Impacts of arc collision on small orogens: New insights from the Coastal Range detrital record of Taiwan

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Taiwan is seen as the archetypical orogen in the development of critical wedge models of mountain building however, despite intense study the issue of how arc collision progressed along the Taiwan margin remains poorly understood. It has been suggested that punctuated collision took place (e.g. Byrne *et al*., 2011) and therefore the classic wedge model may not be applicable. To resolve this, the detrital archive of orogenesis preserved in Coastal Range rocks of eastern Taiwan was used to reconstruct the erosional response of arc collision.

There is a distinct geographic division to the thermochronology data linked to the location of volcanic arc centres of Chimei and Chengkuangao. Detrital zircon fission-track results record grains that were exhumed from depths of 6-8 km ~6 Ma in the region between Chimei and Chengkuangao. These grains were transported and deposited into adjacent retro-foredeep basin(s) bounded by the discrete volcanic centers starting at 1.9 Myr.

South of Chengkuangao rapidly exhumed zircons are detected in sediments deposited < 1.3 Myr hence both exhumation and deposition must be fast. The pattern of exhumation and location of exhumation ages is consistent with southwards progression of arc-continent collision in a punctuated rather than sequential manner and deposition was confined to small foredeep basins.

[1] Byrne, T., Chan, Y-C., Rau, R-J., Lu, C-Y., Lee, Y-H., and Wang, Y-J., 2011, The arc-continent collision in Taiwan, *in* Brown, D., and Ryan, P.D., eds, Arc-Continent Collision: Springer Verlag, New York, p. 213-245.

Decreased export productivity at onset of Eocene hyperthermal events

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Hyperthermals, or abrupt global warming events, occurred frequently throughout the warm early Eocene (~56 to 47 Ma). Two lines of evidence widely used in their identification include a negative $\delta^{13}C$ excursion recorded in marine and terrestrial sources of inorganic and organic carbon and a drop in deep sea sedimentary carbonate content (wt% $CaCO_3$), indicative of the release of large quanities of isotopically depleted carbon to the atmosphere and oceans and subsequent dissolution of deep sea carbonates due to a shoaling carbonate compensation depth. For a number of the smaller hyperthermal events, including H2 [1], C22rH2, C22nH2, C22nH3, and C21rH1 [2], records from multiple deep sea sites show a notable offset in the timing of the $\delta^{13}C$ excursion and the wt% carbonate minimum, though carbonate content never drops below 10%, indicating deposition above the CCD throughout each event. The minima in wt% carbonate have an apparent lead of ~1 to 20 kyr compared to the minima in carbonate $\delta^{13}C$. For each event, the temporal offsets occur at multiple deep sea sites, though the magnitude of the lead varies between sites.

Experiments using the intermediate complexity Earth System model cGENIE (Grid-ENabled Integrated Earth system model) designed to reproduce these hyperthermal events show the same pattern in modeled sediment 'cores.' Hyperthermals are simulated by forcing the addition and removal of isotopically depleted carbon to the atmosphere in order to match the observed $\delta^{13}C$ excursion, with the results recorded in sediment model tracers of carbonate content and isotopes. In the model, the timing of the minimum in sedimentary wt% $CaCO_2$ is a function of decreased $CaCO_3$ export from the surface ocean occurring coincident with the addition of excess carbon to the atmosphere and oceans. In contrast, the carbonate $\delta^{13}C$ minimum records a whole ocean change in the $\delta^{13}C$ of dissolved inorganic carbon and is therefore delayed relative to the carbon addition. Both model results and observational data thus indicate an early reduction in export productivity as a consequence of small hyperthermal events.

[1] Stap, L., *et al*, (2009), *Paleoceanography*, Vol. **24**, PA1211, 13 pp., doi:10.1029/2008PA001655. [2] Sexton, P.N., *et al*, (2011), *Nature*, Vol. **471**, pp. 349-353, doi:10.1038/nature09826.

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