

Catastrophe and Casualties: The History of Earthquake in Darjeeling Himalaya (1835-1947)

Dipanwita Dasgupta

Assistant Professor in History
Cooch Behar Panchanan Barma University
Email:dipanwita.dsgpt@gmail.com

Abstract

The geological history of the Himalayan ranges as well as the alluvial plains of Indus, Ganges, Brahmaputra and tributary rivers shaped by the ever-active tectonic forces in the converging boundary of the Indian plate and Eurasian plate. The region of Darjeeling Himalaya is prone to recurring geological hazards like earthquakes, landslides and floods. The great ranges of the Himalayas have an abiding impact on the adjoining eight countries as they control the atmospheric circulation of air, drainage systems and distribution of precipitation in the foothills. The harsh climatic factors and the natural calamities, sometimes badly affected the lives of the people living in the remote areas of the mountains. The catastrophes have a huge psychological impact on the masses and for a long time generation, after generation, the stories of the catastrophe remained in the memories of the masses. But through their usual patience and calmness, they adjusted to the situation and sometimes they forgot the agony of the calamity and re-established the cities, towns and villages. The article focuses on the history of the earthquake in Darjeeling Himalaya to understand the nature of the destruction held in the last two centuries on the hill slopes.

Keywords: Geology, Tremor, Memory, Collapse, Ruin

In the last two centuries, Darjeeling (27°03'N-88°16'E) was not been the epicentre of the massive seismic activities, rather than the place is mainly affected by the most active seismic zone of North Eastern India, Bihar and Nepal. To understand the history of the earthquakes and their atrocities in Darjeeling, the Imperial Gazetteers, District Gazetteers, Records of Geological Survey of India, Memoirs of Geological Survey of India, Annals of Indian Administration, Administrative Reports of the Government of Bengal, Railway Administrative Reports, 'Daily

rainfall of India' published by Provincial Governments of India, old newspaper and periodicals both in regional and English have been carefully studied.¹ Many contemporary accounts elaborately depicted the personal experience of the travellers during the catastrophe that occurred between 1835 to 1947. Joseph Dalton Hooker's *The Himalayan Journal*, (Vol. I-II), Douglas W. Freshfield, *Round Kanchenjunga* (1903), and Rev. F. W. Warne's *The Darjeeling Disaster: its Bright Side* (1900) in many ways bestowed precious information regarding their experiences during the natural calamities of Darjeeling.² From the geological point of view, Darjeeling has been observed by J. D. Hooker (1856), Mallet (1875), Dyhrenfurth (1931), Auden (1935), Heim and Gansser (1939) during the nineteenth and twentieth centuries.³ In 1947, S. Roy made an in-depth research on the metamorphism in the Eastern Himalayas.

After the independence, several academicians mainly from geography, geology and civil engineering have studied the causes and impact of natural calamities on the highly fragile and sensitive hill areas of Darjeeling from a geological and geographical perspective. A.M.N. Ghosh (1950), K.K. Dutta (1951), and S. Singha Roy (1973) wrote some thought-provoking research articles on the landslides of the Darjeeling and Eastern Himalayas.⁴ Subhash Ranjan Basu has done some remarkable work on the fluvial hazards of the Darjeeling and Sikkim regions from a geographical perspective.⁵ Basu's research concentrated on the landslide and flood hazards that occurred in the post-colonial period. But to some extent, they neglected the study of the history of earthquakes and their impact on the living beings and natural landscape of Darjeeling from the historical point of view. Anis Chattopadhyay in his PhD thesis '*A Study of Landslides and their Impact on Land Use in Darjeeling Hills*' highlighted the impact of the landslides on the land use pattern of the Darjeeling during the post-colonial period. So far no one has studied the impact of the natural calamities in the colonial period consulting and comparing

¹ The Bengali journals and newspapers like *Prabasi*, *Paricharika* (*Nabya Parjaye*), *Manasi o Marmabani*, *Bangabasi*, and *Dainik Basumati* have been cited to find out information regarding the history of earthquake in Darjeeling.

