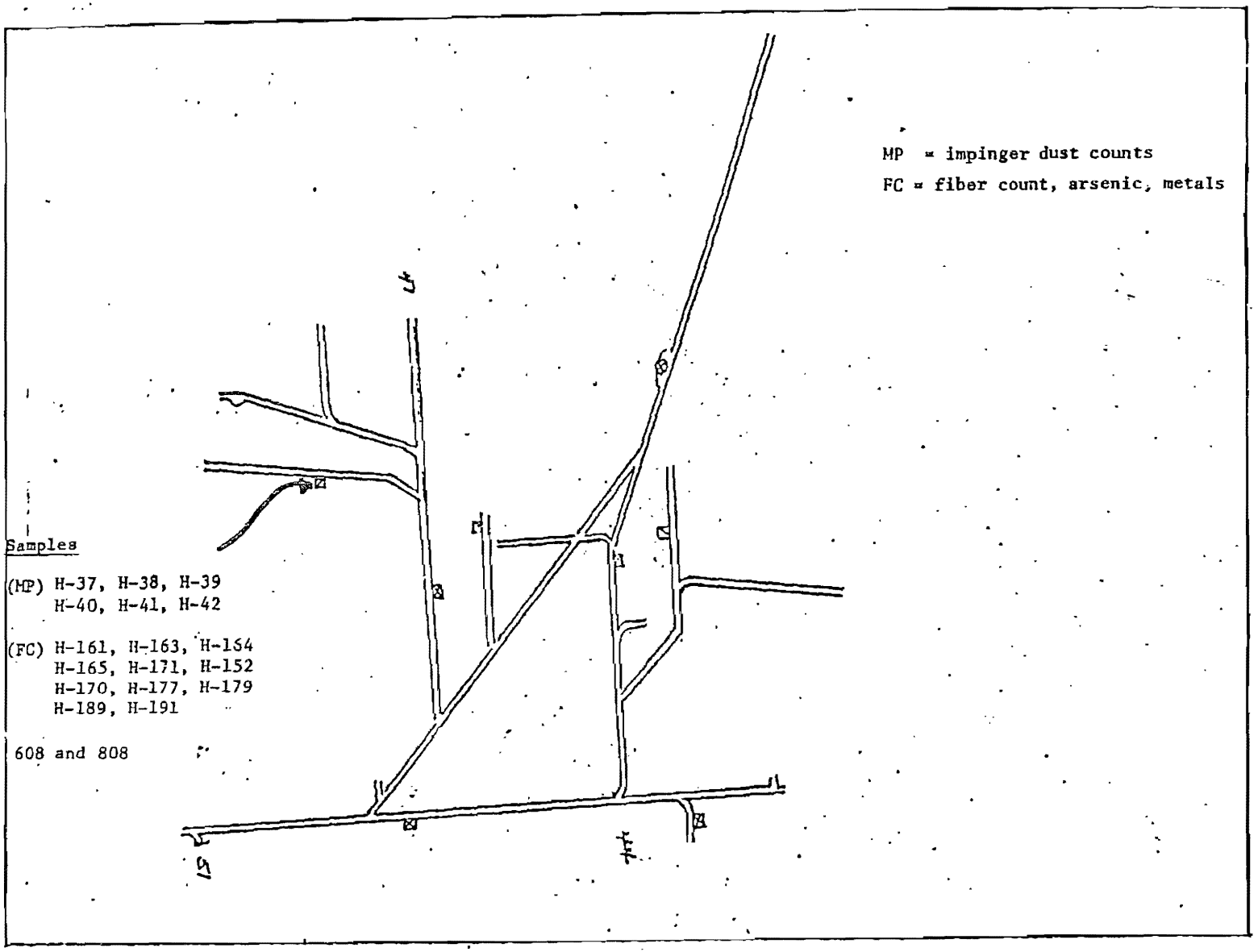


Figure B-19. Level 5450, [illegible]edge and 11 Ledge.

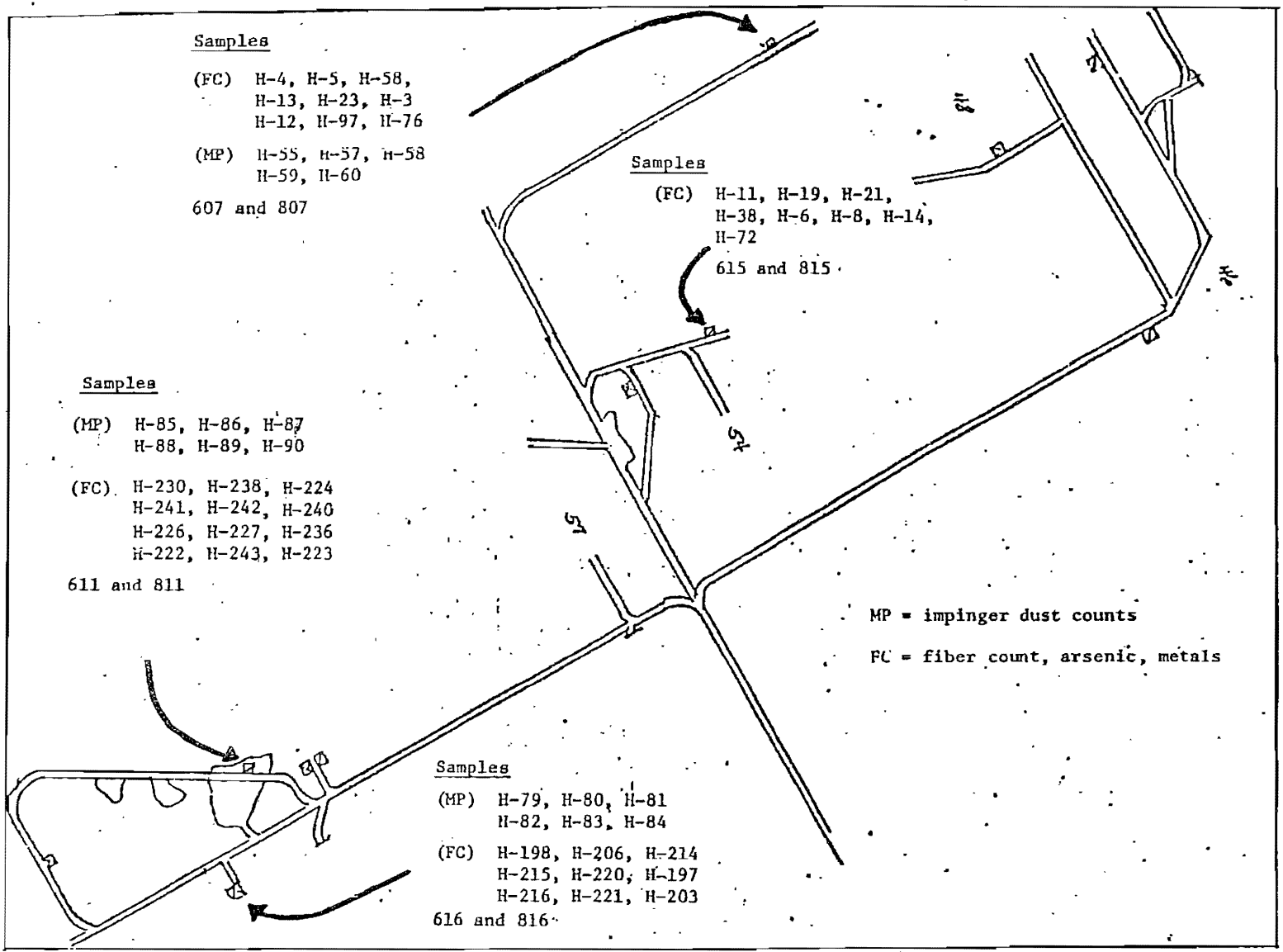


Figure B-20. Level !), 11 Ledge.

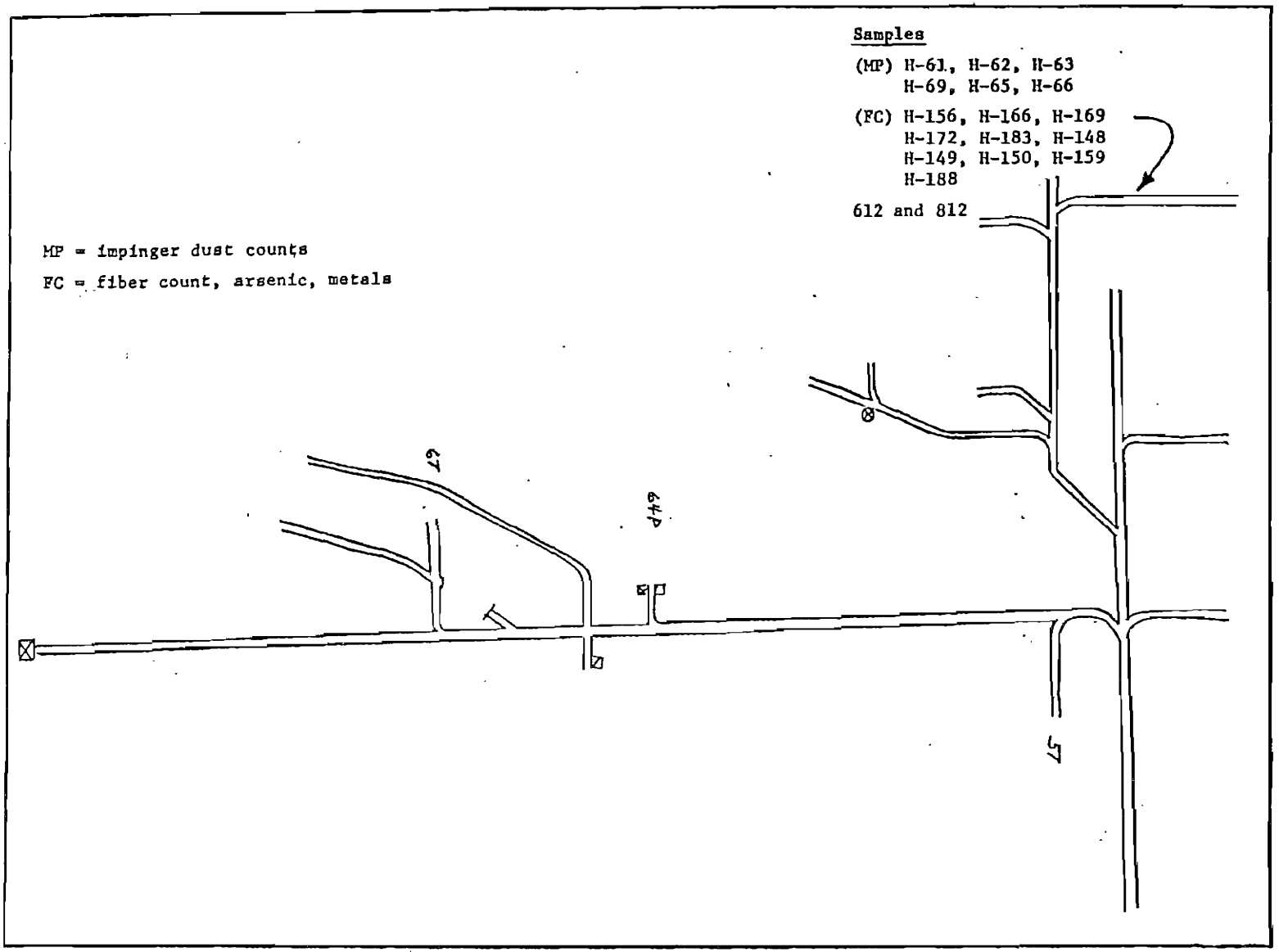


Figure B-21. Level 5750, edge and 11 Ledge.

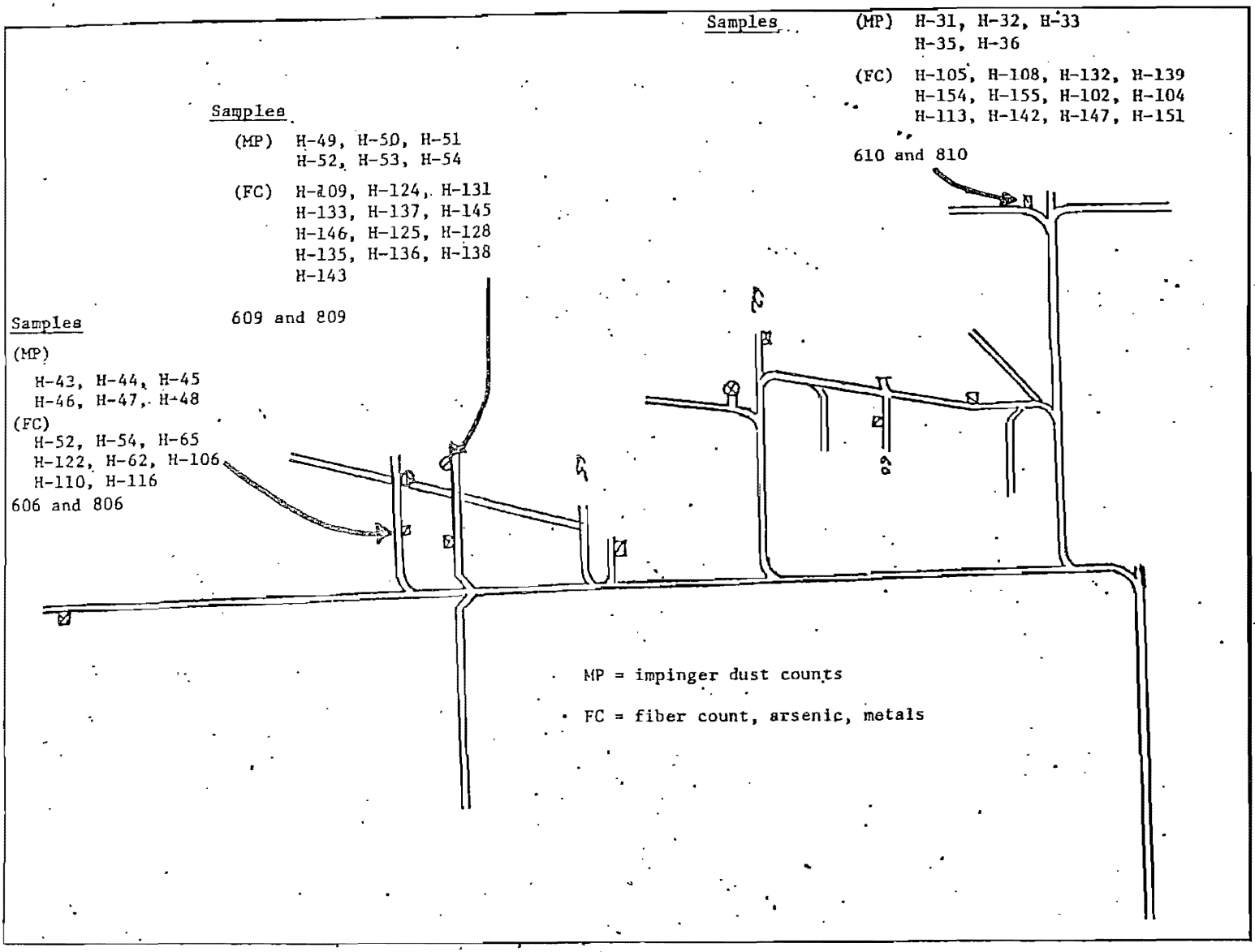


Figure B-22. Level 5), 19 Ledge.

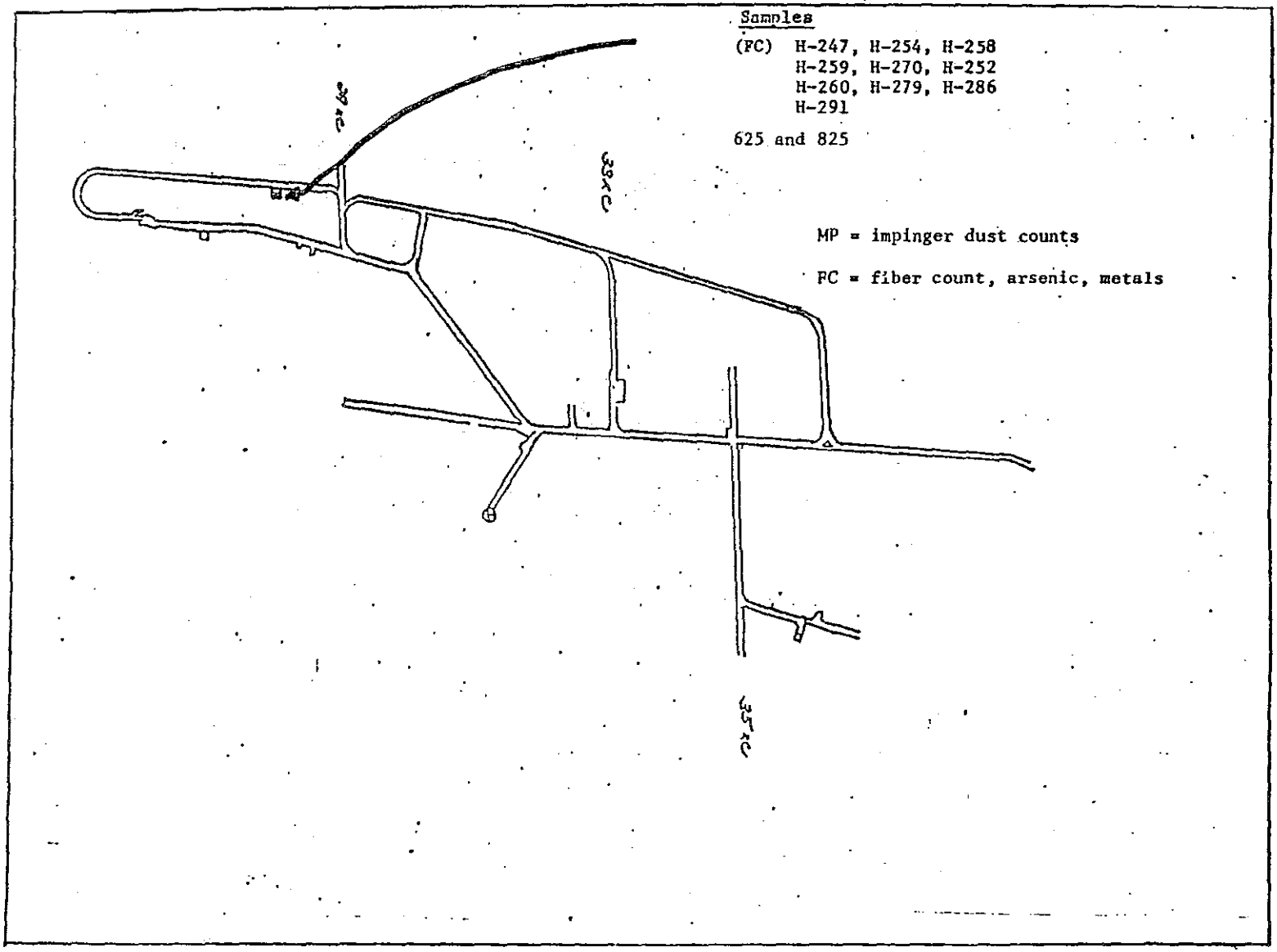
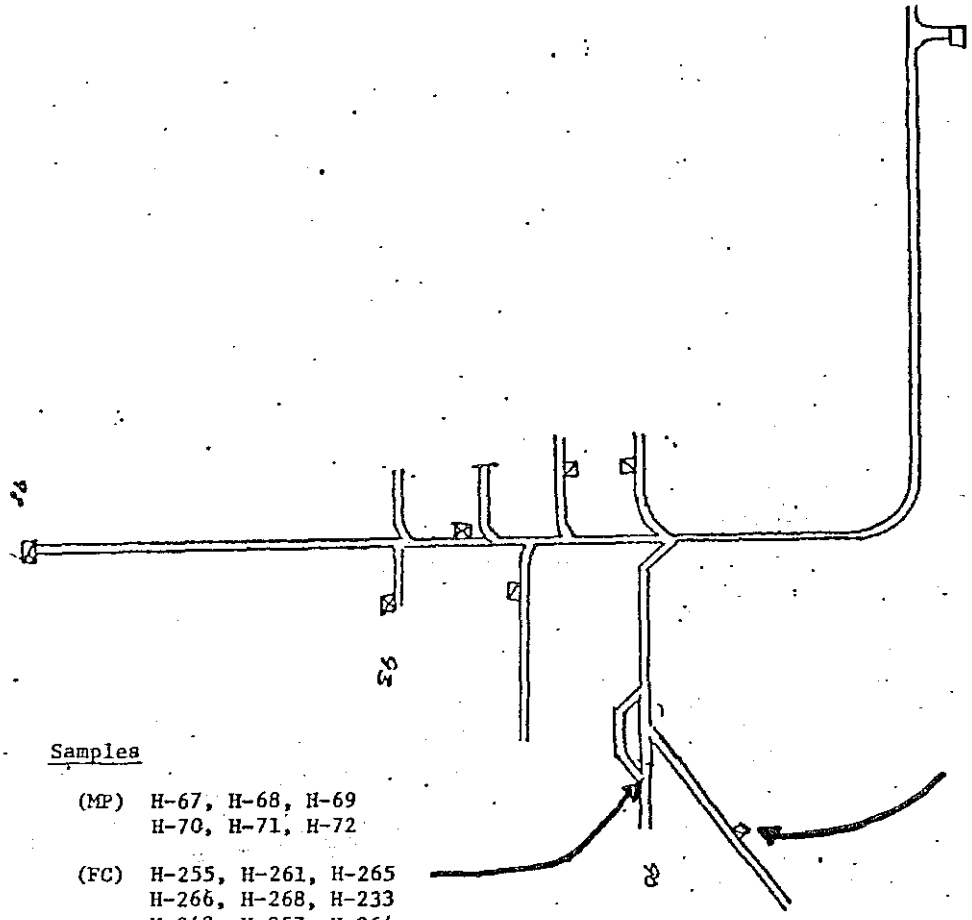


Figure B-23. Level 6 , Main Ledge.



MP = impinger dust counts

FC = fiber count, arsenic, metals

Samples

(MP) H-67, H-68, H-69
H-70, H-71, H-72

(FC) H-255, H-261, H-265
H-266, H-268, H-233
H-248, H-257, H-264
H-234
614 and 814

Samples

(MP) H-1, H-2, H-3
H-4, H-5, H-6

(FC) H-16, H-18, H-37, H-39
H-80, H-17, H-22, H-77
H-78, H-91, H-92, H-33
H-34, H-83, H-84, H-119
H-120

605 and 805

Figure B-24. Level 6 , 13 Ledge.

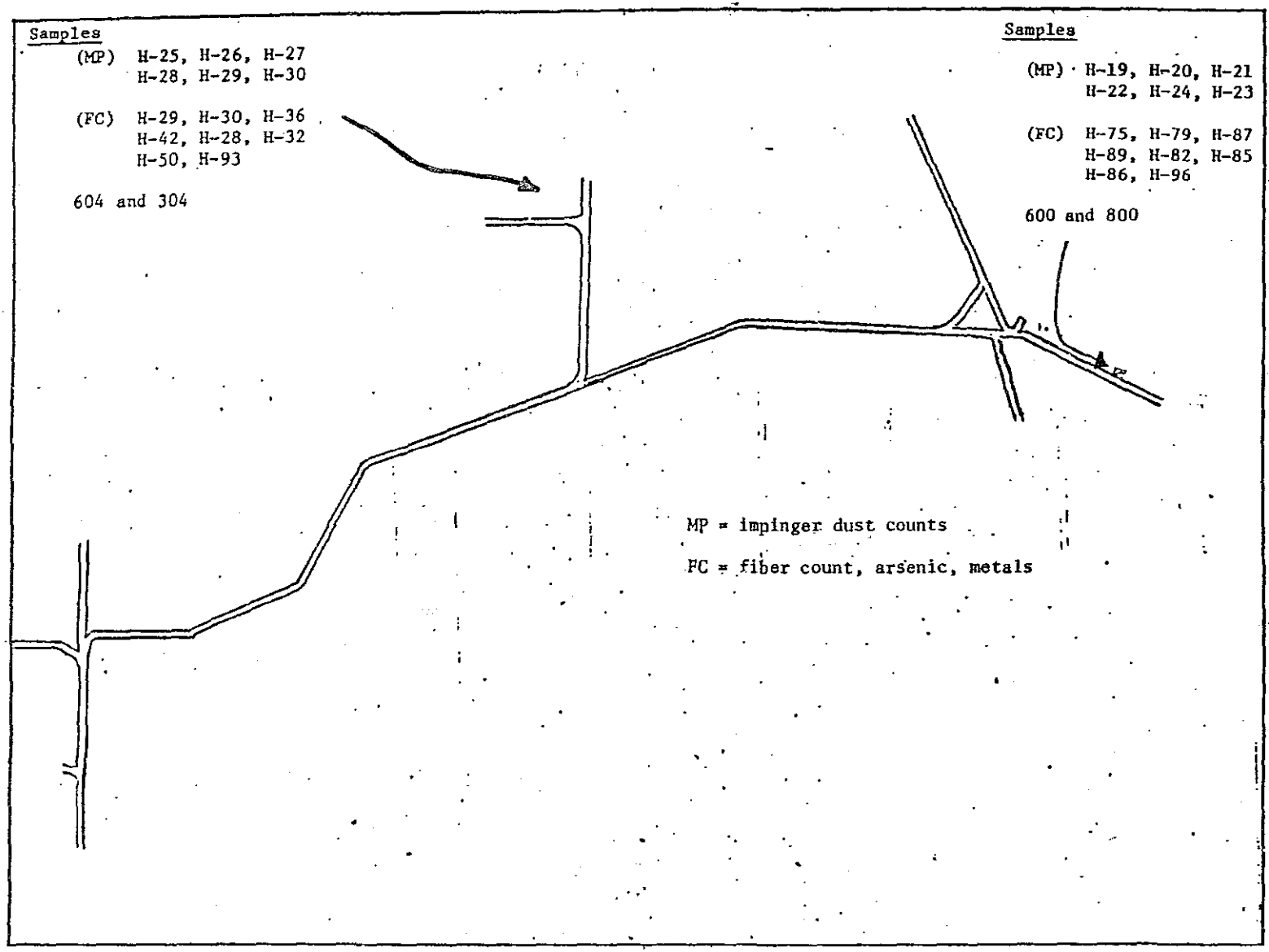


Figure B-25. Level 0, 19 Ledge.

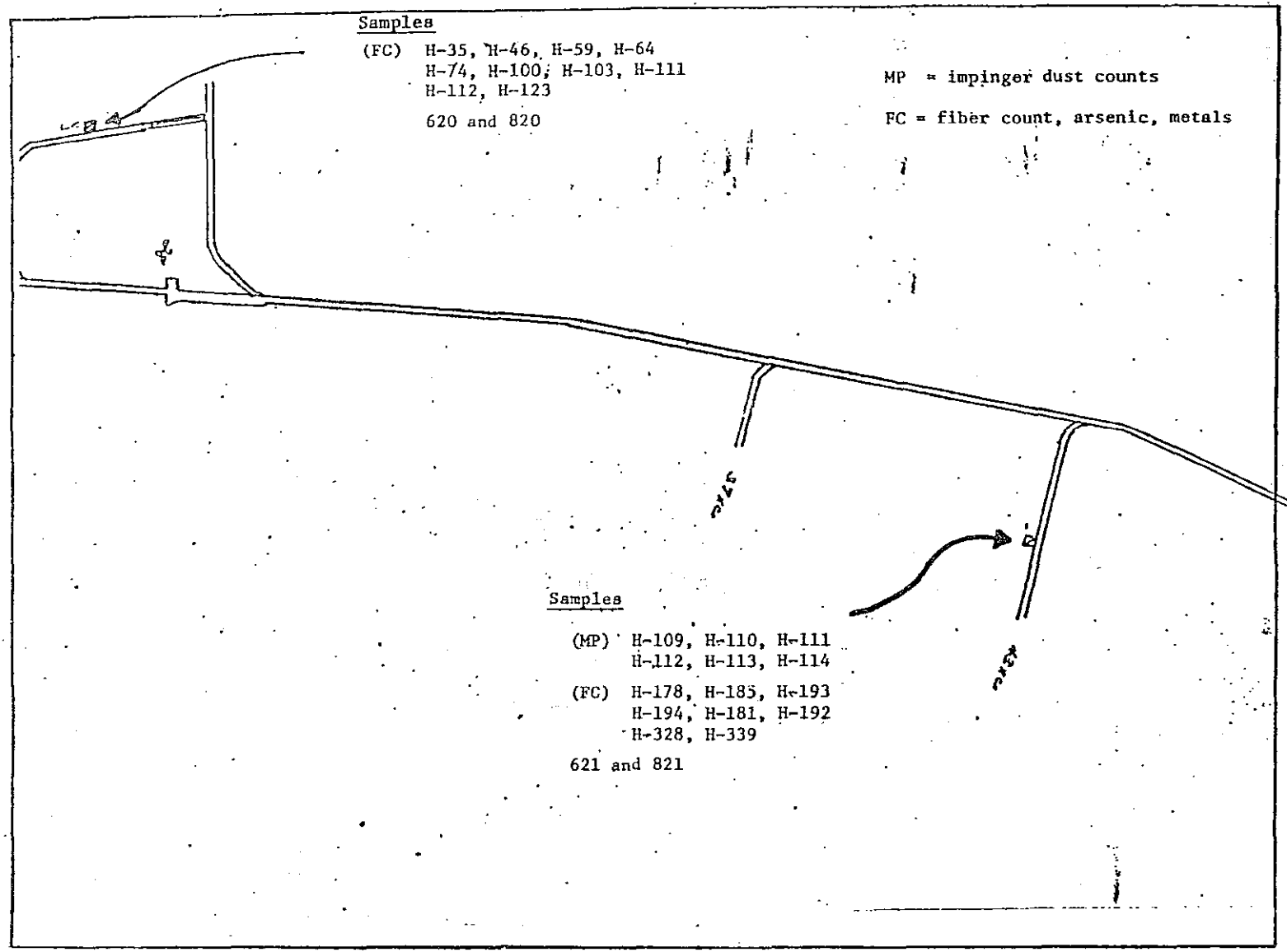
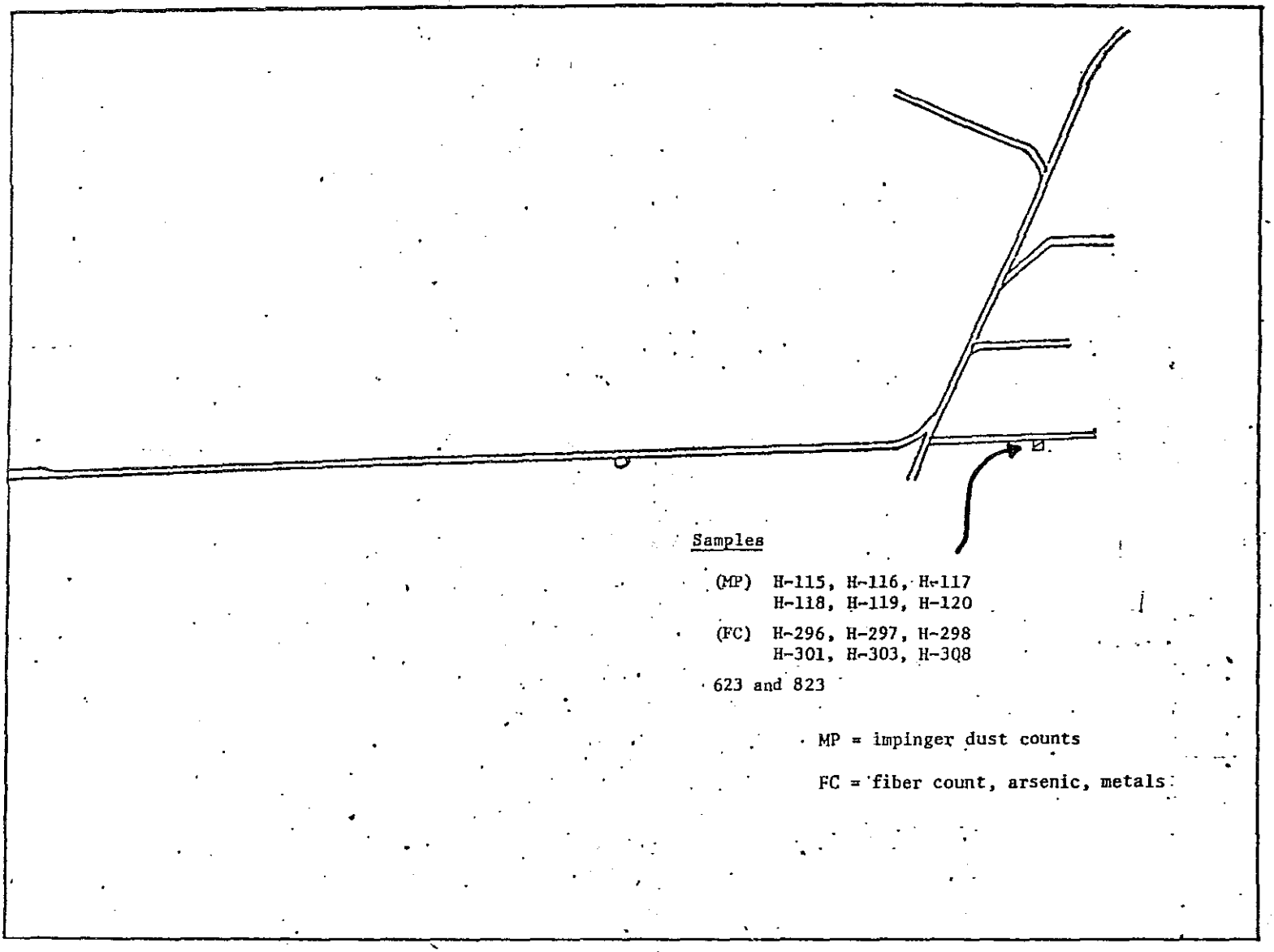


Figure B-26. Level , , 21 Ledge.



