STATUS OF BASELINE SAMPLING FOR ELEMENTS IN SOIL AND VEGETATION AT FOUR KGRA'S IN THE IMPERIAL VALLEY, CALIFORNIA

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ABSTRACT

The EPA's Environmental Monitoring and Support Laboratory in Las Vegas, Nevada, is participating in a major geothermal baseline study of the Imperial Valley in California. Statistically based sampling designs have been developed for monitoring elemental levels in soils and crops at the San Diego Gas and Electric/U.S. Energy Research and Development (SDGE/ERDA) Administration Test Facility at the Salton Sea and the Known Geothermal Resource Areas at Heber, North Brawley and East Mesa. Samples have been collected at all locations. Analyses of samples collected around the SDGE/ERDA test facility indicate that there are no significant differences in soil residue levels of lithium and manganese between the 50 sites. However, there are significant differences between sites for zinc.

INTRODUCTION

The U.S. Environmental Protection Agency's (EPA) Environmental Monitoring and Support Laboratory in Las Vegas (EMSL-LV) is cooperating with the U.S. Energy Research and Development Administration (ERDA) and the Lawrence Livermore Laboratory (LLL) in the Imperial Valley Environmental Project. The EMSL-LV portion of the study, is to characterize the background levels of elements in soils and crops at certain site-specific locations. The geothermal areas currently under study in the Imperial Valley are the San Diego Gas and Electric (SDGE)/ERDA test facility near the Salton Sea, and the Known Geothermal Resource Areas (KGRA) located near North Brawley, Heber, and East Mesa in California.

The baseline data will be used to detect any existing elemental distribution patterns and for comparison with post-geothermal development data. There should be no detectable elemental accumulation by plant and soils attributable to geothermal development. Reinjection of the brine and other engineering designs will reduce the potential for environmental contamination, but verification is needed.

SAMPLING DESIGNS

Three of the areas being investigated, North Brawley, Heber, and the SDGE/ERDA facility, are located in areas of intensive agricultural development. The cropping patterns in these areas are symmetric, with fields being multiples of one quarter-mile-square blocks (40 acres). These blocks were designated as sites and serve as the basic sampling unit for the agricultural areas. To obtain a statistical sample the sites were divided into four quadrats, with two diagonally arranged quadrats usually being sampled. Each sample is a composite of 16 subsamples collected on a 4 x 4 grid.

At the SDGE/ERDA geothermal facility, there are 50 sites, all within a one-mile radius of the power plant (less turbine), as shown in Figure 1. During the initial sampling, all four quadrats of each site were sampled, but, based on preliminary analytical results, the design was changed so that only two diagonal quadrats are currently being sampled. Sampling was restricted to within one mile of the facility to obtain a statistically sensitive design in the area of maximum potential impact. Samples of soil and vegetation were collected prior to plant operation in February 1976 and again in December 1976.

At North Brawley, no power plant exists or is under construction, so the general area of geothermal drilling has been encompassed by the sampling design. The area sampled extends at least one-half mile from all five Union Oil Company wells. The proposed 10 megawatt (MW) power plant would probably be constructed well within the sampling grid. Samples were collected at 55 sites in December 1976.

The Geothermal Resource area at Heber is considerably larger than at North Brawley. The eight geothermal wells are located at least one-half mile within the sampling grid as shown in Figure 3, but due to the size of the area encompassed, only alternate sites are being sampled. If and when the proposed 50 MW power plant is built, additional sampling may be necessary. Vegetation and soil samples were collected in January 1977.

The East Mesa KGRA is situated in a creosote bush plant community just east of the cultivated land in the Imperial Valley. The sampling design was not restricted by the agricultural land-use patterns as at the other sites so an entirely different scheme was employed.

There are three areas of interest at East Mesa: the Bureau of Reclamation (BuRec) desalinization and test facility, the Republic Geothermal proposed 50 MW power plant site to the north and Magma Power Company's proposed 10 MW power plant site to the south. These points serve as the centers for radial sampling grids composed of four geometrically spaced, concentric circles with radii of 200, 400, 800, and 1,600 meters as shown in Figures 4 and 5. The sampling sites are located at the junctures of the circles and four evenly spaced radii. At each site, two soil and vegetation samples are collected. The samples are composites of nine subsamples collected from a 3-square by 3-square grid with 10-meter squares. Creosote bush was the only kind of vegetation collected at East Mesa. Samples were collected in January and February 1977.

