AEROSOL CHARACTERIZATION STUDY OF ANCHORAGE, ALASKA: CHEMICAL ANALYSIS AND SOURCE APPORTIONMENT

Final Report
Volume I

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EXECUTIVE SUMMARY

The impact of residential wood combustion (RWC) and vegetative burn emissions in Anchorage, Alaska, was studied during a sample period which included the latter part of April, all of May, and the first week of June, 1984. Aerosol samples were collected at a Tudor Road site and a Fourth Avenue site, both located in Anchorage proper, and an Eagle River site, located northeast of Anchorage. Samples were collected by Sierra virtual impactor dichotomous samplers, which sort aerosol particles into a fine fraction (< 2.5 μm) and a coarse fraction (> 2.5 μm, < 10 μm). High-volume TSP samples were also collected at all three sites. Nephelometer readings were obtained at the Tudor Road site. Aerosol sampling occurred on an every third day, 24-hour basis, with several additional 24-hour samples collected in May as determined desirable by Anchorage Air Pollution Control Agency (AAPCA) personnel.

Forty-eight fine and coarse teflon filters were analyzed for their elemental content by X-ray fluorescence (XRF). Eight glass fiber TSP filters were analyzed for organic and elemental carbon content by a pyrolysis-flame ionization procedure. Source contributions were quantified using chemical mass balance (CMB) receptor modeling procedures.

The XRF, carbon, size segregation, and CMB results all indicate a heavy impact of crustal materials on the samples collected. Crustal sources accounted for 90 - 98% of the coarse fraction mass and 64 - 85% of the fine fraction mass in CMB fitting. Coarse fraction loadings were higher than fine fraction loadings. Eagle River samples indicate TSP concentrations and crustal impacts to be generally twice those at the other two sites.

A RMC source was fit for only one of the 48 dichotomous filters by CMB calculations, accounting for only 1% of the fine fraction mass at the Tudor Road site. The high-volume organic and elemental carbon data

also indicate that RWC and vegetative burn sources had little or no impact on Anchorage air quality during this sampling period. Sources with consistent impacts on the ambient filters, in addition to crustal sources, were transportation, marine, and secondary sulfate.

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1.0 INTRODUCTION

The airshed of the Municipality of Anchorage, Alaska, has recently been the subject of three concerns: (1) a number of complaints have arisen concerning emissions from residential wood combustion (RWC) in the Eagle River area and within the Anchorage bowl itself; (2) local air quality officials are concerned that burning associated with clearing the Point MacKenzie area, north of Anchorage, may impact air quality in Anchorage; and (3) the source of a brown haze noted in the airshed in the spring (late March through May) is largely undetermined. Presently backyard burning is allowed only outside the Anchorage bowl (i.e., Eagle River) during the month of April. Within Anchorage proper burning is restricted to residential heating only. The primary sources of emissions into this airshed, then, are presumed to be RWC and periodic clearing activities at Point MacKenzie.

The objective of this investigation was to perform a detailed study of the impact of RWC and vegetative burn emissions on Anchorage's air quality using state-of-the-art methods. By quantifying the impact of these emission sources, as well as other sources, effective control strategies may be developed to improve the air quality in this area.

2.0 EXPERIMENTAL

2.1 Modeling Approach

A receptor modeling approach (RMA) was selected over a source-oriented dispersion model approach (DMA) for the study of the Anchorage airshed. The RMA is based on direct measurement of the chemical composition of atmospheric pollutants and their relative apportionment between potential sources. The DMA, on the other hand, is based on estimates of absolute emission rates and meteorological dispersion factors. Although this latter approach has proven useful in some situations, such as annual impacts of emissions from tall stacks in

rather simple terrain, large uncertainties exist when the method is applied to 24 hour impacts from short stacks such as residential heating units. The inherent problem with the DMA, however, is its dependence on highly variable emission and dispersion factors. Emission rates from RWC sources would be difficult to determine; rates for other potential sources such as resuspended road dust and soil would be nearly impossible to quantify.

Selection of the RMA was also based on successful applications to other airsheds to apportion RWC impacts (1-3).

2.2 Source Apportionment Methodology

The relationship between particulate emissions and ambient concentrations at a receptor (hi-vol or dichotomous sampler) site distant from the pollution source is a complicated one. Many variables, primarily meteorological, make the direct correlation between source emissions and ambient concentrations a poor one. Each of these variables is random in nature, will vary with space and time, and may combine with other variables in a nonlinear manner. Thus, any estimation of source impact on ambient particulate loadings at a receptor site using dispersion modeling is approximate at best.

On the other hand, one can start at the other end of the system by collecting an ambient air particulate sample at a receptor site by a representative sampling technique, determine some property such as elemental composition of this sample which is unique to specific sources or source types, and assigning the origin of that fraction of the sample possessing that property to its appropriate source.

The specific RMA used in this study included chemical mass balance (CMB) regression analysis to identify source types and determine their contribution to ambient particulate levels. The CMB receptor model is based on the conservation of aerosol mass from the time a chemical species

is emitted from its source to the time it is measured at a receptor. That is, if p sources are each emitting M_j mass of particles, then

$$m = \sum_{j=1}^{p} M_j, \tag{1}$$

where m is the total particulate mass collected on a filter at a receptor site. This assumes the mass deposited on a filter is a linear combination of the mass contributed from each of the sources.

The mass of a specific chemical species, m_i, is given by

$$m_i = \sum_{j=1}^{p} M_{ij} = \sum_{j=1}^{p} F'_{ij} M_j \tag{2}$$

where M_{ij} is the mass of element i from source j and F'_{ij} is the fraction of chemical species i of the mass from source j as collected at the receptor. It is usually assumed that

$$F_{ij} = F'_{ij}, \tag{3}$$

where F_{ij} is the fraction of chemical species i emitted by source j as measured at the source; that is, the relative fraction of chemical species i of the source mass <u>at the receptor</u> is the same as the relative fraction of i of the source mass <u>at the source</u>. The degree of validity in this assumption depends on the chemical and physical properties of the species and its potential for atmospheric, in-transit modifications such as condensation, volatilization, chemical reactions, sedimentations, etc.

Accepting equation (3) as valid and dividing both sides of equation (2) by the total mass of the deposit collected at the receptor site, it follows that

$$\frac{m_i}{m} = \sum_{j=1}^{p} F_{ij} \frac{M_j}{m} \tag{4}$$

$$\text{or,} \quad C_i = \sum_{j=1}^{p} F_{ij} S_j, \qquad (5)$$

where C_i is the concentration of the chemical component i as measured at the receptor and S_j is the source contribution (i.e., ratio of the mass contributed from source j to the total mass collected at the receptor site). In practice, it is S_j, the fraction of particulate pollution measured at a receptor due to source j, which is of primary interest in CMB calculations.

If the C_i and the F_{ij} at the receptor for all p of the source types suspected of affecting the receptor are known, and if $p < n$ (n = number of chemical species quantified), a set of n simultaneous equations exists from which the source contribution S_j for each source may be calculated by least squares methods.

Implementation of a CMB analysis requires the formation of both ambient and source elemental data sets. The development of these data sets for this study are discussed in detail below.

2.3 Ambient Profile Development

Sierra dichotomous virtual impactor samplers with 10 μm inlets were used to collect fine (< 2.5 μm) and coarse (> 2.5 and < 10 μm) particles on 37 mm ring mounted teflon filters (4). The standard operating procedure for the Sierra dichotomous sampler used by Anchorage Air Pollution Control Agency (AAPA) personnel is presented in Appendix A.1. Filters were collected on an every-third-day schedule during April and May at three sites: 3500 East Tudor Road, 527 East Fourth Avenue, and the Eagle River Parkgate Building. Additional unscheduled sampling took place during May on days that field personnel judged to be particularly hazy or dry. In all, 114 filters were exposed. See Appendix E for summaries of dichotomous sampling field data.

Anchorage Air Pollution Control Agency personnel also operated high-volume samplers with 8" X 10" glass fiber filters at all three sites and an integrating nephelometer from the University of Washington at the Tudor Road site. Standard operating procedures for these instruments are presented in Appendix A.2 and Appendix A.4, respectively. Calibration data for the nephelometer appears in Appendix C.

The AAPCA and NEA, Inc. subsequently selected eight sample days from which 48 dichotomous filters and eight hi-vol filters were analyzed. The selection of these eight days were based on total suspended particulate (TSP) deposit masses, nephelometer data, comments on the quality assurance sheet and field data sheets, and deposit masses on the dichot filters. Refer to Appendices E and L for additional details. Of the eight sample days selected, six were considered to be dirty days, one was considered to be a normal day, and one was labelled as clean. The sample days selected are summarized in Table 1.

2.4 Source Profile Development

Five road dust and soil samples were collected by AAPCA personnel. Three road dust samples were collected using NEA's road dust sampler, a modified high-volume sampler with a special probe; refer to Appendix A.3 for the road dust sampler standard operating procedure. The road dust samples were collected at: Eagle River paved and unpaved areas; the Sandlake Gravel Pit, northwest of Sandlake/Diamond; and 3500 East Tudor Road, paved area.

Two bulk soil samples were also collected. One was "glacial till" collected off the Knik River Road; the other was "peat bag dust" collected near 58th Avenue, east of Arctic. Both samples were collected by spatula and transferred to plastic bags.

All five samples were returned to NEA where they were sieved to < 38 μm and resuspended onto dichotomous teflon filters in NEA's dust resuspension chamber. An exception to this treatment was the Knik River

Table 1

Selected Sampling Days

Date	Designation
April 24-25, 1984	Dirty
April 30, 1984	Dirty
May 10-11, 1984	Dirty
May 15, 1984	Dirty
May 16-17, 1984	Dirty
May 18, 1984	Dirty
May 22-23, 1984	Normal
May 28, 1984	Clean

sample, which had little material pass through the 38 μm sieve. Instead, < 75 μm material was resuspended onto a 47 mm teflon filter using a low volume sampler.

The remaining CMB source profiles were selected from NEA's master source library on the basis of possible sources in the area. Expected sources include crustal materials, RWC, vegetative burning, and transportation. Table 2 lists the actual sources selected for CMB fitting; Appendix J presents the elemental compositions of each of these sources.

The transportation source profile was developed for Seattle in 1982 and takes into account unleaded, leaded, and diesel exhaust emissions, as well as tire wear based on transportation fleet characteristics in Seattle in 1982. Although the use of this source profile for Anchorage introduces a bias into the calculations, it is not expected to be large because of the profile's relative insensitivity to changes in fleet characteristics and the strong fitting pressure provided by Br and Pb.

The secondary sulfate source is based on atmospheric transformations of sulfur. This source is based on a weight percentage of sulfur as ammonium sulfate and is an estimate of an upper limit to the contribution secondary sulfate makes to particulate levels.

The grass field burn and slash burn source profiles were developed during the 1979 Portland Aerosol Characterization Study (PACS). They were included in this study primarily to accomodate any possible contributions the burning at Point MacKenzie or backyard burning in the Eagle River area may have made on ambient loadings. However, the resolvability of these sources from other sources such as residential wood combustion is not good. These two sources are subject to the same limitations as RWC sources as described below.

Table 2

Sources Used in Anchorage CMB Calculations

Source #	Mneumonic	Size*	Source Description†
5036	GRASBN	F	Grass field burn (PACS)
5037	SLSHBN	F	Slash burn (PACS)
5015	RESWD	F	Residential wood combustion (MACS)
5042	MARINE	FC	Marine aerosol (PACS)
5053	TRANS	FT	Transportation (Seattle) composite
5103	PEATDS	FC	Peat dust (Anchorage)
5104	EAGDST	FC	Eagle River road dust (Anchorage)
5105	TDRDST	FC	Tudor Road dust (Anchorage)
5106	GRAVPT	FC	Gravel pit (Anchorage)
5107	GLCLTL	T	Glacial till (Anchorage)
5108	FWDCMP	FC	Residential wood combustion (Fairbanks)
5109	FWDCP2	FC	Residential wood combustion 2 (Fairbanks)
5110	SECSUL	F	Secondary Sulfate (NEA)

* F = fine fraction (< 2.5 μm)
  C = coarse fraction (> 2.5 μm)
  T = total fraction

† PACS = Portland Aerosol Characterization Study, 1979
  MACS = Medford Aerosol Characterization Study, 1981
  Seattle = Seattle-Tacoma Aerosol Characterization Study, 1983
  Fairbanks = Characterization of Air Quality Impacts from Residential Wood Combustion in Juneau and Fairbanks, Alaska, 1984

Emissions from RWC appliances are highly variable and their elemental patterns are not particularly unique. For example, K has been noted in other studies (3,5,6) to range from about 0.1% at the beginning of the burn to about 10% at the end of the burn. This variability is generally thought to be due to the relative abundance of carbonaceous species; i.e., more condensible organic compounds are present at the beginning of a burn, whereas less condensibles are present at the end of a burn when more ash particles are present. Figure 1 shows the range of major chemical components observed in studies at the Oregon Graduate Center (7). For these reasons, source apportionment of RWC emissions by CMB methods have relatively high uncertainties, particularly when local source profiles are not available. Confidence in CMB calculated impacts can be improved by accurately quantifying the contributions of other potential sources.

