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Cosmogenic ^{10}Be and ^{26}Al dating of ancient surfaces and recent fault scarps in south central South Africa – indications of both fault motion and stability in a stable continental region

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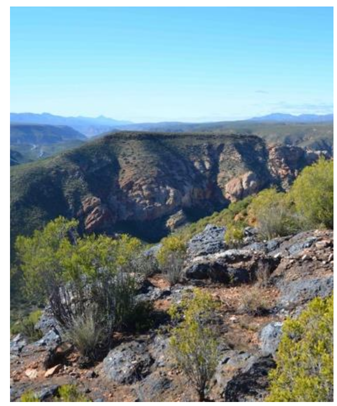
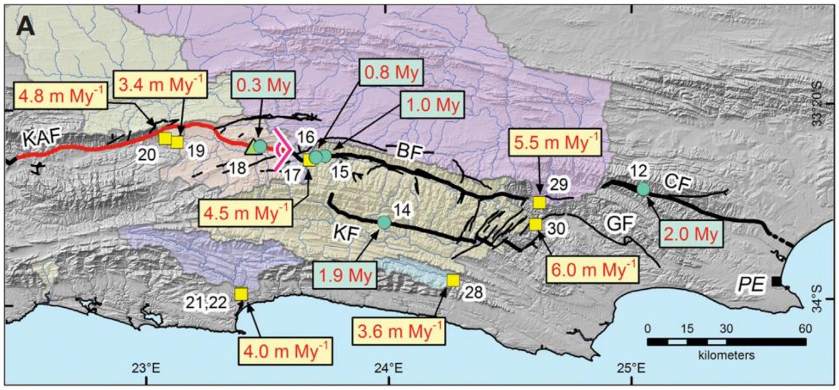
Southernmost Africa, with extensive upland geomorphic surfaces, deep canyons, and numerous faults (some active but most not) has long interested geoscientists. A paucity of dates and low rates of background seismicity make it challenging to quantify rates of landscape change and determine the likelihood and timing of fault movement that could raise and lower parts of the landscape and create associated geohazards.


Example of silcrete-mantled pediment surface in field area, southern Africa.

To estimate the minimum age of extensive, fossil, upland, silcrete-mantled pediment surfaces (which we use as markers for deformation coincident with earthquakes), we measured ^{10}Be and ^{26}Al in exposed quartzite samples. Undeformed upland surfaces are little changed since the Pliocene; some have minimum exposure ages exceeding 2.5 My (median, 1.3 My) consistent with no Quaternary movement on faults that displace the underlying quartzite, but not the more recent silcrete cover.

We directly dated a recent displacement event on the only recognized Quaternary-active fault in South Africa, a fault that displaces both silcrete and the underlying quartzite. The concentration of ^{10}Be in exposed fault scarp samples is consistent with a ~1.5 m displacement occurring ~25 ka ago. Samples from this offset upland surface have lower minimum limiting exposure ages than those from undeformed pediment surfaces, consistent with Pleistocene earthquakes and deformation reducing overall landscape stability proximal to the fault zone.

Rates of landscape change on the extensive, stable, silcretized, upland pediment surfaces are an order of magnitude lower than basin-scale erosion rates that average ~5 m My^{-1}, a slow erosion rate consistent with those measured in other non-tectonically active areas including much of southern Africa. As isostatic response to regional denudation uplifts the entire landscape at several meters per million years, valleys deepen, isolating stable upland surfaces and creating the spectacular relief for which the region is known.



Map of southern Africa showing sampled piedmont surfaces (minimum ages given in My) and drainage basins (shaded with erosion rates given in m My^{-1}). From Bierman et al. [1]

References:

[1] Bierman, P. et al. (2014) *GSA Today*: doi:10.1130/GSATG206A.1