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# TARGETING GEOTHERMAL EXPLORATION SITES IN THE MOUNT ST. HELENS AREA USING SOIL MERCURY SURVEYS

by

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## TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF PLATES

## INTRODUCTION

The measurement of levels of mercury in soil has been found to be useful in locating areas with high geothermal gradients (Matlick and Buseck, 1976; Phelps and Buseck, 1978). It has been shown that soils overlying geothermal areas are generally enriched in Hg which has absorbed onto organic and organometallic compounds and clays. This enrichment occurs because higher temperatures near a geothermal reservoir tend to increase the mobility of Hg with its high vapor pressure. The Hg comes from hydrothermal alteration or weathering of small amounts of sulfides containing trace amounts of Hg. Analysis of soil for mercury content in order to locate geothermal sites has been found to be particularly useful in areas which, like those discussed in this paper, may have few surface manifestations of geothermal activity. In this study, high-sensitivity measurements of soil samples were made in areas centered around features suggestive of geothermal activity near Mount St. Helens, including suspected fault zones, a mineral spring, and Pleistocene volcanic centers, in an effort to target areas for heat flow drill holes.

## AREA STUDIED

Mount St. Helens has long been suspected to be a promising geothermal area. The May 18, 1980 eruption and subsequent eruptions attest to the presence of a magmatic heat source relatively close to the surface in the Mount St. Helens area. Seismic activity around the mountain indicates the presence of a fault zone, though a surface expression has yet to be identified. Post-May 18 seismic patterns have more sharply delineated this fault zone. These seismic patterns indicated two major faults (see figure 1): a 35-km-long right-lateral strike-slip (?) fault with north-northwest striking fault planes north of Mount St. Helens, and, south-southeast of the

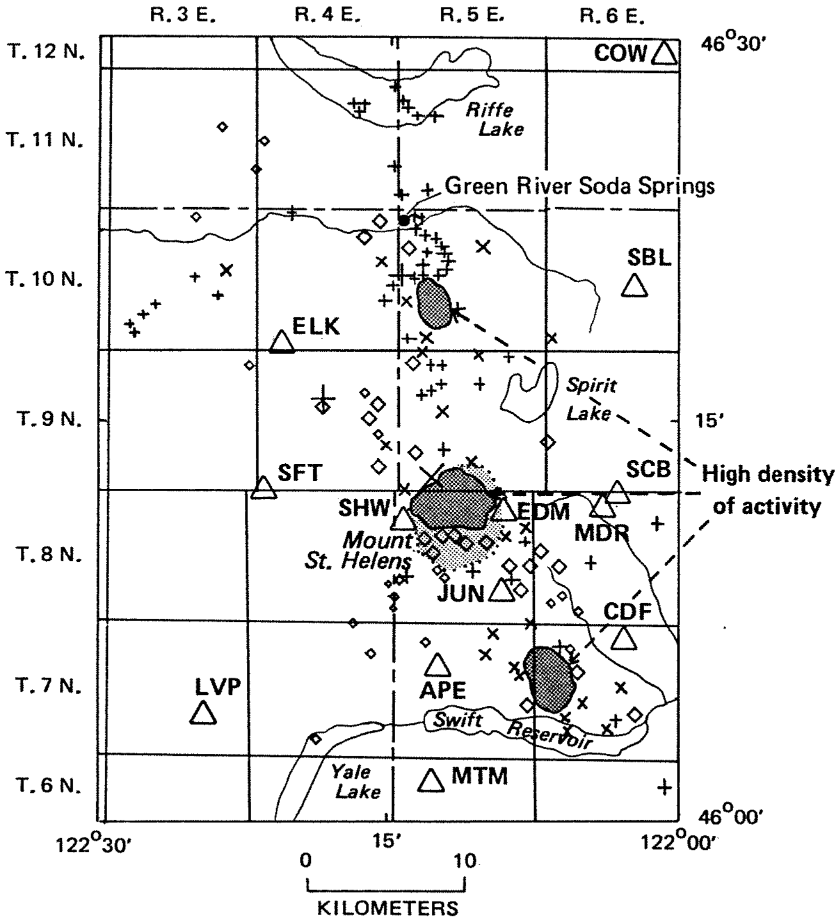


Figure 1. — Composite seismicity pattern from May 18 to August 31, 1980. Triangles, seismic stations. Symbol size indicates magnitude: small symbols, events with magnitudes less than 2.8; large symbols, events with magnitudes greater than 2.8. Depth indicated as follows: +,0-5 km; x, 5-10 km; square, 10-15 km; diamond, greater than 15 km. (from Weaver and others, 1981).

mountain, a 20-km-long right-lateral strike-slip fault striking N 25 W (Weaver and others, 1981). An active fault zone could have a close connection with volcanic activity and might provide opportunities for circulation of fluids down to a volcanic heat source. If this fault system is open, the soil above the faults should contain anomalous amounts of Hg. A method of targeting high heat-flow areas for drilling along this fault zone has been of interest for those involved in assessing the geothermal potential of the Mount St. Helens area. Lack of surface manifestations of geothermal systems and a "cold meteoric water blanket" which may cool and mask geothermal waters result in the lack of specific targets for geothermal drilling (Korosec and others, 1980). Other investigators have questioned whether the "cold water blanket" prevents Hg anomalies in the soil, either by lateral transport and removal of Hg or by slowing the upward migration of the volatile Hg at depth, where the cool water dilutes the geothermal fluids. This method has not been extensively used in the Cascades or areas with similar climatic, vegetative, geomorphic, and pedalogical conditions. Thus another purpose of the study was to assess the applicability of the soil-mercury exploration method for the Cascades and similar areas.

