Accurate location and focal mechanism of small earthquakes near Idukki Reservoir, Kerala: implication for earthquake genesis

Utpal Saikia[1,*], S. S. Rai[1], M. Subrahmanyam[2], Satyajit Dutta[1], Somasish Bose[1], Kajaljyoti Borah[1] and Rishikesh Meena[1]

[1]CSIR-National Geophysical Research Institute, Hyderabad 500 007, India
[2]Department of Geophysics, Andhra University, Visakhapatnam 530 003, India

Earthquake waveform from a new temporary network of 21 seismic stations in South India has been used to significantly improve the detection threshold and parameters of small earthquakes near Idukki Reservoir, Kerala. We present here precise location of 16 earthquakes in this region with a local magnitude of 1.5–3.6 and focal depth 7.2–9.9 km. Fault plane solutions of the selected best six earthquakes show strike-slip faulting and right lateral movement. Reservoir loading usually leads to generation of stress and therefore earthquakes in the shallow depth (< 5 km), that are absent in the region of Idukki Reservoir. Recorded earthquakes are confined to a NW–SE trending fault close to Karur–Kamabam–Painavu–Trichur (KKPT) shear zone. These observations suggest that the earthquakes in Idukki region are tectonic in nature and have no linkage with the reservoir.

Keywords: Earthquake location, fault plane solution, reservoir, tectonics.

As a part of India Deep Earth Imaging Experiment (INDEX)[1], we operated a network of 21 broadband seismographs during January 2011–March 2012 in the South Indian states of Tamil Nadu and Kerala to map the seismic pattern and image the deep structure of the region (Figure 1). In this low strain (10^{-12} to 10^{-13}/year) region[2], our instruments recorded a number of small earthquakes near the Idukki Reservoir (9°50′N; 76°58.5′E) approximately 120 km east of Cochin, across the Periyar River in Kerala. The occurrence of recent seismic activity near the Idukki Reservoir has been earlier reported by Rajendran *et al.*[3]. However, due to inadequate instrumental data, they could not provide precise epicentre location, focal depth and magnitude of these events. Idukki is one of the highest arch dams in Asia (169 m), which has been functional since October 1975. Historically, the Kerala region has witnessed several small to moderate intensity earthquakes[4,5]. These include ($M < 5$) the 1988 Idukki[6,7], the 1994 Wadakachery[8] and the twin events of 2000 and 2001 at Erattupeta/Pala[9,10]. The low-gain seismic network in Idukki region operating since 1971, has recorded a significant number of earthquakes[7]. Some of these earthquakes ($M \leq 3.5$) during 1977 and 1983 occurred near the Idukki Reservoir, and were considered as reservoir induced[11]. Alternate view attributed these earthquakes to reactivation of pre-existing NW–SE trending faults in the region[12,13]. As most of the earthquakes are small, the quality and number of waveform records are poor and inadequate. As a consequence, the earthquake parameters could not be accurately determined. In this communication, we present precise hypocentre location, and focal mechanism of the earthquakes that occurred during the operational period, and discuss the possible linkage of these earthquakes to the surface geological features near the reservoir.

The Idukki Reservoir is situated in the southern part of the Western Ghats hill ranges, which run parallel to the west coast of India. Figure 1 shows the major regional structure of southern India, geologically known as Southern Granulite Terrain (SGT). The terrain is dissected by the well-mapped Moyar and Bhavani shear zones

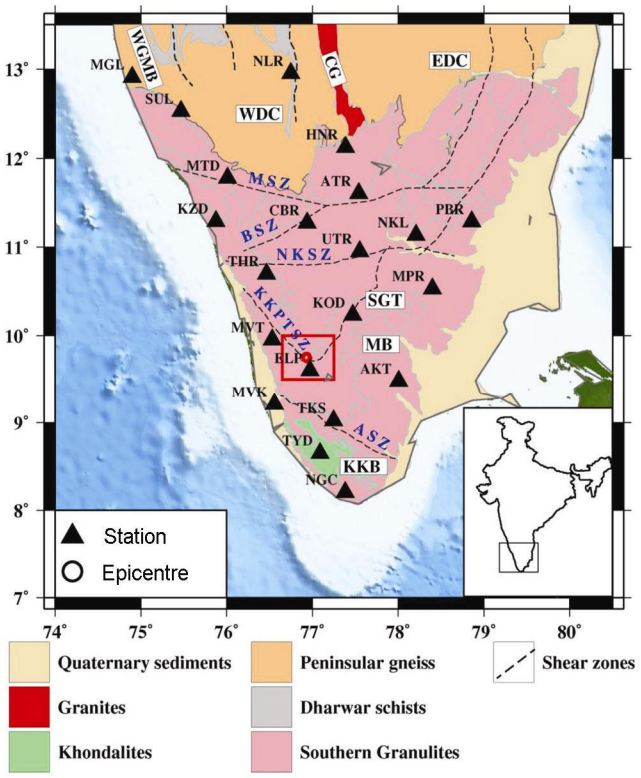

Figure 1. Tectonic map of the South Indian Shield showing major geological terrain, viz. EDC, Eastern Dharwar Craton; WDC, Western Dharwar Craton; SGT, Southern Granulite Terrain; CG, Closepest Granite; MSZ, Moyar Shear Zone; BSZ, Bhavani Shear Zone; NKSZ, Noyil Kaveri Shear Zone; ASZ, Achankovil Shear Zone; KKPT, Karur–Kambam–Painavu–Trichur Shear Zone; MB, Madurai Block; KKB, Kerala Khondalite Belt. The rectangle indicates the area shown in Figure 2. The seismic stations used in this study (2011–2012) are shown as black triangles. The three-letter code for each station is shown and the red circle represents the location of earthquakes.

*For correspondence. (e-mail: ngriutpal@gmail.com)