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Telluric profiling studies on the Papago Indian Reservation, Arizona

by

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards and nomenclature.

During April, 1979, four telluric profiles were made on the Papago Indian Reservation, Arizona as part of a mineral-assessment program by the U.S. Geological Survey. Two profiles were made near the Silver Bell-Waterman mountains, one near the Comababi Mountains, and one near the Santa Rosa Mountains (fig. 1).

Technique

Telluric profiling has proven to be an effective technique to delineate subsurface structure boundaries (particularly faults) in the Basin and Range province.

The technique employs a co-linear spread of three electrodes at 500 meter intervals. The drop in potential is measured between the middle and outer electrodes and a relative ratio of voltages obtained. The spread is leap-frogged along a traverse resulting in a profile of voltage changes relative to the first stations (0-1). The square of these voltage changes is equivalent to the relative changes in resistivity. For more discussion of the method see Beyer (1977).

Silver Bell Area

Two profiles were made in the Silver Bell area and were run perpendicular to each other in an attempt to delineate the boundaries of a basin apparent from audio-magnetotelluric (AMT) and gravity data (C. L. Long, unpub. data, 1979). The traverse locations are shown in figure 2. The telluric profile for line 1 (fig. 3) shows a sharp drop in relative voltage between stations 0 and 3 (comparable to more than a two-order magnitude drop in resistivity) probably the result of a fault between stations 1 and 2, close to the edge of the Waterman Mountains. Another drop in relative voltage between stations 6 and 7 is inferred to be