Two sampling areas north and south of the mountain were selected because of features possibly indicative of geothermal activity (see figure 2). An area of about 100 square kilometers, located within Range 4 and 5 East, and Township 10 and 11 North, in the Green River drainage north of the mountain, was selected because of seismic patterns indicating an active fault zone, and the presence of a low-temperature mineral thermal spring (Green River Soda Springs) in a marshy area north of the river. Small springs or seeps were found during the survey on the south side of the river across from Green River Soda Springs. A fracture zone is probably responsible, in part, for the existence of these springs. The $CO_2$-rich waters of Green River Soda

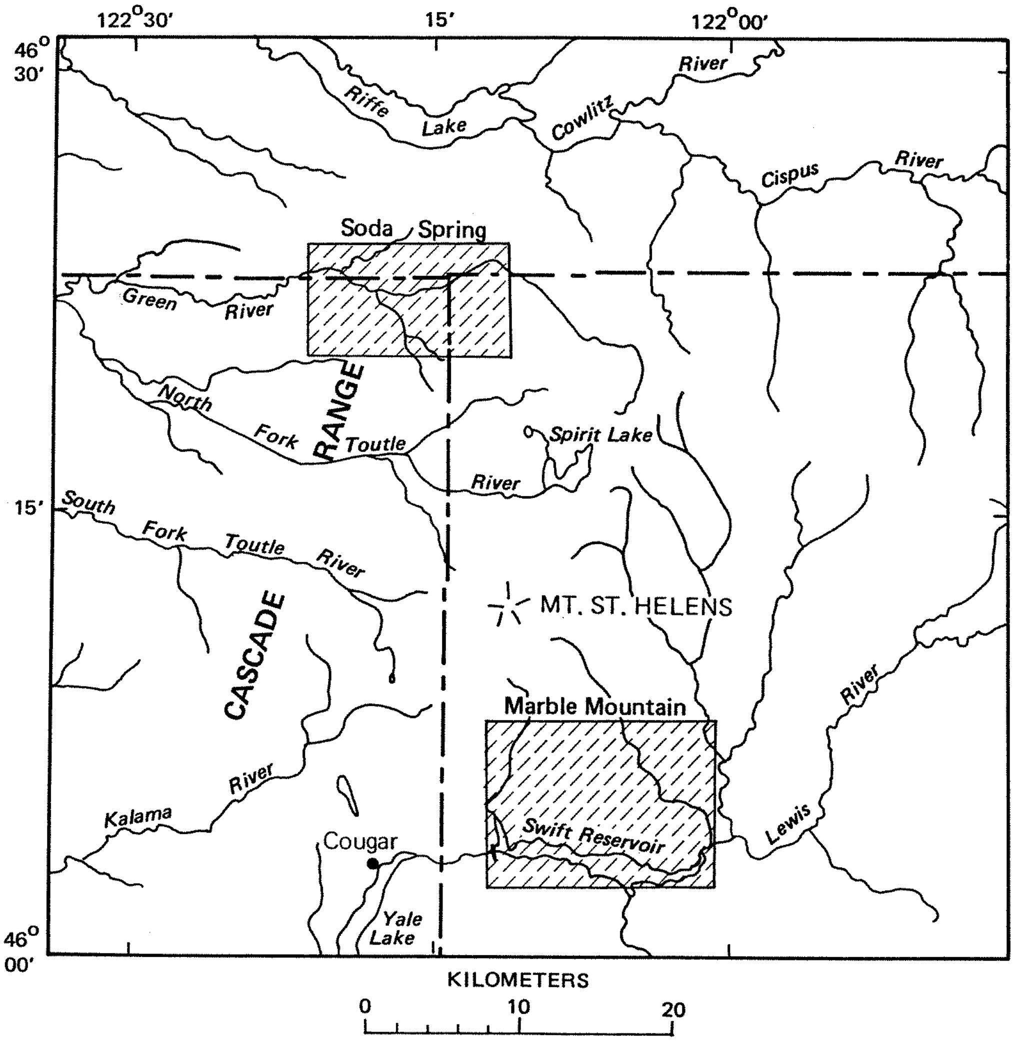


Figure 2. — Location of study areas

Springs, relatively high in lithium and boron, may be the result of circulation of water in close proximity to a magmatic heat source (Korosec, personal communication 1983). The Green River site was almost entirely within the blow-down and singe zones created by the May 18 blast. The area has been extensively logged in the past, and post-eruption salvage operations have taken place in much of the area. Generally, soils on the north side of the valley were thinner than on the south side. Ash covered all the sample sites at depths ranging from 4 to 18 cm. The bedrock of the area consists of primarily volcanic breccias of the Oligocene Ohanapecosh Formation.

The second site is a 150 square kilometer area south of Mount St. Helens surrounding Marble Mountain. The area was selected because of the presence of Quaternary volcanic centers and an andesite flow with a K-Ar date of 160,000 years (Hammond, personal communication, 1983) and seismic patterns indicative of a fault on the southeast side of Marble Mountain. A light cover of pumice and ash from the recent eruptions of Mount St. Helens was present in much of the study area. Almost every hole dug disclosed a layer of pumice at about the 10- to 15-cm level below the organic horizon. This layer of pumice may be set W or X of the Kalama Eruptive Period of 350 to 450 years ago, during which tephra was erupted and pyroclastic flows moved down the south flank of the volcano. Both sets include phenocrysts of hypersthene and hornblende (Mullineaux and Crandell, 1981; Mullineaux and others, 1975).

## SAMPLING AND ANALYTICAL METHODS

Sample stations were spaced along existing logging roads at two different distance intervals. The Soda Springs area was about 100 square kilometers, inside which a smaller area of about 36 square kilometers was designated. Similarly, the Marble Mountain section covered about 150 square kilometers, inside which was selected a smaller area of about 70 square kilometers. In each case, samples were collected every 0.32 kilometers inside the smaller area, with a station spacing of 0.8 km for the rest of the study areas. The smaller area in each case was considered to be more likely to yield anomalies, and so was sampled more intensively.

Sample sites were chosen that were at least 10 meters from the road. Care was taken to find sites that were on relatively level ground (to avoid distortions due to hydrology and horizontal migration), and that were as undisturbed as possible by logging, trails, or other activity.

