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Lhasa seismicity during 2004–2006

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ABSTRACT

The Tibetan Plateau is an active seismic region due to the collision between Indian and Eurasian plates. We have set up a new seismic network in the heart of the Tibetan Plateau, in the Lhasa region, to detect seismic activities. The measured data show that Lhasa is a seismically active region where at least 716 earthquakes were detected and a total of 218 events of magnitude greater than 2.0 occurred in the period between January 2004 and July 2006. Out of them, 11 earthquakes had a magnitude greater than 5.0. A high seismic activity was observed along the Dangshung fault zone.

Keywords: Seismicity, seismotectonics, Lhasa region, seismic network

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INTRODUCTION

The Tibetan Plateau is a seismically active region due to the collision between Indian and Eurasian plates (Molnar and Tapponnier 1975). The Tibet University (Tibet) and the University of Bergen (Norway) have set up a new seismic network (http://www.hf.uio.no/tibetnorway/) in the Lhasa region (26.0°–34.0°N , 88.0°–96.0°E). The main goal of this project is to study seismicity and tectonics in the Lhasa region. Four suitable sites around Lhasa were carefully selected and equipped with Italy-made digital seismometers (http://www.sara.pg.it). The locations of the four stations are shown in Fig. 1. Their names and coordinates are the following.

1. CHUD: 29.6978° N, 91.1438° E;

2. TAGA: 29.7400° N , 91.4603° E;

3. CHUS: 29.9970° N , 90.7462° E;

4. NHIM : 29.4336° N , 90.1643° E.

Among the four stations, one (CHUD) is on a hill within the Lhasa city and the remaining three are located outside of the city. Data collection was started from January 2004.

The instruments used for this work were SR97/S3, which were produced by an Italian company, SARA. The instrument unit is basically made of an aluminium box with all components inside: 3 sensors, an amplifier, a digitiser, and a GPS. The unit is powered by a 12V external power supply. The output from the digitiser is sent through an RS232 line and is recorded on a personal computer. The sensors inside the unit have a natural frequency of 4.5 Hz and their calibration parameters were provided with the instruments.

RESULTS

Spatial distribution of seismic events in Lhasa region from 2004 to 2006

The data are available from the Tibet University Seismic Network (TBU network) from January 2004. A total of 961 events were recorded by the TBU network until July 2006. Among these, 86 were distant events and 865 were local events, whereas 716 events occurred within the target area (i.e., the Lhasa region, see Fig. 2). The detected events with their magnitude (mb) greater than 1 are plotted as small circles in Fig. 2, where the circle size increases with increasing magnitude. Fig. 2 also shows several regions of high seismic activity. A narrow zone of intense seismicity is seen along a marked line near Lake Namtso (Fig. 2). This is the so-called Dangshung fault zone, which runs parallel to the southeastern shore of the lake. Our detected events clearly showed a fault zone near Lhasa and therefore implied the important tectonic structure around the city. The other apparently intense activities around the instrumentation sites can be attributed to the instrument's sensitivity (i.e., the closer the area, the more recorded events). Hence, the International Seismological Centre (ISC) does not include such events in its database (http://www.isc.ac.uk).

