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Active Tectonics and Recent Seismicity in the Golden Triangle and Adjacent Area

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Abstract: Earthquakes worldwide are known to be associated with active tectonics both regional and local scales. The aim of this paper is to present the regional seismotectonic setting and seismicity of recent years in golden triangle (including northern Thailand, northwestern Laos, northeastern Myanmar, and southern Yunnan of China) and its adjacent region, and to discuss the relationship between active faults and seismicity. This region lies in the Indochina Peninsula of southern extension of the Tibetan plateau, characterized by high level seismicity. Owning to being in multinational border zone and transportation inconvenience, research regarding the tectonic activity in this area is very deficient and scarce. This scarcity of faults investigation makes mitigation of earthquake hazards, assessment of seismic risk, and relations between ruptures and geologic structure very tenuous. With the implementation of silks-roads strategy and accelerated pace of construction projects such as hydropower stations, it is urgent to strengthen the research on the active tectonic and seismic risk assessment for this region.

By the approach of geologic and geomorphic field observations along with analyzing the linear image features of satellite images, regional tectonics activities are studied. The golden triangle and adjacent area is a structural province characterized by NE striking left-lateral faults that include the Mong Hpayak, Nam Ma, Mae Chan, Luang Namtha, and Dien Bien Phu faults from north to south, they are all active in late Quaternary. The Mong Hpayak fault runs approximately NE45° from the Mong Tong of Myanmar, through Mong Hsat, Mong Phayak, Mong Yawng, then terminates in Menglun, with a total length of about 310km. At Mengsong, the Mekong River forms a hairpin loop at the fault trace, the left-lateral dislocation of the Mekong River is about 9km. Furthermore, streams of the Mekong River are synchronously offset left-laterally by the fault from 60m to 600m. The Nam Loi River, a tributary of Mekong River, flows from west to east, but after passing through Wan Tapao, it does not flow directly into the Mekong River, but turns north-east and then to south, forming two “V” shaped curvatures. At both tops of the “V” shaped loops, the Nam Loi River is offset left-laterally by 4.5km and 7km, respectively. An alluvial fan near Wan Tapao is displaced left-laterally around 150m, and thus the slip rate of the fault is estimated to be about 3-5 mm/a according to the alluvial fan age. The Nam Ma fault, trending NE with a total length of 150km, originates Mengla basin in southern Yunnan, extends into northwestern Laos and propagates in northeastern Myanmar. The fault displaced deposits of late Quaternary at many localities: the first terrace of Mekong river is offset at Sing Kok; 2.4km west of Xiengkok, the fault displaced the bedrock and overlying diluvium which is (530±30) a.B.P. in age (dated by ^{14}C method); at Nam Na, the second terrace of Nam Na river is left-laterally offset 52m and the ESR dating age of terrace accumulation is (18±3.3) ka.. Lacassin et al(1998) used the mosaic of Spot multispectral images to identify the geomorphic evidence of left-lateral offset around 12 km on the Mekong River along the Nam Ma fault. The Mesozoic stratum within the Muang Xing Basin near the border of Myanmar and China is sinistrally displaced about 10km similar to that on the Mekong River. The NE striking Luang Namtha fault, 230-km-long, starts from the border between China and Laos, crossing northern area of Laos, to Chiang Rai of Thailand. The Chiang Rai, Huay Xai, Ven Bu Ka, Nam O, Ban Nam Bone, Luang Namtha Quaternary basins have developed along the fault. At Nam Deany Tay of Laos, a series of gullies and ridges were offset 8-10m. Many Quaternary faults and bedrock fracture zones are recognized during field investigation. For example, the fault dislocated the middle-late Pleistocene deposits in Chiang Rai; at Nam Ao, the deposit of the second terrace of Namtha river formed in Holocene is displaced. The trench excavated in Huay Xay, revealed that four faults developed in the alluvial deposits which have the ^{14}C dating age of (26000±200)a.B.P. and OSL dating age of (33±3.3) ka., respectively. North of the Luang Namtha fault, another fault named the Mae Chan fault with a NEE striking direction is developed, starting from the Mekong River, running westward along the north edge of Mae Chan Basin, and ending at the west margin of Fang Basin in Thailand. The Mae Chan fault shows characteristics of left lateral slip and normal faulting. At Ban Houay Tab, the Mekong River was left-laterally dislocated 750m and a clear fault escarpment around 10m high on the terrace Ⅱ of Mekong River developed. Because of the fault motion, most Pleistocene gravel strata were raised and tilted with an angel over 30 degrees generally in Fang Basin. A subsidiary fault at Chiang Dao displaced the late Pleistocene gravels which are straightly aligned on the fault plane. The Dien Bien Phu fault zone lie in the southernmost of this region, extends southwesterly nearly 750 km from Sino-Vietnamese border, across northern Laos, to the southwestern end in central Thailand. The fault zone consists of several faults, likewise displays sinistral movement with some normal faulting component. Within a fault trough northeast 25km of Luang Probang, we excavated a trench that revealed five faults, which displaced the Permian argillaceous sandstone, andesite and the

