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A report on Seismic History and Recent Eathquakes in Seoni District, Madhya Pradesh

(Report No.: NCS-NSN-EPG-06)

National Centre for Seismology
Ministry of Earth Sciences, Government of India
IMD Office Complex, Lodhi Road,
New Delhi - 110 003

November 29, 2021

Seismically the Seoni district of Madhya Pradesh is situated in a region where no earthquake of any significance have been located in the past. The swarm type of activity (occurrence of so many earthquake having small Magnitude) also occasionally observed in the Seoni region, which may be attributed to local crustal adjustment. Recently, a spurt of seismicity started in the region with an earthquake M:3.3 that occurred on October 27, 2020. Since then, nine earthquakes of magnitude ranging M:1.8 – 4.3 occurred in the Seoni and surrounding regions in about one month time between the period October 27 – Novemeber 22, 2020. The largest event (M:4.3) among these occurred on November 22, 2020. The activity, however, continued in the region sporadically with an event (M:2.2) recently located on Novemebr 23, 2021; totaling to seventeen earthquakes in the region till date since October 27, 2020. The preliminary hypo-central parameters of these earthquakes, as estimated by the National Seismological Network (NSN), NCS are listed in **Annexure-I**.

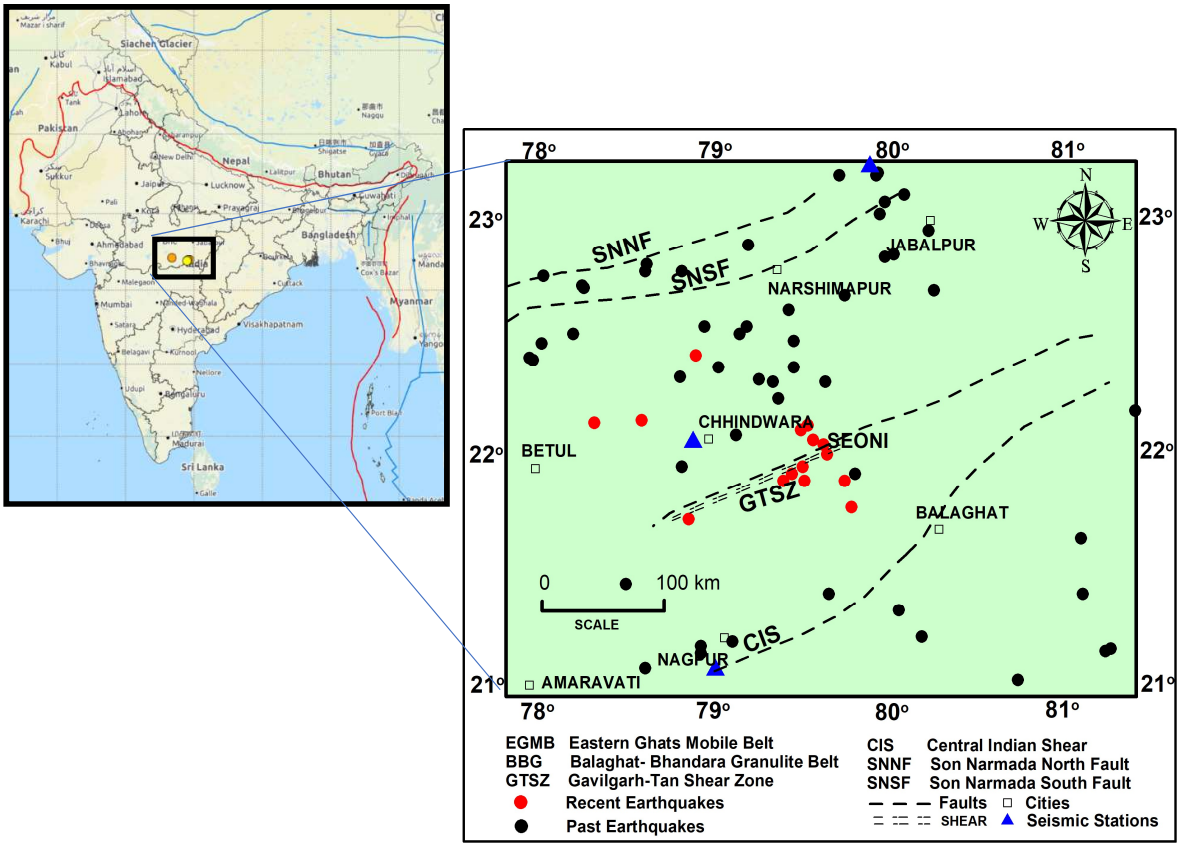

Figure 1: Tectonic map of Seoni district and its region overlapped with seismicity since 1987. The abbreviations used are: GTSZ (Gavilgarh-Tan Shear Zone), CIS (Central Indian Shear), SNNF (Son Narmada North Fault), and SNSF (Son Narmada South Fault).