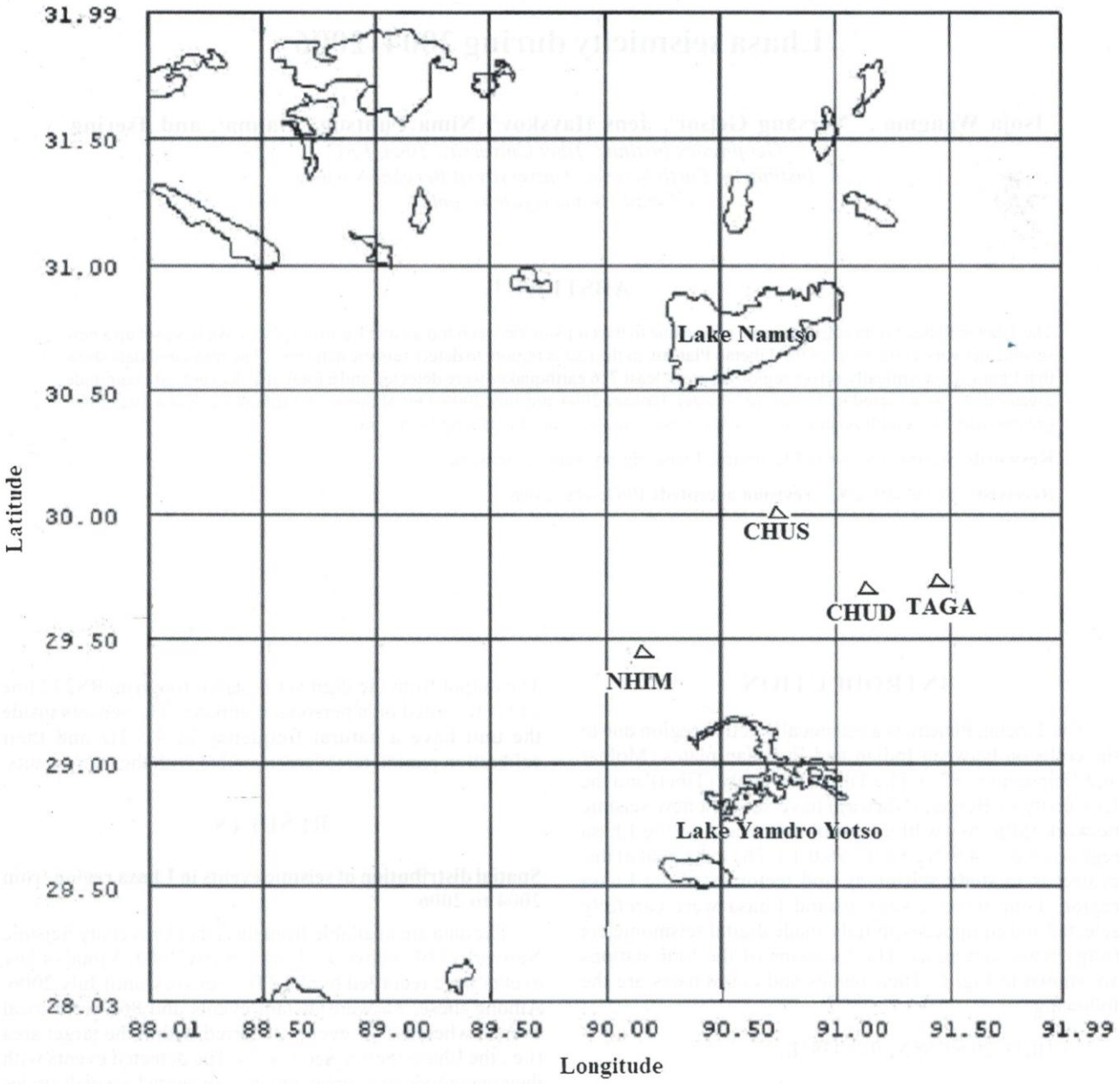

Fig. 1: Locations of the four seismic stations in Lhasa region. △: Seismic station. The other patterns: lakes in this region.

Fig. 3a shows the Gutenberg-Richter relation for the local events. The b-value of the local database is 0.52 and the detection threshold is about 2.0. The Gutenberg-Richter relation for the ISC events from 1998 to 2003 is shown in Fig. 3b. Its b-value is 0.82 and the detection threshold is about 4.5. This is the main advantage of our local seismic network; we can detect seismic events of low magnitude (i.e., lower than 2.0). Therefore, such a seismic network is useful for detailed research on local scale. As to the accuracy of an earthquake location, one of the main factors controlling the precision of an earthquake location is the number of stations recording a given event.

Seismic events sorted with magnitude

A total of 716 events were detected in the Lhasa region between January 2004 and July 2006. They can be divided into different magnitudes as shown in Table 1.

