Paper Number: 4192

Cosmogenically dated marine terraces in South Africa reveal low long-term rates of uplift and no evidence for localized faulting

Bierman, P.R.[1], Coppersmith, R.[2], Hanson, K.[3], and Neveling, J.[4]

[1] Geology Department, University of Vermont, Burlington, VT 05405 pbierman@uvm.edu
[2]Coppersmith Consulting, Inc., Walnut Creek, CA, USA
[3]KLHanson Consulting LLC, Ely, MN, USA
[4]Council for Geoscience, Pretoria, South Africa

Dated marine terraces can be used as strain gauges – an approach taken frequently in tectonically active areas. Once corrected for changes in sea level over time, terrace elevation can be used to calculate uplift rates; deformation of a terrace surface can reveal localized areas of differential uplift. Here we use marine terraces to determine long-term uplift rates and to evaluate evidence for faulting along the south coast of South Africa, a stable continental region. At several different sites, Cape St. Francis, Oyster Bay, Thyspunt, and Cape Recife, we mapped marine terraces cut into quartzite and measured

cosmogenic ^{10}Be in samples collected from outcrops on these terraces as well as measuring both ^{10}Be and ^{26}Al in quarry samples (Motherwell) and in sediment collected from drill cores (Thyspunt), which reached the surface of sediment-mantled marine abrasion platforms.

The cosmogenic ages we calculate are not uniformly distributed in time. Of the 49 individual ages, 21 samples have ages between 0.25 and 0.45 My, coincident with two of the highest relative sea levels in the Pleistocene (MIS, marine oxygen isotope, stage 9 and 11). There is another broader mode between 0.50 and 0.80 My that includes MIS 13 and MIS 15 for which little is known about relative sea level. The cosmogenic data do not show the influence of MIS 5e in the field area, most likely because it reoccupied the marine terrace cut during MIS 11 and perhaps reoccupied during MIS 9. Surface samples from marine terraces are spatially coherent with spatial replicates at single sampling sites usually giving similar results. For the most part, samples are in stratigraphic order.

The most certain estimate of uplift over time (5.0 ± 0.7 m/My; p=0.04) is calculated from the Thyspunt boring data, specifically three pairs of samples that include the uppermost underlying marine terrace bedrock platform and the overlying beach gravel. The highest elevation samples (above contemporary sea level) have burial ages exceeding 1 My. Deeper samples have progressively younger burial ages. The youngest unit we analyzed, has an average clast burial age similar to its isochron age, about 0.6 My. We have the most faith in this estimate of uplift because it spans over a million years of site history and because the ages are less likely to have been affected by intermittent burial and re-exposure than surface samples. The Thyspunt -specific uplift rate matches well the isostatic uplift rate (4.4 m/My) inferred from the regional average rate of erosion (5.5 m/My).

The near-shore gravel at Motherwell (quarry samples, 51.6 m asl) is Pliocene. The isochron age of 3.98 My indicates a maximum uplift rate of ~13 m/My presuming similar eustatic sea-level or 6.2 m/My to 8.7 m/My if eustatic level was ~22±5 m [1]. These estimates are higher than inferred along the south coast (4.4 m/My), similar to the paleo-erosion rate (6 m/My) of the Sundays River [2] and less than the incision rate (17 m/My) of the Sundays River to the north and east [2].

References

[1] Miller et al. (2012) Geology 40: 407–410

[2] Erlanger et al. (2012) Geology 40(11): 1019–1022