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SURFACE GEOPHYSICAL SURVEYS
SWMU 0-031(a)
LOS ALAMOS NATIONAL LABORATORY
MARCH 20, 1993

On March 20, 1993, ERM/Golder conducted integrated surface geophysical surveys at SWMU 0-031(a) (Soil Contamination beneath Former Service Station). The objective of the surveys was to determine the location of underground storage tanks used at the former service station.

SWMU 0-031(a) was a former service station operated by the Zia Company until the early 1960s. A parking lot to the east of the Hilltop House Motel now overlies the location of the Zia service station.

Measures were taken to control potential health and safety hazards that could arise from Environmental Restoration Program activities such as geophysical surveys. Measures included procedures defined in the site-specific Health and Safety Plan and the Environmental Restoration Program's Standard Operating Procedures.

Field Procedures

A 10-foot interval survey grid was established at the SWMU 0-031(a) site using a measuring tape. The grid was marked using hotel building walls and permanent fences for reference. The survey grid was marked with spray paint on the asphalt parking lot. The grid was used for the surveys as magnetic stations and ground-penetrating radar (GPR) traverse lines. Figure 1 shows the survey grid used at the SWMU 0-031(a) site.

Magnetic and GPR surveys were conducted at the site. The magnetic survey is used to locate anomalies, while the GPR aids in characterizing the anomalies. Magnetic surveys measure the intensity of the earth's total magnetic field. Magnetic materials, specifically ferromagnetic materials such as iron and steel objects, will cause local disturbances or anomalies in this field. Naturally occurring minerals, such as magnetite, may also locally perturb the earth's magnetic field.

The magnetic survey was conducted using an EG&G Geometrics G-856 proton precession magnetometer. A base station was established east of the survey in an area free of magnetic disturbances. The magnetometer was tuned to the local magnetic field, and magnetic readings were collected to monitor magnetic field drift and variations during the survey.

GPR is used to map shallow stratigraphy and define buried objects by radiating high frequency radio waves downward into the subsurface. Reflections from interfaces of materials having different electrical properties are received by an antenna, and are

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transmitted to a graphic recorder This recorder produces continuous time cross sections as the transmitting and receiving antennas are slowly moved across the ground surface

The GPR survey employed the SIR System 3 radar system, manufactured by Geophysical Survey Systems, Inc The system included two transducers and a model PR-8304 Profiling Recorder, which supplied power and synchronizing signals to the transducers. The Model 3205TR transducer outputs a pulse of electromagnetic energy with a center frequency of 300 megahertz (MHz) and a 3-nanosecond pulse width, and the Model 3202TR transducer outputs a pulse of electromagnetic energy with a center frequency of 500 MHz and a 2-nanosecond pulse width The 500 MHz antenna provides greater resolution than the 300 MHz antenna, but the 300 MHz antenna usually detects greater depth than the 500 MHz antenna Both 300 MHz and 500 MHz antennas were used during the survey at the SWMU 0-031(a) site

Calibration Procedures

The crystal-controlled clock of the G-856 proton precession magnetometer is factory calibrated. The magnetometer was tuned before the survey to ensure adequate signal strength. A signal strength of 6 1 was noted during the magnetometer tuning, exceeding the manufacturer's recommendation of a signal strength at least 3.0.

At the magnetometer base station, multiple readings were taken to verify instrument repeatability. Standard deviations were all less than 5 gammas. Readings were collected periodically during the course of field work to monitor total field fluctuations due to diurnal variations, magnetic storms, and other time variations. Time variations were less than 100 gammas. Because anomalies measured during the surveys were on the order of thousands of gammas, the magnetic data were not drift corrected.

GPR calibration consists mainly of calibrating the timing clock, which is calibrated at the factory. Field calibration consists of performing a GPR survey over a known object to determine if the electrical properties of the earth materials are such that the radar signals can propagate through the subsurface and reflect upwards back to the receiving antenna, and to approximate the velocity of the subsurface materials. The calculated subsurface velocities are used to approximate the depth of the buried objects detected by the GPR survey.

To perform field calibration at the SWMU 0-031(a) site, GPR survey lines were traversed over three known underground storage tanks located west of the Hilltop House Conoco service station. The 500 MHz antenna was used. The survey successfully detected the tanks beneath reinforced concrete. Using the known hyperbola of the tanks and 2-foot increments over the surface, a subsurface round-trip traveltime of 6.6 nanoseconds per foot was calculated from the GPR profiles collected over these USTs. A total range of 50 nanoseconds was used, giving a depth range to approximately 8 feet.

