REAL-TIME ENVIRONMENTAL SURVEYS FOR SITE INVESTIGATIONS AND CHARACTERIZATIONS WITH USRADS

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ABSTRACT

The Ultra Sonic Ranging And Data System (USRADS) has been connected to a number of different contaminant detection devices in order to provide real- time surveys in the conduct of site characterizations. USRADS was originally developed to provided automated data location and logging of radioactive contamination resulting from uranium mining and milling activities.

With USRADS, the real-time detector reading is sent via radio link to a near site personal computer once each second. In that same second, the computer determines the surveyor location via ultrasonics, plots the surveyor position along with an indication of the value of the corresponding detector reading on the computer monitor, and stores the data on disk for further analysis.

Since the sampling rate of once per second corresponds to a normal walking speed of roughly once per 3 feet, the USRADS generated data density over a site greatly exceeds that of conventional methods and provides real- time data presentation not otherwise available. Added benefits include field reassessment of the data and field generated printouts for biasing and locating soil samples. As a result of the these benefits, efforts are continuing to interface USRADS for use with different types of radiological and non-radiological detectors that are used for site investigation and characterization.

One such effort involves soil conductivity measurements. Through this adaptation, a walkover survey reveals the variation in soil conductivity at depths up to 18 feet below grade. Interpretation of the results can indicate the presence, size and location of trenches and buried objects such as drums, pipelines, and tanks.

Another effort conducted through EPA funding, combines USRADS with a portable X-ray fluorescence analyzer for identification of heavy-metals in surface soils. With this adaptation, USRADS reveals the location of contaminants such as lead, zinc, and mercury in surface soil, in real-time.

The most recent USRADS enhancement is the interface to a micro-R meter to measure and map the dose rate at the same time as the soil contamination is surveyed.

Still another effort is directed at making quantitative determination of gamma photon energy spectra for radiation dose measurements below the ambient background levels. This effort is in response to current recommendations of the IAEA and the ICRP for release of decontaminated facilities.

This paper presents the findings of these and related efforts.

INTRODUCTION

The Ultra Sonic Ranging And Data System (USRADS) was originally developed to provide automated data location, logging, analysis and mapping of radioactive contamination resulting from uranium mining and milling activities. With USRADS, the real-time detector reading is sent via radio link to a near site portable computer once each second. In that same second, the computer determines the surveyor location via ultrasonics, plots the surveyor position along with an indication of the value of the corresponding detector reading on the computer monitor, and stores the data on disk for further analysis. Since the sampling rate of once per second corresponds to a normal walking speed of roughly once per meter, the USRADS generated data density over a site greatly exceeds that of conventional methods and provides real-time data presentation not otherwise available. Added benefits include field reassessment of the data and field generated printouts for biasing and locating soil samples.

As a result of the these benefits, efforts to adapt USRADS for use with different types of radiological and non-radiological detectors has continued. This paper presents several related enhancements to USRADS for use in site investigation and characterization with state-of-the-art detection systems that are used to measure geophysical characteristics, non-radiological hazardous materials, and very low radiation doses.

SOIL CONDUCTIVITY MEASUREMENTS

Figure 1 shows USRADS surveyor backpack interfaced to an EM-31 soil conductivity meter. The EM-31, manufactured by Geonics of Canada, is a common geophysics measurement device for use in site investigations.

Through this adaptation to the USRADS capabilities, a walkover survey reveals the variation in soil conductivity at depths up to 18 feet below grade. Interpretation of the results can indicate the presence, size and location of trenches and buried objects such as drums, pipelines, and tanks, as well as subsurface liquid plume flows. With the EM-31 interfaced to USRADS, a walkover survey records an EM-31 measurement once each second, with corresponding x,y coordinates determined by USRADS, for subsequent analysis by the computer. USRADS automatically records the location and data logging for each coordinate position in the computer. Since the data is automatically in the computer at the conclusion of the survey, it can be analyzed in the field to:

1. map the subterranean topography,
2. map the boundaries of underground liquid to solid interfaces due to subsurface trench, tank or pipe leakage, and
3. show the location of underground buried metallic objects.

The false color contour map shown in Figure 2 was produced by walking over a waste burial trench with the USRADS/EM31. The trench was suspected to be filling with rainwater and subsequently flowing subsurface to a nearby stream, carrying contaminants from the trench. The findings show the trench, shown here as the majenta area extending from the lower right hand corner to just beyond the center of the photo, indeed filled with water, and a resulting subsurface flow that originates at the left end of the trench and extends to the upper border of the photo, and beyond to the stream.

