Challenges Conducting a Radiological Site Assessment at a Remote Uranium Mine – 16259

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ABSTRACT

A radiological site assessment was performed as part of an environmental site assessment at a former uranium mine located in the Northwest Territories of Canada. The only access to the site was by helicopter, so the field program was a limited to only a few days. Radiological surveys were conducted to assess conditions for safety of the field crew as well as to provide overland survey of uranium at the site. Limited radiological data existed for this site and the objective was to collect as much data as possible during the short field program. ScanPlot^{SM} gamma spectroscopy land survey system was utilized for the overland survey utilizing a backpack system. ScanPlot^{SM} platform utilized spectroscopy grade sodium iodide detectors configured for optimal spatial coverage and radiation detection. Survey locations were recorded using an on-board global positioning system (GPS). The radiological spectral data from the radiation detectors is automatically logged and linked with the GPS coordinates to an on-board computer to create isocontour figures using a color scale to represent radioactivity levels (ground concentration by radionuclide). The advantage of utilizing the ScanPlot^{SM} system for this assessment is that the nature and extent of uranium is provided without having to collect and assay a large number of samples during a short period of time.

INTRODUCTION

Radiological surveys were performed over several days as part of an environmental site assessment at a former uranium exploration site, Sun Rose Claim. The Sun Rose Claim is located in the Northwest Territories and previous investigations had identified uranium ore and waste rock. ScanPlot^{SM} [1] gamma spectroscopy land survey system was utilized for the overland survey of uranium with a backpack system configuration. Previous investigations have identified a potential radiation hazard, but the full nature and extent was unknown. The Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials (NORM) [2] will serve as the basis for evaluation of the results.

The Sun Rose Site is a former uranium exploration site from the 1950s, located on the north side of Chico Lake at approximately 63° 07' 23.93" N, 116° 19'3 7.01" W. It is 35 km north of Bechoko, Northwest Territories and 3 km to the east of the Tlicho winter road, before the turnoff to Whati as shown in Figure 1. At present, this site is only accessible by helicopter; however, it was previously accessed by an all-weather road. The Site is approximately 15 hectares in area, consisting of ruins of burned down building structures, waste rock, and miscellaneous scattered metal debris.

Figure 1 Sun Rose Claim Site Location

Previous investigations conducted at the Site indicated radiation levels higher than background in the areas of the exploration/blast pits and the former camp where weathered uranium-bearing minerals were observed in the bedrock outcrops.

Because Sun Rose only mined uranium ore and did not process it, the radiation hazard is considered from NORM. Various radiological measurements were performed during the environmental site assessment for both worker safety and to provide data for assessment of the radiological hazards. The Canadian Guidelines for the Management of NORM [2] were developed to ensure adequate control of NORM, harmonize the standards, and reduce jurisdictional gaps or oversight. The basic principle is that persons exposed to NORM should be subject to the same radiation exposure standards that apply to persons exposed to Canadian Nuclear Safety Commission regulated radioactive materials. Moreover, the ALARA standard should apply to NORM materials as well. Given this basis, the Canadian Guidelines have established recommended radiation dose limits and a tiered NORM management program in order to ensure these objectives.

The dose constraint for control of public exposure, 0.3 mSv in a year, has established amounts of NORM that if released into the environment without further controls would not cause doses in excess of this constraint. The derived release limits for NORM provided for diffuse uranium (U-238 series with progeny) are 1 Bq/L (aqueous), 300 Bq/kg (solid), and 0.003 Bq/m3 (air). Discrete NORM release limit for uranium ore (with progeny) is 1,000 Bq (total radioactivity).

METHODS

The Orion ScanPlot[SM] is a family of mobile radiation detection and measurement systems as shown in Figure 2. The ScanPlot[SM] family provides a versatile and sensitive radiation detection and measurement system solution for overland gamma radiation surveys. A variety of different sizes and configurations of radiation detectors are supported. The ideal detector depends upon the given survey task and objectives. The ScanPlot[SM] family of systems is designed to perform surface and shallow-depth radiological examination of open land, as well as large area gamma exposure rate surveys. ScanPlot[SM] provides virtually instant output in a customizable geographic information system (GIS) format and delivers spatially precise, interactive map reports with plotted locations of detected radioactivity.