These micro to small earthquakes were reported felt in the Seoni District and its region. These events were found located in the vicinity of the Gavilgarh-Tan Shear Zone (GTSZ) mapped in the region. However, the earthquakes in Madhya Pradesh region were found mainly associated to various tectonics as depicted in **Fig.-1**. NCS installed one permanent seismic station in Chhindwada district on 5.07.2021 soon after the spurt of activity in October 2020 (**Fig. 2**). In addition, the activity area is surrounded by 11 more seismic stations namely, Jabalpur, Narmadanagar, Indore, Bhopal, Guna, Nagpur, Akola, Hingoli, Bilaspur, Raipur, and Kanker spreading up to ~ 300 km. The existing network is capable of locating an earthquake of M:2.5 and above in the Seoni region including Narmadanagar and Chhindwara areas.

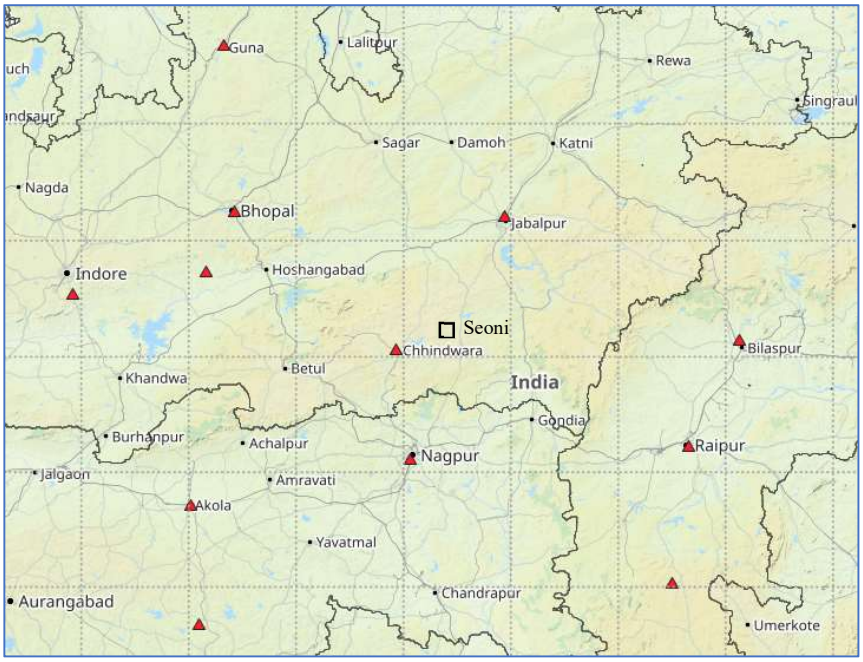

Figure 2: Seismic stations operating in the region surrounanding the Seoni district of Madhya Pradesh.

Historical and instrumentally recorded earthquake database suggests that the area of Seoni and its region is located close to the Son Narmada Fault zones, which are orienting east-west across the central India and observed seismically active. This region has experienced many earthquakes including the event with maximum magnitude M 6.5. Few prominent events among these are:

I. May, 1846 (M 6.5) earthquake near Damoh
II. June 02, 1927 (M 6.5) the Sone valley earthquake
III. March 14, 1938 (M 6.3) the Satpura Earthquake
IV. May 22, 1997 (M 5.8) the Jabalpur earthquake

The Satpura earthquake (M 6.3) was located about 140 km from Khandwa and it was felt over a large area covering up to Agra and Delhi to the north, Belgaum and Bombay to the south, Bhavnagar (Gujarat) to the west, and up to Seoni (epicentral distance ~ 460 km) to the east. The Jabalpur earthquake (M 5.8) was widely felt in the region of Madhya Pradesh and according to an official estimate; it took a toll of 39 human lives and caused extensive damage to property in the epicentral region. The damage was reported maximum in the Jabalpur and Mandla districts.