Figure 3 was also produced by walking over a waste burial trench. The multiple contour lines represent the subterranean topography. The transitions from blue to red hues represents the change from near surface to deepest elevations. The major trench boundaries are clearly shown by the blue and green contours. The red contours show the location and size of the deepest cells within the trench. The yellow dots show the surveyors location/path as determined by USRADS each second. The size of the yellow dot is related to the intensity of the inphase signal, so that the largers dot correspond to stonger magnetic indications and the smaller dots to weaker or absent indications. Note that the major magnetic indications are in the major cell areas and that there are no large dots outside the trench.

PORTABLE X-RAY FLUORESCENCE

Another interface effort recently completed through EPA funding, combines USRADS with a portable X-ray

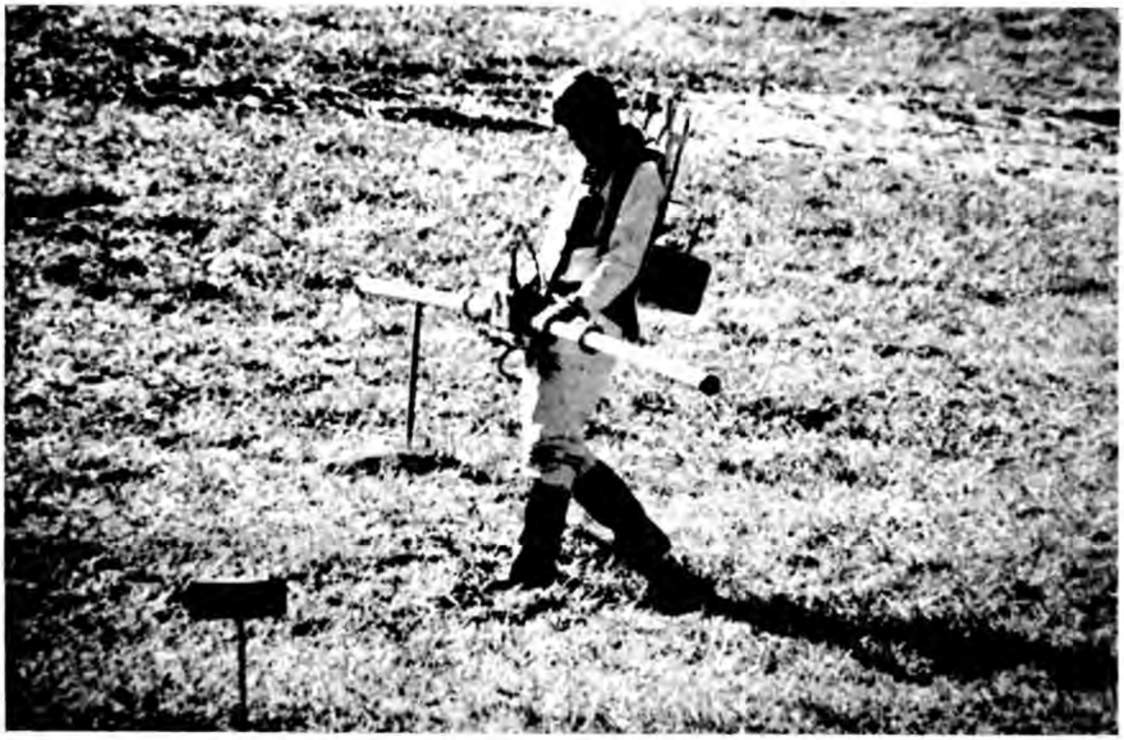

Fig. 1. Surveyor with USRADS backpack interfaced to a Soil Conductivity Meter (EM-31).

