

Identification of first and multi-cycle zircons through U-Pb and (U+Th)/He dating of river sands

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These dating techniques used in tandem on single zircons, so called “double-dating”, can begin to identify first-cycle zircons (volcanic and plutonic) from multi-cycle ones, i.e. those stored, then caught up in younger uplift events.

Double dating was applied to the Navajo Sandstone, an erg in Utah, western USA [1]. Whereas the U-Pb age spectrum indicated that the Appalachian Mountains some 2000 km to the east was the likely source for most zircons (suggested also by [2]), He-dating cemented that controversial conclusion. U-Pb method dates the age of crystallization of the zircon (a truly high temperature age), whereas (U+Th)/He dates when the zircon last passed through ~180°C, essentially when the zircon last reached near-surface (<6 km) conditions. 16 Navajo grains yielded U-Pb ages of 450-1400 Ma including a large ~1000 Ma or Grenville-aged population. 75% of the grains returned He-ages of 260-500 Ma (including all of the Grenville ones), the range of ages of the Appalachian orogenies. Thus the dominant population of zircons from this sample was interpreted to be Grenville exposed in Appalachian mountain-building events.

Double dating has been applied to the North Platte River, just east of the Rocky Mountains to investigate the signal coming straight from the present-day uplift. If what we interpret as the Appalachian double-dating signal is unique to that terrane, the North Platte (Wyoming) should contain no zircons that have He-ages of 270-500 Ma, particularly ones with Grenville U-Pb ages; the North Platte should be strongly dominated by “Cordilleran ones” (<150 Ma). 25 of 28 selected grains that have U-Pb age between 32 and 2675 Ma return He ages < 150 Ma, and half are first-cycle volcanic (i.e. the ages agree). The other half are “multi-cycle, exposed in <150 Ma uplift. 3 zircons, however, that crystallized at 1780-2540 Ma return He ages of 270 to 490 Ma, U-Pb ages rare in the east, but solid Appalachian orogenic He ages. 3 interpretations are: 1. These are Appalachian grains, unlikely given the 2.6 Ga Wyoming craton is adjacent, 2. These grains have partially reset He ages, or 3. There are “Appalachian-aged” exposure events in the Rocky Mountains.

References

- [1] Rahl, J.M., Reiners, P.W., Campbell, I.H., Nicolescu, S., and Allen, C.M. (2003) *Geology* **31**, 761-764
- [2] Gehrels, G.W., Dickinson, W.R., Ross, G.M., Stewart, J.H. and Howell, D.G. (1995) *Geology* **23**, 831-834.