² The colonial travellers made some remarkable observations regarding the catastrophic calamities and its casualties in Darjeeling. Some of them even balm the over exploitation of the natural resources as the cause of the disaster.

³ For more information, see F. R. Mallet, "On the Geology and Mineral Resources of the Darjeeling District and the Western Duars", *Memoires Geological Survey of India* 11 (1875); G. Dyhrenfurth, *Himalaya, Unsure Expedition 1930*, (Berlin: SCHERL, 1931); J.B. Auden, "Traverses in the Himalaya," *Records of the Geological Survey of India* 71(1935).

⁴ A.M.N. Ghosh, *Observations on Landslides of the 11th and 12th of June 1950 in the Darjeeling Himalaya*, (Records of the Geological Survey of India, Calcutta: Office of the Superintendent of Government Printing, 1950); K.K. Dutta, *Report on the Landsides in Darjeeling and Neighbouring Hill Slopes in June 1950*, (Records of the Geological Survey of India, Calcutta: Office of the Superintendent of Government Printing, 1951).

⁵ Subha Ranjan Basu and Sunil Kumar De, *Causes and Consequences of Landslides in the Darjeeling-Sikkim Himalayas*, (India: Starkel, Leszek); Subhashranjan Basu (ed.), *Rains, Landslides, and Floods in Darjeeling Himalaya*, (New Delhi: National Science Academy), 2000.

the primary sources in chronological order to trace the impact of the calamities on the life of the natives and the British citizens residing in the Darjeeling.

The *Journal of the Asiatic Society of Bengal*, Vol. XI - XII and Dr. Oldham's catalogue of Indian Earthquakes shows that the ground of the Darjeeling vibrated three times between May to November 1842. The tremor happened only seven years after the grant of Darjeeling (1835) and at that time a tiny population lived in Darjeeling. So the eyewitness descriptions were very difficult to find. The reports of the contemporary newspaper published from Calcutta in July and August 1845 mention that three successive quakes were felt in the Bengal and Assam on 23rd July, 26th July and 6th August 1845.⁶ The first two earthquakes were rather small than the tremor of 6th August at 11.30 PM. Huge damage to the construction occurred in Guwahati, Cherrapunji and Sylhet.

Four years later, a severe shock was felt at Guwahati and the Eastern Himalayan region. On 22nd January 1849 at about 8.45 AM, the ground of the Guwahati sharply vibrated and created panic among the people. The aftershock continued for the next few days. By this period few major tremor was also felt in the Darjeeling and Sikkim Himalayas.⁷ Major J. Butler and Captain Dalton, the British officials posted in Assam and Mr. C. K. Hodgson from Burpetahfelt the power of the earthquake and reported it to Major Jenkins, the Agent to the Governor General in Assam. Major J. Butler wrote 'It lasted for a minute, and the ground moved greatly, the tree also shook violently'.⁸ All the British officials noticed the rumbling noise and gradually it became louder and was followed by severe shock.⁹ J. D. Hooker came to Darjeeling in 1849, the aftershocks of the Guwahati earthquake were regular in the Darjeeling and Sikkim Himalayas. While living in Darjeeling, he narrated observations regarding the earthquake, J.D. Hooker wrote: "*In the evening (28th February; 1849) we had three sharp jerking shock of an earthquake in quick succession, at 9.8 P.M., appearing to come up from the southward: they were accompanied by a hollow rumbling sound like that of a waggon passing over a wooden bridge.*" The shock was also registered by Mr. Muller at 9.10 P.M. According to Hooker the motion may therefore quickly transmitted northwards through the intervening distance of forty miles in two minutes. Both Mr. Muller and Mr. Hodgson had noticed a much more severe shock on 28th February 1849 at 6.10 P.M. This caused a good deal of damage at Darjeeling, by cracking the well-built walls.¹⁰ Hooker noted that the earthquakes were most common towards the eastern and western extremities of India, owing in the former case to the proximity of the volcanic forces in the Bay of Bengal. Catch and Scindh, as was well known,

⁶ Information gathered from two newspapers. July 26–August 27, 1845, *Bengal Hurkaru*, Calcutta, July 26–August 26, 1845, *Englishman*, Calcutta.

