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ERDA CONTRACT EY-76-C-03-0012

**BASELINE STUDIES IN THE DESERT ECOSYSTEM AT
EAST MESA GEOTHERMAL TEST SITE
IMPERIAL VALLEY, CALIFORNIA**

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IMPERIAL VALLEY, CALIFORNIA

By

E. M. Romney, A. Wallace, O. R. Lunt,
T. A. Ackerman and J. E. Kinnear

SEPTEMBER 1977

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**E. M. Romney, A. Wallace, O. R. Lunt, T. A. Ackerman,
and Jean E. Kinnear**

ABSTRACT

The Environmental Biology Division was invited to undertake baseline studies in support of geothermal development activities at the East Mesa KGRA in October 1975, as part of the Imperial Valley Environmental Project developed for the Energy Research and Development Administration by Lawrence Livermore Laboratory.

Baseline data reported herein for soil, vegetation, and small mammal components of the East Mesa desert ecosystem represent a collection period from October 1975 to September 1977. Inasmuch as changes in salt balance from geothermal brine sources are of potential impact upon the ecosystem, considerable analytical effort was given to the determination of element constituents in soil, plant, and animal samples. A preliminary synthesis of data was done to investigate the heterogeneity of element constituents among the sampled population and to summarize results. Findings indicate that periodic sampling and chemical analysis of vegetation around an industrialized geothermal energy source is probably the best way to monitor the surrounding ecosystem for assuring containment of any resource pollutants.

INTRODUCTION

The geothermal development program underway at East Mesa KGRA involves activities designed to determine the technological feasibility and to subsequently install desalinization facilities for reclaiming water. Plans also include the eventual development of an electric power generating system utilizing the geothermal energy resource. Such an industrial complex would involve heat source input from several different wells feeding a central system through transmission pipelines up to two kilometers in length. When fully developed the environmental insult would include installation of wellhead sites, transmission pipelines, service roadways, power generating station and support facilities, cooling tower installations and power transmission lines. The ecological impact could be so severe that the site would be an ecosystem write-off for all practical purposes. Philosophy of industrial development acknowledges that certain site-specific land areas will be sacrificed from their natural conditions. This loss is recognized as a necessary tradeoff for the benefits of energy production.

Site Development Perturbation

Within the confines of the industrialized complex, the ecosystem components would be insulted by noise and physical disturbance from plant operation and vehicle traffic. Grading and land manipulation to accommodate roadways and pipelines, wellhead operations, and plant installations would destroy the natural vegetation and edaphic features. Surviving fauna would leave the disturbed habitat and move out to the undisturbed surroundings. Restoration of some vegetation for aesthetic purposes probably would occur within the site, and it is probable that some of the native fauna would return to sites which could supply necessary

food and shelter within the industrialized area.

Impact Upon the Surrounding Environment

Ideally, management should strive to minimize deterioration or destruction within the natural ecosystem surrounding the industrialized area. Noise is not expected to be a problem except from vehicle traffic along access roadways. Indiscriminant off-road vehicle movement should be prevented along with any other unnecessary mechanical activity that would disturb natural vegetation and soil. Insults from accidental and controlled brine releases could extend out to uncertain or undetermined distances into the undisturbed ecosystem. There could be off-site erosion and resuspension of salt particulate material from local brine spills unless they are immediately cleaned up or covered over. In the latter case groundwater supplies may be affected if brine is not removed. The main problems foreseen for the surrounding ecosystem are those resulting from deposition of fallout materials such as noncondensable gases, toxic metals, and salt particles emanating from brine holding ponds and cooling tower installations.

Baseline Study Requirements

The extent to which such effects will result from geothermal resource development at East Mesa can best be ascertained from comparison to baseline ecological data characterizing the undisturbed ecosystem. Baseline studies involving soils as well as prominent vegetation and animal species are essential for establishing reference data from a given point in time. A thorough chemical analysis of such kinds of ecosystem component samples is necessary for delineation of future salt imbalance and toxic element pollution problems.

Plants, animals, and microorganisms of the East Mesa area live

together in a system integrated by a complex network of biotic interactions. Hence, the environmental insults resulting from geothermal development will affect the components directly by toxic and noise effects, and indirectly by altering the structure of the communities in which they are enmeshed. The changes likely to take place through both direct and indirect effects are most readily documented by measuring changes in community structure and composition over time. If such measurements were made at selected points surrounding the industrialized area, at points downwind from the plant installation, and at nearby control areas, it should be possible over a period of time to document the changes affected by the development and operation of the geothermal resource. By taking such measurements over at least a two-year period in both likely-to-be-impacted areas as well as nonimpacted control areas, the study could provide baseline data from which any divergence over time between the impacted and control communities could be measured. An argument can be made that longer study periods would be required to obtain unquestionable baseline data for the more mobile animal species. For this reason along with limited budget and time constraints, first priority of the work reported herein was given to soil and vegetation, and to rodent species which occupy a relatively small home range.

STUDY SITE CHARACTERISTICS

The UCLA group was invited to undertake baseline studies at East Mesa KGRA in October 1975 as part of the Imperial Valley Environmental Project developed for the Energy Research and Development Administration by Lawrence Livermore Laboratory. This was done by reprogramming field research activities to East Mesa primarily during the period of December through March in which most of the new annual primary production and

associated animal activity occurs. A study period from October 1975 to September 1977 is represented by this report.

General Description of the East Mesa Area

The East Mesa KGRA is located in the southeastern sector of the Imperial Valley about 160 km east of San Diego. This area was occupied by lakes during Pleistocene time and the old shoreline of prehistoric Lake Cahuilla passes across the East Mesa area. The Imperial Valley is a sediment-filled structural trough comprised primarily of deltaic deposits of the Colorado River and some scattered lake bed and marine deposits.

The climate of the area is arid, with hot, dry summers and mild winters. Precipitation, averaging less than 8 cm annually, comes largely in the fall and winter months. Temperatures exceeding 38°C occur more than 100 days each year. Frost seldom occurs and there is little fog. Winds vary from light to strong usually from west and northwesterly directions.

Surface soils are derived primarily from windblown alluvium materials. Most of them are sandy and unstable, except where stabilized by vegetation. On the extreme western edge of the East Mesa KGRA lies about 15 km² of land suitable for agriculture. Citrus orchards and fallow grain fields presently occupy most of this arable land.

In the East Mesa KGRA the land surface exposures are alluviums of Holocene age with scattered sand dunes on the surface. The surficial deposits probably are underlain by deltaic and marine deposits. The materials encountered when test well 6-1 was drilled were sandy and deltaic to a depth of about 7,000 feet (2134 meters). Below that depth, dense, altered silica-cemented rocks were found (U.S. Department of the Interior, 1973a).

The East Mesa KGRA occupies some 150 km². Two natural types of vegetation communities lie within this area. The following descriptions of them, and their associated wildlife, are taken from the Final Environmental statement for the Geothermal Leasing Program, Volume 2 (U.S. Department of the Interior, 1973b):

"Creosote Community. The creosote community occupies about 50 percent of the land surface of the East Mesa KGRA. Although the type may vary somewhat from site to site, the species composition is the same throughout. Major shrub species include creosote bush¹, Ephedra, cheese bush, brittle bush and coldenia. Creosote is by far the major species, comprising over 90 percent of the total composition, and offering a large desert shrub aspect. Other species, including low growing ephemeral forbs and grasses are only seasonal, but do play a significant role within the total biological complex.

Herbaceous vegetation falls into two basic groups - winter and summer ephemerals. These two groups respond not only to specific moisture conditions, but also to fairly finite temperatures. Cooler temperatures of winter and associated rainstorms result in the germination and growth of flowering plants varying widely both in color and character. Such species as spectacle-pod, desert gold, brown-eyed primrose, dune primrose, plantago and cryptantha are common under these climatic conditions. Other forbs may also be found, but generally occur less frequently. Of special significance is the desert lily, a species considered rare throughout much of its distribution; however, this species is more common in the Glamis dunes area located further north."

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¹Names are given as they appear in the reference quoted.

"Summer ephemerals are restricted to a handful of species including sandmat, gramma, and a few mustards. Those plants, both summer and winter forbs, which are not utilized for food or nest material by the local fauna, persist for some time as dead herbage on the ground surface, and actually assist in holding sandy soil in place."

"Dunes community: The sand dunes community within this KGRA occupies about 40 percent of the land area and offers an aspect ranging from low shrub to barren land. These dunes are less active and dramatic than those to the north near Glamis. Creosote, the major shrub species, has a density of less than 100 plants per acre throughout most of the community, and normally density is less than 25 plants per acre. There has been nothing of special botanical significance identified with this community within the East Mesa KGRA."

"Wildlife: Due to fairly uniform characteristics of the associated habitats within the East Mesa KGRA, a wide variety of wildlife species does not occur. However, there is an abundance of those species which have taken up residence and also of those migrant species which utilize the area during winter months. Among the known residents, ground squirrels, mice, kangaroo rats, occasional kit fox, coyote, badger and bobcat comprise the majority of mammal species. None of these, however, are of particular significance although all are important in maintaining the existing biological complex."

"Reptiles are well represented, with over 20 species recorded as inhabiting the area. The more significant species include the western diamond back rattlesnake (rarely seen), flat-tailed horned lizard, desert horned lizard, zebra-tailed lizard, western collared lizard,

long-nosed leopard lizard, western chuckwalla, and the desert iguana. These species are considered as being threatened throughout much of their natural distribution. Current information indicates, however, that populations of certain of these species appear to be considerably higher than previously reported. The desert iguana and western chuckwalla are two species which appear to be on the increase within this area."

"Over 30 species of birds have been identified in the area. Many of these are winter migrants using the area for just a few months during the winter season. Resident birds include the roadrunner and LeConte's Thrasher which can be found over much of the area. No other significant species have been identified at this time."

"Invertebrates are also well represented within this area. Over 50 species have been identified, and many are believed to be endemic. Of special interest is the possibility that 10 varieties of scorpions are residents of East Mesa, and nearly 30 species of beetles may be found. Most insects inhabiting the area are nocturnal and cannot be observed during daylight hours. However, during early hours of the morning and before sands begin to move, signs of the previous night's activity can be interpreted from the surface patterns. Over half of the invertebrates found within the area are expected to be endemic to eastern Imperial County, California."

Disturbed Site Characteristics

The Bureau of Reclamation test complex area within the East Mesa KGRA (Fig. 1) is dominated by an unstable sand dune formation overlying alluvium materials which are occasionally exposed. Vegetation and associated animal activity generally occur in isolated shrub clumps

● Well

■ Study plot

— Sampling line

Fig. 1. UCLA baseline study site locations within the environs of the U. S. Department of the Interior, Bureau of Reclamation, Geothermal test complex at East Mesa KGRA, Imperial Valley, California.

Fig. 2. Giant growth forms of Larrea tridentata occur at East Mesa KGRA in areas receiving underground seepage water from the East Highland irrigation canal.

around which the sand dunes become partially stabilized. The dominant perennial shrub is creosote (Larrea tridentata) which displays some strikingly unique size aspects within the study area. Elevation varies from about 7 to 25 meters (MSL) within the presently developed site. Drainage is generally from east to west. The East Highline irrigation canal traverses the west side of the KGRA imposing a striking impact upon the desert ecosystem. A saline marshland with standing water during winter months occupies the southwest corner of section 6. Section 31 and its neighboring section north (Section 30) has been markedly influenced by canal seepage water which has extended eastward through clay and silt lenses in the alluvium material underneath the sand dune formations. This has resulted in the development of giant forms of Larrea tridentata shrubs at locations where the underlying soil does not experience seasonal moisture stress (Fig. 2). The giant growth form of the creosote bush extends over part of the northwestern sector of section 6 and nearly all of section 31. There is, however, a gradation in shrub size from west to east across the KGRA, decreasing to size classes more common to the Colorado Desert on most of the eastern half of the area developed by the Bureau of Reclamation (Fig. 3). Community functions and structural differences between the giant and normal-sized Larrea populations are of ecological interest for continuing investigation by our group at UCLA aside from the baseline studies reported herein.

EXPERIMENTAL DESCRIPTION AND METHODS

The sites chosen for investigation lie within the confines of an area under development by the U. S. Department of Interior, Bureau of Reclamation (Fig. 1). Four production wells (31-1, 6-1, 6-2, 8-1), one injection well (5-1) access roadways, brine holding ponds, and a test

pad complex with support facilities, had already been developed before this work began. Consequently, the baseline data obtained from the immediate environs near the wellhead sites during the winter months of 1975-76 would include any impact from earlier drilling and site development. It was decided, therefore, to establish three baseline study plots (32-1, 7-2, and 8-2) during the winter months of 1976-77 at nonimpacted areas some distance from these developed sites, but generally oriented downwind from the main industrial complex. Several additional sampling transect lines also were positioned at sites generally located east and southeast of the main test pad complex (Fig. 1). More details of study plot and transect layout, location, and sampling activities are given in the Appendix.

The locations of belt transects within each study plot and the locations of various points from which soil and vegetation samples were collected were selected at random. The plot and transect configurations were marked with steel fenceposts at 50 meter intervals. Field notes maintained at UCLA will enable one to reconstruct the study sites for future resampling when desired.

Density and cover estimates of shrubs in the study plots were made by the belt transect method and biomass was estimated by nondestructive measurement methods (Wallace et al., 1972; Romney et al., 1973). Ten baseline soil and vegetation samples were collected randomly from each study site. These consisted of about 200 grams of plant tissue from shrubs and 5 kilograms of 0-5 cm surface soil.

An additional 50 random samples of Larrea tridentata and Plantago insularis were collected from plots 32-1, 7-2, and 8-2 in order to determine the baseline heterogeneity of mineral element distribution

within the 200 X 400 meter sampling area. The same number of random alfalfa (Medicago sativa) and sugar beet (Beta vulgaris) samples were collected from areas of similar size in two nearby agricultural fields in order to compare the heterogeneity of elements in plant tissues grown on natural and cultivated soils.

The winter and spring months of 1975-76 represented normal conditions in the East Mesa ecosystem with average moisture input. The same season during 1976-77, however, represented an extreme in favorable primary production as the result of abnormally high rainfall from hurricane Cathleen in September 1976. Response of the ephemeral plant species during this second season of study provided unique opportunity to observe the system during a season of peak biomass. Figures 3 and 4 illustrate the difference in ground cover during the two years of study. In addition to determining density and biomass of winter annuals, a number of different species were sampled randomly for chemical analysis.

An opportunity also was provided during the spring of 1977 to stake out over a thousand new seedlings of Larrea tridentata for continuing investigation of "pulse input" and seedling survival. We have observed that the development of new shrubs in the giant Larrea community where there is less moisture stress, stems significantly from crown sprouting on exposed lateral roots of established shrubs (Fig. 5). On the other hand, community regeneration appears to depend more upon pulse input from new seedling development in the normal-sized Larrea communities which are not influenced by seepage from the East Highland canal.

Fig. 3. Normal size stands of Larrea tridentata cover most of the East Mesa KGRA. These shrub forms seldom grow much larger than 1 meter in any direction. Photo was taken in February 1976.

Fig. 4. Heavy rains from Hurricane Cathleen in September 1977, resulted in heavy ground cover of annual plant species compared to the previous year (Fig. 3). Photo was taken in Feb. 1977.

Fig. 5. Crown sprouting from roots of Larrea tridentata exposed by wind removal of surface soil is common at the East Mesa KGRA. In this photo some additional soil has been removed to better show the main root structure.

A rodent trapping grid consisting of four lines of 25 traps positioned 15 meters apart was superimposed upon selected plots. Trapping was done for three consecutive nights to compare different areas once in the spring of 1976 and again in 1977. Relative densities of different species between plots were obtained, but the method does not provide sufficient data for actual density or population estimates. (Budget restrictions curtailed more extensive trapping effort.) On the last nights of capture, ten random samples were sacrificed for chemical analysis in order to obtain a salt balance baseline for the two prominent kangaroo rat species, Dipodomys deserti and D. merriami.

Soil samples were air dried and screened through a 2 mm sieve in preparation for determining pH and conductivity (USDA Salinity Laboratory Staff, 1954). Elemental composition was determined on a few representative samples of soil by neutron activation analysis performed by Lawrence Livermore Laboratory. Extractable salt contents were determined in 2 N HCl extracts of these same few samples using atomic absorption spectrometry (Bradford et al., 1975). Work is underway to determine the extractable salt contents of all soil samples collected using induction-coupled plasma spectrometry. Plant tissue samples were oven dried at 70°C and pulverized to fine powder for analysis by optical emission spectrometry (Alexander et al., 1975).

Animal carcasses were frozen in dry ice when captured and then later thawed, skinned, and washed carefully before separating into organ and tissue parts (Lindberg et al., 1955). The samples were lyophilized and reduced to fine powder for analysis by optical emission spectrometry. Animal tissue analysis was by individual sample from the 1976 capture, but by pooled samples within each area in 1977 in order to obtain tissue

samples of sufficient size to store for later reference material.

