

## INDIAN OCEAN TSUNAMI – A HISTORICAL PERSPECTIVE

The phenomenon of tsunami is known from ancient times. Historical tsunami research may prove helpful in analyzing the frequency of occurrence of tsunami. It is known from the manuscript written by Plato that a giant sea wave destroyed the town of Amnisos on Crete in the year 1628 B C due to the explosive series of eruptions from the great volcano Santorini in the Aegean Sea. A reference on the engulfment of Dwarka, a city in Gujarat coast about 1500 B C can be traced in Indian Epic Mahabharatha. The drowning of the city Dwarka can be attributable to a great tsunami of that time.

Long before the Christian era, the ancient Tamils had nurtured the three Tamil Sangams and their rich language flourished in their academies. The Early Sangam operated at Thenmadurai, South of Kanyakumari between 300 B C and 50 B C, The Middle Sangam at Kapaadapuram, a coastal town, possibly near NE of Kanyakumari between 50 B C and 100 A D. Late Sangam at Madurai, a city far away from the coast was functional between 100 A D and 300 A D. The Sangam literary works – *Kallithogai*, *Kurunthogai* and *Cilappathikaram* refer to the lost coastal cities of Thenmadurai and Kapaadapuram due to past tsunamis possibly around at 50 B C and 100 A D respectively (In Tamil *Kadalkol* or *Perooly* means Tsunami events).

“ *Pahruli Atrudan Panmalai adukathu Kumari*

*Kodum Kodunkadal Kolla*” – which means that “the ferocious sea has engulfed the river Pahruli along with mountainous terrain up to Kumari” says *Cilappathikaram*, an epic more than 1700 years old (Appadurai, 1941, Karthigesu Sivathamby, 1986). A discernible mountainous terrain of 2 to 3 km breadth with Swamy Vivekananda Rock Memorial seen within the Kanyakumari Sea, is a present key evidence to the past tsunami events.

The Poompuhar, located at north of Nagapattinam, a east coast city of Tamilnadu, also an ancient old harbour under the rule of Chola Kingdom was swallowed by a *Kadalkol* (Tsunami) that occurred around 1500 years B P (i.e., 500 A D). Ancient scriptures and literature in the library of the Thondaiman Kingdom in Pudukottai of Tamil Nadu provide evidence for tsunami of Indian Ocean did hit Nagapattinam in 900 AD, destroyed a Buddhist monastery, washed several temples and killed hundreds of people during the reign of Raja Raja Chozhan (Kalki Krishnamurthy, 1984). In Indian History, the records on earthquake induced tsunamis are available from November 326 B C, when a tsunami hit the Indus Delta/ Kutch region.

It destroyed the Macedonian fleet of Alexander the Great. During the year 1524 a tsunami struck the Indian west coast due to an earthquake that occurred at Dabhol, a coastal town of Maharashtra.

Apart from the above seven tsunami events of 1500 B C, 326 B C, 50 B C, 100 A D, 500 A D, 900 A D, and 1524 A D, National Geophysical Data Centre (NGDC) and Geological Survey of India have documented tsunami events in the Indian Ocean region since 1750, 67 tsunami events are tabulated in chronological order (Table 1). They were generated from three tsunami risk regions around India i.e. (1) The Kutch of Gujarat – Mekran (Pakistan) seismic belt, (2) Java-Sumatra-Malaysia-Andaman-Nicobar and Myanmar Seismic belt and (3) Sri Lanka-Kanyakumari and its adjoining Indian Ocean region. The tsunami events that hit the Indian Ocean are shown in Fig 1.

The tsunamis that most affected India are as follows. On 16<sup>th</sup> June 1819 Rann of Kutch earthquake sent a tsunami which hit the coast of Gujarat and resulted in marine submergence of about 500 square kilometers. During 1847 on 31<sup>st</sup> October, a tsunami struck Nicobar Islands due to strong earthquake [Mw 7.5]. Kondul Island located between Little Nicobar and Great Nicobar Islands was much affected. On 31<sup>st</sup> December 1881 Car Nicobar earthquake, generated a tsunami which propagated throughout the Bay of Bengal and was recorded with amplitude of a few cm to 1.2 m. The rupture on the India/Andaman plate (Burma plate) boundary resulted in 10-60 cm of uplift of the island of Car Nicobar. Nagapattinam and Port Blair were the most affected with maximum amplitudes of tsunami of 0.80 m and 0.90 m respectively (Ortiz and Bilham, 2003).