Samples

(MP) H-115, H-116, H-117
H-118, H-119, H-120

(FC) H-296, H-297, H-298
H-301, H-303, H-308

623 and 823

MP = impinger dust counts

FC = fiber count, arsenic, metals

Figure B-27. Level 65 Main Ledge

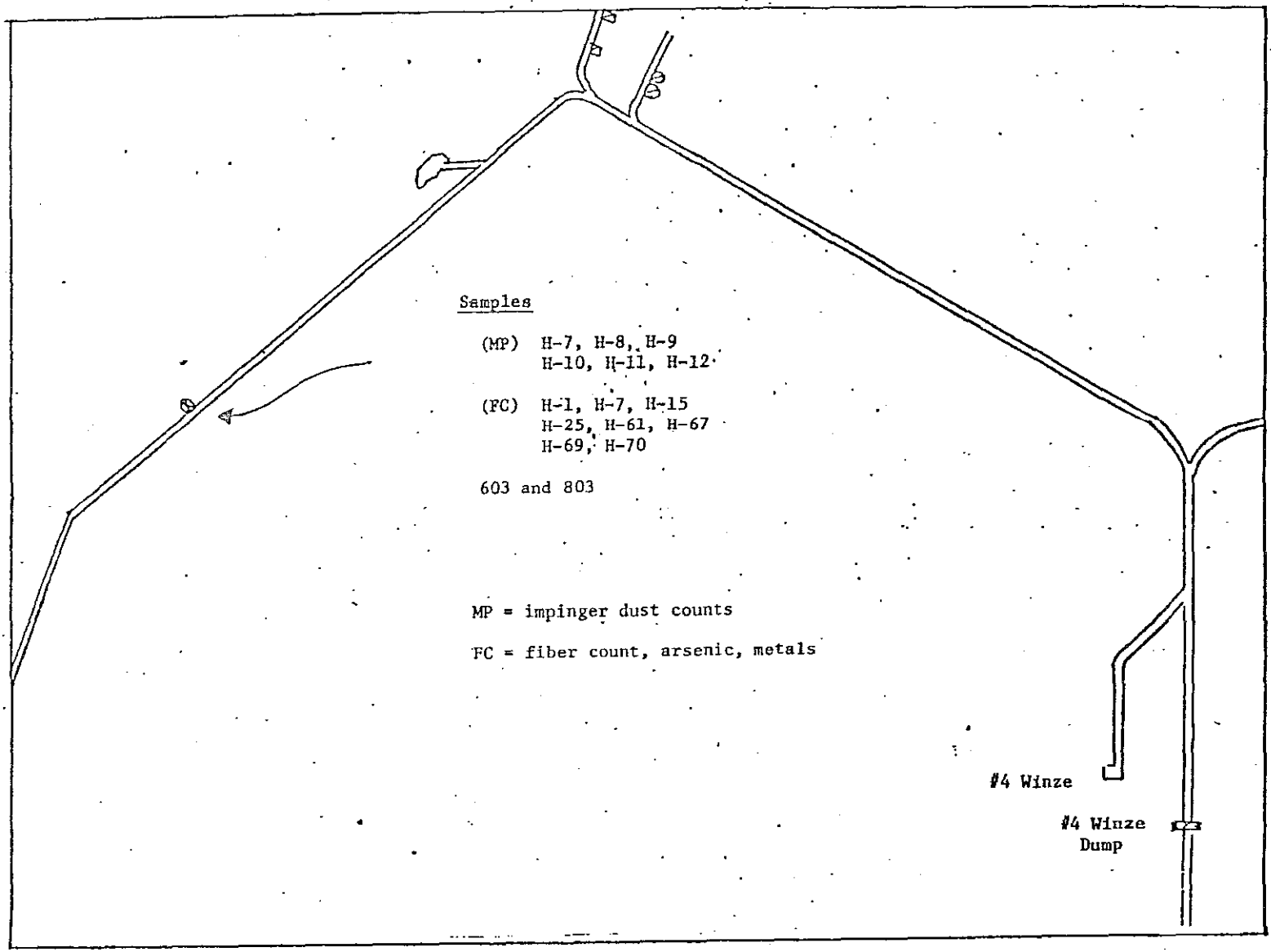


Figure B-28. Level 6 , Main Ledge.

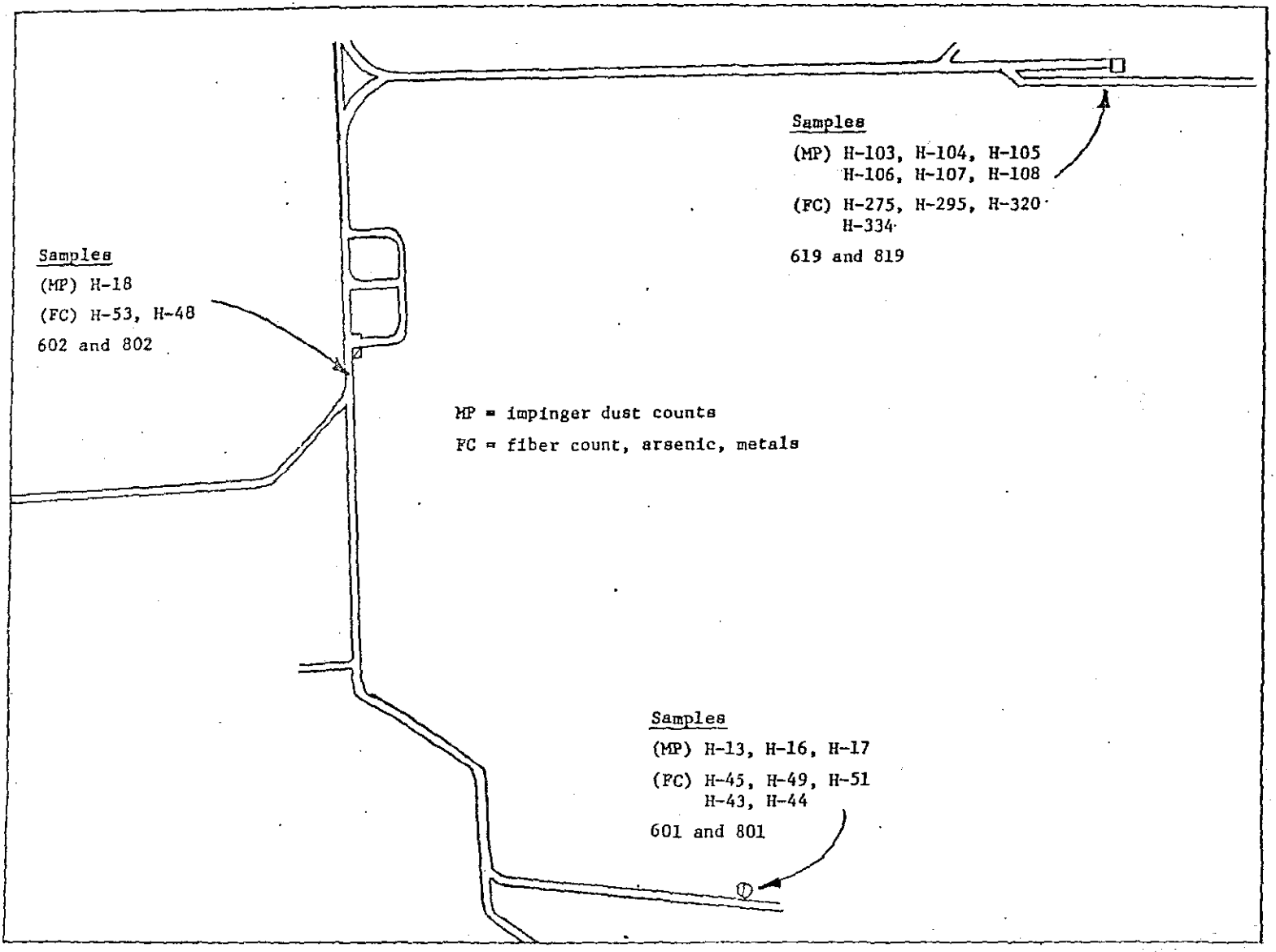
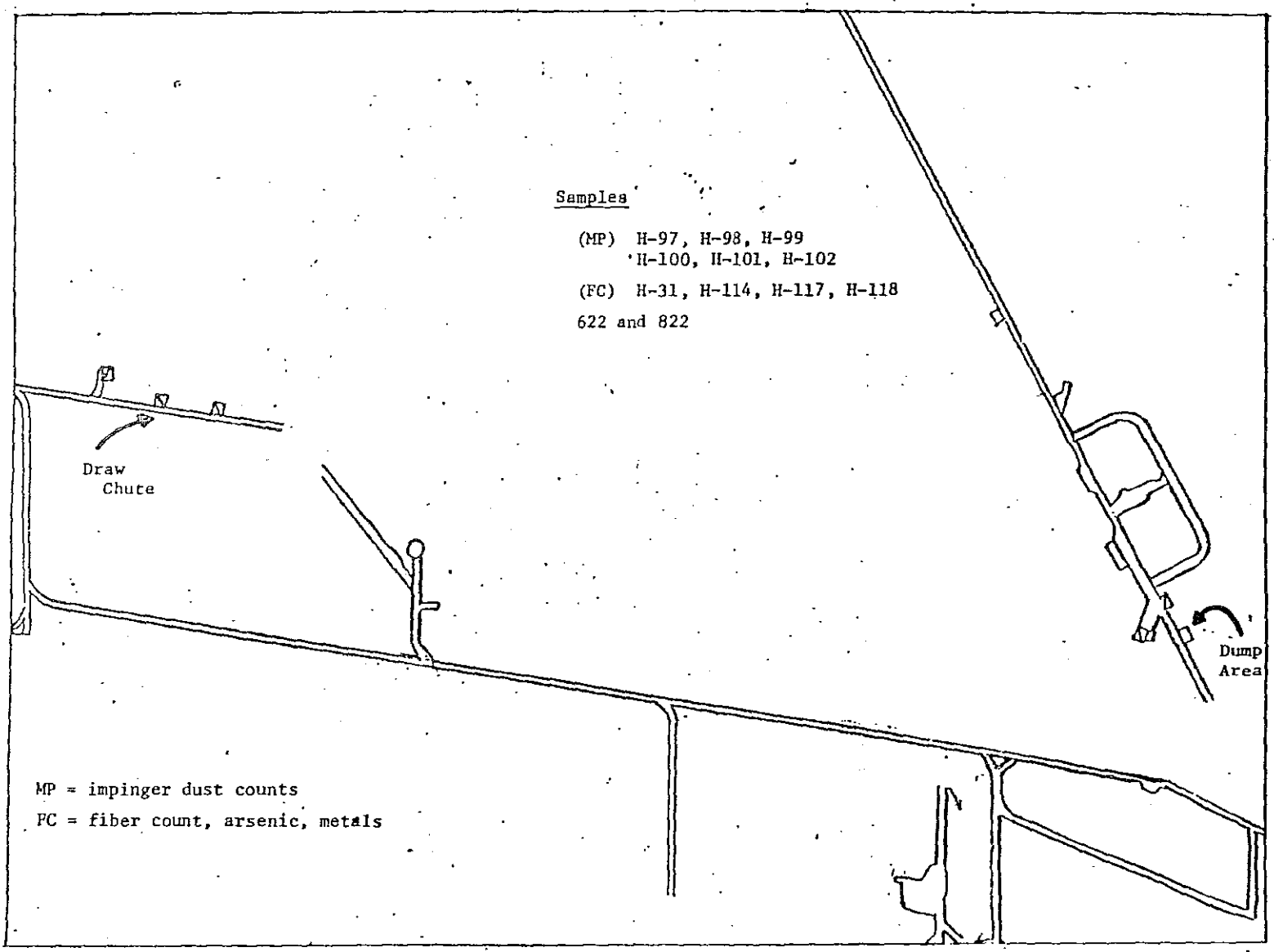


Figure B-29. Level 6E 19 Ledge.



Appendix C. Results of arsenic analysis at the Homestake Gold Mine, Lead, South Dakota.

Table C-1. Airborne arsenic sample results for all underground and surface employees at the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time (minutes)	Volume (m^3)	Time-weighted avg. conc. ($\mu g/m^3$)	Sample information** (i.e. samples used for composite analysis)
0101	13	0817	7/15/77	356	0.236	0.847	Concentration Determined from Filter Samples 327 and 285.
0107	1A	0839	7/20/77	309	0.189	0.529	Concentration Determined from Filter Samples 463 and 464.
0107	1Q	0813	7/14/77	700	0.420	0.100	Concentration Determined from Filter Samples 2, 213, 68 and 66.
0110	1G	0844	7/21/77	625	0.385	0.260	Concentration Determined from Filter Samples 446, 469, 375 and 448.
0121	1U	0818	7/15/77	702	0.422	0.474	Concentration Determined from Filter Samples 289, 304, 315 and 326.
0124	1J	0819	7/15/77	221	0.141	2.128	Concentration Determined from Filter Samples 295 and 275.
0125	1A	0836	7/19/77	354	0.234	0.427	Concentration Determined from Filter Samples 423, 424 and 429.
0125	1I	0837	7/20/77	456	0.296	1.689	Concentration Determined from Filter Samples 336 and 167.
0128	1X	0841	7/20/77	1213	0.733	0.546	Concentration Determined from Filter Samples 478, 482, 473, 483, 471, 485 and 484.
0132	1C	0828	7/18/77	444	0.284	2.113	Concentration Determined from Filter Samples 239 and 27.

Table C-1 (continued)

Job code	Person number	Sample number	Date	Sample time (minutes)	Volume (m^3)	Time-weighted average conc. ($\mu g/m^3$)	Sample information** (i.e. samples used for composite analysis)
0132	1P	0822	7/15/77	310	0.190	0.526	Concentration Determined from Filter Samples 117 and 31.
0142	1D	0812	7/14/77	627	0.387	2.326	Concentration Determined from Filter Samples 148, 150, 159, 149 and 188.
0144	1S	0814	7/14/77	729	0.449	5.791	Concentration Determined from Filter Samples 264, 233, 234, 257 and 248.
0152	1J	0831	7/18/77	954	0.594	1.684	Concentration Determined from Filter Samples 356, 364, 353, 361, 366, 378, 349, 372 and 374.
0154	1D	0826	7/18/77	729	0.449	3.786	Concentration Determined from Filter Samples 208, 63, 173 and 88.
0154	1G	0824	7/15/77	641	0.401	0.499	Concentration Determined from Filter Samples 323, 272, 273 and 287.
0154	1J	0847	7/21/77	629	0.389	1.799	Concentration Determined from Filter Samples 416, 307, 294 and 219.
0155	1A	0806	7/13/77	617	0.377	3.714	Concentration Determined from Filter Samples 65, 54, 52 and 122.
0155	1F	0803	7/12/77	730	0.450	1.111	Concentration Determined from Filter Samples 1, 15, 7 and 25.
0155	16	0825	7/15/77	559	0.359	0.836	Concentration Determined from Filter Samples 291, 252, 260, 286 and 279.
0156	1A	0850	7/22/77	631	0.391	0.256	Concentration Determined from Filter Samples 318, 202, 312 and 276.

Table C-1 (continued)

Job code	Person number	Sample number	Date	Sample time (minutes)	Volume (m^3)	Time-weighted avg. conc. ($\mu g/m^3$)	Sample information** (i.e. samples used for composite analysis)
0156	1B	0845	7/21/77	737	0.457	0.219	Concentration Determined from Filter Samples 386, 310, 357, 250 and 387.
0156*	1D	0807	7/13/77	718	0.438	0.000	Concentration Determined from Filter Samples 97, 4, 5, 58 and 3. Sample Lost During Analysis.
0156	1G	0808	7/13/77	422	0.262	7.252	Concentration Determined from Filter Samples 171, 161, 163, 164 and 165.
0156	1H	0804	7/12/77	546	0.346	0.289	Concentration Determined from Filter Samples 29, 36, 30 and 42.
0156	1J	0809	7/13/77	633	0.393	3.053	Concentration Determined from Filter Samples 124, 145, 133, 146, 131, 109 and 137.
0156	1K	0805	7/12/77	1150	0.710	0.563	Concentration Determined from Filter Samples 78, 91, 92, 77, 17, 22, 18, 80 and 39.
0156	1K	0823	7/15/77	652	0.412	0.243	Concentration Determined from Filter Samples 303, 308 and 301.
0156	1K	0840	7/20/77	745	0.465	0.430	Concentration Determined from Filter Samples 348, 352, 340, 344 and 346.
0156	1L	0832	7/19/77	1016	0.616	7.468	Concentration Determined from Filter Samples 322, 176, 311, 283, 134, 144 and 271.

* Note: This sample not included in the TWA and Statistical Results.

Table C-1 (continued)

Job code	Person number	Sample number	Date	Sample time (minutes)	Volume (m^3)	Time-weighted avg. conc. ($\mu g/m^3$)	Sample information** (i.e. samples used for composite analysis)
0156	1N	0810	7/13/77	657	0.417	0.480	Concentration Determined from Filter Samples 142, 147, 104, 151, 102 and 113.
0156	1N	0842	7/20/77	956	0.596	0.336	Concentration Determined from Filter Samples 445, 439, 450, 449, 451, 444 and 441.
0156	1Q	0833	7/19/77	736	0.456	0.658	Concentration Determined from Filter Samples 402, 400, 406 and 409.
0156	1R	0820	7/15/77	616	0.376	1.862	Concentration Determined from Filter Samples 103, 100, 111, 112 and 123.
0156	1T	0821	7/15/77	457	0.297	0.673	Concentration Determined from Filter Samples 192, 339, 328 and 181.
0156	1V	0834	7/19/77	1109	0.669	0.448	Concentration Determined from Filter Samples 274, 302, 101, 288, 292 and 209.
0157	1D	0846	7/21/77	546	0.346	0.867	Concentration Determined from Filter Samples 350, 162, 351 and 251.
0157	1D	0849	7/22/77	814	0.494	0.607	Concentration Determined from Filter Samples 462, 157, 331 and 385.
0160	1E	0802	7/12/77	441	0.281	0.356	Concentration Determined from Filter Sample 48.
0162	1G	0827	7/18/77	527	0.327	11.621	Concentration Determined from Filter Samples 180, 237 and 168.

Table C-1 (continued)

Job code	Person number	Sample number	Date	Sample time (minutes)	Volume (m^3)	Time-weighted avg. conc. ($\mu g/m^3$)	Sample information** (i.e. samples used for composite analysis)
0163	1L	0829	7/18/77	1036	0.636	3.774	Concentration Determined from Filter Samples 337, 56, 267, 121, 115, 321, 98, 342, 127 and 363.
0166	1B	0800	7/12/77	608	0.368	4.620	Concentration Determined from Filter Samples 86, 85, 96 and 82.
0173	1I	0830	7/18/77	433	0.273	2.564	Concentration Determined from Filter Samples 246, 186 and 182.
0176	1D	0801	7/12/77	650	0.410	0.488	Concentration Determined from Filter Samples 44, 43 and 51.
0176	1U	0815	7/14/77	712	0.432	1.852	Concentration Determined from Filter Samples 14, 72, 8 and 6.
0176	1X	0816	7/14/77	659	0.419	9.785	Concentration Determined from Filter Samples 215, 206, 214, 198 and 220.
0176	1Z	0811	7/14/77	614	0.374	1.070	Concentration Determined from Filter Samples 226, 227, 236, 222, 243 and 223.
0190	1H	0843	7/21/77	215	0.135	2.222	Concentration Determined from Filter Samples 107 and 413.
0200	1G	0848	7/22/77	918	0.558	1.075	Concentration Determined from Filter Samples 293, 401 2118 and 420.

Table C-1 (continued)

Job code	Person number	Sample number	Date	Sample time (minutes)	Volume (m^3)	Time-weighted avg. conc. ($\mu g/m^3$)	Sample information** (i.e. samples used for composite analysis)
0200	1H	0838	7/20/77	1255	0.775	6.452	Concentration Determined from Filter Samples 476, 472, 452, 466, 470, 468, 359, 262, 456 and 460.
0200	1G	0835	7/19/77	1054	0.654	0.765	Concentration Determined from Filter Samples 391, 388, 389, 382, 396 and 383.
0231	1L	0851	7/22/77	536	0.336	0.595	Concentration Determined from Filter Samples 290, 249 and 419.

** 1-10 filter halves from personal samples collected from employees with a similar job title were combined.

Table C-2. Airborne arsenic sample results for underground employees on 9, Main, 11, 13, 19, and 21 Ledges of Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time (minutes)	Volume (m^3)	Time-weighted avg. conc. ($\mu g/m^3$)	Sample information** (i.e. samples used for composite analysis)
0932	1C	0828	7/18/77	444	0.284	2.113	Concentration Determined from Filter Samples 239 and 27.
0952	1J	0831	7/18/77	954	0.594	1.684	Concentration Determined from Filter Samples 356, 364, 353, 361, 366, 378, 349, 372 and 374.
0954	1D	0826	7/18/77	729	0.449	3.786	Concentration Determined from Filter Samples 208, 63, 173 and 88.
0955	1A	0806	7/13/77	617	0.377	3.714	Concentration Determined from Filter Samples 65, 54, 52 and 122.
0956	1A	0850	7/22/77	631	0.391	0.256	Concentration Determined from Filter Samples 318, 202, 312 and 276.
0956	1B	0845	7/21/77	737	0.457	0.219	Concentration Determined from Filter Samples 386, 310, 357, 250 and 387.
0956	1J	0809	7/13/77	633	0393	3.053	Concentration Determined from Filter Samples 124, 145, 133, 146, 131, 109 and 137.
0956	1K	0840	7/20/77	745	0.465	0.430	Concentration Determined from Filter Samples 348, 352, 340, 344 and 346.
0956	1L	0832	7/19/77	1016	0.616	7.468	Concentration Determined from Filter Samples 322, 176, 311, 283, 134, 144 and 271.
0956	1N	0842	7/20/77	956	0.596	0.336	Concentration Determined from Filter Samples 445, 439, 450, 449, 451, 444 and 441.

Table C-2 (continued)

Job code	Person number	Sample number	Date	Sample time (minutes)	Volume (m^3)	Time-weighted avg. conc. ($\mu g/m^3$)	Sample information** (i.e. samples used for composite analysis)
0956	1Q	0833	7/19/77	736	0.456	0.658	Concentration Determined from Filter Samples 402, 400, 406 and 409.
0956	1V	0834	7/19/77	1109	0.669	0.448	Concentration Determined from Filter Samples 274, 302, 101, 288, 292 and 209.
0962	1G	0827	7/18/77	527	0.327	1.621	Concentration Determined from Filter Samples 180, 237 and 168.
0963	1L	0829	7/18/77	1036	0.636	3.774	Concentration Determined from Filter Samples 337, 56, 267, 121, 115, 321, 98, 342, 127 and 363.
0973	1I	0830	7/18/77	433	0.273	2.564	Concentration Determined from Filter Samples 246, 186 and 182.
0976	1X	0816	7/14/77	659	0.419	9.785	Concentration Determined from Filter Samples 215, 206, 214, 198 and 220.
0976	1Z	0811	7/14/77	614	0.374	1.070	Concentration Determined from Filter Samples 226, 227, 236, 222, 243 and 223.
1010	1G	0844	7/21/77	625	0.385	0.260	Concentration Determined from filter Samples 446, 469, 375 and 448.
1044	1S	0814	7/14/77	729	0.449	5.791	Concentration Determined from Filter Samples 264, 233, 234, 257 and 248.
1054	1J	0847	7/21/77	629	0.389	1.799	Concentration Determined from Filter Samples 416, 307, 294 and 219.

Table C-2 (continued)

Job code	Person number	Sample number	Date	Sample time (minutes)	Volume (m^3)	Time-weighted avg. conc. ($\mu g/m^3$)	Sample information** (i.e. samples used for composite analysis)
1055	1F	0803	7/12/77	730	0.450	1.111	Concentration Determined from Filter Samples 1, 15, 7 and 25.
1056	1K	0805	7/12/77	1150	0.710	0.563	Concentration Determined from Filter Samples 78, 91, 92, 77, 17, 22, 18, 80 and 39.
1057	1D	0846	7/21/77	546	0.346	0.867	Concentration Determined from Filter Samples 350, 162, 351 and 251.
1057	1D	0849	7/22/77	814	0.494	0.607	Concentration Determined from Filter Samples 462, 157, 331 and 385.
1060	1E	0802	7/12/77	441	0.281	0.356	Concentration Determined from Filter Sample 48.
1076	1D	0801	7/12/77	650	0.410	0.488	Concentration Determined from Filter Samples 44, 43 and 51.
1090	1H	0843	7/21/77	215	0.135	2.222	Concentration Determined from Filter Samples 176 and 94.
1128	1X	0841	7/20/77	1213	0.733	0.546	Concentration Determined from Filter Samples 478, 482, 473, 483, 471, 485 and 484.
1142	1D	0812	7/14/77	627	0.387	2.326	Concentration Determined from Filter Samples 148, 150, 159, 149 and 188.
1156*	1D	0807	7/13/77	718	0.438	0.000	Concentration Determined from Filter Samples 97, 4, 5, 58 and 3. Sample Lost During Analysis.

* Note: This sample not included in the TWA and Statistical Results.

Table C-2 (continued)

Job code	Person number	Sample number	Date	Sample time (minutes)	Volume (m^3)	Time-weighted avg. conc. ($\mu g/m^3$)	Sample information** (i.e. samples used for composite analysis)
1156	1G	0808	7/13/77	422	0.262	7.252	Concentration Determined from Filter Samples 171, 161, 163, 164 and 165.
1156	1N	0810	7/13/77	657	0.417	0.480	Concentration Determined from Filter Samples 142, 147, 104, 151, 102 and 113.
1176	1U	0815	7/14/77	712	0.432	1.852	Concentration Determined from Filter Samples 14, 72, 8 and 6.
1356	1H	0804	7/12/77	546	0.346	0.289	Concentration Determined from Filter Samples 29, 36, 30 and 42.
1366	1B	0800	7/12/77	608	0.368	4.620	Concentration Determined from Filter Samples 86, 85, 96 and 82.
1932	1P	0822	7/15/77	310	0.190	0.526	Concentration Determined from Filter Samples 117 and 31.
1954	1G	0824	7/15/77	641	0.401	0.490	Concentration Determined from Filter Samples 323, 272, 273 and 287.
1955	16	0825	7/15/77	559	0.359	0.836	Concentration Determined from Filter Samples 291, 252, 260, 286 and 279.
1956	1R	0820	7/15/77	616	0.376	1.862	Concentration Determined from Filter Samples 103, 100, 111, 112 and 123.
1956	1T	0821	7/15/77	457	0.297	0.673	Concentration Determined from Filter Samples 192, 339, 328 and 181.

Table C-2 (continued)

Job code	Person number	Sample number	Date	Sample time (minutes)	Volume (m^3)	Time-weighted avg. conc. ($\mu g/m^3$)	Sample information** (i.e. samples used for composite analysis)
2156	1K	0823	7/15/77	652	0.412	0.243	Concentration Determined from Filter Samples 303, 308 and 301.

** 1-10 filter halves from personal samples collected from employees with a similar job title were combined.

Table C-3. Statistical summary of airborne arsenic sample results for underground employees at the Homestake Gold Mine.

Job code	Number of samples	Arsenic µg/m³ Range High - Low	Arith. mean	Median	TWA	Standard deviation	Standard error	Job title
0101	1	0.847	0.847	0.847	0.847	0.000	0.000	Cager
0107	2	0.100 - 0.529	0.314	0.314	0.231	0.303	0.214	Hoist Operator-Underground
0110	1	0.260	0.260	0.260	0.260	0.000	0.000	Carpenter, 1st.
0121	1	0.474	0.474	0.474	0.474	0.000	0.000	Shaftman
0124	1	2.128	2.128	2.128	2.128	0.000	0.000	Skipper Head
0125	2	1.689 - 0.427	1.058	1.058	1.132	0.892	0.631	Skipper
0128	1	0.546	0.546	0.546	0.546	0.000	0.000	Sandman, Underground
0132	2	2.113 - 0.526	1.320	1.320	1.477	1.122	0.793	Motorman, 1st.
0142	1	2.326	2.326	2.326	2.326	0.000	0.000	Diamond Drill Helper
0144	1	5.791	5.791	5.791	5.791	0.000	0.000	Boring Machine Helper
0152	1	1.684	1.684	1.684	1.684	0.000	0.000	Miner, 1st.
0154	3	3.786 - 0.499	2.028	1.799	2.098	1.655	0.956	Miner, 1st.
0155	3	3.714 - 0.836	1.887	1.111	1.855	1.588	0.917	Miner, 1st.
0156	15	7.468 - 0.219	1.615	0.480	1.545	2.452	0.633	Miner, 1st.
0157	2	0.867 - 0.607	0.737	0.737	0.714	0.184	0.130	Miner, 1st.
0160	1	0.356	0.356	0.356	0.356	0.000	0.000	Miner, 2nd.
0162	1	11.621	11.621	11.621	11.621	0.000	0.000	Miner, 2nd.
0163		3.774	3.774	3.774	3.774	0.000	0.000	Miner, 2nd.
0166	1	4.620	4.620	4.620	4.620	0.000	0.000	Miner, 2nd.
0173	1	2.564	2.564	2.564	2.564	0.000	0.000	Miner, 3rd.
0176	4	9.785 - 0.488	3.299	1.461	3.364	4.360	2.180	Miner, 3rd.
0190	1	2.222	2.222	2.222	2.222	0.000	0.000	Mine Shift Boss
Area 01	Total 47	11.621 - 0.100	2.026	0.836	1.980	2.569	0.375	All Employees Underground

The geometric mean arsenic exposure for underground employees was 1.072 µg/m³ with a geometric standard deviation of 3.114; the lower and upper 95% confidence levels for the geometric mean were 0.768 and 1.497 µg/m³, respectively.

Table C-4. Statistical summary of airborne arsenic sample results for surface workers at the Homestake Gold Mine.

Job code	Number of samples	Arsenic $\mu g/m^3$ Range High - Low	Arith. mean	Median	TWA	Standard deviation	Standard error	Job title
0200	3	6.452 - 0.765	2.764	1.075	2.764	3.198	1.846	Workers in Surface Crushing Mill
0231	1	0.595	0.595	0.595	0.595	0.000	0.000	Motorman - Surface
Area 02	Total 4	6.452 - 0.595	2.222	0.920	2.713	2.827	1.414	Motorman and Workers in Crushing Mill

The geometric mean arsenic exposure for surface employees was 1.333 $\mu g/m^3$ with a geometric standard deviation of 2.941; the lower and upper 95% confidence levels were 0.240 and 7.418 $\mu g/m^3$, respectively.

Table C-5. Statistical summary of airborne arsenic sample results for underground employees on the 9, Main, 11, 13, 19, and 21 Ledges of the Homestake Gold Mine.