Survey Results

Magnetic Survey

Figure 8 is a plan map of SWMU 0-031(a) and shows the locations of significant magnetic anomalies. The magnetic survey results show a strong magnetic anomalous area, on the order of thousands of gammas, in the southern two-thirds of the parking lot, approximately south of survey line N80. Such anomalies usually represent magnetic disturbances resulting from ferrous metals contained in objects such as buildings and fences.

The magnetic anomalies varied significantly from station to station in SWMU 0-031(a). The nature of the magnetic anomalies observed here suggests that multiple shallow sources of magnetic materials are present beneath the asphalt-covered Hilltop House parking lot.

Sources for "noise" at the site include an electrical conduit traversing north-south near survey line E55, a pad-mounted electrical transformer located near N80/E00, metallic debris, and steel concrete reinforcements.

Ground Penetrating Radar Survey

The GPR survey was conducted over all of the anomalous areas detected by the magnetic survey. The most significant anomalies are shown on Figure 2. The profiles indicated areas of subsurface disturbance.

The most significant feature detected by the GPR survey was a 10-foot by 8-foot disturbed area located along GPR profile lines N30 between stations E40 and E50 (Figure 3) and E45 between stations N30 and N40. This area is interpreted as a "rubble pit," that is, an excavated area backfilled with rubble. The location of the rubble pit is shown as "6" on Figure 2. Voids within the rubble would cause strong radar reflections, as seen in the area shown in Figure 3. The interpreted rubble pit shows strong reflections which begin immediately below the asphalt parking surface. The interpreted rubble pit corresponds to the magnetic anomalies detected by the magnetometer survey. Material in this interpreted pit may contain magnetic material, but this cannot be determined from the GPR profiles. The rubble pit interpreted from the GPR survey could be a tank excavation. However, the reflections from the rubble pit could mask any GPR tank signature at depth.

Figure 4 shows what is interpreted to be two pipes and two concrete pads along the GPR profile line N10. The concrete pads can be seen as a wavy black line directly below the solid black line on the profile. These reinforced steel concrete pads may be responsible for the magnetic anomalies observed in this area. Tank signature traces were not observed beneath these pads. Based on estimated GPR signal travel times the pipe labelled "2" on Figure 2 is approximately 1.5 feet below the surface, while the conduit labelled "8" is at approximately 1 foot depth.

Figure 5 shows what appears to be a piece of metal located approximately 2 feet below the asphalt. The metal can also be seen on Figure 2 labelled "1" along the C-C' cross section.

Figure 6 is the GPR Line E30 along cross section D-D'. This figure shows what is interpreted to be a pipe at a depth of approximately 0.5 foot, labelled "4" on Figure 2 and another pipe located at E30 and N30. The second interpreted pipe is approximately 0.5 foot below the surface, and is labelled "3" on Figure 2.

Figure 9 shows the location of the known fuel tanks west of the Conoco Station where a GPR survey was conducted. A survey was conducted over these lines to determine the subsurface velocity, that the GPR was working correctly, and that the correct resolution was used to be able to see the tanks. Figures 10 and 11 show GPR profile lines over three known fuel tanks. These profiles show the unique signatures of tanks, signatures not seen in the profiles over the Hilltop House parking lot. The Conoco tanks were seen through reinforced concrete, proving that adequate GPR signal penetration was achieved at the site and tanks, if present, would appear on the GPR profiles. Consequently, it is interpreted that there are no tanks beneath the pads labelled "5" and "7" on Figure 2.

In general, the GPR survey was successful at locating buried objects throughout the survey area. By detecting such objects as buried pipes, the GPR data indicate that adequate signal strength was achieved by using the 500 MHz antenna. Nine traverses were made with the 500 MHz antenna, while three traverses were made using the 300 MHz antenna. Comparing the traverses conducted with the different antennas, the same features are seen.

Conclusion

The geophysical survey conducted on March 20, 1993, at SWMU 0-031(a) used both magnetic and GPR instruments to attempt to locate the Zia Company underground tanks. Anomalies seen during the magnetic survey were not indicative of 25,000-gal. tanks. Low magnetic readings coupled with high magnetic readings indicate the presence of magnetic anomalies below the ground surface at the southern portion of the survey area. GPR profiles collected over this area suggest that reinforced concrete may be responsible for the magnetic anomalies. The low magnetic anomalies seen next to the building or beside an electric transformer (example: 23516 at N40 and E0 and 09848 at N70 and E0) were determined to be normal due to the presence of magnetic materials in both the transformer and the building.

The GPR profiles did not show any large hyperbolic features at the Hilltop House that would indicate underground storage tanks. Resolution was determined to be adequate since eight other buried features were detected, and known tanks were clearly detected.