DISCUSSION

Comment

(Comment on the paper, "**Seismicity Impact in Patan Taluka, District: Satara, Maharashtra**" by Patwardhan *et al.* Jour. Geol. Soc. India, v.46, No.3, September 1995, pp.275-285)

Patwardhan *et al.* (1995) have said that possibility is indicated that the seismicity in the Koyna region is reservoir induced, and have listed rapid rise in the water level of the Shivaji Sagar (Koyna reservoir) as one of the causes that gives rise to shocks in the Koyna region. The basis for this is apparently the statement of Gupta (1992), that rise in water level exceeding 40 feet per week is a necessary but not a sufficient condition for shocks of M≥5 to occur in the Koyna region. However, computer analysis of the data of reservoir water levels (GOM, ID, 1982, 1995) and shocks (CWPRS, 1974, 1982 and MERI, 1994) for the last 35 years in the records of the Koyna Project has shown that there is no correlation between rate of rise of reservoir level and shocks of M≥5.

In the years 1968, 1993 and 1994 shocks of M≥5 took place, but in these years the weekly rise of reservoir water level never exceeded 40 feet per week. This shows that shocks of M≥5 can take place even when there is no rapid rise of reservoir water level and hence it is not a necessary condition for shocks of M≥5 to occur.

In the years 1961, 62, 63, 69, 74, 79, 81, 88, 92 and 95 the weekly rise of reservoir water level exceeded 40 feet per week, but no shocks of M≥5 took place. In these 9 years, there were as many as 35 instances of reservoir level rising by more than 40 feet per week against a total of 55 instances in 35 years. If an event occurs over and over again for 35 times, and even in a seismically active region such as the Koyna region, is not followed by shock of M≥5, it is obvious that it is of no significance as far as seismicity is concerned, and can hardly be considered as having any relation with the seismicity of the region.

It will thus be seen that shocks of M≥5 have taken place when the reservoir level did not rise by more than 40 feet per week and have not taken place on most occasions when it did, and thus there is no correlation between rate of rise of reservoir level and shocks of M≥5.

I would also like to report another observation which has an important bearing on the contention of Patwardhan *et al.* that the reservoir has induced seismicity. Those who maintain that the seismicity is reservoir induced have long argued that the reservoir water percolated to great depths and brought about changes there that led to the earthquake. But geologists have countered this contending that water cannot seep to any considerable depth through the impervious basalt. This contention is supported by the conditions encountered in the intake tunnels of Stage-IV of the Koyna Hydro Electric Project.

An aggregate reach of 428 m of these tunnels has been excavated below the reservoir. The thinnest rock cover above the crown of the tunnel is only 17.5 m with a 43.0 m water column above it. Yet there is no leakage of water in the tunnels. The fact that water under a head of 43.0 m of water column can not penetrate 17.5 m of basalt, which is representative of the area, shows how completely impervious the basalts are, and it is quite obvious that water can not percolate through such impervious basalt to the focal depth of 8 km.

Quoting *Kesari* of 1-10-93, Patwardhan *et al.* have said that at 0356 on 30-9-93 a shock of M 6.1 was experienced in the Koyna region, and quoting Collector, Satara, they have said that more than 300 tremors of M≥3 were recorded at Koynanagar. Both these statements are factually incorrect. The records of the Koyna Project shows that the shock recorded at 0356 is not a local shock but has originated from the Killari area at the epicentral

distance is 264 km. Similarly, during the next 24 hours only 8 shocks of M≥3 were recorded, all of which were distant shocks. Not a single local shock of M≥3 was recorded in these 24 hours. Here it may be pertinent to mention that during the entire year 1967, which was seismologically the most active year, only 249 shocks of M≥3 were recorded.

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References

Government of Maharashtra, Irrigation Department, Koyna Hydro Electric Project. (1982). Koyna Dam-Shivaji Sagar Lake, Data Compilation v.1, pp.155-176.

Government of Maharashtra, Irrigation Department, Koyna Hydro Electric Project (1995). Koyna Dam-Shivaji Sagar lake, Data Compilation.

Central Water and Power Research Station Pune, (1974). Koyna Earthquakes, V.I (October 1963 to December 1973)

Central Water and Power Research Station, Pune, (1982). Koyna Earthquakes, V.II (1974 to 1981)

Maharashtra Engineering Research Institute, Government of Maharashtra, Nasik. (1994). Seismic Status of Maharashtra, India. Report prepared for the Expert Committee for the study of recent seismic activities in Maharashtra.

Gupta H.K. (1992). Reservoir Induced Earthquakes. Special Issue "Seismology in India" an overview. Current Science, V.62 pp.183-198.

_____ (1992). Earthquake Prediction Related Studies in India. Special Issue "Seismology in India" an overview. Current Science, V.62, pp.257-263.

Reply

We are thankful for the comment by S.L. Bhingare, Superintending Engineer of the Koyna Monitoring Cell on our paper on "Seismicity Impact in Patan Taluka, District Satara, Maharashtra". From the abstract of our paper and from the detailed analysis of the seismicity discussed in the paper, we wonder whether it can be concluded that we are in favour of the seismicity being totally reservoir induced. We have indicated that the "RIS" can be examined only for earthquakes originating from very shallow depths. For earthquakes whose hypocenters lie far below in the basement rocks (depth >3 km), the magnitude frequency relationship (26 years period) is similar to that observed in any tectonically active region. We have concluded that "it seems that the seismicity is related more to the reactivation of basement faults, reflected also in the overall geomorphological features of the region".

The fact brought about by Bhingare is that inspite of the weekly rise of water level in Koyna reservoir exceeding 40 feet/week in the year between 1961 and 1995 no shocks of magnitude >5 took place. On page 281 we have referred to the meeting that we had with the Collector, Satara and the information given was that the Koyna region experienced 300 tremors of magnitude <3 and not >3. The newspaper *Kesari* carried the news of earthquake experienced by Koyna region of magnitude 6.1 on the 30th September which was never refuted by the Koyna Monitoring Cell. Bhingare could have given further details of the shock that he is referring to, which had the epicentral distance of 264 km along with the detailed stress diagram which will indicate the direction of compression and rarefaction. We have quoted authors (Gupta and Iyer, 1984 p.865; Rastogi *et al.* 1990 p.236) who are inclined to consider the seismicity as entirely reservoir-induced but have doubted the authenticity of the data recorded by the Koyna reservoir network.

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