Technologies unique to ScanPlot[SM] include custom spectroscopic scanning detectors with monitoring and reporting software. Scanning Spectroscopy enables ScanPlot[SM] to differentiate between different species of radiation emitting isotopes allowing the analyst to isolate and quantify the isotopes of concern, eliminating a significant conservative error common to typical gamma scanning systems. ScanPlot[SM] can be configured and deployed on a variety of platforms ranging from man-portable backpacks to vehicle-propelled, multi-detector arrays.

ScanPlot[SM] uses real-time spectral stripping to improve the signal-to-noise ratio in a region of interest. Noise-Adjusted Single Value Decomposition (NASVD) can be used to further “strip out” background/Compton interference. Thousands of high-resolution, spatially referenced, radiological measurements can be made and assimilated quickly allowing rapid and reliable assessment of the spatial distributions of radioactive substances of interest. These large datasets permit accurate and defensible demarcation of areas of the site that are “impacted” and aid in the design of an appropriate and effective remedial action strategy.

Orion ScanPlot’s operating system software automates and controls the survey measurement process. This includes real-time system status which is displayed to operators; measures, records, and alarms on radiation signals from multiple isotopes simultaneously; logs and provides real-time survey speed to the operator; and provides speed control feedback to assure that required detection sensitivity is achieved.

Calibration of the ScanPlot[SM] detectors allowed activity levels to be presented in units of gross isotopic activity (similar to counts per unit time) or in units of isotopic concentration (i.e., Bq/g) for a range of radionuclides. For this application, 3 x 3 sodium iodide detectors were utilized for the backpack configuration. Prior to deployment to Sun Rose, the system was calibrated on a large area, National Institute of Standards and Technology (NIST)-traceable source, and isotopic calibration concentration factors were used to derive becquerels per gram [Bq/g] concentrations.

Other options were considered for this site assessment. These primarily included more traditional gamma walkover surveys and environmental sampling. Gamma walkover surveys would only provide counts per minute data while environmental

sampling would be challenging to collect a significant number of samples and have much higher costs for analysis. The limitations of these options include gamma walkover survey data would allow for relative comparisons (levels in one area vs. another) while sampling/analysis would not provide the same data density.

Figure 2 ScanPlot[SM] System

RESULTS

ScanPlot[SM] backpack surveys were performed in accessible areas. Given the limited window of time for Site access, no attempt was made to provide complete coverage of any areas. In essence, data was collected during each day and then processed after the field work was complete. ScanPlot[SM] locations and results for the Sun Rose Site can be seen on Figure 3. As expected, elevated concentrations of uranium were identified at the waste rock pile and exploration pits, as shown in Figure 4. A maximum concentration of 309 Bq/g was assayed by ScanPlot[SM] in the exploration pits.

