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The U-Pb age and Hf isotope record of detrital zircons from Paleozoic sedimentary rocks of the proto-Andean accretionary orogen

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The global record of detrital zircon ages is frequently interpreted as reflecting cycles of supercontinent assembly and dispersal. When peaks in zircon age distributions are combined with data on the relative production of juvenile crust through time, a coincidence between the data sets is discernible for events mainly in the Archean and Paleoproterozoic. Hawkesworth et al. (2009) recently concluded that peaks in U-Pb detrital ages (n=7000; Campbell and Allen, 2008) and juvenile crust production do not always coincide on a global scale, and that a link to supercontinent cycles may in fact not exist. The reason for this is seen in the poor preservation potential of juvenile magmatic arc crust of accretionary orogens relative to continental collisional systems. This is significant as juvenile crust tends to be produced at active margins where it is also prone to destruction by subduction erosion. Granitic magmatic systems in collisional mountain belts, which later may become prolific sources of detrital zircons when eroded, are often formed by partial melting of preexisting crust. They may be volumetrically smaller than arc systems but have a better preservation potential due to their position in the interior of the evolving orogenic belts. The difference in formation and preservation potential is seen as a potential bias of the detrital zircon record towards collisional mountain belts. In contrast, non-collisional accretionary orogens should have detrital zircon age records free of this bias.

The SW Amazonia Orogenic System evolved by the episodic accretion of marginal orogenic belts to Amazonia from c. 2.3 to 0.9 Ga. From 0.9 to 0.25 Ga it was superseded by the Andean portion of the Terra Australis accretionary orogen. Recent reconsiderations of paleomagnetic data (e.g. Evans et al., 2010) together with the tectonic evolution of these orogens indicate that they reflect a c. 2 Ga long orogenic history free of major continental collisions.

A compilation of U-Pb detrital zircon ages (n= c. 5900) from Paleozoic sedimentary rocks representing the proto-Andes from Ecuador to Patagonia shows that age peaks coincide very well with the timing of assembly and dispersal of supercontinents. The coincidence with the respective record including collisional orogenic belts indicates that the preservational bias is not necessarily as pronounced a factor in shaping this record as previously thought.

A similar compilation of Hf isotope data from proto-Andean detrital zircons (n= c. 620) shows a major divergence from the global patterns presented by Hawkesworth et al. (2009). The global data indicate peaks of juvenile crust production at the Archean-Paleoproterozoic transition and between 1.9 and 1.6 Ga. Subsequent orogenic cycles are not strongly reflected by juvenile data. This dichotomy is interpreted as due to the preferential preservation of evolved late stage orogenic crust in the rock record. In contrast, the detrital zircon Hf data from Paleozoic proto-Andean sedimentary rocks located in the the Andes from northern Peru to Patagonia reveal two important patterns, (i) production of juvenile crust occurred in the SW Amazonia Orogenic System and the proto-Andes throughout the Late Archean and Proterozoic; and (ii) a maximum seems to have been attained in the Rondonia-San Ignacio and Sunsas orogenic cycles between 1.55 and 0.9 Ga. The production of juvenile crust appears to have become a minor factor in this region at the Precambrian-Phanerozoic boundary.

References

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