Reference soil, plant, and animal samples are stored in a sample bank at UCLA. All baseline data and supportive information are transmitted to the IVEP computer data base at Lawrence Livermore Laboratory.

RESULTS AND DISCUSSION

Considerable analytical effort has been devoted to determining chemical element constituents in soil, plant and animal samples inasmuch as changes in salt balance from geothermal brine sources are of potential impact upon the East Mesa desert ecosystem. An example would be salt particles drifting downwind from cooling towers and evaporation ponds. Brine spills and subsequent resuspension of salt-laden dust would be another example. The data summarized herein, along with the raw data on file in the IVEP computer base at LLL, will serve as a baseline to which future site comparisons may be made to check on containment of salts from geothermal production sources.

Chemical Characteristics of Surface Soil At East Mesa Baseline Study Sites

The pH and conductivity measurements of surface soil samples collected from the baseline study plots are listed in Table 1. These soils are calcareous in nature exhibiting pH values generally ranging from 8 to 9. The surface materials probably have relatively short residence times at any given site before being moved elsewhere by wind action. Salinity levels were moderately low based upon conductivity levels which were surprisingly variable within and among the different sites sampled. The data showed no consistent pattern of difference in total salt content between what appeared to be more stable and less stable surface soil.

The composition of selected elements determined in 2 N HCl soil extracts by atomic absorption spectrometry is given in Table 2. We were

Table 1. pH and conductivity of 1:1 extracts of surface soil samples from East Mesa study plots.

Site No.	Sample No.	pH	EC ₂₅ mmhos/cm	Site No.	Sample No.	pH	EC ₂₅ mmhos/cm
31-1	8	9.99	3.4	6-2	14	9.46	0.91
	12		6.2		5	7.60	3.17
32-1	1	9.10	1.5	6-3	1	8.59	3.33
	2	9.17	0.9		2	8.89	2.13
	3	8.86	1.72		3	8.24	6.23
	4	8.97	0.76		4	9.43	1.15
	5	9.10	0.93		5	9.24	1.79
	6	9.04	2.29		6	8.99	2.04
	7	8.80	0.93		7	8.53	1.95
	8	9.00	0.83		8	8.51	2.39
	9	9.01	2.61		9	9.13	1.39
	10	8.88	0.91		10	8.82	1.56
5-1	10	9.17	2.4	6-4	1	9.29	1.32
	2	8.69	2.5		2	8.89	1.90
5-2	1	9.11	1.27		3	9.15	1.32
	2	8.90	0.87		4	9.02	1.90
	3	9.09	1.01		5	8.86	1.72
	4	9.23	1.02		6	8.69	2.07
	5	9.09	0.98		7	9.17	1.27
	6	9.05	1.03		8	9.03	1.47
	7	9.17	0.81		9	8.94	1.79
	8	9.21	1.08		10	9.09	3.86
	9	9.15	1.18	6-5	1		0.172
	10	8.92	1.92		2		0.270
5-3	1		0.098		3	7.92	0.204
	2	8.92	0.094		4		0.333
	3		0.083		5		0.125
	4	8.61	0.123		6		0.410
	5	8.85	0.077		7	8.66	0.182
	6		0.094		8	8.64	0.161
	7	8.91	0.100		9		0.286
	8	8.69	0.084		10	8.17	0.357
	9	8.70	0.103	7-1	1	9.06	1.28
	10	8.19	0.118		2	9.14	1.46
22-1	1	8.51	0.200		3	9.19	1.11
	2		0.200		4	9.20	0.96
	3	8.47	0.130		5	8.85	1.77
	4	8.39	0.154		6	8.95	1.02
	5		0.263				

Table 1 (Continued).

Site No	Sample No.	pH	EC ₂₅ mmhos/cm	Sample No.	Site No.	pH	EC ₂₅ mmhos/cm
	7	8.01	0.278		7	8.91	1.49
	8	8.42	0.413		8	8.91	1.08
	9	8.68	0.323		9	8.45	1.76
	10	8.52	0.342		10	8.42	1.63
8-1	1	8.83	3.3	7-2	1	8.10	0.09
	9	7.53	3.0		2	7.55	0.09
					3	8.13	0.11
8-2	1	8.92	0.82		4	7.80	0.12
	2	9.10	0.98		5	7.81	0.11
	3	8.62	3.92		6	7.68	0.13
	4	9.14	1.27		7	8.01	0.15
	5	9.03	3.51		8	8.25	0.07
	6	8.54	4.26		9	8.25	0.11
	7	9.17	0.91		10	7.98	0.11
	8	9.00	0.83				
	9	9.13	0.94				
	10	8.98	3.58				

especially interested in checking out the possibility of salt balance differences in soil underneath shrub clumps as compared to bare surface soil because of our findings of such differences elsewhere in the Mohave Desert ecosystem (Romney et al., 1973). Comparisons of data for the major salt contributors in samples from bare and shrub areas (Table 2) showed no significant differences to suggest salt buildup underneath shrub clumps at East Mesa. Furthermore, the element composition among and between samples from each site showed considerable uniformity, except for Na and Ca. Because of the high wind activity at East Mesa, the residence time of surface soil material deposited on these sites may be too short to permit salt buildup through the litter decomposition process. Unfortunately, the 2 N HCl extraction treatment was so harsh that it swamped any variations that might exist in the readily soluble salt compounds of these soil samples. Work is in progress to measure the chemical constituents in water-soluble extracts of all soil samples collected from the baseline study sites by induction-coupled plasma spectrometry. That data will be transmitted to the IVEP computer data base at LLL when work is completed.

The total chemical composition of soil samples representative of the baseline study sites was determined by neutron activation analysis at Lawrence Livermore Laboratory. Results given in Table 3 generally indicate a relatively high degree of uniformity for each element among the different sampling sites. Because of this uniformity of element distribution in the total soil and in the soil extract, it should be possible to detect any input of salts from geothermal brine sources which would alter the natural salt balance element ratios. Elements of particular interest as geothermal fluid signature tags are antimony,

Table 2. Concentration of selected elements in 2N HCl extracts of surface soil from baseline study plots at East Mesa. (Atomic absorption spectrometric analysis). (N = 3).

Study Site		pH	EC ₂₅ mmhos/cm	Na ug/g		K ug/g		Ca %		Mg ug/g		Zn ug/g	
				$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM
31-1	Bare soil	9.99	3.4	483	16.5	657	20.5	3.50	0.85	1800	13.3	6.2	0.01
	Under shrub	7.17	6.2	436	46.4	550	21.9	2.63	0.58	1616	35.9	3.3	0.03
5-1	Bare soil	9.17	2.4	166	4.2	473	2.2	1.67	0.06	1691	176	6.7	0.3
	Under shrub	8.69	2.5	164	6.5	409	20.2	1.24	0.08	1654	24.3	5.5	0.1
6-2	Bare soil	9.46	0.91	279	9.4	773	2.0	2.77	0.09	1628	308	8.2	0.3
	Under shrub	7.60	3.17	298	25.5	361	5.0	2.04	0.07	1690	18.1	3.4	0.2
8-1	Bare soil	8.83	3.3	308	15.1	474	31.4	1.58	0.04	1673	14.1	5.6	0.1
	Under shrub	7.53	3.0	289	4.5	475	14.2	2.70	0.61	1743	34.1	5.6	0.1
32-1	Bare soil	8.88	0.91	178	12.6	482	100	1.34	0.12	1729	193	6.5	0.1
5-2	" "	9.11	1.27	130	5.9	573	6.8	1.10	0.06	1883	23.7	5.7	0.1
6-3	" "	8.89	2.13	214	10.4	552	167	0.96	0.32	1382	280	6.8	0.03
6-4	" "	9.09	3.86	203	11.9	654	23.1	1.50	0.08	1963	14.7	8.6	0.2
7-1	" "	9.06	1.28	157	10.6	529	36.1	1.11	0.07	1821	19.1	6.2	0.1
7-2	" "	7.80	0.12	147	7.4	496	3.1	1.46	0.17	1746	16.2	6.3	0.1
8-2	" "	8.62	3.92	191	4.0	1227	48.2	1.74	0.06	1957	108	11.1	0.4

Table 2. (Continued)

Study site		Cu ug/g		Ni ug/g		Sr ug/g		Ba ug/g		Li ug/g	
		$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM	$\bar{x}$	SEM
31-1	Bare soil	2.9	0.1	4.2	0.3	20.5	0.2	499	5.9	2.3	0.1
	Under shrub	2.0	0.1	2.7	0.5	24.2	0.3	441	44.7	1.5	0.026
5-1	Bare soil	3.2	0.2	3.6	0.2	19.4	1.0	624	62.6	2.6	0.044
	Under shrub	2.7	0.03	3.7	0.3	16.9	0.3	498	5.1	2.2	0.1
6-2	Bare soil	4.0	0.1	5.1	0.3	31.5	0.7	647	7.2	3.4	0.1
	Under shrub	1.8	0.1	2.5	0.6	19.0	0.6	533	14.2	0.9	0.05
8-1	Bare soil	2.8	0.1	3.1	0.03	20.1	0.8	468	4.1	2.8	0.1
	Under shrub	2.6	0.03	3.7	0.4	21.1	0.1	450	29.2	2.5	0.1
32-1	Bare soil	2.9	0.1	4.0	0.1	16.8	0.2	588	2.4	2.3	0.023
5-2	" "	3.0	0.1	3.5	0.2	19.5	0.2	480	3.1	3.0	0.1
6-3	" "	3.3	0.2	4.1	0.1	24.2	6.2	454	116	3.3	0.2
6-4	" "	4.5	0.1	5.4	0.4	28.5	1.0	643	20.6	4.1	0.1
7-1	" "	2.9	0.1	3.9	0.7	25.1	0.7	529	4.7	2.9	0.1
7-2	" "	3.2	0.03	3.9	0.3	26.4	2.0	578	16.5	2.6	0.035
8-2	" "	5.8	0.3	7.3	0.3	34.3	1.5	790	52.8	5.2	0.2

Table 3. Chemical element contents of soil samples from baseline study sites at East Mesa KGRA determined by neutron activation analysis.

	Na	K	Ca	Mg	Zn	Fe	Mn	Al	Si	Ti	V
	%				ug/g	%	ug/g	%		ug/g	
	Site - 5-1										
Mean	0.633	1.432	1.124	0.621	22.2	0.893	185.8	2.536		1749	
SD	0.013	0.039	0.218	0.189	2.4	0.015	1.3	0.112		366.9	
	Site 5-2										
Mean	0.508	1.256	1.270	0.423	18.5	0.693	150.0	2.053	34.990	1035	18.6
SD	0.005	0.022	0.143	0.035	1.6	0.007	0.9	0.091	5.778	117.4	1.8
	Site 6-2										
Mean	0.583	1.464	1.688	0.599	33.4	1.026	197.5	2.561	34.830	1128	27.4
SD	0.007	0.025	0.260	0.040	3.6	0.011	1.9	0.046	5.288	207.0	2.2
	Site 6-3										
Mean	0.572	1.423	1.845	0.986	21.6	0.730	160.6	2.217			
SD	0.010	0.039	0.116	0.225	1.5	0.007	1.1	0.151			
	Site 6-4										
Mean	0.508	1.274	2.058	0.599	31.9	1.175	196.0	2.438	32.680	1860	31.6
SD	0.005	0.029	0.160	0.043	3.3	0.012	1.5	0.077	7.560	196.4	2.9
	Site 7-1										
Mean	0.593	1.466	1.374	0.379	20.2	0.740	138.0	2.213	30.930	887.6	19.1
SD	0.004	0.028	0.180	0.040	1.7	0.007	0.9	0.065	6.225	144.7	1.8
	Site 7-2										
Mean	0.602	1.370	1.245	0.937	20.4	0.774	166.3	2.337			
SD	0.013	0.045	0.324	0.469	2.5	0.009	2.1	0.091			

Table 3 (continued).

	Co	Cr	Sr	Ba	Sc	Rb	Cs	Zr	Ga	As	Sb	La
	ug/g											
	<u>Site 5-1</u>											
Mean	2.8	15.0	124.4	456.9	2.7	49.5	1.4	328.0	6.9	2.4	0.3	17.4
SD	<0.1	0.5	16.7	9.2	<0.1	1.4	<0.1	27.8	1.9	0.2	<0.1	0.1
	<u>Site 5-2</u>											
Mean	2.3	20.6	110.4	399.7	2.2	43.6	1.2	231.8	5.6	2.3	0.3	13.6
SD	<0.1	0.4	12.5	8.1	<0.1	1.0	<0.1	18.6	1.3	0.1	<0.1	0.1
	<u>Site 6-2</u>											
Mean	3.5	18.3	120.3	449.9	3.3	53.2	1.7	273.0	8.1	2.9	0.4	14.8
SD	<0.1	0.6	14.6	9.9	<0.1	1.6	<0.1	31.5	1.7	0.1	<0.1	0.1
	<u>Site 6-3</u>											
Mean	2.5	16.8	120.5	414.4	2.5	50.2	1.8	233.1		2.4	0.4	12.0
SD	<0.1	0.6	14.8	7.6	<0.1	1.4	<0.1	18.9		0.1	<0.1	0.1
	<u>Site 6-4</u>											
Mean	3.8	26.0	122.5	441.9	3.6	50.2	1.8	544.2	8.5	2.7	0.4	19.8
SD	<0.1	1.1	17.8	11.7	<0.1	1.8	<0.1	42.0	2.0	0.1	<0.1	0.2
	<u>Site 7-1</u>											
Mean	2.5	15.4	118.1	497.4	2.3	53.3	1.4	239.1	7.4	3.1	0.3	12.3
SD	<0.1	0.6	11.0	8.9	<0.1	1.3	<0.1	20.9	1.5	0.1	<0.1	0.1
	<u>Site 7-2</u>											
Mean	2.8	19.9	105.0	497.6	2.6	50.2	1.4	253.2	6.0	2.3	0.3	14.6
SD	<0.1	1.0	27.9	14.5	<0.1	1.5	<0.1	34.1	1.4	0.6	<0.1	0.2

Table 3 (Continued).

	Ce	Nd	Sm	Eu	Th	Dy	Yb	Lu	Hf	Ta	Th	U
	ug/g											
	Site 5-1											
Mean	32.7	15.4	2.5	0.4	0.3	2.3	1.5	0.4	9.5	0.4	3.9	1.2
SD	0.7	1.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
	Site 5-2											
Mean	25.4	12.5	1.8	0.3	0.2	1.5	1.1	0.3	6.6	0.3	3.3	1.1
SD	0.4	0.5	< 0.1	< 0.1	<0.1	<0.1	< 0.1	< 0.1	< 0.1	<0.1	<0.1	<0.1
	Site 6-2											
Mean	27.4	13.7	2.2	0.4	0.3	1.8	1.3	0.3	7.1	0.4	5.7	1.2
SD	0.7	0.9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
	Site 6-3											
Mean	22.3	11.2	1.8	0.3	0.2	1.8	1.3	0.4	6.6	0.3	3.1	1.0
SD	0.4	0.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Site 6-4											
Mean	39.0	17.8	3.1	0.5	0.4	2.2	1.9	0.6	15.2	0.5	5.9	1.7
SD	0.9	1.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
	Site 7-1											
Mean	23.8	11.3	1.9	0.3	0.2	1.6	1.3	0.3	6.6	0.3	3.9	1.0
SD	0.3	0.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Site 7-2											
Mean	31.4	14.8	2.9	0.5	0.3	2.3	1.5	0.3	6.8	0.6	4.1	1.0
SD	2.4	1.3	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1

Table 3. (continued).

	Na	K %	Ca	Mg	Zn ug/g	Fe %	Mn ug/g	Al %	Si	Ti ug/g	V
					<u>Site 8-1</u>						
Mean	0.535	1.251	1.554	0.424	17.1	0.626	131.3	2.158	33.300	1180	17.5
SD	0.005	0.020	0.110	0.042	2.0	0.008	0.9	0.077	9.059	207.6	2.6
					<u>Site 8-2</u>						
Mean	0.486	1.299	1.835	0.673	31.8	1.233	215.5	2.593	25.650	2005	37.9
SD	0.004	0.002	0.342	0.062	3.5	0.015	2.0	0.081	6.080	290.7	2.4
					<u>Site 31-1</u>						
Mean	0.563	1.162	1.346	0.753	16.8	0.690	143.7	2.352			
SD	0.007	0.041	0.222	0.199	1.8	0.007	1.4	0.088			
					<u>Site 32-1</u>						
Mean	0.536	1.207	1.394	0.424	19.5	0.748	147.5	2.292	31.550	1165	20.6
SD	0.005	0.033	0.244	0.032	2.5	0.009	0.9	0.098	5.332	191.3	2.4

Table 3 (continued).

