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**Comparing Time Domain Electromagnetics (TEM) and Early-Time TEM for Mapping Highly Conductive Groundwater in Mars Analog Environments**

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Introduction: The purpose of this study is to evaluate the use of (diffusive) Time Domain Electromagnetics (TEM) for sounding of subsurface water in conductive Mars analog environments. To provide a baseline for such studies, I show data from two field studies: 1) Diffusive sounding data (TEM) from Pima County, Arizona; and 2) Shallower sounding data using the Fast-Turnoff TEM method from Peña de Hierro in the Rio Tinto region of Spain. The latter is data from work conducted under the auspices of the Mars Analog Research and Technology Experiment (MARTE). Pima County TEM Survey: A TEM survey was carried out in Pima County, Arizona, in January 2003. Data was collected using 100 m Tx loops and a ferrite-cored magnetic coil Rx antenna, and processed using commercial software. The survey used a 16 Hz sounding frequency, which is sensitive to slightly salty groundwater. Prominent features in the data from Arizona are the ~500 m depth of investigation and the ~120 m depth to the water table, confirmed by data from four USGS test wells surrounding the field area. Note also the conductive (~20-40  $\omega$  m) clay-rich soil above the water table. Rio Tinto Fast-Turnoff TEM Survey: During May and June of 2003, a Fast-Turnoff (early time) TEM survey was carried out at the Peña de Hierro field area of the MARTE project, near the town of Nerva, Spain. Data was collected using 20 m and 40 m Tx loop antennae and 10 m loop Rx antennae, with a 32 Hz sounding frequency. Data from Line 4 (of 16) from this survey, collected using 40 m Tx loops, show ~200 m depth of investigation and a conductive high at ~90 m depth below Station 20 (second station of 10 along this line). This is the water table, matching the 431 m MSL elevation of the nearby pit lake. The center of the "pileup" below Station 60 is spatially coincident with the vertical fault plane located here. Data from Line 15 and Line 14 of the Rio Tinto survey, collected using 20 m Tx loops, achieve ~50 m depth of investigation and show conductive highs at ~15 m depth

below Station 50 (Line 15) and Station 30 (Line 14), interpreted as subsurface water flow under mine tailings matching surface flows seen coming out from under the tailings, and shown on maps. Conclusions: Results from the Pima County TEM survey were in good agreement with control data from the four USGS test wells located around the field area. This survey also achieved very acceptable 500+ m depths of investigation. Both of the interpretations from Rio Tinto data (Line 4, and Lines 15 & 14) were confirmed by preliminary results from the MARTE ground truth drilling campaign carried out in September and October 2003. Drill Site 1 was moved ~50 m based on recommendations built on data from Line 15 and Line 14 of the Fast-Turnoff TEM survey.

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