Automated mining of detrital Hadean zircons from Jack Hills, Western Australia: Flash geochronology with SHRIMP II.

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Challenging the established paradigms concerning the earliest history of the post-accretional Earth requires samples upon which geochemical data can be measured. Ancient zircon grains >4.2Ga, form a little less than 2 per mille of the total detrital population. Any meaningful quantity of ancient zircons from which an accurate assessment of the Δ^{142}Nd could be made, and hence whether major crustal extraction had already occurred, requires several hundred thousand grains to be surveyed in order to mine those few precious relics. Established non-destructive ion-probe techniques take around 30 sec for a single measurement of the ^{207}Pb/^{206}Pb age with no information as to the concordance of the target. Worse, manual operation of the instrument would balloon running costs to a prohibitive level.

We have used this project to bring the ANU SHRIMP II multi-collector on line, to automate acquisition and to substantially decrease search time without any loss of analytical precision. Our unattended flash geochronology procedure determines a ^{207}Pb/^{206}Pb age in around 5 sec; if the specified age of 3.8Ga is not obtained the next sample is located and measured. Once an "old" grain is found a full multi-collector determination of the ^{206}Pb/^{238}U and ^{207}Pb/^{206}Pb ages is undertaken. Together with standards (AS3), two 400 grain mounts can be run in a day with around 10% of these being targeted for further analysis. Zircons are arranged in a grid pattern such that old grains once identified, can be easily extracted for further analysis. So far we have surveyed in excess of 60,000 grains and are on target to exceed 150,000 grains by the end of 2007. Of these we have found 800 concordant grains with ages between 3.8-4.0Ga, 2100 concordant grains between 4.0-4.2Ga and 126 concordant grains older than 4.2Ga. After a population maximum at 4.1Ga, no gaps in the age distribution are seen, suggesting a continuum of growth or recycling rather than episodic crustal development. A small population maximum at 4.35Ga may record the first crust to survive recycling into the mantle. We have not found any grains older than 4.37Ga.

This rapid survey technique can be equally well applied to finding the youngest grains, or any specified age band within a mixed population of zircon grains from sedimentary, igneous, or metamorphic rocks.