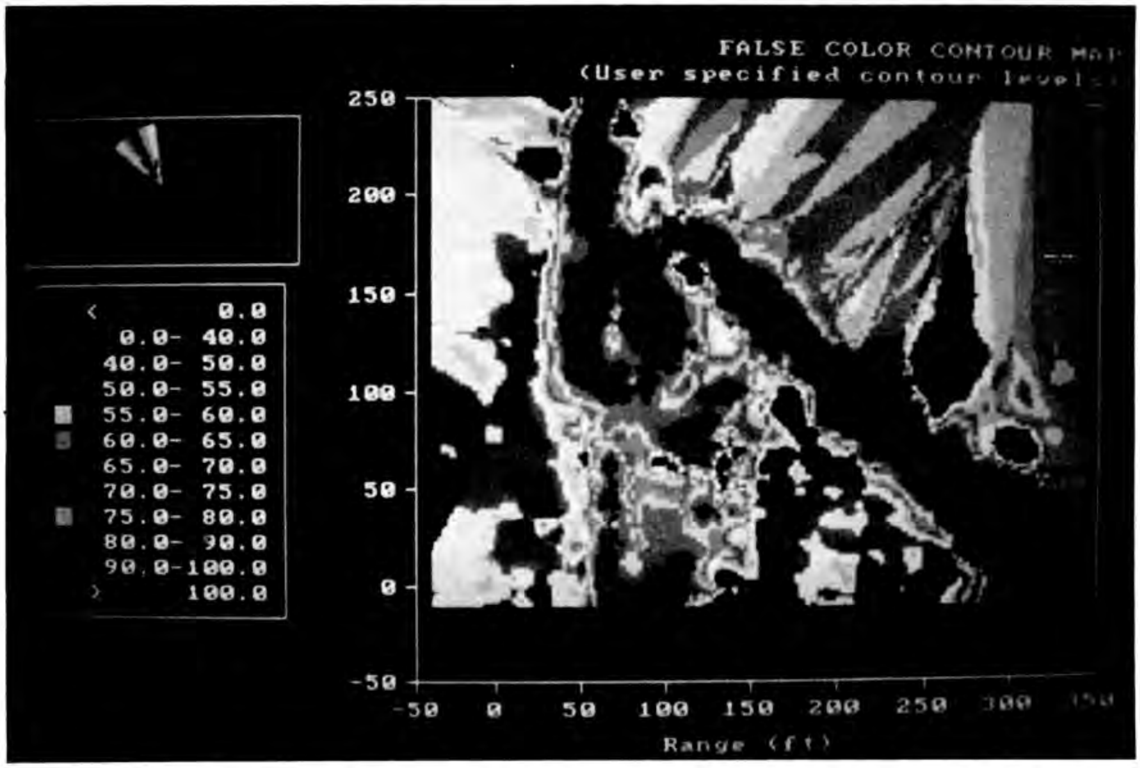

Fig. 2. Sub surface Plume Flow Carrying Contamination from a Waste Burial Trench as Determined with the USRADS/EM-31.

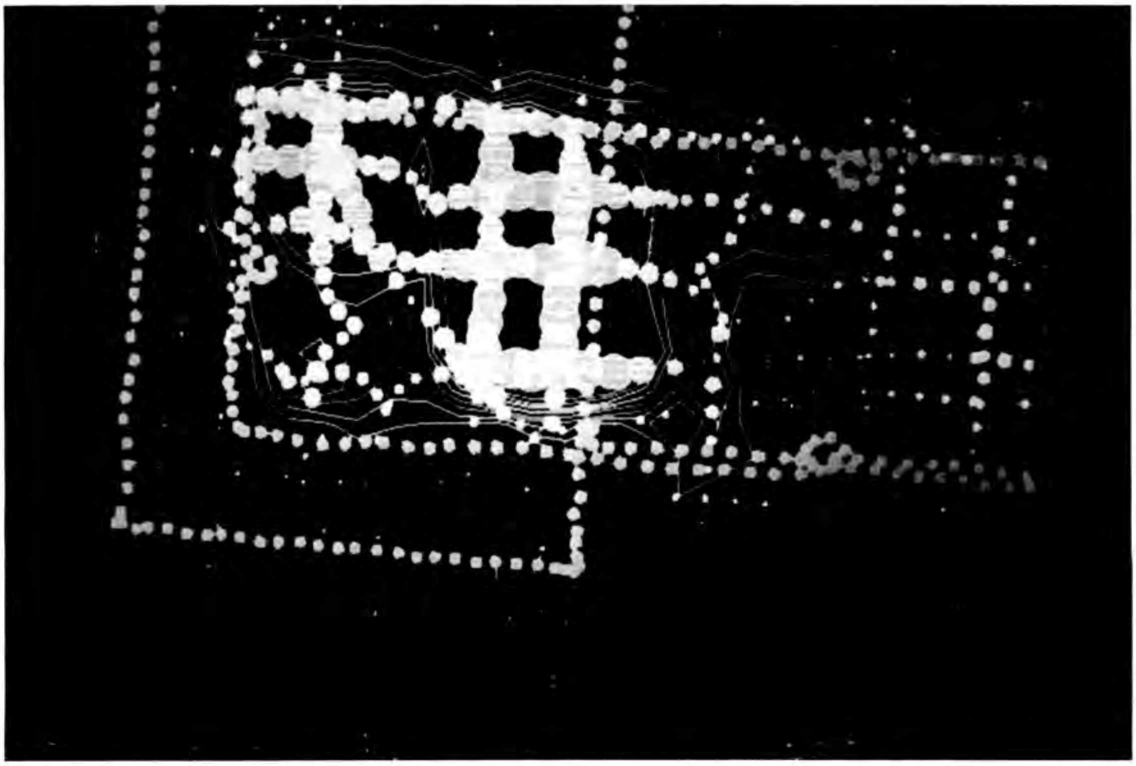

Fig. 3. Trench Site with Subterranean Topograph Showing Trench Boundaries, Cell Walls, and Metallic Indications as Determined with the USRADS/EM-31.