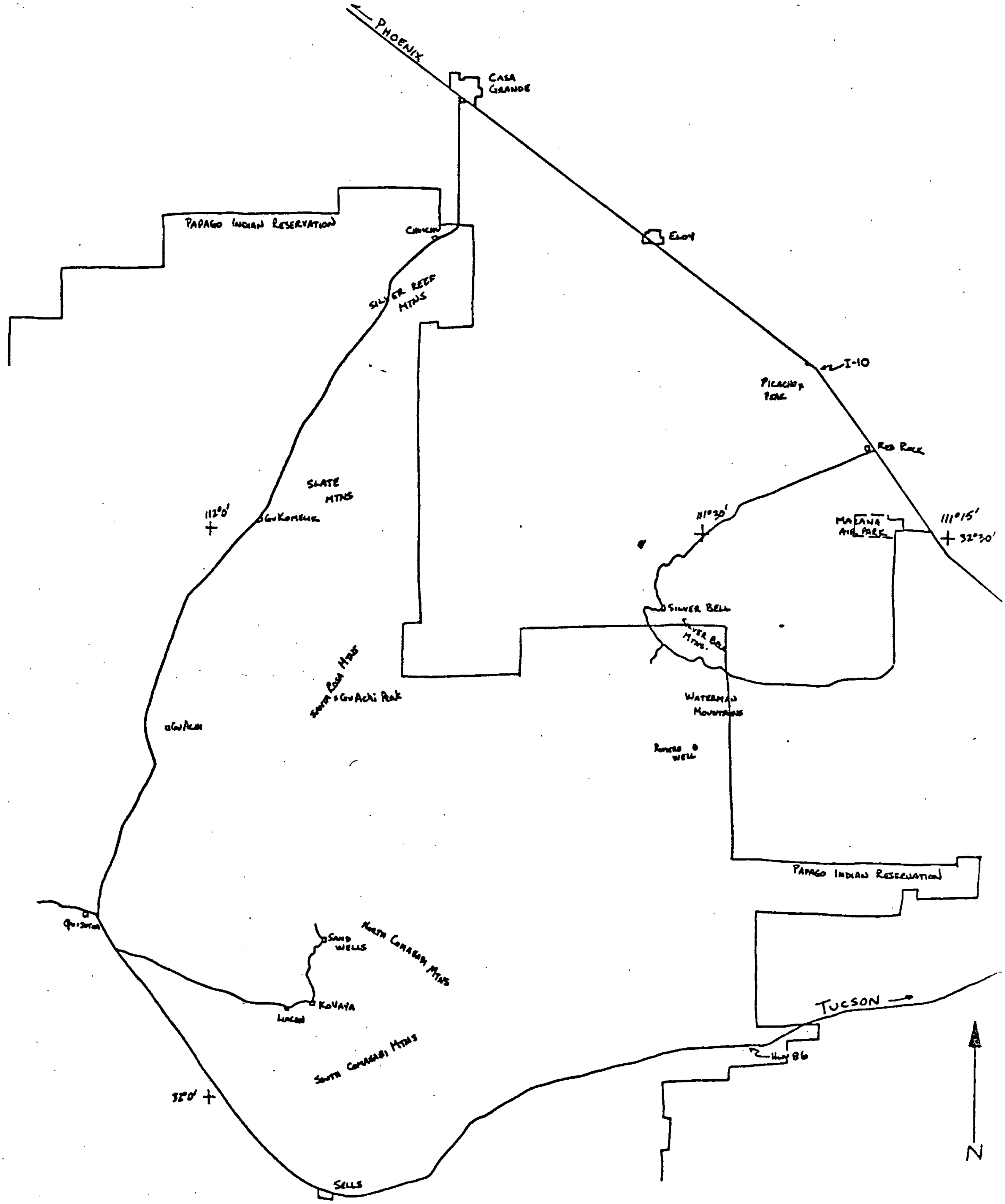

FIG. 1: PAPAGO INDIAN RESERVATION LOCATION MAP

SCALE: 0 1 2 3 4 5 6 MILES
0 2 4 6 8 KILOMETERS

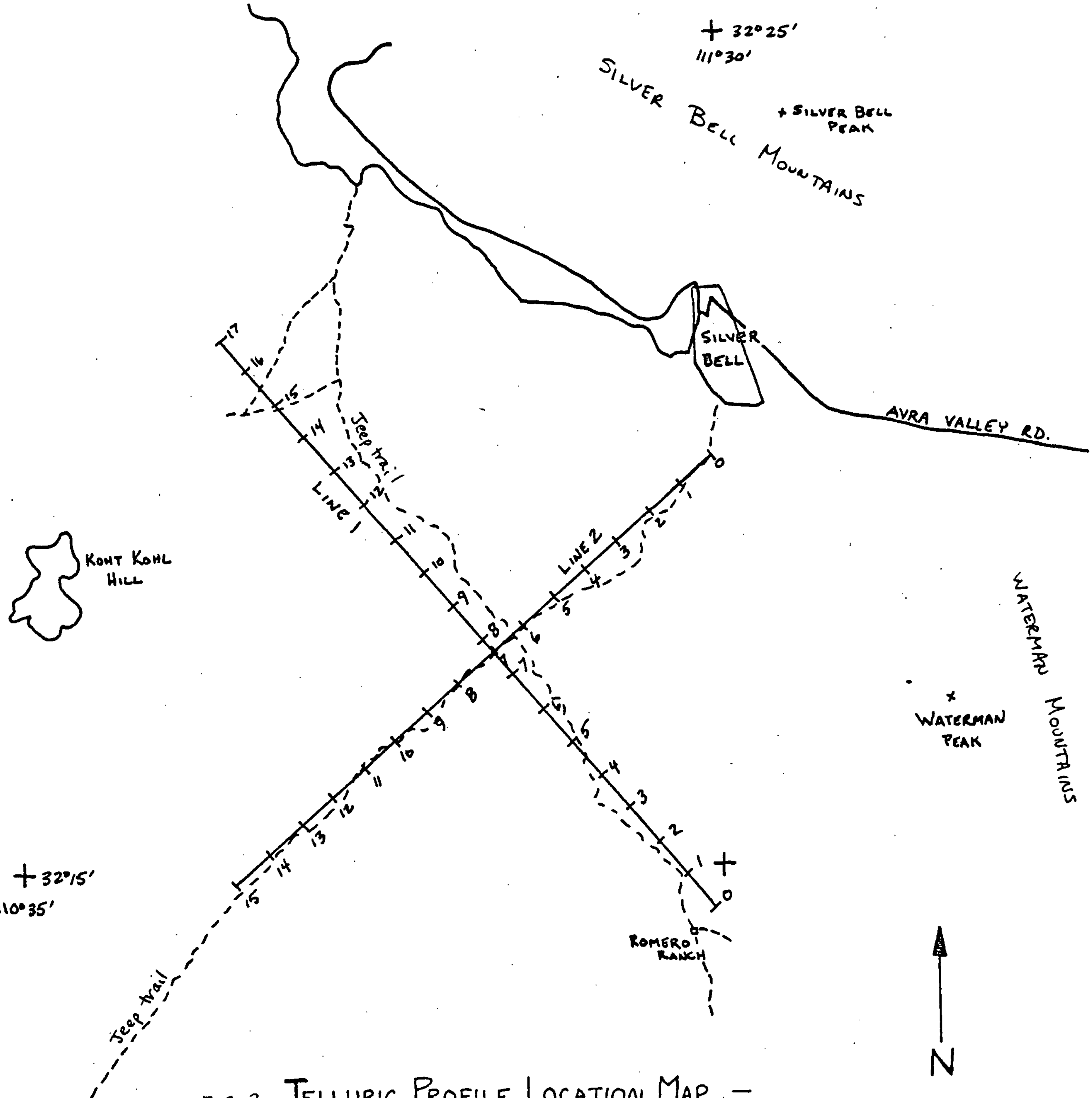

FIG. 2: TELLURIC PROFILE LOCATION MAP – VACA HILLS QUAD
PAPAGO INDIAN RESERVATION, AZ
SCALE 1:62500 0 500 METERS

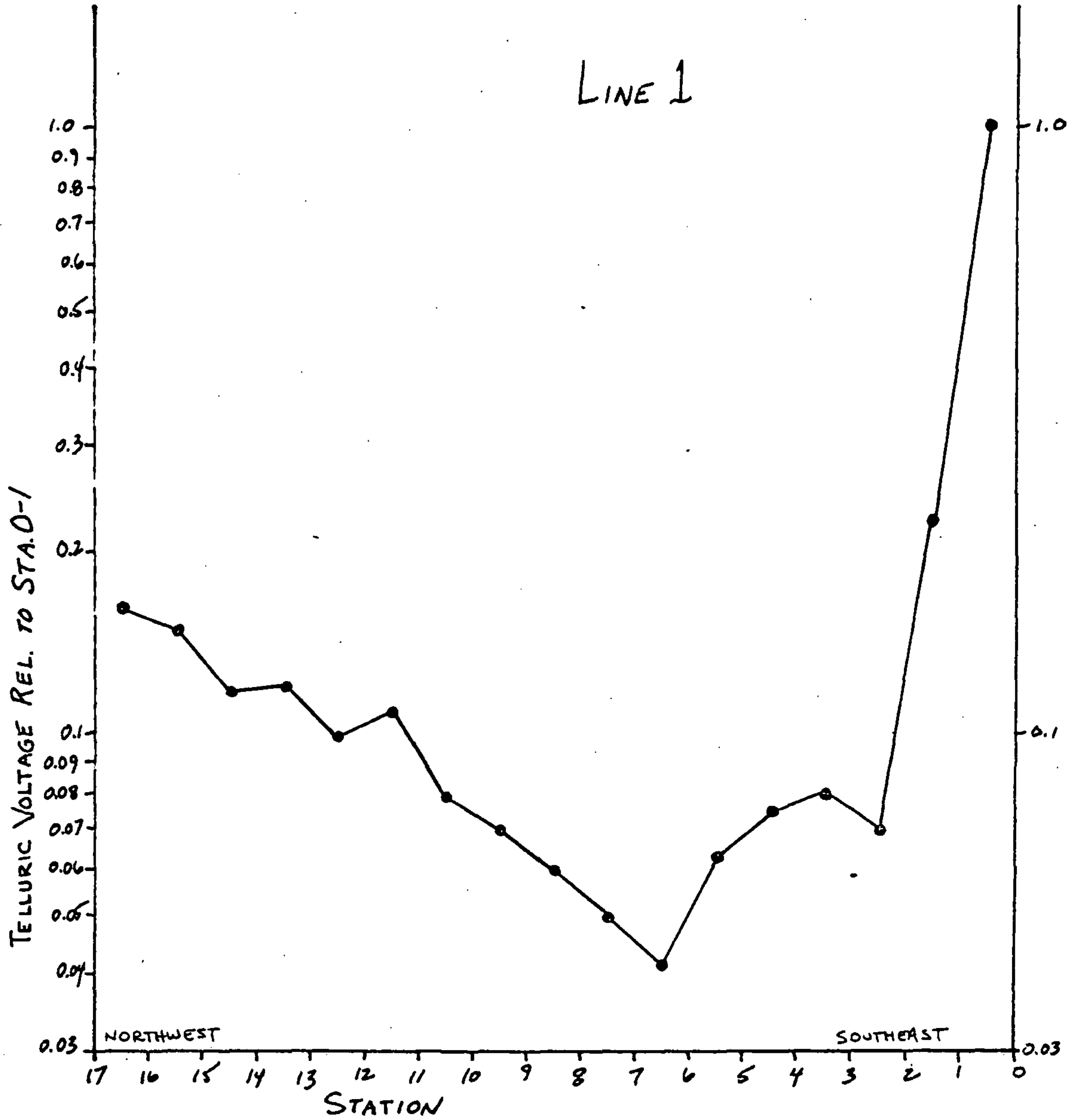

FIG. 3: TELLURIC PROFILE - VACA HILLS QUAD

0 500 METERS

another fault coinciding with the deepest part of the basin. Relative voltage gradually increases to the northwest presumably due to the basin shallowing.

Line 2 (fig. 4) shows a drop in relative voltage to the southwest of station 1 similar to that in line 1. This is probably the result of a major fault, which also causes the sharp decrease in profile 1 and has a trend of almost due north. The deepest part of the basin probably lies beneath stations 6 through 9 where the relative voltage is the lowest. To the southwest of station 9, the resistivity increases gradually, again due to the basin shallowing. The basin is probably of considerable depth reflected by the large voltage drop in both profiles.

Santa Rosa Mountains

The profile done near the Santa Rosa Mountains (fig. 5) shows a decrease in relative voltage (fig. 6) between stations 0 and 2 where the profile was mostly on volcanic rocks of the Santa Rosas. The profile lessens in slope between stations 2 and 8 probably reflecting the presence of a pediment. The sharp decrease in voltage at station 8 marks the faulted edge of the pediment with basin fill lying to the west coinciding with a decrease in resistivity.

Comababi Mountains

The Comababi profiles (fig. 7) shows a decrease in resistivity (fig. 8) as the traverse moved from volcanic bedrock (station 0) onto sediments to the southwest. The relative voltage continued dropping sharply with the lowest point between stations 5 and 6. No data was available at stations 8 and 9 due to very poor signal to noise ratio, probably related to low resistivities and polarization of the signal almost perpendicular