⁷ F. Jenkins, "Earthquakes in Assam", *Journal of the Asiatic Society of Bengal* 18 (1849): 172–175.

⁸ Butler, J, Earthquake in Assam, Communicated by Major Jenkins, Agent to the Governor General, *Journal of the Asiatic Society* 18, no. 1 (1849): 172-173.

⁹ Butler, "Earthquake in Assam," 173.

¹⁰ J. D. Hooker, *The Himalayan Journals I*, (London: John Murray, 1854), 377.

have suffered severely on many occasions, and in several of them the motion has been propagated through Afghanistan and Little Tibet, to the heart of Central Asia.¹¹

Colonel James Arden Crommelin (1801-1893) of Bengal engineers witnessed the earthquakes in Darjeeling in the early 1860s and reported to the Geological Survey of India.¹² From June 1862 to June 1868, eight slight and four moderately sharp tremors were felt in Darjeeling.¹³ The next year, a severe tremor was felt in almost every district of Bengal on Sunday afternoon on 10th January 1869. The earthquake was one of more than usual violence.¹⁴ The amount of destruction caused by the earthquake indicated that the epicentre of the quake lay near Cachar (Silchar, Assam) and Manipur. The epicentre was located in the region by the side of the Barak River at the southern base of the Jaintia hills, about 300 miles from Calcutta.¹⁵ From the data, it was calculated that the earth wave travelled at the rate of 11,256 feet a second.¹⁶ In Darjeeling, it created a 'sharp blow-like sensation'.¹⁷ The Executive Engineer posted at Darjeeling reported that '*the house shook considerably, wood-work of roof cracked and groaned. Buildings not injured very perceptibly at Siliguri; wall of dak bungalow cracked at Punkhabari.*'¹⁸ The Deputy Commissioner of the hills station reported that a little oscillation was felt at Darjeeling on that day.¹⁹ Some observers in the hill station mention it as '*a vertical concussion or blow than as an undulating or wave-like motion*'.²⁰ In Kurseong, around 30 km south of Darjeeling, people panicked as the earthquake started and rushed out of their houses, fearing any moment they would come down. Trees seemed to roll from side to side in the most extraordinary manner.²¹ Sharp jerking was also felt in Punkhabari, Siliguri and the aftershock continued up to

¹¹ Hooker, *The Himalayan Journals I*, 377.

¹² *Memoirs of Geological Survey of India* 10, no.3 (1883): 43.

¹³ On 18th June 1862 at night a severe tremor felt by Colonel James Arden Crommelin and in next day morning the slight earthquake was felt in Darjeeling. On 29th March 1863 a severe shock was felt. On 8th July, 11th August, 21st August, 17th October 1863, 30th August 1864, 9th September, 16th November, 16th December 1865, 23rd May 1866 (three shock were felt, of which one was severe) slight tremor noticed in Darjeeling.

¹⁴ *Bengal Administration Report 1867-68*, (Calcutta: Bengal Secretariat Press, 1868), 286-287.

¹⁵ W. H. Davis, "The Cachar Earthquake of 1869", *Science* 1, no. 3 (1883): 67. (doi:10.1126/science.ns-1.3.67).

¹⁶ *Bengal Administration Report 1867-68*, 286.

¹⁷ Thomas Oldham, "The Cachar Earthquake of 10th January 1869," *Memoirs of Geological Survey of India* 19, no. 1 (1882): 34.

¹⁸ Oldham, "The Cachar Earthquake of 10th January 1869," 31.

¹⁹ Oldham, "The Cachar Earthquake of 10th January 1869," 31.

