Towards the origins of over-dispersion in beta source calibration

The ability to deliver accurate and precise calibration doses is a central part of all trapped charge dating methods. Usually, the radiation source (alpha, β, X-ray) used to deliver these doses is, in turn, calibrated against an absolutely known reference source (usually a γ source) and many laboratories make use of Risø calibration quartz for this purpose. We have previously described this material in detail (Hansen et al., 2015) and discussed the over-dispersion (OD) of 3.2±0.3% in calibrated dose rate observed over 16 years. This dispersion highlights the danger of relying on individual calibrations, and is clearly undesirable. Here we continue our investigation into providing reliable calibration materials for trapped electron dating. A comparison of the apparent quartz β source dose rates shows that there is no significant dependence on geological source. However the β dose rate decreases by 25% with increasing grain size from about 100μm to 1mm, and backscatter leads to a dose rate increase of ~1% per unit atomic number of the substrate. It is concluded that, for the multi-grain aliquots used in this study, the contributions to dose rate variability from grain size and substrate variations are likely to be negligible. Nevertheless there may be a practical advantage in using a high Z substrate because of the higher dose rate. Finally we test the measured to given dose (dose recovery) ratio for five heated feldspar samples and use the pIRIR290 signal for β source calibration; surprisingly this gives an apparent β dose rate 15% lower than that to quartz despite their almost identical stopping power and mass absorption characteristics. Our results are discussed in terms of their significance for reproducibility and accuracy of β dose-rate estimates.

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