Job code	Number of samples	Arsenic $\mu g/m^3$ Range High - Low	Arith. mean	Median	TWA	Standard deviation	Standard error	Job title
0932	1	2.113	2.113	2.113	2.113	0.000	0.000	Motorman, 1st.
0952	1	1.684	1.684	1.684	1.684	0.000	0.000	Miner, 1st.
0954	1	3.786	3.786	3.786	3.786	0.000	0.000	Miner, 1st.
0955	1	3.714	3.714	3.714	3.714	0.000	0.000	Miner, 1st.
0956	8	7.468 - 0.219	1.609	0.439	1.731	2.548	0.901	Miner, 1st.
0962	1	11.621	11.621	11.621	11.621	0.000	0.000	Miner, 2nd.
0963	1	3.774	3.774	3.774	3.774	0.000	0.000	Miner, 2nd.
0973	1	2.564	2.564	2.564	2.564	0.000	0.000	Miner, 3rd.
0976	2	9.785 - 1.070	5.428	5.428	5.675	6.162	4.357	Miner, 3rd.
Area 09	Total 17	11.621 - 0.219	3.116	2.113	2.971	3.439	0.834	Employees on 9 Ledge
1010	1	0.260	0.260	0.260	0.260	0.000	0.000	Carpenter, 1st.
1044	1	5.791	5.791	5.791	5.791	0.000	0.000	Boring Machine Helper
1054	1	1.799	1.799	1.799	1.799	0.000	0.000	Miner, 1st.
1055	1	1.111	1.111	1.111	1.111	0.000	0.000	Miner, 1st.
1056	1	0.563	0.563	0.563	0.563	0.000	0.000	Miner, 1st.
1057	2	0.867 - 0.607	0.737	0.737	0.714	0.184	0.130	Miner, 1st.
1060	1	0.356	0.356	0.356	0.356	0.000	0.000	Miner, 2nd.
1076	1	0.488	0.488	0.488	0.488	0.000	0.000	Miner, 3rd.
1090	1	2.222	2.222	2.222	2.222	0.000	0.000	Mine Shift Boss
Area 10	Total 10	5.791 - 0.260	1.406	0.737	1.358	1.668	0.527	Employees on Main Ledge
1128	1	0.546	0.546	0.546	0.546	0.000	0.000	Sandman, Underground
1142	1	2.326	2.326	2.326	2.326	0.000	0.000	Diamond Drill Helper
1156	2	7.252 - 0.480	3.866	3.866	3.093	4.789	3.386	Miner, 1st.
1176	1	1.852	1.852	1.852	1.852	0.000	0.000	Miner, 3rd.
Area 11	Total 5	7.252 - 0.480	2.491	1.852	1.883	2.781	1.244	Employees on 11 Ledge

Table C-5 (continued)

Job code	Number of samples	Arsenic $\mu g/m^3$ Range High - Low	Arith. mean	Median	TWA	Standard deviation	Standard error	Job title
1356	1	0.289	0.289	0.289	0.289	0.000	0.000	Miner, 1st.
1366	1	4.620	4.620	4.620	4.620	0.000	0.000	Miner, 2nd.
Area 13	Total 2	4.620 - 0.289	2.455	2.455	2.521	3.062	2.165	Employees on 13 Ledge
1932	1	0.526	0.526	0.526	0.526	0.000	0.000	Motorman, 1st.
1954	1	0.499	0.499	0.499	0.499	0.000	0.000	Miner, 1st.
1955	1	0.836	0.836	0.836	0.836	0.000	0.000	Miner, 1st.
1956	2	1.862 - 0.673	1.268	1.268	1.337	0.841	0.594	Miner, 1st.
Area 19	5	1.862 - 0.499	0.879	0.673	0.924	0.566	0.253	Employees on 19 Ledge
2156	1	0.243	0.243	0.243	0.243	0.000	0.000	Miner, 1st.
Area 21	Total 1	0.243	0.243	0.243	0.243	0.000	0.000	Employees on 21 Ledge
Ledges	Total 40	11.621 - 0.219	2.226	0.847	2.110	2.724	0.431	Underground employees on 9, Main, 11, 13, 19, and 21 Ledges

The geometric mean arsenic exposure for underground employees on the various ledges was 1.182 $\mu g/m^3$ with a geometric standard deviation of 3.124; the lower and upper 95% confidence levels were 0.819 and 1.707 $\mu g/m^3$, respectively.

Appendix D. Results of optical microscopy fiber analysis at the Homestake Gold Mine, Lead, South Dakota.

Table D-1. Airborne sample results for fibers >5 μm in length for all underground employees at the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0100	1B	H458	7/20/77	0822	1025	246	0.029	4550 Level, Electrician in Hoist Room for repair, Ross.
							TWA-0.029	
0101	13	H284	7/15/77	0713	0934	282	0.043	4850 Level, Main Ledge, Winze 4 to 6800 Level, Shaft Cage.
0101	13	H285	7/15/77	0934	1145	262	0.046	4850 Level, Main Ledge, Winze 4 to 6800 Level, Shaft Cage.
0101	13	H327	7/15/77	1145	1330	210	0.172	4850 Level, Main Ledge, Winze 4 to 6800 Level, Shaft Cage.
0101	13	H319	7/15/77	1330	1435	130	0.056	4850 Level, Main Ledge, Winze 4 to 6800 Level, Shaft Cage.
							TWA-0.076	
0107	1A	H455	7/20/77	0634	0834	240	0.125	4550 Level-Hoist Room, Spent Time in Cubicle, Ross.
0107	1A	H463	7/20/77	0834	1027	226	0.101	4550 Level-Hoist Room, Spent Time in Cubicle and Hoist Room, Ross.
0107	1A	H457	7/20/77	1027	1230	246	0.088	4550 Level-Hoist Room, Ross.
0107	1A	H464	7/20/77	1230	1346	152	0.127	4550 Level-Hoist Room, In Control Cubicle, Ross.
							TWA-0.109	
0107	1P	H20	7/14/77	658	0908	260	0.157	4850 Level, Main Ledge, Hoist Room, Operated Hoist.
0107	1P	H207	7/14/77	0908	1120	264	0.000	4850 Level, Main Ledge, Hoist Room, Operated Hoist, Ate Lunch.
0107	1P	H24	7/14/77	1120	1245	170	0.014	4850 Level, Main Ledge, Hoist Room, Operated Hoist.
0107	1P	H57	7/14/77	1245	1405	160	0.030	4850 Level, Main Ledge, Hoist Room.
							TWA-0.056	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0107	1Q	H2	7/14/77	0705 -	0906	242	0.020	4850 Level, Main Ledge, Hoist Room, Cleaning Up.
0107	1Q	H213	7/14/77	0906 -	1120	268	0.004	4850 Level, Main Ledge, Hoist Room, Operating Hoist.
0107	1Q	H68	7/14/77	1120 -	1245	170	0.021	4850 Level, Main Ledge, Hoist Room.
0107	1Q	H66	7/14/77	1245 -	1405	160	0.053	4850 Level, Main Ledge, Hoist Room.
							TWA-0.021	
0108	1H	H314	7/15/77	0947 -	1145	236	0.301	19 Ledge, 4850 Level, 46 Crosscut, Installing Water Tank.
0108	1H	H280	7/15/77	1145 -	1401	272	0.323	19 Ledge, 4850 Level, 46 Crosscut, Fitting Pipes.
0108	1H	H317	7/15/77	1401 -	1502	122	0.168	19 Ledge, 4850 Level, 46 Crosscut, Fitting Pipes.
							TWA-0.285	
0110	1G	H365	7/21/77	0728 -	0916	216	1.161	Main Ledge, 4250 Level, 71C Stope, Set Timber for Track.
0110	1G	H446	7/21/77	0916 -	1047	182	0.119	Main Ledge, 4250 Level, 71C Stope, Waited for Timber to Arrive.
0110	1G	H447	7/21/77	1047 -	1248	242	0.264	Main Ledge, 4250 Level, 71C Stope, Ate Lunch. Blasted and Worked on Timberline.
0110	1G	H469	7/21/77	1248 -	1426	196	0.510	Main Ledge, 4250 Level, 71C Stope, Worked on Timberline.
							TWA-0.522	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0110	1H	H443	7/21/77	0728	0917	218	1.741	Main Ledge, 4250 Level, 71C Stope, Set Timbers for Track.
0110	1H	H375	7/21/77	0917	1055	196	0.221	Main Ledge, 4250 Level, 71C Stope, Waiting for Timber.
0110	1H	H435	7/21/77	1055	1248	226	0.888	Main Ledge, 4250 Level, 71C Stope, Ate Lunch, Blasted and Worked on Timberline.
0110	1H	H448	7/21/77	1248	1426	196	0.913	Main Ledge, 4250 Level, 71C Stope, Worked on Timberline.
							TWA-0.960	
0114	1K	H329	7/18/77	0702	0806	248	0.533	9 Ledge, 2150 Level, 49 Crosscut, Putting Up Door.
0114	1K	H130	7/18/77	0806	0909	126	0.851	9 Ledge, 2150 level, Carpenter.
0114	1K	H322	7/18/77	0909	1010	122	3.872	9 Ledge, 2150 Level, Carpenter.
0114	1K	H141	7/18/77	1010	1153	206	0.286	9 Ledge, 2150 Level, Carpenter.
0114	1K	H99	7/18/77	1153	1255	124	0.350	9 Ledge, 2150 Level, Carpenter.
							TWA-1.063	
0121	11	H325	7/15/77	0718	0932	268	0.045	4850 Level, Winze 4, Spent Some Time Mucking at 6880.
0121	11	H313	7/15/77	0932	1147	270	0.049	4850 Level, Winze 4.
0121	11	H304	7/15/77	1147	1333	212	0.102	4850 Level, Area.
0121	11	H289	7/15/77	1333	1436	126	0.105	4850 Level, Area.
							TWA-0.069	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0121*	12	H326	7/15/77	0708	0720	24	0.000	4850 Level, Main Ledge, Winze 4 Area, Voided for count - finger print on filter.
0121	12	H315	7/15/77	0720	0933	226	0.009	4850 Level, Main Ledge, Winze 4, Spent Some Time Mucking at 6880 Sump.
0121	12	H335	7/15/77	0933	1148	270	0.018	4850 Level, Main Ledge, Winze 4 Area, Fixed Door at 4790, Loaded Pipe at 5700, Lowered Cement to 5700.
0121	12	H277	7/15/77	1148	1331	103	0.187	4850 Level, Main Ledge, Winze 4 Area.
							TWA-0.062	
0124	14	H334	7/15/77	0710	0917	254	0.076	6800 Level, Main Ledge, Transfered Waste in Cage.
0124	14	H295	7/15/77	0917	1017	120	3.584	6800 Level, Main Ledge, Some Slushing and Blasting.
0124	14	H320	7/15/77	1017	1109	104	0.347	6800 Level, Main Ledge, Some Slushing, Made Trips to 4850.
0124	14	H275	7/15/77	1109	1230	162	0.602	6800 Level, Main Ledge, Slushing.
							TWA-0.911	
0125*	1A	H428	7/19/77	636	654	0	0.000	4850 Level-Skip Pocket, Yates, Wore Respirator.
0125	1A	H423	7/19/77	655	745	100	0.301	4850 Level-Skip Pocket, Loaded Ore, Yates, Wore Respirator.
0125	1A	H425	7/19/77	745	850	130	0.417	4850 Level-Skip Pocket, Yates.
0125	1A	H424	7/19/77	850	945	110	0.186	4850 Level-Skip Pocket, Yates.
0125	1A	H429	7/19/77	1036	1245	258	0.121	4850 Level-Skip Pocket, Ate Lunch, Yates.
0125	1A	H300	7/19/77	1245	1350	130	0.232	4850 Level-Skip Pocket, Yates.
							TWA-0.228	

* Note: This sample not included in the TWA and Statistical Results.

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0125	11	H354	7/20/77	633 -	855	230	0.335	4850 Level-Skip Pocket, Skipped Ore About Every 10 Minutes, Ross.
0125	11	H336	7/20/77	855 -	1219	398	0.686	4850 Level-Skip Pocket, Skipped Some Ore, Ate Lunch, Ross.
0125	11	H167	7/20/77	1223 -	1400	194	0.341	4850 Level-Skip Pocket, Ross.
							TWA-0.498	
0128	1X	H477	7/20/77	0646 -	0821	190	0.771	11 Ledge, 4550 Level 24-26 Stope, Back Filling with Sand, Plugging Holes with Burlap.
0128	1X	H478	7/20/77	0822 -	1021	238	0.162	11 Ledge, 4550 Level, 24-26 Stope, Back Filling with Sand.
0128	1X	H491	7/20/77	1022 -	1152	180	0.535	11 Ledge, 4550 Level, 24-26 Stope, Ate Lunch.
0128	1X	H482	7/20/77	1152 -	1410	276	0.345	11 Ledge, 4550 Level, 24-26 Stope.
							TWA-0.426	
0128	1Y	H473	7/20/77	0643 -	0835	224	0.226	11 Ledge, 4550 Level, 24-26 Stope, Applied Sand and Water.
0128	1Y	H489	7/20/77	0835 -	1031	232	0.176	11 Ledge, 4550 Level, 24-26 Stope, Filled Manway with Sand.
0128	1Y	H483	7/20/77	1031 -	1204	186	0.376	11 Ledge, 4550 Level, 24-26 Stope, Filled Manway.
0128	1Y	H486	7/20/77	1204 -	1415	262	0.303	11 Ledge, 4550 Level, 24-26 Stope.
							TWA-0.266	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0128	1Z	H471	7/20/77	0645	0829	208	0.174	11 Ledge, 4550 Level, 24-26 Stope, Load Equipment.
0128	1Z	H487	7/20/77	0830	1025	230	0.141	11 Ledge, 4550 Level, 24-26 Stope, Sandfill.
0128	1Z	H485	7/20/77	1026	1154	176	01062	11 Ledge, 4550 Level, 24-26 Stope, Ate Lunch.
0128	1Z	H488	7/20/77	1154	1317	166	0.036	11 Ledge, 4550 Level, 24-26 Stope, Sandfill.
0128	1Z	H484	7/20/77	1317	1436	158	0.137	11 Ledge, 4550 Level, 24-26 Stope, Lowered Equipment.
							TWA-0.114	
0131	1K	H436	7/22/77	0735	0950	270	1.939	Tramway-Surface, Motorman, Near Crushing.
0131	1K	H201	7/22/77	0950	1210	280	0.030	Tramway-Surface, Motorman.
0131	1K	H419	7/22/77	1210	1315	130	0.241	Tramway-Surface, Motorman.
							TWA-0.828	
0131	1L	H290	7/22/77	0739	0950	262	0.156	Tramway-Surface, Motorman.
0131	1L	H249	7/22/77	0950	1210	280	0.125	Tramway-Surface, Motorman.
0131	1L	H94	7/22/77	1210	1315	130	0.046	Tramway-Surface, Motorman.
							TWA-0.122	
0132	1C	H239	7/18/77	0730	0905	190	1.561	9 Ledge, 1700 Level, Motorman, Hauled Ore.
0132	1C	H95	7/18/77	0905	1138	306	0.437	9 Ledge, 1700 Level, Motorman, Hauled Ore, Washed Cars, Dumped Waste.
0132	1C	H27	7/18/77	1138	1447	378	0.796	9 Ledge, 1700 Level, Motorman.
							TWA-0.837	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0132	1P	H114	7/15/77	0754 -	949	230	0.063	19 Ledge, 6800 Level, Motorman, Hauled Rock.
0132	1P	H117	7/15/77	0949 -	1148	238	0.111	19 Ledge, 6800 Level, Motorman, Pulled Raises, Dumped Waste.
0132	1P	H118	7/15/77	1148 -	1324	192	0.207	19 Ledge, 6800 Level, Motorman, Pulled Raises, Dumped Ore.
0132	1P	H31	7/15/77	1324 -	1435	142	0.127	19 Ledge, 6800 Level, Motorman, Pulled Raises, Dumped Ore.
							TWA-0.123	
0133	1G	H69	7/12/77	910 -	1145	310	0.144	Main Ledge, 6500 Level, Helped In Slushing, Ate Lunch.
0133	1G	H61	7/12/77	0801 -	909	136	4.591	Main Ledge, 6500 Level, Hauling Rock, Pulling Raise.
0133	1G	H70	7/12/77	1145 -	1405	520	0.167	Main Ledge, 6500 Level, Helped Muck and Slush Ore.
0133	1G	H67	7/12/77	1405 -	1525	160	0,602	Main Ledge, 6500 Level, Helped Muck and Slush, Drove Motor Car.
							TWA-0.917	
0141	1C	H156	7/14/77	910 -	1030	280	0.009	11 Ledge, 5600 Level, 55 Pillar, Some Drilling.
0141	1C	H166	7/14/77	0751 -	908	154	0.242	11 Ledge, 5600 Level, 55 Pillar, Some Drilling.
0141	1C	H169	7/14/77	1030 -	1125	110	0.011	11 Ledge, 5600 Level, 55 Pillar, Some Drilling, Ate Lunch.
0141	1C	H172	7/14/77	1125 -	1259	188	0.032	11 Ledge, 5600 Level, 55 Pillar, Drilling, Some Slushing.
0141	1C	H183	7/14/77	1300 -	1420	160	0.000	11 Ledge, 5600 Level, 55 Pillar, Drilling, Pulling Core.
							TWA-0.060	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0142	1D	H150	7/14/77	857	1030	186	0.013	11 Ledge, 5600 Level, 55 Pillar, Some Drilling.
0142	1D	H148	7/14/77	0749	0854	130	0.120	11 Ledge, 5600 Level, 55 Pillar, Drilling and Pulling Core.
0142	1D	H159	7/14/77	1030	1125	110	0.022	11 Ledge, 5600 Level, 55 Pillar, Ate Lunch.
0142	1D	H149	7/14/77	1125	1300	190	0.019	11 Ledge, 5600 Level, 55 Pillar, Pulling Core.
0142	1D	H188	7/14/77	1301	1420	158	0.030	11 Ledge, 5600 Level, 55 Pillar, Drilling and Pulling Core.
							TWA-0.037	
0143	1R	H261	7/14/77	0715	0852	194	0.223	Main Ledge, 6050 Level, 90 Pillar, Wet Drilling.
0143	1R	H265	7/14/77	0852	1043	222	2.956	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
0143	1R	H255	7/14/77	1043	1213	160	5.231	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling, Ate Lunch.
0143*	1R	H268	7/14/77	1213	1404	222	0.000	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling, Cap Left On Sample, Voided for Fiber Count.
0143	1R	H266	7/14/77	1404	1446	84	6.647	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
							TWA-2.438	

* Note: This sample not included in the TWA and Statistical Results.

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0144	1S	H248	7/14/77	0717	0850	186	3.431	Main Ledge, 6050 Level, 90 Pillar, Assist in Bore Machine Drilling
0144	1S	H257	7/14/77	0850	1042	224	1.917	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling, Ate Lunch.
0144	1S	H234	7/14/77	1042	1212	180	3.579	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
0144	1S	H233	7/14/77	1212	1401	218	2.210	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
0144	1S	H264	7/14/77	1401	1446	90	1.271	Main Ledge, 6050 Level, 90 Pillar, Some Drilling.
							TWA-2.570	
0152	1B	H211	7/18/77	831	1010	198	0.693	9 Ledge, 1700 Level, 24A Stope.
0152	1B	H153	7/18/77	0657	0831	188	0.128	9 Ledge, 1700 Level, 24A Stope, Drilling.
0152	1B	H174	7/18/77	1010	1210	240	0.100	9 Ledge, 1700 Level, 24A Stope.
0152	1B	H160	7/18/77	1210	1432	284	0.246	9 Ledge, 1700 Level, 24A Stope.
							TWA-0.280	
0152	1F	H378	7/18/77	723	907	208	0.151	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Slushing, Drilling.
0152	1F	H370	7/18/77	907	1117	260	0.634	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Slushing, Drilling, Ate Lunch.
0152*	1F	H373	7/18/77	1117	1312	0	0.000	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Slushing and Prepared for Blasting, Sample Lost.
0152	1F	H349	7/18/77	1312	1433	162	0.074	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Prepared for Blasting.
							TWA-0.331	

* Note: This sample not included in the TWA and Statistical Results.

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0152	1J	H356	7/18/77	835 -	955	160	0.075	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Slushing.
0152	1J	H369	7/18/77	956 -	1016	40	0.151	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Pulling Chute.
0152	1J	H364	7/18/77	1018 -	1034	16	0.376	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Pulling Chute.
0152	1J	H345	7/18/77	1035 -	1044	18	0.067	9 Ledge, 2000 Level, 45-51G/H Blast Hole.
0152	1J	H353	7/18/77	1044 -	1054	20	0.542	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Loading Ore.
0152	1J	H367	7/18/77	1055 -	1158	126	0.994	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Ate Lunch. Loading Ore, Blast.
0152	1J	H361	7/18/77	1158 -	1255	114	0.465	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Loading Ore.
0152	1J	H362	7/18/77	1255 -	1322	54	0.112	9 Ledge, 2000 Level, 45-51G/H Blast Hole.
0152	1J	H366	7/18/77	1322 -	1406	88	0.151	9 Ledge, 2000 Level, 45-51G/H Blast Hole.
0152	1J	H355	7/18/77	1406 -	1440	68	6.559	9 Ledge, 2000 Level, 45-51G/H Blast Hole.
							TWA-0.386	
0153	1H	H204	7/18/77	0725 -	0844	158	2.722	9 Ledge, 2150 Level, 49 Crosscut, Ring Drilling.
0153	1H	H229	7/18/77	0844 -	1000	152	0.681	9 Ledge, 2150 Level, 49 Crosscut, Maintenance Work.
0153	1H	H55	7/18/77	1000 -	1145	210	0.235	9 Ledge, 2150 Level, 49 Crosscut, Ate Lunch.
0153	1H	H245	7/18/77	1145 -	1315	180	0.020	9 Ledge, 2150 Level, 49 Crosscut.
0153	1H	H73	7/18/77	1315 -	1428	146	0.330	9 Ledge, 2150 Level, 49 Crosscut.
							TWA-0.750	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0153	1M	H324	7/18/77	659 -	816	154	0.063	9 Ledge, 2150 Level, 49 Crosscut, Hanging Pipe.
0153	1M	H256	7/18/77	816 -	914	116	1.266	9 Ledge, 2150 Level, 49 Crosscut, Hanging Pipe, Mucking.
0153	1M	H333	7/18/77	914 -	1012	116	0.187	9 Ledge, 2150 Level, 49 Crosscut, Some Mucking.
0153	1M	H338	7/18/77	1012 -	1033	42	0.143	9 Ledge, 2150 Level, 49 Crosscut, Some Mucking.
0153	1M	H126	7/18/77	1033 -	1135	124	0.126	9 Ledge, 2150 Level, 49 Crosscut, Some Mucking, Ate Lunch.
0153	1M	H98	7/18/77	1135 -	1211	72	0.569	9 Ledge, 2150 Level, 49 Crosscut, Some Mucking.
0153	1M	H142	7/18/77	1211 -	1245	68	1.045	9 Ledge, 2150 Level, 49 Crosscut Mucking.
0153	1M	H127	7/18/77	1245 -	1325	80	0.647	9 Ledge, 2150 Level, 49 Crosscut Mucking.
0153	1M	H363	7/18/77	1325 -	1437	144	0.092	9 Ledge, 2150 Level, 49 Crosscut, Worked on Gate.
							TWA-0.411	
0154	1A	H187	7/18/77	850 -	1135	330	0.401	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Some Drilling.
0154	1A	H71	7/18/77	0715 -	0850	190	0.781	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Some Mucking and Drilling.
0154	1A	H184	7/18/77	1135 -	1257	164	0.705	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Drilling.
0154	1A	H196	7/18/77	1257 -	1440	206	0.491	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Blasting.
							TWA-0.559	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0154	1D	H208	7/18/77	0713	0855	204	1.687	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Some Mucking and Drilling.
0154	1D	H63	7/18/77	0855	1135	320	0.166	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Some Mucking, Loading and Drilling.
0154	1D	H173	7/18/77	1135	1255	160	0.715	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Drilling.
0154	1D	H88	7/18/77	1255	1442	214	0.540	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Prepare for Blasting.
							TWA-0.698	
0154	1G	H325	7/15/77	0821	0917	112	0.624	19 Ledge, 4850 Level, 46 Crosscut, Waited for Equipment.
0154	1G	H272	7/15/77	0917	1048	182	0.523	19 Ledge, 4850 Level, 46 Crosscut, Assisted in Installing Pipe.
0154	1G	H273	7/15/77	1048	1401	386	0.162	19 Ledge, 4850 Level, 46 Crosscut, Installed Some Pipe, Ate Lunch.
0154	1G	H287	7/15/77	1401	1502	122	0.454	19 Ledge, 4850 Level, 46 Crosscut, Helped Install Water Tank.
							TWA-0.353	
0154	1J	H416	7/21/77	748	945	234	4.889	Main Ledge, 4250 Level, 70 Crosscut, Some Drilling, Took Break.
0154	1J	H403	7/21/77	945	1152	254	1.831	Main Ledge, 4250 Level, 70 Crosscut, Drilled, Ate Lunch.
0154	1J	H307	7/21/77	1152	1330	196	0.172	Main Ledge, 4250 Level, 70 Crosscut Drilled.
0154	1J	H316	7/21/77	1330	1439	138	4.625	Main Ledge, 4250 Level, 70 Crosscut, Prepared for Blasting.
							TWA-2.775	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0154	1L	H381	7/21/77	0747	0945	236	0.250	Main Ledge, 4250 Level, 70 Crosscut, Set Up Equipment, Wet Drilling.
0154	1L	H294	7/21/77	0945	1130	210	0.080	Main Ledge, 4250 Level, 70 Crosscut, Some Drilling, Ate Lunch.
0154	1L	H414	7/21/77	1155	1333	196	1.360	Main Ledge, 4250 Level, 70 Crosscut, Drilled.
0154	1L	H219	7/21/77	1333	1442	138	3.148	Main Ledge, 4250 Level, 70 Crosscut, Prepared for Blasting.
							TWA-0.996	
0155	1A	H65	7/13/77	0832	0955	166	1.422	9 Ledge, 5750 Level, 68C Stope, Slushing.
0155	1A	H54	7/13/77	0956	1130	188	0.397	9 Ledge, 5750 Level, 68C Stope, Slushing.
0155	1A	H52	7/13/77	1135	1310	190	0.233	9 Ledge, 5750 Level, 68C Stope, Eating Lunch Some of the Time.
0155	1A	H122	7/13/77	1310	1455	210	0.178	9 Ledge, 5750 Level, 68C Stope, Set Up Drill Equipment.
							TWA-0.521	
0155	1B	H110	7/13/77	0834	0922	156	0.984	9 Ledge, 5750 Level, 68C Stope, Pulling Chute.
0155	1B	H62	7/13/77	0922	1053	182	0.569	9 Ledge, 5750 Level, 68C Stope, Barred, Ate Lunch.
0155	1B	H116	7/13/77	1155	1323	176	0.123	9 Ledge, 5750 Level, 68C Stope, Electricity Went Off, Workers Not Working at Time of Sample.
0155	1B	H106	7/13/77	1323	1503	200	0.421	9 Ledge, 5750 Level, 68C Stope, Electricity Went Off, Workers Not Working at Time of Sample.
							TWA-0.508	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0155	1F	H07	7/12/77	0758	0958	240	2.835	Main Ledge, 6500 Level, Mucked, Slushed and Dumped Ore.
0155	1F	H25	7/12/77	0958	1146	216	0.784	Main Ledge, 6500 Level, Mucked, Slushed.
0155	1F	H15	7/12/77	1146	1408	284	0.986	Main Ledge, 6500 Level, Mucked, Slushed, Ate Lunch.
0155	1F	H01	7/12/77	1408	1528	160	0.489	Main Ledge, 6500 Level, Set Up Drilling Equipment.
							TWA-1.342	
0156	1A	H87	7/12/77	0820	1015	230	0.099	13 Ledge, 6050 Level, 46-47C Stope, Some Drilling.
0156	1A	H09	7/12/77	1015	1200	210	0.086	13 Ledge, 6050 Level, 46-47C Stope, Drilling.
0156	1A	H75	7/12/77	1205	1335	180	0.080	13 Ledge, 6050 Level, 46-47C Stope, Some Mucking.
0156	1A	H79	7/12/77	1335	1439	128	0.574	13 Ledge, 6050 Level, 46-47C Stope, Pulling Chute.
							TWA-0.172	
0156	1A	H318	7/22/77	0807	0957	220	2.105	9 Ledge, 4700 Level, 37F Stope, Set Up Equipment, Drilling.
0156	1A	H299	7/22/77	0957	1144	214	0.703	9 Ledge, 4700 Level, 37F Stope, Drilling, Ate Lunch.
0156	1A	H202	7/22/77	1144	1302	156	0.564	9 Ledge, 4700 Level, 37F Stope, Drilling.
0156	1A	H407	7/22/77	1302	1358	112	0.344	9 Ledge, 4700 Level, 37F Stope, Some Drilling.
							TWA-1.054	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0156	1B	H417	7/21/77	0715	0859	208	1.524	9 Ledge, 3950 Level, 24-25B Stope, Loaded Cars with Ore.
0156	1B	H90	7/21/77	1046	1232	212	0.136	9 Ledge, 3950 Level, 24-25B Stope, Loaded Cars, Ate Lunch.
0156	1B	H310	7/21/77	1232	1405	186	0.382	9 Ledge, 3950 Level, 24-25B Stope.
0156	1B	H405	7/21/77	1405	1449	88	0.246	9 Ledge, 3950 Level, 24-25B Stope.
							TWA-0.632	
0156	1B	H312	7/22/77	0807	0955	216	0.307	9 Ledge, 4700 Level, 37F Stope, Slushing.
0156	1B	H465	7/22/77	0955	1223	296	0.232	9 Ledge, 4700 Level, 37F Stope, Drilling, Ate Lunch.
0156	1B	H276	7/22/77	1223	1358	190	0.298	9 Ledge, 4700 Level, 37F Stope, Drilling.
							TWA-0.273	
0156	1C	H49	7/12/77	0805	1055	180	0,335	Main Ledge, 6800 Level, 93-94C Cutting Sill, Slushing.
0156	1C	H45	7/12/77	1301	1531	180	0.381	Main Ledge, 6800 Level, 93-94C Cutting Sill, Slushing.
							TWA-0.357	
0156	1D	H97	7/13/77	920	1015	110	1.286	11 Ledge, 5450 Level, 49-51 Stope, Set Up Drilling.
0156	1D	H04	7/13/77	1015	1250	310	0.105	11 Ledge, 5450 Level, 49-51 Stope, Some Drilling, Lunch.
0156	1D	H05	7/13/77	1250	1405	150	0.361	11 Ledge, 5450 Level, 49-51 Stope.
0156	1D	H58	7/13/77	1407	1443	72	0.368	11 Ledge, 5450 Level, 49-51 Stope.
							TWA-0.397	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0156	1E	H23	7/13/77	922	1020	116	0.031	11 Ledge, 5450 Level, 49-51 Stope, Wet Drilling.
0156	1E	H13	7/13/77	1020	1250	300	0.096	11 Ledge, 5450 Level, 49-51 Stope, Drilling, Lunch.
							TWA-0.078	
0156	1G	H171	7/13/77	0948	1028	80	0.135	11 Ledge, 5300 Level, 49D Stope, Drilling.
0156	1G	H161	7/13/77	1028	1111	86	0.042	11 Ledge, 5300 Level, 49D Stope, Drilling.
0156	1G	H163	7/13/77	1111	1216	130	0.019	11 Ledge, 5300 Level, 49D Stope, Some Drilling, Lunch.
0156	1G	H164	7/13/77	1216	1244	56	1.226	11 Ledge, 5300 Level, 49D Stope, Some Drilling.
0156	1G	H165	7/13/77	1244	1410	172	0.042	11 Ledge, 5300 Level, 49D Stope, Cleaned Area for Blasting.
							TWA-0.177	
0156	1H	H29	7/12/77	820	1018	236	0.398	13 Ledge, 6050 Level, Mucking.
0156	1H	H36	7/12/77	1019	1216	234	0.812	13 Ledge, 6050 Level, Ate Lunch, Mucking.
0156	1H	H30	7/12/77	1216	1355	198	0.122	13 Ledge, 6050 Level, Mucking, Putting in Track.
0156	1H	H42	7/12/77	1356	1408	24	15.483	13 Ledge, 6050 Level, Putting in Track.
							TWA-0.982	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0156	1H	H189	7/13/77	0859	0952	106	0.045	11 Ledge, 5300 Level, 49D Stope, Wetted Ore, Drilled.
0156	1H	H152	7/13/77	0952	1052	120	0.120	11 Ledge, 5300 Level, 49D Stope, Drilled.
0156	1H	H179	7/13/77	1052	1132	80	0.316	11 Ledge, 5300 Level, 49D Stope, Drilled, Ate Lunch.
0156	1H	H177	7/13/77	1133	1220	94	0.256	11 Ledge, 5300 Level, 49D Stope, Drilled.
0156	1H	H191	7/13/77	1220	1340	160	3.305	11 Ledge, 5300 Level, 49D Stope, Some Drilling, Prepared for Blasting.
0156	1H	H170	7/13/77	1340	1410	60	0.723	11 Ledge, 5300 Level, 49D Stope, Prepared for Blasting.
							TWA-1.033	
0156	1I	H28	7/12/77	818	1015	154	0.555	13 Ledge, 6050 Level, Wetted Ore, Mucked.
0156	1I	H32	7/12/77	1016	1228	264	0.810	13 Ledge, 6050 Level, Dumped Ore, Mucked.
0156	1I	H93	7/12/77	1228	1356	176	0.144	13 Ledge, 6050 Level, Put in Track, Mucked.
0156	1I	H50	7/12/77	1357	1408	22	12.772	13 Ledge, 6050 Level, Put in Track.
							TWA-0.934	
0156	1J	H18	7/12/77	0815	0918	126	0.048	Main Ledge, 6050 Level, 89E Stope, Set Up Drill Equipment.
0156	1J	H80	7/12/77	0918	1145	294	0.258	Main Ledge, 6050 Level, 89E Stope, Pulling Chute, Lunch.
0156	1J	H39	7/12/77	1145	1322	194	0.719	Main Ledge, 6050 Level, 89E Stope, Drilling.
0156	1J	H16	7/12/77	1322	1418	112	2.444	Main Ledge, 6050 Level, 89E Stope, Drilling.
0156	1J	H37	7/12/77	1418	1458	80	1.785	Main Ledge, 6050 Level, 89E Stope, Drilling.
							TWA-0.791	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0156	1J	H124	7/13/77	808 -	907	118	0.745	9 Ledge, 5750 Level, 67-68D Stope, Wetted Ore.
0156	1J	H145	7/13/77	907 -	1010	126	0.363	9 Ledge, 5750 Level, 67-68D Stope, Drilled.
0156	1J	H133	7/13/77	1011 -	1140	178	0.325	9 Ledge, 5750 Level, 67-68D Stope, Some Drilling, Ate Lunch.
0156	1J	H146	7/13/77	1140 -	1234	108	0.335	9 Ledge, 5750 Level, 67-68D Stope, Drilled.
0156	1J	H131	7/13/77	1235 -	1309	68	0.496	9 Ledge, 5750 Level, 67-68D Stope, Some Drilling.
0156	1J	H109	7/13/77	1309 -	1355	92	1.204	9 Ledge, 5750 Level, 67-68D Stope, Prepared for Blasting.
0156	1J	H137	7/13/77	1355 -	1443	96	0.100	9 Ledge, 5750 Level, 67-68D Stope, Prepared for Blasting, Put in Roof Bolts.
							TWA-0.486	
0156	1K	H78	7/12/77	0815 -	0918	126	0.363	Main Ledge, 6050 Level, 89E Stope, Set Up for Drilling, Drilling.
0156	1K	H91	7/12/77	0918 -	1025	134	0.620	Main Ledge, 6050 Level, 89E Stope, Drilling.
0156	1K	H92	7/12/77	1025 -	1207	204	0.331	Main Ledge, 6050 Level, 89E Stope, Started Slushing, Ate Lunch.
0156	1K	H77	7/12/77	1207 -	1321	148	0.651	Main Ledge, 6050 Level, 89E Stope, Drilling.
0156	1K	H17	7/12/77	1322 -	1418	112	1.064	Main Ledge, 6050 Level, 89E Stope, Drilling.
0156	1K	H22	7/12/77	1418 -	1459	82	1.145	Main Ledge, 6050 Level, 89E Stope, Drilling.
							TWA-0.627	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0156	1K	H138	7/13/77	808 -	907	118	0.214	9 Ledge, 5750 Level, 67-68D Stope, Set Up for Drilling.
0156	1K	H135	7/13/77	907 -	1010	126	0.134	9 Ledge, 5750 Level, 67-68D Stope, Drilled.
0156	1K	H136	7/13/77	1011 -	1140	178	0.068	9 Ledge, 5750 Level, 67-68D Stope, Some Drilling, Ate Lunch.
0156	1K	H128	7/13/77	1140 -	1234	108	0.290	9 Ledge, 5750 Level, 67-68D Stope, Drilled.
0156	1K	H125	7/13/77	1235 -	1309	68	1.576	9 Ledge, 5750 Level, 67-68D Stope, Drilled.
0156	1K	H143	7/13/77	1355 -	1444	98	0.184	9 Ledge, 5750 Level, 67-68D Stope, Prepared for Blasting, Put in Roof Bolts.
							TWA-0.303	
0156	1K	H308	7/15/77	945 -	1304	398	0.079	21 Ledge, 6200 Level, 50-52B Stope, Operate Crane.
0156	1K	H303	7/15/77	0757 -	0945	216	0.301	21 Ledge, 6200 Level, 50-52B Stope, Drilling.
0156	1K	H301	7/15/77	1305 -	1450	210	0.528	21 Ledge, 6200 Level, 50-52B Stope, Some Drilling, Set Charges for Blasting.
							TWA-0.252	
0156	1K	H235	7/20/77	0728 -	0848	160	0.188	9 Ledge, 4400 Level, 31-32C/D Stope, Slushing, Cable Repair.
0156	1K	H341	7/20/77	1023 -	1139	152	2.010	9 Ledge, 4400 Level, 31-32C/D Stope, Slushing.
0156	1K	H352	7/20/77	1139 -	1332	226	0.437	9 Ledge, 4400 Level, 31-32C/D Stope.
0156	1K	H358	7/20/77	1332 -	1428	112	0.376	9 Ledge, 4400 Level, 31-32C/D Stope, Set Up for Drilling, Drilling.
							TWA-0.733	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0156	1L	H140	7/19/77	0710	0845	190	0.146	9 Ledge, 3650 Level, 18B Stope, Setting Up Equipment.
0156	1L	H175	7/19/77	1015	1134	158	0.610	9 Ledge, 3650 Level, 18B Stope, Lunch.
0156	1L	H176	7/19/77	1134	1300	172	0.182	9 Ledge, 3650 Level, 18B Stope.
0156	1L	H195	7/19/77	1300	1433	186	0.065	9 Ledge, 3650 Level, Constructed Chute and Manway.
							TWA-0.237	
0156	1M	H155	7/13/77	0806	0838	64	0.489	11 Ledge, 5750 Level, 57C Stope, Fixed Slusher Blocks.
0156	1M	H139	7/13/77	0838	0922	88	3.839	11 Ledge, 5750 Level, 57C Stope, Wetted Ore, Drilled.
0156	1M	H132	7/13/77	0922	1116	228	1.007	11 Ledge, 5750 Level, 57C Stope, Set Up Slusher and Ate Lunch.
0156	1M	H108	7/13/77	1116	1258	84	2.485	11 Ledge, 5750 Level, 57C Stope, Repositioned Slusher.
0156	1M	H105	7/13/77	1258	1412	148	0.464	11 Ledge, 5750 Level, 57C Stope, Set Up Slusher.
0156	1M	H154	7/13/77	1412	1502	100	0.421	11 Ledge, 5750 Level, 57C Stope, Took Break.
							TWA-1.462	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0156	1N	H142	7/13/77	0806	0838	64	0.884	11 Ledge, 5750 Level, 57C Stope, Fixed Slusher.
0156	1N	H147	7/13/77	0838	0924	92	0.890	11 Ledge, 5750 Level, 57C Stope, Wet Ore and Drilled.
0156	1N	H104	7/13/77	0924	1116	224	0.043	11 Ledge, 5750 Level, 57C Stope, Put in Slusher Blocks, Ate Lunch.
0156	1N	H151	7/13/77	1116	1254	196	0.203	11 Ledge, 5750 Level, 57C Stope, Repositioned Slusher.
0156	1N	H102	7/13/77	1254	1412	156	0.178	11 Ledge, 5750 Level, 57C Stope, Set Up Slusher.
0156	1N	H113	7/13/77	1412	1503	102	0.118	11 Ledge, 5750 Level, 57C Stope, Took Break.
							TWA-0.273	
0156	1N	H438	7/20/77	730	914	208	0.278	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling.
0156*	1N	H445	7/20/77	914	930	0	0.000	9 Ledge, 4250 Level, 36-37B/C Stope, Dropped Filter.
0156	1N	H439	7/20/77	931	1058	174	0.076	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling, Ate Lunch.
0156	1N	H432	7/20/77	1125	1304	198	0.450	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling.
							TWA-0.276	