Soil samples were taken from the A horizon from within the 10-15 cm depth interval, measured from the bottom of the obvious organic horizon. The A horizon was selected since it has been shown to have a higher concentration of Hg than the B and C horizons (Jonasson and Boyle 1972), probably because it contains a greater amount of organic material to retain the Hg. To sample the soil, a stainless steel spoon was used to tunnel into the side of a pit (dug with a shovel) to be sure that organic material falling from above would not contaminate the sample. The sample was scraped from the entire 5 cm interval between the 10 and 15 cm depth, and immediately transferred to a plastic bag and sealed. Samples were air-dried in the lab. When completely dry, the samples were sieved using a 100-mesh sieve and transferred to air-tight glass vials.

A Jerome Instruments 301 mercury detector was used to determine relative concentrations of mercury in the soil samples employing the low-temperature method. The instrument has an absolute sensitivity of better than 0.05 ppb mercury. A volumetric scoop was used to measure approximately 0.1 g of soil (soil density was assumed to be 1.1 g/cm3) which was placed into a glass bulb on a hot plate at 290°C. The soil was heated for one minute to volatilize a standard fraction of the mercury. The mercury vapor is collected on a gold film. The difference between the electrical resistance of the sensor film (on which the Hg is collected) and the reference film are digitally displayed as a number proportional to Hg concentration.

## RESULTS AND DISCUSSION

During the Spring of 1983, a total of 269 soil samples were taken from both survey areas; 101 from the Marble Mountain area, and 168 from the Soda Springs area. The background level of Hg in the soil was calculated as the mean for each area (see figure 3 and Appendix A). Anomalous values were defined as those which exceeded two standard deviations above the mean, as was done in previous studies (Phelps and Buseck 1978). Hg concentrations in both areas appeared to have log-normal distributions (see Appendix B). The samples from the Soda Springs area had a mean of 60 ppb with a standard deviation of 28. The mean for the Marble Mountain area was 48 ppb with a standard deviation of 24. Thus the threshold level for the Soda Springs area was considered to be 116 ppb, and for the Marble Mountain area 96 ppb (see figure 3).

Statistically anomalous values of Hg generally appeared to be erratically distributed in the areas. No prominent Hg haloes could be discerned, though in both areas there appear to be clusters of stations with relatively higher values which include several statistically anomalous mercury concentrations. More intensive sampling is warranted around these clusters within the sampling areas.

Soil intervals that show the greatest variation in Hg are most favorable for Hg surveys. Most researchers determine an appropriate depth of sampling using analysis of variance in test pit profiles. Some have found a consistent increase in Hg with depth (Hadden and others, 1981). Others have noted just

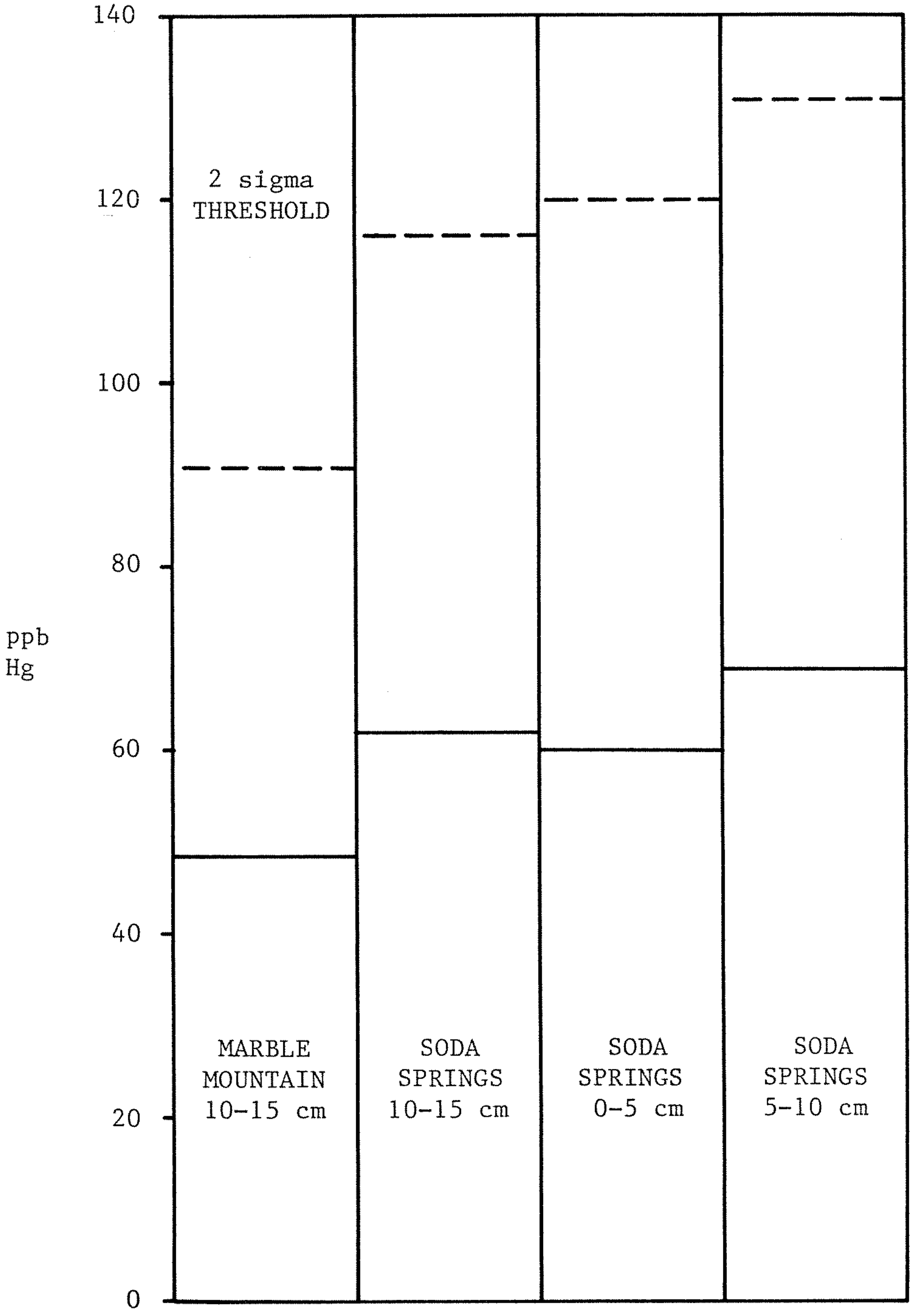


Figure 3. Background Hg levels for soils of both study areas and different depth intervals from the Soda Springs area. Two standard deviations above the mean are represented by the dashed lines.

the opposite (Korosec, personal communication, 1983). For the first 33 holes, 10-15, 5-10, and some 0-5cm depth intervals were sampled to determine if there was a similar trend. A definite tendency toward increasing or decreasing Hg levels with depth was not evident from the data collected. Collecting from the 5-10 and 0-5cm intervals was abandoned for the rest of the project because of time constraints.