	Co	Cr	Sr	Ba	Sc	Rb	Cs	Zr	Ga	As	Sb	La
	ug/g											
	<u>Site 8-1</u>											
Mean	2.2	8.6	111.1	394.1	2.1	47.2	1.3	155.2	5.2	1.9	0.3	10.6
SD	< 0.1	0.4	12.2	10.2	< 0.1	1.4	< 0.1	24.9	1.3	0.3	< 0.1	0.2
	<u>Site 8-2</u>											
Mean	4.1	29.1	116.5	340.8	3.8	49.3	2.1	535.1	6.6	3.3	0.4	19.0
SD	< 0.1	1.3	15.5	13.6	< 0.1	1.6	< 0.1	50.0	1.0	0.2	< 0.1	0.2
	<u>Site 31-1</u>											
Mean	2.5	13.4	129.3	354.0	2.3	43.5	1.4	166.5	4.9	2.5	0.4	11.0
SD	< 0.1	0.5	19.5	10.2	< 0.1	1.5	< 0.1	25.8	1.5	0.2	< 0.1	0.2
	<u>Site 32-1</u>											
Mean	2.6	17.6	119.6	402.1	2.4	46.1	1.4	280.4	5.1	2.0	0.3	13.8
SD	< 0.1	0.6	17.3	14.9	< 0.1	1.5	< 0.1	28.2	1.2	0.3	< 0.1	0.2

Table 3 (Continued)

	Ce	Nd	Sm	Eu	Th	Dy	Yb	Lu	Hf	Ta	Th	U
	ug/g											
	<u>Site 8-1</u>											
Mean	18.4	7.0	1.5	0.3	0.2	1.6	1.4	0.3	4.6	0.3	2.3	0.9
SD	1.0	0.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
	<u>Site 8-2</u>											
Mean	36.3	14.3	2.9	0.4	0.3	2.2	1.7	0.4	13.6	0.5	5.7	1.7
SD	1.8	1.2	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.1	0.1
	<u>Site 31-1</u>											
Mean	20.2	8.7	1.7	0.3	0.2	1.4	0.9	0.2	4.1	0.3	2.7	0.6
SD	0.5	0.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	<u>Site 32-1</u>											
Mean	27.3	11.0	2.1	0.4	0.2	1.5	1.2	0.3	7.9	0.3	3.9	1.4
SD	0.9	0.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1

barium, bismuth, boron, cesium, lithium, selenium, and strontium along with several of the heavy metal elements, including copper, manganese, mercury, nickel, and zinc (U.S. Department of the Interior, 1977). None of these elements were present in anomalous amounts in the soils studied.

Ecological Parameters of East Mesa Vegetation

A list of plant species found at the East Mesa KGRA is given in Table 4. This listing may not be complete, but it does represent all of the different species found during the two-year period of this baseline study. Voucher specimens for most of these species are maintained at UCLA by T. L. Ackerman. Three threatened or endangered species, Croton wigginsii, Eriogonum deserticola and Ammobroma sonorae, are found at the Dunes KGRA about 30 km further east at the same latitude, and Eriogonum deserticola is present at the East Mesa KGRA study sites. We believe that this listing for perennial herbs and winter annual species is fairly complete because of the highly favorable rainfall conditions during the fall and winter periods of 1976-1977.

Ecological parameters for herbaceous perennial and annual plant species were determined within baseline plots 7-2, 8-2, and 32-1 (Tables 5, 6, and 7). These plots were sampled by a stratified random method to determine density and biomass. Each plot had 80 sampling quadrats located randomly in sets of ten along each of eight randomly selected shrub transect lines 200 meters in length. Each sampling quadrat was one square meter in size making a total of 80 m^2 of area sampled per plot. It should be noted that these density and biomass estimates represent only the time of season sampled: November 1976 for plots 8-2 and 32-1; January 1977 for Plot 7-2. Because of the prolonged supply of

soil moisture from Hurricane Cathleen in September 1976 which remained available during the fall and winter months, the biomass of annual plants continued to increase markedly on into the spring months of 1977, except for two summer annuals, Euphorbia micromera and Pectis papposa, which died during the winter months. Late spring annual plant biomass was not measured either year, but the contrasting effects can be ascertained from the difference in ground covers illustrated in Figs. 4 and 5. While some twenty or more herb and annual species were present, the biomass was contributed primarily by fewer than ten species. These ephemeral plants were of keen interest because of their contrasting appearance between the two seasons of study. Their inconsistencies from year to year, however, will probably make them of second order importance as a baseline reference.

The amount and timing of rainfall was sufficiently favorable during both seasons studied to permit some measurements to be made on the germination and survival of new Larrea tridentata seedlings. Estimates of the numbers encountered on the baseline plots are given in Tables 5, 6, and 7. Over a thousand new seedlings were marked with nearby stakes in both the baseline plots and along several transect lines in order to follow their future survival and seedling developments. During the 2-year period of this study only 26 of 1329 Larrea tridentata seedlings had survived (1.96%) and 13 of 43 Ambrosia dumosa seedlings had survived (30.2%). We see evidence of periodic "pulse input" of new Larrea tridentata shrubs in the East Mesa ecosystem. Crown sprouting on roots which have been exposed by wind removal of surface soil is also an important process of shrub regeneration at East Mesa.

Table 4. East Mesa KGRA plant species list.

Species Code	Shrubs
03	<u>Ambrosia dumosa</u> "White Bur-Sage"
02	<u>Atriplex canescens</u> "Four-Winged Saltbush"
07	<u>Baccharis sarathanoides</u> "Broom Baccharis"
06	<u>Ephedra trifurca</u>
04	<u>Eriogonum deserticola</u> "Desert Buckwheat"
08	<u>Haplopappus acradenius</u> "Alkali Goldenbush"
01	<u>Larrea tridentata</u> "Creosote Bush"
09	<u>Pluchea sericea</u> "Arrowweed"
20	<u>Prosopis glandulosa</u> var. <u>torreyana</u> "Mesquite"
1	<u>Prosopis pubescens</u> "Screw-Bean Mesquite"
23	<u>Tamarix ramosissima</u> "Tamarisk"
	Perennial Herbs
42	<u>Aristida californica</u> "Three-Awn"
11	<u>Coldenia plicata</u> "Plicate Coldenia"
12	<u>Dalea mollis</u> "Silk Dalea"
14	<u>Hesperocallis undulata</u> "Desert Lily"
53	<u>Mentzelia longiloba</u> "Blazing Star"
15	<u>Typha</u> sp. "Cattail"
	Annuals
40	<u>Abronia villosa</u> "Sand Verbena"
41	<u>Achyronychia cooperi</u> "Frost Mat"
43	<u>Astragalus aridus</u> "Locoweed"
44	<u>Baileya pauciradiata</u> "Desert-Marigold"
60	<u>Bouteloua bartata</u> "Six-weeks Grama"
65	<u>Brassica tournefortii</u> Wild Turnip
45	<u>Camissonia claviformis</u> subsp. <u>yumae</u> "Brown-Eyed Primrose"
46	<u>Cryptantha angustifolia</u> "Forget-me-not"
47	<u>Cryptantha costata</u> "Forget-me-not"
61	<u>Dicoria canescens</u> "Bugseed"
49	<u>Dithyrea californica</u> "Spectacle-Pod"
63	<u>Eriogonum thomasi</u>
50	<u>Euphorbia micromera</u> "Sand Mat"
51	<u>Geraea canescens</u> "Desert Sunflower"
52	<u>Langloisia schottii</u> "Schott Langlosia"
68	<u>Mentzelia</u> sp.
54	<u>Oenothera deltoides</u> "Dunes Evening-Primrose"
62	<u>Oligomeris linifolia</u> "Linear-Leaved Cambess"
55	<u>Palafoxia linearis</u> "Spanish Needles"
56	<u>Pectis papposa</u> "Chinch Weed"
57	<u>Plantago insularis</u> "Woolly Plantain"
58	<u>Schismus arabicus</u>
66	<u>Sonchus oleraceus</u> "Sow Thistle"
64	<u>Streptanthella longirostris</u> "Long-Beaked Twist-Flower"
99	Unknown

Table 5. Density and biomass of annuals, perennial herbs, and shrub seedlings. Study Site 7-2, East Mesa KGRA, January 1977.

Species	# of plants	Relative density %	Density		Relative biomass %	Biomass	
			#/ha	± 90% C.L.*		kg/ha	± 90% C.L.*
<i>Abronia villosa</i>	54	0.20	6,750	± 3,152	13.65	84.907	± 51.029
<i>Achyronychia cooperi</i>	5	0.02	625	± 454	< 0.01	0.014	± 0.015
<i>Baileya pauciradiata</i>	32	0.12	4,000	± 1,720	4.09	25.440	± 18.444
<i>Camissonia claviformis</i>	248	0.90	31,000	± 9,114	0.92	5.769	± 3.035
<i>Coldenia plicata</i> (1)	7	0.02	875	± 530	0.07	0.492	± 0.491
<i>Cryptantha</i> spp.	1,035	3.76	129,375	± 37,260	1.33	8.284	± 4.407
<i>Dalea mollis</i> (1)	12	0.04	1,500	± 844	0.34	2.154	± 1.829
<i>Dithyria californica</i>	161	0.59	20,125	± 12,719	2.40	14.933	± 18.562
<i>Eriogonum thomasi</i>	1	< 0.01	125	± 208	< 0.01	0.001	± 0.002
<i>Euphorbia micromera</i> (3)	100	0.36	12,500	± 6,438	1.74	10.857	± 12.095
<i>Langloisia schottii</i>	14	0.05	1,750	± 1,214	< 0.01	0.025	± 0.027
<i>Oenothera deltoides</i>	26	0.10	3,250	± 1,671	4.01	24.983	± 16.938
<i>Oligomeris linifolia</i>	9	0.03	1,125	± 1,677	0.15	0.090	± 0.151
<i>Palafoxia linearis</i>	28	0.10	3,500	± 1,264	5.17	32.140	± 16.681
<i>Pectis papposa</i> (3)	87	0.32	10,875	± 4,480	3.19	19.857	± 10.206
<i>Plantago insularis</i>	19,536	71.00	2,442,000	± 336,300	60.17	374.245	± 66.990
<i>Schismus arabicus</i>	6,138	22.31	767,250	± 207,158	2.84	17.685	± 11.831
<i>Sonchus oleraceus</i>	7	0.01	875	± 530	< 0.01	0.022	± 0.022
<i>Streptanthella longirostris</i>	16	0.06	2,000	± 2,576	< 0.01	0.028	± 0.031
Unknown #1	1	< 0.01	125	± 208	< 0.01	0.001	± 0.001
Total	27,517	99.99	3,439,625		100.07	621.927	
<i>Larrea tridentata</i> (2)	45		5,625	± 1,536			
<i>Atriplex canescens</i> (2)	3		375	± 464			

- (1) Perennial herb
(2) Shrub seedling
(3) Summer annual

Note: While *P. insularis* and *S. arabicus* make up 93% of density, they total only 63% of biomass. On the other hand, *A. villosa* makes up only 0.2% of the density, but 13.7% of biomass. Five species (led by *P. insularis*) make up 90.3% of biomass.

*Confidence limit. While we prefer 95% confidence limits, the precision of the estimate of these annuals is less reliable than that of the larger plants, so that we have chosen 90% confidence limits.

Table 6. Density and biomass of annuals, perennial herbs and shrub seedlings. Study Site 8-2, East Mesa KGRA, November 1976.

Species	# of plants	Relative Density %	Density		Relative biomass %	Biomass	
			#/ha	± 90% C.L.*		kg/ha	± 90% C.L.*
<i>Abronia villosa</i>	86	1.05	10,750	± 3,580	21.12	108.119	± 43.680
<i>Achyronychia cooperi</i>	3	0.04	375	± 1,336	0.01	0.014	± 0.015
<i>Aristida californica</i> (1)	2	0.03	250	± 417	0.01	0.060	± 0.100
<i>Astragalus aridus</i>	16	0.20	2,000	± 2,576	0.05	0.301	± 0.502
<i>Baileya pauciradiata</i>	35	0.43	4,375	± 1,645	1.07	5.483	± 2.336
<i>Camissonia claviformis</i>	8	0.10	1,000	± 818	0.01	0.072	± 0.075
<i>Coldenia plicata</i> (1)	1	0.01	125	± 208	0.01	0.006	± 0.011
<i>Cryptantha</i> spp.	100	1.22	12,500	± 3,850	0.45	2.301	± 1.146
<i>Dalea mollis</i> (1)	6	0.07	750	± 576	0.03	0.154	± 0.138
<i>Dithyria californica</i>	45	0.55	5,625	± 2,632	0.96	4.893	± 2.202
<i>Euphorbia micromera</i> (3)	24	0.29	3,000	± 1,608	0.56	2.889	± 2.834
<i>Geraea canescens</i>	2	0.03	250	± 293	0.32	1.641	± 2.736
<i>Mentzelia longiloba</i> (1)	13	0.16	1,625	± 752	0.39	1.975	± 1.580
<i>Oenothera detoides</i>	37	0.45	4,625	± 2,095	3.59	18.395	± 11.276
<i>Palafoxia linearis</i>	23	0.28	2,875	± 1,334	1.71	8.770	± 5.902
<i>Pectis papposa</i> (3)	44	0.54	5,500	± 2,552	1.90	9.746	± 6.218
<i>Plantago insularis</i>	7,515	91.94	939,375	± 185,996	67.67	346.372	± 78.973
<i>Schismus arabicus</i>	214	2.62	26,750	± 12,546	0.12	0.634	± 0.468
Total	8,174	100.01	1,021,750				
<i>Larrea tridentata</i> (2)	64		8,000	± 2,664	99.98	511,823	

(1) Perennial herb

(2) Shrub seedling

(3) Summer annual

* C.L. Confidence limit

Note: Three species (*P. insularis*, *A. villosa*, *Oenothera detoides*) make up 92.4% of the total biomass.

Total area = 80 quadrats, 1m each.

Table 7. Density and biomass of annual, perennial herbs and shrub seedlings. Study Site 32-1, East Mesa KGRA, November 1976.

Species	# of plants	Relative density %	Density #/ha/	C.L.*	Relative biomass	Biomass kg/ha	C.L.*
<u>A. villosa</u>	26	0.28	3,250 ±	2051	9.80	61.070 ±	66.383
<u>A. californica</u> (1)	1	0.01	125 ±	208	0.00	0.019 ±	0.032
<u>A. aridus</u>	4	0.04	500 ±	656	0.01	0.025 ±	0.028
<u>B. pauciradiata</u>	76	0.83	9,500 ±	2888	2.00	12.474 ±	7.397
<u>C. claviformis</u>	103	1.12	12,875 ±	4210	1.13	7.045 ±	5.178
<u>Cryptantha spp.</u>	324	3.52	40,500 ±	8181	0.79	4.945 ±	1.622
<u>D. mollis</u> (1)	1	0.01	125 ±	208	0.01	0.057 ±	0.095
<u>D. californica</u>	129	1.40	16,125 ±	6031	3.79	23.622 ±	25.086
<u>E. micromera</u> (3)	106	1.15	13,250 ±	6016	1.82	11.399 ±	9.756
<u>H. undulata</u> (1)	1	0.01	125 ±	208	-	-	-
<u>L. schottii</u>	5	0.05	625 ±	454	0.04	0.027 ±	0.024
<u>M. longiloba</u> (1)	12	0.13	1500 ±	1190	1.07	6.724 ±	8.943
<u>O. detoides</u>	11	0.12	1375 ±	1016	1.57	9.786 ±	13.475
<u>P. linearis</u>	41	0.45	5125 ±	1543	4.28	26.682 ±	15.716
<u>P. papposa</u>	30	0.33	3750 ±	1714	0.91	5.698 ±	2.883
<u>P. insularis</u>	8293	90.16	1,036,625 ±	192,812	72.77	453.539 ±	143.772
<u>S. arabicus</u>	35	0.38	4375 ±	2218	0.12	0.078 ±	0.057
Total	9198	99.99	1,149,750		100.11	623.190	
<u>Larrea tridentata</u> (2)	64		8000 ±	1952			

Note: Four species (P. insularis, A. villosa, P. linearis, and D. californica) make up 90.7% of total biomass.
Total area = 80 quadrats, 1 m² each.

- (1) Perennial herb
(2) Shrub seedling
(3) Summer annual

*90% confidence limits.

Density, cover, and biomass estimates for shrubs at several study sites are given in Table 8. Considerable variation occurs from site to site in the East Mesa KGRA due to anomalies in topography, partly attributable to shifting sand dunes, and to extreme variations in soil moisture stress to which the shrub populations are subjected. We were able to estimate biomass by nondestructive dimensional methods in the normal sized Larrea community. Biomass at the three baseline plots was about 4500 kg/ha for plot 7-2, 1100 kg/ha for plot 8-2 and 1300 kg/ha for plot 32-1. No attempts were made to determine biomass in the giant Larrea community near well 31-1 because that would require considerable destruction of shrubs in order to obtain data to expand our weight versus volume nomographs. Biomass in the giant Larrea community could be as much as ten times greater than the biomass in normal sized communities. The shrub populations near the geothermal development wells at East Mesa are, with few exceptions, virtual monocultures of Larrea tridentata.