* Note: This sample not included in the TWA and Statistical Results.

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0156	1O	H440	7/20/77	731 -	915	208	0.573	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling.
0156	1O	H449	7/20/77	915 -	1058	206	0.164	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling, Ate Lunch.
0156	1O	H451	7/20/77	1127 -	1304	194	0.217	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
0156	1O	H434	7/20/77	1304 -	1432	176	0.513	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
							TWA-0.364	
0156	1P	H431	7/20/77	916 -	1055	198	0.341	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling, Ate Lunch.
							TWA-0.341	
0156	1Q	H74	7/15/77	0803 -	0935	184	0.582	19 Ledge, 6200 Level, 27 Crosscut, Cutting and Hoisting Timber for Chute.
0156	1Q	H59	7/15/77	0935 -	1102	174	0.055	19 Ledge, 6200 Level, 27 Crosscut, Cutting and Hoisting Timber.
0156	1Q	H35	7/15/77	1102 -	1230	176	0.096	19 Ledge, 6200 Level, 27 Crosscut, Ate Lunch, Cut and Hoisted Timber.
0156	1Q	H64	7/15/77	1230 -	1330	120	0.050	19 Ledge, 6200 Level, 27 Crosscut, Hoisted Timber.
0156	1Q	H46	7/15/77	1330 -	1440	140	0.499	19 Ledge, 6200 Level, 27 Crosscut, Some Drilling on Roof and Wood.
							TWA-0.264	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0156	1Q	H408	7/19/77	702	0901	238	0.025	9 Ledge, 3950 Level, 18G Stope, Set Up Equipment.
0156	1Q	H402	7/19/77	0901	1143	324	0.190	9 Ledge, 3950 Level, 18G Stope.
0156	1Q	H411	7/19/77	1143	1312	178	0.636	9 Ledge, 3950 Level, 18G Stope, Drilling.
0156	1Q	H400	7/19/77	1312	1421	138	0.131	9 Ledge, 3950 Level, 18G Stope, Some Drilling.
							TWA-0.226	
0156	1R	H111	7/15/77	0804	0937	186	0.045	19 Ledge, 6200 Level, 27 Crosscut, Placed Timber into Chute.
0156	1R	H112	7/15/77	0937	1102	170	0.064	19 Ledge, 6200 Level, 27 Crosscut, Ate Lunch, Placed Timber into Chute.
0156	1R	H123	7/15/77	1102	1230	176	0.075	19 Ledge, 6200 Level, 27 Crosscut, Cut and Placed Timber into Chute.
0156	1R	H100	7/15/77	1230	1330	120	0.100	19 Ledge, 6200 Level, 27 Crosscut, Placed Timber into Chute.
0156	1R	H103	7/15/77	1330	1420	100	0.289	19 Ledge, 6200 Level 27 Crosscut, Some Drilling on Wood and Roof.
							TWA-0.098	
0156	1R	H406	7/19/77	0718	0935	274	0.105	9 Ledge, 3950 Level, 18G Stope, Set Up Equipment.
0156	1R	H404	7/19/77	0935	1144	258	0.075	9 Ledge, 3950 Level, 18G Stope.
0156	1R	H409	7/19/77	1144	1312	176	0.897	9 Ledge, 3950 Level, 18G Stope, Drilling.
0156	1R	H412	7/19/77	1312	1420	136	0.027	9 Ledge, 3950 Level, 18G Stope, Some Drilling.
							TWA-0.248	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0156	1S	H194	7/15/77	830 -	1000	180	0.100	19 Ledge, 6200 Level, 41-42C Stope, Some Slushing.
0156	1S	H178	7/15/77	1000 -	1146	212	0.187	19 Ledge, 6200 Level, 41-42C Stope, Some Slushing, Ate Lunch.
0156	1S	H185	7/15/77	1146 -	1250	128	0.160	19 Ledge, 6200 Level, 41-42C Stope, Drilling.
0156	1S	H193	7/15/77	1252 -	1423	182	0.033	19 Ledge, 6200 Level, 41-42C Stope, Drilling.
							TWA-0.120	
0156	1T	H192	7/15/77	830 -	1000	180	0.027	19 Ledge, 6200 Level, 41-42C Stope, Some Slushing.
0156	1T	H339	7/15/77	1000 -	1145	210	0.109	19 Ledge, 6200 Level, 41-42C Stope, Some Slushing, Ate Lunch.
0156	1T	H328	7/15/77	1146 -	1251	130	0.102	19 Ledge, 6200 Level, 41-42C Stope, Drilling.
0156	1T	H181	7/15/77	1253 -	1330	74	0.130	19 Ledge, 6200 Level, 41-42C Stope, Some Drilling.
							TWA-0.085	
0156	1V	H306	7/19/77	706 -	850	208	0.666	9 Ledge, 3650 Level, 27D Stope, Set Up Equipment, Some Drilling.
0156	1V	H274	7/19/77	850 -	1104	268	0.279	9 Ledge, 3650 Level, 27D Stope, Drilling.
0156	1V	H302	7/19/77	1315 -	1440	170	0.170	9 Ledge, 3650 Level, 27D Stope, Some Drilling.
							TWA-0.375	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0156	1W	H101	7/19/77	706 -	850	208	0.434	9 Ledge, 3650 Level, 27D Stope, Some Drilling.
0156	1W	H278	7/19/77	850 -	1104	268	0.431	9 Ledge, 3650 Level, 27D Stope, Drilling.
0156	1W	H305	7/19/77	1315 -	1440	170	0.425	9 Ledge, 3650 Level, 27D Stope, Some Drilling.
							TWA-0.430	
0156	1Y	H221	7/14/77	0754 -	0950	232	0.296	9 Ledge, 5450 Level, 66-67C Stope, Set Up Equipment, Some Slushing.
0156	1Y	H216	7/14/77	0950 -	1143	226	1.715	9 Ledge, 5450 Level, 66-67C Stope, Some Drilling, Ate Lunch.
0156	1Y	H203	7/14/77	1143 -	1313	180	1.216	9 Ledge, 5450 Level, 66-67C Stope, Drilling.
0156	1Y	H197	7/14/77	1313 -	1457	208	0.156	9 Ledge, 5450 Level, 66-67C Stope, Drilling.
							TWA-0.836	
0156	15	H259	7/15/77	811 -	859	96	0.050	19 Ledge, 5900 Level, 28-29F Stope, Slushing.
0156	15	H247	7/15/77	900 -	1010	140	0.637	19 Ledge, 5900 Level, 28-29F Stope, Slushing.
0156	15	H270	7/15/77	1010 -	1130	160	0.331	19 Ledge, 5900 Level, 28-29F Stope, Some Slushing, Ate Lunch.
0156	15	H258	7/15/77	1130 -	1300	180	0.388	19 Ledge, 5900 Level, 28-29F Stope, Repaired Slusher, Load Rock.
0156	15	H254	7/15/77	1300 -	1425	170	0.050	19 Ledge, 5900 Level, 28-29F Stope, Prepared for Blasting.
							TWA-0.302	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0156	16	H291	7/15/77	810 -	859	98	0.184	19 Ledge, 5900 Level, 28-29F Stope, Pulling Chute.
0156	16	H252	7/15/77	900 -	1010	140	0.705	19 Ledge, 5900 Level, 28-29F Stope, Pulling Chute.
0156	16	H260	7/15/77	1010 -	1213	246	1.454	19 Ledge, 5900 Level, 28-29F Stope, Some Slushing, Ate Lunch.
0156	16	H286	7/15/77	1213 -	1305	104	0.938	19 Ledge, 5900 Level, 28-29F Stope, Pulled Chute Prepared for Blasting.
0156	16	H279	7/15/77	1305 -	1410	130	0.000	19 Ledge, 5900 Level, 28-29F Stope, Prepared for Blasting, Uneven particulate distribution. Filter voided for Fiber Count.
							TWA-0.973	
0157	1D	H350	7/21/77	855 -	1055	240	0.226	Main Ledge, 4100 Level, 58E Stope, Timber Stope, Ate Lunch.
0157	1D	H41	7/21/77	0723 -	0855	184	0.808	Main Ledge, 4100 Level, 58E Stope, Timber Stope.
0157	1D	H343	7/21/77	1146 -	1323	194	0.273	Main Ledge, 4100 Level, 58E Stope.
0157	1D	H162	7/21/77	1324 -	1416	104	0.197	Main Ledge, 4100 Level, 58E Stope, Bracing.
							TWA-0.383	

* Note: This sample not included in the TWA and Statistical Results.

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0157	1D	H380	7/22/77	0746	0940	228	0.058	Main Ledge, 4100 Level, 61 Crosscut, Cut and Stand Timber.
0157	1D	H462	7/22/77	0940	1149	258	1.111	Main Ledge, 4100 Level, 61 Crosscut, Cut and Stand Timber.
0157	1D	H390	7/22/77	1149	1329	200	0.217	Main Ledge, 4100 Level, 61 Crosscut.
0157	1D	H157	7/22/77	1329	1445	152	0.222	Main Ledge, 4100 Level, 61 Crosscut.
							TWA-0.450	
0157	1E	H228	7/21/77	0725	0855	180	0.107	Main Ledge, 4100 Level, 58E Stope.
0157	1E	H251	7/21/77	1322	1416	108	0.100	Main Ledge, 4100 Level, 58E Stope.
							TWA-0.104	
0157	1E	H331	7/22/77	0745	0939	228	0.185	Main Ledge, 4100 Level, 61 Crosscut.
0157	1E	H427	7/22/77	0939	1149	260	0.435	Main Ledge, 4100 Level, 61 Crosscut, Cut and Stand Timber.
0157	1E	H385	7/22/77	1150	1445	350	0.206	Main Ledge, 4100 Level, 61 Crosscut.
							TWA-0.271	
0160	1E	H53	7/12/77	0810	1050	320	0.117	Main Ledge, 6800 Level, in Pump Room, Repaired Track.
0160	1E	H48	7/12/77	1050	1531	562	0.528	Main Ledge, 6800 Level, Ate Lunch, Repaired Track.
							TWA-0.379	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0162	1G	H237	7/18/77	833 -	1007	188	0.045	9 Ledge, 1700 Level, 24A Stope.
0162	1G	H180	7/18/77	0700 -	0833	186	0.123	9 Ledge, 1700 Level, 24A Stope, Set Up Drill Equipment.
0162	1G	H410	7/18/77	1007 -	1210	246	0.078	9 Ledge, 1700 Level, 24A Stope.
0162	1G	H168	7/18/77	1210 -	1430	280	2.258	9 Ledge, 1700 Level, 24A Stope.
							TWA-0.759	
0163	1L	H337	7/18/77	703 -	806	126	0.191	9 Ledge, 2150 Level, at Motor Barn, Put Up Door.
0163	1L	H56	7/18/77	806 -	909	126	5.018	9 Ledge, 2150 Level, Some Drilling, Put Up Door.
0163	1L	H267	7/18/77	909 -	1010	122	3.085	9 Ledge, 2150 Level, Put Up Door.
0163	1L	H121	7/18/77	1010 -	1216	252	0.540	9 Ledge, 2150 Level, Put Up Door, Ate Lunch.
0163	1L	H115	7/18/77	1216 -	1327	142	0.483	9 Ledge, 2150 Level, Worked on Gate.
0163	1L	H321	7/18/77	1327 -	1437	140	1.677	9 Ledge, 2150 Level, Worked on Gate.
							TWA-1.621	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0166	1A	H357	7/21/77	0714	0856	204	0.575	9 Ledge, 3950 Level, 24-25B Stope, Set Up Slushing Equipment.
0166	1A	H205	7/21/77	0856	1049	226	0.208	9 Ledge, 3950 Level, 24-25B Stope, Slushing.
0166	1A	H250	7/21/77	1049	1236	214	0.657	9 Ledge, 3950 Level, 24-25B Stope, Ate Lunch, Slushed.
0166	1A	H418	7/21/77	1236	1401	170	0.120	9 Ledge, 3950 Level, 24-25B Stope.
0166	1A	H387	7/21/77	1401	1449	96	0.106	9 Ledge, 3950 Level, 24-25B Stope.
							TWA-0.420	
0166	1B	H82	7/12/77	822	1016	228	0.170	13 Ledge. 6050 Level, 46-47C Stope, Some Drilling.
0166	1B	H96	7/12/77	1018	1200	204	0.047	13 Ledge, 6050 Level, 46-47C Stope, Drilling.
0166	1B	H85	7/12/77	1207	1330	166	0.232	13 Ledge, 6050 Level, 46-47C Stope, Pulling Chute.
0166	1B	H86	7/12/77	1330	1439	138	1.589	13 Ledge, 6050 Level, 46-47C Stope, Pulling Chute.
							TWA-0.478	
0166	1L	H368	7/20/77	0848	1012	168	0.151	9 Ledge, 4400 Level, 31-32C/D Stope, Pulled Chute, Put Car Back on Track.
0166	1L	H344	7/20/77	1012	1153	202	0.060	9 Ledge, 4400 Level, 31-32C/D Stope, Pulled Chute, Ate Lunch.
0166	1L	H210	7/20/77	1153	1311	156	0.093	9 Ledge, 4400 Level, 31-32C/D Stope, Some Pulling of Chute.
0166	1L	H346	7/20/77	1311	1427	152	0.452	9 Ledge, 4400 Level, 31-32C/D Stope, Set Up and Drilled.
							TWA-0.178	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0166	1M	H311	7/19/77	0712	0845	186	1.942	9 Ledge, 3650 Level, 18B Stope, Set Up Drill Equipment.
0166	1M	H200	7/19/77	0845	1014	178	3.229	9 Ledge, 3650 Level, 18B Stope, Drill Sampling.
0166	1M	H283	7/19/77	1014	1134	160	3.838	9 Ledge, 3650 Level, 18B Stope, Ate Lunch.
0166	1M	H281	7/19/77	1134	1301	174	6.056	9 Ledge, 3650 Level, 18B Stope.
0166	1M	H134	7/19/77	1301	1433	184	2.247	9 Ledge, 3650 Level, 18B Stope.
							TWA-3.421	
0173	1I	H246	7/18/77	0810	1004	228	0.433	9 Ledge, 2150 Level, 49 Crosscut, Assemble Ring Drill.
0173	1I	H186	7/18/77	1004	1142	196	0.092	9 Ledge, 2150 Level, 49 Crosscut, Assemble Ring Drill.
0173	1I	H232	7/18/77	1142	1348	252	0.005	9 Ledge, 2150 Level, 49 Crosscut, Repair Ring Drill.
0173	1I	H182	7/18/77	1348	1449	122	0.039	9 Ledge, 2150 Level, 49 Crosscut, Repair Ring Drill.
							TWA-0.154	
0176	1A	H242	7/14/77	834	932	116	0.187	9 Ledge, 5450 Level, 64-65D Stope, Set Up Slusher.
0176	1A	H224	7/14/77	933	1038	130	0.639	9 Ledge, 5450 Level, 64-65D Stope, Loading Ore into Cars.
0176	1A	H238	7/14/77	1039	1154	150	0.698	9 Ledge, 5450 Level, 64-65D Stope, Slushing, Ate Lunch.
0176	1A	H240	7/14/77	1154	1252	116	0.602	9 Ledge, 5450 Level, 64-65D Stope, Slushing, Drilling.
0176	1A	H230	7/14/77	1252	1402	140	0.224	9 Ledge, 5450 Level, 64-65D Stope, Drilling.
0176	1A	H241	7/14/77	1403	1451	96	4.921	9 Ledge, 5450 level, 64-65D Stope, Some Drilling.
							TWA-1.047	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0176	1D	H44	7/12/77	0840	1053	266	0.804	Main Ledge, 6800 Level, 93-94C Cutting Sill, Slushing.
0176	1D	H43	7/12/77	1053	1305	264	0.420	Main Ledge, 6800 Level, 93-94C Cutting Sill, Ate Lunch.
0176	1D	H51	7/12/77	1306	1531	290	0.514	Main Ledge, 6800 Level, 93-94C Cutting Sill, Cleaned Mud from Slusher.
							TWA-0.578	
0176	1J	H297	7/15/77	0756	0935	198	0.085	21 Ledge, 6200 Level, 50-52B Stope, Hoisted Materials into Stope.
0176	1J	H298	7/15/77	0935	1304	418	0.089	21 Ledge, 6200 Level, 50-52B Stope, Some Drilling, Ate Lunch.
0176	1J	H296	7/15/77	1305	1450	208	0.191	21 Ledge, 6200 Level, 50-52B Stope, Set Charges for Blasting.
							TWA-0.114	
0176	1T	H38	7/14/77	0754	1015	282	0.821	11 Ledge, 5450 Level, 54B Stope, Loaded Lagging.
0176	1T	H11	7/14/77	1015	1145	180	1.174	11 Ledge, 5450 Level, 54B Stope, Some Drilling, Moved Equipment.
0176	1T	H19	7/14/77	1200	1327	174	0.800	11 Ledge, 5450 Level, 54B Stope, Some Drilling.
0176	1T	H21	7/14/77	1330	1510	200	1.962	11 Ledge, 5450 Level, 54B Stope.
							TWA-1.166	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0176	1U	H14	7/14/77	0754 -	915	162	1.018	11 Ledge, 5450 Level, 54B Stope, Washed Down. Stope.
0176	1U	H72	7/14/77	0915 -	1050	190	0.222	11 Ledge, 5450 Level, 54B Stope, Some Drilling.
0176	1U	H08	7/14/77	1050 -	1327	314	0.146	11 Ledge, 5450 Level, 54B Stope, Some Drilling, Ate Lunch.
0176	1U	H06	7/14/77	1330 -	1510	200	1.559	11 Ledge, 5450 Level, 54B Stope, Prepared for Blasting.
							TWA-0.652	
0176	1X	H215	7/14/77	0754 -	0950	232	0.535	9 Ledge, 5450 Level, 66-67C Stope, Wet Ore, Set Up Equipment.
0176	1X	H206	7/14/77	0950 -	1143	226	0.410	9 Ledge, 5450 Level, 66-67C Stope, Some Drilling, Ate Lunch.
0176	1X	H214	7/14/77	1143 -	1313	180	0.462	9 Ledge, 5450 Level, 66-67C Stope, Drilling.
0176	1X	H198	7/14/77	1313 -	1348	70	0.344	9 Ledge, 5450 Level, 66-67C Stope, Drilling.
0176	1X	H220	7/14/77	1352 -	1457	130	0.037	9 Ledge, 5450 Level, 66-67C Stope, Some Drilling.
							TWA-0.392	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0176	1Z	H226	7/14/77	828 -	932	128	1.103	9 Ledge, 5450 Level, 64-65D Stope, Removing Loose Rock and Wetting Ore.
0176	1Z	H227	7/14/77	933 -	1026	106	0.534	9 Ledge, 5450 Level, 64-65D Stope, Slushing, Wetting Ore.
0176	1Z	H236	7/14/77	1026 -	1153	174	0.961	9 Ledge, 5450 Level, 64-65D Stope, Slushing, Ate Lunch.
0176	1Z	H222	7/14/77	1153 -	1252	118	1.276	9 Ledge, 5450 Level, 64-65D Stope, Slushing, Drilling.
0176	1Z	H243	7/14/77	1254 -	1402	136	0.195	9 Ledge, 5450 Level, 64-65D Stope, Drilling.
0176	1Z	H223	7/14/77	1403 -	1446	86	0.490	9 Ledge, 5450 Level, 64-65D Stope, Some Drilling.
							TWA-0.781	
0182	1E	H379	7/18/77	720 -	908	216	0.045	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Drilling.
0182	1E	H372	7/18/77	908 -	1117	258	0.121	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Drilling, Ate Lunch.
0182	1E	H376	7/18/77	1117 -	1312	115	0.021	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Prepared for Blasting.
0182	1E	H374	7/18/77	1312 -	1433	162	0.134	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Prepared for Blasting.
							TWA-0.078	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0186	1F	H76	7/13/77	920	1020	120	0.080	11 Ledge, 5450 Level, 49-51 Stope, Set Up Drilling.
0186	1F	H12	7/13/77	1025	1243	138	0.192	11 Ledge, 5450 Level, 49-51 Stope, Some Drilling, Ate Lunch.
0186	1F	H03	7/13/77	1243	1440	234	0.896	11 Ledge, 5450 Level, 49-51 Stope, Some Drilling.
							TWA-0.432	
0186	1L	H83	7/12/77	0815	0918	126	0.268	Main Ledge, 6050 Level, 89E Stope, Set Up and Drilling.
0186	1L	H84	7/12/77	0918	1025	134	0.467	Main Ledge, 6050 Level, 89E Stope, Drilling.
0186	1L	H120	7/12/77	1025	1207	204	0.277	Main Ledge, 6050 Level, 89E Stope, Slushing, Ate Lunch.
0186	1L	H119	7/12/77	1207	1322	150	0.602	Main Ledge, 6050 Level, 89E Stope, Drilling.
0186	1L	H33	7/12/77	1321	1418	114	0.549	Main Ledge, 6050 Level, 89E Stope, Drilling.
0186	1L	H34	7/12/77	1418	1458	80	0.587	Main Ledge, 6050 Level, 89E Stope, Drilling.
							TWA-0.437	
0186	1N	H212	7/19/77	0714	0846	184	2.836	9 Ledge, 3650 Level, 18B Stope, Set Up Equipment.
0186	1N	H144	7/19/77	0846	1014	176	6.124	9 Ledge, 3650 Level, 18B Stope, Remove Ore, Haul Equipment.
0186	1N	H269	7/19/77	1014	1135	162	9.812	9 Ledge, 3650 Level, 18B Stope.
0186	1N	H271	7/19/77	1135	1302	174	0.923	9 Ledge, 3650 Level, 18B Stope.
0186	1N	H199	7/19/77	1302	1434	184	0.977	9 Ledge, 3650 Level, 18E Stope.
							TWA-4.011	

Table D-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0186	1P	H444	7/20/77	730 -	916	212	0.057	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling, Took Break.
0186	1P	H431	7/20/77	916 -	1055	198	0.341	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling, Ate Lunch.
0186	1P	H441	7/20/77	1125 -	1305	200	0.030	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
0186	1P	H442	7/20/77	1305 -	1430	170	0.184	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
							TWA-0.150	
0186	1P	H217	7/19/77	0705 -	0850	210	1.125	9 Ledge, 3650 Level, 27D Stope, Set Up Equipment.
0186	1P	H292	7/19/77	0850 -	1100	260	0.056	9 Ledge, 3650 Level, 27D Stope, Some Drilling.
0186	1P	H225	7/19/77	1100 -	1315	270	0.165	9 Ledge, 3650 Level, 27D Stope, Some Drilling, Ate Lunch.
0186	1P	H209	7/19/77	1315 -	1440	170	0.248	9 Ledge, 3650 level, 27D Stope, Some Drilling.
							TWA-0.371	
0190	1M	H421	7/21/77	805 -	930	170	0.071	Main Ledge, 4100-4250 Levels, Went to 62 Crosscut and 71 Pillar West.
0190	1M	H413	7/21/77	930 -	1058	176	0.212	Main Ledge, 4100-4250 Levels, Went to 58C East, 61 Timberline, 71C Timber and 70 Drift.
0190	1M	H415	7/21/77	1157 -	1327	180	1.079	Main Ledge, 4100-4250 Levels, Went to 64-65C Stope.
0190	1M	H107	7/21/77	1327 -	1414	94	0.410	Main Ledge, 4100-4250 Levels, Went to 4400 Level, 71 Crosscut.
							TWA-0.455	

Table D-2. Airborne sample results for fibers >5 μm in length for surface employees in the crushing mills at the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0201	1H	H396	7/19/77	632 -	844	264	2.577	Crushing-Surface, Feeder, Some Feeding, Operation Shut Down.
0201	1H	H393	7/19/77	844 -	1025	202	1.192	Crushing-Surface, Feeder, Some Feeding of Ore Switched to Waste, Yates.
0201	1H	H383	7/19/77	1025 -	1230	250	0.250	Crushing-Surface, Feeder, Some Feeding of Waste Ore, Ate Lunch, Yates.
0201	1H	H332	7/19/77	1230 -	1354	168	2.761	Crushing-Surface, Feeder, Some Feeding of Waste Ore.
							TWA-1.637	
0201	1I	H371	7/22/77	939 -	1132	226	0.213	Crushing-Surface, Crusher Feeder, Ate Lunch, Yates.
0201	1I	H401	7/22/77	0713 -	0939	292	1.718	Crushing-Surface, Crusher Feeder, Waste Ore, Yates.
0201	1I	H218	7/22/77	1132 -	1352	280	1.551	Air Hose for Clogged Rocks, Yates.
							TWA-1.233	
0202	1F	H466	7/20/77	0634 -	0845	262	1.017	Crushing-Surface, Ore Crusher Feeder, Ross.
0202	1F	H480	7/20/77	0845 -	1032	214	3.011	Crushing-Surface, Ore Crusher Feeder, Ross.
0202	1F	H470	7/20/77	1032 -	1250	276	1.498	Crushing-Surface, Ore Crusher Feeder, Ross.
0202	1F	H459	7/20/77	1250 -	1405	150	6.061	Crushing-Surface, Ore Crusher Feeder, Ross.
							TWA-2.476	