During this study, several questions emerged concerning the applicability of this method to the sample areas. There was considerable variation in the nature of the sites chosen which may limit the ability to define anomalies attributable to geothermal activity. One question concerned the inability to find relatively level and/or undisturbed sites in some areas. The extensive log-salvaging activity in the Soda Springs area since the 1980 blast made it difficult to find sites which had not been markedly disturbed by human activity. Since the soil horizons of some of the sample sites may have been disturbed, their Hg-absorbing characteristics may have been significantly changed. The ability to measure a consistent depth for the soil sample was also a concern. In some parts of the Soda Springs study area, the organic layer was missing, possibly due to burial by the May 18, 1980 volcanic blast or erosion. Two other factors made it difficult to measure intervals at consistent depths in some places in the study areas; a greatly undulating soil horizon, and an extensive covering of rotting wood.

An important question may be how inconsistency in soil horizon characteristics affects the ability to discern Hg anomalies. Some factors found to affect soil retention of Hg include the amount of organic matter in the soil. Much organic material will increase the Hg content since Hg adsorbs to some humic substances. North-facing slopes may have higher Hg levels than south-facing slopes since they have been less exposed to the sun and therefore may have more vegetation and more organic material in the soil. The amount of clay in the soil may also affect retention of Hg. Klusman and Landress (1978) found that the influence of these factors is secondary in significance to variations produced by the presence of geothermal activity.

Topography influences the hydrologic characteristics of a given area and may affect the importance of the above secondary controls. Both sample areas, especially Soda Springs, had significant variation in topography. This type of variation was minimized by sampling relatively level sites whenever possible.

Some relationships between the nature of the environment and the Hg levels in samples taken there were apparent from the data. Samples taken from an area almost level with the Green River yielded Hg values significantly lower than the mean of 60 ppb (11 and 29 ppb for 5-10 cm and 32 ppb for 10-15 cm). These lower than average values can probably be attributed to the high water table and lateral transportation of the Hg down-gradient. Samples from 8 wet or swampy sites in the Soda Springs area ranged from 12 to 65 ppb with an average of 39 ppb. A high water table appears to result in generally lower Hg levels in these soils. More samples could be collected to confirm these suspected relationships.

The soil around thermal springs is often enriched in mercury. But a sample taken within one meter of the main spring at Soda Springs had a relatively low 12 ppb Hg concentration. Since Soda Springs lies in the flood plain of the river, this low Hg value may be a result of a high water table. Additionally, the low value may be related to the incomplete volatilization of Hg with the low temperature method. The soil within about a 3 m radius of Soda Springs was clayey, hard, coarse, and extremely oxidized. Given the nature of the soil, the Hg may be locked up in oxides that do not allow for complete Hg volatilization at the temperature used.

When plotted on a map of the Soda Springs area, the Hg readings show no distinct trends (see plate 1). Single high values are usually surrounded by lower ones. There is, however, a cluster of several relatively high values (76-107 ppb) south of the Green River (directly across the river and south of Green River Soda Springs) on several parallel roads all less than a mile from the spring. One mile north of the spring are two more relatively high readings (103 and 118). These readings, plus their distribution along a line of earthquake hypocenters which may define a major fault zone, and the presence of a thermal spring, made the Green River Soda Springs an interesting target for a geothermal test hole. Sampling at more frequent intervals might well be useful to pinpoint areas of potential high geothermal gradient.

In the Marble Mountain area (see plate 2), five samples taken along the upper part of a road bordering the northeast side of Pine Creek Valley range from 20 to 38 ppb with an average of 27 ppb. These values are lower than the mean of 48 ppb, possibly because of the thick layers of pyroclastic and mudflow material in the area which could make the soils less prone to significant Hg adsorbtion.

A cluster of values above the mean, including three above the threshold (94, 99 and 144 ppb), was found in section 15 of T. 7 N., R. 5 E. in the Marble Mountain area. It should be noted that this area almost parallels the contact between Quaternary Basalts of Marble Mountain and the Tertiary volcanics of the Ohanapecosh Formation. It is possible that a contact between differing lithologies or structural characteristics of the contact may allow Hg to flux out at a relatively higher rate and consequently accumulate at a relatively high concentration in soils above the contact.

# CONCLUSIONS

The main accomplishment of this study was to determine the background mercury level for the areas studied, providing preliminary information for future work. Identification of areas which might merit more intensive sampling was also accomplished. The clusters of samples with high Hg concentrations in both areas may indicate high heat flow and should be investigated further. Problems involving the use of this method in the Cascades were also identified. A thorough study of the influence of secondary controls might be useful for further work in this type of geographic province. Both areas had approximately the same standard deviation (expressed as a percentage of the mean), even though the sampling horizons seemed much more consistent and less disturbed in the Marble Mountain area. This may indicate that for these areas, secondary controls are more important, or that Hg anomalies are much smaller than indicated in studies of other areas. More work should be done using analysis of variance to determine appropriate sampling intervals and grid spacing for these areas. It may be that a closer grid spacing is needed because geothermal Hg anomalies may not appear with the grid spacing used in this and previous studies.

# REFERENCES

Hadden, M. M.; Priest, G. R.; and Woller, N. M.; 1982, Preliminary soil-mercury survey of Newberry volcano, Deschutes County, Oregon: Oregon Department of Geology and Mineral Industries.

Jonasson, I. R.; and Boyle, R. W., 1972, Geochemistry of mercury and origin of natural contamination of the environment: Can. Inst. Min. Metall., Trans., v. 75, p. 8-15.

