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Are neutron-monitor data suitable for scaling production rates of cosmogenic 10Be with altitude?

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Accurate assessment of production rates of cosmogenic beryllium-10 (10Be) in situ in terrestrial solids is necessary for using this isotope in geochronology. We measured 10Be in water targets exposed for more than three years at altitudes between ~50 m and ~4200 m above sea level in Hawaii, and measured high-energy cosmic-ray neutrons over similar range of altitudes using mobile neutron monitors. The production rate of 10Be at sea level in Hawaii is 5.0±0.5 atoms per gram of H_2O per year, corresponding to 3.0±0.3 atoms per g of quartz per year (quartz is the main mineral used in 10Be geochronology), broadly comparable to the current estimates. The atmospheric attenuation length for total production of 10Be (neutrogenic and muogenic) is 164±3 g/cm2 and that for neutrons is 147±2 g/cm2. The difference between the two can be explained by production of 10Be by slow muons, but the fraction of muogenic production at sea level would have to be an order of magnitude larger than the current estimates. Another possible explanation is that neutron monitors yield attenuation lengths that are too short for scaling spallogenic production of 10Be in water. These seemingly irreconcilable results suggest that our understanding of cosmogenic production of 10Be is incomplete and that the spatial scaling formulations for 10Be should be derived from 10Be measurements and not from neutron monitor data.