Chemical Element Composition of Vegetation Samples from East Mesa Baseline Study Sites

The mineral element composition of samples of annual and perennial herb species is given in Table 9. Uniformity of element composition for each species between site locations generally was high for most elements. Sodium contents were quite variable among sites; however, the levels were not high, except in the accumulator species Abronia villosa, because of the moderate salinity of the soil. This general uniformity of element composition in plant tissues was further borne out by the extensive sampling and analysis (n=50) of Larrea tridentata (Table 10) and Plantago insularis (Table 11) from the East Mesa baseline study plots. An even higher uniformity in element distribution among samples

Table 8. Density, cover and biomass estimates for shrubs at East Mesa KGRA study sites.

Study Site	Transect			Species	Cover			Density		Relative density %	Biomass	
	Type	Size	No.		%	±	S.D.	No/ha	± C.L.*		kg/ha	C.L.*
31-1	Line	200m	8	<u>L. tridentata</u>	22.3	±	6.7					
	Belt	200X2	8									
32-2	Belt	200X4	8	<u>L. tridentata</u>	7.2	±	2.2	264	± 73.2	100.0	1379.0	± 507.0
5-1	Line	200	10)	<u>L. tridentata</u>	5.1	±	2.1					
		300m	2)									
	Belt (n)	200X2	6	<u>L. tridentata</u>				212.5	± 93.5			
	Belt (s)	200X2	6	<u>L. tridentata</u>				170.8	± 90.0			
	Both		12	<u>L. tridentata</u>				191.7	± 54.8	100.0		
37 6-2	Line	200m	8	<u>L. tridentata</u>	4.0	±	2.2					
				<u>A. dumosa</u>	0.2	±	0.5					
				<u>A. confertifolia</u>	1.8	±	1.0					
				A11	6.0	±	2.4					
	Belt	200X2	8	<u>L. tridentata</u>				215.6	± 61.1	39.0		
				<u>A. dumosa</u>				93.8	± 205.0	17.0		
				<u>A. canescens</u>				243.8	± 101.6	44		
				A11				553.13		100.1		
7-2 (6400m ²)	Belt	200X4	8	<u>L. tridentata</u>	14.6	±	6.2	153.1	± 42.1	79.0	4555.6	± 1966.6
				<u>A. canescens</u>	1.0	±	1.3	37.5	± 26.2	19.4	266.0	± 320.2
				<u>E. deserticola</u>	0.09			1.6	± 3.7	0.8	0.8	0.0
				<u>A. dumosa</u>	0.001			1.6	± 3.7	0.8	< 0.1	
				A11	15.1	±	7.1	193.8		100.0	4822.5	
8-2 (6500m ²)	Belt	200X4	8	<u>L. tridentata</u>	5.0	±	4.9	189.1	± 85.2	100.0	1105.1	± 1050.4

*95% confidence limits.

Table 9. Mineral element composition of annuals and perennial herbs sampled March 31, 1977 from Baseline study plots.

Study site		P	Na	K	Ca	Mg	Zn	Cu	Fe	Mn	B	Al	
		%					ug/g						
		<i>Abronia villosa</i>											
7-2	Mean	0.089	2.080	4.810	1.333	0.621	17.5	6.6	233	11.5	49.2	264	
	S.D.	0.046	0.334	1.304	0.117	0.017	6.2	1.2	43.5	3.5	8.4	161	
8-2	Mean	0.149	0.381	4.777	1.870	0.651	14.4	5.0	186	9.2	28.8	295	
	S.D.	0.005	0.022	2.117	0.212	0.060	2.6	1.1	10.5	2.5	2.0	77.4	
31-1	Mean	0.174	2.380	3.730	1.650	0.745	11.4	8.9	345	23.1	32.4	716	
	S.D.	0.012	0.192	1.347	0.135	0.043	3.0	1.2	76.9	8.1	1.0	101	
32-1	Mean	0.114	0.969	3.407	1.247	0.512	14.5	7.0	393	10.2	25.6	583	
	S.D.	0.019	0.019	0.342	0.273	0.030	2.6	0.4	66.4	1.3	3.4	107	
		Si	Ti	V	Ni	Mo	Cr	Sr	Ba	Li	Sn	Pb	
		%	ug/g										
7-2	Mean	0.332	19.7	-	1.7	1.8	tr	621	16.3	8.5	0.9	-	
	S.D.	0.175	8.1			0.2		158	5.6	1.7	0.3		
8-2	Mean	0.220	32.8	tr	-	0.6	tr	535	43.2	4.9	tr	-	
	S.D.	0.056	9.2			0.3		82.6	11.4	0.4			
31-1	Mean	1.081	35.3	tr	-	2.1	0.6	536	78.2	8.2	-	-	
	S.D.	0.080	3.0			0.3	0.0	33.3	11.7	0.9			
32-1	Mean	0.759	56.2	-	-	0.8	0.4	549	74.1	4.0	-	-	
	S.D.	0.205	34.2			0.1	0.1	85.6	4.4	0.2			

Table 9 (Continued).

Study Site		P	Na	K %	Ca	Mg	Zn	Cu	Fe	Mn	B	Al
		ug/g										
Baileya pauciradiata												
7-2	Mean	0.219	0.138	2.627	1.800	0.386	13.4	10.0	441	27.2	68.5	745
	S.D.	0.005	0.011	0.192	0.150	0.032	3.4	0.2	57.0	0.7	4.9	60.6
8-2	Mean	0.380	0.072	2.143	1.523	0.347	13.0	15.2	549	31.1	50.3	1091
	S.D.	0.056	0.015	0.123	0.170	0.020	2.3	2.4	74.3	7.3	5.7	211
31-1	Mean	0.175	0.214	2.050	1.450	0.236	11.6	6.2	411	11.2	39.0	621
	S.D.	0.018	0.029	0.079	0.147	0.016	3.9	0.4	44.7	0.4	1.2	81.8
32-1	Mean	0.219	0.178	2.133	1.570	0.384	12.4	13.2	476	31.2	59.7	782
	S.D.	0.014	0.048	0.246	0.150	0.026	1.6	0.4	96.9	14.2	4.7	135

Table 9 (Continued).

Study site		P	Na	K	Ca	Mg	Zn	Cu	Fe	Mn	B	Al
				%					ug/g			
Mentzelia longiloba												
8-2	Mean	0.247	0.027	1.827	1.880	0.434	14.3	6.5	144	49.6	52.1	102
	S.D.	0.024	0.001	0.080	0.082	0.034	2.5	0.6	4.6	2.3	4.4	15.1
32-1	Mean	0.288	0.053	2.163	2.047	0.394	11.3	8.5	157	37.4	67.2	146
	S.D.	0.016	0.003	0.074	0.070	0.016	2.0	0.1	5.7	2.5	5.9	15.5
Oenothera deltoides												
4-2	Mean	0.131	0.129	1.153	2.663	0.443	23.0	7.7	112	40.0	76.1	85.5
	S.D.	0.026	0.020	0.095	0.091	0.057	10.3	1.2	11.2	6.4	13.2	11.6
Palafoxia linearis												
31-1	Mean	0.178	0.294	2.250	0.678	0.242	15.9	13.6	268	16.8	42.3	237
	S.D.	0.014	0.022	0.191	0.103	0.019	1.0	1.4	43.2	2.3	2.7	43.7

Table 10. Mineral element composition of Larrea tridentata from East Mesa Baseline study sites.

Stat	P	Na	K	Ca	Mg	Zn	Cu	Fe	Mn	B	Al
	ug/g	%				ug/g					
Site 32-1											
Mean	1958	0.035	2.176	1.035	0.175	14.8	7.3	295	35.9	32.7	324
SD	329	0.017	0.248	0.248	0.039	5.2	1.7	57.5	14.1	8.4	101
SEM	46.6	0.002	0.035	0.035	0.006	0.7	0.2	8.1	2.0	1.2	14.2
CV (%)	16.8	49.5	11.4	23.9	22.5	34.9	23.4	19.5	39.4	25.7	31.1
n	50	50	50	50	50	50	50	50	50	50	50
Site 5-2											
Mean	1771	0.059	2.131	0.783	0.167	15.9	8.3	371	32.7	39.1	373
SD	298	0.035	0.230	0.220	0.048	3.4	2.2	50.9	12.6	8.6	55.3
SEM	66.5	0.008	0.051	0.049	0.011	0.8	0.5	11.4	2.8	1.9	12.4
CV (%)	16.8	59.5	10.8	28.1	29.0	21.4	26.1	13.7	38.7	22.1	14.8
n	20	20	20	20	20	20	20	20	20	20	20
Site 5-3											
Mean	2166	0.058	2.043	0.898	0.187	26.8	6.0	287	28.6	27.1	278
SD	294	0.048	0.221	0.172	0.030	7.7	2.1	57.6	12.6	7.0	77.5
SEM	92.8	0.015	0.070	0.054	0.010	2.4	0.6	18.2	4.0	2.2	24.5
CV (%)	13.5	81.8	10.8	19.1	16.0	28.8	34.1	20.1	44.1	25.7	27.8
n	10	10	10	10	10	10	10	10	10	10	10

Table 10. (Continued).

Stat	Si	Ti	V	Ni	Mo	Cr	Sr	Ba	Li	Sn	Pb
	%	ug/g									
Site 32-1											
Mean	0.222	20.3	2.0	3.2	0.4	0.4	247	19.0	3.5	0.6	-
SD	0.212	9.1	0.3	0.8	0.1	0.1	68.0	6.4	0.7		
SEM	0.030	1.3	0.1	0.3	< 0.1	0.1	9.6	0.9	0.1		
CV (%)	95.5	44.7	17.1	24.8	21.5	36.5	27.6	33.6	19.6		
n	50	50	48	10	8	5	50	50	50	1	
Site 5-2											
Mean	0.265	30.7	2.5	-	0.5	0.5	230	15.9	3.9	2.6	3.6
SD	0.082	9.6	0.4		0.1	0.3	82.9	3.8	1.5	2.7	
SEM	0.018	2.1	0.1		< 0.1	0.1	18.5	0.9	0.3	1.6	
CV (%)	31.1	31.2	14.8		28.1	71.3	36.0	23.9	28.6	105	
n	20	20	20		16	18	20	20	20	3	1
Site 5-3											
Mean	0.223	20.0	3.4	3.5	0.5	0.4	322	10.5	4.1	1.4	10.3
SD	0.158	6.2	0.5	0.8	0.2	0.1	94.5	2.3	1.3	1.1	
SEM	0.050	2.0	0.2	0.2	0.1	< 0.1	29.9	0.7	0.4	0.6	
CV (%)	70.6	30.8	15.7	22.5	40.1	16.8	29.4	21.4	30.5	80.7	
n	10	10	10	10	5	9	10	10	10	4	1

Table 10 (Continued).

Stat	P	Na	K	Ca	Mg	Zn	Cu	Fe	Mn	B	Al
	ug/g	%				ug/g					
Site 6-3											
Mean	1594	0.185	1.654	0.949	0.202	13.3	6.2	305	34.4	34.4	351
SD	304	0.031	0.225	0.205	0.032	2.0	1.0	45.6	5.6	6.6	52.9
SEM	96.0	0.010	0.071	0.065	0.010	0.6	0.3	14.4	1.8	2.1	16.7
CV(%)	19.1	16.7	13.6	21.6	15.7	14.7	16.0	15.0	16.4	19.3	15.0
n	10	10	10	10	10	10	10	10	10	10	10
Site 6-4											
Mean	1552	0.223	1.938	1.204	0.266	19.4	8.3	352	35.4	34.9	401
SD	490	0.059	0.757	0.679	0.209	17.9	5.5	53.5	9.1	3.3	106
SEM	155	0.019	0.240	0.215	0.066	5.7	1.7	16.9	2.9	1.0	33.5
CV (%)	31.6	26.4	39.1	56.4	78.4	92.1	65.6	15.2	25.6	9.3	26.4
n	10	10	10	10	10	10	10	10	10	10	10
Site 6-5											
Mean	1454	0.067	1.892	1.066	0.217	11.4	5.3	301	35.7	25.2	366
SD	451	0.034	0.273	0.260	0.048	2.3	1.0	56.9	10.6	5.7	97.5
SEM	143	0.011	0.086	0.082	0.015	0.8	0.3	18.0	3.3	1.8	30.8
CV (%)	31.0	50.2	14.4	24.4	22.3	20.0	18.3	18.9	29.6	22.5	26.6
n	10	10	10	10	10	8	10	10	10	10	10

Table 10. (Continued).

Stat	Si %	Ti	V	Ni	Mo	Cr ug/g	Sr	Ba	Li	Sn	Pb
<u>Site 6-3</u>											
Mean	0.219	26.9	1.8	3.3	0.3	0.4	330	12.7	10.6	0.8	4.8
SD	0.060	5.1	0.3	0.4	0.1	0.1	71.6	2.4	1.6	0.3	
SEM	0.019	1.6	0.1	0.1	<0.1	< 0.1	22.6	0.8	0.5	0.2	
CV (%)	27.4	19.1	15.3	11.0	30.7	20.1	21.7	19.2	15.1	37.7	
n	10	10	9	8	6	9	10	10	10	3	1
<u>Site 6-4</u>											
Mean	0.252	25.0	1.9	3.6	0.3	0.4	363	13.1	11.3	1.6	-
SD	0.074	4.6	0.3	0.5	0.1	<0.1	68.3	1.4	3.3	0.3	
SEM	0.024	1.4	0.1	0.2	<0.1	<0.1	21.6	0.4	1.1	0.2	
CV (%)	29.5	18.2	16.6	15.0	28.3	11.3	18.8	10.7	29.4	18.4	
n	10	10	10	9	2	9	10	10	10	3	
<u>Site 6-5</u>											
Mean	0.207	28.1	2.5	3.4	0.4	0.4	400	12.7	5.9	2.5	7.9
SD	0.085	7.1	0.4	0.8	0.1	0.1	94.1	2.5	0.8	0.4	2.5
SEM	0.027	2.3	0.1	0.3	<0.1	< 0.1	29.8	0.8	0.3	0.1	1.1
CV (%)	41.3	25.3	16.1	23.7	31.4	20.1	23.5	19.8	13.8	14.5	31.4
n	10	10	10	10	7	10	10	10	10	10	5

Table 10. (Continued).

Stat	P ug/g	Na	K %	Ca	Mg	Zn	Cu	Fe	Mn ug/g	B	Al
<u>Site 7-1</u>											
Mean	1849	0.143	1.909	1.038	0.184	16.3	6.2	339	35.6	35.1	363
SD	317	0.039	0.141	0.189	0.024	3.5	1.5	42.5	6.0	7.6	57.7
SEM	100	0.012	0.045	0.060	0.008	1.1	0.5	13.4	1.9	2.4	18.2
CV(%)	17.2	27.0	7.4	18.2	13.1	21.5	24.7	12.5	16.8	21.7	15.9
n	10	10	10	10	10	10	10	10	10	10	10
<u>Site 7-2</u>											
Mean	2148	0.128	1.907	0.995	0.170	15.3	9.1	367	24.9	35.7	388
SD	345	0.054	0.274	0.247	0.042	6.0	6.8	68.0	11.0	9.3	84.7
SEM	48.8	0.008	0.039	0.035	0.006	0.9	1.0	9.6	1.6	1.3	12.0
CV(%)	16.1	42.5	14.4	24.8	24.7	39.5	74.7	18.5	44.1	26.1	21.9
n	50	50	50	50	50	44	50	50	50	50	50
<u>Site 8-2</u>											
Mean	1852	0.030	2.489	0.932	0.161	15.1	8.0	303	31.6	31.4	302
SD	338	0.012	0.284	0.189	0.029	4.1	1.7	49.3	11.6	7.7	70.3
SEM	47.8	0.002	0.040	0.027	0.004	0.6	0.2	7.0	1.6	1.1	9.9
CV(%)	18.2	38.9	11.4	20.3	18.3	27.4	21.3	16.3	36.8	24.5	23.3
n	50	50	50	50	50	50	50	50	50	50	50
<u>Site 22-1</u>											
Mean	1370	0.049	1.834	0.968	0.205	12.3	6.6	352	35.7	27.3	388
SD	548	0.025	0.261	0.212	0.059	3.6	1.2	90.3	9.7	7.4	115
SEM	173	0.008	0.083	0.067	0.019	1.3	0.4	28.6	3.1	2.4	36.3
CV(%)	40.0	52.2	14.2	21.9	28.7	29.0	18.4	25.7	27.3	27.3	29.6
n	10	10	10	10	10	10	10	10	10	10	10

Table 10. (Continued).