The region has also experienced fringe effects of the large earthquakes (M > 7.0) originating in the Great Himalayan Boundary Fault Zone. Occasional a spurt of swarm type seismic activity has also been reported in the different parts of the Madhya Pradesh due to local crustal adjustment. The entire state of Madhya Pradesh falls in seismic zone II & III of the seismic zoning map of India prepared by Bureau of Indian Standards (BIS). The Seoni district and its nearby area lie in seismic zone-II, which is broadly associated with seismic intensity VI on the MMI (Modified Mercali Intensity) scale.

The intensity of an earthquake at a specific place depends on magnitude, distance from the focus, duration of the earthquake, type of underlying soil, and its damping characteristics. The damage to the buildings constructed over soft soil or land fill area will be higher than that in the similar type of buildings having their foundation on hard bedrock. It is submit that earthquake prediction is not possible as on date. No proven scientific technique is available in any part of the world, to predict the future earthquakes precisely with regard to space, time and earthquake magnitude. Hence, the structures are to be properly engineered as per the earthquake resistant building codes specified by the Bureau of Indian Standards (BIS).

A list of some significant old earthquakes that occurred in Madhya Pradesh and its border region is given in **Annexure-II**.

Annexure-I

S.No.	Date	Origin Time (in IST)	Latitude (deg N)	Longitude (deg E)	Depth (in km)	Magnitude
1	27-10-2020	04:10:50	21.92	79.50	15	3.3
2	31-10-2020	12:49:17	22.01	79.55	10	3.1
3	31-10-2020	17:20:41	22.13	78.37	10	3.2
4	31-10-2020	18:16:37	22.00	79.70	10	3.5
5	09-11-2020	06:46:41	21.89	79.57	12	3.4
6	22-11-2020	01:45:02	22.10	79.55	10	4.3
7	22-11-2020	03:12:11	21.78	79.84	10	2.4
8	22-11-2020	03:40:53	21.89	79.80	10	1.8
9	22-11-2020	06:23:59	21.89	79.45	10	2.7
10	10-03-2021	08:29:10	22.14	78.64	20	2.8
11	11-04-2021	12:53:59	23.28	81.73	10	3.9
12	07-05-2021	00:41:36	22.41	78.95	30	3.0
13	21-09-2021	01:05:58	22.06	79.62	10	2.1
14	01-10-2021	11:49:09	22.11	79.59	05	3.6
15	04-10-2021	07:49:47	21.95	79.56	05	3.7
16	04-10-2021	08:12:04	22.04	79.68	05	2.9
17	23-11-2021	22:53:16	21.73	78.91	10	2.2

Annexure-II

S. No.	Year	Month	Day	origin time (UTC) [Hr Min Sec]	Latitude (deg N)	Longitude (deg E)	Focal depth (Km)	Magnitude
1	1987	4	18	16 59 49.2	22.53	79.24	20	4.8
2	1993	10	31	3 47 28.0	23.00	80.00	0	4.7
3	1995	5	2	0 46 31.0	22.70	78.30	33	4.4
4	1997	6	4	13 50 18.0	22.93	80.28	0	3.6
5	1997	6	9	3 41 40.0	22.50	78.25	0	2.9
6	1998	3	9	7 41 17.8	22.40	78.00	10	4.3
7	1998	3	29	18 54 22.0	22.50	79.20	33	3.9
8	1998	7	19	12 57 37.7	22.39	78.02	33	4.4
9	1998	8	11	9 50 3.7	22.76	78.87	11	2.8
10	1998	8	16	9 48 59.7	23.15	81.74	15	2.4
11	1998	9	14	20 42 26.5	21.80	76.47	5	2.7
12	1998	9	16	1 55 40.4	21.73	76.31	5	2.9
13	1998	9	24	10 48 45.7	19.71	81.92	15	3
14	1998	9	26	23 16 25.1	21.97	76.32	5	2.3
15	1998	10	19	12 21 34.4	21.59	76.28	1	3.1
16	1998	10	20	9 05 10.6	21.69	76.09	2	3.4
17	1998	10	21	11 13 9.6	24.62	78.77	15	2.2
18	1998	10	22	22 06 10.8	21.69	76.22	1	2.8
19	1998	10	24	7 48 38.2	21.62	76.23	1	3.1
20	1998	11	4	9 07 53.5	21.62	76.17	1	2.1
21	1998	11	5	5 42 8.5	21.63	76.38	10	3.5
22	1999	4	3	9 38 9.8	23.54	78.01	30	4.2
23	1999	5	11	1 56 12.1	22.12	77.19	5	3
24	1999	11	24	4 39 22.7	22.71	77.70	33	2.7
25	2000	3	4	1 26 47.2	24.08	79.40	0	2.7
26	2000	5	2	9 25 46.9	22.53	79.00	15	3.1
27	2000	6	30	13 57 32.4	21.95	78.87	15	3.6
28	2000	7	27	6 39 7.5	22.87	79.25	10	2.4
29	2000	9	12	2 46 33.7	22.36	79.08	8	3
30	2000	9	29	5 03 38.7	23.55	81.52	33	3.1
31	2000	10	16	22 33 12.3	23.22	80.33	33	5.2
32	2000	12	5	8 55 50.7	22.18	81.46	33	2.6
33	2001	1	3	16 45 41.9	22.47	79.51	33	3
34	2001	1	23	17 52 51.4	23.16	79.77	13	3.4
35	2001	2	21	18 22 20.2	22.68	80.31	33	3.1
36	2001	4	4	1 57 13.0	22.74	78.08	20	2.7
37	2001	10	17	9 06 16.2	24.00	80.82	10	3.7
38	2002	3	6	19 24 39.7	22.31	79.31	37	3
39	2002	4	17	3 47 49.9	22.60	79.48	18	3.2
40	2002	4	20	10 36 50.7	22.33	76.01	20	2.3
41	2002	5	1	5 46 21.7	23.54	79.96	15	2.7

