Description of supplemental materials

The supplemental materials provided include:

* A QTQt tutorial with practice exercises to help users develop intuition with sensitive tests and model interpretation.
* Necessary .qtqt and .txt files to use in the tutorial exercises, as well as examples of model outputs, which users can compare with to confirm their own tutorial results.
* Six supplemental figures (captions below)
* Five supplemental tables (described below)

**Supplemental Figures**

Figure S1: Thermal History inversion model example of Path 3 with 25 AHe crystals with a broad range in [eU] and size, used to show a “best-case” scenario for resolving the true thermal history.

Figure S2: Data predictions for models shown in Figure 6.

Figure S3: Models to accompany Figure 7, showing results of setting the priors to 150 ± 150 Ma, and 250 ± 250 Ma.

Figure S4: Data predictions for models shown in Figure 7.

Figure S5: Data predictions for Path 1 models shown in Figure 8.

Figure S6: Data predictions for Path 4 models shown in Figure 8.

**Supplemental Tables**

Table S1: Model inputs and data predictions for forward models on Paths 1 – 6.

Table S2: Model inputs and decisions made for inverse models of Paths 1 – 6.

Table S3: Model inputs and decisions made for vertical profile sensitivity tests.

Table S4: Model inputs and decisions made for single chronometer sensitivity tests.

Table S5: Model inputs and decisions made for multi-chronometer sensitivity tests.

Table S6: Model inputs and decisions made for sensitivity tests on complex data with age variability not clearly related to diffusion and annealing kinetics.

Table S7: Model inputs and decisions made for Path Structure Approach example.