Table D-2 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0204	1G	H399	7/19/77	626 -	840	268	2.332	Crushing-Surface, Chip Picking Occasionally, Operation Shut Down, Yates.
0204	1G	H391	7/19/77	840 -	1030	220	0.257	Crushing-Surface, Some Chip Picking Switched to Waste, Yates.
0204	1G	H394	7/19/77	1030 -	1229	238	1.879	Crushing-Surface, Some Chip Picking, Ate Lunch, Waste Ore, Yates.
0204	1G	H388	7/19/77	1229 -	1354	170	0.595	Crushing-Surface, Some Chip Picking of Waste Ore, Yates.
							TWA-1.373	
0204	1G	H481	7/20/77	0639 -	0843	248	1.087	Crushing-Surface, Chip Picker, Inspects Ore on Conveyor from 30 Inch, Ross.
0204	1G	H262	7/20/77	0843 -	1029	212	3.948	Crushing-Surface, Chip Picker, Ross.
0204	1G	H475	7/20/77	1029 -	1240	262	1.039	Crushing-Surface, Chip Picker, Ross.
0204	1G	H456	7/20/77	1241 -	1405	168	2.571	Crushing-Surface, Chip Picker, Ross.
							TWA-2.034	
0204	1G	H253	7/22/77	0709 -	0936	294	0.061	Crushing-Surface, Beltman-Chip Picker Waste Ore, Yates.
0204	1G	H293	7/22/77	0936 -	1213	314	0.403	Crushing-Surface, Beltman-Chip Picker, Yates.
0204	1G	H398	7/22/77	1213 -	1351	196	0.252	Crushing-Surface, Beltman-Chip Picker, Yates.
							TWA-0.241	

Table D-2 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0205	1E	H430	7/20/77	0627	0839	264	4.174	Crushing-Surface, Clean Up, Ore Crusher Feeder, and Shoveled Spills From Conveyor, Ross.
0205	1E	H468	7/20/77	0839	1027	216	1.430	Crushing-Surface, Clean Up, Ross.
0205	1E	H467	7/20/77	1028	1248	280	4.279	Crushing-Surface, Clean Up, Ross.
0205	1E	H359	7/20/77	1248	1407	158	1.427	Crushing-Surface, Clean Up, Ross.
							TWA-3.088	
0205	1F	H384	7/19/77	622	848	292	0.982	Crushing-Surface, Clean Up, Some Chip Picking of Ore, Yates.
0205	1F	H389	7/19/77	848	1040	224	2.849	Crushing-Surface, Clean Up-Switch to Waste Ore, Yates.
0205	1F	H392	7/19/77	1040	1224	208	1.256	Crushing-Surface, Clean Up-Waste Ore, Ate Lunch, Yates.
0205	1F	H382	7/19/77	1224	1354	180	1.024	Crushing-Surface, Clean Up-Waste Ore.
							TWA-1.516	
0205	1H	H360	7/22/77	0712	0935	286	0.147	Crushing-Surface, Clean Up-Waste Ore, Yates.
0205	1H	H420	7/22/77	0935	1130	230	0.607	Crushing-Surface, Clean Up, Yates.
0205	1H	H397	7/22/77	1130	1351	282	1.452	Crushing-Surface, Clean Up, Yates.
							TWA-0.741	

Table D-2 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0206	1H	H479	7/20/77	0650	0724	68	16.204	Crushing-Surface, Clean Up, Sweep Floor, Clean Off Grate, Ross.
0206	1H	H476	7/20/77	0724	0752	56	10.068	Crushing-Surface, Clean Up, Shovels Ore Off Floor, Ross.
0206	1H	H453	7/20/77	0752	0828	72	15.722	Crushing-Surface, Clean Up, Ross.
0206	1H	H472	7/20/77	0828	0914	92	8.181	Crushing-Surface, Clean Up, Ross.
0206	1H	H474	7/20/77	0914	1105	222	0.980	Crushing-Surface, Clean Up, Ate Lunch, Ross.
0206	1H	H437	7/20/77	1159	1350	222	1.257	Crushing-Surface, Clean Up, Swept Floor, Shoveled Floor, Ross.
0206	1H	H452	7/20/77	1350	1405	30	0.723	Crushing-Surface, Clean Up, Ross.
							TWA-5.339	

Table D-3. Airborne sample results for fibers >5 μm in length for underground employees on the 9 Ledge of the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0914	1K	H329	7/18/77	0702	0806	248	0.533	9 Ledge, 2150 Level, 49 Crosscut, Putting Up Door.
0914	1K	H130	7/18/77	0806	0909	126	0.851	9 Ledge, 2150 Level, Carpenter.
0915	1K	H322	7/18/77	0909	1010	122	3.872	9 Ledge, 2150 Level, Carpenter.
0914	1K	H141	7/18/77	1010	1153	206	0.286	9 Ledge, 2150 Level, Carpenter.
0914	1K	H99	7/18/77	1153	1255	124	0.350	9 Ledge, 2150 Level, Carpenter.
							TWA-1.063	
0932	1C	H239	7/18/77	0730	0905	190	1.561	9 Ledge, 1700 Level, Motorman, Hauled Ore.
0932	1C	H95	7/18/77	0905	1138	306	0.437	9 Ledge, 1700 Level, Motorman, Hauled Ore, Washed Cars, Dumped Waste.
0932	1C	H27	7/18/77	1138	1447	378	0.796	9 Ledge, 1700 Level, Motorman.
							TWA-0.837	
0952	1B	H211	7/18/77	831	1010	198	0.693	9 Ledge, 1700 Level, 24A Stope.
0952	1B	H153	7/18/77	0657	0831	188	0.128	9 Ledge, 1700 Level, 24A Stope, Drilling.
0952	1B	H174	7/18/77	1010	1210	240	0.100	9 Ledge, 1700 Level, 24A Stope.
0952	1B	H160	7/18/77	1210	1432	284	0.246	9 Ledge, 1700 Level, 24A Stope.
							TWA-0.280	

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0952	1F	H378	7/18/77	723	907	208	0.151	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Slushing, Drilling.
0952	1F	H370	7/18/77	907	1117	260	0.634	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Slushing, Drilling, Ate Lunch.
0952*	1F	H373	7/18/77	1117	1312	0	0.000	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Slushing and Prepared for Blasting (Lost Sample).
0952	1F	H349	7/18/77	1312	1433	162	0.074	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Prepared for Blasting.
							TWA-0.331	
0952	1J	H356	7/18/77	835	955	160	0.075	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Slushing.
0952	1J	H369	7/18/77	956	1016	40	0.151	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Pulling Chute.
0952	1J	H364	7/18/77	1018	1034	16	0.376	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Pulling Chute.
0952	1J	H345	7/18/77	1035	1044	18	0.067	9 Ledge, 2000 Level, 45-51G/H Blast Hole.
0952	1J	H353	7/18/77	1044	1054	20	0.542	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Loading Ore.
0952	1J	H367	7/18/77	1055	1158	126	0.994	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Ate Lunch, Loading Ore, Blast.
0952	1J	H361	7/18/77	1158	1255	114	0.465	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Loading Ore.
0952	1J	H362	7/18/77	1255	1322	54	0.112	9 Ledge, 2000 Level, 45-51G/H Blast Hole.
0952	1J	H366	7/18/77	1322	1406	88	0.151	9 Ledge, 2000 Level, 45-51G/H Blast Hole.
0952	1J	H355	7/18/77	1406	1440	68	6.559	9 Ledge, 2000 Level, 45-51G/H Blast Hole.
							TWA-0.952	

* Note: This sample not included in the TWA and Statistical Results.

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0953	1H	H204	7/18/77	0725 -	0844	158	2.722	9 Ledge, 2150 Level, 49 Crosscut, Ring Drilling.
0953	1H	H229	7/18/77	0844 -	1000	152	0.681	9 Ledge, 2150 Level, 49 Crosscut, Maintenance Work.
0953	1H	H55	7/18/77	1000 -	1145	210	0.235	9 Ledge, 2150 Level, 49 Crosscut, Ate Lunch.
0953	1H	H245	7/18/77	1145 -	1315	180	0.020	9 Ledge, 2150 Level, 49 Crosscut.
0953	1H	H73	7/18/77	1315 -	1428	146	0.330	9 Ledge, 2150 Level, 49 Crosscut.
							TWA-0.750	
0953	1M	H324	7/18/77	659 -	816	154	0.063	9 Ledge, 2150 Level, 49 Crosscut, Hanging Pipe.
0953	1M	H256	7/18/77	816 -	914	116	1.266	9 Ledge, 2150 Level, 49 Crosscut, Hanging Pipe, Mucking.
0953	1M	H333	7/18/77	914 -	1012	116	0.187	9 Ledge, 2150 Level, 49 Crosscut, Some Mucking.
0953	1M	H338	7/18/77	1012 -	1033	42	0.143	9 Ledge, 2150 Level, 49 Crosscut, Some Mucking.
0953	1M	H126	7/18/77	1033 -	1135	124	0.126	9 Ledge, 2150 Level, 49 Crosscut, Some Mucking, Ate Lunch.
0953	1M	H98	7/18/77	1135 -	1211	72	0.569	9 Ledge, 2150 Level, 49 Crosscut, Some Mucking.
0953	1M	H342	7/18/77	1211 -	1245	68	1.045	9 Ledge, 2150 Level, 49 Crosscut, Mucking.
0953	1M	H127	7/18/77	1245 -	1325	80	0.647	9 Ledge, 2150 Level, 49 Crosscut, Mucking.
0953	1M	H363	7/18/77	1325 -	1437	144	0.092	9 Ledge, 2150 Level, 49 Crosscut, Worked on Gate.
							TWA-0.411	

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operaation, activity, etc.)
0954	1A	H187	7/18/77	850	1135	330	0.401	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Some Drilling.
0954	1A	H71	7/18/77	0715	0850	190	0.781	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Some Mucking and Drilling.
0954	1A	H184	7/18/77	1135	1257	164	0.705	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Drilling.
0954	1A	H196	7/18/77	1257	1440	206	0.491	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Blasting.
							TWA-0.559	
0954	1D	H208	7/18/77	0713	0855	204	1.687	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Some Mucking and Drilling.
0954	1D	H63	7/18/77	0855	1135	320	0.166	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Some Mucking, Loading and Drilling.
0954	1D	H173	7/18/77	1135	1255	160	0.715	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Drilling.
0954	1D	H88	7/18/77	1255	1442	214	0.540	9 Ledge, 1700 Level, Drift South of 22 Crosscut, Prepare for Blasting.
							TWA-0.698	

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0955	1A	H65	7/13/77	0832	0955	166	1.422	9 Ledge, 5750 Level, 68C Stope, Slushing.
0955	1A	H54	7/13/77	0956	1130	188	0.397	9 Ledge, 5750 Level, 68C Stope, Slushing.
0955	1A	H52	7/13/77	1135	1310	190	0.235	9 Ledge, 5750 Level, 68C Stope, Eating Lunch Some of the Time.
0955	1A	H122	7/13/77	1310	1455	210	0.178	9 Ledge, 5750 Level, 68C Stope, Set Up Drill Equipment.
							TWA-0.521	
0955	1B	H110	7/13/77	0804	0922	156	0.984	9 Ledge, 5750 Level, 68C Stope, Pulling Chute.
0955	1B	H62	7/13/77	0922	1053	182	0.569	9 Ledge, 5750 Level, 68C Stope, Barred, Ate Lunch.
0955	1B	H116	7/13/77	1155	1323	176	0.123	9 Ledge, 5750 Level, 68C Stope, Electricity Went Off, Workers Not Working at Time of Sample.
0955	1B	H106	7/13/77	1323	1503	200	0.421	9 Ledge, 5750 Level, 68C Stope, Electricity Went Off, Workers Not Working.
							TWA-0.508	
0956	1A	H318	7/22/77	0807	0957	220	2.105	9 Ledge, 4700 Level, 37F Stope, Set Up Equipment, Drilling.
0956	1A	H299	7/22/77	0957	1144	214	0.703	9 Ledge, 4700 Level, 37F Stope, Drilling, Ate Lunch.
0956	1A	H202	7/22/77	1144	1302	156	0.564	9 Ledge, 4700 Level, 37F Stope, Drilling.
0956	1A	H407	7/22/77	1302	1358	112	0.344	9 Ledge, 4700 Level, 37F Stope, Some Drilling.
							TWA-1.054	

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0956	1B	H417	7/21/77	0715	0859	208	1.524	9 Ledge, 3950 Level, 24-25B Stope, Loaded Cars with Ore.
0956	1B	H90	7/21/77	1046	1232	212	0.136	9 Ledge, 3950 Level, 24-25B Stope, Loaded Cars, Ate Lunch.
0956	1B	H310	7/21/77	1232	1405	18′	0.382	9 Ledge, 3950 Level, 24-25B Stope.
0956	1B	H405	7/21/77	1405	1449	88	0.246	9 Ledge, 3950 Level, 24-25B Stope.
							TWA-0.632	
0956	1B	H312	7/22/77	0807	0955	216	0.307	9 Ledge, 4700 Level, 37F Stope, Slushing.
0956	1B	H465	7/22/77	0955	1223	296	0.232	9 Ledge, 4700 Level, 37F Stope, Drilling, Ate Lunch.
0956	1B	H276	7/22/77	1223	1358	190	0.298	9 Ledge, 4700 Level, 37F Stope, Drilling.
							TWA-0.273	
0956	1J	H124	7/13/77	808	907	118	0.745	9 Ledge, 5750 Level, 67-68D Stope, Wetted Ore.
0956	1J	H145	7/13/77	907	1010	126	0.363	9 Ledge, 5750 Level, 67-68D Stope, Drilled.
0956	1J	H133	7/13/77	1011	1140	178	0.325	9 Ledge, 5750 Level, 67-68D Stope, Some Drilling, Ate Lunch.
0956	1J	H146	7/13/77	1140	1234	108	0.335	9 Ledge, 5750 Level, 67-68D Stope, Drilled.
0956	1J	H131	7/13/77	1235	1309	68	0.496	9 Ledge, 5750 Level, 67-68D Stope, Some Drilling.
0956	1J	H109	7/13/77	1309	1355	92	1.204	9 Ledge, 5750 Level, 67-68D Stope, Prepared for Blasting.
0956	1J	H137	7/13/77	1355	1443	96	0.100	9 Ledge, 5750 Level, 67-68D Stope, Prepared for Blasting, Put in Roof Bolts.
							TWA-0.486	

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0956	1K	H138	7/13/77	808 -	907	118	0.214	9 Ledge, 5750 Level, 67-68D Stope, Set Up for Drilling.
0956	1K	H135	7/13/77	907 -	1010	126	0.134	9 Ledge, 5750 Level, 67-68D Stope, Drilled.
0956	1K	H136	7/13/77	1011 -	1140	178	0.068	9 Ledge, 5750 Level, 67-68D Stope, Some Drilling, Ate Lunch.
0956	1K	H128	7/13/77	1140 -	1234	108	0.290	9 Ledge, 5750 Level, 67-68D Stope, Drilled.
0956	1K	H125	7/13/77	1235 -	1309	68	1.576	9 Ledge, 5750 Level, 67-68D Stope, Drilled.
0956	1K	H143	7/13/77	1355 -	1444	98	0.184	9 Ledge, 5750 Level, 67-68D Stope, Prepared for Blasting, Put in Roof Bolts.
							TWA-0.303	
0956	1K	H235	7/20/77	0728 -	0848	160	0.188	9 Ledge, 4400 Level, 31-32C/D Stope, Slushing, Cable Repair.
0956	1K	H341	7/20/77	1023 -	1139	152	2.010	9 Ledge, 4400 Level, 31-32C/D Stope, Slushing.
0956	1K	H352	7/20/77	1139 -	1332	226	0.437	9 Ledge, 4400 Level, 31-32C/D Stope.
0956	1K	H358	7/20/77	1332 -	1428	112	0.376	9 Ledge, 4400 Level, 31-32C/D Stope, Set Up for Drilling, Drilling.
							TWA-0.733	
0956	1L	H140	7/19/77	0710 -	0845	190	0.146	9 Ledge, 3650 Level, 18B Stope, Setting Up Equipment.
0956	1L	H175	7/19/77	1015 -	1134	158	0.610	9 Ledge, 3650 Level, 18B Stope, Lunch.
0956	1L	H176	7/19/77	1134 -	1300	172	0.182	9 Ledge, 3650 Level, 18B Stope,
0956	1L	H195	7/19/77	1300 -	1433	186	0.065	

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0956	1N	H438	7/20/77	730 -	914	208	0.278	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling.
0956*	1N	H445	7/20/77	914 -	930	0	0.000	9 Ledge, 4250 Level, 36-37B/C Stope, Dropped Filter, Voided for Fiber Count.
0956	1N	H439	7/20/77	931 -	1058	174	0.076	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling, Ate Lunch.
0956	1N	H432	7/20/77	1125 -	1304	198	0.450	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling.
							TWA-0.276	
0956	1O	H440	7/20/77	731 -	915	208	0.573	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling.
0956	1O	H449	7/20/77	915 -	1058	206	0.164	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling, Ate Lunch.
0956	1O	H451	7/20/77	1127 -	1304	194	0.217	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
0956	1O	H434	7/20/77	1304 -	1432	176	0.513	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
							TWA-0.364	
0956	1P	H431	720/77	916 -	1055	198	0.341	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling, Ate Lunch.
							TWA-0.341	

* Note: This sample is not included in the TWA and Statistical Results.

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0956	1Q	H408	7/19/77	702 -	0901	238	0.025	9 Ledge, 3950 Level, 18G Stope, Set Up Equipment.
0956	1Q	H402	7/19/77	0901 -	1143	324	0.190	9 Ledge, 3950 Level, 18G Stope.
0956	1Q	H411	7/19/77	1143 -	1312	178	0.636	9 Ledge, 3950 Level, 18G Stope, Drilling.
0956	1Q	H400	7/19/77	1312 -	1421	138	0.131	9 Ledge, 3950 Level, 18G Stope, Some Drilling.
							TWA-0.226	
0956	1R	H406	7/19/77	0718 -	0935	274	0.105	9 Ledge, 3950 Level, 18G Stope, Set Up Equipment.
0956	1R	H404	7/19/77	0935 -	1144	258	0.075	9 Ledge, 3950 Level, 18G Stope.
0956	1R	H409	7/19/77	1144 -	1312	176	0.897	9 Ledge, 3950 Level, 18G Stope, Drilling.
0956	1R	H412	7/19/77	1312 -	1420	136	0.027	9 Ledge, 3950 Level, 18G Stope, Some Drilling.
							TWA-0.248	
0956	1V	H306	7/19/77	706 -	850	208	0.666	9 Ledge, 3650 Level, 27D Stope, Set Up Equipment, Some Drilling.
0956	1V	H274	7/19/77	850 -	1104	268	0.279	9 Ledge, 3650 Level, 27D Stope, Drilling.
0956	1V	H302	7/19/77	1315 -	1440	170	0.170	9 Ledge, 3650 Level, 27D Stope, Some Drilling.
							TWA-0.375	
0956	1W	H101	7/19/77	706 -	850	208	0.434	9 Ledge, 3650 Level, 27D Stope, Some Drilling.
0956	1W	H278	7/19/77	850 -	1104	268	0.431	9 Ledge, 3650 Level, 27D Stope, Drilling.
0956	1W	H305	7/19/77	1315 -	1440	170	0.425	9 Ledge, 3650 Level, 27D Stope, Some Drilling.
							TWA-0.430	

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0956	1Y	H221	7/14/77	0745 -	0950	232	0.296	9 Ledge, 5450 Level, 66-67C Stope, Set Up Equipment, Some Slushing.
0956	1Y	H216	7/14/77	0950 -	1143	226	1.715	9 Ledge, 5450 Level, 66-67C Stope, Some Drilling, Ate Lunch.
0956	1Y	H203	7/14/77	1143 -	1313	180	1.216	9 Ledge, 5450 Level, 66-67C Stope, Drilling.
0956	1Y	H197	7/14/77	1313 -	1457	208	0.156	9 Ledge, 5450 Level, 66-67C Stope, Drilling.
							TWA-0.836	
0962	1G	H237	7/18/77	833 -	1007	188	0.045	9 Ledge, 1700 Level, 24A Stope.
0962	1G	H180	7/18/77	0700 -	0833	186	0.123	9 Ledge, 1700 Level, 24A Stope, Set Up Drill Equipment.
0962	1G	H140	7/18/77	1007 -	1210	246	0.078	9 Ledge, 1700 Level, 24A Stope.
0962	1G	H168	7/18/77	1210 -	1430	280	2.258	9 Ledge, 1700 Level, 24A Stope.
							TWA-0.759	
0963	1L	H337	7/18/77	703 -	806	126	0.191	9 Ledge, 2150 Level, at Motor Barn, Put Up Door.
0963	1L	H56	7/18/77	806 -	909	126	5.018	9 Ledge, 2150 Level, Some Drilling, Put Up Door.
0963	1L	H267	7/18/77	909 -	1010	122	3.085	9 Ledge, 2150 Level, Put Up Door.
0963	1L	H121	7/18/77	1010 -	1216	252	0.540	9 Ledge, 2150 Level, Put Up Door, Ate Lunch.
0963	1L	H115	7/18/77	1216 -	1327	142	0.483	9 Ledge, 2150 Level, Worked on Gate.
0963	1L	H321	7/18/77	1327 -	1437	140	1.677	9 Ledge, 2150 Level, Worked on Gate.
							TWA-1.621	

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On - Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0966	1A	H357	7/21/77	0714 - 0856	204	0.575	9 Ledge, 3950 Level, 24-25B Stope, Set Up Slushing Equipment.
0966	1A	H205	7/21/77	0856 - 1049	226	0.208	9 Ledge, 3950 Level, 24-25B Stope, Slushing.
0966	1A	H250	7/21/77	1049 - 1236	214	0.657	9 Ledge, 3950 Level, 24-25B Stope, Ate Lunch, Slushed.
0966	1A	H418	7/21/77	1236 - 1401	170	0.120	9 Ledge, 3950 Level, 24-25B Stope.
0966	1A	H387	7/21/77	1401 - 1449	96	0.106	9 Ledge, 3950 Level, 24-25B Stope.
						TWA-0.420	
0966	1L	H368	7/20/77	0848 - 1012	168	0.151	9 Ledge, 4400 Level, 31-32C/D Stope, Pulled Chute, Put Car Back on Track.
0966	1L	H344	7/20/77	1012 - 1153	202	0.060	9 Ledge, 4400 Level, 31-32C/D Stope, Pulled Chute, Ate Lunch.
0966	1L	H210	7/20/77	1153 - 1311	156	0.093	9 Ledge, 4400 Level, 31-32C/D Stope, Some Pulling of Chute.
0966	1L	H346	7/20/77	1311 - 1427	152	0.452	9 Ledge, 4400 Level, 31-32C/D Stope, Set Up and Drilled.
						TWA-0.178	
0966	1M	H311	7/19/77	0712 - 0845	186	1.942	9 Ledge, 3650 Level, 18B Stope, Set Up Drill Equipment.
0966	1M	H200	7/19/77	0845 - 1014	178	3.229	9 Ledge, 3650 Level, 18B Stope, Drill Sampling.
0966	1M	H283	7/19/77	1014 - 1134	160	3.838	9 Ledge, 3650 Level, 18B Stope, Ate Lunch.
0966	1M	H281	7/19/77	1134 - 1301	174	6.056	9 Ledge, 3650 Level, 18B Stope.
0966	1M	H134	7/19/77	1301 - 1433	184	2.247	9 Ledge, 3650 Level, 18B Stope.
						TWA-3.421	

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0973	1I	H246	7/18/77	0810 -	1004	228	0.433	9 Ledge, 2150 Level, 49 Crosscut, Assemble Ring Drill.
0973	1I	H186	7/18/77	1004 -	1142	196	0.092	9 Ledge, 2150 Level, 49 Crosscut, Assemble Ring Drill.
0973	1I	H232	7/18/77	1142 -	1348	252	0.005	9 Ledge, 2150 Level, 49 Crosscut, Repair Ring Drill.
0973	1I	H182	7/18/77	1348 -	1449	122	0.039	9 Ledge, 2150 Level, 49 Crosscut, Repair Ring Drill.
							TWA-0.154	
0976	1A	H242	7/14/77	834 -	932	116	0.187	9 Ledge, 5450 Level, 64-65D Stope, Set Up Slusher.
0976	1A	H224	7/14/77	933 -	1038	130	0.639	9 Ledge, 5450 Level, 64-65D Stope, Loading Ore into Cars.
0976	1A	H238	7/14/77	1039 -	1154	150	0.698	9 Ledge, 5450 Level, 64-65D Stope, Slushing, Ate Lunch.
0976	1A	H240	7/14/77	1154 -	1252	116	0.602	9 Ledge, 5450 Level, 64-65D Stope, Slushing, Drilling.
0976	1A	H230	7/14/77	1252 -	1402	140	0.224	9 Ledge, 5450 Level, 64-65D Stope, Drilling.
0976	1A	H241	7/14/77	1403 -	1451	96	4.921	9 Ledge, 5450 Level, 64-65D Stope, Some Drilling.
							TWA-1.047	

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0976	1X	H215	7/14/77	0745	0950	232	0.535	9 Ledge, 5450 Level, 66-67C Stope, Wet Ore, Set Up Equipment.
0976	1X	H206	7/14/77	0950	1143	226	0.410	9 Ledge, 5450 Level, 66-67C Stope, Some Drilling, Ate Lunch.
0976	1X	H214	7/14/77	1143	1313	180	0.462	9 Ledge, 5450 Level, 66-67C Stope, Drilling.
0976	1X	H198	7/14/77	1313	1348	70	0.344	9 Ledge, 5450 Level, 66-67C Stope, Some Drilling.
0976	1X	H220	7/14/77	1352	1457	130	0.037	9 Ledge, 5450 Level, 66-67C Stope, Some Drilling.
							TWA-0.392	
0976	1Z	H226	7/14/77	828	932	128	1.103	9 Ledge, 5450 Level, 64-65D Stope, Removing Loose Rock and Wetting Ore.
0976	1Z	H227	7/14/77	933	1026	106	0.534	9 Ledge, 5450 Level, 64-65D Stope, Slushing, Wetting Ore.
0976	1Z	H236	7/14/77	1026	1153	174	0.961	9 Ledge, 5450 Level, 64-65D Stope, Slushing, Ate Lunch.
0976	1Z	H222	7/14/77	1153	1252	118	1.276	9 Ledge, 5450 Level, 64-65D Stope, Slushing, Drilling.
0976	1Z	H243	7/14/77	1254	1402	136	0.195	9 Ledge, 5450 Level, 64-65D Stope, Drilling.
0976	1Z	H223	7/14/77	1403	1446	86	0.490	9 Ledge, 5450 Level, 64-65D Stope, Some Drilling.
							TWA-0.781	

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0982	1E	H379	7/18/77	720	908	216	0.045	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Drilling.
0982	1E	H372	7/18/77	908	1117	258	0.121	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Drilling, Ate Lunch.
0982	1E	H376	7/18/77	1117	1312	115	0.021	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Prepared for Blasting.
0982	1E	H374	7/18/77	1312	1433	162	0.134	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Prepared for Blasting.
							TWA-0.078	
0986	1N	H212	7/19/77	0714	0846	184	2.836	9 Ledge, 3650 Level, 18B Stope, Set Up Equipment.
0986	1N	H144	7/19/77	0846	1014	176	6.124	9 Ledge, 3650 Level, 18B Stope, Remove Ore and Haul Equipment.
0986	1N	H269	7/19/77	1014	1135	162	9.812	9 Ledge, 3650 Level, 18B Stope.
0986	1N	H271	7/19/77	1135	1302	174	0.923	9 Ledge, 3650 Level, 18B Stope.
0986	1N	H199	7/19/77	1302	1434	184	0.977	9 Ledge, 3650 Level, 18B Stope.
							TWA-4.011	
0986	1P	H444	7/20/77	730	916	212	0.057	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling, Took Break.
0986	1P	H431	7/20/77	916	1055	198	0.341	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling, Ate Lunch.
0986	1P	H441	7/20/77	1125	1305	200	0.030	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
0986	1P	H442	7/20/77	1305	1430	170	0.184	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
							TWA-0.150	

Table D-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
0986	1P	H217	7/19/77	0705 -	0850	210	1.125	9 Ledge, 4250 Level, 36-37B/C Stope, Set Up Equipment.
0986	1P	H292	7/19/77	0850 -	1100	260	0.056	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling.
0986	1P	H225	7/19/77	1100 -	1315	270	0.165	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling, Ate Lunch.
0986	1P	H209	7/19/77	1315 -	1440	170	0.248	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling.
							TWA-0.371	

Table D-4. Airborne sample results for fibers >5 μm in length for underground employees on the Main Ledge of the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1010	1G	H365	7/21/77	0728	0916	216	1.161	Main Ledge, 4250 Level, 71C Stope, Set Timber for Track.
1010	1G	H446	7/21/77	0916	1047	182	0.119	Main Ledge, 4250 Level, 71C Stope, Waited for Timber to Arrive.
1010	1G	H447	7/21/77	1047	1248	242	0.264	Main Ledge, 4250 Level, 71C Stope, Ate Lunch, Blasted and Worked on Timberline.
1010	1G	H469	7/21/77	1248	1426	196	0.510	Main Ledge, 4250 Level, 71C Stope, Worked on Timberline.
							TWA-0.522	
1010	1H	H443	7/21/77	0728	0917	218	1.741	Main Ledge, 4250 Level, 71C Stope, Set Timbers for Track.
1010	1H	H375	7/21/77	0917	1055	196	0.221	Main Ledge, 4250 Level, 71C Stope, Waiting for Timber.
1010	1H	H435	7/21/77	1055	1248	226	0.888	Main Ledge, 4250 Level, 71C Stope, Ate Lunch, Blasted and Worked on Timberline.
1010	1H	H448	7/21/77	1248	1426	196	0.913	Main Ledge, 4250 Level, 71C Stope, Worked on Timberline.
							TWA-0.960	

Table D-4 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1033	1G	H69	7/12/77	910 -	1145	310	0.144	Main Ledge, 6500 Level, Helped in Slushing, Ate Lunch.
1033	1G	H61	7/12/77	0810 -	909	136	4.591	Main Ledge, 6500 Level, Hauling Rock, Pulling Raise.
1033	1G	H70	7/12/77	1145 -	1405	520	0.167	Main Ledge, 6500 Level, Helped Muck and Slush Ore.
1033	1G	H67	7/12/77	1405 -	1525	160	0.602	Main Ledge, 6500 Level, Helped Muck and Slush, Drove Motor Car.
							TWA-0.917	
1043	1R	H261	7/14/77	0715 -	0852	194	0.223	Main Ledge, 6050 Level, 90 Pillar, Wet Drilling.
1043	1R	H265	7/14/77	0852 -	1043	222	2.956	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
1043	1R	H255	7/14/77	1043 -	1213	160	5.231	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling, Ate Lunch.
1043*	1R	H268	7/14/77	1213 -	1404	222	0.000	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling. Cap Left on Sample, Voided For Fiber Count.
1043	1R	H266	7/14/77	1404 -	1446	84	6.647	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
							TWA-2.438	

* Note: This sample not included in the TWA and Statistical Results.