²⁰ Oldham, "The Cachar Earthquake of 10th January 1869," 32.

²¹ Oldham, "The Cachar Earthquake of 10th January 1869," 32. Also cited in Englishman, January 18th 1869.

March and August.²²

Almost thirteen years after the earthquake in Cachar, the Geological Survey of India published a general account of the shock and its destructive effects in *Memoirs of Geological Survey of India*, Vol. XIX, Part. I (1882).²³ W.H. Davis, in the review of the memoir mentions that the precious description of the Late Thomas Oldham, Godwin-Austen, H.F. Blanford and Archdeacon Pratt seem largely erroneous in their theoretical part and discussion of position, depth shape of the seismic area and the velocity of the earth-wave's motion and transmission.²⁴ The earthquake had an impact of over 2,50,000 square miles. Despite the massive tremor, the death toll was very low and only a few buildings near the epicentre close to the Barak Valley were overthrown. In 1869, the number of concrete construction in the earthquake zone Cachar, Assam and Manipur was very low. Most of the native houses were built with wood and bamboo and these were elastic enough to escape the great injury.²⁵ The earthquake of 1881 was severely felt at Darjeeling.²⁶ Within the next four years, another tremor affected the various parts of the Bengal province. The epicentre of the Bengal earthquake of 14th July 1885 was in Bangladesh.²⁷ But the rate of casualty was low in Darjeeling.

In June 1897 the entire Eastern India suffered from a terrible earthquake.²⁸ The earthquake of 12th June 1897 was one of the greatest natural calamities in the history of the British Indian Empire. In the evening of the fateful day, the earth shocked for two and a half minutes and ruined 150,000 square miles, interrupted all means of communication, water and sand poured out of the surface soil and created unaccountable landslips in the hills cantering on Shillong.²⁹ The one-third quarter miles felt the shock and everywhere people recognized it as rather abnormal. On that day station masters, the officer posted at the telegraph office or the tea planters of Darjeeling recorded the time of the catastrophe. The Darjeeling Himalayan Terminal station in Darjeeling and Eastern Bengal Terminus station in

²² Arthur Jules Dash, *Bengal District Gazetteer: Darjeeling*, (Alipore: Bengal Government Press, 1947), 10.

²³ The observation of Dr. Thomas Oldham regarding the earthquake of Cachar (1869) published in *Memoirs of Geological Survey of India* 29, Part I (1882), a few years after his death. It became possible due to the initiative of his son, Dr. R. D. Oldham.

²⁴ Davis, "The Cachar Earthquake of 1869," 67.

²⁵ Davis, "The Cachar Earthquake of 1869," 67.

²⁶ R.D. Oldham, "Note on the earthquake of 31st December 1881", *Records of the Geological Survey of India* 17, no. 2 (1884): 47–53.

²⁷ C. S. Middlemiss, "Report on the Bengal earthquake of July 14th, 1885," *Records of the Geological Survey of India*, 18, no. 4 (1885): 200–221. Englishman, July 15-28, 1885.

²⁸ R. D. Oldham, "Report of the Great Earthquake of 12th June 1897," *Memoirs of the Geological Survey of India* 29, (Calcutta: Office of the Superintendent of Government Printing, 1899). List of Aftershocks of the Great Earthquake of 12th June 1897, compiled by R.D. Oldham, *Memoires of the Geological Survey of India* 30: 1-102.

²⁹ These were also known as systematic aftershocks. *Memoirs of the Geological Survey of India* 29 (1899): 1.

Siliguri reported that the earthquake started at 16.26 PM and ended at 16.29 PM or around 16.30 PM.³⁰ After the Great earthquake of 1897, a large number of aftershocks were felt at Darjeeling though it was laid well outside the epicenter of the principal shock.

