Performance of UAV-borne gamma spectrometers for radiometric surveying in mineral exploration and environmental monitoring

CM Chen[1]; LE Sinclair[2]; C Samson[1]; R Fortin[3]

[1]Department of Earth Sciences, Carleton University, Ottawa, Ontario; [2] Canadian Hazards Information Service, Natural Resources Canada, Ottawa, Ontario; [3]Geological Survey of Canada, Natural Resources Canada, Ottawa, Ontario;

Gamma spectrometry has been used for many years for mineral exploration through the mapping of the distribution of uranium, thorium and potassium. It has further applications in mapping environmental contamination for monitoring and remediation purposes around uranium mine sites and nuclear power facilities. Surveys are typically conducted by ground crews and conventional manned airborne methods. As technology advances, unmanned aerial vehicles (UAVs) have become a viable platform for conducting radiometric surveys. They deliver higher resolution maps as they can fly lower and slower than conventional airborne platforms. As well, within a certain amount of time, they cover more area than surveying on foot. For these reasons, Natural Resources Canada is developing two new UAV-borne gamma spectrometer systems to examine their potential in radiometric surveying for environmental contamination and for mineral exploration. The first system uses a novel directional gamma spectrometer, called the Advanced Radiation Detector for UAV Operations (ARDUO), mounted on a main- and tail-rotor UAV. The ARDUO is composed of eight thallium-doped cesium iodide (CsI(Tl)) crystals in a self-shielding arrangement, and is able to provide a direction vector towards a radioactive source. The second system uses a single cadmium zinc telluride (CZT) solid-state detector mounted on a 3DR Solo quadcopter airframe. Prior to conducting radiometric surveys over geologic sources, the performance of each system needs to be characterized under controlled conditions. The energy resolution, linearity, gain temperature dependence, and aircraft attenuation of each system are being examined through benchtop experiments. The direction-finding capability of the ARDUO detector is also being examined. To test the feasibility of each system in mapping a radioactive source, a series of surveys over point sources of cesium-137 (5 mCi), cobalt-60 (1 mCi, 5 mCi), and sodium-22 (0.5 mCi) are being conducted. The results from these experiments will be used to determine whether these systems are capable of conducting radiometric surveys for mineral exploration and environmental applications.