Table D-4 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1044	1S	H248	7/14/77	0717	0850	186	3.431	Main Ledge, 6050 Level, 90 Pillar, Assist in Bore Machine Drilling.
1044	1S	H257	7/14/77	0850	1042	224	1.917	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling, Ate Lunch.
1044	1S	H234	7/14/77	1042	1212	180	3.579	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
1044	1S	H233	7/14/77	1212	1401	218	2.210	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
1044	1S	H264	7/14/77	1401	1446	90	1.271	Main Ledge, 6050 Level, 90 Pillar, Some Drilling.
							TWA-2.570	
1054	1J	H416	7/21/77	748	945	234	4.889	Main Ledge, 4250 Level, 70 Crosscut, Some Drilling, Took Break.
1054	1J	H403	7/21/77	945	1152	254	1.831	Main Ledge, 4250 Level, 70 Crosscut, Drilled, Ate Lunch.
1054	1J	H307	7/21/77	1152	1330	196	0.172	Main Ledge, 4250 Level, 70 Crosscut, Drilled.
1054	1J	H316	7/21/77	1330	1439	138	4.625	Main Ledge, 4250 Level, 70 Crosscut, Prepared for Blasting.
							TWA-2.775	
1054	1L	H381	7/21/77	0747	0945	236	0.250	Main Ledge, 4250 Level, 70 Crosscut, Set Up Equipment, Wet Drilling.
1054	1L	H294	7/21/77	0945	1130	210	0.080	Main Ledge, 4250 Level, 70 Crosscut, Some Drilling, Ate Lunch.
1054	1L	H414	7/21/77	1155	1333	196	1.360	Main Ledge, 4250 Level, 70 Crosscut, Drilled.
1054	1L	H219	7/21/77	1333	1442	138	3.148	Main Ledge, 4250 Level, 70 Crosscut, Prepared for Blasting.
							TWA-0.996	

Table D-4 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1055	1F	H07	7/12/77	0758	0958	240	2.835	Main Ledge, 6500 Level, Mucked, Slushed and Dumped Ore.
1055	1F	H25	7/12/77	0958	1146	216	0.784	Main Ledge, 6500 Level, Mucked, Slushed.
1055	1F	H15	7/12/77	1146	1408	284	0.986	Main Ledge, 6500 Level, Mucked, Slushed, Ate Lunch.
1055	1F	H01	7/12/77	1408	1528	160	0.489	Main Ledge, 6500 Level, Set Up Drilling Equipment.
							TWA-1.342	
1056	1C	H49	7/12/77	0805	1055	180	0.335	Main Ledge, 6800 Level, 93-94C Cutting Sill, Slushing.
1056	1C	H45	7/12/77	1301	1531	180	0.381	Main Ledge, 6800 Level, 93-94C Cutting Sill, Slushing.
							TWA-0.357	
1056	1J	H18	7/12/77	0815	0918	126	0.048	Main Ledge, 6050 Level, 89E Stope, Set Up Drill Equipment.
1056	1J	H80	7/12/77	0918	1145	294	0.258	Main Ledge, 6050 Level, 89E Stope, Pulling Chute, Lunch.
1056	1J	H39	7/12/77	1145	1322	194	0.719	Main Ledge, 6050 Level, 89E Stope, Drilling.
1056	1J	H16	7/12/77	1322	1418	112	2.444	Main Ledge, 6050 Level, 89E Stope, Drilling.
1056	1J	H37	7/12/77	1418	1458	80	1.785	Main Ledge, 6050 Level, 89E Stope, Drilling.
							TWA-0.791	

Table D-4 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1056	1K	H78	7/12/77	0815	0918	126	0.363	Main Ledge, 6050 Level, 89E Stope, Set Up for Drilling, Drilling.
1056	1K	H91	7/12/77	0918	1025	134	0.620	Main Ledge, 6050 Level, 89E Stope, Drilling.
1056	1K	H92	7/12/77	1025	1207	204	0.331	Main Ledge, 6050 Level, 89E Stope, Started Slushing, Ate Lunch.
1056	1K	H77	7/12/77	1207	1321	148	0.651	Main Ledge, 6050 Level, 89E Stope, Drilling.
1056	1K	H17	7/12/77	1322	1418	112	1.064	Main Ledge, 6050 Level, 89E Stope, Drilling.
1056	1K	H22	7/12/77	1418	1459	82	1.145	Main Ledge, 6050 Level, 89E Stope, Drilling.
							TWA-0.627	
1057	1D	H350	7/21/77	855	1055	240	0.226	Main Ledge, 4100 Level, 58E Stope, Timber Stope, Ate Lunch.
1057	1D	H41	7/21/77	0723	0855	184	0.808	Main Ledge, 4100 Level, 58E Stope, Timber Stope.
1057	1D	H343	7/21/77	1146	1323	194	0.273	Main Ledge, 4100 Level, 58E Stope.
1057	1D	H162	7/21/77	1324	1416	104	0.197	Main Ledge, 4100 Level, 58E Stope, Bracing.
							TWA-0.383	
1057	1D	H380	7/22/77	0746	0940	228	0.058	Main Ledge, 4100 Level, 61 Crosscut, Cut and Stand Timber.
1057	1D	H462	7/22/77	0940	1149	258	1.111	Main Ledge, 4100 Level, 61 Crosscut, Cut and Stand Timber.
1057	1D	H390	7/22/77	1149	1329	200	0.217	Main Ledge, 4100 Level, 61 Crosscut.
1057	1D	H157	7/22/77	1329	1445	152	0.222	Main Ledge, 4100 Level, 61 Crosscut.
							TWA-0.450	

Table D-4 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1057	1E	H228	7/21/77	0725	0855	180	0.107	Main ledge, 4100 Level, 58E Stope.
1057	1E	H251	7/21/77	1322	1416	108	0.100	Main Ledge, 4100 Level, 58E Stope.
							TWA-0.104	
1057	1E	H331	7/22/77	0745	0939	228	0.185	Main Ledge, 4100 Level, 61 Crosscut.
1057	1E	H427	7/22/77	0939	1149	260	0.435	Main Ledge, 4100 Level, 61 Crosscut, Cut and Stand Timber.
1057	1E	H385	7/22/77	1150	1445	350	0.206	Main Ledge, 4100 Level, 61 Crosscut.
							TWA-0.271	
1060	1E	H53	7/12/77	0810	1050	320	0.117	Main Ledge, 6800 Level, in Pump Room, Repaired Track.
1060	1E	H48	7/12/77	1050	1531	562	0.528	Main Ledge, 6800 Level, Repaired Track, Ate Lunch.
							TWA-0.379	
1076	1D	H44	7/12/77	0840	1053	266	0.804	Main Ledge, 6800 Level, 93-94C Cutting Sill, Slushing.
1076	1D	H43	7/12/77	1053	1305	264	0.420	Main Ledge, 6800 Level, 93-94C Cutting Sill, Ate Lunch.
1076	1D	H51	7/12/77	1306	1531	290	0.514	Main Ledge, 6800 Level, 93-94C Cutting Sill, Cleaned Mud from Slusher.
							TWA-0.578	

Table D-4 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1086	1L	H83	7/12/77	0815	0918	126	0.268	Main Ledge, 6050 Level, 89E Stope, Set Up and Drilling.
1086	1L	H84	7/12/77	0918	1025	134	0.467	Main Ledge, 6050 Level, 89E Stope, Drilling.
1086	1L	H120	7/12/77	1025	1207	204	0.277	Main Ledge, 6050 Level, 89E Stope, Slushing, Ate Lunch.
1086	1L	H119	7/12/77	1207	1322	150	0.602	Main Ledge, 6050 Level, 89E Stope, Drilling.
1086	1L	H33	7/12/77	1321	1418	114	0.549	Main Ledge, 6050 Level, 89E Stope, Drilling.
1086	1L	H34	7/12/77	1418	1458	80	0.587	Main Ledge, 6050 Level, 89E Stope, Drilling.
							TWA-0.437	
1090	1M	H421	7/21/77	805	930	170	0.071	Main Ledge, 4100-4250 Levels, Went to 62 Crosscut and 71 Pillar West.
1090	1M	H413	7/21/77	930	1058	176	0.212	Main Ledge, 4100-4250 Levels, Went to 58C East, 61 Timberline, 71C Timber and 70 Drift.
1090	1M	H415	7/21/77	1157	1327	180	1.079	Main Ledge, 4100-4250 Levels, Went to 64-65C Stope.
1090	1M	H107	7/21/77	1327	1414	94	0.410	Main Ledge, 4100-4250 Levels, Went to 4400 Level, 71 Crosscut.
							TWA-0.455	

Table D-5. Airborne sample results for fibers >5 μm in length for underground employees on the 11 Ledge of the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1128	1X	H477	7/20/77	0646	0821	190	0.771	11 Ledge, 4550 Level, 24-26 Stope, Back Filling With Sand, Plugging Holes With Burlap.
1128	1X	H478	7/20/77	0822	1021	238	0.162	11 Ledge, 4550 Level, 24-26 Stope, Back Filling With Sand.
1128	1X	H491	7/20/77	1022	1152	180	0.535	11 Ledge, 4550 Level, 24-26 Stope, Ate Lunch.
1128	1X	H482	7/20/77	1152	1410	276	0.345	11 Ledge, 4550 Level, 24-26 Stope.
							TWA-0.426	
1128	1Y	H473	7/20/77	0643	0835	224	0.226	11 Ledge, 4550 Level, 24-26 Stope, Applied Sand and Water.
1128	1Y	H489	7/20/77	0835	1031	232	0.176	11 Ledge, 4550 Level, 24-26 Stope, Filled Manway With Sand.
1128	1Y	H483	7/20/77	1031	1204	186	0.376	11 Ledge, 4550 Level, 24-26 Stope, Filled Manway.
1128	1Y	H486	7/20/77	1204	1415	262	0.303	11 Ledge, 4550 Level, 24-26 Stope.
							TWA-0.266	
1128	1Z	H471	7/20/77	0645	0829	208	0.174	11 Ledge, 4550 Level, 24-26 Stope, Load Equipment.
1128	1Z	H487	7/20/77	0830	1025	230	0.141	11 Ledge, 4550 Level, 24-26 Stope, Sandfill.
1128	1Z	H485	7/20/77	1026	1154	176	0.062	11 Ledge, 4550 Level, 24-26 Stope, Ate Lunch.
1128	1Z	H488	7/20/77	1154	1317	166	0.036	11 Ledge, 4550 Level, 24-26 Stope, Sandfill.
1128	1Z	H484	7/20/77	1317	1436	158	0.137	11 Ledge, 4550 Level, 24-26 Stope, Lowered Equipment.
							TWA-0.114	

Table D-5 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1141	1C	H156	7/14/77	910	1030	280	0.009	11 Ledge, 5600 Level, 55 Pillar, Some Drilling.
1141	1C	H166	7/14/77	0751	908	154	0.242	11 Ledge, 5600 Level, 55 Pillar, Some Drilling.
1141	1C	H169	7/14/77	1030	1125	110	0.011	11 Ledge, 5600 Level, 55 Pillar, Some Drilling, Ate Lunch.
1141	1C	H172	7/14/77	1125	1259	188	0.032	11 Ledge, 5600 Level, 55 Pillar, Drilling, Some Slushing.
1141	1C	H183	7/14/77	1300	1420	160	0.000	11 Ledge, 5600 Level, 55 Pillar, Drilling and Pulling Core.
							TWA-0.060	
1142	1D	H150	7/14/77	857	1030	186	0.013	11 Ledge, 5600 Level, 55 Pillar, Some Drilling.
1142	1D	H148	7/14/77	0749	0854	130	0.120	11 Ledge, 5600 Level, 55 Pillar, Drilling and Pulling Ore.
1142	1D	H159	7/14/77	1030	1125	110	0.022	11 Ledge, 5600 Level, 55 Pillar, Ate Lunch.
1142	1D	H149	7/14/77	1125	1300	190	0.019	11 Ledge, 5600 Level, 55 Pillar, Pulling Ore.
1142	1D	H188	7/14/77	1301	1420	158	0.030	11 Ledge, 5600 Level, 55 Pillar, Drilling and Pulling Core.
							TWA-0.037	
1156	1D	H97	7/13/77	920	1015	110	1.286	11 Ledge, 5450 Level, 49-51 Stope, Set Up Drilling.
1156	1D	H04	7/13/77	1015	1250	310	0.105	11 Ledge, 5450 level, 49-51 Stope, Some Drilling, Ate Lunch.
1156	1D	H05	7/13/77	1250	1405	150	0.361	11 Ledge, 5450 Level, 49-51 Stope.
1156	1D	H58	7/13/77	1407	1443	72	0.368	11 Ledge, 5450 Level, 49-51 Stope.
							TWA-0.397	

Table D-5 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1156	1E	H23	7/13/77	922	1020	116	0.031	11 Ledge, 5450 Level, 49-51 Stope, Wet Drilling.
1156	1E	H13	7/13/77	1020	1250	300	0.096	11 Ledge, 5450 Level, 49-51 Stope, Drilling, Ate Lunch.
							TWA-0.078	
1156	1G	H171	7/13/77	0948	1028	80	0.135	11 Ledge, 5300 Level, 49D Stope, Drilling.
1156	1G	H161	7/13/77	1028	1111	86	0.042	11 Ledge, 5300 Level, 49D Stope, Drilling.
1156	1G	H163	7/13/77	1111	1216	130	0.019	11 Ledge, 5300 Level, 49D Stope, Some Drilling and Ate Lunch.
1156	1G	H164	7/13/77	1216	1244	56	1.226	11 Ledge, 5300 Level, 49D Stope, Some Drilling.
1156	1G	H165	7/13/77	1244	1410	172	0.042	11 Ledge, 5300 Level, 49D Stope, Cleaned Area for Blasting.
							TWA-0.177	
1156	1H	H189	7/13/77	0859	0952	106	0.045	11 Ledge, 5300 Level, 49D Stope, Wetted Ore, Drilled.
1156	1H	H152	7/13/77	0952	1052	120	0.120	11 Ledge, 5300 Level, 49D Stope, Drilled.
1156	1H	H179	7/13/77	1052	1132	80	0.316	11 Ledge, 5300 Level, 49D Stope, Drilled, Ate Lunch.
1156	1H	H177	7/13/77	1133	1220	94	0.256	11 Ledge, 5300 Level, 49D Stope, Drilled.
1156	1H	H191	7/13/77	1220	1340	160	3.305	11 Ledge, 5300 Level, 49D Stope, Some Drilling, Prepared for Blasting.
1156	1H	H170	7/13/77	1340	1410	60	0.723	11 Ledge, 5300 Level, 49D Stope, Prepared for Blasting.
							TWA-1.033	

Table D-5 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1156	1M	H155	7/13/77	0806	0838	64	0.489	11 Ledge, 5750 Level, 57C Stope, Fixed Slusher Blocks.
1156	1M	H139	7/13/77	0838	0922	88	3.839	11 Ledge, 5750 Level, 57C Stope, Wetted Ore, Drilled.
1156	1M	H132	7/13/77	0922	1116	228	1.007	11 Ledge, 5750 Level, 57C Stope, Set Up Slusher and Ate Lunch.
1156	1M	H108	7/13/77	1116	1258	84	2.485	11 Ledge, 5750 Level, 57C Stope, Repositioned Slusher.
1156	1M	H105	7/13/77	1258	1412	148	0.464	11 Ledge, 5750 Level, 57C Stope, Set Up Slusher.
1156	1M	H154	7/13/77	1412	1502	100	0.421	11 Ledge, 5750 Level, 57C Stope, Took Break.
							TWA-1.462	
1156	1N	H142	7/13/77	0806	0838	64	0.884	11 Ledge, 5750 Level, 57C Stope, Fixed Slusher.
1156	1N	H147	7/13/77	0838	0924	92	0.890	11 Ledge, 5750 Level, 57C Stope, Wet Ore and Drilled.
1156	1N	H104	7/13/77	0924	1116	224	0.043	11 Ledge, 5750 Level, 57C Stope, Put in Slusher Blocks, Ate Lunch.
1156	1N	H151	7/13/77	1116	1254	196	0.203	11 Ledge, 5750 Level, 57C Stope, Repositioned Slusher.
1156	1N	H102	7/13/77	1254	1412	156	0.178	11 Ledge, 5750 Level, 57C Stope, Set Up Slusher.
1156	1N	H113	7/13/77	1412	1503	102	0.118	11 Ledge, 5750 Level, 57C Stope, Took Break.
							TWA-0.273	

Table D-5 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1176	1T	H38	7/14/77	0754	1015	282	0.821	11 Ledge, 5450 Level, 54B Stope, Loaded Lagging.
1176	1T	H11	7/14/77	1015	1145	180	1.174	11 Ledge, 5450 Level, 54B Stope, Some Drilling, Moved Equipment.
1176	1T	H19	7/14/77	1200	1327	174	0.800	11 Ledge, 5450 Level, 54B Stope, Some Drilling.
1176	1T	H21	7/14/77	1330	1510	200	1.962	11 Ledge, 5450 Level, 54B Stope.
							TWA-1.166	
1176	1U	H14	7/14//77	0754	915	162	1.018	11 Ledge, 5450 Level, 54B Stope, Washed Down Stope.
1176	1U	H72	7/14/77	0915	1050	190	0.222	11 Ledge, 5450 Level, 54B Stope, Some Drilling.
1176	1U	H08	7/14/77	1050	1327	314	0.146	11 Ledge, 5450 Level, 54B Stope, Some Drilling, Ate Lunch.
1176	1U	H06	7/14/77	1330	1510	200	1.559	11 Ledge, 5450 Level, 54B Stope, Prepared for Blasting.
							TWA-0.652	
1186	1F	H76	7/13/77	920	1020	120	0.080	11 Ledge, 5450 Level, 49-51 Stope, Set Up Drilling.
1186	1F	H12	7/13/77	1025	1243	138	0.192	11 Ledge, 5450 Level, 49-51 Stope, Some Drilling, Ate Lunch.
1186	1F	H03	7/13/77	1243	1440	234	0.896	11 Ledge, 5450 Level, 49-51 Stope, Some Drilling.
							TWA-0.432	

Table D-6. Airborne sample results for fibers >5 μm in length for underground employees on the 13 Ledge of the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1356	1A	H87	7/12/77	0820	1015	230	0.099	13 Ledge, 6050 Level, 46-47C Stope, Some Drilling.
1356	1A	H89	7/12/77	1015	1200	210	0.086	13 Ledge, 6050 Level, 46-47C Stope, Drilling.
1356	1A	H75	7/12/77	1205	1335	180	0.080	13 Ledge, 6050 Level, 46-47C Stope, Some Mucking.
1356	1A	H79	7/12/77	1335	1439	128	0.574	13 Ledge, 6050 Level, 46-47C Stope, Pulling Chute.
							TWA-0.172	
1356	1H	H29	7/12/77	820	1018	236	0.398	13 Ledge, 6050 Level, Mucking.
1356	1H	H36	7/12/77	1019	1216	234	0.812	13 Ledge, 6050 Level, Ate Lunch, Mucking.
1356	1H	H30	7/12/77	1216	1355	198	0.122	13 Ledge, 6050 Level, Mucking, Putting in Track.
1356	1H	H42	7/12/77	1356	1408	24	15.483	13 Ledge, 6050 Level, Putting in Track.
							TWA-0.982	
1356	1I	H28	7/12/77	818	1015	154	0.555	13 Ledge, 6050 Level, Wetted Ore, Mucked.
1356	1I	H32	7/12/77	1016	1228	264	0.810	13 Ledge, 6050 Level, Dumped Ore, Mucked.
1356	1I	H93	7/12/77	1228	1356	176	0.144	13 Ledge, 6050 Level, Put in Track, Mucked.
1356	1I	H50	7/12/77	1357	1408	22	12.772	13 Ledge, 6050 Level, Put in Track.
							TWA-0.934	

Table D-6 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1366	1B	H82	7/12/77	822 -	1016	228	0.370	13 Ledge, 6050 Level, 46-47C Stope, Some Drilling.
1366	1B	H96	7/12/77	1018 -	1200	204	0.047	13 Ledge, 6050 Level, 46-47C Stope, Drilling.
1366	1B	H85	7/12/77	1207 -	1330	166	0.232	13 Ledge, 6050 Level, 46-47C Stope, Pulling Chute.
1366	1B	H86	7/12/77	1330 -	1439	138	1.589	13 Ledge, 6050 Level, 46-47C Stope, Pulling Chute.
							TWA-0.478	

Table D-7. Airborne sample results for fibers >5 μm in length for underground employees on the 19 Ledge of the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1908	1H	H314	7/15/77	0947	1145	236	0.301	19 Ledge, 4850 Level, 46 Crosscut, Installing Water Tank.
1908	1H	H280	7/15/77	1145	1401	272	0.323	19 Ledge, 4850 Level, 46 Crosscut, Fitting Pipes.
1908	1H	H317	7/15/77	1401	1502	122	0.168	19 Ledge, 4850 Level, 46 Crosscut, Fitting Pipes.
							TWA-0.285	
1932	1P	H114	7/15/77	0754	949	230	0.063	19 Ledge, 6800 Level, Motorman, Hauled Rock.
1932	1P	H117	7/15/77	0949	1148	238	0.111	19 Ledge, 6800 Level, Motorman, Pulled Raises, Dumped Waste.
1932	1P	H118	7/15/77	1148	1324	192	0.207	19 Ledge, 6800 Level, Motorman, Pulled Raises, Dumped Ore.
1932	1P	H31	7/15/77	1324	1435	142	0.127	19 Ledge, 6800 Level, Motorman, Pulled Raises, Dumped Ore.
							TWA-0.123	
1954	1G	H323	7/15/77	0821	0917	112	0.624	19 Ledge, 4850 Level, 46 Crosscut, Waited for Equipment.
1954	1G	H272	7/15/77	0917	1048	182	0.523	19 Ledge, 4850 Level, 46 Crosscut, Assisted in Installing Pipe.
1954	1G	H273	7/15/77	1048	1401	386	0.162	19 Ledge, 4850 Level, 46 Crosscut, Installed Some Pipe and Ate Lunch.
1954	1G	H287	7/15/77	1401	1502	122	0.454	19 Ledge, 4850 Level, 46 Crosscut, Helped Install Water Tank.
							TWA-0.353	

Table D-7 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1956	1Q	H74	7/15/77	0803	0935	184	0.582	19 Ledge, 6200 Level, 27 Crosscut, Cutting and Hoisting Timber for Chute.
1956	1Q	H59	7/15/77	0935	1102	174	0.055	19 Ledge, 6200 Level, 27 Crosscut, Cutting and Hoisting Timber.
1956	1Q	H35	7/15/77	1102	1230	176	0.096	19 Ledge, 6200 Level, 27 Crosscut, Ate Lunch, Cut and Hoisted Timber.
1956	1Q	H64	7/15/77	1230	1330	120	0.050	19 Ledge, 6200 Level, 27 Crosscut, Hoisted Timber.
1956	1Q	H46	7/15/77	1330	1440	140	0.499	19 Ledge, 6200 Level, 27 Crosscut, Some Drilling on Wood and Roof.
							TWA-0.264	
1956	1R	H111	7/15/77	0804	0937	186	0.045	19 Ledge, 6200 Level, 27 Crosscut, Placed Timber into Chute.
1956	1R	H112	7/15/77	0937	1102	170	0.064	19 Ledge, 6200 Level, 27 Crosscut, Ate Lunch, Placed Timber into Chute.
1956	1R	H123	7/15/77	1102	1230	176	0.075	19 Ledge, 6200 Level, 27 Crosscut, Cut and Placed Timber into Chute.
1956	1R	H100	7/15/77	1230	1330	120	0.100	19 Ledge, 6200 Level, 27 Crosscut, Placed Timber into Chute.
1956	1R	H103	7/15/77	1330	1420	100	0.289	19 Ledge, 6200 Level, 27 Crosscut, Some Drilling on Wood and Roof.
							TWA-0.098	

Table D-7 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1956	1S	H194	7/15/77	830	1000	180	0.100	19 Ledge, 6200 Level, 41-42C Stope, Some Slushing.
1956	1S	H178	7/15/77	1000	1146	212	0.187	19 Ledge, 6200 Level, 41-42C Stope, Some Slushing, Ate Lunch.
1956	1S	H185	7/15/77	1146	1250	128	0.160	19 Ledge, 6200 Level, 41-42C Stope, Drilling.
1956	1S	H193	7/15/77	1252	1423	182	0.033	19 Ledge, 6200 Level, 41-42C Stope, Drilling.
							TWA-0.120	
1956	1T	H192	7/15/77	830	1000	180	0.027	19 Ledge, 6200 Level, 41-42C Stope, Some Slushing.
1956	1T	H339	7/15/77	1000	1145	210	0.109	19 Ledge, 6200 Level, 41-42C Stope, Some Slushing, Ate Lunch.
1956	1T	H328	7/15/77	1146	1251	130	0.102	19 Ledge, 6200 Level, 41-42C Stope, Drilling.
1956	1T	H181	7/15/77	1253	1330	74	0.130	19 Ledge, 6200 Level, 41-42C Stope, Some Drilling.
							TWA-0.085	
1956	1S	H259	7/15/77	811	859	96	0.050	19 Ledge, 5900 Level, 28-29F Stope, Slushing.
1956	1S	H247	7/15/77	900	1010	140	0.637	19 Ledge, 5900 Level, 28-29F Stope, Slushing.
1956	1S	H270	7/15/77	1010	1130	160	0.331	19 Ledge, 5900 Level, 28-29F Stope, Some Slushing, Ate Lunch.
1956	1S	H258	7/15/77	1130	1300	180	0.388	19 Ledge, 5900 Level, 28-29F Stope, Repaired Slusher, Load Rock.
1956	1S	H254	7/15/77	1300	1425	170	0.050	19 Ledge, 5900 Level, 28-29F Stope, Prepared for Blasting.
							TWA-0.302	

Table D-7 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
1956	16	H291	7/15/77	810	859	98	0.184	19 Ledge, 5900 Level, 28-29F Stope, Pulling Chute.
1956	16	H252	7/15/77	900	1010	140	0.705	19 Ledge, 5900 Level, 28-29F Stope, Pulling Chute.
1956	16	H260	7/15/77	1010	1213	246	1.454	19 Ledge, 5900 Level, 28-29F Stope, Some Slushing, Ate Lunch.
1956	16	H286	7/15/77	1213	1305	104	0.938	19 Ledge, 5900 Level, 28-29F Stope, Pulled Chute, Prepared for Blasting.
1956*	16	H279	7/15/77	1305	1410	130	0.000	19 Ledge, 5900 Level, 28-29F Stope, Prepared for Blasting. Uneven particulate distribution. Filter voided for Fiber Count.
							TWA-0.973	

*Note: This sample not included in the TWA and Statistical Results.

Table D-8. Airborne sample results for fibers >5 μm in length for underground employees on the 21 Ledge of the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (liters)	Concentration fibers/cc	Sample information (i.e. location, operation, activity, etc.)
2156	1K	H308	7/15/77	945	1304	398	0.079	21 Ledge, 6200 Level, 50-52B Stope, Operate Crane.
2156	1K	H303	7/15/77	0757	0945	216	0.301	21 Ledge, 6200 Level, 50-52B Stope, Drilling.
2156	1K	H301	7/15/77	1305	1450	210	0.528	21 Ledge, 6200 Level, 50-52B Stope, Some Drilling, Set Charges for Blasting.
							TWA-0.252	
2176	1J	H297	7/15/77	0756	0935	198	0.085	21 Ledge, 6200 Level, 50-52B Stope, Hoisted Materials into Stope.
2176	1J	H298	7/15/77	0935	1304	418	0.089	21 Ledge, 6200 Levels, 50-52B Stope, Some Drilling, Ate Lunch.
2176	1J	H296	7/15/77	1305	1450	208	0.191	21 Ledge, 6200 Level, 50-52B Stope, Set Charges for Blasting.
							TWA-0.114	

Table D-9. Statistical summary of airborne sample results for fibers >5 μm in length for all underground employees of the Homestake Gold Mine.

Job code	Number of samples	Range fibers/cc High - Low	Fibers/cc Mean	Median	TWA	Standard deviation	Standard error	Job title
0100	1	0.03	0.03	0.03	0.03	--	--	Electrician
0101	4	0.17 - 0.04	0.08	0.05	0.08	0.06	0.03	Cager
0107	12	0.16 - 0.00	0.06	0.04	0.06	0.06	0.02	Hoist Operator-Underground
0108	3	0.32 - 0.17	0.26	0.30	0.29	0.08	0.05	Pipeman, Master
0110	8	1.74 - 0.12	0.73	0.70	0.74	0.56	0.20	Carpenter, 1st
0114	5	3.87 - 0.29	1.18	0.53	1.06	1.52	0.68	Carpenter, Master
0121	7	0.19 - 0.01	0.07	0.05	0.07	0.06	0.02	Shaftman
0124	4	3.58 - 0.08	1.15	0.48	0.91	1.64	0.82	Skipper Head
0125	8	0.69 - 0.12	0.33	0.32	0.38	0.17	0.06	Skipper
0128	13	0.77 - 0.04	0.27	0.18	0.27	0.21	0.06	Sandman, Underground
0131	6	1.94 - 0.03	0.42	0.14	0.48	0.75	0.31	Motorman-Surface
0132	8	1.56 - 0.03	0.42	0.17	0.44	0.53	0.19	Motorman, 1st
0133	4	4.59 - 0.14	1.38	0.39	0.92	2.15	1.08	Motorman, 2nd
0141	5	0.24 - 0.00	0.06	0.01	0.06	0.10	0.05	Diamond Drill Operator
0142	5	0.12 - 0.01	0.04	0.02	0.04	0.05	0.02	Diamond Drill Helper
0143	5	6.65 - 0.00	3.01	2.96	2.44	2.96	1.32	Boring Machine Operator
0144	5	3.58 - 1.27	2.48	2.21	2.57	1.00	0.45	Boring Machine Helper
0152	18	6.65 - 0.07	0.68	0.15	0.51	1.54	0.37	Miner, 1st
0153	14	2.72 - 0.02	0.58	0.28	0.57	0.73	0.19	Miner, 1st
0154	20	4.89 - 0.08	1.18	0.58	1.07	1.43	0.32	Miner, 1st
0155	13	2.84 - 0.12	0.76	0.51	0.81	0.72	0.20	Miner, 1st
0156	142	15.48 - 0.02	0.69	0.32	0.49	1.73	0.15	Miner, 1st
0157	13	1.11 - 0.06	0.32	0.22	0.34	0.31	0.09	Miner, 1st
0160	2	0.53 - 0.12	0.32	0.32	0.38	0.29	0.20	Miner, 2nd

Table D-9 (continued)

Job code	Number of samples	Range fibers/cc High - Low	Fibers/cc Mean	Median	TWA	Standard deviation	Standard error	Job title
0162	4	2.26 - 0.05	0.63	0.10	0.76	1.09	0.54	Miner, 2nd
0163	6	5.02 - 0.19	1.83	1.11	1.62	1.89	0.77	Miner, 2nd
0166	17	6.06 - 0.05	1.25	0.37	1.23	1.72	0.42	Miner, 2nd
0173	4	0.43 - 0.01	0.14	0.07	0.15	0.20	0.10	Miner, 3rd
0176	31	4.92 - 0.04	0.76	0.53	0.67	0.90	0.16	Miner, 3rd
0182	4	0.13 - 0.02	0.08	0.08	0.08	0.06	0.03	Miner, 4th
0186	22	9.81 - 0.03	1.22	0.40	1.15	2.34	0.50	Miner, 4th
0190	4	1.08 - 0.07	0.44	0.31	0.46	0.45	0.22	Mine Shift Boss
Area	Total							
01	417	15.48 - 0.00	0.74	0.30	0.63	1.47	0.07	All Underground Employees

Table D-10. Statistical summary of airborne sample results for fibers >5 μm in length for surface employees in the crushing mills of the Homestake Gold Mine.

Job code	Number of samples	Range fibers/cc High - Low	Fibers/cc Mean	Median	TWA	Standard deviation	Standard error	Job title
0201	7	2.76 - 0.21	1.47	1.55	1.45	1.01	0.38	Crusher-Feeder
0202	4	6.06 - 1.02	2.90	2.26	2.48	2.27	1.14	Mechanic, 3rd
0204	11	3.95 - 0.06	1.31	1.04	1.25	1.23	0.37	Belt/Chip Picker
0205	11	4.28 - 0.15	1.78	1.43	1.83	1.38	0.42	Laborer, 2nd
0206	7	16.20 - 0.72	7.59	8.18	5.34	6.80	2.57	Laborer, 1st
Area 02	Total 40	16.20 - 0.06	2.73	1.43	1.96	3.73	0.59	All Surface Employees in Crushing Mills

Table D-11. Statistical summary of the airborne sample results for fibers >5 μm in length for underground employees on the 9, Main, 11, 13, 19, and 21 Ledges of the Homestake Gold Mine.

