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Mechanism of low-grade metamorphic alteration of zircon

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Recent advances in characterization techniques, such as in particular spherical aberration corrected- Scanning Transmission Electron Microscopy (Cs-STEM), allow to probe matter down to the nanometric scale. In this study, Cs-STEM was used to explain alteration mechanism of zircon crystals from a Variscan granite (External Crystalline Massifs, Western Alps). Granite microstructures and mineral parageneses indicate granite deformation and alteration during Alpine orogeny at low greenschist facies conditions. Zircon show complex microstructures in SEM and CL with (1) homogeneous cores with intense CL signal, sometimes replaced by (2) porous cores, and (3) rim with oscillatory zoning. U-Pb *in situ* dating gives magmatic ages around 340 Ma in the homogeneous core only; porous regions and rim give discordant dates indicating U-Pb mobility. The TEM analysis of FIB sections prepared in the three domains provides clues to explain the U-Pb disturbances observed outside the homogeneous core. In particular, nano-characterizations in the rim reveals the occurrence of thin U-rich bands (50-200 nm) with high density of irradiation damage, and wider bands (0.5-2 µm) free of irradiation defects and depleted in U. The porous core (2) is filled with nanopores (20-50 nm) and dislocations, which seems to progress to the detriment of the perfectly crystallized core (1).This interconnected nanopore network may provide a reaction path for the alteration fluid and mass transfer explaining the discordant dates.