Some significant seismic events of magnitude larger than 5.0 in the Lhasa area recorded during January 2004 – July

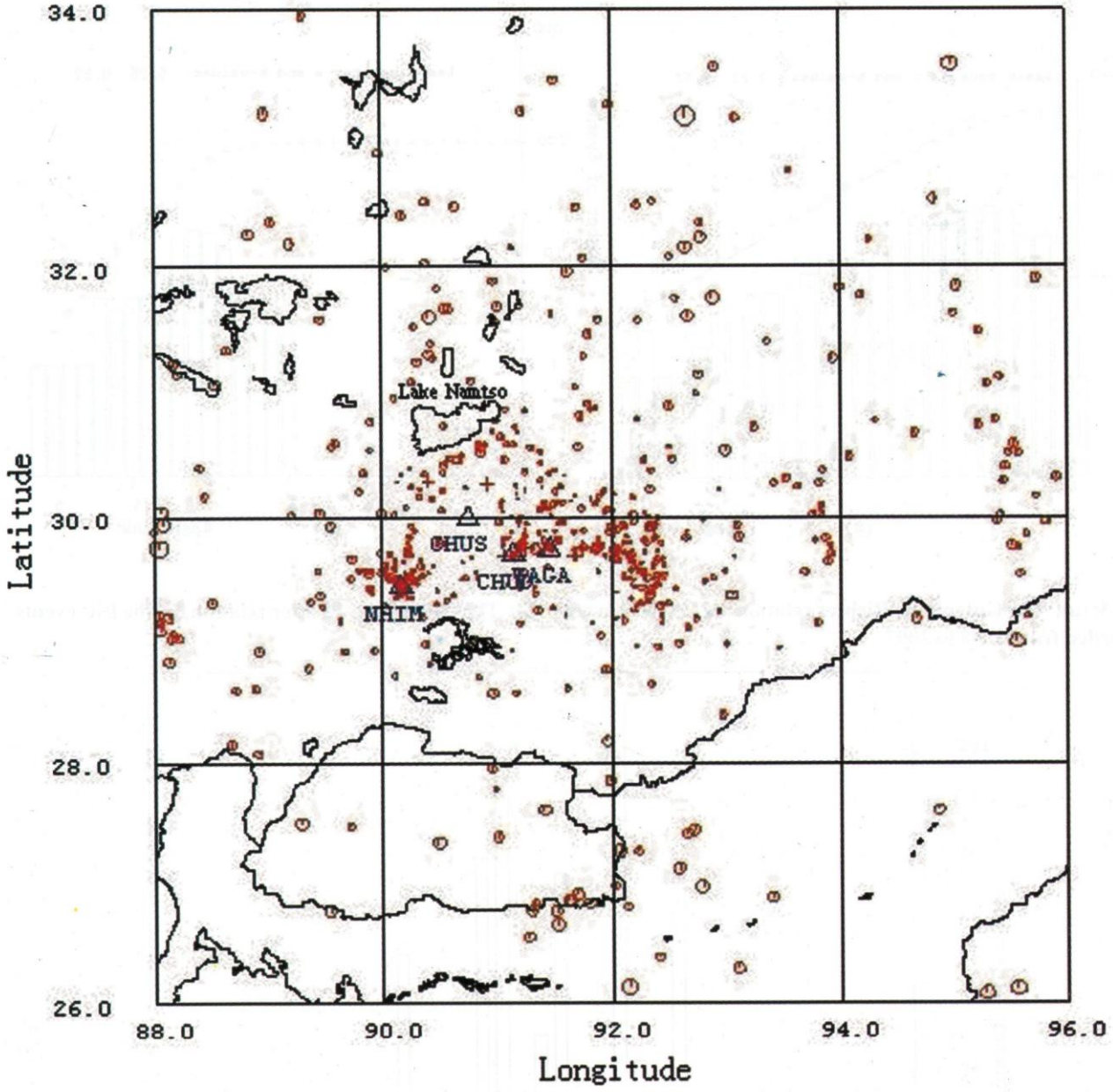

Fig. 2: Spatial distribution of earthquakes in Lhasa region between January 2004 and July 2006. ⊙: an earthquake with mb>1, magnitude indicated by the size of circle; +: an earthquake with mb≤1; Δ: seismic station.