Juncal, R. W., 1980, Mercury and arsenic soil geochemistry, in MacKay Minerals Minerals Research Institute, Geothermal reservoir assessment case study, northern Basin and Range Province, northern Dixie Valley, Nevada: Reno, Nev., University of Nevada MacKay Minerals Research Institute report, 117 p.

Korosec, M. A., Schuster, J. E., Blackwell, D. D.; Danes, Z. F.; and Clayton, G. A.; 1980, The 1979-1980 geothermal resource assessment program in Washington: Washington State Department of Natural Resources, Division of Geology and Earth Resources, Open-File Report 81-3.

Matlick, J. S. III; and Buseck, P. R., 1976, Exploration for geothermal areas using mercury--a new geochemical technique: Proceedings; 2nd United Nations Symposium on development and use of geothermal resources, v. 1, p. 785-792.

Mullineaux, D. R., and Crandell, D. R., 1981, The eruptive history of Mount St. Helens, in Lipman, P. W., and Mullineaux, D. R., Editors, The 1980 eruptions of Mount St. Helens, Washington: U.S. Geological Survey Professional Paper 1250, p. 3-15.

Mullineaux, D. R.; Hyde, J. H.; and Rubin, M.; 1975, Widespread late glacial and postglacial tephra deposits from Mount St. Helens volcano, Washington: Journal of Research U.S. Geological Survey, v. 3, p. 329-335.

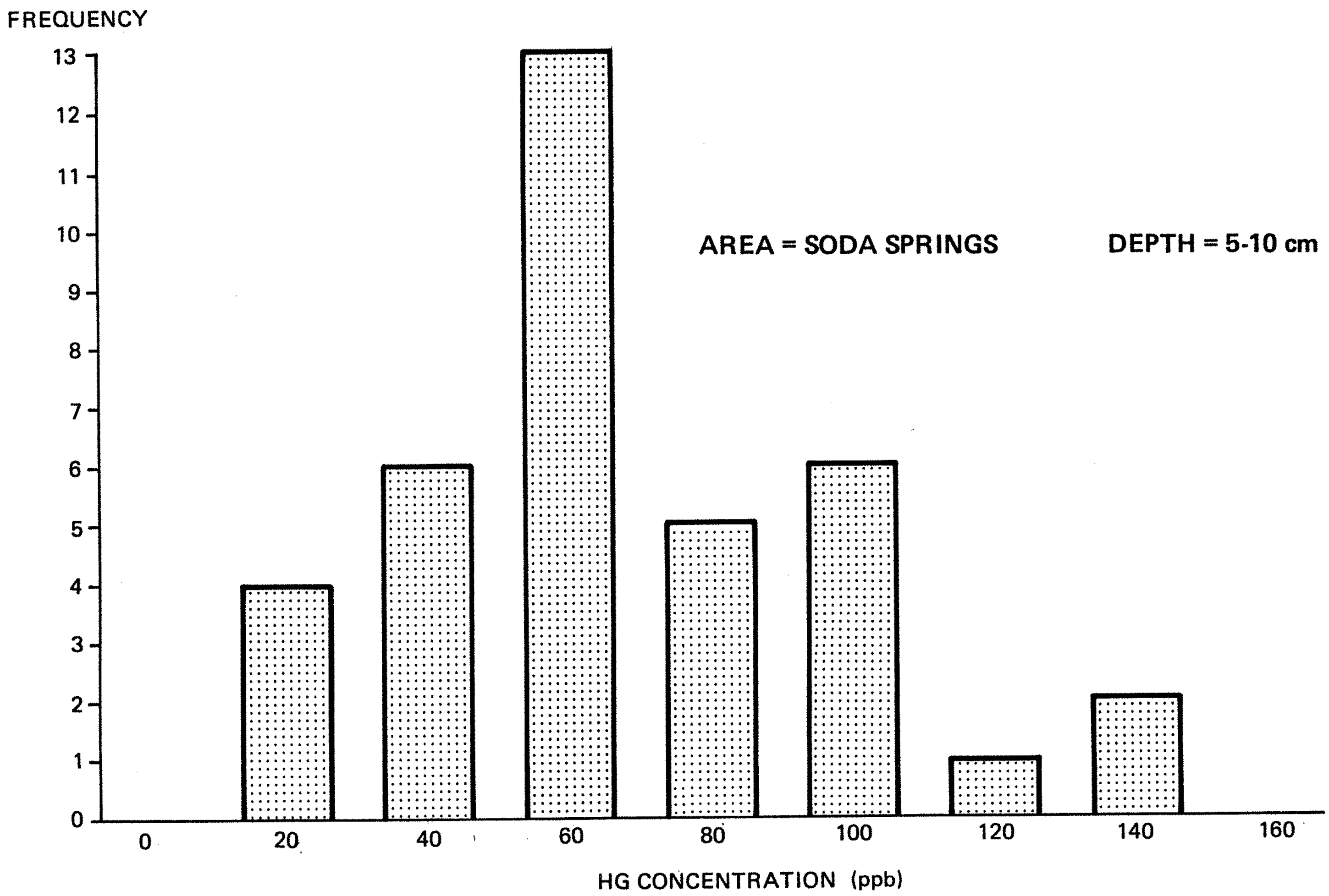
Phelps, D. W.; and Buseck, P. R., 1978, Natural concentrations of Hg in the Yellowstone and Coso geothermal fields: Geothermal Resources Council, Transactions, v. 2, p. 521-522.

Weaver, C. S.; Grant, W. C.; Malone, S. D.; and Endo, E. T.; 1981, Post-May 18 seismicity: volcanic and tectonic implications, in Lipman, P. W., and Mullineaux, Donal R., Editors, The 1980 eruptions of Mount St. Helens, Washington: U.S. Geological Survey Professional Paper 1250, p. 109-121.