Stat	Si	Ti	V	Ni	Mo	Cr	Sr	Ba	Li	Sn	Pb
	%	ug/g									
Site 7-1											
Mean	0.220	22.6	2.0	3.4	0.4	0.3	293	14.6	6.7	0.5	-
SD	0.040	5.3	0.3	0.7	0.1	0.1	56.8	2.4	1.1		
SEM	0.013	1.7	0.1	0.3	<0.1	<0.1	18.0	0.8	0.4		
CV(%)	18.3	23.4	14.5	20.6	24.7	22.8	19.4	16.4	17.2		
n	10	10	10	7	3	8	10	10	10	1	
Site 7-2											
Mean	0.236	27.7	3.1	2.1	0.4	0.5	367	14.9	6.7	0.9	9.7
SD	0.103	7.0	0.9	0.9	0.1	0.2	100	2.6	1.6	0.2	8.6
SEM	0.015	1.0	0.1	0.1	<0.1	<0.1	14.2	0.4	0.2	<0.1	3.2
CV(%)	43.9	25.2	27.5	45.6	22.1	29.7	27.3	17.6	24.1	25.9	88.8
n	50	50	50	42	8	15	50	50	50	36	7
Site 8-2											
Mean	0.197	18.0	2.0	4.0	0.5	0.4	263	16.0	3.6	0.7	-
SD	0.104	4.8	0.4	1.2	0.3	0.2	75.6	4.0	0.9	0.2	
SEM	0.015	0.7	<0.1	0.2	0.1	<0.1	10.7	0.6	0.1	0.1	
CV(%)	52.7	26.4	18.3	29.1	63.6	40.8	28.7	25.2	26.0	22.9	
n	50	50	50	43	23	14	50	50	50	6	
Site 22-1											
Mean	0.287	23.9	3.3	3.3	0.3	0.5	371	12.9	4.0	1.0	7.6
SD	0.229	5.2	0.7	0.9	0.1	0.1	120	2.6	0.2	0.4	
SEM	0.072	1.6	0.2	0.3	<0.1	<0.1	37.9	0.8	<0.1	0.1	
CV(%)	79.9	21.8	22.8	26.3	17.3	24.3	32.3	20.1	5.4	38.4	
n	10	10	10	10	3	10	10	10	10	10	1

Table 11. Mineral element composition of Plantago insularis from East Mesa Baseline study sites.

Stat	P ug/g	Na	K %	Ca	Mg	Zn	Cu	Fe ug/g	Mn	B	Al
<u>Site 32-1</u>											
Mean	3078	0.413	1.869	2.001	0.334	10.5	17.9	418	72.6	26.3	980
SD	798	0.186	0.331	0.392	0.064	3.8	2.5	151	25.6	3.2	519
SEM	113	0.026	0.047	0.056	0.009	0.9	0.3	21.3	3.6	0.5	73.4
CV (%)	25.9	45.0	17.7	19.6	19.1	35.8	13.7	36.1	35.2	12.3	53.0
n	50	50	50	50	50	18	50	50	50	50	50
<u>Site 5-2</u>											
Mean	2219	0.420	1.863	2.283	0.285	18.2	20.4	273	45.0	27.8	444
SD	374	0.139	0.227	0.432	0.028	6.2	3.4	68.5	11.8	4.3	278
SEM	118	0.044	0.072	0.137	0.009	2.1	1.1	21.7	3.7	1.4	88.0
CV (%)	16.9	33.1	12.2	18.9	9.8	34.1	16.7	25.1	26.3	15.5	62.6
n	10	10	10	10	10	9	10	10	10	10	10
<u>Site 6-4</u>											
Mean	2061	0.283	1.932	2.418	0.267	14.7	20.7	178	35.1	24.3	238
SD	241	0.049	0.150	0.307	0.034	8.4	3.5	46.2	11.2	2.3	219
SEM	76.1	0.016	0.047	0.097	0.011	2.8	1.1	14.6	3.5	0.7	69.1
CV (%)	11.7	17.4	7.8	12.7	12.9	57.2	16.9	25.9	31.9	9.6	91.9
n	10	10	10	10	10	9	10	10	10	10	10

Table 11 (Continued).

Stat	Si	Ti	V	Ni	Mo	Cr	Sr	Ba	Li	Sn	Pb
	%	ug/g									
	Site 32-1										
Mean	1.107	61.3	3.2	42.8	1.5	0.7	575	135	9.1	1.9	19.3
SD	0.830	39.0	0.7	87.3	0.6	0.6	140	24.3	2.6	1.4	17.3
SEM	0.117	5.5	0.1	39.0	0.1	0.1	19.8	3.4	0.4	0.5	12.2
CV (%)	75.0	63.6	22.9	204	43.0	77.0	24.3	18.1	28.2	75.0	90.0
n	50	50	49	5	50	34	50	50	50	7	2
	Site 5-2										
Mean	0.517	33.9	2.3	6.2	4.0	0.5	639	114	16.0	0.7	-
SD	0.428	35.2	0.6		1.4	0.2	94.3	15.6	5.9		
SEM	0.135	11.1	0.2		0.4	0.1	29.8	4.9	1.9		
CV (%)	82.8	104	24.4		34.0	31.1	14.8	13.7	37.0		
n	10	10	9	1	10	10	10	10	10	1	
	Site 6-4										
Mean	0.270	16.8	1.9	4.0	2.7	0.5	578	84.3	12.3	1.3	6.0
SD	0.342	18.5	0.4	0.1	0.8	0.1	73.2	20.6	2.2	0.2	2.5
SEM	0.108	5.8	0.2	0.1	0.3	<0.1	23.2	6.5	0.7	0.1	1.5
CV (%)	127	110	18.6	3.5	29.9	13.4	12.7	24.4	17.9	19.3	41.9
n	10	10	5	2	10	10	10	10	10	10	3

Table 11. (Continued).

Stat	P ug/g	Na	K %	Ca	Mg	Zn	Cu	Fe ug/g	Mn	B	Al
<u>Site 7-1</u>											
Mean	2639	0.283	1.914	1.452	0.297	12.8	15.7	686	76.1	24.5	1688
SD	991	0.073	0.254	0.259	0.036	3.4	2.0	148	24.1	2.5	492
SEM	330	0.024	0.085	0.086	0.012	1.3	0.7	49.4	8.0	0.8	164
CV (%)	37.6	25.9	13.3	17.8	12.3	26.6	12.5	21.6	31.7	10.1	29.1
n	9	9	9	9	9	7	9	9	9	9	9
<u>Site 7-2</u>											
Mean	2420	0.293	1.903	2.222	0.279	18.5	19.9	242	44.4	36.3	358
SD	306	0.108	0.201	0.300	0.041	6.6	5.6	64.6	11.0	5.5	148
SEM	43.2	0.015	0.028	0.042	0.006	0.9	0.8	9.1	1.6	0.8	20.9
CV (%)	12.6	37.0	10.6	13.5	14.6	35.4	28.0	26.7	24.7	15.3	41.3
n	50	50	50	50	50	50	50	50	50	50	50
<u>Site 8-2</u>											
Mean	2558	0.265	2.152	1.926	0.298	12.2	18.3	412	83.3	26.3	894
SD	753	0.136	0.359	0.369	0.055	2.8	4.3	130	32.5	4.2	393
SEM	106	0.019	0.051	0.052	0.008	0.5	0.6	18.3	4.6	0.6	55.6
CV (%)	29.4	51.3	16.7	19.2	18.4	23.2	23.7	31.5	39.0	16.1	44.0
n	50	50	50	50	50	39	50	50	50	50	50

Table 11 (Continued).

Stat	Si %	Ti	V	Ni	Mo	Cr	Sr	Ba	Li	Sn	Pb
						ug/g					
<u>Site 7-1</u>											
Mean	1.906	114	2.8	5.6	1.6	1.6	407	89.4	9.3	1.5	-
SD	0.611	41.1	0.7	2.1	0.5	1.6	63.9	15.6	1.6	0.4	
SEM	0.204	13.7	0.3	1.5	0.2	0.5	21.3	5.2	0.5	0.2	
CV (%)	32.1	36.0	25.9	37.9	31.5	98.4	15.7	17.4	16.7	27.8	
n	9	9	8	2	9	9	9	9	9	6	
<u>Site 7-2</u>											
Mean	0.414	26.4	2.3	1.7	1.5	0.8	552	87.5	9.7	1.0	24.5
SD	0.182	16.3	1.0	0.9	0.5	0.3	59.0	16.5	2.6	0.3	57.6
SEM	0.026	2.3	0.2	0.1	0.1	<0.1	8.3	2.3	14	0.1	21.8
CV (%)	44.0	62.0	42.7	55.2	32.6	40.6	10.7	18.9	27.0	32.6	235
n	50	50	39	50	50	50	50	50	50	40	7
<u>Site 8-2</u>											
Mean	1.254	69.3	2.7	29.7	2.2	0.9	499	111	10.1	2.1	-
SD	0.715	44.2	0.6		1.2	0.9	127	18.2	2.9		
SEM	0.101	6.3	0.1		0.2	0.1	17.9	2.6	0.4		
CV (%)	57.0	63.8	21.8		52.3	95.3	25.4	16.3	28.9		
n	50	50	50	1	50	50	50	50	50	1	

Table 12. Mineral element composition of Baileya pauciradiata from East Mesa and alfalfa and sugar beet samples collected from an agricultural area near East Mesa KGRA.

Stat	P ug/g	Na	K %	Ca	Mg	Zn	Xu	Fe ug/g	Mn	B	Al
<u>Baileya pauciradiata, Site 6-3</u>											
Mean	3046	0.307	3.011	2.297	0.430	12.3	17.6	266	42.8	52.0	558
SD	406	0.145	0.345	0.317	0.072	4.3	3.8	72.7	16.6	12.3	258
SEM	128	0.046	0.109	0.100	0.023	1.5	1.2	23.0	5.2	3.9	81.5
CV (%)	13.3	47.4	11.4	13.8	16.7	34.8	21.5	27.3	38.7	23.6	46.2
n	10	10	10	10	10	8	10	10	10	10	10
<u>Alfalfa</u>											
Mean	4493	0.192	2.593	1.954	0.306	30.2	11.7	310	28.9	42.2	373
SD	559	0.044	0.254	0.231	0.018	6.8	0.7	31.0	3.7	5.8	43.3
SEM	79.0	0.006	0.036	0.033	0.003	1.0	0.1	4.4	0.5	0.8	6.1
CV (%)	12.4	22.9	9.8	11.8	5.9	22.4	6.4	10.0	13.0	13.9	11.6
n	50	50	50	50	50	50	50	50	50	50	50
<u>Sugar Beet (leaf tissue)</u>											
Mean	3393	3.176	2.601	1.140	1.057	37.7	12.8	482	48.0	45.0	489
SD	581	0.753	0.817	0.217	0.314	8.1	3.2	88.9	17.1	9.1	85.7
SEM	82.2	0.107	0.116	0.031	0.044	1.1	0.5	12.6	2.4	1.3	12.1
CV (%)	17.1	23.7	31.4	19.0	29.8	21.5	25.2	18.4	35.6	20.1	17.5
n	50	50	50	50	50	50	50	50	50	50	50

Table 12 (Continued).

Stat	Si %	Ti	V	Ni	Mo	Cr ug/g	Sr	Ba	Li	Sn	Pb
<u>Baileya pauciradiata, Site 6-3</u>											
Mean	0.767	34.3	2.0	-	1.9	0.4	569	42.0	29.0	0.8	-
SD	0.435	14.8	0.6		1.3	0.2	41.9	6.7	10.7	0.2	
SEM	0.137	4.7	0.2		0.4	0.1	13.2	2.1	3.4	0.1	
CV(%)	56.7	43.2	28.1		67.5	38.2	7.4	16.0	36.9	24.8	
n	10	10	7		10	7	10	10	10	7	
<u>Alfalfa</u>											
Mean	0.151	26.4	2.4	3.8	5.9	0.4	299	12.9	5.8	1.8	12.1
SD	0.027	5.0	0.4	0.4	1.0	0.3	39.3	1.7	0.6	0.3	18.0
SEM	0.004	0.7	0.1	0.2	0.1	<0.1	5.6	0.2	0.1	<0.1	9.0
CV(%)	17.9	19.1	18.5	11.7	16.9	66.7	13.1	12.9	11.1	18.7	148
n	50	50	48	5	50	35	50	50	50	50	4
<u>Sugar Beet (leaf tissue)</u>											
Mean	0.233	40.4	3.0	2.7	1.0	0.6	115	18.0	14.9	1.6	7.7
SD	0.051	8.4	0.7	1.2	0.2	0.2	46.7	5.9	3.2	0.5	4.7
SEM	0.007	1.2	0.1	0.2	<0.1	<0.1	6.6	0.8	0.4	0.1	2.1
CV(%)	22.1	20.9	23.1	44.4	20.8	30.8	40.8	32.8	21.3	32.1	61.9
n	50	50	49	47	50	48	50	50	50	50	5

(based upon C.V. values) occurred in the alfalfa and sugar beet tissues collected from the same sized plots in nearby fields of cultivated soil (Table 12). One might expect this because the annual plowing and land manipulation activities would have produced a more uniform soil matrix for the crop plant roots. Furthermore, the homogenous source of seed for the field crop plants should insure greater uniformity in mineral element uptake by alfalfa and sugar beet plants than one would expect in the native plant species.

Some examples of frequency distribution of elements in Larrea tridentata leaf tissue sampled from baseline plot 7-2 are illustrated in Appendix B. Both normal and log normal distribution conditions were encountered among the different elements examined. Further studies are underway to examine within and between collection sites variability of elements using the Duncan multiple range technique. We are doing this in order to sort out problems likely to be encountered in future sampling and also to determine the minimum of sampling necessary to make vegetation analysis an accurate monitoring procedure for detecting any dissemination of source element pollutants into the surrounding environment. Such findings should have generic application to all geothermal energy production sites as well as any other kind of industrial site where pollutants may be scattered through atmospheric and fluid transport processes.

No anomalies were found in the baseline element composition of East Mesa vegetation. In fact, the distribution and amount of each specific element was typical of that found in vegetation of the Nevada Test Site in Southern Nevada (Wallace and Romney 1972; Romney et al., 1973) and in the environs surrounding the Mohave Power Generating Plant near Bullhead

City, Arizona (Turner, 1976). Both of these areas are located further north in the Colorado River drainage system which has been the main source route for alluvial materials ultimately deposited in the Imperial Valley. The amounts in vegetation of elements which might serve as geothermal source tags are at normally low background concentrations. Therefore, any extraneous contamination deposited upon plant foliage should be easily detected when the amounts are significantly above the baseline levels. We believe that periodic sampling and chemical analysis of vegetation around an industrialized geothermal energy site is probably the best way to monitor the surrounding ecosystem for assurance of source pollutant containment.

Chemical Element Composition of Tissue Samples of Small Mammal Samples from East Mesa Baseline Study Sites

Table 13 shows the relative densities of small mammals trapped at baseline study sites in February 1976 and in March 1977. Most notable from this data was the preference (greater density) of Dipodomys deserti to inhabit areas of relatively low shrub cover while D. merriami preferred the higher shrub cover areas. Population data obtained during three successive nights of trapping is recorded by numbers, species, and sex at each location in field notes maintained at UCLA. As mentioned earlier, statistically valid population estimates cannot be determined from this small a sampling effort. Because of budget limitations, our main objective was to obtain relative densities as an index for comparing the different areas sampled and to obtain some representative samples for chemical analysis.

Individual animal specimens were analyzed from the 1976 collection. Samples were pooled by site for analysis from the 1977 collection in

Table 13. Relative densities of small mammals trapped at East Mesa Baseline study sites.

Study site	Species	Total adults caught	Relative density %	% of total adults caught each year
<u>Trapped Feb. 23-26, 1976</u>				
5-1 (5% shrub cover)	<u>Dipodomys deserti</u>	32	94.1	44.4
	<u>Dipodomys merriami</u>	2	5.9	2.8
31-1 (22% shrub cover)	<u>Dipodomys deserti</u>	4	10.5	5.6
	<u>Dipodomys merriami</u>	34	89.5	47.2
<u>Trapped Mar. 22-24, 1977</u>				
7-2 (14% shrub cover)	<u>Dipodomys deserti</u>	15	50.0	23.1
	<u>Dipodomys merriami</u>	14	46.7	21.5
	<u>Perognathus longimembris</u>	1	3.3	1.5
8-2 (5% shrub cover)	<u>Dipodomys deserti</u>	28	80.0	43.1
	<u>Dipodomys merriami</u>	5	14.3	7.7
	<u>Perognathus longimembris</u>	2	5.7	3.1

order to provide enough tissue for a sample reference bank maintained at UCLA. The pelt was washed in non-ionic detergent before a hair sample was clipped from the same area on the back of each animal. Tissues examined in addition to hair were heart, lung, liver, spleen, kidney and muscle. Spleens were analyzed only for D. deserti in the 1976 specimens since samples were too small in individual D. merriami. The stomach and colon contents also were analyzed, but data are not included. No unusual distribution patterns were detected, but the day to day variability of ingested food usually is too great for stomach and colon data to be useful for a baseline reference.

The chemical element contents in tissue samples analyzed by optical emission spectrometry have been transmitted to the computer data base at LLL. All samples except spleen from the 1976 collection were run in triplicate in order to compute variance due to animals, and/or species or location as distinct from analytical variability. Hair samples, which could only be cut into short lengths, not ground, exhibited more analytical error than did other tissues, as one would expect. The component of variance for hair due to analytical error was typically equal to variance due to differences among animals, whereas in other tissues it was typically about one-fourth that for the among animals component of variance.

