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Segmented ruptures during intracontinental earthquakes: Kyrgyz Range, N-Tien Shan

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In the late 19th and early 20th centuries, the northern Tien Shan of Kyrgyzstan and Kazakhstan was affected by a series of major M 6.9 to ∼8 earthquakes. Ruptures affected either range fronts or range interiors. During these events (AD1885 Belovodskoe; AD1887 Verny; AD1889 Chilik; AD1911 Chon-Kemin; and AD1938 Kemino-Chu), neighboring faults ruptured and caused severe damage in the area of the Kyrgyz capital Bishkek and the former Kazakh capital Almaty (previously also called Alma-Ata or Verny), which were located in the epicentral areas. As recurrence intervals along single faults in this region are on the order of hundreds to thousands of years, such a sequence of earthquakes is not known in the remaining historic record. Earlier events may thus be recorded in long-term geomorphic archives.

Through a combination of high-resolution offset measurements in the field, cosmogenic nuclide and luminescence dating of Quaternary landforms, stratigraphic analysis, and paleoseismological trenching, we evaluate the Quaternary deformation and analyze the paleoseismic history of neighboring fault systems along the Kyrgyz range mountain front. Our study sites are located close to the Kyrgyz capital Bishkek and include the epicentral area of the M6.9 Belovodskoe event of AD1885, but also the region west of it, which was not affected by this remarkable earthquake sequence.

To date, the paleoseismic and historical seismic records for the Kyrgyz range indicate segmented ruptures that hardly exceed magnitude seven. Based on scaling relationships, however, the linked fault systems would be capable of generating M 8-events, similar to the long segmented ruptures observed in the mountain interior farther east during the late nineteenth and early twentieth centuries. The available observations, thus, point to incomplete fault ruptures along the mountain front, rather than earthquakes failing along a full rupture length.