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Incomplete retention of radiation damage in zircon from Sri Lanka

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ABSTRACT

A suite of 18 zircon gemstones from placers in the Highland/Southwestern Complex, Sri Lanka, were subjected to a comprehensive study of their radiation damages and ages. The investigation included X-ray diffraction, Raman and PL spectroscopy, electron microprobe, PIXE and HRTEM analysis, as well as (U-Th)/He and SHRIMP U-Th-Pb age determinations. Zircon samples described in this study are virtually homogeneous. They cover the range from slightly metamict to nearly amorphous. Generally concordant U-Th-Pb ages averaging 555 ± 11 Ma were obtained. Late Ordovician zircon (U-Th)/He ages scattering around 443 ± 9 Ma correspond reasonably well with previously determined biotite Rb-Sr ages for rocks from the HSWC. Slightly to moderately metamict zircon has retained the radiogenic He whereas only strongly radiation-damaged zircon (calculated total fluences exceeding ~3.5×10^{18} α-events/g) has experienced significant He loss. When compared to unannealed zircon from other localities, Sri Lanka zircon is about half as metamict as would correspond to complete damage accumulation over a ~555 m.y. lasting self-irradiation period, suggesting significant annealing of the structural radiation damage. Insufficient consideration of this has often resulted in significant underestimation of radiation effects in zircon. We suggest to estimate "effective α-doses" for Sri Lanka zircon by multiplying total α-fluences, which were calculated using the zircon U-Th-Pb age, by a correction factor of 0.55. This conversion may be applied to literature data as well, because all gem-zircon samples from Sri Lanka (this work and previous studies) seem to reveal the same general trends of property changes depending on the radiation damage. The use of "effective α-doses" for Sri Lanka zircon contributes to more reliable quantitative estimates of radiation effects and makes possible direct comparison between natural and synthetic radiation-damaged zircon.