The numbers of each species trapped at each location in 1976 were too small and/or uneven to allow for good 3-way ANOVA's which would sort out the components of variance due to species, location, and analytical error. We attempted 2-way ANOVA's, first based on location, assuming no species differences; then based on species, assuming no location differences. There were problems connected with each of these trials, however, because we encountered both species and location variations in many

of the elements which showed significant differences between means. Pending further investigation of analytical and computational work, we have tabulated the mean and standard error of the mean (SEM) for each tissue of each species at each location sampled (Table 14). The SEM reported is based upon the variation between animals since the means of three replicates were used in each case.

Tissue samples collected in 1977 were as noted earlier, pooled by species at each location in order to obtain samples of sufficient size to serve as a baseline reference for future analytical needs. We have reported the mean and SEM for each species at each location sampled (Table 15). In this case the data presented reflect the analytical error including any lack of homogeneity in the pooled sample of freeze-dried pulverized tissue.

The concentrations of required mineral nutrient elements in kangaroo rat tissues varied significantly among vital organs and muscle. For example, the phosphorous contents were highest in spleen, but rather uniform among the other kinds of tissues examined. Sodium contents were lower in muscle than in the vital organs in contrast to potassium which was highest in muscle tissue. The calcium contents generally were uniform, but low in all tissues examined, and the range in variation was narrow except for lung and heart tissue sampled in 1977. The magnesium concentrations varied broadly in all tissues except heart and lung for both species of kangaroo rats collected in 1976 and in 1977. Zinc contents generally were higher in spleen, liver, and kidney than in heart, muscle, and lung tissues. Copper was much lower in muscle, lung and spleen than in heart, liver, or kidney. Iron contents were considerably lower in muscle tissue than in other vital organs, while manganese concentrated highest in liver tissue. The suspected geothermal source fluid signature

Table 14 Mineral element composition of tissue of Kangaroo rats samples from East Mesa study sites, 1976 (heart).

			P	Na %	K	Ca	Mg	Zn ug/g	Cu	Fe	Mn	B	Al
5-1	<u>Dipodomys</u> <u>deserti</u>	Mean SEM n	0.522 0.056 10	1.031 0.059 10	1.026 0.029 10	714 241 10	573 19.5 10	49.9 3.5 10	22.3 1.9 10	608 33.9 10	1.3 0.2 10	2.1 0.6 10	10.5 3.7 10
6-2	<u>Dipodomys</u> <u>merriami</u>	Mean SEM n	0.380 0.055 4	0.861 0.107 4	0.964 0.040 4	265 74.4 4	516 55.8 4	75.0 36.1 4	20.7 1.7 4	690 29.9 4	2.3 0.3 4	1.5 0.3 4	7.5 3.6 4
	<u>Dipodomys</u> <u>deserti</u>	Mean SEM n	0.842 1 1	1.713 1 1	0.803 1 1	653 1 1	644 1 1	107 1 1	29.4 1 1	373 1 1	1.1 1 1	1.3 1 1	5.7 1 1
31-1	<u>Dipodomys</u> <u>merriami</u>	Mean SEM n	0.349 0.048 12	0.815 0.040 12	1.032 0.027 12	582 144 12	606 23.5 12	58.7 7.0 12	22.6 1.5 12	785 37.7 12	2.0 0.1 12	0.7 0.1 6	11.1 1.7 12
	<u>Dipodomys</u> <u>deserti</u>	Mean SEM n	0.569 0.146 3	1.024 0.056 3	1.001 0.024 3	1299 960 3	644 59.0 2	60.4 10.5 3	23.6 2.8 3	671 30.5 3	1.4 0.2 3	0.7 0.1 2	3.8 0.8 3

Table 14 (Continued) (heart).

Study site	Species		Si	Ti	V	Ni	Mo	Cr ug/g	Sr	Ba	Li	Sn	Pb
5-1	<u>Dipodomys deserti</u>	Mean	112	1.8	tr	4.3	0.5	0.3	1.4	0.5	0.5	-	-
		SEM	26.4	0.4			<0.1		0.3	<0.1	0.1		
		n	10	8		1	10	1	10	10	6		
6-2	<u>Dipodomys merriami</u>	Mean	33.0	1.3	tr	7.1	0.5	-	0.4	0.3	0.7	-	-
		SEM	8.6	0.2		1.7	0.1		<0.1	<0.1	0.1		
		n	4	4		2	4		4	4	4		
	<u>Dipodomys deserti</u>	Mean	77.2	1.0	tr	-	0.4	-	1.3	0.4	tr	-	-
		SEM											
		n	1	1			1		1	1			
31-1	<u>Dipodomys merriami</u>	Mean	136	1.5	tr	4.2	0.5	0.9	0.9	0.5	0.5	0.4	-
		SEM	62.1	0.2		0.6	<0.1	0.4	0.2	0.1	<0.1	0.0	
		n	12	12		4	12	6	12	12	4	2	
	<u>Dipodomys deserti</u>	Mean	13.5	1.2	tr	2.9	0.6	1.0	1.7	0.6	0.8	0.7	-
		SEM	1.6	0.1			0.1		0.5	0.2	0.3		
		n	3	3		1	3	1	3	3	2	1	

Table 14 (Continued) (muscle).

Study site	Species		Al	Si	Ti	V	Ni	Mo	Cr	Sr	Ba	Li	Sn	Pb
			ug/g											
5-1	<u>Dipodomys deserti</u>	Mean	4.7	100	1.0	tr	-	0.2	-	0.7	0.5	0.8	-	-
		SEM	1.0	34.8	0.2					0.1	0.1	0.5		
		n	10	10	7			3		10	10	5		
6-2	<u>Dipodomys merriami</u>	Mean	7.8	70.3	0.9	tr	9.7	0.4	1.3	0.5	0.5	0.6	0.6	-
		SEM	1.9	24.4	0.1					0.1	< 0.1	0.1		
		n	4	4	4		1	1		4	4	3	1	
	<u>Dipodomys deserti</u>	Mean	4.6	46.9	1.1	tr	5.6	4.0	-	0.5	0.4	tr	-	-
		SEM												
		n	1	1	1		1	1		1	1			
31-1	<u>Dipodomys deserti</u>	Mean	5.6	49.4	0.8	tr	4.1	0.2	0.4	0.6	0.4	0.5	0.4	-
		SEM	0.8	25.0	0.1		1.2	0.0		0.1	< 0.1	0.2		
		n	12	12	12		2	2	1	11	12	10	1	
	<u>Dipodomys deserti</u>	Mean	6.8	59.6	0.7	tr	-	4.5	-	0.8	0.5	0.6	-	-
		SEM	1.0	38.7	< 0.1			0.9		0.1	< 0.1	0.4		
		n	3	3	3			3		3	3	2		

Table 14 (Continued) (lung).

Study site	Species		P	Na %	K	Ca	Mg	Zn ug/g	Cu	Fe	Mn	B
5-1	<u>Dipodomys deserti</u>	Mean	0.481	1.137	1.037	716	368	46.5	13.7	788	1.7	2.6
		SEM	0.048	0.040	0.021	76.7	10.0	6.0	3.5	33.7	0.2	0.7
		n	10	10	10	10	10	10	10	10	10	10
6-2	<u>Dipodomys merriami</u>	Mean	0.446	1.033	1.119	535	391	44.7	8.2	650	1.7	0.9
		SEM	0.055	0.160	0.061	51.5	33.5	4.1	0.9	18.1	0.1	0.2
		n	4	4	4	4	4	4	4	4	4	4
	<u>Dipodomys deserti</u>	Mean	0.773	1.067	1.210	956	668	81.6	22.6	817	4.1	1.0
		SEM										
		n	1	1	1	1	1	1	1	1	1	1
31-1	<u>Dipodomys merriami</u>	Mean	0.446	0.956	1.216	1285	472	98.0	13.0	833	1.7	1.4
		SEM	0.059	0.035	0.021	567	14.9	35.7	3.6	29.5	0.2	0.6
		n	11	12	12	12	12	12	12	12	12	7
	<u>Dipodomys deserti</u>	Mean	0.570	1.222	0.954	694	522	68.2	18.1	787	3.8	0.6
		SEM	0.196	0.233	0.111	244	88.7	22.0	5.4	81.7	1.8	0.3
		n	3	3	3	3	3	3	3	3	3	2

Table 14 (Continued) (lung).

Study site	Species		Al	Si	Ti	V	Ni	Mo ug/g	Cr	Sr	Ba	Li	Sn	Pb
5-1	<u>Dipodomys merriami</u>	Mean	30.1	166	2.2	tr	-	1.1	0.5	1.5	0.6	0.5	-	-
		SEM	5.2	28.2	0.4			0.1	0.2	0.2	< 0.1	0.1		
		n	10	10	10			10	2	10	10	5		
6-2	<u>Dipodomys merriami</u>	Mean	21.3	118	3.1	tr	-	0.6	0.4	0.8	0.5	0.6	-	-
		SEM	8.9	36.9	1.2			< 0.1		0.1	0.1	0.1		
		n	4	4	4			4	1	4	4	4		
	<u>Dipodomys deserti</u>	Mean	15.8	52.6	1.7	tr	29.4	3.8	-	1.7	0.5	tr	-	-
		SEM												
		n	1	1	1		1	1		1	1			
31-1	<u>Dipodomys merriami</u>	Mean	41.5	199	2.6	tr	12.5	0.9	0.9	1.9	0.7	0.4	0.6	-
		SEM	6.8	46.4	0.3		8.1	0.1	0.5	0.5	0.1	0.1		
		n	12	12	12		6	12	4	12	12	7	1	
	<u>Dipodomys deserti</u>	Mean	42.3	347	2.6	tr	-	3.7	0.6	1.8	0.7	0.6	0.6	-
		SEM	23.2	238	0.6			2.2	0.3	0.9	0.2	0.3		
		n	3	3	2			3	2	3	3	2	1	

Table 14 (Continued) (spleen).

Study site	Species		P	Na %	K	Ca	Mg	Zn	Cu	Fe	Mn	B	Al
								ug/g					
5-1	<u>Dipodomys deserti</u>	Mean	1.088	0.799	1.612	580	752	98.2	5.9	717	2.7	8.3	34.6
		SEM	0.074	0.043	0.062	74.3	46.4	5.9	0.3	99.2	0.5	2.3	10.7
		n	9	9	9	9	9	9	9	9	9	9	9
31-1	<u>Dipodomys deserti</u>	Mean	1.104	0.907	1.767	493	869	86.1	5.9	710	3.0	0.6	51.8
64		SEM	0.099	0.081	0.087	48.8	122	7.2	0.7	170	0.1		5.8
		n	3	3	3	3	3	3	3	3	3	1	3
			Si	Ti	V	Ni	Mo	Cr ug/g	Sr	Ba	Li	Sn	Pb
5-1	<u>Dipodomys deserti</u>	Mean	112	1.3	tr	4.3	0.8	1.9	1.9	1.0	0.7	-	-
		SEM	30.1	0.1		1.7	0.3	0.4	0.7	0.3	0.3		
		n	9	5		2	9	3	9	9	3		
31-1	<u>Dipodomys deserti</u>	Mean	72.4	0.8	tr	2.2	0.9	4.3	1.3	0.7	1.2	0.6	-
		SEM	52.8	0.3			0.3	1.7	0.3	0.2			
		n	3	3		1	3	3	3	3	1	1	

Table 14 (Continued) (liver).

Study site	Species		P	Na %	K	Ca	Mg	Zn	Cu ug/g	Fe	Mn	B
5-1	<u>Dipodomys deserti</u>	Mean	0.766	0.897	1.120	301	762	95.9	31.7	647	10.9	0.9
		SEM	0.066	0.038	0.031	44.6	13.0	4.9	1.4	33.9	1.1	0.3
		n	10	10	10	10	10	10	10	10	10	9
6-2	<u>Dipodomys merriami</u>	Mean	0.559	0.811	1.193	199	612	725	27.4	652	13.7	0.9
		SEM	0.083	0.016	0.009	27.9	41.7	7.3	2.3	38.5	1.7	0.2
		n	4	4	4	4	4	4	4	4	4	3
	<u>Dipodomys deserti</u>	Mean	1.073	0.801	1.210	271	795	168	50.4	541	10.4	1.0
		SEM										
		n	1	1	1	1	1	1	1	1	1	1
31-1	<u>Dipodomys merriami</u>	Mean	0.596	0.824	1.212	234	897	123	33.2	759	16.8	0.7
		SEM	0.054	0.015	0.028	16.2	42.7	6.9	1.4	55.7	0.9	0.2
		n	12	12	12	12	12	12	12	12	12	4
	<u>Dipodomys deserti</u>	Mean	0.720	1.215	1.166	481	649	94.0	27.6	756	9.8	0.6
		SEM	0.160	0.131	0.140	194	131	25.4	9.2	89.3	4.1	0.1
		n	3	3	3	3	3	3	3	3	3	2

Table 14 (Continued) (liver).

Study Site	Species		Al	Si	Ti	V	Ni ug/g	Mo	Cr	Sr	Ba	Li	Sn	Pb
5-1	<u>Dipodomys deserti</u>	Mean	14.3	96.2	1.1	tr	9.6	11.2	0.4	1.0	0.4	0.6	-	-
		SEM	12.1	27.0	0.6		5.5	1.2	0.0	0.2	<0.1	0.2		
		n	10	10	3		2	10	2	10	10	7		
6-2	<u>Dipodomys merriami</u>	Mean	3.7	14.1	0.7	tr	3.5	12.3	8.7	0.4	0.4	0.8	0.4	-
		SEM	1.9	5.1	0.1		0.9	2.6		<0.1	<0.1	0.1		
		n	4	4	4		2	4	1	3	4	4	1	
	<u>Dipodomys deserti</u>	Mean	3.2	68.2	tr	tr	-	11.6	-	0.7	0.3	tr	-	-
		SEM												
		n	1	1				1		1	1			
31-1	<u>Dipodomys merriami</u>	Mean	4.3	58.1	0.9	tr	2.9	11.6	0.3	0.7	0.5	0.5	-	-
		SEM	0.8	19.0	0.1			0.9		0.1	<0.1	0.2		
		n	12	12	10		1	12	1	12	12	9		
		Mean	26.1	71.4	1.5	tr	-	8.2	1.1	1.3	0.6	0.8	0.4	-
		SEM	21.4	44.5	0.7			3.5	0.9	0.3	0.1	0.4		
		n	3	3	3			3	2	3	3	2	1	

Table 14 (Continued) (kidney).

Study site	Species		P	Na %	K	Ca	Mg	Zn	Cu ug/g	Fe	Mn	B	Al
5-1	<u>Dipodomys</u> <u>deserti</u>	Mean	0.937	1.141	1.315	428	824	84.0	35.3	417	5.6	1.8	4.4
		SEM	0.052	0.036	0.035	21.9	43.1	4.0	1.8	17.1	0.3	0.8	0.6
		n	9	9	9	9	9	9	9	9	9	9	9
6-2	<u>Dipodomys</u> <u>merriami</u>	Mean	0.726	0.933	1.390	307	724	111	29.9	478	6.2	0.8	4.7
		SEM	0.066	0.087	0.049	22.8	40.3	29.5	1.6	13.3	0.4	0.1	1.5
		n	4	4	4	4	4	4	4	4	4	4	4
	<u>Dipodomys</u> <u>deserti</u>	Mean	1.200	0.761	1.480	394	919	132	52.1	336	5.9	1.4	3.2
		SEM											
		n	1	1	1	1	1	1	1	1	1	1	1
31-1	<u>Dipodomys</u> <u>merriami</u>	Mean	0.730	0.966	1.456	353	766	110	33.2	602	5.6	0.5	9.1
		SEM	0.064	0.042	0.023	14.4	34.4	9.4	1.7	20.3	0.2	0.1	4.3
		n	12	12	12	12	12	12	12	12	12	8	12
	<u>Dipodomys</u> <u>deserti</u>	Mean	0.910	1.199	1.219	379	768	86.7	35.8	390	6.1	0.6	5.1
		SEM	0.082	0.063	0.032	19.1	67.0	4.8	4.9	33.9	0.3	0.1	2.3
		n	3	3	3	3	3	3	3	2	2	2	3

Table 14 (Continued) (kidney).

