Radiation damage and U-Pb discordance in detrital zircon in Palaeoproterozoic sandstones from South Africa

TOM ANDERSEN[1,2] MARLINA A. ELBURG[2]

[1]Department of Geosciences, University of Oslo, Norway, tom.andersen@geo.uo.no

[2]Department of Geology, University of Johannesburg, South Africa, marlinae@uj.ac.za

A well-preserved, low-wavelength – low-amplitude oscillatory zoning pattern in a cathodoluminescence image of a detrital zircon grain is commonly regarded as evidence that its crystalline structure is intact, and that the U-Pb isotope system reflects the age of crystallization of the rock in which the zircon formed (i.e. the protosource). However, combined SEM-CL, laser-Raman and LA-ICPMS U-Pb data on detrital zircon in Palaeoproterozoic sandstones from South Africa (Magaliesberg Formation and Waterberg Group) suggest that there is no simple connection between the extent of radiation damage to the crystal structure, CL characteristics and degree of discordance.

The Raman spectrum of fully crystalline zircon has a Si-O stretching peak at 1008 cm^{-1}, typically with peak width at half-maximum < 10cm^{-1}. This peak is displaced to lower wavenumbers and significantly broadened by radiation damage (e.g. Nasdala et al., 2003). Detrital zircons with well-preserved "magmatic" zonation patterns in our samples range from concordant to strongly discordant, and show displaced Raman peaks with peak widths of 10 to 25 cm^{-1} indicating significant structural damage. Further damage of the crystal structure indicated by Raman peak widths >25 cm^{-1} is accompanied by an increase of contrast in CL zoning, increasing discordance and uptake of common lead, and eventually by obliteration of the CL zonation pattern.

The breakdown of the zircon structure (metamictization) is a consequence of the U and Th content, and pre-conditions the zircon for loss of radiogenic lead. However, obliteration of the CL zonation pattern, development of normal U-Pb discordance and uptake of common lead are in our examples not directly related to the degree of structural damage, and more likely to be due to interaction with aqueous solutions during recent weathering.

Nasdala, L., et al., 2003. Reviews in Mineralogy and Geochemistry 53, 427-467.