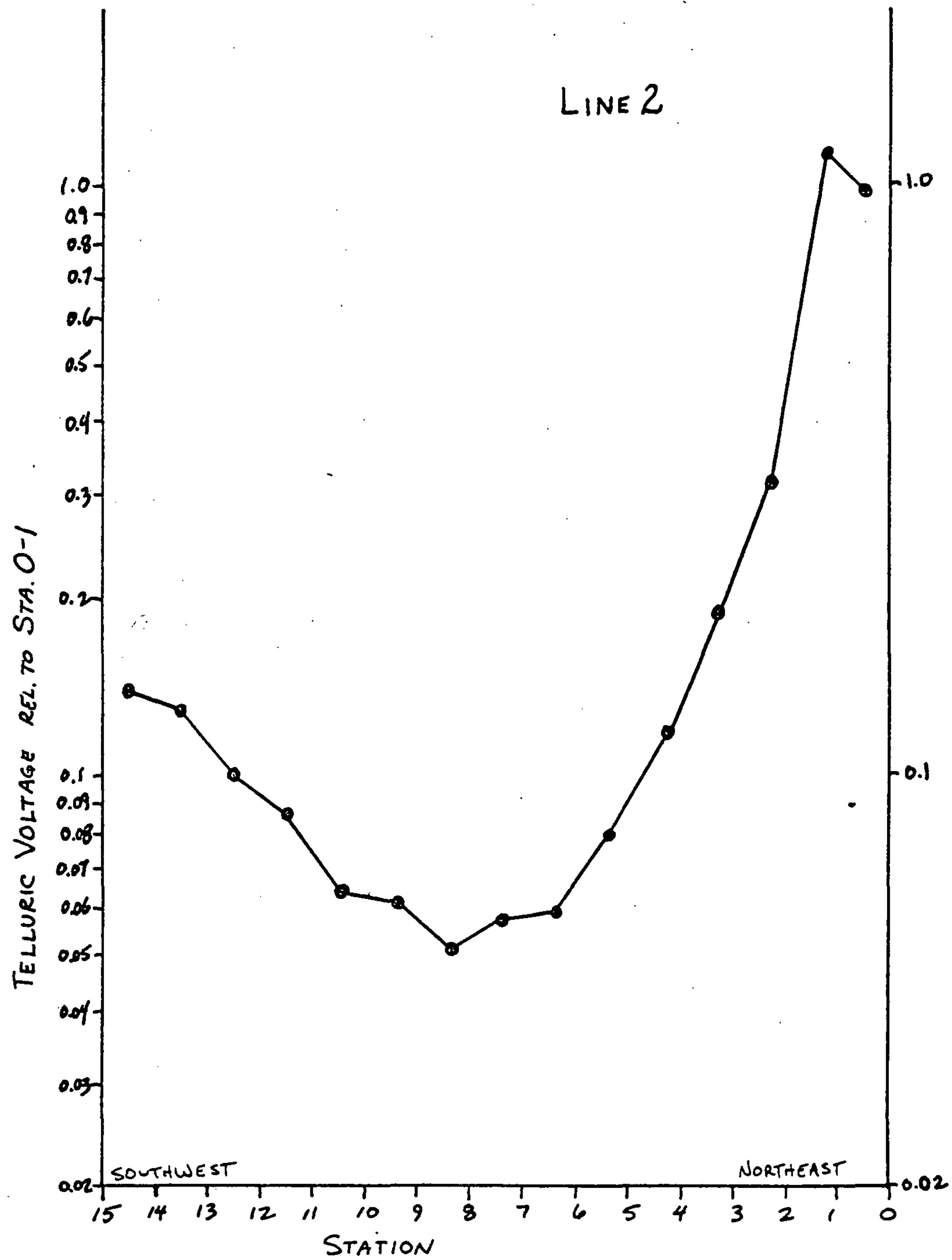

FIG. 4: TELLURIC PROFILE - VACA HILLS QUAD

0 500 METERS

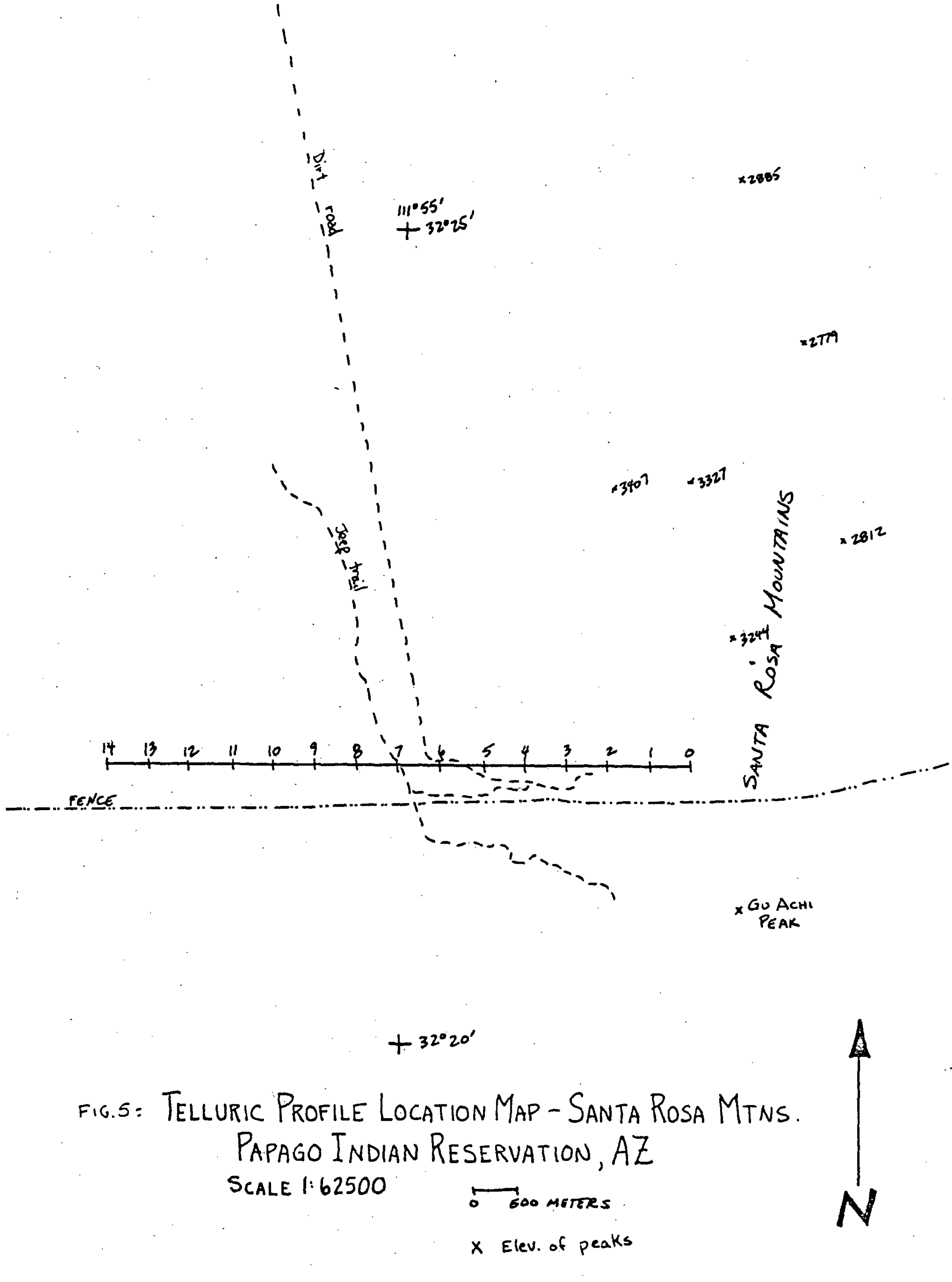

FIG. 5: TELLURIC PROFILE LOCATION MAP - SANTA ROSA MTNS.