The Great Indian Earthquake of 1897 opened up a new era in the research on seismic activities in India. Previously there was no regular system of recording the data of the earthquakes in India. The people who have watched the calamity recorded their observations and the data of the aftershocks. After the massive earthquake of 1897, the British geologists followed the pattern of scientists and investigators such as Omori and C. Davison who studied the aftershock of the great Japanese Earthquake of 1891 and threw light on the laws which governed the gradual diminution of the aftershock in number and gradual shifting of the main centre of seismic activities.³¹

Because of the massive span of the destruction, one person couldn't survey and report about the Earthquake of 1897. The four officials T. D. LaTouche, were appointed to inspect the Assam Valley, Shillong, Cherapunji and Sylhet. Mr. Hayden was entrusted to examine the railway tracks from Calcutta to Darjeeling and at the same time inspect several towns in North Bengal. Mr. Vredenburg examined the country located at the West of the North Bengal and Mr. Grimes made a report on Eastern Bengal and Cachar valley. Pramatha Nath Bose was appointed to inspect the eastern deltaic district and many volunteers were appointed to maintain the records of the aftershocks. In 1897-98, R. D. Oldham was entrusted to find out the epicentral track of the Great Earthquake. But his attempt failed due to three reasons, viz, the vastness of the area, the impressive character of the country and time-constrained.

Mr. H. H. Hayden mentions that from the Atrai River onward considerable damage had been notable everywhere. In the North Bengal fissures were visible parallel to the Atrai River and stretching from east to west up to several hundred yards with an average breadth of 6 to 8 inches. Most surprisingly, according to Mr. Hayden, no damage appeared to have been done in Siliguri all signs of the violent earthquake were strictly absent; the railway station was slightly cracked but does not appear to have suffered any damage beyond the loss of a few loose bricks; and it was not till the Mahanadi river was crossed and the observers come on any marked effects of the shock.³² Between the Mahanada and Sukna Station, the earth was cracked in several places and Cart Road was also affected by the tremor. Very little damage occurred in the railway tracks of the Darjeeling Himalayan Railways. But the damage happened to the factories and gardens near the spar. The Tindharia railway station building was cracked and some stones fell from the gables. After 12th June two small landslips occurred in the south of the hill slopes. But on 24th

³⁰ Oldham, "Report of the Great Earthquake of 12th June 1897," 63.

³¹ Oldham, "Report of the Great Earthquake of 12th June 1897," 124.

³² Oldham, "Report of the Great Earthquake of 12th June 1897", 282.

June a massive landslide occurred at the hillside of Tindharia below the station master's house.³³

In the aftermath of the earthquake, the most striking effect was seen in Darjeeling where large numbers of chimneys were fallen.³⁴ Most of the house was damaged due to the fall of the huge chimneys on the roofs. According to Hayden, these were not severe in determining the direction in which the wave travelled. In the Old Bhutia Cemetery below the Calcutta Road on the eastern side of the ridge several tombs stones which were made of loose stones and uncemented badly affected by the tremor. In the European Cemetery below the Shrubbery, no severe damage was done, only two to three obelisks were damaged. But the effect of the tremor in Senchal was quite different from the Darjeeling proper. In Senchal the walls of the old barracks completely disappeared but the Old chimneys remained as isolated towers. T. Oldham prepared a catalogue of the aftershocks of the 16th June earthquake.³⁵

On 3rd July 1930 at 3.23 local time in Dhubri (Assam), an earthquake occurred at a magnitude of 7.1. A strong tremor was felt in the entire Bengal, Assam, Bihar and Nepal.³⁶ The movement of the land was severe in Assam, the Northern part of Bengal and Rungpur especially in Cooch Behar, Lalmonihat, Nilphamari and Tura. In Darjeeling and Kalimpong cracks appeared in the buildings but the damage was 'small and practically negligible'.³⁷