42	2002	9	21	10 47 41.0	23.75	80.40	10	3.3
43	2002	11	2	21 57 7.9	21.28	76.36	10	2.9
44	2003	3	10	22 45 7.5	21.27	77.19	9	3.8
45	2003	5	21	10 36 27.5	22.83	80.08	19	2.8
46	2003	9	20	22 59 44.4	22.36	79.51	33	2.6
47	2003	11	17	4 20 53.0	23.49	77.61	13	2.5
48	2003	11	22	0 18 29.0	21.47	76.01	3	3.5
49	2003	11	29	7 05 21.3	21.24	80.24	13	3.1
50	2003	12	1	14 08 30.7	22.69	78.31	19	2.5
51	2003	12	25	9 15 13.6	21.65	81.15	5	2.7
52	2004	1	12	9 02 39.7	23.33	81.97	20	3.3
53	2004	5	12	0 29 52.5	21.20	78.98	4	3
54	2005	2	16	8 54 17.1	23.15	81.66	5	2.8
55	2005	2	21	8 08 37.7	23.16	79.98	15	2.7
56	2005	3	25	14 03 41.5	22.46	78.07	10	3.8
57	2005	4	1	16 40 22.5	21.46	76.28	17	3.2
58	2005	5	27	5 21 2.5	22.08	79.18	5	2.8
59	2005	6	5	11 45 39.0	21.42	81.16	5	2.7
60	2005	7	3	12 52 56.4	20.98	77.41	24	2.3
61	2006	3	7	4 39 29.8	22.43	77.77	15	3.1
62	2006	8	5	2 57 29.1	22.30	79.39	10	3.4
63	2006	9	14	1 40 3.0	22.23	79.42	20	2.9
64	2007	1	10	22 58 42.9	22.82	80.03	10	2.7
65	2007	6	6	8 15 40.2	22.76	78.66	8	3.3
66	2008	1	10	23 48 55.2	22.79	78.67	10	3.3
67	2008	10	20	10 15 17.7	23.44	78.44	10	2.4
68	2009	8	1	18 49 57.5	22.30	79.69	10	3.5
69	2011	2	8	7 23 11.8	22.66	79.80	10	3.5
70	2011	8	6	17 24 53.0	23.17	79.99	12	2.6
71	2012	6	12	1 09 44.0	22.32	78.86	15	3.4
72	2012	9	12	16 34 6.3	21.30	76.51	20	3
73	2012	10	18	2 33 29.1	23.78	81.36	10	5
74	2012	10	30	13 52 53.0	22.72	77.70	10	2.9
75	2012	11	20	4 15 41.7	22.06	76.03	15	3.3
76	2013	11	18	11 21 18.7	21.92	79.86	10	2.9
77	2014	10	22	5 18 47.4	23.05	80.03	6	3.5
78	2015	7	23	14 36 6.0	21.35	80.11	10	4
79	2019	4	8	14 09 11.0	21.35	76.29	10	3.5