Multichronometers of detrital accessory minerals – implications for provenance studies

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Plutons in the Stepladder Mountains, SE California, are exposed in a series of inselbergs, i.e. sediment point sources. Apatite and zircon were separated from sediment in arroyos in the inselbergs and compared to grains extracted from the granitic bedrock. 80% of bedrock U-Pb zircon dates are 74 Ma; 20% are xenocrysts with U-Pb dates of 1.4 or 1.65 Ga. Detrital zircon ages overlap those of the bedrock, but do not show the same age frequency; in all sediment size fractions there is > 50% of Proterozoic grains. To determine if apatite was a more faithful recorder of provenance we analysed grains for Sr isotopic composition. Apatite in bedrock samples range in $^{87}Sr/^{86}Sr$ of 0.7097- 0.7106, suggesting that the pluton is isotopically zoned. The $^{87}Sr/^{86}Sr$ ratio of detrital apatite largely overlap those of bedrock apatite but some analyses are significantly higher (0.7113) implying an exotic component. Single apatite crystals from both bedrock and alluvium were also analysed for (U-Th)/He. The average cooling date for bedrock apatite is 21.8 Ma. Forty three of 56 detrital grains overlap of the bedrock values demonstrating the value this technique to provenance studies. However, 23% of the cooling dates are ≥ 30 Ma also implying exotic sources. Because sediment was collected in a single watershed contained entirely within the granite these apatite grains are potentially of aeolian origin. A similar origin could also explain the enigmatic detrital zircon U-Pb age distributions. These results suggest considerable caution in interpreting provenance, particularly if relying on single mineral studies.