Growth and rate of deformation of an accretionary thrust wedge, western Lachlan Orogen

DAVID A. FOSTER[1] AND DAVID R. GRAY[2]

[1]Department of Geological Sciences, University of Florida, Gainesville, Florida 32611 USA (dfoster@geology.ufl.edu)
[2]School of Earth Sciences, University of Melbourne, Melbourne, 3010 Vic., Australia (drgray@unimelb.edu.au)

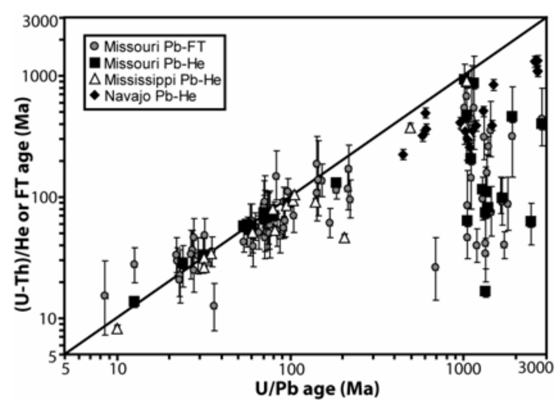
Quantifying deformation rates or orogenic strain rates has been more challenging than determining the timing of discrete geological events in ancient orogens. It is possible to determine strain rates across the low-grade (~280-350˚C), external parts of orogens by $^{40}Ar/^{39}Ar$ dating metamorphic white mica from cleavage bands in slates and phyllites lacking detrital muscovite, and from syntectonic quartz veins. White mica closes to argon loss at 350˚±50˚C so that at low greenschist and prehnite-pumpellyite facies, grow occurs at or below the closure temperatures, and apparent ages reflect the timing of growth. In polydeformed zones this requires some early metamorphic mica to be preserved in low-strain domains through episodes of transposition cycling. Timing of mica growth combined with measured finite strains and/or palinspastic restorations can be used to estimate time-averaged strain and displacement rates. Dating mica growth in the basal decollement gives the rate of fault propagation, and dating micas defining cleavage growth gives the rate of fold propagation. Deformation of a turbidite dominated, accretionary-style thrust wedge in the western Lachlan Orogen occurred by chevron folding and faulting over an eastward propagating decollement. Based on $^{40}Ar/^{39}Ar$ dates of white micas, this deformation started at ~455 Ma in the western part and ended at ~385 Ma in the eastern part, with distinct "pulses" of deformation at about 440, 420 and 390 Ma. These data suggest a time-averaged decollement propagation rate on the order of 10 mm/yr or a strain rate of 10^{-14} to 10^{-15} s^{-1} at the orogen scale. The rates were probably higher than average during the deformation pluses. At the scale of two individual thrust sheets in the western Lachlan $^{40}Ar/^{39}Ar$ dating of micas from (1) bedding-parallel cleavage and veins, (2) sub-vertical cleavage and folded viens, (3) and cross-cutting veins on late thrust faults, defines the duration of tectonic shortening as it evolved from open folding, to chevron fold lock-up, finally to thrusting over 10-15 million years.

Continental-scale tectonics: Zircon He-FT-Pb triple-dating of modern river sediment

P.W. REINERS[1], I.H. CAMPBELL[2], S. NICOLESCU[1], C. ALLEN[2], AND J.I. GARVER[3]

[1]Dept. of Geol. and Geophys., Yale Univ., New Haven, CT, USA
[2]RSES, Australian National Univ., Canberra ACT 0200, Australia
[3]Dept. of Geol., Union College, Schenectady, NY, USA

U/Pb, fission-track, and (U-Th)/He systems provide independent formation and cooling ages on single zircons. We measured He-FT-Pb triple-dates on single detrital zircons from modern sediment in the Mississippi and Missouri rivers, to interpret Precambrian through Recent tectonic and volcanic histories of a large region of North America.



Combined formation-cooling age distributions in these rivers show distinct populations corresponding to different magmatic and exhumation events. About 85% of U/Pb ages fall within 25-35 Ma (~10%), 55-100 Ma (~25%), 140-220 (10%), 1.0-1.1 Ga (~20%), and 1.3-1.8 Ga (~20%), with pronounced magmatic age gaps at 35-55 Ma, 100-140 Ma, and 0.2-1.0 Ga. Nearly all zircons younger than 100 Ma are first-cycle volcanic, with indistinguishable He and Pb ages. Most Grenville zircons have Appalachian cooling ages, reflecting continental-scale disperal of Appalachian detritus. Most 1.3-1.8 Ga zircons have 17-150 Ma cooling ages, reflecting Cordilleran exhumation. Some 1.0-1.1 Ga zircons have nearly identical (~0.9-1.0 Ga) cooling ages, which may represent dispersed Grenvillian volcanics or other ancient eroded sources. Abundant volcanic zircons younger than 100 Ma reflect the strong magmatic character of the Cordilleran orogen, whereas abundant cooling ages coupled with a near absence of formation ages between 0.2 and 0.6 Ga reflect the weak magmatic but strong exhumational signature of the fundamentally tectonically different Appalachian orogen.