MILD TREMORS NEAR THALASSERI (NOVEMBER, 2003): EVIDENCE FOR A SEISMIC SOURCE IN NORTH KERALA

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This note deals with the mild earth tremors that occurred near Thalasseri, Kannur District on November 8, 2003. Based on the activity detected by the broadband observatory at Peechi (PCH), we suggest an additional source zone in Kerala.

Introduction

Two mild tremors occurred near Thalasseri (Tellicherri), Kannur (Cannanore) District, Kerala, on November 08, 2003. The first one occurred at 9:30 pm (15:57:45.45 GMT) and its magnitude was estimated as M_L 3.2. The tremor, felt by almost everyone around Thalasseri was followed by another one (M_L 2.5), ten minutes later (16:10:19.57 GMT). While most residents of Thalasseri, Mahe and nearby areas felt the first tremor, many did not feel the second one; majority of them reported vibrations and thundering sound accompanying the larger tremor. There was no serious damage, but some of the well-constructed RCC structures developed minor cracks. The Broadband Observatory at Peechi (PCH), located about ~150 km south of Thalasseri recorded both these tremors (Fig. 1). Two mild tremors had occurred in the same region previously, on January 12, 2003 (M_L 2.6) and November 4, 2003 (M_L 2.8), probably as part of the same sequence. In this paper we present details on the larger tremor that occurred on 8th of November. Based on the current activity detected by the station at Peechi and the possible spatial coincidence of the previous low-level seismicity, we suggest the existence of a source, capable of generating mild to moderate earthquakes, in this part of Kerala.

Background: Mild tremors have been occurring in many parts of Kerala since historic times, mainly associated with WNW-ESE to NNW-SSE trending structures, roughly parallel to the west coast. (Fig.1). Spatial association of these tremors with some of the known faults and shear zones has been discussed in many earlier papers. For example, the June 07, 1988 earthquake (M_L 4.5) was associated with strike-slip faulting along the continuation of the NW-SE-oriented Periyar fault, a structure inferred from satellite imagery as well as gravity data (Singh et al. 1989; Rastogi et al. 1995). The more recent Pala/Erattupettah tremors (December 12, 2000; M_L 5.0 and January 07, 2001; M_L 4.8) were also associated with another NW-SE fault, possibly a structure parallel to the aforementioned Periyar fault (Rastogi, 2001; Bhattacharya and Dattatrayam, 2002). The December 4, 1994 Wadakkancheri tremor (M_L 4.3) originated on a WNW-ESE trending fault within the Palghat Gap, a major physiographic and possibly

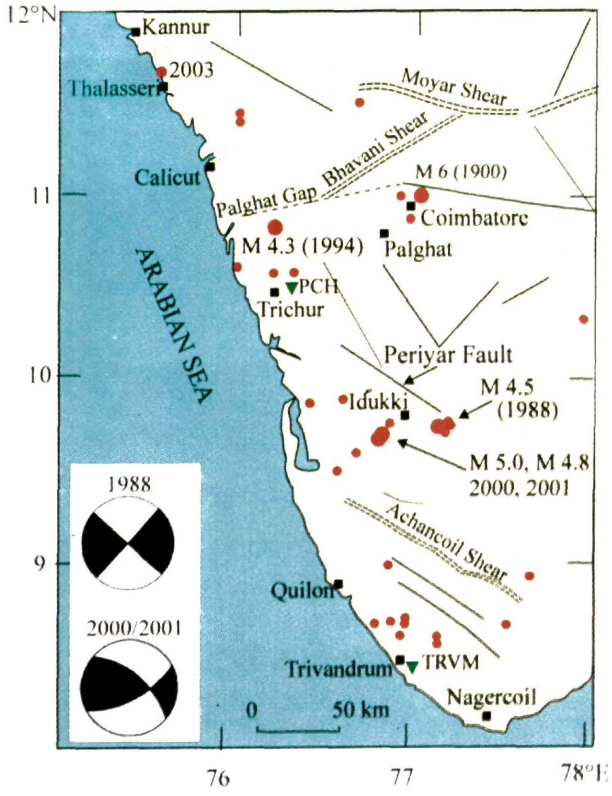

Fig.1. Map of southwest India, which includes Kerala and adjoining area, showing historical and recent earthquakes, represented by red dots (data updated from GSI, 2000). White dots denote historical earthquakes in the vicinity of Tellicheri (Thalasseri) and Calicut (Kozhikode). *Inset:* Focal mechanisms of the 1988 earthquake (Rastogi et al. 1995) and the 2000/2001 earthquakes (Bhattacharya and Dattatrayam, 2001). PCH and TRVM are the broadband (BB) stations.

structural break in south India. A structure that has generated mild to moderate tremors in the past, such as the 1900 Coimbatore earthquake, the seismogenic status of Palghat Gap is being studied in detail (Rajendran and Rajendran, 1996; Gundu Rao et al. 2002; John and Rajendran, 2004).

Most tremors in the Kerala State during the last ten years have originated in regions where low-level activity has been reported in the past (Fig. 1). Due to their association with known faults and their tendency to occur at locations of previous activity, it is important to assess each of these tremors from a seismotectonic perspective. An important objective of setting up additional broadband observatories (BB) in various locations in the Indian shield (a nationally coordinated programme, funded by the Department of Science and Technology) is to improve the detection threshold, which helps to place better constraints on identifying little known sources and emerging seismicity patterns. In this brief note, we examine the recent mild tremors near Thalasseri, the first instrumentally located from the north Kerala, from this perspective. Information presented here justifies the need for improved station coverage and continuous monitoring, even in regions that may not be very active currently. A major thrust of the nationally coordinated seismic monitoring programmes in the shield region is thus amply warranted.