Job code	Number of samples	Range fibers/cc High - Low	Fibers/cc Mean	Median	TWA	Standard deviation	Standard error	Job title
0914	5	3.87 - 0.29	1.18	0.53	1.06	1.52	0.68	Carpenter, Master
0932	3	1.56 - 0.44	0.93	0.80	0.84	0.57	0.33	Motorman, 1st
0952	18	6.56 - 0.07	0.68	0.15	0.51	1.54	0.37	Miner, 1st
0953	14	2.72 - 0.02	0.58	0.28	0.57	0.73	0.19	Miner, 1st
0954	8	1.69 - 0.17	0.69	0.62	0.63	0.45	0.16	Miner, 1st
0955	8	1.42 - 0.12	0.54	0.41	0.52	0.45	0.16	Miner, 1st
0956	59	2.11 - 0.03	0.48	0.33	0.46	0.48	0.06	Miner, 1st
0962	4	2.26 - 0.05	0.63	0.10	0.76	1.09	0.54	Miner, 2nd
0963	6	5.02 - 0.19	1.83	1.11	1.62	1.89	0.77	Miner, 2nd
0966	13	6.06 - 0.06	1.47	0.45	1.48	1.90	0.53	Miner, 2nd
0973	4	0.43 - 0.01	0.14	0.07	0.15	0.20	0.10	Miner, 3rd
0976	17	4.92 - 0.04	0.80	0.53	0.73	1.11	0.27	Miner, 3rd
0982	4	0.13 - 0.02	0.08	0.08	0.08	0.06	0.03	Miner, 4th
0986	13	9.81 - 0.03	1.76	0.34	1.55	2.96	0.82	Miner, 4th
Area 09	Total 176	9.81 - 0.01	0.78	0.38	0.72	1.31	0.10	Employees on 9 Ledge
1010	8	1.74 - 0.12	0.73	0.70	0.74	0.56	0.20	Carpenter, 1st
1033	4	4.59 - 0.14	1.38	0.39	0.92	2.15	1.08	Motorman, 2nd
1043	5	6.65 - 0.00	3.01	2.96	2.44	2.96	1.32	Boring Machine Operator
1044	5	3.68 - 1.27	2.48	2.21	2.57	1.00	0.45	Boring Machine Helper
1054	8	4.89 - 0.08	2.04	1.60	1.91	1.97	0.70	Miner, 1st
1055	4	2.84 - 0.49	1.27	0.89	1.34	1.06	0.53	Miner, 1st
1056	13	2.44 - 0.05	0.78	0.62	0.61	0.68	0.19	Miner, 1st
1057	13	1.11 - 0.06	0.32	0.22	0.34	0.31	0.09	Miner, 1st
1060	2	0.53 - 0.12	0.32	0.32	0.38	0.29	0.21	Miner, 2nd
1076	3	0.80 - 0.42	0.58	0.51	0.58	0.20	0.12	Miner, 3rd
1086	6	0.60 - 0.27	0.46	0.51	0.44	0.15	0.06	Miner, 4th

Table D-11 (continued)

Job code	Number of samples	Range fibers/cc High - Low	Fibers/cc Mean	Median	TWA	Standard deviation	Standard error	Job title
1090	4	1.08 - 0.07	0.44	0.31	0.46	0.45	0.22	Mine Shift Boss
Area 10	Total 75	6.65 - 0.00	1.09	0.51	0.98	1.40	0.16	Employees on Main Ledge
1128	13	0.77 - 0.04	0.27	0.18	0.27	0.21	0.06	Sandman, Underground
1141	5	0.24 - 0.00	0.06	0.01	0.06	0.10	0.05	Diamond Drill Operator
1142	5	0.12 - 0.01	0.04	0.02	0.04	0.05	0.02	Diamond Drill Helper
1156	29	3.84 - 0.02	0.67	0.32	0.64	0.97	0.18	Miner, 1st
1176	8	1.96 - 0.15	0.96	0.92	0.90	0.62	0.22	Miner, 3rd
1186	3	0.90 - 0.08	0.39	0.19	0.43	0.44	0.26	Miner, 4th
Area 11	Total 63	3.84 - 0.00	0.51	0.20	0.49	0.75	0.10	Employees on 11 Ledge
1356	12	15.48 - 0.08	2.66	0.48	0.68	5.39	1.5o	Miner, 1st
1366	4	1.59 - 0.05	0.56	0.30	0.48	0.70	0.35	Miner, 2nd
Area 13	Total 16	15.48 - 0.05	2.14	0.38	0.63	4.72	1.18	Employees on 13 Ledge

Table D-11 (continued)

Job code	Number of samples	Range fibers/cc High - Low	Fibers/cc Mean	Median	TWA	Standard deviation	Standard error	Job title
1908	3	0.32 - 0.17	0.26	0.30	0.29	0.08	0.05	Pipeman, Master
1932	4	0.21 - 0.06	0.13	0.12	0.12	0.06	0.03	Motorman, 1st
1954	4	0.62 - 0.16	0.44	0.49	0.35	0.20	0.10	Miner, 1st
1956	27	1.45 - 0.03	0.28	0.11	0.29	0.34	0.07	Miner, 1st
Area 19	Total 38	1.45 - 0.03	0.28	0.16	0.28	0.30	0.05	Employees on 19 Ledge
2156	3	0.53 - 0.08	0.30	0.30	0.25	0.23	0.13	Miner, 1st
2176	3	0.19 - 0.09	0.12	0.09	0.11	0.06	0.04	Miner, 3rd
Area 21	Total 6	0.53 - 0.08	0.21	0.14	0.18	0.18	0.07	Employees on 21 Ledge
Surface and Underground	Total 457	16.20 - 0.00	0.86	0.34	0.73	1.72	0.06	All Employees

Appendix E. Results of impinger dust counting at the Homestake Gold Mine in Lead, South Dakota.

Table E-1. Impinger dust sample results for all underground employees at the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0107	1A	H185	7/20/77	0656	0729	3.265	0.303	4550 Level, Hoist Room, in Control Cubicle, Ross.
0107	1A	H186	7/20/77	0818	0848	2.968	0.327	4550 Level, Hoist Room, in Control Cubicle, Ross.
0107	1A	H184	7/20/77	0930	1002	3.166	1.313	4550 Level, Hoist Room, not in Cubicle but in Hoist Room, Ross.
0107	1A	H188	7/20/77	1049	1120	3.067	0.801	4550 Level, Hoist Room, in Control Cubicle, Ross.
0107	1A	H189	7/20/77	1215	1245	2.968	1.050	4550 Level, Hoist Room, in Control Cubicle, Ross.
0107	1A	H190	7/20/77	1302	1332	2.968	1.358	4550 Level, Hoist Room, in Control Cubicle, Ross.
							TWA-0.854	
0107	1P	H74	7/14/77	0710	0730	1.979	0.679	4850 Level, Main Ledge, Hoist Room, Operating Hoist.
0107	1P	H73	7/14/77	0850	0910	1.979	0.406	4850 Level, Main Ledge, Hoist Room, Operating Hoist.
0107	1P	H76	7/14/77	1055	1115	1.979	1.170	4850 Level, Main Ledge, Hoist Room, Eating Lunch.
0107	1P	H75	7/14/77	1205	1225	1.979	1.137	4850 Level, Main Ledge, Hoist Room, Operating Hoist.
0107	1P	H78	7/14/77	1255	1315	1.979	1.057	4850 Level, Main Ledge, Hoist Room, Took Break.
0107	1P	H77	7/14/77	1325	1345	1.979	1.242	4850 Level, Main Ledge, Hoist Room, Operating Hoist.
							TWA-0.949	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0110	1G	H226	7/21/77	0738	0808	2.968	0.338	Main Ledge, 4250 Level, 71C Stope, Set Timber Using Chain Saw.
0110	1G	H227	7/21/77	1000	1030	2.968	0.313	Main Ledge, 4250 Level, 71C Stope, Waiting for Timber.
0110	1G	H228	7/21/77	1144	1216	3.166	0.256	Main Ledge, 4250 Level, 71C Stope, Working on Timberline.
0110	1G	H230	7/21/77	1308	1438	8.905	0.671	Main Ledge, 4250 Level, 71C Stope, Working on Timberline.
0110	1G	H231	7/21/77	1348	1418	1.979	1.369	Main Ledge, 4250 Level, 71C Stope, Working on Timberline.
							TWA-0.609	
0114	1K	H139	7/18/77	0715	0735	1.979	0.506	9 Ledge, 2150 Level, Carpenter.
0114	1K	H141	7/18/77	0819	0849	2..968	0.756	9 Ledge, 2150 Level, Carpenter.
0114	1K	H143	7/18/77	0924	0954	2.968	1.463	9 Ledge, 2150 Level, Carpenter.
0114	1K	H144	7/18/77	1030	1100	2.968	0.426	9 Ledge, 2150 Level, Carpenter.
0114	1K	H142	7/18/77	1218	1248	2.968	0.346	9 Ledge, 2150 Level, Carpenter.
							TWA-0.713	
0124	14	H105	7/15/77	1002	1012	0.707	2.481	6800 Level, Main Ledge, Skipper Head, Slushed Ore.
0124	14	H106	7/15/77	1041	1054	1.236	4.758	6800 Level, Main Ledge, Skipper Head, Slushed Ore.
0124	14	H108	7/15/77	1115	1125	0.989	2.315	6800 Level, Main Ledge, Skipper Head, Slushed Ore.
0124	14	H104	7/15/77	1216	1226	0.989	2.134	6800 Level, Main Ledge, Skipper Head, Slushed Ore.
0124	14	H107	7/15/77	1306	1320	1.385	2.257	6800 Level, Main Ledge, Skipper Head, Fixed Chute Door.
0124	14	H103	7/15/77	1354	1407	1.286	1.261	6800 Level, Main Ledge, Skipper Head, Some Slushing.
							TWA-2.559	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0125	1A	H178	7/19/77	0640	0710	2.968	0.209	4850 Level, Skip Pocket, Some Loading of Ore, Yates.
0125	1A	H176	7/19/77	0715	0745	2.968	0.161	4850 Level, Skip Pocket, Yates.
0125	1A	H174	7/19/77	0815	0845	2.968	0.068	4850 Level, Skip Pocket, Yates.
0125	1A	H175	7/19/77	0930	1000	2.968	0.277	4850 Level, Skip Pocket, Some Loading of Ore, Yates.
0125	1A	H173	7/19/77	1210	1240	2.968	0.076	4850 Level, Skip Pocket, Yates.
0125	1A	H177	7/19/77	1245	1315	2.968	0.309	4850 Level, Skip Pocket, Yates.
							TWA-0.183	
0125	1I	H191	7/20/77	0640	0710	2.968	1.345	4850 Level, Skip Pocket, Skipped Ore About Every 10 Minutes, Ross.
0125	1I	H192	7/20/77	0825	0855	2.968	3.213	4850 Level, Skip Pocket, Ross.
0125	1I	H193	7/20/77	0949	1019	2.968	3.269	4850 Level, Skip Pocket, Ross.
0125	1I	H194	7/20/77	1232	1302	2.968	3.794	4850 Level, Skip Pocket, Ross.
0125	1I	H195	7/20/77	1317	1342	2.473	1.604	4850 Level, Skip Pocket, Took Break, Ross.
							TWA-2.681	
0132	1P	H97	7/15/77	0759	0814	1.484	1.174	19 Ledge, 6800 Level, Motorman, Hauling Ore.
0132	1P	H98	7/15/77	0952	1002	0.989	0.844	19 Ledge, 6800 Level, Motorman, Unloading Equipment.
0132	1P	H99	7/15/77	1025	1039	1.385	5.460	19 Ledge, 6800 Level, Pulling Raises.
0132	1P	H100	7/15/77	1226	1236	0.989	1.013	19 Ledge, 6800 Level, Motorman, Dumping Ore.
0132	1P	H101	7/15/77	1320	1335	1.484	0.080	19 Ledge, 6800 Level, Motorman, Hauling Ore.
0132	1P	H102	7/15/77	1405	1420	1.484	0.096	19 Ledge, 6800 Level, Motorman, Dumping Ore.
							TWA-1.459	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location operation, activity, etc.)
0141	1C	H63	7/14/77	0754	0807	1.286	0.928	11 Ledge, 5600 Level, 55 Pillar, Set Up Equipment, Some Drilling.
0141	1C	H61	7/14/77	0852	0908	1.583	0.522	11 Ledge, 5600 Level, 55 Pillar, Some Drilling.
0141	1C	H64	7/14/77	0955	1010	1.484	1.313	11 Ledge, 5600 Level, 55 Pillar, Drilled.
0141	1C	H62	7/14/77	1130	1145	1.484	0.643	11 Ledge, 5600 Level, 55 Pillar, Pulled Core, Drilled.
0141	1C	H65	7/14/77	1250	1305	1.484	0.756	11 Ledge, 5600 Level, 55 Pillar, Pulled Core, Drilled.
0141	1C	H66	7/14/77	1358	1410	1.187	0.777	11 Ledge, 5600 Level, 55 Pillar, Some Drilling.
							TWA-0.819	
0143	1R	H69	7/14/77	0735	0750	1.484	0.525	Main Ledge, 6050 Level, 90 Pillar, Set Up Bore Drill.
0143	1R	H72	7/14/77	0830	0845	1.484	4.067	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
0143	1R	H71	7/14/77	0932	0942	0.989	2.717	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
0143	1R	H70	7/14/77	1047	1059	1.187	2.257	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
0143	1R	H67	7/14/77	1302	1317	1.484	1.945	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
0143	1R	H68	7/14/77	1408	1418	0.989	4.212	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
							TWA-2.525	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0152	1F	H145	7/18/77	0743	0753	0.989	7.138	9 Ledge, 2000 Level, 45-51C/H Blast Hole, Slushing.
0152	1F	H146	7/18/77	0913	0923	0.989	0.567	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Drilling.
0152	1F	H147	7/18/77	1030	1040	0.989	8.139	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Slushing.
0152	1F	H148	7/18/77	1210	1220	0.989	3.967	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Slushing.
0152	1F	H149	7/18/77	1253	1303	0.989	0.555	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Ate Lunch.
0152	1F	H150	7/18/77	1400	1415	1.484	0.289	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Took Break.
							TWA-3.200	
0152	1J	H127	7/18/77	0728	0743	1.484	4.051	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Building Wall.
0152	1J	H128	7/18/77	0845	0900	1.484	0.587	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Pulling Chute.
0152	1J	H129	7/18/77	0952	1007	1.484	0.973	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Loading Ore.
0152	1J	H130	7/18/77	1035	1050	1.484	1.415	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Loading Ore.
0152	1J	H131	7/18/77	1147	1202	1.484	1.479	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Loading Ore.
0152	1J	H132	7/18/77	1330	1345	1.484	0.683	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Shoveling Ore.
							TWA-1.531	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0153	1H	H133	7/18/77	0724	0754	2.968	2.617	9 Ledge, 2150 Level, 49 Crosscut, Ring Drilling.
0153	1H	H134	7/18/77	0838	0908	2.968	1.326	9 Ledge, 2150 Level, 49 Crosscut, Ring Drilling.
0153	1H	H135	7/18/77	1002	1032	2.968	1.017	9 Ledge, 2150 Level, 49 Crosscut, Ring Drilling.
0153	1H	H136	7/18/77	1143	1213	2.968	0.205	9 Ledge, 2150 Level, 49 Crosscut, Ring Drilling.
0153	1H	H137	7/18/77	1247	1317	2.968	0.261	9 Ledge, 2150 Level, 49 Crosscut, Drilling.
0153	1H	H138	7/18/77	1350	1420	2.968	0.599	9 Ledge, 2150 Level, 49 Crosscut, Drilling.
							TWA-1.004	
0154	1A	H123	7/18/77	0731	0758	2.671	1.049	9 Ledge, 1700 Level, Drift South 22 Crosscut, High-Balling.
0154	1A	H122	7/18/77	0900	0930	2.968	1.117	9 Ledge, 1700 Level, Drift South 22 Crosscut.
0154	1A	H126	7/18/77	1057	1128	3.067	0.249	9 Ledge, 1700 Level, Drift South 22 Crosscut.
0154	1A	H121	7/18/77	1250	1321	3.067	1.797	9 Ledge, 1700 Level, Drift South 22 Crosscut, Blasting.
0154	1A	H125	7/18/77	1410	1430	1.979	0.953	9 Ledge, 1700 Level, Drift South 22 Crosscut, Mucking.
							TWA-1.038	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0154	1G	H94	7/15/77	0839	0906	2.671	0.058	19 Ledge, 4850 Level, 46 Crosscut, Took Break.
0154	1G	H95	7/15/77	1142	1226	4.353	0.049	19 Ledge, 4850 Level, 46 Crosscut, Installing Water Pipes.
0154	1G	H96	7/15/77	1414	1444	2.968	0.092	19 Ledge, 4850 Level, 46 Crosscut, Installing Water Pipes.
							TWA-0.064	
0154	1L	H236	7/21/77	0759	0829	2.968	0.257	Main Ledge, 4250 Level, 70 Crosscut, Drilling.
0154	1L	H233	7/21/77	1025	1055	2.968	0.149	Main Ledge, 4250 Level, 70 Crosscut, Some Drilling.
0154	1L	H234	7/21/77	1216	1246	2.968	0.318	Main Ledge, 4250 Level, 70 Crosscut, Drilling.
0154	1L	H232	7/21/77	1345	1415	2.968	1.342	Main Ledge, 4250 Level, 70 Crosscut, Prepare for Blasting.
							TWA-0.517	
0155	1B	H45	7/13/77	0832	0843	1.088	1.834	9 Ledge, 5750 Level, 68C Stope, in Manway while Slushing.
0155	1B	H44	7/13/77	0922	0932	0.989	0.434	9 Ledge, 5750 Level, 68C Stope.
0155	1B	H43	7/13/77	0924	0941	1.682	0.979	9 Ledge, 5750 level, 68C Stope, Barring Down.
0155	1B	H47	7/13/77	1245	1255	0.989	0.289	9 Ledge, 5750 Level, 68C Stope, Not Working at Time of Sample.
0155	1B	H46	7/13/77	1328	1345	1.682	0.402	9 Ledge, 5750 Level, 68C Stope, in Main Drift not Working.
0155	1B	H48	7/13/77	1426	1442	1.583	0.306	9 Ledge, 5750 Level, 68C Stope, in Main Drift not Working.
							TWA-0.689	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0155	1F	H11	7/12/77	0808	0828	1.979	16.599	Main Ledge, 6500 Level, Dumped Waste.
0155	1F	H09	7/12/77	0942	0957	1.484	1.393	Main Ledge, 6500 Level, Fixed Slusher.
0155	1F	H10	7/12/77	1152	1207	1.484	4.828	Main Ledge, 6500 Level, Some Mucking.
0155	1F	H07	7/12/77	1310	1325	1.484	3.594	Main Ledge, 6500 Level, Mucking.
0155	1F	H12	7/12/77	1414	1429	1.484	3.666	Main Ledge, 6500 Level, Unloaded Equipment.
0155	1F	H08	7/12/77	1458	1513	1.484	2.583	Main Ledge, 6500 Level, on Train.
							TWA-6.031	
0156	1A	H20	7/12/77	0828	0848	1.979	0.366	13 Ledge, 6050 Level, 46-47C Stope, Some Drilling.
0156	1A	H22	7/12/77	0920	0940	1.979	1.025	13 Ledge, 6050 level, 46-47C Stope, Drilling, Mucking.
0156	1A	H21	7/12/77	1102	1122	1.979	3.730	13 Ledge, 6050 Level, 46-47C Stope, Lunch.
0156	1A	H19	7/12/77	1220	1235	1.484	1.570	13 Ledge, 6050 Level, 46-47C Stope, Drilling.
0156	1A	H23	7/12/77	1340	1355	1.484	1.061	13 Ledge, 6050 Level, 46-47C Stope, Pulling Chute.
0156	1A	H24	7/12/77	1412	1427	1.484	5.171	13 Ledge, 6050 Level, 46-47C Stope, Pulling Chute.
							TWA-2.090	
0156	1B	H223	7/21/77	0710	0740	2.968	0.100	9 Ledge, 3950 Level, 24-25B Stope, Operated Hoist in Chute.
0156	1B	H220	7/21/77	0846	0917	3.067	13.217	9 Ledge, 3950 Level, 24-25B Stope, Filling Ore Cars.
0156	1B	H225	7/21/77	1007	1043	3.562	0.961	9 Ledge, 3950 Level, 24-25B Stope, Using Gamby to Fill Cars.
0156	1B	H224	7/21/77	1200	1230	2.968	0.949	9 Ledge, 3950 Level, 24-25B Stope, Gamby Loading Area.
0156	1B	H221	7/21/77	1335	1353	1.781	0.409	9 Ledge, 3950 Level, 24-25B Stope.
0156	1B	H222	7/21/77	1415	1442	2.671	0.143	9 Ledge, 3950 Level, 24-25B Stope.
							TWA-2.831	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0156	1C	H13	7/12/77	0931	0946	1.484	0.809	Main Ledge, 6800 Level, 93-94C Cutting Sill, Slushing.
0156	1C	H17	7/12/77	1152	1207	1.484	0.906	Main Ledge, 6800 Level, 93-94C Cutting Sill, Slushing.
0156	1C	H16	7/12/77	1400	1415	1.484	1.270	Main Ledge, 6800 Level, 93-94C Cutting Sill, Slushing.
							TWA-0.995	
0156	1D	H58	7/13/77	0930	0940	0.989	0.635	11 Ledge, 5450 Level, 49-51 Stope, Drilling.
0156	1D	H59	7/13/77	1155	1205	0.989	0.410	11 Ledge, 5450 Level, 49-51 Stope, Ore Sample Drilling.
0156	1D	H60	7/13/77	1235	1245	0.989	0.434	11 Ledge, 5450 Level, 49-51 Stope, Ore Sample Drilling.
0156	1D	H57	7/13/77	1335	1350	1.484	0.273	11 Ledge, 5450 Level, 49-51 Stope, Drilling.
0156	1D	H55	7/13/77	1434	1444	0.989	0.434	11 Ledge, 5450 Level, 49-51 Stope, Took Break.
							TWA-0.422	
0156	1G	H37	7/13/77	0910	0922	1.187	1.728	11 Ledge, 5300 Level, 49D Stope, Prying Off Loose Rock.
0156	1G	H41	7/13/77	0927	0932	0.495	1.350	11 Ledge, 5300 Level, 49D Stope, Wetting Ore, Drilling.
0156	1G	H40	7/13/77	1028	1038	0.989	3.537	11 Ledge, 5300 Level, 49D Stope, Drilling.
0156	1G	H38	7/13/77	1142	1152	0.989	0.675	11 Ledge, 5300 Level, 49D Stope, Wetting Ore.
0156	1G	H42	7/13/77	1302	1317	1.484	1.093	11 Ledge, 5300 Level, 49D Stope, Some Drilling.
0156	1G	H39	7/13/77	1340	1350	0.989	2.653	11 Ledge, 5300 Level, 49D Stope, Cleaning Up.
							TWA-1.815	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0156	1H	H26	7/12/77	0832	0851	1.880	1.400	13 Ledge, 6050 Level.
0156	1H	H25	7/12/77	0928	0947	1.880	1.214	13 Ledge, 6050 Level, Not Working at Time of Sample.
0156	1H	H27	7/12/77	1057	1117	1.979	1.298	13 Ledge, 6050 Level, Ate Lunch, Some Mucking.
0156	1h	H29	7/12/77	1155	1214	1.880	1.202	13 Ledge, 6050 Level, Mucking.
0156	1H	H28	7/12/77	1329	1348	1.880	1.540	13 Ledge, 6050 Level, Putting in Track.
0156	1H	H30	7/12/77	1425	1439	1.385	12.471	13 Ledge, 6050 Level, Putting in Track.
							TWA-2.748	
0156	1J	H51	7/13/77	0815	0830	1.484	0.434	9 Ledge, 5750 Level, 67-68D Stope, Prying Off Loose Rock.
0156	1J	H49	7/13/77	0934	0947	1.286	0.278	9 Ledge, 5750 Level, 67-68D Stope, Wet Drilling.
0156	1J	H54	7/13/77	1150	1206	1.583	0.638	9 Ledge, 5750 Level, 67-68D Stope, Drilling.
0156	1J	H53	7/13/77	1243	1258	1.484	0.402	9 Ledge, 5750 Level, 67-68D Stope, Wet Drilling.
0156	1J	H50	7/13/77	1332	1347	1.484	0.536	9 Ledge, 5750 Level, 67-68D Stope.
0156	1J	H52	7/13/77	1412	1427	1.484	0.482	9 Ledge, 5750 Level, 67-68D Stope, Loading Explosives.
							TWA-0.468	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0156	1K	H1	7/12/77	0826	0841	1.484	0.954	Main Ledge, 6050 Level, 89E Stope, Not Working at Time of Sample.
0156	1K	H2	7/12/77	0955	1015	1.979	1.439	Main Ledge, 6050 Level, 89E Stope, Some Slushing.
0156	1K	H3	7/12/77	1210	1225	1.484	3.928	Main Ledge, 6050 Level, 89E Stope, Wet Ore, Slushing.
0156	1K	H4	7/12/77	1305	1315	0.989	6.423	Main Ledge, 6050 Level, 89E Stope, Drilling.
0156	1K	H5	7/12/77	1405	1415	0.989	1.021	Main Ledge, 6050 Level, 89E Stope, Drilling.
0156	1K	H6	7/12/77	1430	1440	0.989	1.214	Main Ledge, 6050 Level, 89E Stope, Drilling.
							TWA-2.174	
0156	1K	H204	7/20/77	0748	0815	2.671	0.994	9 Ledge, 4400 Level, 31-32C/D Stope, Set Up for Slushing.
0156	1K	H202	7/20/77	0924	0953	2.869	2.240	9 Ledge, 4400 Level, 31-32C/D Stope, Set Up for Slushing.
0156	1K	H206	7/20/77	1020	1050	2.968	2.106	9 Ledge, 4400 Level, 31-32C/D Stope, Slushing.
0156	1K	H207	7/20/77	1230	1300	2.968	2.192	9 Ledge, 4400 Level, 31-32C/D Stope, Slushing.
0156	1K	H205	7/20/77	1337	1402	2.473	4.756	9 Ledge, 4400 Level, 31-32C/D Stope, Slushing, Drilling.
							TWA-2.409	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0156	1L	H161	7/19/77	0717	0747	2.968	0.784	9 Ledge, 3650 Level, 18B Stope, First Aid Station, Set Up Equipment in Stope.
0156	1L	H160	7/19/77	0848	0918	2.968	0.040	9 Ledge, 3650 Level, 18B Stope, Some Drilling, Repaired Equipment.
0156	1L	H159	7/19/77	0935	1005	2.968	0.088	9 Ledge, 3650 Level, 18B Stope, Drilled an Ore Sample.
0156	1L	H156	7/19/77	1255	1325	2.968	0.217	9 Ledge, 3650 Level, 18B Stope, Some Drilling, Set Up Slusher.
0156	1L	H158	7/19/77	1348	1418	2.968	0.028	9 Ledge, 3650 Level, 18B Stope, Helped Construct Manway and Chute.
							TWA-0.231	
0156	1N	H33	7/13/77	0825	0835	0.989	0.820	11 Ledge, 5750 Level, 57C Stope, Drilled.
0156	1N	H32	7/13/77	0910	0920	0.989	0.563	11 Ledge, 5750 Level, 57C Stope, Drilled.
0156	1N	H31	7/13/77	1007	1017	0.989	4.116	11 Ledge, 5750 Level, 57C Stope, Put Up Slusher Blocks.
0156	1N	H36	7/13/77	1300	1315	1.484	0.000	11 Ledge, 5750 Level, 57C Stope, Repositioned Slusher.
0156	1N	H35	7/13/77	1417	1432	1.484	1.200	11 Ledge, 5750 Level, 57C Stope, Took Break.
							TWA-1.217	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0156	1N	H198	7/20/77	0734	0804	2.968	0.667	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
0156	1N	H199	7/20/77	0813	0843	2.968	0.581	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling.
0156	1N	H197	7/20/77	0904	0935	3.067	0.493	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
0156	1N	H201	7/20/77	1001	1031	2.968	0.940	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
0156	1N	H200	7/20/77	1223	1253	2.968	0.833	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
0156	1N	H187	7/20/77	1336	1406	2.968	0.571	9 Ledge, 4250 Level, 36-37B/C Stope.
							TWA-0.680	
0156	1Q	H124	7/19/77	0727	0756	2.869	0.661	9 Ledge, 3950 Level, 18G Stope, Highball Drilling.
0156	1Q	H151	7/19/77	0940	1007	2.671	0.152	9 Ledge, 3950 Level, 18G Stope, Not Drilling at Time of Sample.
0156	1Q	H152	7/19/77	1155	1227	3.166	0.452	9 Ledge, 3950 Level, 18G Stope, Some Drilling.
0156	1Q	H153	7/19/77	1240	1310	2.968	0.084	9 Ledge, 3950 Level, 18G Stope, Repaired Drill.
0156	1Q	H154	7/19/77	1321	1351	2.968	0.060	9 Ledge, 3950 Level, 18G Stope, Some Drilling.
0156	1Q	H155	7/19/77	1400	1420	1.979	0.295	9 Ledge, 3950 Level, 18G Stope, this sample was taken as a general area sample within the stope.
							TWA-0.285	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0156	1S	H113	7/15/77	0831	0847	1.583	0.151	19 Ledge, 6200 Level, 41-42C Stope, Moving Some Hose.
0156	1S	H114	7/15/77	0945	1000	1.484	0.153	19 Ledge, 6200 Level, 41-42C Stope, Splicing Cable.
0156	1S	H112	7/15/77	1040	1055	1.484	0.370	19 Ledge, 6200 Level, 41-42C Stope, Wetting Ore.
0156	1S	H111	7/15/77	1159	1213	1.385	0.086	19 Ledge, 6200 Level, 41-42C Stope, Some Drilling.
0156	1S	H110	7/15/77	1310	1327	1.682	0.043	19 Ledge, 6200 Level, 41-42C Stope, Took Break.
0156	1S	H109	7/15/77	1356	1410	1.385	0.396	19 Ledge, 6200 Level, 41-42C Stope, Drilling.
							TWA-0.195	
0156	1Y	H79	7/14/77	0801	0816	1.484	1.109	9 Ledge, 5450 Level, 66-67C Stope, Set Up Equipment.
0156	1Y	H80	7/14/77	0919	0929	0.989	1.013	9 Ledge, 5450 Level, 66-67C Stope, Some Drilling.
0156	1Y	H81	7/14/77	1021	1031	0.989	10.667	9 Ledge, 5450 Level, 66-67C Stope, Drilling.
0156	1Y	H82	7/14/77	1202	1212	0.989	8.770	9 Ledge, 5450 Level, 66-67C Stope, Drilling.
0156	1Y	H83	7/14/77	1250	1300	0.989	2.219	9 Ledge, 5450 level, 66-67C Stope, Some Drilling.
0156	1Y	H84	7/14/77	1348	1358	0.989	2.074	9 Ledge, 5450 Level, 66-67C Stope, Some Drilling.
							TWA-4.063	
0157	1D	H214	7/21/77	0730	0832	6.134	0.035	Main ledge, 4100 Level, 58E Stope.
0157	1D	H215	7/21/77	0803	0832	2.869	0.058	Main Ledge, 4100 Level, 58E Stope.
0157	1D	H216	7/21/77	0833	0903	2.968	0.237	Main Ledge, 4100 Level, 58E Stope.
0157	1D	H217	7/21/77	1007	1037	2.968	0.338	Main Ledge, 4100 Level, 58E Stope.
0157	1D	H218	7/21/77	1150	1220	2.968	0.414	Main Ledge, 4100 Level, 58E Stope, Bracing.
0157	1D	H219	7/21/77	1220	1250	2.968	0.908	Main Ledge, 4100 Level, 58E Stope.
							TWA-0.288	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0160	1E	H18	7/12/77	0820	0840	1.979	0.293	Main Ledge, 6800 Level, Near Loading Shaft.
							TWA-0.293	
0176	1J	H119	7/15/77	0805	0816	1.088	0.132	21 Ledge, 6200 Level, 50-52B Stope, Loading Equipment.
0176	1J	H120	7/15/77	0919	0929	0.989	0.760	21 Ledge, 6200 Level, 50-52B Stope, Took Break.
0176	1J	H118	7/15/77	1015	1030	1.484	0.394	21 Ledge, 6200 Level, 50-52B Stope, Some Drilling.
0176	1J	H117	7/15/77	1150	1200	0.989	0.350	21 Ledge, 6200 Level, 50-52B Stope.
0176	1J	H115	7/15/77	1315	1330	1.484	1.632	21 Ledge, 6200 Level, 50-52B Stope, Drilling.
0176	1J	H116	7/15/77	1415	1430	1.484	0.932	21 Ledge, 6200 Level, 50-52B Stope, Prepared for Blasting.
							TWA-0.749	
0176	1Z	H90	7/14/77	0831	0846	1.484	1.211	9 Ledge, 5450 Level, 64-65D Stope, Set Up Equipment.
0176	1Z	H89	7/14/77	0939	0954	1.484	0.788	9 Ledge, 5450 Level, 64-65D Stope, Took Break.
0176	1Z	H88	7/14/77	1015	1030	1.484	2.213	9 Ledge, 5450 Level, 64-65D Stope, Slushing.
0176	1Z	H87	7/14/77	1154	1210	1.583	1.397	9 Ledge, 5450 Level, 64-65D Stope, Slushing.
0176	1Z	H85	7/14/77	1304	1319	1.484	4.293	9 Ledge, 5450 Level, 64-65D Stope, Drilling.
0176	1Z	H86	7/14/77	1412	1427	1.484	2.765	9 Ledge, 5450 Level, 64-65D Stope, Drilling.
							TWA-2.103	

Table E-1 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0186	1X	H162	7/19/77	0714	0744	2.968	0.084	9 Ledge, 3650 Level, 27D Stope, Set Up Equipment.
0186	1X	H163	7/19/77	0850	0920	2.968	0.032	9 Ledge, 3650 Level, 27D Stope, Some Wet Drilling.
0186	1X	H164	7/19/77	1155	1225	2.968	0.084	9 Ledge, 3650 Level, 27D Stope, Wet Drilling.
0186	1X	H165	7/19/77	1303	1333	2.968	0.104	9 Ledge, 3650 Level, 27D Stope, Wet Drilling.
0186	1X	H166	7/19/77	1400	1430	2.968	0.277	9 Ledge, 3650 Level, 27D Stope, Wet Drilling.

