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Power Line Noise in Transient Electromagnetic (TEM) Data: Identification and Removal in a Practical Field Study.

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INTRODUCTION: To evaluate the appropriateness of TEM in mapping deep groundwater tables (in Mars analog environmnets), a field study was carried out in the desert ~30 miles SW of Tucson, Arizona. The study was also designed to observe effects of powerline noise on TEM data. The clay-rich soil in the area is quite conductive. The study consisted of 40 in-loop TEM stations, divided into 3 lines, for 4 line-km of data. The survey was carried out by a crew of one person, with square Tx wire loops 100 m on a side, and a ferrite-core magnetic coil Rx antenna in the center of each Tx loop. Maximum useful depth of investigation achieved was ~600 m. TEM DATA: The field area is surrounded by powerlines on all 4 sides: Line 1 has the outside of the first Tx loop under the powerline to the West; Line 2 starts with the powerline to the North passing above just inside its first Tx loop, and ends with the outside of the last station's transmitter loop ~20 m shy of the powerline to the South; finally, Line 3 starts ~50 m East of the powerline to the West, and runs parallel to the powerline to the South along its entire length, at a separation distance of ~70 m. Line 3 was placed largely in an effort to obeserve powerline noise. The decay curve for the first station on Line 1(Line 1/Station 50) is raised above the other curves from Line 1. This is due to the charge (noise) from the adjacent powerline, which is at a distance of ~50 m from the Rx coil. In effect, the transient decay is recorded as being slower than it would be without the presence of the powerline. This also artficially lowers the apparent resistivity, readily observed in Line 1/Station 50 data. These effects are present to a lesser extent (lower magnitude noise) in the data from Line1/Station 150, the second station on Line 1. On the smooth-model inversion cross-section of the data from Line 1, the effects of the powerline noise appears as a pulling up of the low-resistivity water table contact towards the surface under the first two stations. Line 2/Station 50 data shows the same artificially slow decay and lowered apparent resistivity, compare to Line1/Station 50. Lower magnitude noise in Line 2/Station 150 data compares to Line 1 data. On the cross-section the effect is again a pulling up of the low-resistivity water table. The effects of the powerline noise on Line 2/Station 1550 data (last station) is mostly reflected in the fact that this data runs into noise at an earlier decay time than the data from other stations on Line 2. The last two stations do show shallower depths of investigation than the bulk of Line 2. Data from Line 3 uniformly runs into noise at earlier decay times than Line 1 and Line 2 data. Line 3 data achieves shallower depths of investigation than those possible along Line 1 and Line 2, and the water table contact is modeled at an artificially shallower than real depth along Line 3. Both of these effects are observable on the resistivity cross-section of Line 3 data. CONCLUSIONS: Line 1 and Line 2 observations are in good agreement. Effects observed in raw data include artifically slow decay and correspondingly low apparent resisitvities. The powerline noise lowers signal to noise ratios and depths of investigation. An artificial pulling up of the low-resistivity water table towards the surface is observed under affected stations in model cross-sections. There are a few ways in which to deal with this sort of noise in practical terms: remove noisy data at the end of each decay curve; throw out data from affected

stations; keep data from affected stations, but be keenly aware of noise source locations and their effects on the data; and if at all possible, record data ~200+ m from any powerline noise source.

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