The many lives and faces of zircon

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A mineral that forms at conditions as variable as diagenesis to deep subduction, magma crystallization to low temperature alteration, and that retains information on time, temperature, trace elements and other isotopic signatures is bound to be a useful petrogenetic tool. The variety of conditions at which zircon forms and reacts is a great asset, but also a challenge as interpretation of any geochemical data obtained form zircon has to be placed in P-T context. At which condition and by which process a zircon formed in rocks remains a crucial question to answer.

Textural relationships with other minerals and zoning within zircon itself are qualitative indicators of the type of reactions and conditions of formation. Particularly, internal zircon textures (revealed by cathodoluminescence and BSE) and structures (revealed by TEM and EBSD) combined with chemical variations have been used to distinguish between processes such as crystallization from a melt, recrystallization at sub-solidus conditions and dissolution-precipitation reactions in the presence of a fluid phase. Natural zircon textures have been partly reproduced in controlled experiments that have identified the most aggressive fluids to promote zircon recrystallization. Changes in oxygen, Lu-Hf and U-Pb isotopes can additionally assist in identifying the process that led to zircon formation or alteration. The different retentivity of distinct elements (for example REE versus Pb or oxygen) will also depend on the temperature and process.

Examples from zircon in magmatic and metamorphic rocks will be used to illustrate how the many faces of zircons can be recognised and what the limits are currently in our understanding of the processes related to zircon formation and modification.