Study site	Species		Si	Ti	V	Ni	Mo ug/g	Cr	Sr	Ba	Li	Sn	Pb
5-1	<u>Dipodomys deserti</u>	Mean SEM n	170 95.2 9	1.1 0.2 8	tr	10.4 4.8 4	3.6 0.2 9	-	1.2 0.1 9	0.5 <0.1 9	0.6 0.2 4	-	-
6-2	<u>Dipodomys merriami</u>	Mean SEM n	80.8 46.4 4	1.4 0.2 4	tr	16.6 10.5 2	3.1 0.2 4	-	0.5 0.1 4	0.4 <0.1 4	0.8 0.1 3	-	-
	<u>Dipodomys deserti</u>	Mean SEM	27.0 1	0.7 1	tr	-	4.0 1	-	0.9 1	0.4 1	tr	-	-
31-1	<u>Dipodomys merriami</u>	Mean SEM n	38.1 8.5 12	1.1 0.1 12	tr	6.9 1	3.8 0.3 12	0.8 0.3 3	0.8 0.1 12	0.5 <0.1 12	0.9 0.9 10	-	1.2 1
	<u>Dipodomys deserti</u>	Mean SEM n	145 134 3	0.8 <0.1 3	tr	-	4.5 0.9 3	-	1.3 0.3 3	0.6 0.1 3	1.4 1.3 2	0.6 0.1 2	-

Table 15. Mineral element composition of pooled Kangaroo Rat tissues sampled from East Mesa study sites in 1977. (Heart).

Study site	Species		P	Na %	K	Ca	Mg	Zn ug/g	Cu	Fe	Mn	B	Al
7-2	<u>Dipodomys merriami</u>	Mean	0.822	0.331	1.130	183	467	51.1	11.6	759	0.2	-	10.9
		SEM	0.028	0.006	0.025	9.2	40.1	2.3	0.7	44.8	0.0		2.2
		n	3	3	3	3	3	3	3	3	2		3
	<u>Dipodomys deserti</u>	Mean	0.831	0.441	1.473	293	750	42.6	14.4	881	-	0.9	2.4
		SEM	0.027	0.014	0.052	16.2	54.2	4.9	0.5	9.4			0.3
		n	3	3	3	3	3	3	3	3		1	3
8-2	<u>Dipodomys merriami</u>	Mean	0.681	0.351	1.069	258	537	33.0	13.0	677	0.4	-	5.7
		SEM	0.010	0.005	0.079	25.5	74.1	3.7	1.0	4.4	0.1		1.1
		n	3	3	3	3	3	3	3	3	3		3
	<u>Dipodomys deserti</u>	Mean	0.753	0.456	1.142	283	536	49.9	12.8	713	0.2	-	19.2
		SEM	0.16	0.024	0.042	24.0	37.7	2.9	0.8	48.8	0.1		5.4
		n	6	6	6	6	6	6	6	6	4		6

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			Si	Ti	V	Ni	Mo ug/g	Cr	Sr	Ba	Li	Sn	Pb
7-2	<u>Dipodomys merriami</u>	Mean	16.8	-	tr	1.0	0.6	-	0.3	0.7	-	-	-
		SEM	5.0				0.1		<0.1	0.1			
		n	3			1	3		3	3			
	<u>Dipodomys deserti</u>	Mean	5.4	-	tr	0.8	1.1	-	0.4	0.8	-	-	-
		SEM	1.9			0.2	0.1		0.1	0.1			
		n	3			2	3		2	3			
8-2	<u>Dipodomys merriami</u>	Mean	11.4	1.2	tr	1.8	1.0	-	0.4	0.7	-	1.0	-
		SEM	1.0	0.1		0.8	0.3		<0.1	1			
		n	3	2		3	3		3	3		1	
	<u>Dipodomys deserti</u>	Mean	16.2	-	tr	0.8	0.6	-	0.7	0.9	-	-	-
		SEM	3.7				<0.1		0.1	0.1			
		n	6			1	6		6	6			

Table 15 . (Continued) (muscle).

Study site	Species		P	Na %	K	Ca	Mg	Zn	Cu	Fe	Mn	B	Al
ug/g													
7-2	<u>Dipodomys merriami</u>	Mean	0.868	0.238	1.967	222	947	59.0	5.4	135	0.6	-	7.2
		SEM	0.031	0.015	0.165	40.3	25.4	3.9	0.4	7.8	0.1		0.3
		n	3	3	3	3	3	3	3	3	3		3
	<u>Dipodomys deserti</u>	Mean	0.819	0.238	1.993	293	934	36.9	4.3	118	0.4	-	6.0
		SEM	0.035	0.007	0.122	38.3	68.8	3.1	0.1	9.5	0.1		1.0
		n	3	3	3	3	3	3	3	3	3		3
8-2	<u>Dipodomys merriami</u>	Mean	0.773	0.207	1.897	261	1178	32.8	5.4	143	0.7	-	14.0
		SEM	0.028	0.010	0.107	19.3	260	1.3	0.2	9.5	<0.1		1.6
		n	3	3	3	3	3	3	3	3	3		3
	<u>Dipodomys deserti</u>	Mean	0.846	0.248	1.893	205	872	52.0	4.1	82.7	0.7	-	12.6
		SEM	0.028	0.007	0.072	17.9	80.6	3.2	0.2	5.5	0.1		4.1
		n	6	6	6	6	6	6	6	6	6		6
ug/g													
			Si	Ti	V	Ni	Mo	Cr	Sr	Ba	Li	Sn	Pb
7-2	<u>Dipodomys merriami</u>	Mean	20.1	0.5	tr	tr	0.3	-	0.4	0.8	-	-	-
		SEM	0.4						0.1	0.1			
		n	3	1			1		3	3			
	<u>Dipodomys deserti</u>	Mean	16.9	tr	tr	2.5	-	-	0.4	1.0	-	0.9	-
		SEM	2.0			0.7			0.1	0.1		0.6	
		n	3			3			3	3		3	
8-2	<u>Dipodomys merriami</u>	Mean	50.0	1.3	tr	1.8		-	0.3	1.2	-	0.8	-
		SEM	11.0	0.8		0.5			0.0	0.2		0.1	
		n	3	2		2	1		3	3		-	
	<u>Dipodomys deserti</u>	Mean	52.2	0.7	tr	1.0	-	-	0.5	1.4	-	-	-
		SEM	25.0						0.1	0.3			
		n	3	2		2	1	3	3		-		

Table 15 . (Continued) (lung).

Study site	Species		P	Na %	K	Ca	Mg	Zn	Cu ug/g	Fe	Mn	B	Al
7-2	<u>Dipodomys merriami</u>	Mean	0.820	0.585	1.270	463	482	50.9	7.0	737	-	-	22.5
		SEM	0.015	0.005	0.038	37.9	45.8	6.8	0.1	24.1			2.3
		n	3	3	3	3	3	3	2	3			3
	<u>Dipodomys deserti</u>	Mean	0.770	0.781	1.423	551	486	34.4	8.7	763	-	-	15.2
		SEM	0.043	0.039	0.143	38.3	8.3	4.8	0.9	58.5			2.9
		n	3	3	3	3	3	3	3	3			3
8-2	<u>Dipodomys merriami</u>	Mean	0.789	0.692	1.400	559	544	29.8	5.7	697	-	-	23.1
		SEM	0.027	0.015	0.131	29.2	49.1	2.6	0.4	24.5			2.8
		n	3	3	3	3	3	3	3	3			3
	<u>Dipodomys deserti</u>	Mean	0.797	0.621	1.202	462	359	35.6	6.9	816	-		22.7
		SEM	0.021	0.046	0.067	73.0	22.7	0.9	0.5	37.4			3.6
		n	6	6	6	6	6	6	6	6			6

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Study site	Species		Si	Ti	V	Ni	Mo	Cr	Sr	Ba	Li	Sn	Pb
7-2	<u>Dipodomys merriami</u>	Mean	83.1	0.7	tr	0.6	1.3	-	1.2	1.1	-	-	-
		SEM	21.6				0.2		0.1	0.1			
		n	3	1		1	3		3	3			
	<u>Dipodomys deserti</u>	Mean	35.4	0.8	tr	4.6	1.5	-	0.8	0.8	-	0.7	-
		SEM	6.6	0.1			0.3		0.1	0.1			
		n	3	2		1	3		3	3		3	
8-2	<u>Dipodomys merriami</u>	Mean	59.7	1.3	tr	2.9	1.1	-	0.8	1.1	-	0.8	-
		SEM	7.3	0.3		0.5	0.3		0.1	0.1		0.1	
		n	3	2		3	3		3	3		2	
	<u>Dipodomys deserti</u>	Mean	54.9	0.8	tr	tr	1.3	-	1.1	1.3	-	-	-
		SEM	12.9	0.3			0.1		0.1	0.1			
		n	6	4			6		6	6			

Table 15 . (Continued) (spleen).

Study site	Species		P	Na %	K	Ca	Mg	Zn	Cu	Fe	Mn	B	Al
			ug/g										
7-2	<u>Dipodomys merriami</u>	Mean	1.467	0.452	1.807	232	773	108	33	468	1.8	-	8.3
		SEM	0.090	0.008	0.037	12.5	69.4	17.7	0.1	52.1	0.1	-	1.3
		n	3	3	3	3	3	3	3	3	3	-	3
	<u>Dipodomys deserti</u>	Mean	1.850	0.559	2.773	333	803	77.8	3.8	649	0.7	-	6.7
		SEM	0.476	0.124	0.721	91.7	134	23.1	0.8	303	0.2	-	1.8
		n	3	3	3	3	3	3	3	3	3	-	3
8-2	<u>Dipodomys merriami</u>	Mean	1.420	0.452	1.730	504	1170	85.0	12.9	563	2.8	-	6.4
		SEM										-	
		n	1	1	1	1	1	1	1	1	1	-	1
	<u>Dipodomys deserti</u>	Mean	1.280	0.469	1.607	248	776	73.6	3.5	620	1.8	-	7.7
		SEM	0.101	0.010	0.119	35.6	59.7	8.1	0.5	22.7	0.5	-	1.2
		n	6	6	6	6	6	6	6	6	6	-	6

Study site	Species		Si	Ti	V	Ni	Mo	Cr	Sr	Ba	Li	Sn	Pb
			ug/g										
7-2	<u>Dipodomys merriami</u>	Mean	17.7	tr	tr	-	0.6	-	0.7	1.0	-	-	-
		SEM	3.6				0.0		0.1	0.1			
		n	3				3		3	3			
	<u>Dipodomys deserti</u>	Mean	9.4	tr	tr	-	0.9	-	0.8	1.0	-	0.6	-
		SEM	1.7				0.4		0.2	0.3		0.4	
		n	3				3		3	3		2	
8-2	<u>Dipodomys merriami</u>	Mean	18.0	tr	tr	0.7	0.8	2.4	1.1	2.4	-	tr	-
		SEM											
		n	1			1	1	1	1	1			
	<u>Dipodomys deserti</u>	Mean	23.4	tr	tr	1.0	1.1	-	1.2	1.5	-	-	-
		SEM	6.3			0.2	0.2		0.1	0.3			
		n	5			2	6		6	6			

Table 15 (liver).

Study site	Species		P	Na %	K	Ca	Mg	Zn	Cu ug/g	Fe	Mn	B	Al
7-2	<u>Dipodomys merriami</u>	Mean	1.022	0.449	1.283	180	641	82.1	19.3	572	5.9	-	2.3
		SEM	0.019	0.016	0.054	8.0	92.3	8.1	2.5	5.5	0.5	-	0.1
		n	3	3	3	3	6	3	3	6	3	-	3
	<u>Dipodomys deserti</u>	Mean	1.024	0.511	1.323	196	782	82.1	19.7	538	7.3	-	2.9
		SEM	0.037	0.010	0.027	12.4	188	5.8	2.4	41.6	1.6	-	0.4
		n	3	3	3	3	3	3	3	3	3	-	3
8-2	<u>Dipodomys merriami</u>	Mean	0.941	0.547	1.247	192	772	58.2	17.1	578	7.9	-	4.0
		SEM	0.032	0.022	0.112	9.1	209	7.8	0.8	14.1	1.1	-	0.5
		n	3	3	3	3	3	3	3	3	3	-	3
	<u>Dipodomys deserti</u>	Mean	0.900	0.482	1.159	164	578	64.9	14.6	577	5.7	-	3.4
		SEM	0.028	0.032	0.074	9.0	29.2	3.1	1.4	15.0	0.5	-	0.8
		n	6	6	6	6	6	6	5	6	6	-	5

Study site	Species		Si	Ti	V	Ni	Mo ug/g	Cr	Sr	Ba	Li	Sn	Pb
7-2	<u>Dipodomys merriami</u>	Mean	5.8	-	tr	1.2	7.3	-	0.6	0.8	-	-	-
		SEM	0.2				1.8		<0.1	<0.1			
		n	3			1	3		3			1	
	<u>Dipodomys deserti</u>	Mean	8.0	tr	tr	1.7	11.3	-	0.5	0.7	-	0.5	-
		SEM	1.1			0.8	3.1		<0.1	<0.1			
		n	2			3	3		3	3		1	
8-2	<u>Dipodomys merriami</u>	Mean	5.5	-	tr	1.2	7.2	-	0.4	0.8	-	0.7	-
		SEM	0.4				2.3		0.1	0.1			
		n	3			1	3		3	3		1	
	<u>Dipodomys deserti</u>	Mean	8.9	0.9	tr	0.7	8.4	-	0.7	1.6	-	-	-
		SEM	1.4				1.1		0.1	0.8			
		n	5	1		1	6		6	6			

Table 15 . (kidney).

Study site	Species		P	Na %	K	Ca	Mg	Zn ug/g	Cu	Fe	Mn	B	Al
7-2	<u>Dipodomys merriami</u>	Mean	1.213	0.576	1.623	231	607	92.8	22.9	527	2.9	-	4.3
		SEM	0.048	0.010	0.087	13.1	83.4	4.1	0.5	30.4	0.2		1.4
		n	3	3	3	3	3	3	3	3	3		3
	<u>Dipodomys deserti</u>	Mean	1.187	0.690	1.593	288	718	81.5	26.8	399	4.9	-	11.2
		SEM	0.092	0.019	0.074	16.1	80.8	5.8	1.2	35.9	1.1		0.4
		n	3	3	3	3	3	3	3	3	3		3
8-2	<u>Dipodomys merriami</u>	Mean	1.050	0.565	1.367	242	768	66.8	20.4	457	3.9	0.3	6.3
		SEM	0.027	0.010	0.034	14.8	134	3.5	0.8	42.0	0.5		0.5
		n	3	3	3	3	3	3	3	3	3	1	3
	<u>Dipodomys deserti</u>	Mean	1.060	0.587	1.448	246	852	76.9	26.9	448	5.5	-	37.1
		SEM	0.046	0.047	0.060	22.8	67.8	4.2	3.0	24.7	0.8		16.5
		n	6	6	6	6	6	6	6	6	6		6

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Study site	Species		Si	Ti	V	Ni	Mo	Cr	Sr	Ba	Li	Sn	Pb
ug/g													
7-2	<u>Dipodomys merriami</u>	Mean	7.8	-	tr	0.9	4.3	-	0.5	0.9	-	-	-
		SEM	0.2				0.9		< 0.1	0.1			
		n	3			1	3	1	3	3		3	
	<u>Dipodomys deserti</u>	Mean	14.2	1.6	tr	2.8	3.7	1.0	0.7	0.8	-	0.9	-
		SEM	5.1				1.1		<0.1	0.1		0.2	
		n	3	1		1	3		3	3			
8-2	<u>Dipodomys merriami</u>	Mean	14.2	-	tr	0.8	3.3	-	0.5	0.9	-	0.7	-
		SEM	0.4				1.9		<0.1	0.1		0.1	
		n	3			1	3		3	3		3	
	<u>Dipodomys deserti</u>	Mean	67.0	tr	tr	-	4.7	-	0.8	1.4	-	-	-
		SEM	22.8				0.8		<0.1	0.2			
		n	6				6		6	6			

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[illegible]

Table 16 . (Continued).

Study site	Species		Si	Ti	V	Co	Ni	Mo ug/g	Cr	Sr	Ba	Li	Sn	Pb
7-2	<u>Dipodomys merriami</u>	Mean	865	21.3	4.5	2.1	6.6	1.4	1.4	2.2	7.6	0.8	0.9	3.8
		SEM	125	1.4	0.2		0.7	1.1	0.2	0.4	1.0	0.1	0.1	1.7
		n	11	11	11	1	11	4	11	11	11	11	11	11
8-2	<u>Dipodomys deserti</u>	Mean	610	13.8	3.6	2.6	7.4	0.3	1.9	2.6	7.4	0.8	1.1	8.9
		SEM	120	3.5	0.3	0.1	0.8	0.1	0.3	1.2	1.1	0.1	0.1	7.3
		n	9	9	9	9	9	5	9	9	9	9	9	3
8-2	<u>Dipodomys merriami</u>	Mean	582	12.5	3.3	2.7	7.6	tr	1.0	0.9	5.7	0.9	0.7	1.6
		SEM	50.4	4.8	0.4	0.2	0.8		0.2	0.3	1.2	0.1	0.3	
		n	3	3	3	3	3		3	3	3	3	3	1
	<u>Dipodomys deserti</u>	Mean	1158	23.5	4.7	2.2	6.4	0.4	1.6	4.1	15.6	0.4	1.2	1.4
		SEM	287	8.4	0.4	0.2	0.6	0.1	0.2	1.2	5.4	0.1	0.1	0.2
		n	12	12	12	10	12	3	12	12	11	4	12	4

tag elements generally were uniformly low in all kangaroo rat tissues examined.