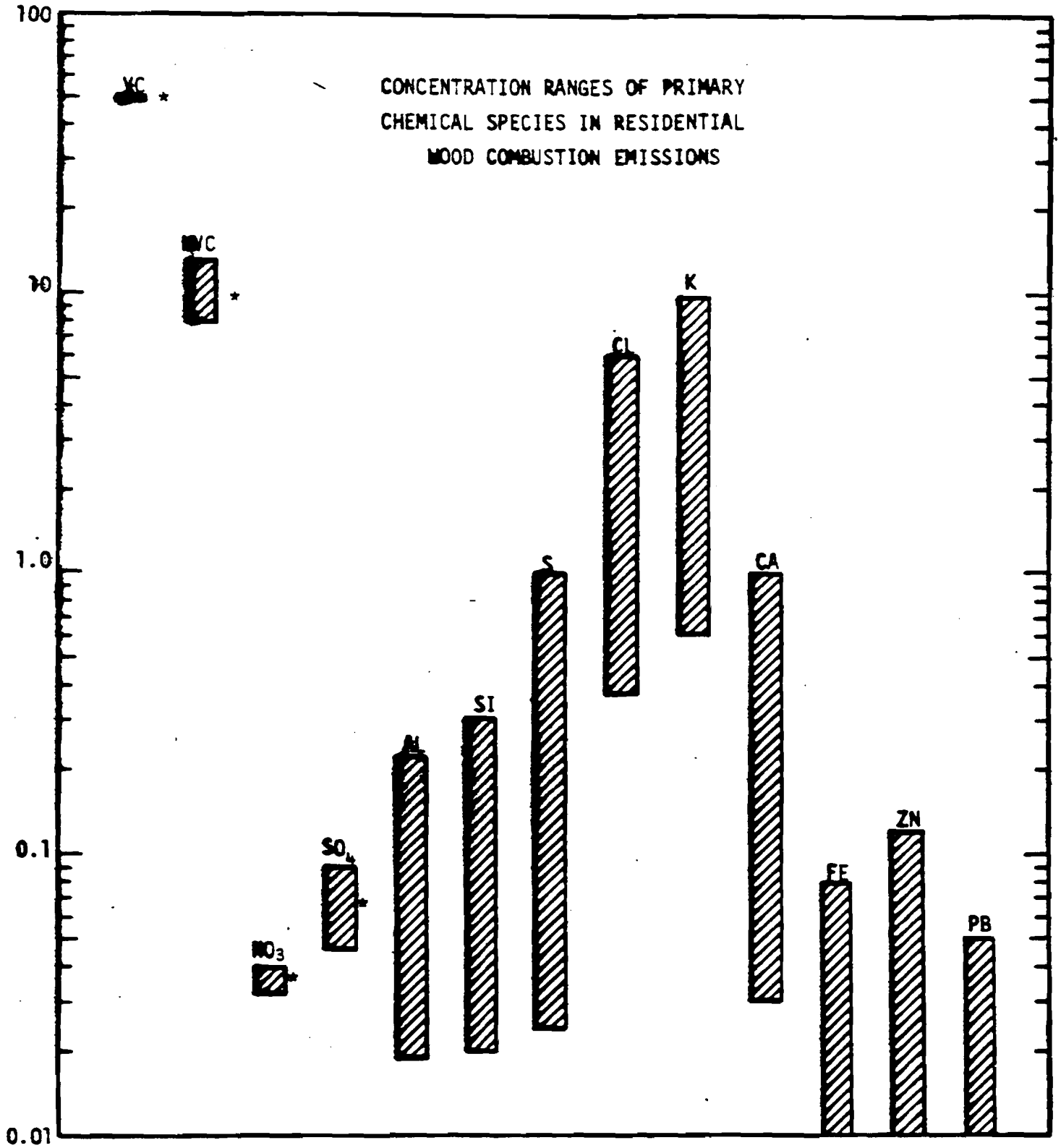
The RWC sources used in this study include a profile from the 1981 Medford [Oregon] Aerosol Characterization Study, a composite profile from a recent Fairbanks study, and a modified composite profile of only spruce and birch burns from the Fairbanks study. Although these three RWC sources may not be readily resolvable from one another, their CMB-calculated contributions to ambient filters may be summed and attributed to a general RWC source.

Finally, the marine profile is from the PACS. Although the marine profile is relatively stable, it is difficult to quantify without the measurement of Na because there are several other significant sources of Cl, such as RWC and road salt. The marine aerosol is generally evenly split between fine and coarse particles.

2.5 Analysis

The deposit masses on all 37 mm dichot filters were determined using a CAHN 27 electrobalance. NEA performed both pre- and post-sample weighings.

Figure 1


CONCENTRATION RANGES OF PRIMARY
CHEMICAL SPECIES IN RESIDENTIAL
WOOD COMBUSTION EMISSIONS
100
10
1.0
0.1
0.01
VC
NVC
NO3
SO4
AL
SI
S
CL
K
CA
FE
ZN
PB

The masses on the high-volume glass fiber filters were determined by AAPCA personnel.

The elemental compositions of fine and coarse particles on selected dichot filters were determined by X-ray fluorescence (XRF) analysis using an Ortec TEFA III tube excited fluorescence analyzer. Each filter was analyzed with three different excitation conditions, each designed to optimize the sensitivity for a different group of elements.

Elemental and organic carbon (EC/OC) analysis was performed on the eight selected high-volume TSP glass fiber filters. Carbon content was determined by a pyrolytic-flame ionization method by Bob Cary at the Oregon Graduate Center. Organic carbon was first determined by heating the sample incrementally in the absence of oxygen; elemental carbon is measured by heating the sample with oxygen.

2.6 Quality Assurance

The quality assurance program is based on well-trained, experienced personnel using previously validated standard operating procedures (SOP's); copies of relevant SOP's are included in Appendix A.

The CAHN 27 electrobalance at NEA is calibrated with Class M weights before and after each set of fifty filters. Reweighs are performed on ten percent of weighed filters; weight differences of $> \pm 10$ µg or $> \pm 2\%$ of the net deposit result in the entire set being reweighed.

Electronic and freon calibrations were periodically performed on the integrating nephelometer by AAPCA personnel. Calibration data is included in Appendix C.

The dichotomous samplers were operated in the field by AAPCA technicians following a SOP provided by NEA. The samplers were calibrated by NEA prior to sampling, and the calibrations were rechecked by NEA after sampling was completed.

The TEFA III analyzer is operated with a quality assurance and a blank filter for each run of ten filters. In addition, the raw analytical data is reviewed by a laboratory supervisor before processing is completed. NEA has participated in several inter-laboratory comparisons, including an EPA validation of XRF calibration films for NBS certification (8). Additional QA documentation is provided in Appendix B.

QA documentation for EC/OC analysis is included in Appendix M.

Finally, the source apportionment calculations were performed by using an effective-variance CMB approach developed at the Oregon Graduate Center. Several inter-laboratory comparison studies have validated the source apportionment approach and are listed in the reference section of this report (9, 10).

3.0 RESULTS AND DISCUSSION

3.1 Meteorology

Climatological data covering all sampling days is summarized in Table 3. In general, the April through June period was mild, with a moderate breeze predominantly from the south and west. Precipitation was light, resulting in dry, dusty conditions several times during the study.

3.2 Suspended Particulate Concentrations

Table 4 summarizes suspended particulate concentrations as calculated from high-volume and dichot fine and coarse particulate loadings for all sampling days for each of the three sites. The ambient particulate concentrations for the fine fractions and TSP are consistently higher at the Eagle River site as compared to the other two sampling sites.

Table 3

ANCHORAGE CLIMATOLOGICAL DATA
DURING DICHOTOMOUS SAMPLING PERIODS*

Date	Weather	Wind		Temp (°C)	Relative Humidity(%)	Visibility (miles)	Precipitation
		Speed(mph)	Direction				
4/12/84		5	160°	3	52	70	0.00
4/15/84	Snow, Fog	6	240°	3	74	45	0.09
4/19/84-4/20/84 noon/noon	Snow, Fog	7	220°	3	63	30	0.07
4/24/84		8	240°	5	42	70	0.00
4/30/84		5	260°	8	59	50	0.00
5/3/84		7	180°	7	59	50	0.00
5/6/84		4	170°	6	58	50	0.00
5/9/84		6	170°	11	36	70	0.00
5/10/84-5/11/84 1pm/1pm		9	280°	11	32	70	0.00
5/12/84		6	180°	9	33	70	0.00
5/15/84		10	230°	11	47	40	0.00
5/16/84-5/17/84 noon/noon		8	180°	14	41	60	0.00
5/18/84		8	210°	13	51	60	0.00
5/21/84	Rain	9	140°	12	53	40	Trace
5/22/84-5/23/84 noon/noon		7	170°	11	57	70	0.00
5/24/84		8	240°	11	52	70	Trace
5/28/84		8	170°	11	49	80	0.00
5/30/84	Rain	6	170°	9	66	20	0.34
5/31/84-6/1/84 noon/noon	Rain	5	210°	12	59	80	Trace
6/2/84		7	230°	16	44	90	0.00

*Data from NOAA publications for April, May, and June; values are averages of observations made at 3 hour intervals during the times that dichotomous sampling took place.

Table 4

Suspended Particulate Concentrations in Anchorage
($\mu g/m^3$)

Date	Tudor Road			Fourth Avenue			Eagle River		
	Dichot Fine	Dichot Coarse	Hi-vol	Dichot Fine	Dichot Coarse	Hi-vol	Dichot Fine	Dichot Coarse	Hi-vol
4/12/84	15.8	62.1	226	-	-	-	-	-	254
4/15/84	3.7	2.7	20	-	-	-	3.6	1.9	21
4/19/84-4/20/84	7.6	26.7	99	4.0	6.9	58	14.1	85.5	340
[a]*4/24/84-4/25/84	10.7	32.9	146	5.6	19.7	139	14.5	70.8	388
*4/30/84	9.3	41.7	146	6.6	22.8	160	19.1	74.5	345
5/3/84	9.0	38.2	144	4.9	23.2	132	13.5	85.6	247
5/6/84	4.9	15.1	56	3.1	8.5	55	7.2	36.0	110
5/9/84	13.8	35.6	127	7.9	30.2	164	23.4	110.0	352
*5/10/84-5/11/84	14.0	30.3	136	5.6	13.3	122	26.2	104.8	326
5/12/84	10.0	25.8	104	4.8	13.7	94	19.1	61.2	269
*5/15/84	11.5	30.8	129	9.1	39.4	220	22.0	91.6	352
*5/16/84-5/17/84	14.9	41.2	148	8.3	25.9	146	28.8	112.1	389
*5/18/84	11.1	36.2	167	5.8	15.4	163	19.7	23.6[b]	328
5/21/84	6.2	19.4	83	3.5	11.9	76	17.9	123.5	327
*5/22/84-5/23/84	7.4	19.8	80	5.1	15.5	99	9.4	49.2	173
5/24/84	5.8	25.0	107	3.5	19.2	122	9.8	54.2	217
*5/28/84	3.6	8.5	42	1.7	5.1	40	6.1	23.5	118
5/30/84	3.1	2.5	20	1.7	2.9	25	3.2	6.4	43
5/31/84-6/1/84	4.9	12.3	61	3.6	10.4	67	6.8	24.6	106
6/2/84	4.0	13.0	66	4.5	16.9	102	7.7	37.5	155
Arithmetic Mean	8.6	26.0	105	5.0	16.7	110	14.3	64.1[c]	243
% of Avg. TSP	8.2%	24.8%		4.5%	15.2%		5.9%	26.4%	

* Filters analyzed
[a] Hi-vol and dichot sampling times do not completely overlap
[b] Material visibly falling off filter when received at NEA
[c] Average does not include value marked with [b]

In fact, the average TSP value at Eagle River is over twice the average TSP values at both Fourth Avenue and Tudor Road. The average fine fraction concentration is also higher at Eagle River, although not by as wide a margin as the TSP. The percent fine fraction of TSP is highest at the Tudor Road site, which indicates that less material with an aerodynamic diameter of greater than 2.5 μm was collected there compared to the other two sites.

The coarse fraction concentrations follow the same pattern as the TSP; that is, the coarse concentrations are greater at Eagle River than at Tudor Road or Fourth Avenue. Two exceptions are April 15 and May 18 data. The April 15 discrepancy is most likely due to low suspended particulate levels, as the coarse concentration value is less than the fine concentration value at both Eagle River and Tudor Road. The May 18 Eagle River coarse fraction deposit was visibly falling off the filter when received at NEA, and its weight as measured is unquestionably lower than when originally collected.

The average coarse concentration value at Eagle River, like that of the TSP, is over twice the coarse averages at the other two sites. The fine/coarse ratios follow the same inter-site pattern.

Percent inhalable (sum of coarse and fine fractions) concentrations of TSP are 33.0%, 19.7%, and 32.3% for Tudor Road, Fourth Avenue, and Eagle River, respectively. In other words, at least two-thirds of the particulate mass is in the > 10 μm fraction.

The ratios of coarse to fine mass concentrations, with a few exceptions, range between 2 and 4 for the Tudor Road and Fourth Avenue sites and between 4 and 7 for the Eagle River site. The few exceptions to these ranges are characterized by light loadings on both fractions (e.g., Tudor Road during April 15). Based on a general assumption that the coarse particle fraction is dominated by soil and road dust and the

fine fraction by wood smoke, clearly crustal components are impacting the samplers much more than is wood smoke. This is consistent with the implication in the above paragraph.

