Exhumational and incisional response to active faulting in the Japanese forearc, northeast Honshu

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Abstract

Late Neogene shortening in northern Honshu, Japan is documented along a network of reverse faults and fault-related folds that record Pliocene contractional deformation associated with inversion of Miocene extensional basins. Active slip along several of these structures is recorded by offset Holocene deposits and the presence of topographic scarps, but anthropogenic disturbance of young deposits, deep weathering of the substrate, and thick vegetative cover in the region obscure records of Quaternary slip in many locations. However, the erosional response of fluvial systems to active slip provides a complimentary data set to assess long-term rates and patterns of deformation. Here we present new results from 10Be basin-averaged erosion rates, low-temperature thermochronology, and stream profile analyses within the hanging wall of the Futaba fault in the forearc of northeastern Honshu, that indicate a recent pulse of transient incision and erosion induced by active slip along this thrust fault. The Futaba fault is a steep, west-dipping reverse fault that bounds the basement-cored Abukuma massif on the east. Tephras in growth strata bracket the initiation of slip along the fault to ~3.9 - 5.6 Ma and yield uplift rates of 0.3-0.6 mm/yr at the southern portion of the fault. The highest elevations in the massif are characterized by a low-relief surface with low hillslope angles, saprolitic bedrock, and low-gradient, alluviated streams. Near the mountain front however, relief and hillslope angles increase, and the surface is dissected by deeply incised bedrock streams. Knickzones in hanging wall streams cluster at ~400m elevation, and are located coincident with this transition. Basin-averaged10Be erosion rates from catchments above these knickzones are lower than erosion rates below the knickzones by 10-30%, but maximum erosion rates are less than half the rates of uplift. These data are consistent with the upstream migration of knickzones in response to an increase in uplift

rate caused by the initiation of slip along the Futaba fault, but suggest that the stream gradients and basin averaged erosion are not yet adjusted to Plio-Quaternary uplift rates. In contrast, AFT and AHe ages from granites in the hanging wall of the Futaba fault yield ages approximately equal to the Ar/Ar ages of granite emplacement, requiring that the granites have been above the 50-60° isotherm since the late Cretaceous with minimal net Cenozoic exhumation. These data are consistent with our tectonic model of Mio-Pliocene thrust inversion of a normal fault, and suggest that the morphology observed in the hanging wall of the Futaba fault results from a transient wave of incision imparted by active shortening in the forearc.

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