Recipe of air abrasion for geochronological purposes

Following the experience gained in the abrasion experiments, I suggest a certain procedure that warrants

. minimized breakage of instable zircons

. controlled grain size reduction

. virtually no expenses and

. a reasonably expenditure of time.

Before starting, let SRIM (www.srim.org) calculate the stopping distance of helium in the mineral of interest. Interpolate the stopping distances for the decay energies of the U and Th decay chains. The energies range between approximately 5 and 10 MeV and can be found in Farley et al. (1996). Take the excel sheet FT-abraded_euhedral.xls or FT-abraded_nat-rounded.xls and adopt the stopping distances in the tab "probability" according to the calculation through SRIM. Then think about how much abrasion is appropriate considering the calculated bulk retentivities (FT-abraded_nat-rounded.xls, FT-abraded_euhedral.xls) and the grain size of your sample. The hardness of the abrasive used should be around 1-2 scales on the Mohs' hardness scale below the hardness of the mineral you're abrading. The parameters in the below procedure is fitted for zircon abrasion.

General abrasion procedure (parameters fitted to zircon)

1) Pick the desired quantity of zircons out of your sample and divide them into groups with narrow grain size ranges that must not exceed 10 µm in the minimum dimension. It is advised to abrade naturally abraded crystals separately from euhedral crystals because the same amount of abrasion produces different bulk retentivities in the two types.

2) Pour them into the mount of the AAD together with one tip point of crushed pyrite (that is approximately 30 mg). Then dash the tilted mount slightly against the table to bring the grains to the margin of the mount. That avoids the grains from getting stuck between the cap and the floor of the mount.

3) Unscrew the cap from the stem and place a nylon sieve with a mesh opening of 5 µm over it and mark the area you have to cut to obtain a ring. Place the ring-shaped nylon sieve on the bottom side of the cover and fasten it by screwing on the cap. Place the cover on the mount and screw the collar over it.

4) Attach the air-pipe to the top of the stem. Make sure that the tuning outlet is closed. Open the air tap and adjust the manometer of the oil filter to approximately 1 bar - you won't need higher pressures. Open the fine tuning outlet slowly (ca. 1 minute) until you gain a pressure of 0.3 bar which you can read off at the second manometer with a higher precision.

5) Keep the sample for 16 to 17 hours at 0.3 bar dynamic pressure, then slowly increase the pressure to 0.5 bar and leave it there for another 2 hours.

6) Close the fine tuning outlet, then the main outlet. Remove the air pipe, the collar, and the cover. Empty out the mount over a piece of weighing paper through tilting it steeply and giving it light dashes on the table. If necessary, use a paint brush to guarantee complete sample transfer. Put the sample to a big glass slide by tilting the weighing paper over it. By bending the weighing paper, the grains are forced to roll in one direction and you will have better chances that they won't get lost.

7) Check the grain size under the binocular microscope with a calibrated reticule and see whether the grain size reduction was sufficient or not. Removing at least 15 µm on each side of the grains should yield reasonably high retentivities of the grain (see fig. 1).

8) When the grain size reduction is not sufficient, bring the sample back to the weighing paper, then into the mount and repeat the latter abrasion step. Try out first with one additional hour, then add more abrasion time if necessary.

Abrasion of apatite: P= 0.3 mbar for t= 60 minutes with magnetite as abrasive is sufficient to remove approximately 20 µm.

Abrasion of rutile: P= 0.5 mbar for t=10 min with quartz as abrasive reduces fragments of ca. 250 µm to 50 - 100 µm. Grain size reduction is mostly due to fracturing and fragments are only slightly rounded.

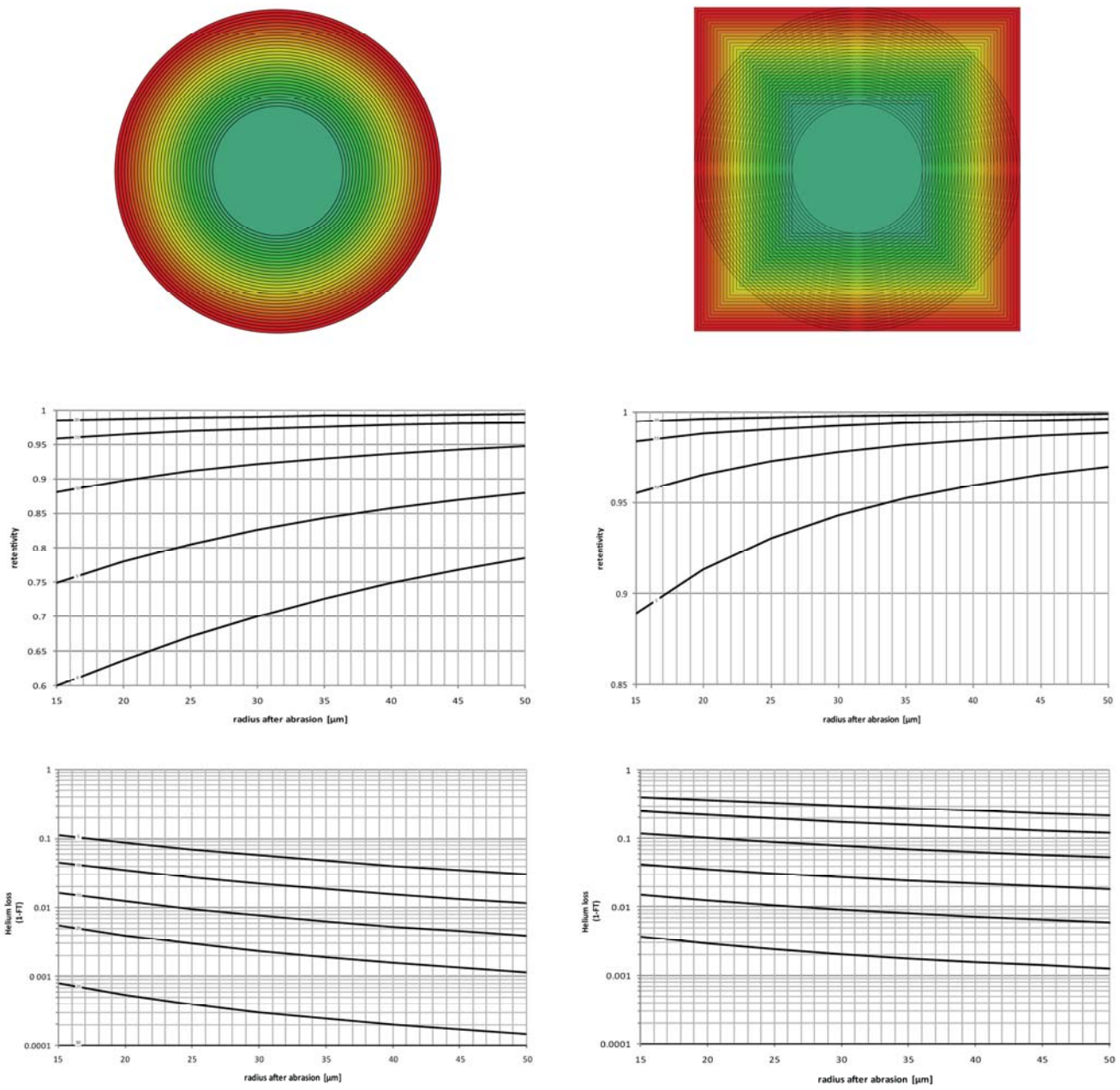

Figure 1: Retentivity in abraded zircon. Left: naturally rounded, right: euhedral crystal. The lines refer to the indicated amounts of abrasion.