Blake Pinnell and Martin Pinnell, two sons of L.G. Pinnell, the Deputy Commissioner of the Darjeeling district witnessed the Bihar earthquake of 15th January 1934 while they were camping at Bagdogra just below Darjeeling and narrated that the ground suddenly shook and it was difficult for him to stand up.³⁸ When the earthquake started they were listening to their favourite song 'Forty-seven ginger-headed Sailors' in a child gramophone. But because of the strong quake, the pin of the gramophone sailed across the record and ruined it. Their own house along with the other houses was destroyed in Darjeeling due to the violence of the tremor. The earthquake causes massive damage to manmade structures creates cracks in buildings, bridges, roads and railway tracks and also leads to the displacement of the earth's crust. John Langley while in a school at Darjeeling experienced a minor tremor which caused a little damage in the Darjeeling.³⁹

³³ Oldham, "Report of the Great Earthquake of 12th June 1897", 282.

³⁴ Oldham, "Report of the Great Earthquake of 12th June 1897", 282.

³⁵ R. D. Oldham, "List of aftershocks of the Great Earthquake of 12th August 1897", *Memoirs of the Geological Survey of India* 30 (1900): 1-102.

³⁶ E. R. Gee, "The Dhubri earthquake of 3rd July, 1930," *Memoirs of the Geological Survey of India* 65 (1934): 35.

³⁷ Gee, "The Dhubri earthquake of 3rd July, 1930," 35.

³⁸ Laurence Flaming, *The Last Children of the Raj: British Childhood in India 1919-1939, Vol. I*, (London: The Radcliffe Press, 2004), 248-249.

³⁹ Flaming, *The Last Children of the Raj*, 287.

It was supposed that the renewed movement along the thrusts in the Nepal and Darjeeling Himalayas might have been the cause of the earthquake of 15th January 1934.⁴⁰ After Bihar, the worst affected area in British India was Darjeeling district in Bengal.⁴¹ Mr. D.N. Wadia was entrusted to prepare a report on the effect of the earthquake on the hill station of Darjeeling. Following the Mercalli Scale of Isoseismal, the intensity of the earthquake in the hilly region of Darjeeling and Kurseong reached VIII.⁴² Mr. Wadia reported that several houses in Darjeeling have collapsed. Other was damaged by the crashing of the heavy missionary chimneys in the roof and upper floors. The ground fissures have appeared at several places in Darjeeling, Tindharia and Nepal hill villages.⁴³ Furthermore, Wadia observed that no landslides appeared on the traverse through the Darjeeling from Nepal and the earthquake had no apparent effect on the unstable areas of old landslide areas at Happy Valley.⁴⁴ The Bihar-Nepal earthquake had a strong impact on Indian politics. The newspapers, journals and magazines wrote extensively regarding the intensity and death toll of the massive earthquake.⁴⁵ In the aftermath of the earthquake Mahatma Gandhi visited affected areas of Bihar and declared that this earthquake was God's punishment for the sin of untouchability existing in India. Rabindranath Tagore accused Gandhi of superstition and expressed his observation of the earthquake.⁴⁶

The analysis of the historical records on earthquakes reveals that Darjeeling is located just outside the highly active seismic zone of North Eastern India and the Bihar-Nepal border. It is situated middle of the two seismic zones V and these zones witness at least one or two massive tremors in every century. When the grant of Darjeeling was received in 1835, it consisted of only one hundred lephas. The population rapidly increased both in colonial and post-colonial times. According to the census of 2011, the Darjeeling agglomeration had a population of 132,016. Since the colonial days, the Queen of Hills has witnessed massive urbanization on the hill slopes. The reckless urbanization became a feature of Darjeeling Hills in the post-colonial period. In the last two decades, a large number of five to eight storied buildings constructed in the Darjeeling hills. Ten years back, the Darjeeling Civic Body had identified 337 high-rise buildings within the old town and these are more than 14.5 meters. A massive earthquake in the nearby two seismic zones

⁴⁰ The colonial geologists recognized three thrust zones in Nepal viz., lower Siwalik rocks from underlying upper Siwalik conglomerate near Hitaura and Nepaltar, the 'main boundary fault' found in north of Sanotat and probably run through Dharan bazaar to pass below Tindharia in Darjeeling Himalayan Railway and the third thrust was seen near the Udaipur Garhi.