Table 16 represents the mineral element composition of hair samples from the 1977 collection. Since no good method of homogenizing the hair samples was available, these samples were analyzed as individuals rather than as pooled samples. The 1976 hair samples are not presented here because improvements made in the emission spectrometric calibration standards for hair make them suspect of possible error. Original sample size was inadequate to permit another complete analysis of 1976 hair samples. The data in Table 16, like the 1976 tissue data in Table 14, represent variations among animals, since the values used in the tabulations are averages of three replicates.

As mentioned above, we encountered both species and location variations in many of the elemental constituents of the kangaroo rat tissues tabulated in Table 14. Because of our early decision to pool the 1977 tissues in order to provide samples of sufficient size to serve for future analytical reference, we cannot completely sort out all components of variance. Trends do occur, however, which raise some interesting questions when comparing the data for samples collected in 1976 and 1977 (Tables 14 and 15). It is generally advocated by animal physiologists that metabolically involved mineral element constituents in tissues should not vary significantly from time to time. Exceptions are trace elements of unknown physiological benefit which might accumulate in "sink" tissues. However, among the data reported herein for the two species of kangaroo rats, we found a number of cases where the ranges in tissue contents of several elements were strikingly lower in 1977 samples compared to 1976 samples. Examples of this are illustrated by the comparisons presented in Appendix C. We cross checked this situation and found it not to be analytical error. Influential in this situation

are two exceptionally different years (dry 1976; wet 1977) in which different kinds of seed-producing and succulent plant species might have contributed a significantly different food source each year, and which might have altered the moisture stress to which each year's population of kangaroo rats was subjected. Questions yet to be resolved in future investigations will examine the extent to which the mineral elements in tissues of these small mammals may inherently vary seasonally and from location to location. In spite of such variations, if indeed they occur, these small mammals should be useful for monitoring any input of geothermal source pollutants into the ecosystem which, in turn, move through their food chain.

CONCLUSIONS

Data presented herein will serve as a baseline reference source for comparing the chemical composition of soil, vegetation, and small mammal samples collected from the same sampling sites at future times in order to determine if geothermal source pollutants are being disseminated into the surrounding environment. These data will be especially useful to help identify any salts and elemental pollutants likely to be carried downwind from a future geothermal power generating installation in East Mesa. Weaknesses lie primarily in the relatively few sampling sites one could afford to establish around the proposed installation and continue to monitor periodically. We learned from this study that certain compromises due to land conditions and accessibility are necessary when orienting and selecting baseline study sites in relation to several different site-specific sources of environmental pollution such as would be represented by several production wells feeding into a central geothermal power generating plant. Nevertheless, the dispersal mechanisms for potential geothermal pollutants are such that one should always take

advantage of downwind locations from a source and select sampling sites using wind-rose information.

Ideally, biological baseline data should be collected at potential geothermal energy development sites before any road building, well drilling, and construction activities begin. However, one can always establish baseline reference data for a given point in time relative to a potential pollution source through chemical analysis of major ecosystem components as represented in this report.

REFERENCES

- Alexander, G. V., D. R. Young, D. J. McDermott, M. J. Sherwood, A. J. Mearns, and O. R. Lunt. 1975. Marine organisms in the Southern California Bight as Indicators of Pollution, p. 955-992, In Int. Conf. on Heavy Metals in the Environment, Toronto, Ontario, Canada, Oct. 27-31, 1975.
- Bradford, G. R., A. L. Page, L. J. Lund, and W. Olmstead. 1975. Trace element concentration of sewage treatment plant effluents and sludges: Their interaction with soils and uptake by plants. J. Environ. Qual. 4(1):123-126.
- Lindberg, R. G., E. M. Romney, J. H. Olafsen, and K. H. Larson. 1955. Factors influencing the biological fate and persistence of radioactive fallout. USAEC Report WT-1177, p. 30.
- Romney, E. M., V. Q. Hale, A. Wallace, O. R. Lunt, J. D. Childress, H. Kaaz, G. V. Alexander, J. E. Kinnear, and T. L. Ackerman. 1973. Some Characteristics of Soil and Perennial Vegetation in Northern Mojave Desert Areas of the Nevada Test Site, USERDA Report, UCLA #12-916, p. 9-12.
- Turner, F. B. 1976. EPA Quarterly Report, Jan. 1, 1976.
- USDA, Salinity Laboratory Staff. 1954. Methods for soil characterization, p. 83-126 In Diagnosis and Improvement of Saline and Alkali Soils, L. A. Richards, ed., USDA Handbook 60.
- U. S. Department Of The Interior. 1973a. Special Report, Test Well 6-1, Geothermal Resources investigations, Imperial Valley, CA 44 p.
- U. S. Department Of The Interior. 1973b. Final Environmental Statement For the Geothermal Leasing Program, Vol. 2, U. S. Govt. Printing Office.

U. S. Department of the Interior. 1977. Geothermal Resource Investigations, East Mesa Test Site, p. 28-38, Imperial Valley, CA.

Wallace, A. and E. M. Romney. 1972. Radioecology and Ecophysiology of Desert Plants at the Nevada Test Site. USAEC Report TID-25954, p. 247-257.

APPENDIX A

Location, Design and Description of Study Sites

Location of Study Sites at East Mesa KGRA

UCLA Site

number	Township	Range	Section	Subsection
31-1	15S	17E	31	D
32-1	15S	17E	32	Q
5-1	16S	17E	5	A
5-2	16S	17E	5	N
5-3	16S	17E	5	J
6-2	16S	17E	6	R
6-3	16S	17E	6	R
6-4	16S	17E	7	R
6-5	16S	17E	6	H
7-1	16S	17E	7	A
7-2	16S	17E	7	A
8-2	16S	17E	8	F
22-2	16S	17E	22	B
Alfalfa field	16S	16E	13	M
Sugar beet field	15S	16E	30	E

PLOT 31-1

Township 15 S

Range 17 E

Section 31D

Location: East of well, ca 100 m after
beginning of vegetation.

Transect Pattern: 8 line transects (200 m each), E-W at random from N-S line. 8 belt transects (200 X 2m) centered on line transects. 5 quadrats (50 X 50m).

Vegetative Characteristics: % cover from line transects. All shrubs whose base is inside belt transect were counted for density determination. Quadrats (H , W_1 , W_2) were measured for all shrubs whose base is inside, and those outside whose canopy touches belt transect.

Plant Samples: Composite samples of prominent vegetation were taken.

Soil Samples: Surface (0-2.5 cm) samples taken in bare area and under shrubs. Profile samples taken along N-transect #2 which lies in this plot. Moisture and temperature probes installed.

Animals; 4 lines, 15 m apart starting at line one and south of line one. 100 traps at 15 m intervals. Sampled February 1976.

PLOT 32-1

Township 15 S

Range 17 E

Section 32 Q

Location: 0.3 mile west of well 5-1
100 m N of Section Road.

Transect Pattern: 8 belt transects (200 X 4 m), E-W at random from a N-S line.

Vegetative Characteristics: Dimensions (H, W_1 , W_2) of shrubs whose base is inside the transect. Density and biomass of annuals and herbaceous perennials in quadrats (1 m² each).

Plant Samples: New growth from 6 staked Larrea tridentata along each of 7 transects, 8 along the 8th. Plantago insularis (annual) sampled at each stake. 50 samples, each species. Sample numbers are stake numbers, as above.

Soil Samples: 10 surface samples (0 - 2.5 cm) at staked locations throughout grid in the open (bare surfaces). Moisture and temperature probes set out.

Animals: No sampling.

PLOT 5-1

Township 15S & 16 S

Range 17 E

Section 32R & 5A

Location: Split plot N & S
of well 5-1, ca 100 m
after start of vege-
tation.

Well 5-1

Transect Pattern: 12 lines (200 m each) at random from E-W lines. 1 thru 6 are south of well, 7 thru 12 are north. 12 belt transects (200 X 2 m) centered on lines.

Vegetative Characteristics: % cover from line intercept measurements.

Density measured by counting shrubs whose base is inside belt transect.

Plant Samples: Composite samples of Larrea tridentata were taken.

Soil Samples: Soil profile samples taken from N-transect #1 in this plot. Surface (0-2.5 cm) samples also collected in bare area and under shrubs.

Animal Samples: 2 lines north of well 15 m apart; plus 2 lines south, each with 25 traps at 15 m intervals. Sampled Feb. 1976.

LINE 5-2

N-S line 0.1 mile east of
section road and parallel to it.
#1 stake is 0.1 mile east of turn
off to well 6-1. Numbers increase
to south.

Township 16 S

Range 17 E

Section 5N

Transect Pattern: A line of 20 stakes.

Vegetative Characteristics: No measurements.

Plant Samples: New growth taken from 20 staked Larrea tridentata
shrubs for mineral analysis. Plantago insularis
(annual) taken at each stake.

Soil Samples: Surface samples (0-2.5 cm) taken at 10 staked
locations along line.

Animals: No samples.

Line 5-3

A N-S line ca 1 mile east of well
6-1, #1 stake is at south end,
numbers increase to north

Township 16 S
Range 17 E
Section 5J

Transect Pattern: A line of 10 stakes.

Vegetative Characteristics: No measurements.

Plant Samples: 10 Larrea tridentata samples were taken at staked
locations.

Soil Samples: 10 surface (0-2.5 cm) samples at staked locations
along line.

Animals: No samples.

PLOT 6-2

Township 16 S

Range 17 E

Section 6F

Location: N of well 6-2

Transect Pattern: 8 line transects (200 m each), running N-S at random locations along an E-W line; 8 belt transects (200 X 2 m) centered on lines.

Vegetative Characteristics: Cover and density measurements from line and belt transects.

Plant Samples: Composite samples of prominent vegetation taken.

Soil Samples: Surface (0-2.5 cm) soil samples taken in bare areas and under shrubs.

Animal Samples: Four lines 15 m apart, 25 traps each line, 15 m apart. Lines located along transects 1 - 4. Sampled in Feb. 1976.

LINE 6-3

N-S line starting 0.16 mile east of
well 6-1, running south to large
pipeline.

Township 16 S
Range 17 E
Section 6R

Transect Pattern: A line of 10 stakes.

Vegetative Characteristics: No determinations.

Plant Samples: 10 staked Larrea tridentata were sampled, and the
annual Baileya pauciradiata was sampled near each
stake.

Soil Samples: 10 surface (0-2.5 cm) soil samples were taken at
staked locations:

Animal Samples: None taken.

LINE 6-4

Line running SW of the large pipeline, starting 0.25 mile SE of well 6-1. #1 stake at the pipeline.

Township 16 S

Range 17 E

Section 6R

Transect Pattern: A line of 10 stakes.

Vegetative Characteristics: No determinations.

Plant Samples: 10 staked Larrea tridentata shrubs were sampled for mineral analysis. Samples of annual Plantago insularis were taken near each stake.

Soil Samples: 10 surface (0-2.5 cm) samples were taken at stakes in open near the plant locations.

Animal Samples: None taken.

LINE 6-5

E-W line ca 0.4 mile north
of well 6-1 and 0.2 mile west
of road, #1 stake at E end.

Township 16 S
Range 17 E
Section 6H

Transect Pattern: A line of 10 stakes.

Vegetative Characteristics: No determinations.

Plant Samples: Samples were taken from 10 staked Larrea tridentata
shrubs.

Soil Samples: 10 surface (0-2.5 cm) samples taken from staked
locations.

Animal Samples: None taken.

LINE 7-1

A SW-NE line, 0.42 mile SE
of well 6-1. Starts at large
pipeline, runs SW.

Township 16 S
Range 17 E
Section 7A

Transect Pattern: A line of 10 stakes.

Vegetative Characteristics: No determinations.

Plant Samples: 10 staked Larrea tridentata were sampled for mineral
analysis. The annual, Plantago insularis, was
sampled at each stake.

Soil Samples: 10 surface (0-2.5 cm) soil samples were taken at
stakes in the open.

Animal Samples: None taken.

Plot 7-2

Township 16 S

Range 17 E

Section 7A

Location: 1/2 mile SE well 6-1

Transect Pattern: 8 belt transects (200 X 4m) running N-S at random from E-W line; 80 quadrats (1 m^2), 10 at random along each transect line.

Vegetative Characteristics: Dimensions (H, W_1 , W_2) of all shrubs whose base is inside belt transect. Density and biomass of annuals and herbaceous perennials in 1 m^2 quadrats.

Plant Samples: New growth of Larrea tridentata at 50 staked locations for mineral analysis. Plantago insularis (annual) sampled at each stake.

Soil Samples: 10 staked surface (0-2.5 cm) soil samples were taken.

Animal Samples: Four lines, 15 m apart; 25 traps, 15 m apart, each line. Grid starts N & W of line 4. Sampled March 1977.

PLOT 8-2

Township 16 S

Range 17 E

Section 8F

Location: 8/10 mile SE well 6-1, 3/10 mile SE well 8-1.

Transect Pattern: 8 belt transects (200 X 4 m) N-S at random from an E-W line; 80 quadrats, (1 m^2 each), 10 at random along each transect.

Vegetative Characteristics: Dimensions (H , W_1 , W_2) of all shrubs whose base is inside transect. Density and biomass of annuals and herbaceous perennials determined on 1 m^2 quadrats.

Plant Samples: 50 staked Larrea tridentata were sampled. Plantago insularis (annual) was sampled at each stake.

Soil Samples: 10 surface (0-2.5 cm) soil samples were staked. Moisture and temperature probes set out.

Animal Samples: 4 lines 15 m apart, 25 traps each, 15 m apart. Grid starts at N end of transect 3. Sampled Mar. 1977.

LINE 22-1

A line, SE to NW, 3.25
miles SE of well 6-1.

Township 16 S
Range 17 D
Section 22B

Transect Pattern: A line of 10 stakes.

Vegetative Characteristics: No determinations.

Plant Samples: 10 staked Larrea tridentata were sampled for mineral
analysis.

Soil Samples: 10 surface (0-2.5 cm) soil samples were staked.

Animal Samples: None taken.

APPENDIX B

Frequency distributions of selected elements in leaf tissues of Larrea tridentata sampled from baseline study plot 7-2, East Mesa KGRA.

PHOSPHORUS

$\bar{x} = 2147.8800$
 $s^2 = 119217.3465$

POTASSIUM

$\bar{x} = 1.9067$
 $s = .0752$

100

CALCIUM

$\bar{x} = 1.005$
 $s = 0.055$

MAGNESIUM

$\bar{x} = .1699$
 $s = .0018$

SILICON

MEAN: 23.56
SD: 2.07

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STRONTIUM

$\bar{x} = 367.3060$
 $s^2 = 10024.6508$

LITHIUM

MEAN: 6.5
STDEV: 0.5
N: 50

Evaluation of Frequency Distribution Histograms for
Larrea tridentata in East Mesa Study Site 7-2

Element	Mean	S.D.	n	Chi-square goodness of fit test ¹	Skewness index ²	Sig- nificant at 5%	kurtosis index ³	Sig- nificant at 5%
	%							
Na	0.128	0.054	50	Cannot reject N*	0.4334	No	0.8204	No
K	1.907	0.274	50	"	-0.4081	"	0.8242	"
Ca	0.995	0.247	50	"	0.5826	Yes	0.8076	No
Mg	0.170	0.042	50	"	0.4817	No	0.7760	"
Si	0.236	0.103	50	Reject N	1.5864	Yes	0.7146	Yes
	ug/g							
P	2148	345	50	Cannot reject N*	0.4334	No	0.8204	No
Zn	15.3	6.0	44	"	1.5536	Yes	0.7538	"
Cu	8.2	2.5	49	"	2.1093	"	0.6816	Yes
Fe	367	68.0	50	"	0.2693	No	0.8133	No
Mn	24.9	11.0	50	Reject N	1.7495	Yes	0.7478	"
B	35.7	9.3	50	Cannot reject N	0.1769	No	0.8534	"
Al	387	85.0	50	"	0.7029	Yes	0.7919	"
Ti	27.7	7.0	50	"	0.8885	"	0.7784	"
Ni	2.1	1.0	42	"	0.7536	"	0.8178	"
Sr	367	100	50	"	0.3042	No	0.8081	"
Ba	14.9	2.6	50	"	0.6222	Yes	0.8078	"
Li	6.7	1.6	50	"	0.3337	No	0.8114	"
Sn	0.9	0.2	36	"	-0.1553	"	0.7803	"

¹Ref: Snedecor & Cochran, "Statistical Methods," Iowa State Univ. Press, 6th Ed.(1967).

²Ibid. p. 86.

³ Ibid. p. 87-88, and R. C. Geary, Biometrika 18:295 (1936).

*N = normality

APPENDIX C

Comparison of Mineral Element Components of Kangaroo Rat Tissues

Mean and 95% Confidence Limits

COMPARISON OF MINERAL ELEMENT COMPONENTS OF KANGAROO RAT TISSUES MEAN AND 95% CONFIDENCE LIMITS

PHOSPHORUS

MANGANESE