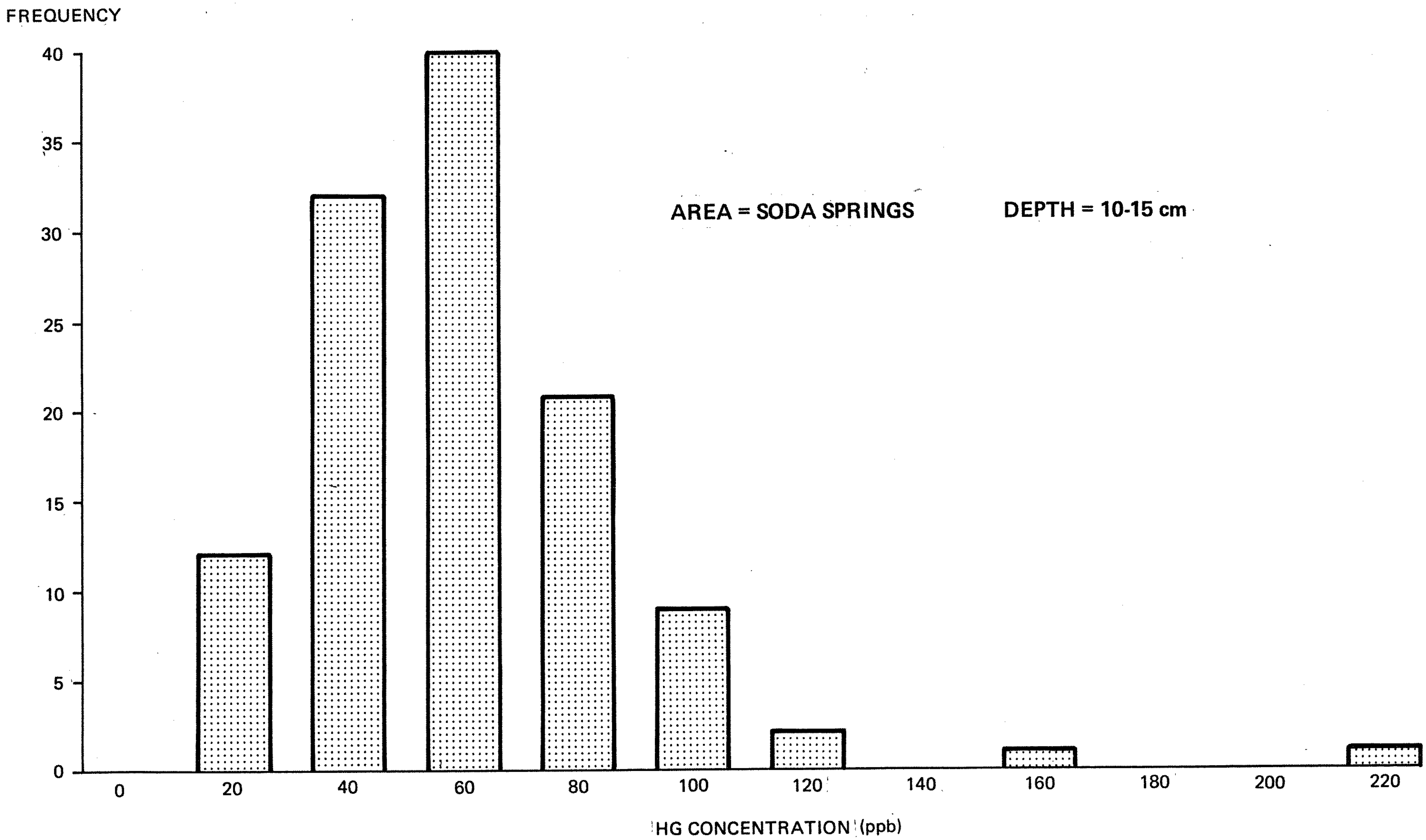
# APPENDIX A

## TABLE A-1. - Mercury Survey, Southern Cascades, Washington

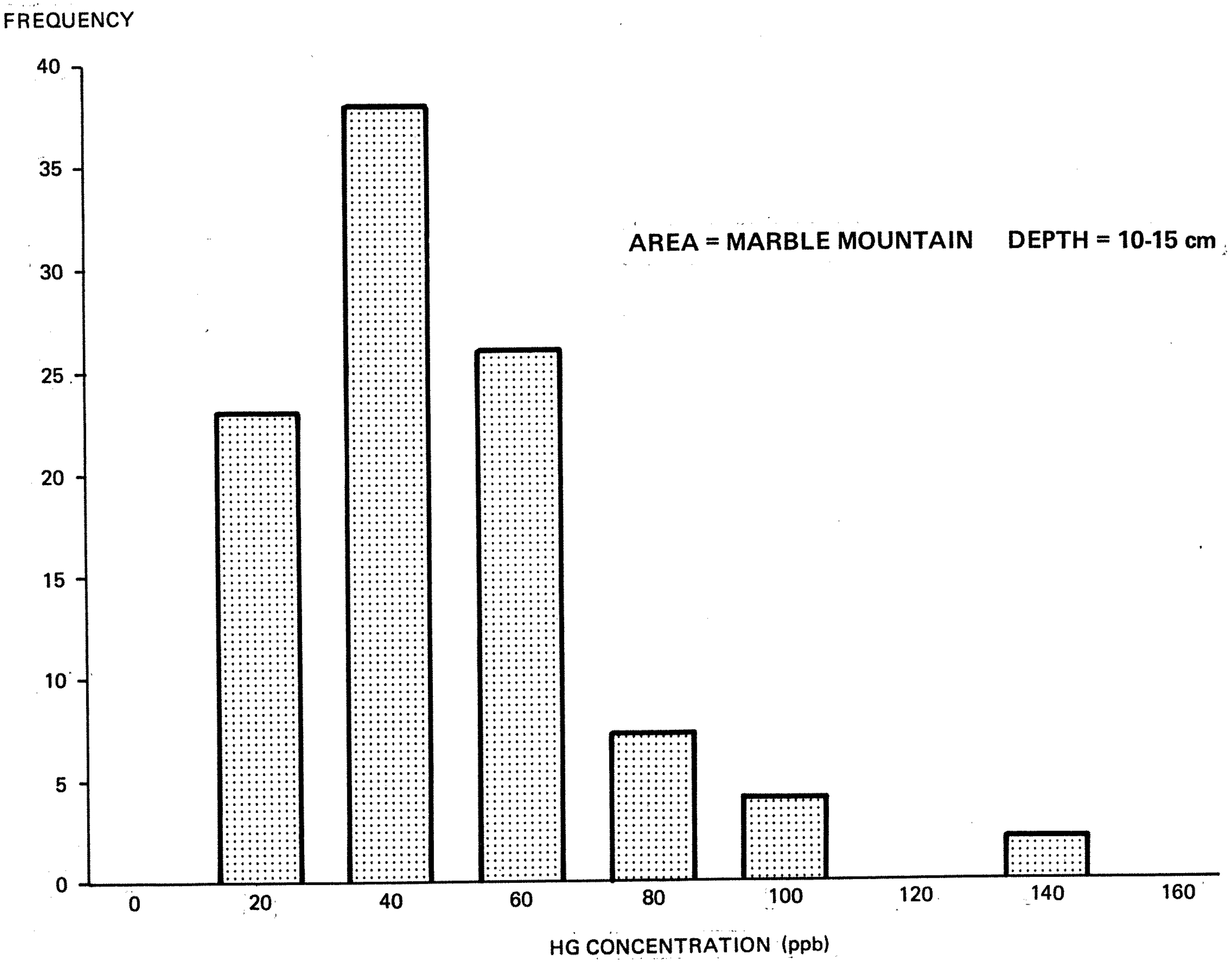
| AREA | NUMBER | MINIMUM VALUE | MAXIMUM VALUE | RANGE | MEAN | STANDARD DEVIATION | STD ERROR OF MEAN | COEFFICIENTS OF VARIATION |
|---|---|---|---|---|---|---|---|---|
| Marble Mtn. Depth = 10-15 | 101 | 18.00 | 144.00 | 126.00 | 48.25 | 24.09 | 2.39 | 49.93 |
| Marble Mtn. Depth = 20-25 | 1 | 47.00 | 47.00 | 0 | 47.00 | | | |
| Seaquest State Park Depth = 05-10 | 2 | 165.00 | 175.00 | 10.0 | 170.00 | 7.07 | 5.00 | 4.15 |
| Seaquest State Park Depth = 10-15 | 8 | 28.00 | 125.00 | 97.00 | 63.12 | 32.17 | 11.37 | 50.97 |
| Soda Springs Depth = 00-05 | 12 | 13.00 | 103.00 | 90.00 | 59.50 | 30.33 | 8.75 | 50.99 |
| Soda Springs Depth = 05-10 | 37 | 11.00 | 149.00 | 138.00 | 68.18 | 31.61 | 5.19 | 46.36 |
| Soda Springs Depth = 10-15 | 118 | 12.00 | 211.00 | 199.00 | 60.47 | 27.66 | 2.54 | 45.75 |



Appendix B - Frequency bar chart for Soda Springs area; depth interval 5-10 cm.



Appendix B cont. - Frequency bar chart for Soda Springs area; depth interval 10-15 cm.



**Appendix B cont. - Frequency bar chart for Marble Mountain area; depth interval 10-15 cm.**

# APPENDIX C

## TABLE C-1.

## MERCURY SURVEY, SOUTHERN CASCADES, WASHINGTON

SAMPLING AREA = SODA SPRINGS

SAMPLE DEPTH (CM)=00-05

| SAMPLE NUMBER | MERCURY CONCENTRATION (PPB) |
|---|---|
| 3 | 17 |
| 8 | 59 |
| 9 | 103 |