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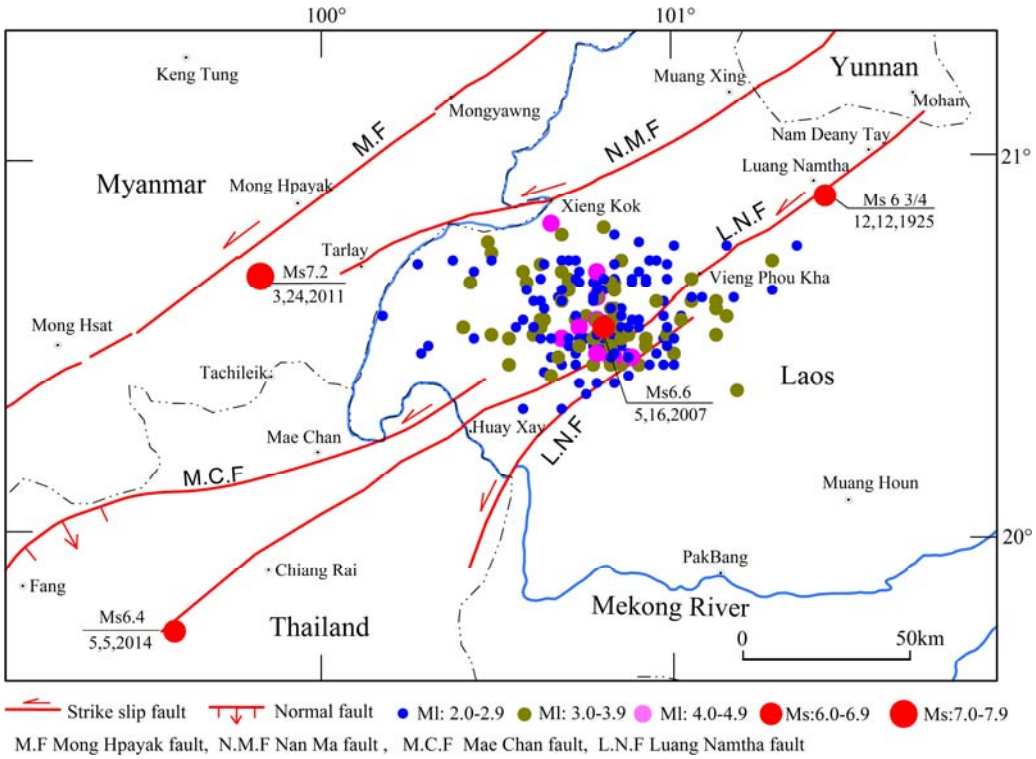

Fig. 1. The distribution map of the 2007 Ms6.6 earthquake and aftershocks.

overlying river accumulation. The river deposits here are dated by ^{14}C dating method at Beta Analytic Laboratory, ages of deposits displaced are (12010±40)a.B.P., (7910±30)a.B.P., (5830±30)a.B.P., (1900±30)a.B.P., (1180±30)a.B.P. and (1120±30)a.B.P., suggesting it is active in Holocene. In summary, all the above-named faults display left-lateral slip characteristics and recent activity. In the past century, the fault system has produced many significant and destructive earthquakes, including the 1925 Luang Namtha M6 3/4 earthquake occurred on the Luang Namtha fault, the 1983 Lai Chou Ms7.0 earthquake on the Dien Bien Phu fault and the 1995 Myanmar-China border Ms7.3 earthquake. In recent times, several moderately strong earthquakes also occurred in this area. On March 24 2011, the Ms7.2 Tarlay, Myanmar, earthquake occurred between the Mong Hpayak and Nam Ma faults. The Ms7.2 earthquake generated 19km long ground rupture showing remarkably sinistral strike-slip (Soe T. T. et al, 2014). On May 16, 2007, a Ms6.6 earthquake struck northern Laos and the border region shared by China, Myanmar and Thailand. The main quake and aftershocks concentrate in the Luang Namtha fault (Fig.1), and the focal mechanism as well as shows left-lateral strike-slip. On the southwestern segment of Luang Namtha fault, the Ms 6.4 earthquake of May 5, 2014 generated in northern Thailand. It is the largest earthquake in the history of Thailand and caused serious damage to buildings and casualties. The maximum modified Mercalli intensity (MMI, by China national standard) is estimated at Ⅷ by our field investigation results. The recent significant activity of tectonics and appreciable historical seismicity in the golden triangle and adjacent area indicate that it is a remarkably vigorous tectonic region.

Key words: active fault, left-lateral slip, seismicity, the golden triangle area

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