Related to the suspended particulate concentrations are the Tudor Road nephelometer readings. Table 5 summarizes the visibility data collected during April, May, and the first part of June. As light scattering is largely dependent on particle size and concentration, this data is useful in confirming days of high small-particle concentrations. Figures 2 and 3 are plots of fine and coarse concentrations at Tudor Road versus the readings from the collocated nephelopmeter. As would be expected, the fine particle concentrations show much better correlation with light scattering measurements than do the coarse data. The data corresponding to days selected by AAPCA for analysis are quite close to this linear fine fraction/scattering relationship; that is, none of the selected days are questionably far removed from the plotted line, providing additional validity assurance for the days selected.

3.3 Ambient Chemistry

The individual results of the XRF analysis for the 48 dichotomous filters are presented in Appendices F and G and are included in the individual source apportionment results in Appendix K.

Eight high-volume glass fiber filters were analyzed for organic and elemental carbon. These correspond to seven of the eight selected sample days at the Tudor Road site plus one blank filter. The carbon results for April 30 were also applied to April 19 based on similarities in particulate levels. The carbon analysis results are presented in Appendix H and summarized in Table 6. Organic carbon accounted for 6 to 10% of the total mass; elemental carbon accounted for less than 2% of TSP. These relatively low levels are consistent with the large crustal impacts noted in Section 3.2.

Table 5

Integrating Nephelometer Data at Tudor Road Site, Anchorage

	yr/mo/da/hr	b_{scat} x 10^{-6} m^{-1} (9999 denotes missing dat.											
VISIBILITY	84041200	9999999999999999999999999999999999999999999999999999											
VISIBILITY	84041212	99999999999	28	34	34	68	80	68	63	44	21		
VISIBILITY	84041300	30	11	13	11	13	19	30	46	28	20	24	26
VISIBILITY	84041312	31	34	40	43	49	46	40	40	45	49	74	73
VISIBILITY	84041400	70	66	66	49	46	31	39	53	28	29	24	18
VISIBILITY	84041412	16	14	16	14	18	18	18	16	25	25	11	14
VISIBILITY	84041500	23	21	24	23	20	20	23	23999999999999999				
VISIBILITY	84041512	99999999999999999999999999999999999999999999999999999											
VISIBILITY	84041600	99999999999999999999999999999999999999999999999999999											
VISIBILITY	84041612	999999999999	20	22	24	24	24	26	27	35	34		
VISIBILITY	84041700	32	38	32	31	36	43	43	46	39	43	36	32
VISIBILITY	84041712	31	31	28	24	24	28	26	28	40	50	22	20
VISIBILITY	84041800	20	20	19	20	24	31	52	50	38	31	32	34
VISIBILITY	84041812	30	27	26	30	28	31	35	34	39	46	43	35
VISIBILITY	84041900	36	28	47	43	48	73	110	140	68	60	54	51
VISIBILITY	84041912	42	36	36	46	58	63	58	56	35	35	28	28
VISIBILITY	84042000	28	28	28	24	24	24	27	31	46	47	44	4.
VISIBILITY	84042012	43	30	24	269999	15	16	16	16	18	35	43	90
VISIBILITY	84042100	235	198	212	288	282	144	213	34	26	26	26	14
VISIBILITY	84042112	11	6	7	10	12	19	12	26	38	39	43	53
VISIBILITY	84042200	37	37	32	27	37	39	43	42	29	23	23	22
VISIBILITY	84042212	22	26	28	27	24	22	29	30	29	41	47	49
VISIBILITY	84042300	43	43	32	35	38	144	74	39	329999999999999			
VISIBILITY	84042312	99999999999999999			15	22	25	34	45	51	64	30	
VISIBILITY	84042400	35	18	30	29	29	48	56	45	46	33	21	18
VISIBILITY	84042412	13	7	7	4	4	10	6	11	20	39	40	28
VISIBILITY	84042500	37	22	32	39	25	58	104	69	22	27	27	26
VISIBILITY	84042512	37	31	23	21	6	4	4	4	3	12	22	26
VISIBILITY	84042600	34	25	16	14	13	16	25	28	24	28	28	31
VISIBILITY	84042612	27	28	28	14	19	25	25	28	23	25	21	16
VISIBILITY	84042700	14	16	16	14	24	39	31	28	2999999999			26
VISIBILITY	84042712	20	23	24	31	46	46	23	22	29	24	24	30
VISIBILITY	84042800	26	27	26	26	189999999999999999999999999999							
VISIBILITY	84042812	9999	1	1	1	1	1	1	1	3	1	17	20
VISIBILITY	84042900	199999	34	21	15	12	12	139999		23	30	36	
VISIBILITY	84042912	42	33	20	18	7	9	11	26	28	48	55	19
VISIBILITY	84043000	25	23	19	13	12	48	42	28	48	40	44	32
VISIBILITY	84043012	35	31	31	32	33	26	33	31	40	47	34	23
VISIBILITY	84050100	36	34	32	22	28	31	77	36	45	23	23	67
VISIBILITY	84050112	40	2999999999		14	19	14	15	20	19	27	23	
VISIBILITY	84050200	14	9	9	14	199999999999999999999999999							36
VISIBILITY	84050212	28	1399999999		9	7	5	5	4	5	16	24	
VISIBILITY	84050300	24	24	24	29	24	21	30	33	50	50	50	27
VISIBILITY	84050312	24	26	23	22	22	22	22	21	21	21	32	32
VISIBILITY	84050400	38	45	41	23	21	32	50	28	41	33	16	11
VISIBILITY	84050412	12	9	10	12	5	5	5	5	7	9	10	13
VISIBILITY	84050500	9	7	14	19	27	45	32	32	37	35	31	38
VISIBILITY	84050512	46	41	38	33	30	25	239999		9	18	24	19
VISIBILITY	84050600	22999999999999999999999999999999999999999999999999999											
VISIBILITY	84050612	99999999999999999999999999999999999999999999999999999											
VISIBILITY	84050700	99999999999999999999999999999999999999999999999999999											
VISIBILITY	84050712	99999999999999999999999999999999999999999999999999999											
VISIBILITY	84050800	99999999999999999999999999999999999999999999999											16
VISIBILITY	84050812	18	37	33	33	33	33	27	19	18	18	27	29
VISIBILITY	84050900	55	46	52	35	439999999999999999999999999999							
VISIBILITY	84050912	99999999999999999999999999999999999999999999999999999											
VISIBILITY	84051000	99999999999999999999999999999999999								36	37	37	
VISIBILITY	84051012	33	26	24	27	27	27	24	23	26	26	40	35
VISIBILITY	84051100	72	67	43	41	409999999999999999				35	26	184	
VISIBILITY	84051112	53	25	16	27	24	23	26	30	23	25	26	

VISIBILITY	84051312	19	24	26	33	31	25	25	23	22	23	59	33
VISIBILITY	84051400	38	37	29	36	35	49	113	111	53	47	75	59
VISIBILITY	84051412	44	41	39	399999		52	34	37	16	13	21	26
VISIBILITY	84051500	31	21	35	35	30	44	68	36	27	52	61	57
VISIBILITY	84051512	36	23	28	29	28	27	15	13	5999999999999			
VISIBILITY	84051600	99999999999999999999999999999999999999999999999999999											
VISIBILITY	84051612	9999999999999999			21	22	23	22	22	22	54	53	
VISIBILITY	84051700	54	54	41	49	104	31	44	55	63	36	32	27
VISIBILITY	84051712	23	23	34	23	26	17	10	6	5	5	9	15
VISIBILITY	84051800	15	16	22	22	21	31	62	35	44	52	27	28
VISIBILITY	84051812	17	16	16	23	23	27	13	23	23	14	23	33
VISIBILITY	84051900	27	45	64	88	53	44	31	31	26	23	31	17
VISIBILITY	84051912	5	5	15	10	10	10	10	10	10	13	15	23
VISIBILITY	84052000	22	16	15	10	10	9	9	10	12	14	17	28
VISIBILITY	84052012	31	32	33	35	23	14	10	5	2.	2	7	2
VISIBILITY	84052100	2	2	3	7	8	8	30	23	24	20	22	30
VISIBILITY	84052112	31	22	26	20	16	13	12	10	10	14	13	22
VISIBILITY	84052200	22	13	26	44	20	39	47	53	34	24	16	14
VISIBILITY	84052212	21	15	14	16	13	13	9	9	8	11	22	24
VISIBILITY	84052300	35	31	12	13	10	10	13	16	22	49	66	22
VISIBILITY	84052312	13	13	12	10	12	139999		20	13	13	14	16
VISIBILITY	84052400	18	11	10	24	8	15	47	44	16	11	11	16
VISIBILITY	84052412	18	19	19	19	14	14	12	18	18	9	11	16
VISIBILITY	84052500	20	15	22	23	19	21	35	24	22	22	28	27
VISIBILITY	84052512	33	32	35	25	16	13	13	13	12	13	15	12
VISIBILITY	84052600	14	13	15	13	12	13	15	18	18	15	15	14
VISIBILITY	84052612	13	8	5	5	7	8	6	899999999999999999				
VISIBILITY	84052700	99999999999999999999999999999999999999999999999999999											
VISIBILITY	84052712	99999999	6	5	5	5	5	5	5	5	5	17	
VISIBILITY	84052800	15	15	13	9	6	12	13	11	9	9	10	8
VISIBILITY	84052812	6	6	5	5	5	5	5	5	6	5	44	16
VISIBILITY	84052900	15	8	5	6	5	16	134	53	16	11	12	6
VISIBILITY	84052912	8	11	16	11	18	11	5	5	6	8	11	10
VISIBILITY	84053000	6	899999999999999999999999999999999999999999999999										
VISIBILITY	84053012	99999999999999999999999999999999999999999999999999999											
VISIBILITY	84053100	99999999999999999999999999999999999999999999999999999											
VISIBILITY	84053112	9999	15	15	14	11	11	12	13	9	13	13	13
VISIBILITY	84060100	15	17	12	12	17	22	31	22	23	26	20	26
VISIBILITY	84060112	46	26	16	17	17	12	10	12	13	11	12	8
VISIBILITY	84060200	11	6	15	11	23	11	19	20	19	14	12	20
VISIBILITY	84060212	19	11	10	11	11	11	13	9	9	6	6	9
VISIBILITY	84060300	13	18	17	10	9	9	10	10	8	8	10	8
VISIBILITY	84060312	13	33	43	54	41	27	20	12	15	17	27	24
VISIBILITY	84060400	25	16	17	11	13	30	33	39	469999999999999			
VISIBILITY	84060412	99999999999999999999999999999999999999999999999999999											

Figure 2

Suspended Fine Particle Concentration vs. Nephelometer Readings
at Tudor Road, Anchorage

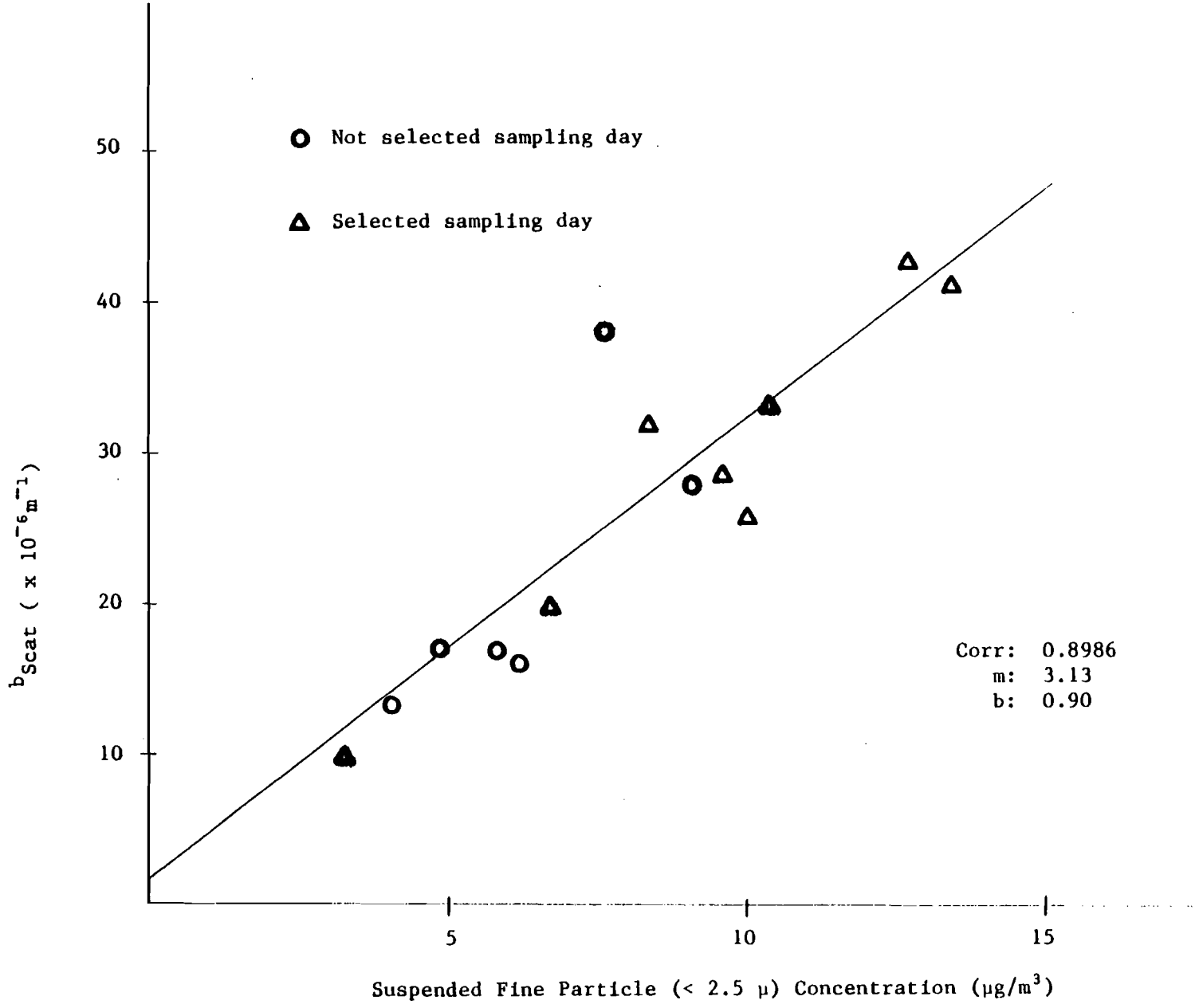


Figure 3

Suspended Coarse Particle Concentration vs. Nephelometer Readings
at Tudor Road, Anchorage