The soil subsamples (surface 0-3 cm) were collected by trowel, composited in a plastic bag lined bucket, mixed, and an aliquot placed in a pint-sized glass jar. Vegetation samples were usually collected in pint-sized plastic mason jars. The samples were oven dried at 60^{o} C. The soil samples were pulverized in a grinder equipped with ceramic plates which effectively mixed the samples and destroyed the soil structure. The particle size of the agricultural soils is probably not reduced since the grinder is only capable of reducing particle size to about 149 μm (100-mesh). Sixty-five percent of one ground sample from the SDGE/ERDA area pass a 400-mesh screen (<37 μm) upon wet sieving. The East Mesa soil samples were sieved to 10-mesh (2 mm) prior to grinding. The vegetation samples were usually ground with a blender in the same jar in which they were collected and dried.

SAMPLE ANALYSES

An idealized list of elements to be monitored at each site can be drafted. Elements to be monitored should be relatively concentrated in the geothermal fluid as compared to the media being sampled and irrigation waters. Thus, a small amount of contamination would result in a more easily detectable change of the elemental concentration of the sample.

There is no need to compile a master list of elements for all KGRAs since each KGRA is distinct both geographically and chemically. The elements of particular interest at the Salton Sea KGRA are antimony, boron, barium, cadmium, cesium, copper, lead, lithium, manganese, nickel, sodium, strontium, and zinc. The resources required to determine all of these elements in each sample would be unduly large.

As an alternative, we propose to analyze the samples by x-ray fluorescence. Unfortunately, not all the elements listed above can be determined by x-ray fluorescence, but the resulting multi-elemental data should indicate whether geothermal contamination has taken place. If contamination is detected or suspected, the library of baseline samples can be reanalyzed for specific elements.

Some analyses have been completed on the soil samples collected around the SDGE/ERDA facility in February 1976. Five samples were analyzed for a broad spectrum of elements by EPA's Environmental Research Laboratory in Athens, Georgia, using instrumental neutron activation analysis. The results of these analyses were published in the proceedings of the Geothermal Environmental Symposium-1976 which was held at Clearlake, California. These data indicate that the soil around the geothermal facility is quite homogenous relative to elemental concentrations.

Additional preliminary data have now been compiled. One hundred and ninety-six soil samples have been acid extracted and analyzed by atomic absorption spectrometry. Twenty-five milliliters (ml) of concentrated nitric acid were added to 10 grams of oven-dried soil in a 125-ml Erlenmeyer flask. The samples were boiled under reflux for seventeen hours. The soil was separated from the supernate by centrifugation or filtration and washed three times with distilled deionized water. The supernate and washes were combined in a volumetric flask and diluted to 100 ml. The extracts were analyzed for several elements using a Perkin-Elmer Model 603 Atomic Absorption Spectrophotometer although reliable information was only obtained for lithium, manganese, and zinc.

All sample extracts, distilled water blanks, acid blanks, standards, and spike standards were analyzed in duplicate. For each element, determinations were made on 200 soil extracts, over 30 distilled water blanks, 10 acid blanks, 23 standards at three different dilution levels, 15 spiked samples and 20 duplicate soil extracts.

The data generated indicate basically no differences between the refluxed acid blanks and the distilled water blanks. The data have been corrected for recovery of the standards but not for spike recovery. The mean residue levels for lithium, manganese, and zinc at each site are presented in Figure 6 as well as the ranges and standard deviations. The average recoveries of spiked samples for lithium, manganese, and zinc were 100, 96, and 87 percent, respectively.

A one-way analysis of variance (AOV) was performed to determine whether significant differences exist between the 50 sites. The data used for the AOV were the mean sample residue levels as determined from duplicate analyses of the same extract. The resultant F ratios of 1.16 and 1.11, for lithium and manganese, respectively, with 49 and 146 degrees of freedom are not statistically significant at the 95 percent confidence level. However, the F ratio of 1.45 for zinc is marginally significant. These data, therefore, indicate no significant differences between sites for residues of lithium and manganese although differences do exist for zinc at the 95 percent confidence level.

CONCLUSION

The four principal KGRA's in the Imperial Valley are being examined to establish baseline levels of elements in soil and vegetation. The sampling plants have been made and the first set of samples has been collected. Soil residue data from around the SDGE/ERDA facility indicate that elements are distributed quite evenly. Samples will be collected on a semi-annual or annual basis and the residue levels will be compared with the baseline data.

