Table 3
Factors than may contribute to variations in intra-sample apatite (U–Th)/He ages

Contributing factor	Effect	Result	How to monitor or avoid	References
U–Th rich inclusions	Contributes "parentless" ^4He	(U–Th)/He ages are older than what they would be if U and Th-rich inclusions were not present.	Careful grain selection, characterize grain population using SEM, running re-extracts.	(Farley, 2002; Lippolt et al., 1994)
Fluid inclusions	Contributes "parentless" or "excess" ^4He	(U–Th)/He ages may be older than what they would be if fluid inclusions were not present.	Careful grain selection, characterize grain population using SEM, running re-extracts.	(Farley, 2002; Lippolt et al., 1994; Stockli et al., 2000)
Grain size variation	Apatite grain is the diffusion domain	Larger grains have a higher closure temperature (older age). Large variation in single grain ages may indicate slow cooling.	Select same size grains for comparison within or between samples or use grain size variation for information on cooling rate.	(Farley, 2000; Reiners and Farley, 2001)
F_T correction (α-particle ejection)	Daughter α-particles from parent U and Th within 20 μm of grain boundary may be ejected from grain	Need to correct for α-particle ejection, homogeneous [U,Th] is usually assumed.	Careful grain selection (not too small, good crystal shape) and measurement of grain.	(Farley et al., 1996)
U and Th Zonation (effect on F_T correction)	If grain is zoned with respect to [U,Th]	As the F_T correction assumes homogeneous [U,Th], if grain is [U,Th] "core-rich" the age will be overcorrected. If grain is [U,Th] "rim-rich" the age will be under-corrected.	Examine grain population in fission track mount or SEM.	(Farley, 2002)
Fractured grains	Fractures provide rapid diffusion pathways (effectively reduces "grain size")	Grain size is less than measured and ages are therefore not "corrected enough" (i.e. corrected ages are too young).	Careful grain selection.	
Broken grains	Broken grains mean that the assumed α-particle distribution upon which the F_T correction is based is not correct.	Unless broken parts taken into account, the F_T correction will typically over-correct the age as more daughter α-particles are assumed lost than actually are; age too old.	Careful grain selection.	
Apatite grain boundary is not a zero concentration boundary	Daughter α-particles are either implanted into the grain from adjacent mineral phase or diffusion of ^4He is inhibited.	Less ^4He is ejected or diffuses from the grain than expected; or additional ^4He is implanted. F_T correction too great; age "too old".	Thin section analysis of rock type to determine if this may be a problem.	(Belton et al., 2004a; Spencer et al., 2004)
^{147}Sm	^{147}Sm decays via α-particle decay to ^{143}Nd.	A component of measured ^4He (typically 0.1–10% of total) could be from ^{147}Sm decay. Will result in overestimation of ages (ages too old).	Monitor [U,Th], measure ^{147}Sm.	(Belton et al., 2004b)
Zonation and rate of cooling.	Interplay of α-ejection and diffusion modifies He-concentration profile. Diffusion more important if sample is slowly cooled through PRZ.	Spread of single grain ages can occur if grains are variably zoned, and single grain age variation is enhanced if rate of cooling is slow.	Measure single grain ages. Use multiple thermochronometers to constrain cooling rate.	(Meesters and Dunai, 2002b)
Rock type (alkali granites, volcanics, metamorphic, sedimentary rocks)	Non-suitable apatites (too small and/or too many inclusions).	Small grains mean a less precise F_T correction, non-detectable inclusions give anomalously old ages.	Avoid some rock types, careful grain selection.	(Ehlers and Farley, 2003)
Rock type (granites and gneisses)	Phases such as Fe-oxides, titanite, epidote have high [U,Th]. Can implant α-particles into apatite.	(U–Th)/He ages may be too old (possibly > AFT ages).	Thin section analysis of rock type. Limit (U–Th)/He analyses to when ages will be < 100 Ma?	(Spencer et al., 2004)