PAPAGO INDIAN RESERVATION, AZ

SCALE 1:62500

0 600 METERS

X Elev. of peaks

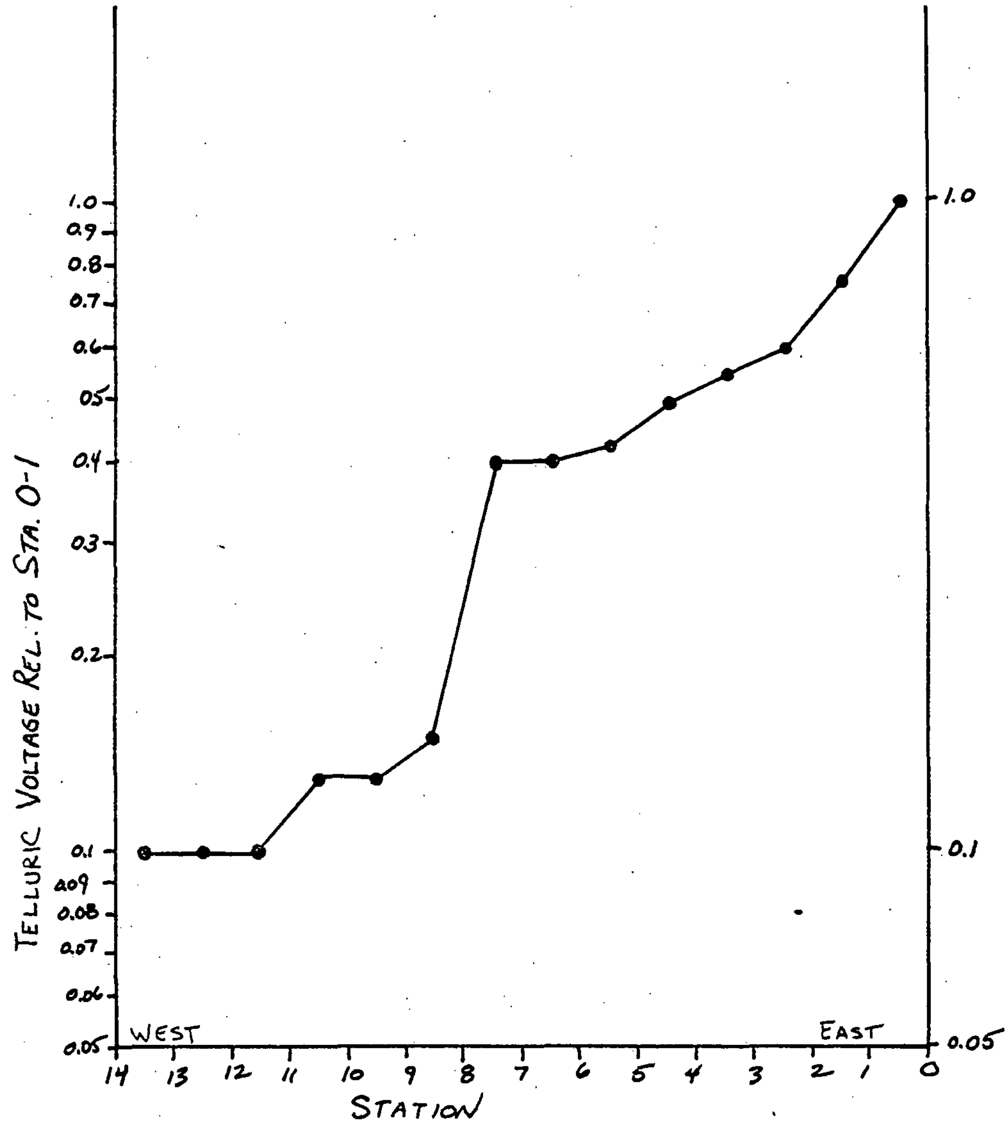

FIG. 6: TELLURIC PROFILE – SANTA ROSA MTNS.

