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# Characterization of scintillator-based gamma spectrometers for determination of sample dose rate in OSL dating applications

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A recent inter-comparison [1] has helped to highlight variability in the measurement of dose rate between luminescence laboratories. Part of this variability probably reflects the difficulties of homogenising and dissolving samples so that the <500 mg used in e.g. ICPMS, NAA is representative. High resolution gamma spectrometry is the obvious alternative because it can measure samples 100-1000 times larger, but the instrumentation is low-throughput, high capital and running cost, and requires skilled personnel to maintain operation over many years. Here we investigate the potential of traditional low-cost, low maintenance alternatives based on scintillation crystals, especially NaI(Tl).

The first spectrometer tested includes a detector based on a NaI(Tl) crystal ( $\Phi 3'' \times 3''$  long; measured FWHM 7.4% at 662 keV, Harshaw) and a digital MCA (TB-5 Digital Tube Base, Amptek). The spectrometer is housed in a lead castle (100 mm wall thickness); a temperature control system stabilises the temperature inside the lead to within  $\pm 0.1$  °C. Samples are prepared in a cup-shaped geometry by mixing ground material with high viscosity wax (~2:1 ratio); this gives typical sample sizes of ~200 g. They are then stored for >20 days to ensure <sup>222</sup>Rn equilibrium with the parent <sup>226</sup>Ra. Calibration standards are based on a well-known uranium ore (BL-5 [2]) aged thorium nitrate [3], and analytically pure KCl.

It is well-known that NaI(Tl) detectors are significantly temperature sensitive; the <sup>40</sup>K peak (1461 keV) in our system moves by ~0.6%/°C above room temperature. Although our detector is temperature controlled, this introduces an extra level of complexity and is undesirable in routine applications. We first report on the reliability of an alternative approach of compensation using peak-shifting [4] and the ubiquitous <sup>40</sup>K peak. Two approaches to data reduction are then compared: (i) using a traditional 3 window algorithm (<sup>40</sup>K - 1461 keV, <sup>238</sup>U (<sup>214</sup>Bi) - 1760 keV and <sup>232</sup>Th (<sup>208</sup>Tl) - 2614 keV), and (ii) best fit of the 3 standard spectra to the unknown. Minimum detection limits are derived, and the overall performance evaluated by comparing the results from a range of samples with those from high resolution gamma spectrometry.

Preliminary results suggest that dose rates based on our scintillation spectrometer are within 5% of those determined by high-resolution spectrometry. This indicates that the scintillation spectrometer is a useful laboratory method of determining dose rate.

## References

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3. Refined in 1906, previously available from Amersham International.
4. Casanovas, R., Morant, J. J., Salvado, M., Temperature peak-shift correction methods for NaI(Tl) and LaBr<sub>3</sub>(Ce) gamma-ray spectrum stabilisation, *Radiat. Meas.* 47 (2012) 588-595.