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Tectonic and sedimentary evolution of the Ili Basin (northern Tien Shan, Kazakhstan)

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The Tien Shan active intraplate orogen between about 75° and 80°E presents a strongly asymmetric structure: Its southern front in China has a typical foreland fold-and-thrust belt. Its northern front in Kazakhstan is characterized by a fragmented array of anticlinal basement highs whose wavelengths range from c. 5 to 30 km. Range-bounding faults are mostly E- to ENE-trending thrust or reverse faults and SE-trending dextral strike-slip faults. Faults of large displacement (more than several tens of meters) are conspicuously absent. The synclinal lows between the basement highs preserve Cenozoic strata of Oligocene to Quaternary age, probably deposited in a once continuous basin (the Ili Basin) and recording the entire history of Tien Shan uplift. Very gentle, long-wavelength folds affect the Cenozoic strata. As far as visible, the basement is always folded conformably. The basin fill starts in the middle Oligocene (mammal fossils; Indricotherium horizon). The facies of these oldest deposits is characterized by fluvial deposits of a large river system and varying flood-plain deposits with intense soil formation (calcretes and gypsisols). Transport directions and quartz content of the sediments suggest they were not sourced from the nearby mountain ranges present today. The fluvial succession is followed by late Oligocene to early Miocene lake deposits which reflect the transition from an evaporitic lake/playa system to freshwater lacustrine conditions. The Oligocene to Early Miocene deposits are limited to a small area in the core of the Aktau anticline and show no relationship to the sediment succession overlying the basement in the uplifts surrounding the Aktau mountains in the north and west. There, alluvial and fluvial deposits of middle Miocene (?) age rest on deeply weathered paleosurfaces. Transport is mainly to the south. Changes in colour, grain size and ratio of channel to interchannel deposits probably reflect climatic changes. Rapid facies and thickness-changes allow the reconstruction of several alluvial fans interfingering with thick mud deposits. Since these crudely-bedded sandy mudstones are rich in calcite and even contain platy limestones or carbonate nodules, they were earlier interpreted as lake deposits. In fact, most of the carbonates represent calcretes, indicating that the majority of the distal succession represents playa and terminal fan deposits. Lake deposits occur as green to light grey bioturbated marlstones with freshwater molluscs, ostracods and characeans. They are limited to the upper Miocene (Santash Formation). N and NNW-trending normal faults with as much as 100 m throw displace the Cenozoic strata at least up to the Santash Fm. They are associated with E-W thickness gradients, suggesting that depositional patterns were influenced by E-W extensional tectonics. At the southern basin margin, deposition starts only in Pliocene time with red alluvial fan sediments derived from local sources and transported to the north. Later, as yet undated pediment surfaces evolved adjacent to uplifts on the northern and southern basin margins. Fold scarps locally tilt the young pediments, indicating ongoing, approximately N-S shortening. The Ili Basin apparently originated as a mildly extensional basin in the Paleogene and evolved into a foreland basin possibly as late as Pliocene time. Both the present-day main thrust front along the southern border of the Ili basin and contractional deformation within the basin appear to be relatively recent features of the Tien Shan orogeny, suggesting that the far-field effects of the Himalaya-Tibet orogeny continue to be encroaching upon Asia′s interior today.