THE KOREAN JOURNAL OF QUATERNARY RESEARCH Vol. 22, No. 2, p. 36-37 (December. 2008)

Earthquake Geology of Mongolia

A. Bayasgalan

School of Geology, Mongolian University of Science and technology
bayas99@yahoo.com

Central Asia has been a site of four great (Ms >8) and many moderate sized (Ms 5.3-7.5) earthquakes in 20th century. This activity is related to the peculiar position of Mongolia, situated between the extensional structures of the Baykal rift system and the transpressional mountain belts of central Asia. The active faulting in western Mongolia forms a pattern resembling a parallelogram of conjugate strike-slip faulting surrounding the Hangay dome. Right-lateral faulting on NW-SE or N-S faults occurs in the west (Mongolian Altay) and east (Mogod), while E-W left-lateral faulting occurs to the north (Bulnay) and south (Gobi Altay). This pattern can help accommodate the expected NNE-SSW shortening in this part of Asia (Holt & Haines, 1993; England & Molnar, 1997). Although the Hövsgöl graben system appears to be an extension of the Baykal rift system, the few earthquake mechanisms available in that region show strike-slip faulting.

Most earthquakes within the Mongolian Altay range are consistent with right-lateral strike-slip on NW-SE faults or thrusting on roughly E-W faults. The area has a high risk for great earthquakes. The Fu Yun earthquake of 10 August 1931 produced surface ruptures 180 km long with NW-SE right-lateral slip. There are also many known late Quaternary fault scarps produced by large earthquakes (Baljinnyam et al., 1993), and probably many more that have not been discovered yet. Most of these scarps follow NW-SE right-lateral strike-slip faults. The overall geometry of the Mongolian Altay mountains resembles a wedge shape, very wide (~600 km) in the northern part and narrower (less than 100km) toward the south-east where it joins with the mountain ranges of the Gobi Altay. In the northern part of the mountains, near the border between Mongolia and Russia, the mountain ranges of the Mongolian Altay turn gradually into a north-westerly trend. In this region the earthquakes are predominantly thrust faults. At the southern end of the range there are also E-W striking thrust events, although this trend in the topography is not as prominent as in the north. The configuration of faulting and especially the terminations of the strike-slip faults in the Mongolian Altay mountains might be related to rotations about a vertical axis.

The Gobi Altay mountains consist of E-W elongated ridges about 600 km long. These mountains also have the potential to generate great earthquakes such as that in 1957, which produced about 260 km of surface ruptures involving left-lateral strike-slip motion with a reverse component (Kurushin et al., 1997). The Valley of Lakes fault system, the eastern part of which ruptured during the 1957 earthquake, is the most prominent active fault system within the range. There are many other late Quaternary fault scarps further west in the Gobi Altay, probably produced by earthquakes in the Holocene. There have not been many significant earthquakes within the range since 1957. Those earthquakes occurred in the western part are consistent with E-W left-lateral strike-slip faulting. In the south, the range is bounded by a very prominent fault, well-expressed in the topography. However, there has been no recent

seismic activity on this fault and no late Quaternary ruptures have been reported there either.

The area immediately south of the Altay ranges has a different topographic character, with much smaller isolated mountains. Not many earthquakes have occurred in this part of Mongolia. The Tahiin Shar earthquake of 4 July, 1974 is the biggest one in last century, and produced short surface ruptures on a WSW trending fault with left-lateral slip, approximately at same place with the epicenter. This event occurred south of the point where the mountain ranges of Mongolian Altay and Gobi Altay join. It is somewhat anomalous in that it involved left-lateral slip, consistent with the earthquakes in the Gobi Altay, but its position is closer to the Mongolian Altay mountains where the right-lateral strike-slip faults are dominant. It is not clear what happens in detail where the Mongolian Altay and Gobi Altay conjugate strike-slip fault systems meet. Although this is an interesting and general problem in structural geology and active tectonics, at this moment there is insufficient information to resolve it in this region.

There are number of moderate-sized earthquakes recorded in the Hövsgöl area of northern Mongolia. In this region three north-south grabens, known as the Hövsgöl graben system, are the most prominent expression of recent tectonic activity. Surprisingly, most earthquakes west of lake Hövsgöl have strike-sliip fault plane solutions, such as the most recent and largest event of 27 December, 1991 at 13 km depth. A similar first motion solution was obtained for an earlier earthquake (760401) by Petit et al. (1996). It is not clear whether the slip in these events was left-lateral on a north-east fault or right-lateral on a north-west fault. Both events occurred near the sterp eastern edge of the Busht-lGol graben, a prominent north-northeast rift. Southwest of Busht-lGol th eventriangular-steped Tere-Kol basin with a sterp faulted boundery on even-Ninsidelt or l on a north-w720226lipyts was left-laton a mincontinuation of the Tere-Kol fault, involving p-laominantth NE-minright-lateral strike slip. Further west, thrusting becomes dominant (780803 and 810816). Other events in the region outside the grabens themselves mainly show strike-slip faulting or strike-slip with a significant thrust component. The events east of lake Hövsgöl, towards Baykal, have strike-slip faulting mechanism.

The Hangay dome in central western Mongolia is a site of late Cenozoic volcanic eruptions. In some places these basaltic flows create the highest topography, showing that Hangay was uplifted relatively recently, from which it has been inferred that a mantle plume upwells beneath the region (Zorin et al., 1982; Baljinnyam et al., 1993; Windley & Allen, 1993; Cunningham, 1998). There are number of short normal fault scarps within the Hangay, although it has been quiet seismically last century. On the northern border of the Hangay dome, the E-W Bulnay fault produced the great 1905 earthquakes, with left-lateral surface ruptures up to 400 km long, and displacements up to 11 m (Schlupp, 1996).

Seismic activity is much less in central and eastern Mongolia. The Mogod earthquake of 5 January 1967 is the biggest recent one in this region and was located near the northeast edge of the Hangay. It produced right-lateral strike-slip ruptures on north-south faults. The 890513 event in northern central Mongolia is located near structures that appear to be eastern continuatioes of the large E-W left-lateral faults which bound the northern edge of the Hangay dome. However, its source mechanism implies right-lateral, not left-lateral slip on those structures, and so is enigmatic. Another event nearly on 570226 apparently had a similar mechanism (Petit et al., 1996).