0 500 METERS

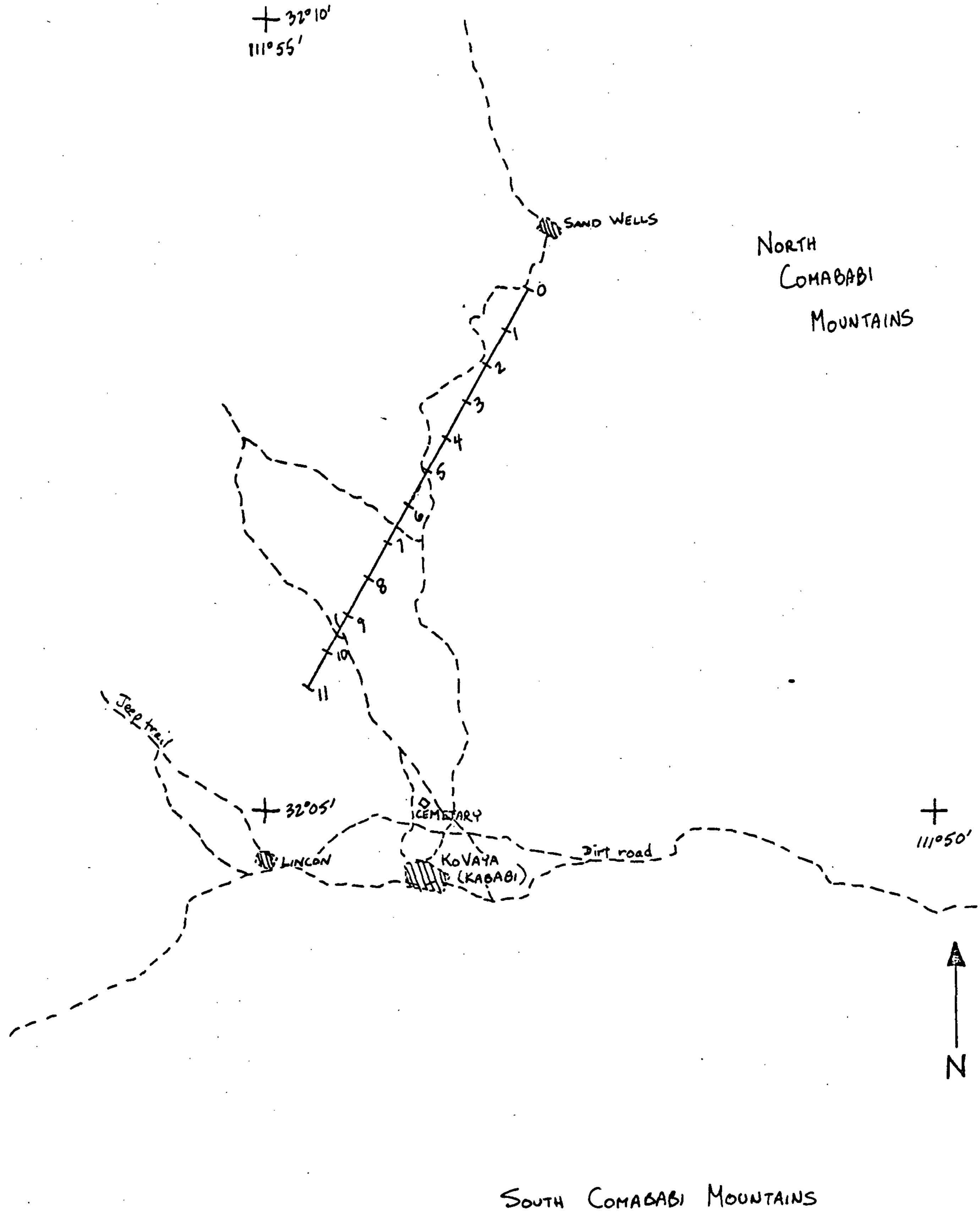

FIG. 7: TELLURIC PROFILE LOCATION MAP - COMABABI MTNS.
PAPAGO INDIAN RESERVATION, AZ
SCALE 1:62500 0 500 METERS

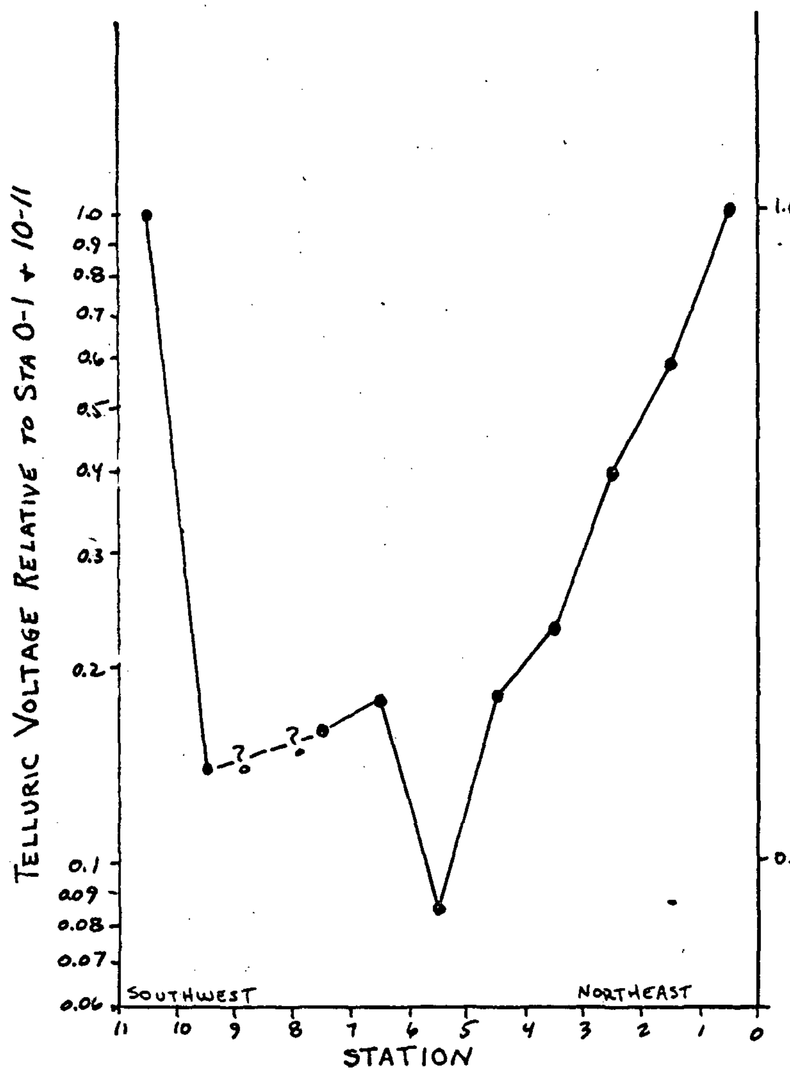

FIG. 8: TELLURIC PROFILE - COMABABI MTNS.
PAPAGO INDIAN RESERVATION, AZ

0 500 METERS

to the traverse caused by local structures. Because of this, the profile was moved to the southwest where station 11 was on volcanic bedrock and stations 10-11 was given a value of 1.0. The southwest end of the profile then shows almost an one-order drop in relative voltage between stations 11 and 9.

Conclusions

The telluric profiling technique proved to be very useful in detecting subsurface faults on the Papago Indian Reservation. The results tied in well with audio-magnetotelluric measurements made in the same areas (C. L. Long, unpub. data, 1979). The telluric method is a relatively fast and inexpensive means of reconnaissance, especially in mapping basins and faults. It takes a three-man crew who can complete two to five miles of traverse per day provided adequate signal strengths and the data can be reduced in a matter of hours.

References

Beyer, J. H., 1977, Telluric and D.C. Resistivity Techniques Applied to the Geophysical Investigation of Basin and Range Geothermal Systems, Part I--The E-field Ratio Telluric Method; Berkeley, California, Thesis, Lawrence Berkeley Laboratories, Report LBL-6325, 1/3.