2006 are listed in Table 2. The table also shows their arrival time and epicentre. Present study reveals that two to three significant events have occurred every year in the study area. Fortunately, these big events took place in sparsely populated areas and did not cause much damage, except at some small nomadic villages, according to local news reports (http://www.hwcc.com.cn/newsdisplay/newsdisplay.asp?Id =148360).

Monthly events in Lhasa region

For the purpose of studying the earthquake activity or frequency in the Lhasa region, we also analysed the monthly events detected during the observation period. Fig. 4 depicts the monthly events recorded by the TBU network during the observed period. A large number (over 40) of events occurred during several months of the observing period. Most months detected around 20 events. Only a limited

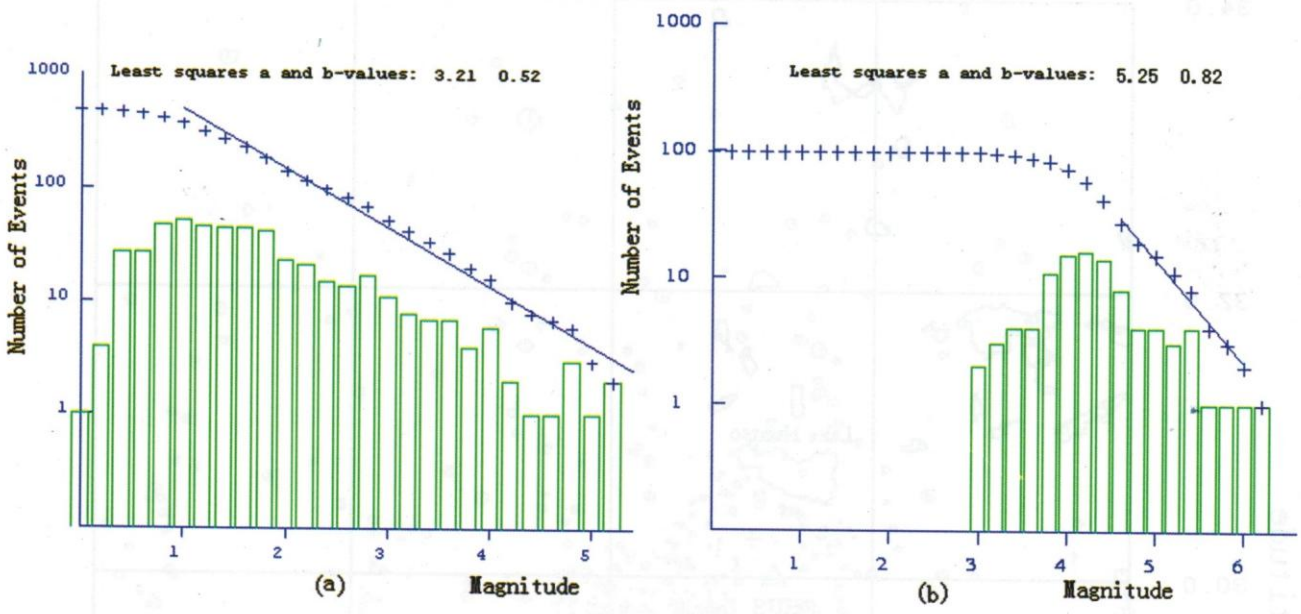

Fig. 3: (a): The Gutenberg-Richter relation for the local events, (b): The Gutenberg-Richter relation for the ISC events recorded from 1998 to 2003

