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Constraining the Quaternary evolution of the Hida range of the Japanese Alps

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Japan is one of the most tectonically active locations on Earth, situated adjacent to two triple junctions between four tectonic plates. Within this convergent zone, the Hida, Kiso and Akaishi ranges of the Japanese Alps are thought to have been uplifted within the last 1 to 3 Ma. Whilst undoubtedly tectonically driven, this mountain-building is also coincident with the onset of the Quaternary period, and the associated global climatic transition to ice-house conditions. Extremely high rates of precipitation (>3,000 mm/a) coupled with earthquake-enhanced landsliding potentially make the Japanese Alps one of the most rapidly exhuming places on Earth. Quantifying erosion rates across a range of timescales will provide insights into the tectonic evolution of the Japanese Alps as well as an improved understanding of the coupling between tectonics and climate through erosion processes.

Thermochronometry enables exhumation rates to be determined from the measurement of rates of rock cooling. A number of higher-temperature thermochronometry ages for the Hida range have been reported previously (e.g. Ito et al., 2013) indicating that the Hida range is undergoing rapid exhumation. We applied two ultra-low temperature thermochronometric methods based on the trapped-charge dating methods of Optically Stimulated Luminescence (OSL) and Electron Spin Resonance (ESR) dating to a suite of 19 bedrock samples collected from the Hida range. These techniques are sensitive to temperatures of as low as $\sim$25 ^{0}C, enabling late-Quaternary erosion histories to be constrained. In contrast to OSL which can only be applied over timescales of up to $\sim$400 ka, ESR may be applicable over the whole Quaternary period, significantly extending the applicability of trapped-charge dating based thermochronometric methods.

The ESR and OSL data yield similar cooling histories indicating rapid erosion of the Hida range over the past 100 ka. Inverting the data for erosion rates, assuming a geothermal gradient of 60 ^{0}C/km, reveals a reduction in rates from $\sim$10 mm/a throughout MIS4, during which the most intense glaciation of the Japanese Alps occurred, to $\sim$1-3 mm/a over the past 20 ka. Our preliminary data indicate that erosion rates within the Hida range were higher under a cooler and wetter climate.

References

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