TWA-0.116

Table E-2. Impinger dust sample results for surface workers at the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0204	1G	H167	7/19/77	0639	0709	2.968	0.615	Crushing-Surface, Chip Picking Ore, Yates.
0204	1G	H168	7/19/77	0808	0838	2.968	0.297	Crushing-Surface, Chip Picking Occasionally, Yates.
0204	1G	H169	7/19/77	1046	1106	1.979	0.223	Crushing-Surface, Chip Picking Waste Ore, Ate Lunch, Yates.
0204	1G	H170	7/19/77	1232	1302	2.968	0.109	Crushing-Surface, Chip Picking Occasionally, Waste Ore, Yates.
0204	1G	H171	7/19/77	1326	1354	2.770	0.073	Crushing-Surface, Chip Picking Waste, Yates.
							TWA-0.269	
0206	1H	H182	7/20/77	0748	0822	3.364	4.017	Crushing-Surface, Cleanup, Swept Floor, Ross.
0206	1H	H183	7/20/77	0918	0950	3.166	2.005	Crushing-Surface, Cleanup, Some Sweeping, Ate Lunch, Ross.
0206	1H	H180	7/20/77	1035	1105	2.968	5.956	Crushing-Surface, Cleanup, Ross.
0206	1H	H179	7/20/77	1300	1238	2.770	3.655	Crushing-Surface, Cleanup, Ross.
0206	1H	H181	7/20/77	1332	1350	1.781	3.363	Crushing-Surface, Cleanup, Ross.
							TWA-3.819	

Table E-3. Impinger dust sample results for underground employees on the 9 Ledge at the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0914	1K	H139	7/18/77	0715	0735	1.979	0.506	9 Ledge, 2150 Level, Carpenter.
0914	1K	H141	7/18/77	0819	0849	2.968	0.756	9 Ledge, 2150 Level, Carpenter.
0914	1K	H143	7/18/77	0924	0954	2.968	1.463	9 Ledge, 2150 Level, Carpenter.
0914	1K	H144	7/18/77	1030	1100	2.968	0.426	9 Ledge, 2150 Level, Carpenter.
0914	1K	H142	7/18/77	1218	1248	2.968	0.346	9 Ledge, 2150 Level, Carpenter.
							TWA-0.713	
0952	1F	H145	7/18/77	0743	0753	0.989	7.138	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Slushing.
0952	1F	H146	7/18/77	0913	0923	0.989	0.567	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Drilling.
0952	1F	H147	7/18/77	1030	1040	0.989	8.139	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Slushing.
0952	1F	H148	7/18/77	1210	1220	0.989	3.967	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Slushing.
0952	1F	H149	7/18/77	1253	1303	0.989	0.555	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Ate Lunch.
0952	1F	H150	7/18/77	1400	1415	1.484	0.289	9 Ledge, 2000 level, 45-51G/H Blast Hole, Took Break.
							TWA-3.200	

Table E-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0952	1J	H127	7/18/77	0728	0743	1.484	4.051	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Building Wall.
0952	1J	H120	7/18/77	0845	0900	1.484	0.587	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Pulling Chute.
0952	1J	H129	7/18/77	0952	1007	1.484	0.973	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Loading Ore.
0952	1J	H130	7/18/77	1035	1050	1.484	1.415	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Loading Ore.
0952	1J	H131	7/18/77	1147	1202	1.484	1.479	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Loading Ore.
0952	1J	H132	7/18/77	1330	1345	1.484	0.683	9 Ledge, 2000 Level, 45-51G/H Blast Hole, Shoveling Ore.
							TWA-1.531	
0953	1H	H133	7/18/77	0724	0754	2.968	2.617	9 Ledge, 2150 Level, 49 Crosscut, Ring Drilling.
0953	1H	H134	7/18/77	0838	0908	2.968	1.326	9 Ledge, 2150 Level, 49 Crosscut, Ring Drilling.
0953	1H	H135	7/18/77	1002	1032	2.968	1.017	9 Ledge, 2150 Level, 49 Crosscut, Ring Drilling.
0953	1H	H136	7/18/77	1143	1213	2.968	0.205	9 Ledge, 2150 Level, 49 Crosscut, Ring Drilling.
0953	1H	H137	7/18/77	1247	1317	2.968	0.261	9 Ledge, 2150 Level, 49 Crosscut, Drilling.
0953	1H	H138	7/18/77	1350	1420	2.968	0.599	9 Ledge, 2150 Level, 49 Crosscut, Drilling.
							TWA-1.004	

Table E-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0954	1A	H123	7/18/77	0731	0758	2.671	1.049	9 Ledge, 1700 Level, Drift South 22 Crosscut, Highballing.
0954	1A	H122	7/18/77	0900	0930	2.968	1.117	9 Ledge, 1700 Level, Drift South 22 Crosscut.
0954	1A	H126	7/18/77	1057	1128	3.067	0.249	9 Ledge, 1700 Level, Drift South 22 Crosscut.
0954	1A	H121	7/18/77	1250	1321	3.067	1.797	9 Ledge, 1700 Level, Drift South 22 Crosscut, Blasting.
0954	1A	H125	7/18/77	1410	1430	1.979	0.953	9 Ledge, 1700 Level, Drift South 22 Crosscut, Mucking.
							TWA-1.038	
0955	1B	H45	7/13/77	0832	0843	1.088	1.834	9 Ledge, 5750 Level, 68C Stope, in Manway While Slushing.
0955	1B	H44	7/13/77	0922	0932	0.989	0.434	9 Ledge, 5750 Level, 68C Stope, Spilled Sample.
0955	1B	H43	7/13/77	0924	0941	1.682	0.979	9 Ledge, 5750 Level, 68C Stope, Barring Down.
0955	1B	H47	7/13/77	1245	1255	0.989	0.289	9 Ledge, 5750 Level, 68C Stope, Not Working at Time of Sample.
0955	1B	H46	7/13/77	1328	1345	1.682	0.402	9 Ledge, 5750 Level, 68C Stope, in Main Drift Not Working.
0955	1B	H48	7/13/77	1426	1442	1.583	0.306	9 Ledge, 5750 Level, 68C Stope, in Main Drift Not Working.
							TWA-0.689	

Table E-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0956	1B	H223	7/21/77	0710	0740	2.968	0.100	9 Ledge, 3950 Level, 24-25B Stope, Operated Hoist in Chute.
0956	1B	H220	7/21/77	0846	0917	3.067	13.217	9 Ledge, 3950 Level, 24-25B Stope, Filling Ore Cars.
0956	1B	H225	7/21/77	1007	1043	3.562	0.961	9 Ledge, 3950 Level, 24-25B Stope, Using Gamby to Fill Cars.
0956	1B	H224	7/21/77	1200	1230	2.968	0.949	9 ledge, 3950 Level, 24-25B Stope, Gamby Loading Area.
0956	1B	H221	7/21/77	1335	1353	1.781	0.409	9 Ledge, 3950 Level, 24-25B Stope.
0956	1B	H222	7/21/77	1415	1442	2.671	0.143	9 Ledge, 3950 Level, 24-25B Stope.
							TWA-2.831	
0956	1J	H51	7/13/77	0815	0830	1.484	0.434	9 Ledge, 3950 Level, 67-68D Stope, Prying Off Loose Rock.
0956	1J	H49	7/13/77	0934	0947	1.286	0.278	9 Ledge, 3950 Level, 67-68D Stope, Wet Drilling.
0956	1J	H54	7/13/77	1150	1206	1.583	0.638	9 Ledge, 3950 Level, 67-68D Stope, Drilling.
0956	1J	H53	7/13/77	1243	1258	1.484	0.402	9 Ledge, 3950 Level, 67-68D Stope, Wet Drilling.
0956	1J	H50	7/13/77	1332	1347	1.484	0.536	9 Ledge, 3950 Level, 67-68D Stope.
0956	1J	H52	7/13/77	1412	1427	1.484	0.482	9 Ledge, 3950 Level, 67-68D Stope, Loading Explosives.
							TWA-0.468	

Table E-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0956	1K	H204	7/20/77	0748	0810	2.671	0.994	9 Ledge, 4400 Level, 31-32C/D Stope, Set Up for Slushing.
0956	1K	H202	7/20/77	0924	0953	2.869	2.240	9 Ledge, 4400 Level, 31-32C/D Stope, Set Up for Slushing.
0956	1K	H206	7/20/77	1020	1050	2.968	2.106	9 Ledge, 4400 Level, 31-32C/D Stope, Slushing.
0956	1K	H207	7/20/77	1230	1300	2.968	2.192	9 Ledge, 4400 Level, 31-32D Stope, Slushing.
0956	1K	H205	7/20/77	1337	1402	2.473	4.756	9 Ledge, 4400 Level, 31-32D Stope, Slushing, Drilling.
							TWA-2.409	
0956	1L	H161	7/19/77	0717	0747	2.968	0.784	9 Ledge, 3650 Level, 18B Stope, First Aid Station, and Set Up Equipment in Stope.
0956	1L	H160	7/19/77	0848	0918	2.968	0.040	9 Ledge, 3650 Level, 18B Stope, Some Drilling, Repaired Equipment.
0956	1L	H159	7/19/77	0935	1005	2.968	0.088	9 Ledge, 3650 Level, 18B Stope, Drilled Ore Sample.
0956	1L	H156	7/19/77	1255	1325	2.968	0.217	9 Ledge, 3650 Level, 18B Stope, Some Drilling, Set Up Slusher.
0956	1L	H158	7/19/77	1348	1418	2.968	0.028	9 Ledge, 3650 Level, 18B Stope, Helped Construct Manway and Chute.
							TWA-0.231	

Table E-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0956	IN	H198	7/20/77	0734	0804	2.968	0.667	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
0956	IN	H199	7/20/77	0813	0843	2.968	0.581	9 Ledge, 4250 Level, 36-37B/C Stope, Some Drilling.
0956	IN	H197	7/20/77	0904	0935	3.067	0.493	9 Ledge, 4250 level, 36-37B/C Stope, Drilling.
0956	IN	H201	7/20/77	1001	1031	2.968	0.940	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
0956	IN	H200	7/20/77	1223	1253	2.968	0.833	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
0956	IN	H187	7/20/77	1336	1406	2.968	0.571	9 Ledge, 4250 Level, 36-37B/C Stope, Drilling.
							TWA-0.680	
0956	1Q	H124	7/19/77	0727	0756	2.869	0.661	9 Ledge, 3950 Level, 18G Stope, Highball Drilling.
0956	1Q	H151	7/19/77	0940	1007	2.671	0.152	9 Ledge, 3950 Level, 18G Stope, Not Drilling at Time of Sample.
0956	1Q	H152	7/19/77	1155	1227	3.166	0.452	9 Ledge, 3950 Level, 18G Stope, Some Drilling.
0956	1Q	H153	7/19/77	1240	1310	2.968	0.084	9 Ledge, 3950 Level, 18G Stope, Repaired Drill.
0956	1Q	H154	7/19/77	1321	1351	2.968	0.060	9 Ledge, 3950 Level, 18G Stope, Some Drilling.
0956	1Q	H155	7/19/77	1400	1420	1.979	0.295	9 Ledge, 3950 Level, 18G Stope, This Sample Was Taken as a General Area Sample Within the Stope.
							TWA-0.285	

Table E-3 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
0956	1Y	H79	7/14/77	0801	0816	1.484	1.109	9 Ledge, 5450 Level, 66-67C Stope, Set Up Equipment.
0956	1Y	H80	7/14/77	0919	0929	0.989	1.013	9 Ledge, 5450 Level, 66-67C Stope, Some Drilling.
0956	1Y	H81	7/14/77	1021	1031	0.989	10.667	9 Ledge, 5450 Level, 66-67C Stope, Drilling.
0956	1Y	H82	7/14/77	1202	1212	0.989	8.770	9 Ledge, 5450 Level, 66-67C Stope, Drilling.
0956	1Y	H83	7/14/77	1250	1300	0.989	2.219	9 Ledge, 5450 Level, 66-67C Stope, Some Drilling.
0956	1Y	H84	7/14/77	1348	1358	0.989	2.074	9 Ledge, 5450 Level, 66-67C Stope, Some Drilling.
							TWA-4.063	
0976	1Z	H90	7/14/77	0831	0846	1.484	1.211	9 Ledge, 5450 Level, 64-65D Stope, Set Up Equipment.
0976	1Z	H89	7/14/77	0939	0954	1.484	0.788	9 Ledge, 5450 Level, 64-65D Stope, Took Break.
0976	1Z	H88	7/14/77	1015	1030	1.484	2.213	9 Ledge, 5450 Level, 64-65D Stope, Slushing.
0976	1Z	H87	7/14/77	1154	1210	1.583	1.397	9 Ledge, 5450 Level, 64-65D Stope, Slushing.
0976	1Z	H85	7/14/77	1304	1319	1.484	4.293	9 Ledge, 5450 Level, 64-65D Stope, Drilling.
0976	1Z	H86	7/14/77	1412	1427	1.484	2.765	9 Ledge, 5450 Level, 64-65D Stope, Drilling.
							TWA-2.103	
0986	1X	H162	7/19/77	0714	0744	2.968	0.084	9 Ledge, 3650 Level, 27D Stope, Set Up Equipment.
0986	1X	H163	7/19/77	0850	0920	2.968	0.032	9 Ledge, 3650 Level, 27D Stope, Some Wet Drilling.
0986	1X	H164	7/19/77	1155	1225	2.968	0.084	9 Ledge, 3650 Level, 27D Stope, Wet Drilling.
0986	1X	H165	7/19/77	1303	1333	2.968	0.104	9 Ledge, 3650 Level, 27D Stope, Wet Drilling.
0986	1X	H166	7/19/77	1400	1430	2.968	0.277	9 Ledge, 3650 Level, 27D Stope, Wet Drilling.
							TWA-0.116	

Table E-4. Impinger dust sample results for underground employees on the Main Ledge at the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
1010	1G	H226	7/21/77	0738	0808	2.968	0.338	Main Ledge, 4250 Level, 71C Stope, Set Up Timber Using Chain Saw.
1010	1G	H227	7/21/77	1000	1030	2.968	0.313	Main Ledge, 4250 Level, 71C Stope, Waiting for Timber.
1010	1G	H228	7/21/77	1144	1216	3.166	0.256	Main Ledge, 4250 Level, 71C Stope, Working on Timberline.
1010	1G	H230	7/21/77	1308	1438	8.905	0.671	Main Ledge, 4250 Level, 71C Stope, Working on Timberline.
1010	1G	H231	7/21/77	1348	1418	1.979	1.369	Main Ledge, 4250 Level, 71C Stope, Working on Timberline.
							TWA-0.609	
1043	1R	H69	7/14/77	0735	0750	1.484	0.525	Main Ledge, 6050 Level, 90 Pillar, Set Up Bore Drill.
1043	1R	H72	7/14/77	0830	0845	1.484	4.067	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
1043	1R	H71	7/14/77	0932	0942	0.989	2.717	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
1043	1R	H70	7/14/77	1047	1059	1.187	2.257	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
1043	1R	H67	7/14/77	1302	1317	1.484	1.945	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
1043	1R	H68	7/14/77	1408	1418	0.989	4.212	Main Ledge, 6050 Level, 90 Pillar, Bore Machine Drilling.
							TWA-2.525	

Table E-4 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
1054	1L	H236	7/21/77	0759	0829	2.968	0.257	Main Ledge, 4250 level, 70 Crosscut, Drilling.
1054	1L	H233	7/21/77	1025	1055	2.968	0.149	Main Ledge, 4250 Level, 70 Crosscut, Some Drilling.
1054	1L	H234	7/21/77	1216	1246	2.968	0.318	Main Ledge, 4250 Level, 70 Crosscut, Drilling.
1054	1L	H232	7/21/77	1345	1415	2.968	1.342	Main Ledge, 4250 Level, 70 Crosscut, Prepare for Blasting.
							TWA-0.517	
1055	1F	H11	7/12/77	0808	0828	1.979	16.599	Main Ledge, 6500 Level, Dumped Waste.
1055	1F	H09	7/12/77	0942	0957	1.484	1.393	Main Ledge, 6500 Level, Fixed Slusher.
1055	1F	H10	7/12/77	1152	1207	1.484	4.828	Main Ledge, 6500 Level, Some Mucking.
1055	1F	H07	7/12/77	1310	1325	1.484	3.596	Main Ledge, 6500 Level, Mucking.
1055	1F	H12	7/12/77	1414	1429	1.484	3.666	Main Ledge, 6500 Level, Unloaded Equipment.
1055	1F	H08	7/12/77	1458	1513	1.484	2.583	Main Ledge, 6500 Level, on Train.
							TWA-6.031	
1056	1C	H13	7/12/77	0931	0946	1.484	0.809	Main Ledge, 6800 Level, 93-94C Cutting Sill, Slushing.
1056	1C	H17	7/12/77	1152	1207	1.484	0.906	Main Ledge, 6800 Level, 93-94C Cutting Sill, Slushing.
1056	1C	H16	7/12/77	1400	1415	1.484	1.270	Main Ledge, 6800 Level, 93-94C Cutting Sill, Slushing.
							TWA-0.995	

Table E-4 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
1056	1K	H1	7/12/77	0826	0841	1.484	0.954	Main ledge, 6050 Level, 89E Stope, Not Working at Time of Sample.
1056	1K	H2	7/12/77	0955	1015	1.979	1.439	Main ledge, 6050 Level, 89E Stope, Some Slushing.
1056	1K	H3	7/12/77	1210	1225	1.484	3.928	Main Ledge, 6050 Level, 89E Stope, Wet Ore, Slushing.
1056	1K	H4	7/12/77	1305	1315	0.989	6.423	Main Ledge, 6050 Level, 89E Stope, Drilling.
1056	1K	H5	7/12/77	1405	1415	0.989	1.021	Main Ledge, 6050 Level, 89E Stope, Drilling.
1056	1K	H6	7/12/77	1430	1440	0.989	1.214	Main Ledge, 6050 Level, 89E Stope, Drilling.
							TWA-2.174	
1057	1D	H214	7/21/77	0730	0832	6.134	0.035	Main Ledge, 4100 Level, 58E Stope.
1057	1D	H215	7/21/77	0803	0832	2.869	0.058	Main Ledge, 4100 Level, 58E Stope.
1057	1D	H216	7/21/77	0833	0903	2.968	0.237	Main Ledge, 4100 Level, 58E Stope.
1057	1D	H217	7/21/77	1007	1037	2.968	0.338	Main Ledge, 4100 Level, 58E Stope.
1057	1D	H218	7/21/77	1150	1220	2.968	0.414	Main Ledge, 4100 Level, 58E Stope, Bracing.
1057	1D	H219	7/21/77	1220	1250	2.968	0.908	Main Ledge, 4100 Level, 58E Stope.
							TWA-0.288	
1060	1E	H18	7/12/77	0820	0840	1.979	0.293	Main Ledge, 6800 Level, Near Loading Shaft.
							TWA-0.293	

Table E-5. Impinger dust sample results for underground employees on the 11 Ledge at the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
1141	1C	H63	7/14/77	0754	0807	1.286	0.928	11 Ledge, 5600 Level, 55 Pillar, Set Up Equipment, Some Drilling.
1141	1C	H61	7/14/77	0852	0908	1.583	0.522	11 Ledge, 5600 Level, 55 Pillar, Some Drilling.
1141	1C	H64	7/14/77	0955	1010	1.484	1.313	11 Ledge, 5600 Level, 55 Pillar, Drilled.
1141	1C	H62	7/14/77	1130	1145	1.484	0.643	11 Ledge, 5600 Level, 55 Pillar, Pulled Core, Drilled.
1141	1C	H65	7/14/77	1250	1305	1.484	0.756	11 Ledge, 5600 Level, 55 Pillar, Pulled Core, Drilled.
1141	1C	H66	7/14/77	1358	1410	1.187	0.777	11 Ledge, 5600 Level, 55 Pillar, Some Drilling.
							TWA-0.819	
1156	1D	H58	7/13/77	0930	0940	0.989	0.635	11 Ledge, 5450 Level, 49-51 Stope, Drilling.
1156	1D	H59	7/13/77	1155	1205	0.989	0.410	11 Ledge, 5450 Level, 49-51 Stope, Ore Sample Drilling.
1156	1D	H60	7/13/77	1235	1245	0.989	0.434	11 Ledge, 5450 Level, 49-51 Stope, Ore Sample Drilling.
1156	1D	H57	7/13/77	1335	1350	1.484	0.273	11 Ledge, 5450 Level, 49-51 Stope, Drilling.
1156	1D	H55	7/13/77	1434	1444	0.989	0.434	11 Ledge, 5450 Level, 49-51 Stope, Took Break.
							TWA-0.422	

Table E-5 (continued)

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
1156	1G	H37	7/13/77	0910	0922	1.187	1.728	11 Ledge, 5300 Level, 49D Stope, Prying Off Loose Rock.
1156	1G	H41	7/13/77	0927	0932	0.495	1.350	11 Ledge, 5300 Level, 49D Stope, Wetting Ore, Drilling.
1156	1G	H40	7/13/77	1028	1038	0.989	3.537	11 Ledge, 5300 Level, 49D Stope, Drilling.
1156	1G	H38	7/13/77	1142	1152	0.989	0.675	11 Ledge, 5300 Level, 49D Stope, Wetting Ore.
1156	1G	H42	7/13/77	1302	1317	1.484	1.093	11 Ledge, 5300 Level, 49D Stope, Some Drilling.
1156	1G	H39	7/13/77	1340	1350	0.989	2.653	11 Ledge, 5300 Level, 49D Stope, Cleaning Up.
							TWA-1.815	
1156	1N	H33	7/13/77	0825	0835	0.989	0.820	11 Ledge, 5750 Level, 57C Stope, Drilled.
1156	1N	H32	7/13/77	0910	0920	0.989	0.563	11 Ledge, 5750 Level, 57C Stope, Drilled.
1156	1N	H31	7/13/77	1007	1017	0.989	4.116	11 Ledge, 5750 Level, 57C Stope, Putting in Slusher Blocks.
1156	1N	H36	7/13/77	1300	1315	1.484	0.000	11 Ledge, 5750 Level, 57C Stope, Repositioned Slusher.
1156	1N	H35	7/13/77	1417	1432	1.484	1.200	11 Ledge, 5750 Level, 57C Stope, Took Break.
							TWA-1.217	

Table E-6. Impinger dust sample results for underground employees on the 13 Ledge at the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
1356	1A	H20	7/12/77	0828	0848	1.979	0.366	13 Ledge, 6050 Level, 46-47C Stope, Some Drilling.
1356	1A	H22	7/12/77	0920	0940	1.979	1.025	13 Ledge, 6050 Level, 46-47C Stope, Drilling, Mucking.
1356	1A	H21	7/12/77	1102	1122	1.979	3.730	13 Ledge, 6050 Level, 46-47C Stope, Ate Lunch.
1356	1A	H19	7/12/77	1220	1235	1.484	1.570	13 Ledge, 6050 Level, 46-47C Stope, Drilling.
1356	1A	H23	7/12/77	1340	1355	1.484	1.061	13 Ledge, 6050 Level, 46-47C Stope, Pulling Chute.
1356	1A	H24	7/12/77	1412	1427	1.484	5.171	13 Ledge, 6050 Level, 46-47C Stope, Pulling Chute.
							TWA-2.090	
1356	1H	H26	7/12/77	0832	0851	1.880	1.400	13 Ledge, 6050 Level.
1356	1H	H25	7/12/77	0928	0947	1.880	1.214	13 Ledge, 6050 Level, Not Working at Time of Sample.
1356	1H	H27	7/12/77	1057	1117	1.979	1.298	13 Ledge, 6050 Level, Ate Lunch, Some Mucking.
1356	1H	H29	7/12/77	1155	1214	1.880	1.202	13 Ledge, 6050 Level, Mucking.
1356	1H	H28	7/12/77	1329	1348	1.880	1.540	13 Ledge, 6050 Level, Putting in Track.
1356	1H	H30	7/12/77	1425	1439	1.385	12.471	13 Ledge, 6050 Level, Putting in Track.
							TWA-2.748	

Table E-7. Impinger dust sample results for underground employees on the 19 Ledge at the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
1932	1P	H97	7/15/77	0759	0814	1.484	1.174	19 Ledge, 6800 Level, Motorman, Hauling Ore.
1932	1P	H98	7/15/77	0952	1002	0.989	0.844	19 Ledge, 6800 Level, Motorman, Unloading Equipment.
1932	1P	H99	7/15/77	1025	1039	1.385	5.460	19 Ledge, 6800 Level, Pulling Raises.
1932	1P	H100	7/15/77	1226	1236	0.989	1.013	19 Ledge, 6800 Level, Motorman, Dumping Ore.
1932	1P	H101	7/15/77	1320	1335	1.484	0.080	19 Ledge, 6800 Level, Motorman, Hauling Ore.
1932	1P	H102	7/15/77	1405	1420	1.484	0.096	19 Ledge, 6800 Level, Motorman, Dumping Ore.
							TWA-1.459	
1954	1G	H94	7/15/77	0839	0906	2.671	0.058	19 Ledge, 4850 Level, 46 Crosscut, Took Break.
1954	1G	H95	7/15/77	1142	1226	4.353	0.049	19 Ledge, 4850 Level, 46 Crosscut, Installing Water Pipes.
1954	1G	H96	7/15/77	1414	1444	2.968	0.092	19 Ledge, 4850 Level, 46 Crosscut, Installing Water Pipes.
							TWA-0.064	
1956	1S	H113	7/15/77	0831	0847	1.583	0.151	19 Ledge, 6200 Level, 41-42C Stope, Moving Some Hose.
1956	1S	H114	7/15/77	0945	1000	1.484	0.153	19 Ledge, 6200 Level, 41-42C Stope, Splicing Cable.
1956	1S	H112	7/15/77	1040	1055	1.484	0.370	19 Ledge, 6200 Level, 41-42C Stope, Wetting Ore.
1956	1S	H111	7/15/77	1159	1213	1.385	0.086	19 Ledge, 6200 Level, 41-42C Stope, Some Drilling.
1956	1S	H110	7/15/77	1310	1327	1.682	0.043	19 Ledge, 6200 Level, 41-42C Stope, Took Break.
1956	1S	H109	7/15/77	1356	1410	1.385	0.396	19 Ledge, 6200 Level, 41-42C Stope, Drilling.
							TWA-0.195	

Table E-8. Impinger dust sample results for underground employees on the 21 Ledge at the Homestake Gold Mine.

Job code	Person number	Sample number	Date	Sample time On	Sample time Off	Volume (ft^3)	Concentration (mppcf)	Sample information (i.e. location, operation, activity, etc.)
2176	IJ	H119	7/15/77	0805	0816	1.088	0.132	21 Ledge, 6200 Level, 50-52B Stope, Loading Equipment.
2176	IJ	H120	7/15/77	0919	0929	0.989	0.760	21 Ledge, 6200 Level, 50-52B Stope, Took Break.
2176	IJ	H118	7/15/77	1015	1030	1.484	0.394	21 Ledge, 6200 Level, 50-52B Stope, Some Drilling.
2176	IJ	H117	7/15/77	1150	1200	0.989	0.350	21 ledge, 6200 Level, 50-52B Stope.
2176	IJ	H115	7/15/77	1315	1330	1.484	1.632	21 Ledge, 6200 Level, 50-52B Stope, Drilling.
2176	IJ	H116	7/15/77	1415	1430	1.484	0.932	21 Ledge, 6200 Level, 50-52B Stope, Prepared for Blasting.
							TWA-0.749	

Table E-9. Statistical summary of impinger dust sample results for all underground employees at the Homestake Gold Mine.

Job code	Number of samples	Range mppcf High - Low	MPPCF Mean	Median	TWA	Standard deviation	Standard error	Job title
0107	12	1.358 - 0.303	0.904	1.054	0.891	0.389	0.112	Hoist Operator-Underground
0110	5	1.369 - 0.256	0.589	0.338	0.609	0.465	0.208	Carpenter, 1st
0114	5	1.463 - 0.346	0.699	0.506	0.713	0.454	0.203	Carpenter, Master
0124	6	4.758 - 1.261	2.534	2.286	2.559	1.171	0.478	Skipper Head
0125	11	3.794 - 0.068	1.302	0.309	1.298	1.462	0.441	Skipper
0132	6	5.460 - 0.080	1.445	0.929	1.459	2.021	0.825	Motorman, 1st
0141	6	1.313 - 0.522	0.823	0.767	0.819	0.276	0.113	Diamond Drill Operator
0143	6	4.212 - 0.525	2.621	2.487	2.525	1.387	0.566	Bore Machine Operator
0152	12	8.139 - 0.289	2.487	1.194	2.231	2.272	0.787	Miner, 1st
0153	6	2.617 - 0.205	1.004	0.808	1.004	0.901	0.368	Miner, 1st
0154	12	1.797 - 0.049	0.619	0.288	0.591	0.599	0.173	Miner, 1st
0155	11	16.599 - 0.289	3.316	1.834	3.761	4.664	1.406	Miner, 1st
0156	84	13.217 - 0.000	1.622	0.870	1.473	2.516	0.275	Miner, 1st
0157	6	0.908 - 0.035	0.332	0.288	0.288	0.320	0.130	Miner, 1st
0160	1	0.293 - 0.293	0.293	0.293	0.293	0.000	0.000	Miner, 1st
0176	12	4.293 - 0.132	1.423	1.211	1.499	1.146	0.318	Miner, 3rd
0186	5	0.277 - 0.032	0.116	0.084	0.116	0.094	0.042	Miner, 4th
Area 01	Total 206	16.599 - 0.000	1.514	0.906	1.287	2.224	0.155	All Underground Employees

Table E-10. Statistical summary of impinger dust sample results for surface employees in the crushing mills at the Homestake Gold Mine.

Job code	Number of samples	Range mppcf High - Low	MPPCF Mean	Median	TWA	Standard deviation	Standard error	Job title
0204	5	0.615 - 0.073	0.263	0.223	0.269	0.216	0.097	Belt/Chip Picker
0206	5	5.956 - 2.005	3.799	3.655	3.819	1.426	0.638	Laborer, 1st
Area 02	Total 10	5.956 - 0.073	2.031	1.310	2.069	2.097	0.663	Surface Employees in the Crushing Mills

Table E-11. Statistical summary of impinger dust sample results for underground employees on the 9, Main, 11, 19, and 21 Ledges at the Homestake Gold Mine.

Job code	Number of samples	Range mppcf High - Low	MPPCF Mean	Median	TWA	Standard deviation	Standard error	Job title
0914	5	1.463 - 0.346	0.699	0.506	0.713	0.454	0.203	Carpenter, Master
0952	12	8.139 - 0.289	2.487	1.194	2.231	2.272	0.787	Miner, 1st
0953	6	2.617 - 0.205	1.004	0.808	1.004	0.901	0.368	Miner, 1st
0954	5	1.797 - 0.249	1.003	1.049	1.038	0.550	0.246	Miner, 1st
0955	6	1.834 - 0.289	0.707	0.418	0.689	0.608	0.248	Miner, 1st
0956	40	13.217 - 0.028	1.591	0.610	1.385	2.870	0.454	Miner, 1st
0976	6	4.293 - 0.788	2.111	1.805	2.103	1.286	0.525	Miner, 3rd
0986	5	0.277 - 0.032	0.116	0.084	0.116	0.094	0.042	Miner, 4th
Area 09	Total 85	13.217 - 0.028	1.478	0.667	1.248	2.321	0.252	All Employees on 9 Ledge
1010	5	0.912 - 0.256	0.498	0.338	0.545	0.283	0.126	Carpenter, 1st
1043	6	4.212 - 0.525	2.621	2.487	2.525	1.387	0.566	Boring Machine Operator
1054	4	1.342 - 0.149	0.517	0.288	0.517	0.555	0.277	Miner, 1st
1055	6	16.599 - 1.393	5.444	3.631	6.031	5.585	2.280	Miner, 1st
1056	9	6.423 - 0.809	1.940	1.242	1.808	1.816	0.574	Miner, 1st
1057	6	0.908 - 0.035	0.332	0.288	0.288	0.320	0.130	Miner, 1st
1060	1	0.293 - 0.293	0.293	0.293	0.293	0.000	0.000	Miner, 2nd
Area 10	Total 37	16.599 - 0.035	1.990	1.214		2.930	0.482	All Employees on Main Ledge
1141	6	1.313 - 0.225	0.735	0.710	0.726	0.371	0.151	Diamond Drill Operator
1156	16	4.116 - 0.000	1.245	0.748	1.179	1.200	0.300	Miner, 1st
Area 11	Total 22	4.116 - 0.000	1.130	0.798		1.340	0.286	All Employees on 11 Ledge

Table E-11 (continued)

Job code	Number of samples	Range mppcf High - Low	MPPCF Mean	Median	TWA	Standard deviation	Standard error	Job title
1356	12	12.471 - 0.366	2.671	1.349	2.427	3.362	0.970	Miner, 1st
Area 13	Total 12	12.471 - 0.366	2.671	1.349	2.427	3.362	0.970	All Employees on 13 Ledge
1932	6	5.460 - 0.080	1.445	0.929	1.459	2.021	0.825	Motorman, 1st
1954	3	0.092 - 0.049	0.066	0.058	0.064	0.023	0.013	Miner, 1st
1956	6	0.396 - 0.043	0.200	0.152	0.195	0.148	0.060	Miner, 1st
Area 19	Total 15	5.460 - 0.043	0.671	0.151	0.515	1.377	0.356	All Employees on 19 Ledge
2176	6	1.632 - 0.132	0.700	0.577	0.749	0.541	0.225	Miner, 3rd
Area 21	Total 6	1.632 - 0.132	0.700	0.577	0.749	0.541	0.225	All Employees on 21 Ledge