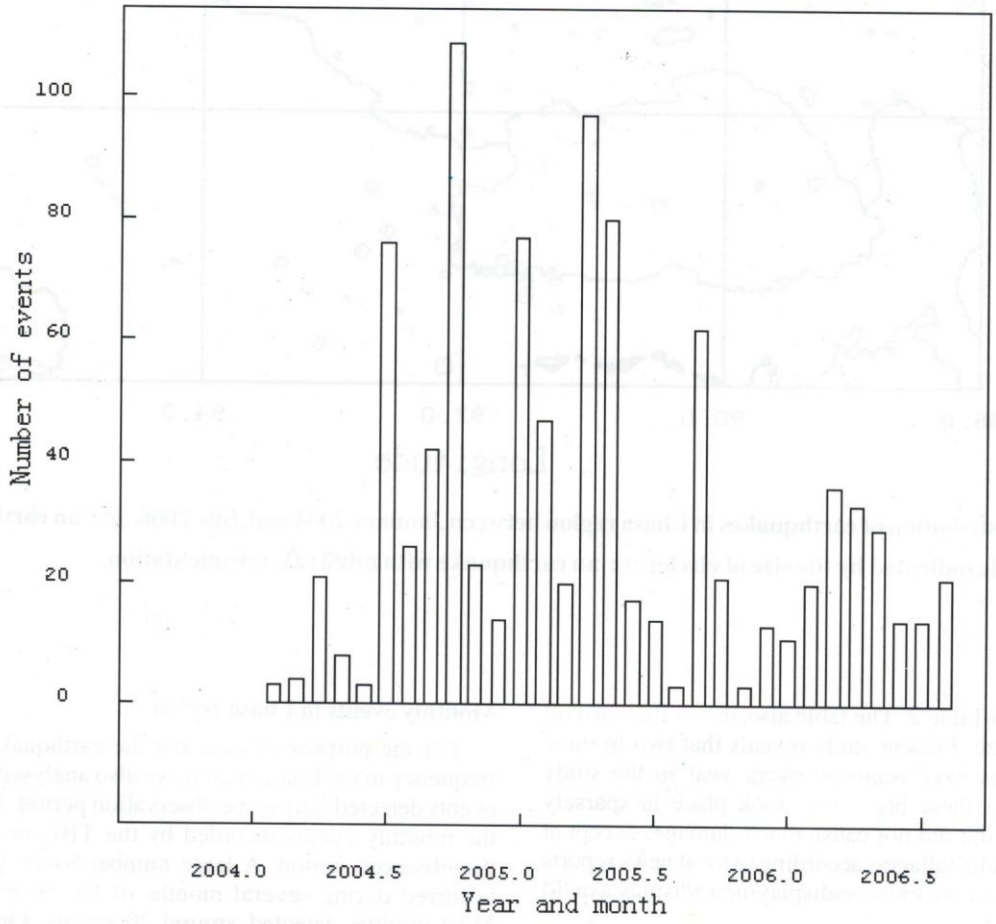

Fig. 4: Monthly seismic events observed in the Lhasa region between January 2004 and July 2006

Table 1: Number of earthquake events sorted according to their magnitude (mb)

Magnitude	>5.0	4.0 – 4.9	3.0 – 3.9	2.0 – 2.9	1.0 – 1.9	< 0.9
Event Number	11	16	36	155	383	115

Table 2: The arrival time and epicentre of earthquakes with magnitude larger than 5.0 in Lhasa region, recorded between January 2004 and July 2006

Year and Date (yyyy mm dd)	UTC (hh mm ss)	Latitude (° N)	Longitude (° E)	Magnitude (mb)
2004 08 24	10 05 34	33.176	92.670	5.5
2004 09 27	17 05 46	29.773	95.515	5.3
2005 02 03	20 13 35	26.125	95.563	5.2
2005 03 23	05 59 11	26.080	95.285	5.1
2005 08 20	12 50 49	31.223	88.168	5.1
2006 02 23	20 04 51	26.912	91.705	5.5
2006 02 23	17 05 46	29.773	95.515	5.2
2006 04 19	21 05 38	31.607	90.413	5.2

number of earthquakes were recorded in a few months owing to some operational problems with the TBU network.

CONCLUSIONS

The analysis of available data indicates that the Lhasa region is seismically very active. A total of 218 seismic events of magnitude greater than 2.0 occurred in the Lhasa region between January 2004 and July 2006. The most notable events during this period were those 11 earthquakes with magnitudes greater that 5.0. High seismic activity was observed along the Dangshung fault zone. The newly made Golmud–Lhasa railway crosses this highly hazardous active fault (Wu and Barosh 2004). On the other hand, the TBU seismic network is useful especially for detecting small-scale seismicity. This network detected many small quakes occurring in the fault that had not previously been detected by other remote stations. Thus, our TBU network can provide more detailed seismic information for the local target area.

ACKNOWLEDGEMENTS

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