⁴¹ J.B. Auden and A.M.N. Ghosh, "Preliminary Account of the earthquake of the 15th January 1934, in Bihar and Nepal", *Geological Survey of India* 68, no. 2 (1935): 235.

⁴² Ghosh, "Preliminary Account of the earthquake of the 15th January," 186.

⁴³ Ghosh, "Preliminary Account of the earthquake of the 15th January," 193.

⁴⁴ Ghosh, "Preliminary Account of the earthquake of the 15th January," 203.

⁴⁵ Sen, "Bumikampa," *Prabasi* 33, no. 2 (1933): 697-706. The Bengali journal namely *Prabasi* was edited by Ramananda Chattopadhyay, a renowned Bengali journalist from 1901 to 1943.

⁴⁶ Sen, "Bumikampa," 723.

can ruin the entire hill town unless the common people, political persons and local administration of the region understand the destructive seismological history of the Himalayan range and prohibit the illicit and unscientific construction in the hill slopes.

Declaration of conflicting interest

The author declared that there are no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding statement

The author did not receive any financial assistance for the research, authorship, and/or publication of this article.

References

- Bengal Administration Report 1867-68*. Calcutta: Bengal Secretariat Press, 1868.
- Chattopadhyay, Ramananda (Ed.). *Prabasi* 33, no. 2 (1933).
- Dash, Arthur Jules. *Bengal District Gazetteer: Darjeeling*. Alipore: Bengal Government Press 1947.
- Dyhrenfurth, G. *Himalaya, Unsure Expedition 1930*. Berlin: Scherl, 1931.
- _____. *To the third Pole*. London: W. Laurie, 1953.
- Flaming, Laurence. *The Last Children of the Raj: British Childhood in India 1919-1939. Vol. I*, London: The Radcliffe Press, 2004.
- Gautam, Ashutosh. *Earthquake: A Natural Disaster*. New Delhi: A.P.H. Publishing Corporation, 2008.
- Hooker, J. D. *The Himalayan Journals I*. London: John Murray, 1854.
- Journal of the Asiatic Society of Bengal* 18. Bishop's College Press: Calcutta, 1849.
- Memoires Geological Survey of India* 11. Calcutta: Office of the Superintendent of Government Printing, 1875.
- Memoirs of Geological Survey of India* 10 (3). Calcutta: Office of the Superintendent of Government Printing, 1883.
- Memoirs of Geological Survey of India* 19 (I). Calcutta: Office of the Superintendent of Government Printing, 1882.
- Memoirs of the Geological Survey of India* 65. Calcutta: Office of the Superintendent of Government Printing, 1934.
- Records of the Geological Survey of India* 17 (2). Calcutta: Office of the Superintendent of Government Printing, 1884.
- Rajendran, C. P. and Kusala Rajendran. *The Rumbling Earth: The Story of Indian*

Earthquake. New Delhi: Vintage Books, 2024.

_____ *Earthquakes of the Indian Subcontinent: Seismotectonic Perspectives*.
Singapore: Springer, 2022.

Records of the Geological Survey of India 18 (4). Calcutta: Office of the Superintendent
of Government Printing, 1885.

Records of the Geological Survey of India 71. Calcutta: Office of the Superintendent of
Government Printing, 1935.

Records of the Geological Survey of India. Calcutta: Office of the Superintendent of
Government Printing, 1950.

Records of the Geological Survey of India. Calcutta: Office of the Superintendent of
Government Printing, 1951.

Roy, Tirthankar. *Natural Disasters and Indian History*. New Delhi: Oxford University
Press, 2012.

Starkel, Leszek and Subhashranjan Basu (Ed.). *Rains, Landslides, and Floods in
Darjeeling Himalaya*. New Delhi: National Science Academy, 2000.