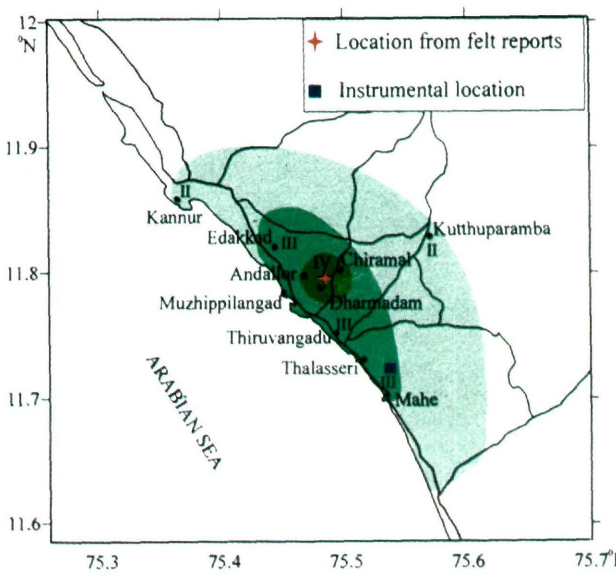

Fig.2. Isoseismal map of the November 8, 2003 earthquake. Star denotes the location based on maximum intensity; larger filled square denotes the single-station location based on data from PCH (location shown in Fig. 1). The black lines within the figure denote road network.

The November Tremors

Intensity Surveys: We conducted field surveys to assess the nature of damage and record how local residents felt the tremors. Starting from Kannur in the north to Mahe in the south and Kutthuparamba in the east, our survey covered an area of about 200 km^2. Most people who experienced the tremor reported of vibration of the ground, with a thundering sound. Many reported rattling of windows, falling of objects (most frequently vessels). In a couple of instances, people were knocked off their chairs. While almost all the people at Thalasseri and its immediate vicinity felt the tremor, only less than 50% of the people felt it in Kannur. No cases of damage to houses (cracks, falling of tiles etc.) were also reported from here. However, we noted that most damages occurred close to Dharmadam and Chiramal (Fig.2). Based on these reports, we have assigned a maximum intensity IV (MM scale). Maximum damage to a built structure occurred at Andallor, about 2 km north of Dharmadam. Walls of a two-storied tiled house had developed cracks, and more than 80% of its tiles had fallen off the roof (see location marked by a small filled square in Fig.2). From the distribution of maximum intensity, we have placed the source of the tremor between Chiramal and Dharmadam (Fig.2).

Instrumental data and previous earthquakes: The station at Peechi (PCH), more than 150 km away from Thalasseri, is the closest for which we have three-component data (Fig. 2). The Idukki and Kulamavu Observatories (close to Idukki Reservoir, operated by the Kerala State Electricity Board) and the broadband observatory at Trivandrum (TRVM) as well as other India Meteorological Department (IMD) stations at Goa, Karad and Pune (Maharashtra) also recorded the tremor. Since the analogue stations at Idukki and Kulamavu are not backed up by GPS clocks, we anticipate some discrepancies in their timings, compared to the digital data from the broadband stations at PCH and TRVM, both of which are linked to satellite-based GPS time. For the present study, we used the BB data from various IMD stations to locate the earthquake by HYPO71 (standard computer programme for locating earthquakes), but due to their large distances from the source, the location errors were high.

Where data from many stations are not available, Roberts et al. (1989) offer single-station method for earthquake location. In this method, the arrival times of P and S phases and the back azimuth from the station to source (computed from the ratio of the horizontal component amplitudes) are used for obtaining single-station locations. By using the data

from PCH and SEISAN analysis programme, we located the earthquake at 11 72 N, 75 55E (Fig 2) The location obtained is not very far from that based on maximum intensity, and we believe that the location error may be only within a few kilometres

It is worth noting that Oldham (1883) had reported an earthquake that was felt in Malabar Coast, in the middle of August 1858 Although it is difficult to locate its source precisely, the available data gathered in Oldham's catalogue (1883) imply that the source could be near Thalasseri Mild tremors have also been reported from northern Kerala during 1959, possibly near Thalasseri, while later events (1961, 1964, and 1984) occurred to its south, near Calicut (Kozhikode) (Fig 1)

Comments

Tremors in the Kerala region are not spatially isolated, they seem to be associated with mapped structures (preexisting faults and shear zones) With expanded monitoring capabilities including the broadband stations, the detection level of microearthquake activity has improved Mild/light tremors in Kerala that have been studied using instrumental data appear to be spatially clustered The sequence near Thalasseri is also located in a region, noted for previous incidences Repeat occurrence of tremors, although of low level, makes case for an independent source The November sequence of tremors appears to be the most significant to have occurred in the northern part of the state

Instrumental location presented in this paper is based on single-station method, most reliable for data from single broadband stations BB stations elsewhere in the peninsular shield also rely on this method to locate local events for which data from multiple stations are not available However, the accuracy of these locations vis-à-vis that obtained from local networks needs to be assessed More examples as described here will help to develop a good database of epicentral locations based on single-station method, and also to make estimates of error

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