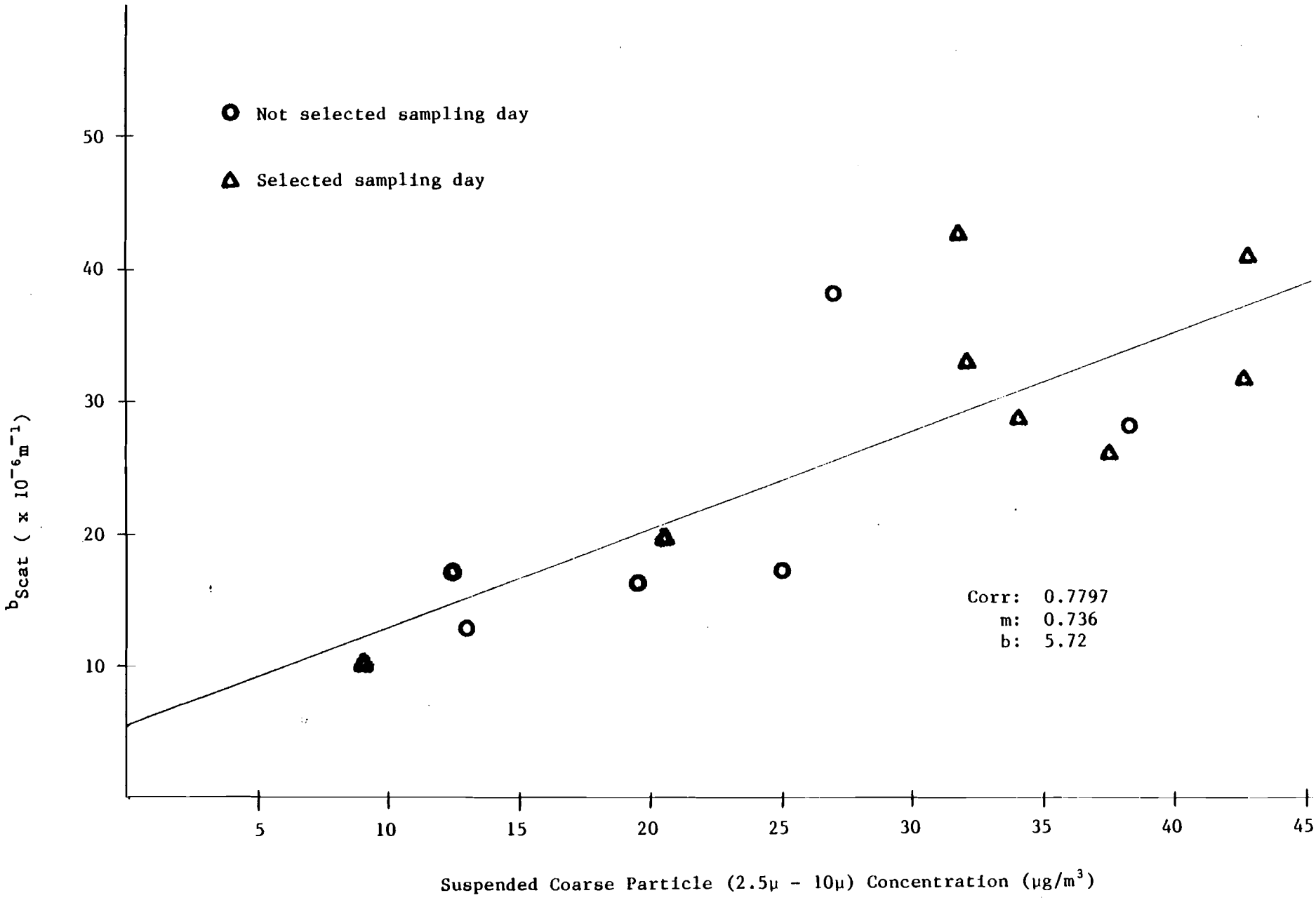


Table 6

EC and OC Analyses of High-Volume Glass Fiber Filters
Tudor Road, Anchorage
Summary

Filter ID	Description	TSP ($\mu g/m^3$)	OC ($\mu g/m^3$)	% OC of TSP	EC ($\mu g/m^3$)	% EC of TSP
4054288	4/30/84 00:00 to 4/30/84 24:00	146	8.3	5.7	1.6	1.1
4054311	5/10/84 13:00 to 5/11/84 13:00	136	12.5	9.2	1.3	1.0
4054325	5/15/84 00:00 to 5/15/84 24:00	129	11.4	8.8	1.9	1.5
4054329	5/16/84 12:00 to 5/17/84 12:00	148	15.4	10.4	1.7	1.1
4054214	5/18/84 00:00 to 5/18/84 24:00	167	8.2	4.9	1.2	0.7
4054220	5/22/84 12:00 to 5/23/84 12:00	80	7.2	9.0	1.3	1.6
4054230	5/28/84 00:00 to 5/28/84 24:00	42	3.7	8.8	0.5	1.2

3.4 Source Profiles

The five resuspended soil and road dust samples are summarized in Table 7. XRF elemental analysis results, as well as chemical profiles for each of the samples, are included in Appendix I.

Note should be made of arsenic levels in the Gravel Pit dust, Tudor Road dust, and the Eagle River road dust. The reported arsenic concentrations in both coarse and fine fractions range between 0.1 and 0.3%. The other two dust sources, peat bog dust and glacial till, show no reportable arsenic levels. A careful review of the entire sampling and analyzing procedure for these samples suggests that some contamination may have occurred from NEA's road dust sampler. This sampler was used immediately before the Anchorage sampling at a lead smelter site with known high levels of arsenic. Although the sampler was cleaned before shipment to Anchorage, the three samples collected with it have elevated arsenic levels. A design change is being made in the sampler to reduce the possibility of a similar problem in the future. The contamination of these three source samples had no impact on the CMB fitting process as As was not used as a fitting element; this did not affect the validity of the fitting process, as none of the ambient samples showed detectable levels of As.

The remaining sources used in the source apportionment calculations are described in Section 2.4.

3.5 Source Apportionment

Individual source apportionment results for each ambient dichotomous filter are presented in Appendix K. Table 8 is an example of the CMB results. The filter identification number and size fraction are listed at the top of each computer printout, along with sample date, start time, and duration. The reduced chi square and degrees of freedom are

Table 7

Summary of Anchorage Resuspension

Sample Description	Sample Type*	Filter ID	Final Net Deposit (µg)	Ratio of Net Intermediate Fine to Net Coarse
Eagle River, paved & unpaved road dust	dichot fine dichot coarse	MD279 MD278	535 1563	0.087
Sandlake Gravel Pit	dichot fine dichot coarse	MD283 MD282	361 1163	0.138
3500 E. Tudor, paved road dust	dichot fine dichot coarse	MD281 MD280	386 1861	0.071
Construction/peat bog dust, 58th Ave.	dichot fine dichot coarse	MD277 MD276	300 1521	0.058
Glacial till, off Knik River Road	lo-vol TSP	MD284	6241	-

* Fine is < 2.5µ, coarse is 2.5-15µ, TSP is < 30µ

Table 8

Example of CMB Calculation Results
(Eagle River Coarse Fraction)

SAMPLE ID: MA942 PARTICLE SIZE: COARSE
FIELD FLAG: MASS FLAG: ANALYSIS FLAGS:
SITE: 3 EAGLE RIVER
SAMPLE DATE: 840515 START TIME: .0 DURATION: 24.3 HOURS
REDUCED CHI SQUARE: .884 DEGREES OF FREEDOM: 12

--SOURCE----	SIZE----	UG/M3----------	PERCENT---
5103	PEATDS C	16.519+- 9.245	18.030+-10.250
5104	EAGDST C	64.875+-11.084	70.807+-14.017
5106	GRAVPT C	10.206+- 8.472	11.139+- 9.314
	TOTAL:	91.600+-16.737	99.976+-20.823

--SPECIES----		MEAS. UG/M3-----	%	CALC. UG/M3---	CALC./MEAS.------	
Al	*	6.965+- .785	7.602	7.694+- .288	1.105+- .131	Al
Si	*	25.858+- 2.906	28.223	28.730+- 1.070	1.111+- .132	Si
P		.111+- .026	.121	.118+- .018	1.063+- .297	P
S	*	.160+- .023	.175	.186+- .014	1.157+- .190	S
Cl	*	.208+- .025	.227	.194+- .012	.935+- .124	Cl
K	*	.854+- .097	.933	.854+- .033	.999+- .119	K
Ca	*	1.600+- .180	1.747	1.553+- .063	.970+- .116	Ca
Ti	*	.515+- .058	.562	.465+- .018	.903+- .107	Ti
V	*	.026+- .006	.028	.023+- .003	.897+- .244	V
Cr	*	.034+- .004	.037	.032+- .002	.934+- .126	Cr
Mn	*	.131+- .015	.143	.112+- .005	.856+- .103	Mn
Fe	*	5.019+- .564	5.478	4.865+- .188	.969+- .115	Fe
Ni	*	.013+- .002	.014	.013+- .001	1.028+- .176	Ni
Cu		.008+- .001	.009	.071+- .003	8.950+-1.452	Cu
Zn		.027+- .003	.029	.062+- .002	2.338+- .297	Zn
Ga		.002+- .001	.002	.001+- .001	.721+- .402	Ga
As		< .005		.067+- .005	.000+- .000	As
Se		< .000		.001+- .001	.000+- .000	Se
Br	*	.010+- .001	.011	.007+- .001	.757+- .135	Br
Rb		.004+- .001	.004	.004+- .001	.954+- .277	Rb
Sr	*	.024+- .003	.026	.022+- .001	.923+- .126	Sr
Y		.003+- .001	.003	.003+- .001	1.056+- .518	Y
Zr		< .004		.001+- .004	.316+-1.516	Zr
Mo		< .003		.011+- .003	4.907+-7.775	Mo
Pd		< .003		.003+- .003	2.907+-*****	Pd
Ag		< .004		.000+- .004	.413+-5.919	Ag
Cd		< .006		.002+- .006	.000+- .000	Cd
In		.010+- .006	.011	.002+- .006	.225+- .608	In
Sn		< .008		.003+- .007	.000+- .000	Sn
Sb		< .013		.003+- .012	.000+- .000	Sb
Ba		.048+- .036	.052	.000+- .035	.000+- .729	Ba
La		< .052		.000+- .052	.000+- .000	La
Hg		.001+- .001	.001	.002+- .001	1.731+-1.322	Hg
Pb	*	.062+- .008	.068	.077+- .004	1.237+- .171	Pb

MASS 91.6 +- 9.2 * FITTING SPECIES

followed by calculated source contributions and their uncertainties. For each element is listed its measured concentration, its calculated concentration based on the sources summarized near the top of the printout, and the ratio of calculated to measured concentration. Elements actually used in the fitting process are indicated with asterisks.

The CMB results presented in the appendices represent the best solution as determined by an iterative procedure which optimizes goodness-of-fit parameters. These paraments, in order of importance, are:

1. Source contributions must be positive and greater than their uncertainties.
2. Reduced chi square should be minimized, generally to less than 2.
3. The calculated to measured concentration ratio for individual chemical species should approach 1.0 within the listed uncertainty.
4. The calculated total mass concentrations should approach the measured mass concentrations within the uncertainties.
5. The number of degrees of freedom should be maximized.

In the example illustrated in Table 8, nearly 100% of the mass was explained by the sources indicated, and a reduced chi square of 0.884 with 12 degrees of freedom was obtained. This example is a particularly good fit. For the 48 CMB calculations done, the fine fraction results ranged from 72 to 113% of mass explained, and the coarse fraction results ranged from 71% to 109% of mass explained. Note that percentages over 100 are within their uncertainties of 100, and so should not be cause for alarm. The majority of the source apportionment results accounted for 90 to 95 percent of the measured mass concentrations for both fine and coarse fractions.

Figures 4 and 5 are alternative representations of the same source apportionment results as Table 8. The open circles in Figure 4 indicate calculated elemental concentrations; the asterisks indicate elements used in the fitting process. Figure 5 is self-explanatory.