fluorescence (XRF) analyzer for identification of heavy-metals in surface soils. A sixteen pound XRF unit manufactured by Outokumpu Electronics of Finland, called the XMET-880, has recently been approved by EPA for use on hazardous sites for the in-situ identification of contaminants such as lead, zinc, and mercury. With this adaptation, USRADS reveals the location of such heavy-metal contaminants in surface soil, in real-time.

The XRF unit shown in Fig. 4 is a modular portable XRF analyzer composed of an electronics unit that will accommodate a variety of probe types. The various combinations allow the use to configure the system for specific analytical requirements. Exciter source configurations are available for identification of elements from aluminum through uranium. One probe configuration is appropriate for use in field measurement of in-situ soils. The electronics unit includes a 256 channel MCA and an internal microcomputer. The unit is capable of analyzing up to 6 elements simultaneously. Measurement times are user variable from 1 to 36000 seconds.

As with the other USRADS applications, the location of the XRF probe is determined using ultrasonics. In contrast to the typical continuous walkover surveys, the XRF probe must be on station from 5 to 36,000 seconds depending on the desired degree of accuracy (typically 120 seconds). This facilitates repeated measurements by USRADS

Fig. 4. Surveyors with XMET-880 in Use.

for each survey location so that the positioning accuracy will be known to less than +/- 3 centimeters. At the end of a measurement cycle the entire spectrum and/or the summary XRF findings (contaminant level of mg/kg soil) for up to 6 elements are transmitted by the USRADS radio transmitter to the USRADS portable computer for storage, tagged by the corresponding survey coordinates. In this manner, as soon as the site survey is complete, the site data is in the portable computer and available for immediate analysis, display, and documentation.

DOSE RATE AND PHOTON ENERGY SPECTROMETRY

The most recent enhancement connects a micro-R meter to USRADS. A Victreen 450P, which utilizes a pressurized ion chamber, was connected for surveys to be conducted at the Oak Ridge National Laboratory. This interface allows the simultaneous measurement and mapping of soil contamination and determination of the location specific radiation levels once each second. In areas of where the soil contamination may cause significant dead-time losses for the contamination probe, this USRADS interface will automatically provide the corresponding dose rate measurement.

Another effort is directed at making quantitative determination of gamma photon energy spectra for radiation dose measurements below the ambient background levels. This effort is in response to current recommendations of the International Atomic Energy Agency and the International Commission on Radiological Protection for release of decontaminated facilities. These groups have recommended that the release of contaminated facilities for unrestricted use should be based on a maximum dose limit to any individual of 10 mrem per year. In order to measure such low dose levels in ambient backgrounds, typically ranging from 100 to 200 mrem per year, a portable high purity germanium (HPGe) detector/multi-channel analyzer system will be interfaced to USRADS to window the photo peaks of interest and thereby reduce the "noise" contributed by the ambient natural background radiation. With the USRADS/HPGe, a continuous walkover surveys will provide the gamma photon energy spectra by location each second, which in turn will be converted to energy dependent dose equivalent maps by the USRADS portable computer, in real-time.

CONCLUSION

The USRADS system is adaptable to almost any detection equipment that can provide either analog, serial, or parallel output. Most of the detection devices normally used in the conduct of site characterizations can be readily interfaced to USRADS to provide automatic real-time collection, location, analysis, and mapping of detection data. This facilitates preliminary field analysis of the data to determine the adequacy of the survey coverage and to direct other sampling regimens, such as soil sampling for subsequent lab analysis. The large number of data points collected with USRADS and the automated data location allow the interpretation of the results to be based on a much larger volume of data than normally achievable by other methods. Also since the data collection process is automated, it is unbiased, free of human error, thoroughly documented, and generally more defensible than other data location and recording techniques.

REFERENCES

1. C. R. FLYNN, R. F. DECKER, J. M. WILLIFORD, "Use of the USRADS System for Real Time Radiation Survey Measurements for Depleted Uranium Environmental Contamination", Waste Management '89, Tucson, Arizona, March 1, 1989.