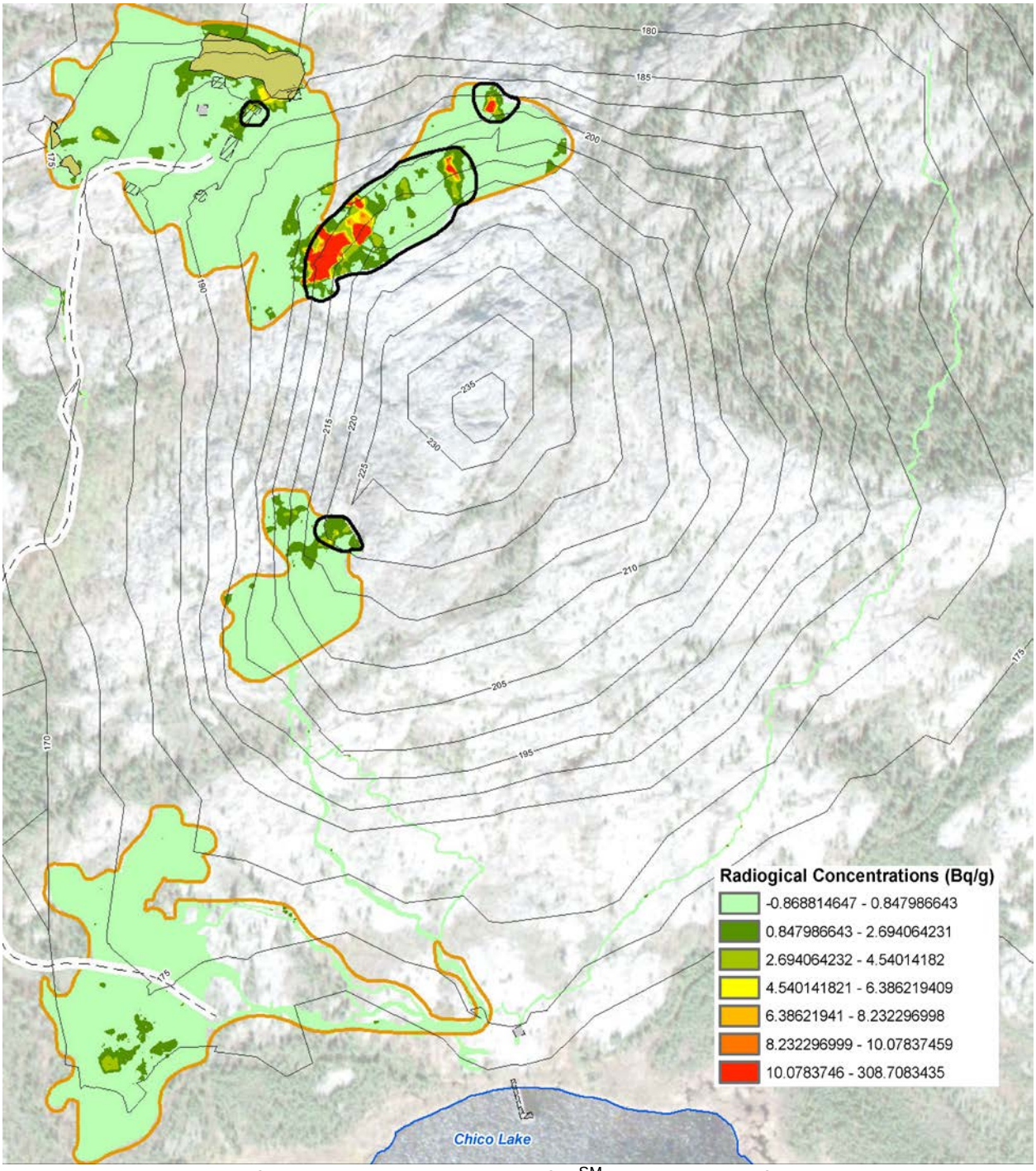

Figure 3 Sun Rose ScanPlot[SM] Survey Results

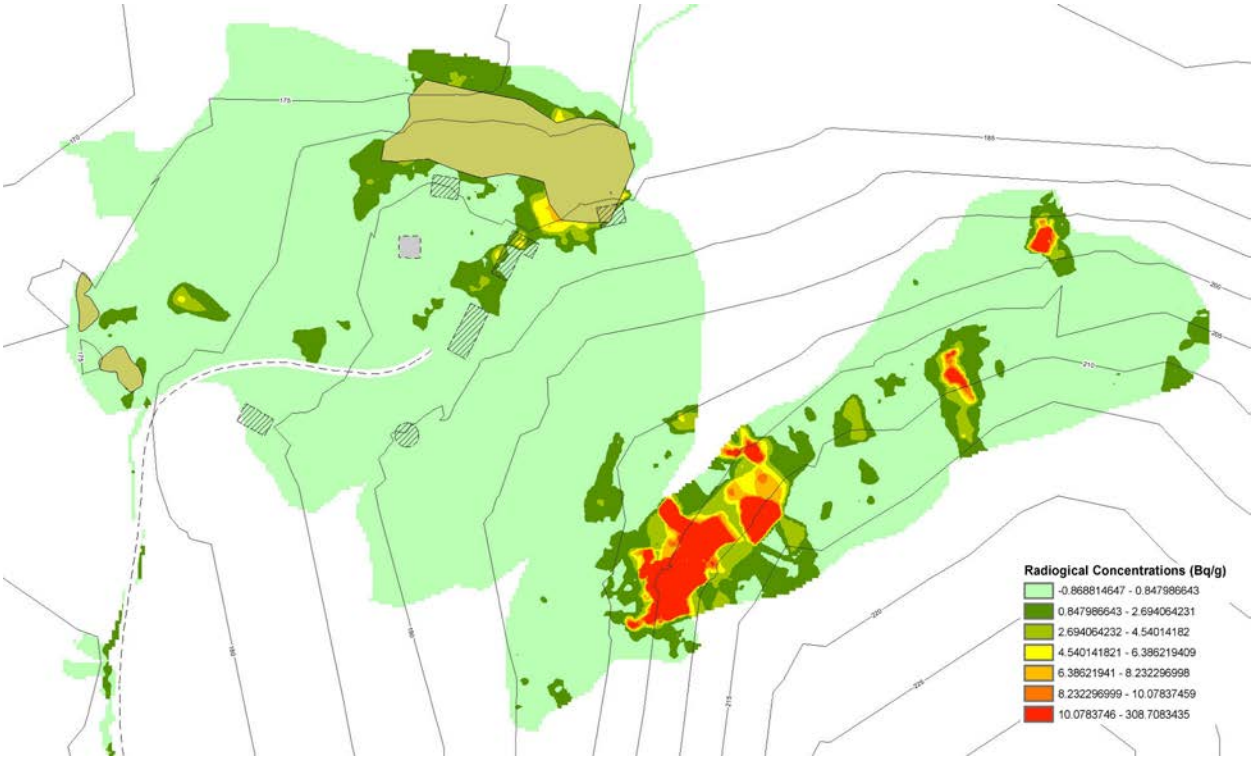

Figure 4 Sun Rose Elevated Results Area

There were several challenges related to deployment of the ScanPlot[SM] system at such a remote site. The primary concern was power as the system runs off batteries but there was no way to recharge them during the day. This was addressed by bringing multiple sets of batteries for each system deployed and charging them each night back at the hotel. The other major concern was failure of a system component. This was addressed by deploying two backpack systems (would have one to use if the other was not functioning) and by bringing limited spare parts to the site each day. These included cables, connectors and other components that are more common to be damaged during transport/use of the system. The ScanPlot[SM] system is designed for outdoor use (i.e., waterproof connections) and no weather issues or problems occurred during this site assessment.

CONCLUSIONS

The nature and extent of uranium was performed using an advanced radiation detection system collecting isotopic measurement data from gamma-emitting radionuclides in the near surface soil. Survey locations were recorded using an on-board GPS that was automatically logged and linked with the radiological spectral data from the radiation detectors to create isocontour figures using a color scale to represent activity levels. The advantage of utilizing ScanPlot[SM] system for these surveys is that the nature and extent of uranium in the areas that were accessible is provided without collecting and assaying a large number of samples.

Results identified a maximum concentration of 309 Bq/g. The derived release limits

for NORM (Health Canada, 2011) for diffuse uranium is 300 Bq/kg or 0.3 Bq/g. There are large sections of the waste rock pile and exploration pits that exceed this limit, with the maximum concentrations on the order of 100 times higher. In addition, having the complete ScanPlot^{SM} data set (with uranium concentrations) will greatly assist future evaluations regarding the level of radiation hazard and potential options to achieve the Canadian Guidelines for NORM.

The ScanPlot^{SM} system was effectively used to detect and delineate uranium at the Sun Rose site and represents a dramatic improvement in the type and function of potential information that can be generated by overland gamma scan surveys.

REFERENCES

1 ScanPlot^{SM}, Amec Foster Wheeler proprietary system, Grand Junction, Colorado, United States of America.

2 Health Canada, “Canadian Guidelines for the management of Naturally Occurring Radioactive Materials (NORM)”, 2011.