Figure 4

Example of Histogram of CMB Calculation Results
(Eagle River Coarse Fraction, Filter MA942)

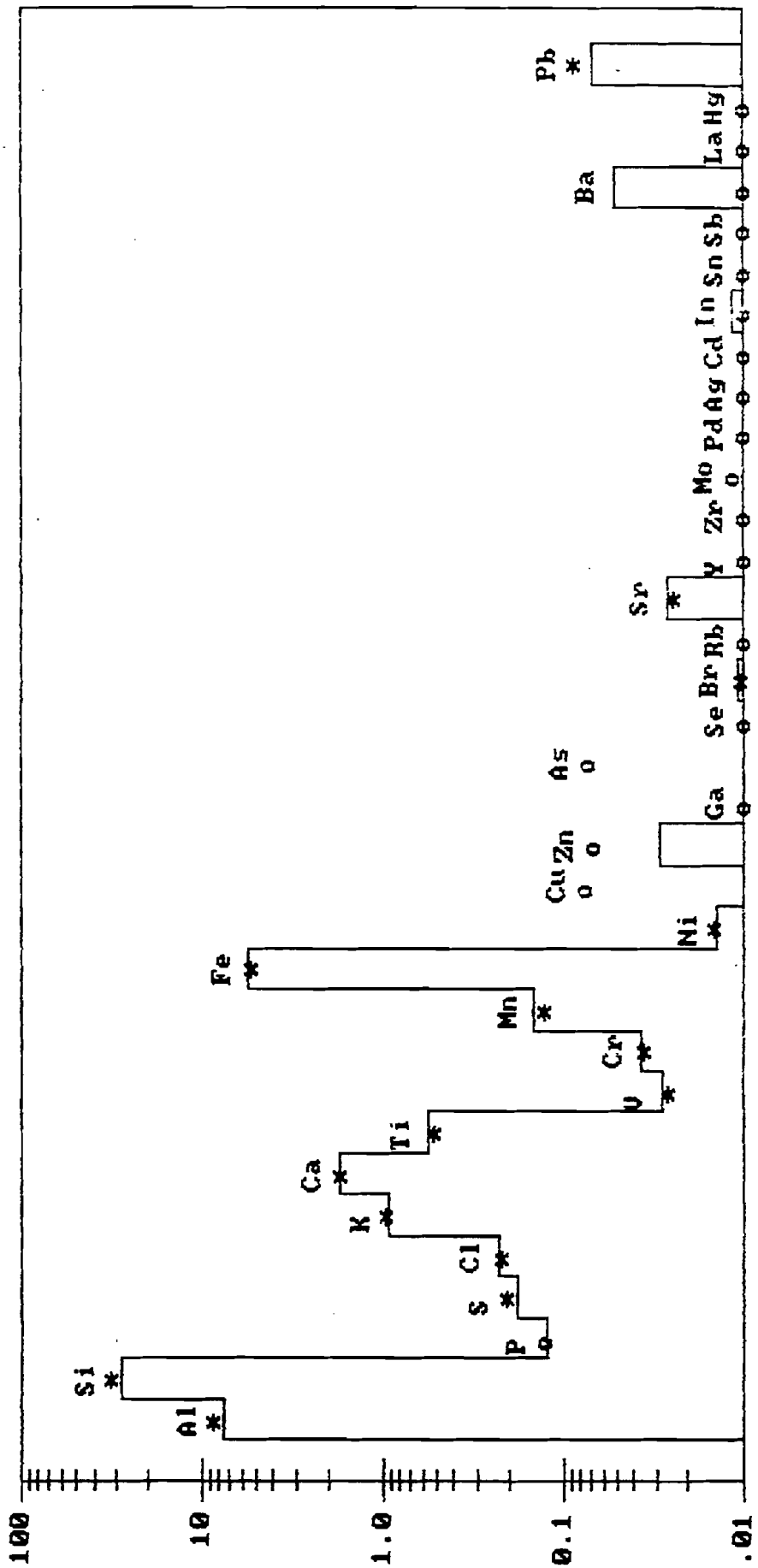
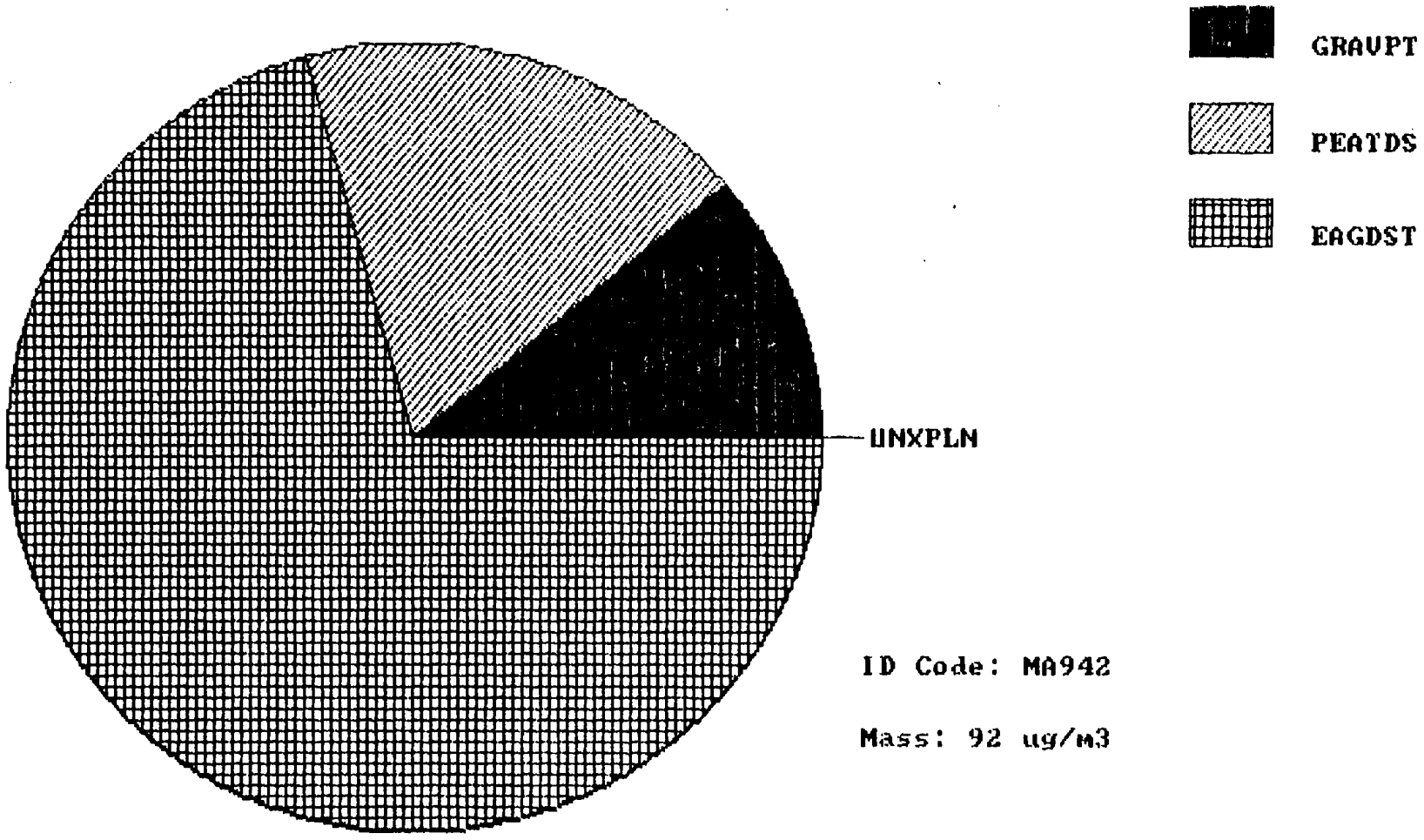


Figure 5

Example of Pie Chart of CMB Calculation Results
(Eagle River Coarse Fraction, Filter MA942)



Tables 9-14 and Figures 6-11 summarize the CMB calculation results at each of the three sampling sites for both the fine and coarse particle fractions. Not surprisingly, soil and road dust account for an overwhelming majority (90-98%) of the mass in the coarse fractions at all three sites. Soil and road dust also account for unusually high percentages (64-85%) of the fine fractions as well. One should be aware that the apportionments between the different crustal sources in the CMB results are not absolute. The reasons for this are two-fold. First the crustal samples collected are similar in chemical composition, and during the CMB fitting process one crustal source may be fit simply at the expense of another. Second, although the crustal sources are designated by the geographical area where they were collected, that does not mean those sources are unique to only that area; that is, a soil sample similar to that labelled "Eagle River" may exist near the Tudor Road site. For these two reasons, CMB results which indicate no Tudor Road dust impacts at the Tudor Road sampling site should not be cause for alarm.

Wood combustion is fit in only one of the 24 fine fraction filters, representing an average of one percent of the measured mass concentration at the Tudor Road site. No RWC or vegetative burn sources were fit at either of the other two sites. Wood burning emissions are not totally eliminated as sources by these results, keeping in mind the uncertainties and variabilities discussed in Section 3.4. However, the large percentages of particulate mass explained by crustal sources indicate that RWC and vegetative burning had at most small impacts during the time these samples were collected.

Transportation accounted for 10-15% of the fine fraction mass at all three sites. Essentially no transportation impact was calculated for the coarse fraction filters. Secondary sulfate explained 4-10% of the fine fraction mass at all three sites, again with no impacts on the coarse fractions. Both transportation and secondary sulfate particles are predominantly less than 2.5 μm due to the chemistry and physics of their

Table 9

Summary of CMB Results for Fine Particles at Tudor Road Site, Anchorage

Date	Filter ID	Measured Mass ($\mu g/m^3$)	Calculated Mass ($\mu g/m^3$)	% Mass Explained	Reduced Chi^2	Source Contributions ($\mu g/m^3$)					
						Marine	Transportation	Tudor Road Dust	Secondary Sulfate	Wood Combustion	Peat Dust
4/24/84	MA901	10.7 ± 1.1	7.7 ± 0.5	71.9 ± 8.8	0.270	0.1 ± 0.0	1.5 ± 0.3	4.9 ± 0.3	1.3 ± 0.2	-	-
4/30/84	MA907	9.3 ± 1.0	9.3 ± 0.6	100.2 ± 12.7	0.175	-	2.4 ± 0.5	6.6 ± 0.3	0.3 ± 0.1	-	-
5/10/84	MA931	14.0 ± 1.5	12.6 ± 0.7	90.3 ± 10.5	0.343	-	1.7 ± 0.3	8.7 ± 0.4	2.3 ± 0.4	-	-
5/15/84	MA945	11.4 ± 1.2	10.9 ± 0.6	95.3 ± 11.3	0.377	-	1.4 ± 0.3	7.6 ± 0.4	2.0 ± 0.3	-	-
5/16/84	MA949	14.9 ± 1.5	12.7 ± 0.7	85.2 ± 9.9	0.489	-	2.0 ± 0.4	9.5 ± 0.5	1.1 ± 0.2	-	-
5/18/84	MA959	11.1 ± 1.2	10.0 ± 0.5	90.6 ± 10.6	0.593	0.1 ± 0.0	1.1 ± 0.2	8.4 ± 0.4	0.4 ± 0.1	-	-
5/22/84	MA969	7.4 ± 0.8	6.4 ± 1.9	85.8 ± 27.5	0.126	-	1.7 ± 0.4	1.8 ± 1.2	0.4 ± 0.1	0.9 ± 0.8	1.5 ± 1.2
5/28/84	MA981	3.7 ± 0.5	2.8 ± 0.2	76.4 ± 12.4	0.795	-	0.6 ± 0.1	1.7 ± 0.1	0.5 ± 0.1	-	-
Mean		10.3	9.1	87.0	0.396	0.0	1.6	6.2	1.0	0.1	0.2
Std. Deviation		3.6	3.3	9.4	0.223	0.0	0.5	3.1	0.8	0.3	0.5
Avg. Uncertainty		1.1	0.7	13.0	-	0.0	0.3	0.5	0.2	0.1	0.2
Avg. % Contribution to Measured Mass		-	-	-	-	0.0%	15.5%	60.2%	9.7%	1.0%	1.9%

Table 10

Summary of CMB Results for Coarse Particles at Tudor Road Site, Anchorage

Date	Filter ID	Measured Mass ($\mu g/m^3$)	Calculated Mass ($\mu g/m^3$)	% Mass Explained	Reduced Chi^2	Source Contributions ($\mu g/m^3$)			
						Marine	Peat Dust	Tudor Road Dust	Gravel Pit
4/24/84	MA900	33.0 ± 3.3	28.9 ± 3.2	87.8 ± 13.1	1.054	0.4 ± 0.1	16.1 ± 2.4	12.5 ± 2.1	-
4/30/84	MA906	41.7 ± 4.2	40.6 ± 4.4	97.4 ± 14.4	1.769	0.1 ± 0.0	21.6 ± 3.4	18.9 ± 2.9	-
5/10/84	MA930	30.3 ± 3.1	21.6 ± 3.6	71.4 ± 13.8	0.724	0.1 ± 0.0	5.0 ± 2.7	-	16.6 ± 2.4
5/15/84	MA944	30.9 ± 3.1	29.1 ± 1.2	94.2 ± 10.2	1.147	0.2 ± 0.1	-	-	28.8 ± 1.2
5/16/84	MA948	41.2 ± 4.1	45.1 ± 6.7	109.3 ± 19.5	0.772	0.4 ± 0.1	6.9 ± 5.0	-	37.8 ± 4.4
5/18/84	MA958	36.2 ± 3.6	33.7 ± 2.8	93.1 ± 12.1	1.569	0.6 ± 0.1	25.6 ± 2.2	7.5 ± 1.6	-
5/22/84	MA968	19.8 ± 2.0	18.1 ± 2.5	91.3 ± 15.5	2.089	0.2 ± 0.1	5.6 ± 1.8	12.3 ± 1.7	-
5/28/84	MA980	8.5 ± 0.9	8.5 ± 1.3	100.2 ± 19.0	0.853	0.1 ± 0.0	5.3 ± 0.9	3.1 ± 0.9	-
Mean		30.2	28.2	93.1	1.247	0.3	10.8	6.8	10.4
Std. Deviation		11.2	12.0	10.9	0.505	0.2	9.2	7.2	15.4
Avg. Uncertainty		3.0	3.2	14.7	-	0.1	2.3	1.2	1.0
Avg. % Contribution to Measured Mass		-	-	-	-	1.0%	35.8%	22.5%	34.4%

