Surface break-through of a basement fault by repeated seismic slip episodes: the Ostler Fault, South Island, New Zealand

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In print in Tectonics, 2007

Abstract

The Ostler Fault is one of the major active reverse faults in the piedmont of the Southern Alps, SE of the Alpine Fault. We present a new geological and morphotectonic map of the southern Ostler Fault, integrated with two seismic reflection profiles across the active central segments of the fault. Segmented, sub-parallel scarps define a N-S belt (~40 km long and 2-3 km wide) of pure reverse faults, which upthrow and back-tilt a panel of Plio-Pleistocene terrestrial units (2.4-1.0 Ma) plus the overlying glacial outwash (< 200 ka). Uplift gradients, the chronology of newly faulted markers, and tectonically-controlled diversion of paleodrainages, all indicate progressive S to N breakthrough of the surface trace of the Ostler Fault in the last 2.4 Ma. The new seismic data define a main fault segment dipping 50-60º W to depths of ~1.5 km, with a vertical throw of 800 m, and a shortening of ~30%. The fault geometry and kinematics and the subsurface data favor the interpretation that the Ostler Fault propagated up-dip across the Plio-Quaternary terrestrial sequence as the emerging, high-angle splay of an inherited Late Cretaceous-Paleocene normal fault, that underwent repeated cycles of compressional reactivation in the last 2.4 Ma.