Geochronology and the initiation of Altyn Fault, western China

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The samples of Proterozoic and Early Paleozoic metasediments, Caledonian mylonitized granite and Jurassic metasedimentary rocks were collected in Aksay-Dangjin Pass and Geshi fault-valley. Biotite, muscovite, hornblende and K-feldspar were dated by $^{40}Ar/^{39}Ar$ method in the Isotopic Dating Laboratory-ARGONAUT with a laser fusion $^{40}Ar/^{39}Ar$ dating system in the Institute of Geology and Paleontology, Salzburg University, Austria. Several age groups were obtained. Biotites of the Early-Middle Jurassic samples from Geshi fault-valley yield an isochron age of 92±2.7 Ma. In Aksay-Dangjin Pass profile, samples away from the middle shear zone of the Altyn fault belt yield two plateau age groups in the range of 461-445.2 Ma and 414.9-342.8 Ma. But the samples of deformed granitic gneiss from northern belt give two plateau age groups of 178.4-137.5 Ma and 89.2±1.6 Ma, while the sample from middle shear zone of Altyn fault belt yields two plateau ages of 36.4 Ma and 26.3 Ma.

The age groups of 461-445.2 Ma and 414.9-342.8 Ma represent the tectono-thermal events that had been recorded in the rocks that were displaced by Altyn strike-slip fault in late Ordovician-Early Silurian and Devonian respectively. These two age groups should be related to the closures of Northern and Southern Qilian Oceans, not to the activities of Altyn fault. The ages of 178.4-137.5 Ma are interpreted as the active ages of Altyn fault in the Middle-Late Jurassic-Early Cretaceous, and should be related to the accretion of Lhasa Block to the north. The age groups of 92±2.7-89.2±1.6 Ma and 26.3-36.4 Ma suggest the strike-slip movements with strong metamorphism of greenschist facies along the Altyn fault in the Late Jurassic and Late Eocene. These tectonic thermal events occurred in most areas of northern Tibet Plateau and should be the response of the collision between Indian and Eurasian continents along the north margin. The study shows that the Altyn fault is characterized by multiple pulse-style activities under the tectonic setting of convergence between Indian and Eurasian continents.

Recently there are several suggestions or ideas about the initiation of the Altyn strike-slip fault. By $^{40}Ar/^{39}Ar$ dating method the oldest age, which we have obtained from the syntectonic-growing minerals in the Altyn fault belt, is 178.4 Ma. This suggests that the initiation of the strike-slip movement along the Altyn fault is about Middle Jurassic. Li et al. (2001) reported a zircon age of 223-226 Ma by SHRIMP method from the deformed rocks within the Altyn fault belt, which is interpreted as the initiation age of the strike-slip movement along the Altyn fault. Yue et al. (2001) argued that the initiation age of the strike-slip movement is Oligocene according to the offset of the Altyn fault, which is estimated by the distance of Oligocene sediments in Xorkol basin and Subei basin.

There are many reports of the estimated offset along the Altyn strike-slip fault belt by using different markers of different ages. **Table 1** lists some representative reports in recent years. These results show that the maximum offset is about 350-400 km. The results are consistent although the offsets were estimated by different markers of Proterozoic and Early-Middle Jurassic. This suggests that the strike-slip movement should start from Middle Jurassic or a little later. If it started before Middle Jurassic, the offset estimated from the Proterozoic marker should be more than the maximum offset (350-400 km).

Based on the investigation of the Cenozoic sediments in Xorkol basin in the north of Altyn Mountains, Yue et al. (2001) described that the pebbles in the Oligocene sediments are similar to that in the Subei basin in Northern Qilian, and do not contain high-grade metamorphic rocks and granites on the SE side of Xorkol basin. Therefore, they deduced that high grade metamorphic pebbles in Shanggancaigou and Xiayoushasan Formations should come from the Northern Qilian Mountains. They concluded that the Xorkol basin should be connected with Subei basin during Oligocene, and the offset of Altyn strike-slip fault is 380 ± 60 km with the initiation in Oligocene. In fact, according to our field investigations, there are many outcrops of granites and high grade metamorphic rocks of Dakendaban

TABLE 1. List of reported offsets of the Altyn strike-slip fault

Reference	Offset and age of displaced marker			
	Proterozoic	**Early-Middle Jurassic**	**Middle Jurassic**	**Middle-Late Cenozoic**
Ge et al., 1999	350-400 km			
Cui et al., 1997	350-400 km			
Che et al., 1998	350-400 km			
Zhang et al., 2001a	350-400 km			
Sobel et al., 2001		350 +/- 100 km		
Ritts et al., 2000			400 +/- 60 km	
Zhang et al., 2001b				80-100 km

Group to the SE of Xorkol basin from Dangjinshan to Datongshan. We argue that the pebbles in the Oligocene sediments in Xorkol basin might not be eroded from the Northern Qilian Mountains but from Dangjinshan-Datongshan, which might be originally derived from the Northern Qilian, but dragged or/and displaced by Altyn strike-slip fault from the Northern Qilian to Dangjinshan-Datongshan before they were eroded. Furthermore, the pebbles could be transported for quite a long distance from source to the destinated basin, and also eroded and deposited while the source rocks are displaced. Therefore, it is not reliable to use pebbly sediments as a marker to estimate offset of the Altyn strike-slip fault. Zhang et al. (2001b) reported that the offset of the Altyn fault is 80-100 km after Late Tertiary based on the studies of the displaced Late Tertiary sediments in Xorkol basin. The report of Zhang et al. (2001b) does not support the model of Yue et al. (2001).

The evidences of offsets estimated by different markers of different ages and the ages of isotopic dating suggest a Middle Jurassic (178.4 Ma) initiation of the Altyn strike-slip fault.

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