Table 11

Summary of CMB Results for Fine Particles at Fourth Avenue Site, Anchorage

Date	Filter ID	Measured Mass ($\mu g/m^3$)	Calculated Mass ($\mu g/m^3$)	% Mass Explained	Reduced Chi^2	Source Contributions ($\mu g/m^3$)					
						Marine	Transportation	Tudor Road Dust	Secondary Sulfate	Gravel Pit	Peat Dust
4/24/84	MA891	5.6 ± 0.7	5.4 ± 0.3	95.5 ± 13.0	0.454	0.2 ± 0.1	0.9 ± 0.2	3.4 ± 0.2	0.9 ± 0.2	-	-
4/30/84	MA897	6.6 ± 0.8	6.5 ± 0.4	98.9 ± 13.1	0.604	-	1.5 ± 0.3	4.7 ± 0.2	0.4 ± 0.1	-	-
5/10/84	MA929	5.6 ± 0.7	6.3 ± 0.6	113.4 ± 17.5	0.520	0.9 ± 0.5	0.5 ± 0.1	3.8 ± 0.2	1.2 ± 0.2	-	-
5/15/84	MA941	9.1 ± 1.0	8.8 ± 0.4	96.0 ± 11.5	0.502	-	0.9 ± 0.2	6.8 ± 0.3	1.0 ± 0.2	-	-
5/16/84	MA951	8.3 ± 0.9	8.5 ± 2.7	102.4 ± 34.6	0.555	-	0.9 ± 0.2	3.0 ± 1.7	0.8 ± 0.1	3.8 ± 2.1	-
5/18/84	MA955	5.8 ± 0.7	5.5 ± 0.1	94.7 ± 12.4	0.503	0.1 ± 0.0	0.5 ± 0.1	4.6 ± 0.2	0.3 ± 0.1	-	-
5/22/84	MA965	5.1 ± 0.7	5.3 ± 1.1	104.1 ± 26.0	0.173	0.9 ± 0.4	1.1 ± 0.2	-	0.2 ± 0.1	2.2 ± 0.9	1.1 ± 0.6
5/28/84	MA977	1.7 ± 0.4	1.6 ± 0.1	94.3 ± 25.8	0.406	0.0 ± 0.0	0.4 ± 0.1	0.9 ± 0.1	0.3 ± 0.1	-	-
Mean		6.0	6.0	99.9	0.465	0.3	0.8	3.4	0.6	0.8	0.1
Std. Deviation		2.2	2.2	6.5	0.132	0.4	0.4	2.2	0.4	1.5	0.4
Avg. Uncertainty		0.7	0.7	19.2	-	0.1	0.2	0.4	0.1	0.4	0.1
Avg. % Contribution to Measured Mass		-	-	-	-	5.0%	13.3%	56.7%	10.0%	13.3%	1.7%

Table 12

Summary of CMB Results for Coarse Particles at Fourth Avenue Site, Anchorage

Date	Filter ID	Measured Mass ($\mu g/m^3$)	Calculated Mass ($\mu g/m^3$)	% Mass Explained	Reduced Chi^2	Source Contributions ($\mu g/m^3$)				
						Marine	Tudor Road Dust	Gravel Pit	Peat Dust	Transportation
4/24/84	MA890	19.7 ± 2.0	17.1 ± 4.6	86.9 ± 25.1	1.351	0.7 ± 0.2	8.3 ± 3.3	8.0 ± 3.2	-	-
4/30/84	MA896	22.8 ± 2.3	23.3 ± 1.0	102.4 ± 11.3	1.493	0.1 ± 0.0	-	23.2 ± 1.0	-	-
5/10/84	MA928	13.4 ± 1.4	11.8 ± 3.0	88.5 ± 24.5	0.938	0.1 ± 0.0	5.5 ± 2.2	6.1 ± 2.1	5.5 ± 2.2	0.1 ± 0.1
5/15/84	MA940	39.4 ± 4.0	40.4 ± 5.6	102.7 ± 17.6	0.633	0.4 ± 0.1	-	31.4 ± 3.7	8.7 ± 4.2	-
5/16/84	MA950	26.0 ± 2.6	24.3 ± 3.6	93.7 ± 16.8	0.817	0.3 ± 0.1	-	18.2 ± 2.4	5.8 ± 2.7	-
5/18/84	MA954	15.4 ± 1.6	14.7 ± 4.7	95.5 ± 32.1	0.885	0.3 ± 0.1	2.8 ± 2.6	7.1 ± 3.4	4.3 ± 1.9	-
5/22/84	MA964	15.5 ± 1.6	14.1 ± 2.5	91.0 ± 18.5	1.028	0.1 ± 0.0	-	11.5 ± 1.7	2.5 ± 1.8	-
5/28/84	MA976	5.1 ± 0.7	5.0 ± 1.2	98.3 ± 26.5	0.848	0.1 ± 0.0	-	3.1 ± 0.8	1.8 ± 0.9	-
Mean		19.7	18.8	94.9	0.999	0.3	2.1	13.6	3.6	0.0
Std. Deviation		10.2	10.7	6.0	0.287	0.2	3.2	9.8	3.1	0.0
Avg. Uncertainty		2.0	3.3	21.6	-	0.1	1.0	2.3	1.7	0.0
Avg. % Contribution to Measured Mass		-	-	-	-	1.5%	10.7%	69.0%	18.3%	0.0%

Table 13

Summary of CMB Results for Fine Particles at Eagle River Site, Anchorage

Date	Filter ID	Measured Mass ($\mu g/m^3$)	Calculated Mass ($\mu g/m^3$)	% Mass Explained	Reduced Chi^2	Source Contributions ($\mu g/m^3$)			
						Transportation	Peat Dust	Eagle River Dust	Secondary Sulfate
4/24/84	MA899	14.5 ± 1.5	13.1 ± 2.5	90.1 ± 19.5	0.196	1.8 ± 0.4	5.8 ± 1.8	4.1 ± 1.6	1.3 ± 0.2
4/30/84	MA905	19.1 ± 2.0	17.8 ± 3.7	93.3 ± 21.6	0.487	3.6 ± 0.6	8.4 ± 2.7	5.8 ± 2.4	-
5/10/84	MA933	26.2 ± 2.7	25.3 ± 5.3	96.4 ± 22.3	0.493	1.8 ± 0.4	3.9 ± 3.8	17.5 ± 3.5	2.1 ± 0.4
5/15/84	MA943	22.0 ± 2.2	21.4 ± 0.9	97.1 ± 10.7	0.387	1.9 ± 0.4	-	18.0 ± 0.8	1.5 ± 0.3
5/16/84	MA947	28.8 ± 2.9	31.2 ± 7.5	108.2 ± 28.3	0.330	1.8 ± 0.4	11.0 ± 6.1	17.8 ± 4.4	0.7 ± 0.2
5/18/84	MA957	19.7 ± 2.0	19.2 ± 0.8	97.3 ± 10.8	0.587	1.2 ± 0.2	-	17.9 ± 0.8	-
5/22/84	MA967	9.4 ± 1.0	8.8 ± 0.6	94.3 ± 11.9	0.324	2.4 ± 0.5	-	6.1 ± 0.3	0.3 ± 0.1
5/28/84	MA979	6.1 ± 0.7	5.5 ± 1.2	90.8 ± 22.9	0.263	0.9 ± 0.2	1.9 ± 0.9	2.4 ± 0.8	0.4 ± 0.1
Mean		18.2	17.8	95.9	0.383	1.9	3.9	11.2	0.8
Std. Deviation		7.9	8.5	5.7	0.131	0.8	4.2	7.1	0.8
Avg. Uncertainty		1.9	2.8	18.5	-	0.4	1.9	1.8	0.2
Avg. % Contribution to Measured Mass		-	-	-	-	10.4%	21.4%	61.5%	4.4%

Table 14

Summary of CMB Results for Coarse Particles at Eagle River Site, Anchorage

Date	Filter ID	Measured Mass ($\mu g/m^3$)	Calculated Mass ($\mu g/m^3$)	% Mass Explained	Reduced Chi^2	Source Contributions ($\mu g/m^3$)				
						Marine	Peat Dust	Eagle River Dust	Gravel Pit	Transportation
4/24/84	MA898	70.8 ± 7.1	71.0 ± 20.6	100.2 ± 30.7	0.655	0.3 ± 0.1	19.0 ± 9.4	22.0 ± 15.0	29.6 ± 10.4	-
4/30/84	MA904	94.5 ± 9.5	86.7 ± 13.9	91.8 ± 17.4	0.619	-	19.2 ± 8.4	30.5 ± 7.8	36.9 ± 8.0	-
5/10/84	MA932	104.8 ± 10.5	94.7 ± 14.7	90.4 ± 16.7	0.999	-	31.9 ± 8.6	44.7 ± 9.1	18.0 ± 7.6	-
5/15/84	MA942	91.6 ± 9.2	91.6 ± 16.7	100.0 ± 20.8	0.884	-	16.5 ± 9.2	64.9 ± 11.1	10.2 ± 8.5	-
5/16/84	MA946	112.1 ± 11.2	85.4 ± 10.0	76.2 ± 11.7	0.968	-	41.0 ± 8.0	44.3 ± 5.9	-	-
5/18/84	MA956	23.6 ± 2.4	18.9 ± 3.9	79.9 ± 18.2	0.579	0.2 ± 0.1	7.0 ± 2.9	11.7 ± 2.5	-	-
5/22/84	MA966	49.2 ± 4.9	45.9 ± 9.5	93.2 ± 21.4	0.376	-	-	30.2 ± 6.3	15.6 ± 7.1	0.2 ± 0.1
5/28/84	MA978	23.5 ± 2.4	18.4 ± 3.7	78.6 ± 17.6	0.592	-	5.9 ± 2.8	12.6 ± 2.4	-	-
Mean		71.3	64.1	88.8	0.709	0.1	17.6	32.6	13.8	0.0
Std. Deviation		35.4	32.0	9.5	0.219	0.1	13.7	18.1	14.1	0.1
Avg. Uncertainty		7.2	11.6	19.3	-	0.0	6.2	7.5	5.2	0.0
Avg. % Contribution to Measured Mass		-	-	-	-	0.1%	24.7%	45.7%	19.4%	0.0%

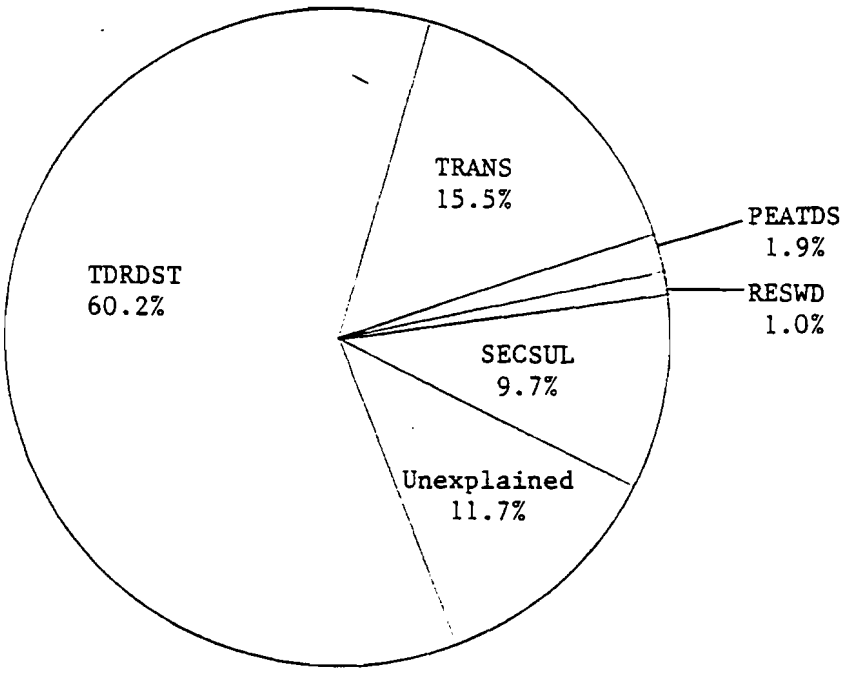


Figure 6. Pie Chart of Percent Source Contributions to Fine Particle Mass Measured at Tudor Road Site

