Basin-wide denudation rates of claystone lithologies in Taiwan from meteoric $^{10}\text{Be}/^{9}\text{Be}$ ratios

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Small mountainous rivers (SMRs) in southern Asia and Oceania contribute $\sim1/3$ of the suspended load\(^1\), and thus act as a critical part of global source-to-sink systems and an especially significant role in the material cycling of the Earth’s surface. Because of active tectonics and a high typhoon frequency, SMRs in Taiwan Island is characterized by extremely high erosion rates (several mm/yr) and rapid mass wasting\(^2\).

In order to quantitatively determine denudation rates averaged over centennial-millennial time scales, denudation rates from \textit{in situ} $^{10}\text{Be}$ ($D_{\text{insitu}}$) are commonly the first choice. However, claystone lithologies in the headwaters of many Taiwan rivers limit the reliability of this method to quartz-bearing units. Hence, we apply a promising new denudation rate tool, the meteoric $^{10}\text{Be}/^{9}\text{Be}$ ratio\(^3,4\). This new proxy combines an atmospheric tracer of known flux, meteoric cosmogenic $^{10}\text{Be}$, with stable $^{9}\text{Be}$ released from rocks by weathering, and can be measured on small sample amounts and quartz-free lithologies\(^5\).

$^{10}\text{Be}$ and $^{9}\text{Be}$ concentrations were analyzed in the 30-63 $\mu$m fraction of bedload sediments along the Choshui River, whose headwaters drain a region dominated by claystone lithologies, the so-called Slate Belt. To first assess $^{10}\text{Be}$ steady state conditions that are a prerequisite for the application of this meteoric proxy, $^{10}\text{Be}$ fluxes exported from the basin by river transport must equal their production by deposition. We determined the exported meteoric $^{10}\text{Be}$ flux by multiplying $^{10}\text{Be}$ concentrations with an independent erosion rate estimate from \textit{in situ} $^{10}\text{Be}$\(^6\), and compared it with the depositional $^{10}\text{Be}$ flux derived from global atmospheric circulation models\(^7\). The ratios of exported to produced $^{10}\text{Be}$ flux scatter around 1 in the Choshui River, indicating their balance, and thus we proceed to calculate meteoric $^{10}\text{Be}/^{9}\text{Be}$-derived denudation rates ($D_{\text{met}}$). Downstream of the Slate Belt, our $D_{\text{met}}$ agree with published $D_{\text{insitu}}$, where both methods yield rates on the order of 1-2 mm/yr. In comparison, $D_{\text{met}}$ in the slate-dominated upstream are significantly higher, similar with higher modern uplift rates in the Central Range\(^8\).

We conclude that the $^{10}\text{Be}/^{9}\text{Be}$ ratio is a promising tool to derive denudation rates characterized by rapid erosion and claystone lithologies.

\textbf{References:}