| 12 | 90 |
| 15 | 74 |
| 20 | 63 |
| 21 | 83 |
| 26 | 92 |
| 33 | 13 |
| 83 | 36 |
| 93 | 55 |
| 151 | 29 |

# APPENDIX C

## TABLE C-2.

## MERCURY SURVEY, SOUTHERN CASCADES, WASHINGTON

SAMPLING AREA = SODA SPRINGS    SAMPLE DEPTH (CM)=05-10

| SAMPLE NUMBER | MERCURY CONCENTRATION (PPB) |
|---|---|
| 1 | 54 |
| 4 | 62 |
| 6 | 140 |
| 10 | 109 |
| 13 | 78 |
| 16 | 149 |
| 19 | 57 |
| 22 | 98 |
| 24 | 65 |
| 27 | 93 |
| 29 | 66 |
| 32 | 66 |
| 35 | 94 |
| 37 | 70 |
| 39 | 38 |
| 41 | 11 |
| 42 | 29 |
| 44 | 69 |
| 46 | 58 |
| 48 | 46 |
| 50 | 80 |
| 52 | 53 |
| 54 | 100 |
| 56 | 67 |
| 59 | 58 |
| 60 | 43 |
| 62 | 36 |
| 64 | 75 |
| 66 | 57 |
| 68 | 75 |
| 70 | 47 |
| 72 | 19 |
| 75 | 44 |
| 76 | 99 |
| 77 | 87 |
| 79 | 13 |
| 92 | 118 |

# APPENDIX C

## TABLE C-3.

## MERCURY SURVEY, SOUTHERN CASCADES, WASHINGTON

SAMPLING AREA = SODA SPRINGS SAMPLE DEPTH (CM)=10-15

| SAMPLE NUMBER | MERCURY CONCENTRATION (PPB) |
|---|---|
| 2 | 55 |
| 5 | 107 |
| 7 | 99 |
| 11 | 97 |
| 14 | 85 |
| 17 | 85 |
| 18 | 71 |
| 23 | 156 |
| 25 | 84 |
| 28 | 54 |
| 30 | 67 |
| 31 | 76 |
| 34 | 65 |
| 36 | 124 |
| 38 | 105 |
| 40 | 37 |
| 43 | 32 |
| 45 | 62 |
| 47 | 68 |
| 49 | 42 |
| 51 | 66 |
| 53 | 67 |
| 55 | 60 |
| 57 | 75 |
| 58 | 74 |
| 61 | 40 |
| 63 | 40 |
| 65 | 65 |
| 67 | 60 |
| 69 | 80 |
| 71 | 40 |
| 73 | 12 |
| 74 | 53 |
| 78 | 211 |
| 80 | 22 |
| 81 | 79 |
| 82 | 55 |
| 84 | 30 |
| 85 | 75 |
| 86 | 55 |
| 87 | 56 |
| 88 | 38 |
| 89 | 54 |