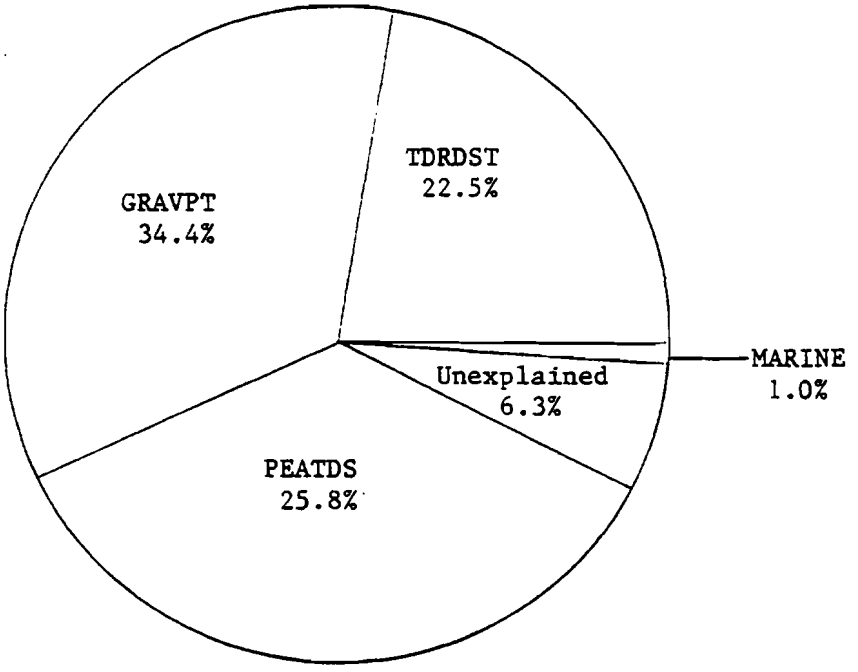


Figure 7. Pie Chart of Percent Source Contributions to Coarse Particle Mass Measured at Tudor Road Site

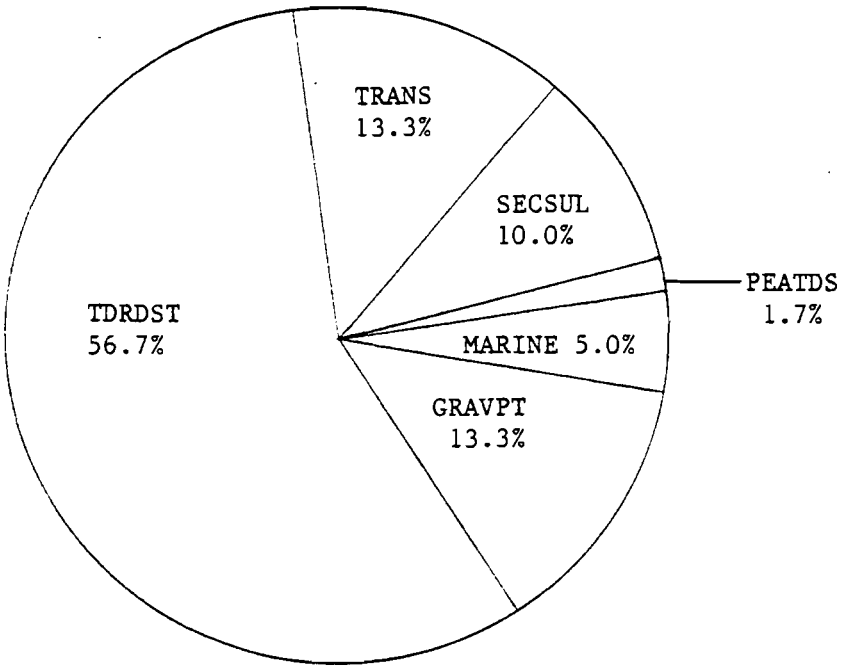


Figure 8. Pie Chart of Percent Source Contributions to Fine Particle Mass Measured at Fourth Avenue Site

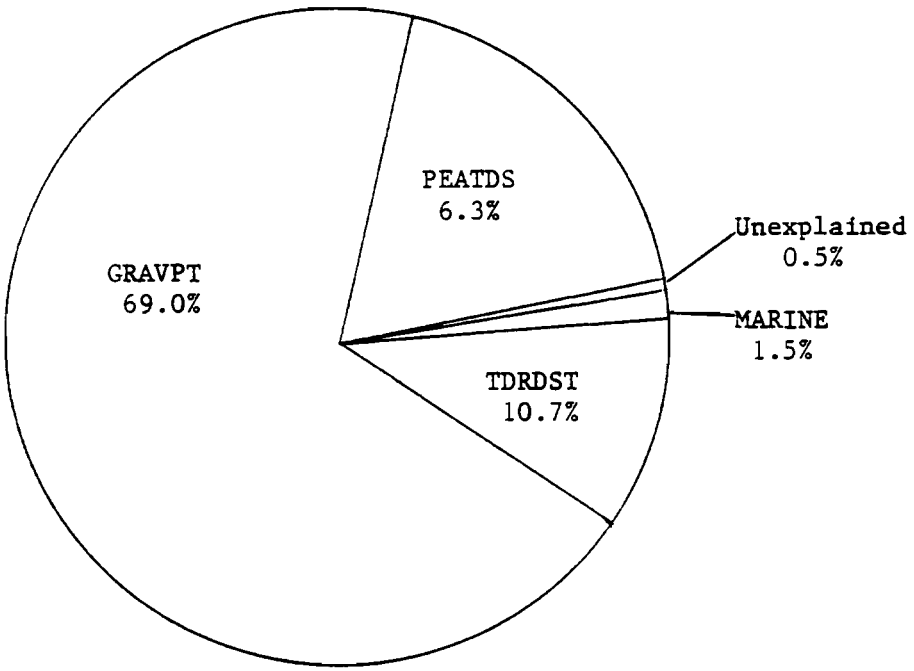


Figure 9. Pie Chart of Percent Source Contributions to Coarse Particle Mass Measured at Fourth Avenue Site

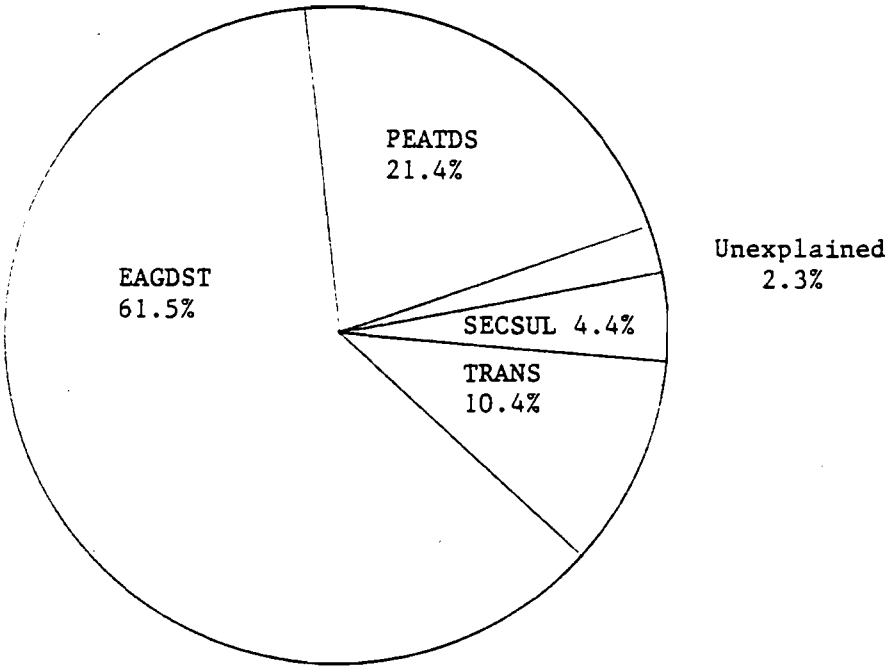


Figure 10. Pie Chart of Percent Source Contributions to Fine Particle Mass Measured at Eagle River Site

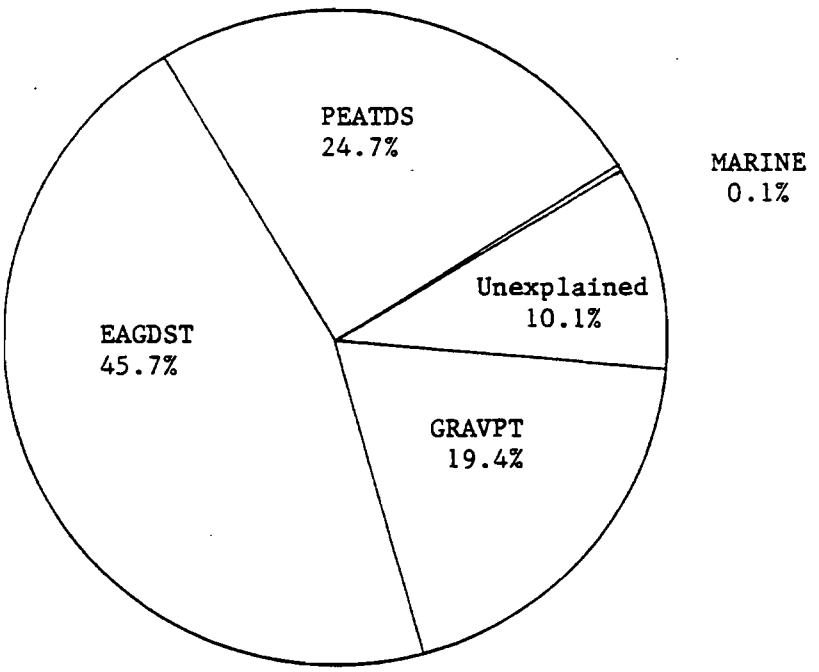


Figure 11. Pie Chart of Percent Source Contributions to Coarse Particle Mass Measured at Eagle River Site

formation, so these results serve as confirmation that the dichotomous samplers and the RMA were functioning properly.

Marine aerosol impacts ranged between 0.1 and 5%, the highest impact being at the Fourth Avenue site in the fine fraction. As the Fourth Avenue sampling site is about one mile from a salt water body (the Knik Arm), the CMB results continue to be consistent with physical facts.

Tables 15-17 summarize the differences in CMB results between the AAPCA-designated dirty, normal, and clean days for each of the three sites. One should keep in mind the small number of filters from which this data is derived when drawing conclusions. However, the differences in crustal contributions during dirty days as opposed to both normal and clean days are significant. For all three sites and for both size fractions, dirty day crustal impacts are roughly twice those of normal or clean day contributions. The contributions of transportation, marine, and secondary sulfate are relatively low and consistent at each site, regardless of the day.

Carbon data from hi-volume filters at the Tudor Road site were incorporated into the CMB fitting process as well. The organic and elemental carbon concentrations, as calculated from the high-volume filters, were assumed to be entirely due to fine particle sources, such as automobile and vegetative burn emissions; based on this assumption, all of the carbon was added to the chemical profile of the corresponding fine fraction dichotomous filters at Tudor Road. As noted previously, the carbon data of April 30 was used for both April 24 and April 30 sampling days. CMB calculations were then performed with the modified ambient profiles. A typical result is presented in Table 18; the CMB result for the same filter without carbon data is presented in Table 19 for comparison. As can be seen in these two tables, organic carbon as a fitting species has resulted in a small contribution by the slash burn source. However, the calculated uncertainty in this source is large, the elemental carbon is overexplained, and the percent contributions of the transportation, Tudor Road dust, and secondary sulfate sources change little.

Table 15

Comparison of CMB Results for Dirty, Normal, and Clean Days at Tudor Road Site

Sampling Day Description	Mean Measured Mass ($\mu g/m^3$)	Mean Calculated Mass ($\mu g/m^3$)	Mean % Mass Explained	Mean Reduced Chi^2	Mean Source Contributions ($\mu g/m^3$)				
					Crustal	Transportation	Marine	Secondary Sulfate	Wood Combustion
Dirty Days, Fine Fraction	11.9 ± 1.3	10.5 ± 0.6	88.9 ± 10.6	0.375	7.6 ± 0.4	1.7 ± 0.3	-	1.2 ± 0.2	-
Normal Day, Fine Fraction	7.4 ± 0.8	6.4 ± 1.9	85.8 ± 27.5	0.126	3.3 ± 2.4	1.7 ± 0.4	-	0.4 ± 0.1	0.9 ± 0.8
Clean Day, Fine Fraction	3.7 ± 0.5	2.8 ± 0.2	76.4 ± 12.4	0.795	1.7 ± 0.1	0.6 ± 0.1	-	0.5 ± 0.1	-
Dirty Days, Coarse Fraction	35.6 ± 3.6	33.2 ± 3.7	92.2 ± 13.9	1.173	32.9 ± 5.1	-	0.3 ± 0.1	-	-
Normal Day, Coarse Fraction	19.8 ± 2.0	18.1 ± 2.5	91.3 ± 15.5	2.089	17.9 ± 3.5	-	0.2 ± 0.1	-	-
Clean Day, Coarse Fraction	8.5 ± 0.9	8.5 ± 1.3	100.2 ± 19.0	0.853	8.4 ± 1.8	-	0.1 ± 0.0	-	-

Table 16

Comparison of CMB Results for Dirty, Normal, and Clean Days at Fourth Avenue Site

Sampling Day Description	Mean Measured Mass ($\mu g/m^3$)	Mean Calculated Mass ($\mu g/m^3$)	Mean % Mass Explained	Mean Reduced Chi^2	Mean Source Contributions ($\mu g/m^3$)			
					Crustal	Transportation	Marine	Secondary Sulfate
Dirty Days, Fine Fraction	6.8 ± 0.8	6.8 ± 0.8	100.2 ± 17.0	0.523	5.0 ± 0.8	0.9 ± 0.2	0.2 ± 0.1	0.8 ± 0.2
Normal Day, Fine Fraction	5.1 ± 0.7	5.3 ± 1.1	104.1 ± 26.0	0.173	3.3 ± 1.5	1.1 ± 0.2	0.9 ± 0.4	0.2 ± 0.1
Clean Day, Fine Fraction	1.7 ± 0.4	1.6 ± 0.1	94.3 ± 25.8	0.406	0.9 ± 0.1	0.4 ± 0.1	0.0 ± 0.0	0.3 ± 0.1
Dirty Days, Coarse Fraction	22.8 ± 2.3	21.9 ± 3.8	95.0 ± 21.2	1.020	22.5 ± 5.8	-	0.3 ± 0.1	-
Normal Day, Coarse Fraction	15.5 ± 1.6	14.1 ± 2.5	91.0 ± 18.5	1.028	14.0 ± 3.5	-	0.1 ± 0.0	-
Clean Day, Coarse Fraction	5.1 ± 0.7	5.0 ± 1.2	98.3 ± 26.5	0.848	4.9 ± 1.7	-	0.1 ± 0.0	-

