Problem Setup: (SAND2019-7334 O 2/3)

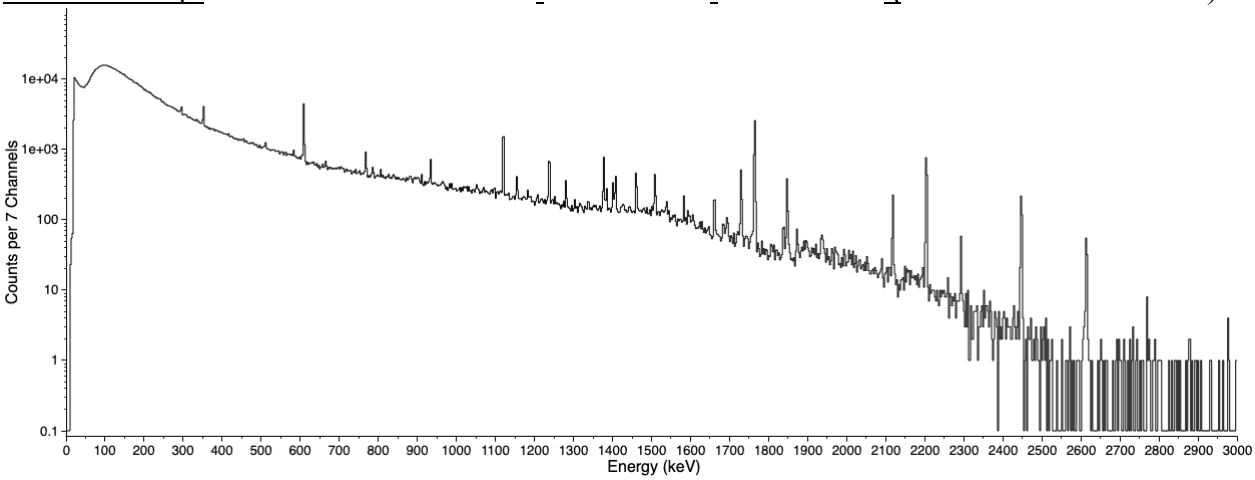

Figure 1 Overview of spectrum collected by 40% HPGe detector.

A law enforcement officers personal radiation detector alarmed in a vehicle parking lot. The officer isolated the source to being located underneath the concrete. A spectrum of the source was then taken with a 40% HPGe detector directly above the hotspot, with the detector face 2 cm above the pavement. From a nearby pothole it was estimated the cement is 4 cm thick. No background is provided, and there was no effort to use $1/r^2$ to estimate source depth.

Information you will need:

The file "buried_source_40%_HPGe.n42" shown in Figure 1 is the item of interest spectrum.

You can estimate the attenuation from the concrete using an areal density of 2.3 g/cm^2, and effective atomic number 11.3. For soil you can assume a 35% water content giving an areal density of 1.6 g/cm2, and effective atomic number of 9.8. InterSpec has both of these materials in its shielding database as "Concrete" and "Wet Soil (35% H2O)" respectively.

If opened in InterSpec the N42 file will have the appropriate detector response function (DRF) included. The "HPGe 40%" DRF included with InterSpec is also acceptable.

For other programs, you can assume the detector has a face diameter of 6.6 cm, and an *intrinsic efficiency* equation of:

$$exp(-2.0333 - 0.657987 * ln(x) + 0.0331352 * \ln(x)^2 - 0.176174 * ln(x)^3 - 0.077921 * ln(x)^4 + 0.010443 * ln(x)^5 + 0.00134222 * ln(x)^6)$$

Where *x* is energy in MeV. This equation was derived from data available from https://github.com/sandialabs/InterSpec/tree/master/tutorials/make_drf/cal_data_HPGe

Questions:

a) What isotope is present?
b) How far below the pavement is the source buried?
c) What is the activity of the source?

(solution on next page)