## TABLE C-3. (CONT'D)

## MERCURY SURVEY, SOUTHERN CASCADES, WASHINGTON

SAMPLING AREA = SODA SPRINGS SAMPLE DEPTH (CM)=10-15

| SAMPLE NUMBER | MERCURY CONCENTRATION (PPB) |
|---|---|
| 90 | 83 |
| 91 | 55 |
| 94 | 103 |
| 95 | 50 |
| 96 | 53 |
| 97 | 26 |
| 98 | 17 |
| 99 | 46 |
| 100 | 55 |
| 101 | 86 |
| 102 | 42 |
| 103 | 30 |
| 104 | 40 |
| 105 | 37 |
| 106 | 48 |
| 107 | 57 |
| 108 | 80 |
| 109 | 68 |
| 110 | 95 |
| 111 | 54 |
| 112 | 56 |
| 113 | 38 |
| 114 | 62 |
| 115 | 50 |
| 127 | 30 |
| 128 | 40 |
| 129 | 58 |
| 130 | 91 |
| 131 | 30 |
| 132 | 37 |
| 133 | 22 |
| 134 | 44 |
| 135 | 82 |
| 136 | 46 |
| 137 | 53 |
| 138 | 51 |
| 139 | 30 |
| 140 | 57 |
| 141 | 39 |
| 142 | 46 |
| 143 | 45 |
| 144 | 39 |
| 145 | 123 |

## TABLE C-3. (CONT'D)

## MERCURY SURVEY, SOUTHERN CASCADES, WASHINGTON

SAMPLING AREA = SODA SPRINGS SAMPLE DEPTH (CM)=10-15

| SAMPLE NUMBER | MERCURY CONCENTRATION (PPB) |
|---|---|
| 146 | 44 |
| 147 | 46 |
| 148 | 42 |
| 149 | 54 |
| 150 | 41 |
| 152 | 74 |
| 153 | 41 |
| 154 | 26 |
| 155 | 62 |
| 157 | 40 |
| 260 | 57 |
| 261 | 52 |
| 262 | 42 |
| 263 | 91 |
| 264 | 79 |
| 265 | 70 |
| 266 | 63 |
| 267 | 52 |
| 268 | 56 |
| 269 | 73 |
| 270 | 52 |
| 271 | 56 |
| 272 | 40 |
| 273 | 43 |
| 274 | 84 |
| 275 | 26 |
| 276 | 97 |
| 277 | 83 |
| 278 | 52 |
| 279 | 84 |
| 280 | 61 |
| 281 | 81 |

# APPENDIX C

## TABLE C-4.

## MERCURY SURVEY, SOUTHERN CASCADES, WASHINGTON

SAMPLING AREA = MARBLE MOUNTAIN SAMPLE DEPTH (CM)=10-15

| SAMPLE NUMBER | MERCURY CONCENTRATION (PPB) |
|---|---|
| 158 | 70 |
| 159 | 26 |
| 160 | 18 |
| 161 | 54 |
| 162 | 34 |
| 163 | 43 |
| 164 | 60 |
| 165 | 60 |
| 166 | 32 |
| 167 | 20 |
| 168 | 57 |
| 169 | 59 |
| 170 | 33 |
| 171 | 38 |
| 172 | 20 |
| 173 | 22 |
| 174 | 36 |
| 175 | 20 |
| 176 | 87 |
| 177 | 37 |
| 178 | 40 |
| 179 | 55 |
| 180 | 35 |
| 181 | 73 |
| 182 | 22 |
| 183 | 55 |
| 184 | 108 |
| 185 | 21 |
| 186 | 32 |
| 187 | 44 |
| 188 | 18 |
| 189 | 30 |
| 190 | 138 |
| 191 | 24 |
| 192 | 68 |
| 193 | 18 |
| 194 | 62 |
| 195 | 20 |
| 196 | 38 |
| 197 | 40 |
| 198 | 30 |
| 199 | 49 |
| 200 | 72 |
| 201 | 46 |
| 202 | 55 |

## TABLE C-4. (CONT'D)

## MERCURY SURVEY, SOUTHERN CASCADES, WASHINGTON

SAMPLING AREA = MARBLE MOUNTAIN SAMPLE DEPTH (CM)=10-15

| SAMPLE NUMBER | MERCURY CONCENTRATION (PPB) |
|---|---|
| 204 | 53 |
| 205 | 67 |
| 206 | 69 |
| 207 | 99 |
| 208 | 94 |
| 209 | 144 |
| 210 | 43 |
| 211 | 47 |
| 212 | 78 |
| 213 | 23 |
| 214 | 61 |
| 215 | 42 |
| 216 | 109 |
| 217 | 78 |
| 218 | 51 |
| 219 | 79 |
| 220 | 50 |
| 221 | 37 |
| 222 | 36 |
| 223 | 42 |
| 224 | 19 |
| 225 | 60 |
| 226 | 30 |
| 227 | 71 |
| 228 | 41 |
| 229 | 63 |
| 230 | 40 |
| 231 | 40 |
| 232 | 50 |
| 233 | 70 |
| 234 | 46 |
| 235 | 51 |
| 236 | 62 |
| 237 | 51 |
| 238 | 47 |
| 239 | 72 |
| 240 | 33 |
| 241 | 47 |
| 242 | 24 |
| 243 | 40 |
| 244 | 51 |
| 245 | 31 |

## APPENDIX C

## TABLE C-4. (CONT'D)

## MERCURY SURVEY, SOUTHERN CASCADES, WASHINGTON

SAMPLING AREA = MARBLE MOUNTAIN SAMPLE DEPTH (CM)=10-15

| SAMPLE NUMBER | MERCURY CONCENTRATION |
|---|---|
| 246 | 56 |
| 247 | 40 |
| 248 | 28 |
| 249 | 32 |
| 250 | 38 |
| 251 | 55 |
| 252 | 38 |
| 253 | 25 |
| 254 | 25 |
| 255 | 30 |
| 256 | 26 |
| 257 | 33 |
| 258 | 32 |
| 259 | 56 |