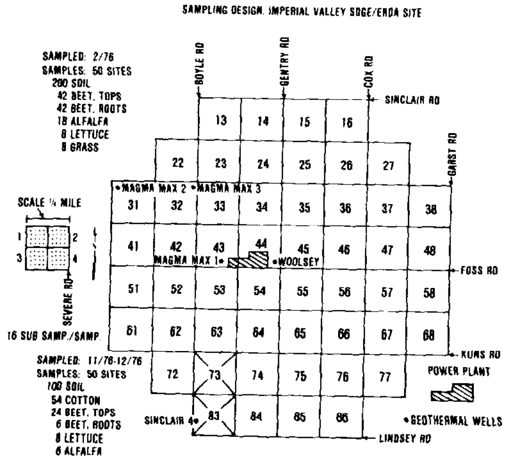

FIG. 1

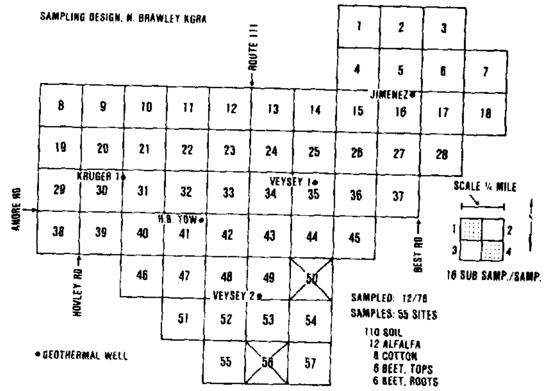

FIG. 2

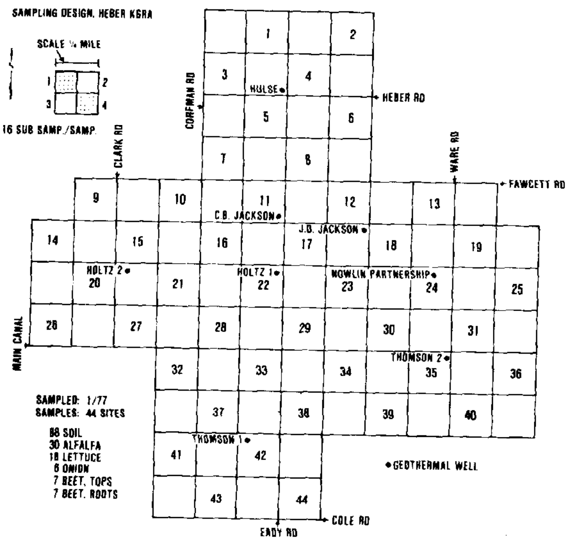

FIG. 3

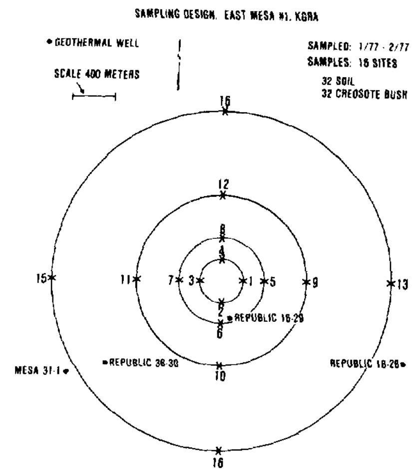

FIG. 4

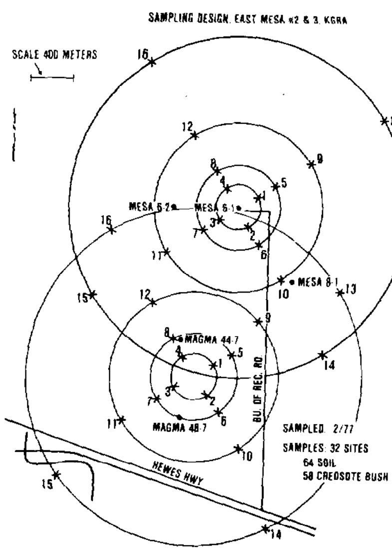

FIG. 5

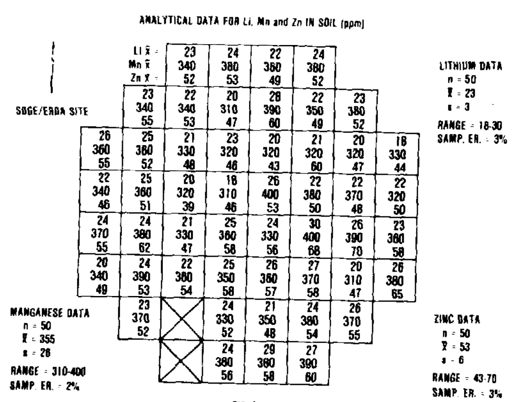

FIG. 6