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Constraining the age of Aboriginal rock art using cosmogenic Be-10 and Al-26 dating of rock shelter collapse in the Kimberley region, Australia.

Gaël Cazes (1,2), David Fink (2), Réka-Hajnalka Fülöp (1,2), and Alexandru T. Codilean (1)

(1) School of Earth and Environmental Sciences, University of Wollongong, Wollongong NSW 2522, Australia, (2) Australian Nuclear Science and Technology Organisation (ANSTO), Menai 2234, Australia

The Kimberley region, northwest Australia, possesses an extensive and diverse collection of aboriginal rock art that potentially dates to more than 40,000 years ago. However, dating of such art using conventional techniques remains problematic. Here, we develop a new approach which makes use of the difference in production rates of in-situ ^{10}Be and ^{26}Al between intact rock walls and exposed surfaces of detached slabs from rock art shelters to constrain the age of Aboriginal rock-art.

In the prevailing sandstone lithology of the Kimberley region, open cave-like rock shelters with cantilevered overhangs evolve by the collapse of unstable, partially rectangular, blocks weakened typically along joint-lines and fractures. On release, those slabs which extend outside the rock face perimeter will experience a higher production rate of cosmogenic ^{10}Be and ^{26}Al than the adjacent rock which remains intact within the shelter. The dating of these freshly exposed slabs can help reconstruct rock-shelter formation and provide either maximum or minimum ages for the rock art within the shelter. At each site, both the upper-face of the newly exposed fallen slab and the counterpart intact rock surface on the ceiling need to be sampled at their exact matching-point to ensure that the initial pre-release cosmogenic nuclide concentration on slab and ceiling are identical.

The calculation of the timing of the event of slab release is strongly dependent on the local production rate, the new shielding of the slab surface and the post-production that continues on the ceiling sample at the matching point. The horizon, ceiling and slab shielding are estimated by modelling the distribution of neutron and muon trajectories in the irregular shaped rock-shelter and slab using 3D photogrammetric reconstruction from drone flights and a MATLAB code (modified from G. Balco, 2014) to estimate attenuation distances and model the production rate at each sample.

Five rock-art sites have been dated and results range from 9.8 $\pm$ 1.9 kyr to 180.8 $\pm$ 22.3 kyr, While the date obtained for the youngest site can be interpreted as both a maximum and minimum age for the art due to its positioning over different walls of this specific shelter, all the other sites give maximum art ages which are significantly older than presumed human occupation in Australia. However, within the context of regional landscape geomorphology, these relatively young ages give new insights into the contrasting modes of landscape evolution in the Kimberley, and the importance of episodic escarpment retreat overprinted by passive basin-wide denudation which from numerous previous measurements are as low as 1-5 mm/ka (i.e. averaging timescales of $\sim$400 kyr). A large number of similar sites in the region have been mapped and are potential candidates for this new approach which can constrain the controversial relative chronology of the various aboriginal rock art styles.