Table 17

Comparison of CMB Results for Dirty, Normal, and Clean Days at Eagle River Site

Sampling Day Description	Mean Measured Mass ($\mu g/m^3$)	Mean Calculated Mass ($\mu g/m^3$)	Mean% Mass Explained	Mean Reduced Chi^2	Mean Source Contributions ($\mu g/m^3$)			
					Crustal	Transportation	Marine	Secondary Sulfate
Dirty Days, Fine Fraction	21.7 ± 2.2	21.3 ± 3.5	97.1 ± 18.9	0.413	18.4 ± 4.7	2.0 ± 0.4	-	0.9 ± 0.2
Normal Day, Fine Fraction	9.4 ± 1.0	8.8 ± 0.6	94.3 ± 11.9	0.324	6.1 ± 0.3	2.4 ± 0.5	-	0.3 ± 0.1
Clean Day, Fine Fraction	6.1 ± 0.7	5.5 ± 1.2	90.8 ± 22.9	0.264	4.3 ± 1.7	0.9 ± 0.2	-	0.4 ± 0.1
Dirty Days, Coarse Fraction	82.6 ± 8.3	74.7 ± 13.3	89.8 ± 19.3	0.784	74.6 ± 22.1	-	0.1 ± 0.0	-
Normal Day, Coarse Fraction	49.2 ± 4.9	45.9 ± 9.5	93.2 ± 21.4	0.376	45.8 ± 13.4	0.2 ± 0.1	-	-
Clean Day, Coarse Fraction	23.5 ± 2.4	18.4 ± 3.7	78.6 ± 17.6	0.592	18.5 ± 5.2	-	-	-

Table 18

Example of CMB Calculation Including Carbon Fitting Species
(Tudor Road Fine Fraction)

SAMPLE ID: MA901 PARTICLE SIZE: FINE
FIELD FLAG: MASS FLAG: ANALYSIS FLAGS:
SITE: 1 TUDOR ROAD
SAMPLE DATE: 840424 START TIME: .0 DURATION: 24.1 HOURS
REDUCED CHI SQUARE: .227 DEGREES OF FREEDOM: 10

--SOURCE--	--SIZE--	--UG/M3--	--PERCENT--
5037	SLSHBN F	.318+- .229	2.972+- 2.166
5053	TRANS F	1.450+- .289	13.550+- 3.063
5105	TDRDST F	4.802+- .256	44.880+- 5.367
5110	SECSUL F	1.296+- .225	12.115+- 2.470
	TOTAL:	7.866+- .502	73.517+- 9.163

--SPECIES--		--MEAS. UG/M3--	--%	--CALC. UG/M3--	--CALC./MEAS.--	
Al	*	.575+- .064	5.376	.593+- .034	1.031+- .129	Al
Si	*	1.739+- .192	16.257	1.735+- .098	.997+- .123	Si
P		.029+- .006	.272	.012+- .003	.408+- .126	P
S	*	.363+- .043	3.389	.363+- .034	1.000+- .150	S
Cl	*	.058+- .008	.543	.053+- .014	.916+- .273	Cl
K	*	.064+- .008	.603	.061+- .004	.952+- .126	K
Ca	*	.085+- .010	.790	.089+- .006	1.047+- .140	Ca
Ti	*	.024+- .003	.226	.023+- .001	.933+- .126	Ti
V	*	.002+- .001	.019	.002+- .000	.934+- .316	V
Cr	*	.001+- .000	.011	.001+- .000	1.247+- .507	Cr
Mn	*	.007+- .001	.069	.007+- .001	.909+- .151	Mn
Fe	*	.271+- .030	2.531	.289+- .018	1.067+- .136	Fe
Ni		< .000		.001+- .000	5.643+-*****	Ni
Cu		.002+- .001	.015	.008+- .002	4.859+-2.530	Cu
Zn		.009+- .001	.084	.012+- .006	1.319+- .671	Zn
Ga		< .001		.000+- .000	.000+- .000	Ga
As		< .006		.002+- .001	1.243+-4.107	As
Se		< .000		.000+- .000	1.526+-4.944	Se
Br	*	.036+- .004	.337	.025+- .015	.703+- .410	Br
Rb		< .001		.000+- .000	.000+- .000	Rb
Sr		.001+- .001	.010	.002+- .000	1.582+-1.149	Sr
Y		< .001		.000+- .000	.000+- .000	Y
Zr		< .003		.000+- .001	.000+- .000	Zr
Mo		.004+- .003	.041	.000+- .001	.109+- .198	Mo
Pd		< .002		.000+- .001	.000+- .000	Pd
Ag		< .003		.000+- .001	.000+- .364	Ag
Cd		< .005		.000+- .001	.209+-1.243	Cd
In		< .005		.002+- .002	9.999+-9.999	In
Sn		< .006		.000+- .002	.011+- .430	Sn
Sb		< .010		.000+- .003	.000+- .000	Sb
Ba		< .029		.002+- .009	.000+- .000	Ba
La		< .042		.000+- .013	.000+- .000	La
Hg		< .001		.000+- .000	2.451+-*****	Hg
Pb	*	.113+- .013	1.057	.113+- .016	1.000+- .181	Pb
OC	*	.610+- .089	5.700	.666+- .120	1.092+- .253	OC
EC		.118+- .016	1.100	.591+- .116	5.022+-1.200	EC

MASS 10.7 +- 1.1 * FITTING SPECIES

Table 19

Example of CMB Calculation Without Carbon Fitting Species
(Tudor Road Fine Fraction)

TYPE

SAMPLE ID: MA901 PARTICLE SIZE: FINE
FIELD FLAG: MASS FLAG: ANALYSIS FLAGS:
SITE: 1 TUDOR ROAD
SAMPLE DATE: 840424 START TIME: .0 DURATION: 24.1 HOURS
REDUCED CHI SQUARE: .270 DEGREES OF FREEDOM: 9

--SOURCE--	--SIZE--	--UG/M3--		--PERCENT--	
5042	MARINE F	.055+-	.044	.517+-	.417
5053	TRANS F	1.485+-	.297	13.883+-	3.145
5105	TDRDST F	4.863+-	.255	45.452+-	5.419
5110	SECSUL F	1.290+-	.225	12.056+-	2.466
	TOTAL:	7.694+-	.453	71.909+-	8.788

--SPECIES--		--MEAS. UG/M3--		--%	--CALC. UG/M3--		--CALC./MEAS.--	
Al	*	.575+-	.064	5.376	.596+-	.034	1.036+- .130	Al
Si	*	1.739+-	.192	16.257	1.754+-	.099	1.008+- .125	Si
P		.029+-	.006	.272	.012+-	.003	.414+- .129	P
S	*	.363+-	.043	3.389	.363+-	.034	1.000+- .150	S
Cl	*	.058+-	.008	.543	.059+-	.015	1.007+- .288	Cl
K	*	.064+-	.008	.603	.061+-	.004	.946+- .125	K
Ca	*	.085+-	.010	.790	.087+-	.006	1.030+- .139	Ca
Ti	*	.024+-	.003	.226	.023+-	.001	.945+- .128	Ti
V	*	.002+-	.001	.019	.002+-	.000	.946+- .321	V
Cr	*	.001+-	.000	.011	.002+-	.000	1.264+- .514	Cr
Mn	*	.007+-	.001	.069	.006+-	.001	.869+- .138	Mn
Fe	*	.271+-	.030	2.531	.292+-	.018	1.078+- .138	Fe
Ni		<	.000		.001+-	.000	5.724+-*****	Ni
Cu		.002+-	.001	.015	.008+-	.002	4.755+-2.515	Cu
Zn		.009+-	.001	.084	.012+-	.006	1.342+- .687	Zn
Ga		<	.001		.000+-	.000	.000+- .000	Ga
As		<	.006		.002+-	.001	1.259+-4.159	As
Se		<	.000		.000+-	.000	1.546+-5.009	Se
Br	*	.036+-	.004	.337	.026+-	.015	.718+- .420	Br
Rb		<	.001		.000+-	.000	.000+- .000	Rb
Sr		.001+-	.001	.010	.002+-	.000	1.603+-1.164	Sr
Y		<	.001		.000+-	.000	.000+- .000	Y
Zr		<	.003		.000+-	.001	.000+- .000	Zr
Mo		.004+-	.003	.041	.000+-	.001	.111+- .200	Mo
Pd		<	.002		.000+-	.001	.000+- .000	Pd
Ag		<	.003		.000+-	.001	.000+- .369	Ag
Cd		<	.005		.000+-	.001	.215+-1.264	Cd
In		<	.005		.002+-	.002	9.999+-9.999	In
Sn		<	.006		.000+-	.002	.011+- .435	Sn
Sb		<	.010		.000+-	.004	.000+- .000	Sb
Ba		<	.029		.002+-	.009	.000+- .000	Ba
La		<	.042		.000+-	.013	.000+- .000	La
Hg		<	.001		.000+-	.000	2.483+-*****	Hg
Pb	*	.113+-	.013	1.057	.116+-	.016	1.023+- .186	Pb

MASS 10.7 +- 1.1 * FITTING SPECIES

Similar results were obtained with the remaining seven filters at this site. Even using this worst case assumption (that all the TSP carbon appears on the fine fraction filters,) RWC and vegetative burn emissions have little calculated impact on the ambient filters analyzed.

4.0 COMPOSITE ANALYSIS

The CMB calculation results are quite consistent with the analytical results and other data collected in this study. Specifically, high crustal source impacts on the ambient particulate mass are indicated by:

- Little precipitation and moderate winds during the sampling period, creating dry, dusty conditions.
- A large discrepancy between TSP mass concentrations and dichotomous mass concentrations; specifically, two-thirds of the TSP was greater than 10 μm.
- Coarse fraction loadings greater than fine fraction loadings, again indicating a predominance of large diameter particles.
- Relatively low levels of organic and elemental carbon as percent of TSP.
- High levels of crustal species (Al, Si, Ca, Fe) in XRF analysis of dichotomous filters.
- Good CMB fits with crustal sources; specifically, low reduced chi square values and high explained mass percentages.
- Relatively small calculated CMB contributions from other sources; RWC and vegetative burn sources account for only one or two percent of even the fine fraction, where these sources are usually dominant.
- Higher crustal impacts during AAPCA-designated dirty days as compared to normal and clean days, while contributions from other sources remained relatively constant.

High TSP values at Eagle River as measured on high-volume filters were verified by higher dichotomous filter loadings at this site compared to loadings at the other two sites. The dichot deposits, particularly in the coarse fraction, were also notably different in appearance: coarse fraction filters from Eagle River were light brown or yellow in color, while coarse filters from the other two sites were dark brown or grey. As previously noted, one Eagle River coarse filter was loaded to the extent that particle loss was a problem.

Nephelometer readings were well-correlated with dichotomous fine fraction filter loadings at the Tudor Road site, providing an additional quality assurance check on TSP values and the selection of sample days to be analyzed.

CMB calculations were consistent with wind data for the sampling period. For example, marine aerosol impacts were noted at the Fourth Avenue site when westerly winds were prevalent. Also, no impact from the Knik River glacial till source was calculated for any of the three sampling sites, a result consistent with the fact that the glacial till sample was collected north of Anchorage and predominant winds during the sampling period were from westerly and southerly directions. This wind pattern is probably the reason why burning in the Point MacKenzie area, which took place on May 10-11, did not impact the samples collected then.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The source apportionment conclusions of this study are summarized in Figures 6-11. In general, crustal sources accounted for 90-98% of the coarse fraction mass and 64-85% of the fine fraction mass. Other sources included transportation, marine, and secondary sulfate. Little or no RWC or vegetative burn emissions were fit in CMB calculations for the three sites, fine or coarse fractions.

The crustal impact on the filters collected during the April-May sampling period is supported by a number of other data, including fine/coarse dichotomous filter loading ratios, inhalable/TSP particulate loading ratios, dry and windy weather during the sampling period, relatively low organic and elemental carbon levels as percentages of TSP, and the low chi squares and high percentages of explained mass obtained from the CMB calculations.

The Eagle River site experienced much higher particulate levels in TSP, fine, and coarse fractions than the Fourth Avenue or Tudor Road sites.

While the contributions from sources such as transportation, marine, and secondary sulfate did not show much site-dependence, crustal impacts at Eagle River were roughly twice those at either of the other two sites.

The AAPCA-designated dirty days were characterized by higher crustal impacts in both fine and coarse fractions at all three sites as compared to normal and clean days. The other three primary sources also show drops in impacts on normal and clean days, but not with nearly the magnitude of the crustal sources.

An obvious recommendation is that future studies to quantify RWC and vegetative burn impacts in the Anchorage area be conducted on days with less wind or with winds from a northerly direction. While weather is not readily controlled, a longer sampling period would improve chances of including RWC and vegetative burn impacts in the ambient data set. Control strategies for improvement in Anchorage air quality, given the results of this study, should include implementation of a dust control program.

6.0 REFERENCES

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