In August 1883, violent eruptions were occurring from about a dozen vents of Krakatau volcano. At 2 PM on 26 August, a large blast shot volcanic ash and pumice 28 km high, as one of the cones collapsed into the sea, setting a huge tsunami. In the early morning hours of 27 August the eruptions were intense and subsequently resulted in giant tsunami waves to wreck the coastal villages. Stupendous explosions of Krakatau volcano blew away 4 cubic kilometre materials of incandescent pumice, gases and dust upto a height of 80 km into the atmosphere. This blast was distinctly heard as far away as 5000 km. At 10 AM the gigantic tsunami (40 m) generated by the explosion, rolled onto Java and Sumatra killing 36,417 people in 295 towns. This tsunami also struck Kanyakumari and Madras (2 m wave height) of east coast of India and Sri Lanka (Abbott, 2002). The tsunamigenic great earthquake of Andaman occurred

**Table 1.** Tsunami events in the Ocean around Indian region (sources National Geophysical Data Centre (NGDC)-NOAA Satellites and Information- Paula Dunbar@noaa.gov and Geological Survey of India)

Date			Tsunami Source Location				Source Earthquake		Tsunami Parameters	Tsunami Effects
Year	Mo	Dt	Country	Name	Latitude	Longitude	Depth (km)	Mag (Ms)	Intensity	Deaths
1750			Myanmar	Burma Coast	18 500	93 400			4 00	0
1762	4	12	Indian Ocean	Bay of Bengal Northern End	21 000	89 000				0
1770			Indonesia	SW Sumatra	-5 000	102 000		7	50 00	0
1797	2	10	Indonesia	SW Sumatra	-1 000	99 000		8	3 00	300
1816	4	29	Malaysia	Penang Island, Malacca Peninsula	5 383	100 250				0
1818	3	18	Indonesia	Bengkulu, Sumatra	-3 767	102 267		7	1 50	0
1819	6	16	India	Rann of Kutch				7 5		
1833	11	24	Indonesia	SW Sumatra	3 500	102 200		8 2	2 50	0
1837	9		Indonesia	Banda Atjeh Indonesia	5 500	96 000		7 2	50 00	0
1842	11	11	Indian Ocean	Bay of Bengal Northern End	21 000	89 000				0
1843	1	5	Indonesia	SW Sumatra	1 500	98 000		7 2	2 00	0
1845	6	19	India	Rann of Kutch	23 583	68 367				0
1847	10	31	India	Little Nicobar Island	7 333	93 667				0
1852	11	11	Indonesia	Sibolga, Sumatra	1 700	98 800		6 8		0
1861	2	16	Indonesia	SW Sumatra	-1 000	97 500		8 5	3 00	905
1861	3	9	Indonesia	SW Sumatra	0 300	99 370		7	2 00	1700
1861	4	26	Indonesia	SW Sumatra	1 000	97 500		7	1 50	0
1861	9	26	Indonesia	SW Sumatra	-1 500	100 000		6 5	1 50	0
1863	3	16	Indonesia	Java, Indonesia	-6 133	106 750				0
1868	8	19	India	Andaman Islands	11 670	92 730				0
1874	5		Bangladesh	Bhola district	Suderbans of Bangladesh were affected					1200000
1881	12	31	Indian Ocean	Bay of Bengal W of Car Nicobar Islands	9 000	92 000	15	7 9		0
1882	1		Sri Lanka	Sri Lanka	8 570	81 230				0
1883	8	26	Indonesia	Krakatau	-6 102	105 423			1 00	0
1883	8	27	Indonesia	Krakatau	-6 102	105 423			5 00	36500
1884	2		Indonesia	Krakatau	-6 102	105 423				0
1884			India	Western Bay of Bengal	Port Blair, Dublet (Kolkatta) were affected					
1885	7	29	Indonesia	Ayerbangis Sumatra	0 200	99 383		6 8		0
1885	12	14	Indonesia	Banda Atjeh	5 500	96 000				0
1886	1	31	Indonesia Ocean	Bay of Bengal						0
1889	8	16	Indonesia	Java-S Java Indonesia					1 00	0
1896	10	10	Indonesia	SW Sumatra	-3 500	102 500		6 8		0
1907	1	4	Indonesia	SW Sumatra	2 000	94 500		7 6	2 00	400
1908	2	6	Indonesia	SW Sumatra	-5 000	100 000	130	7 5	1 00	0
1909	6	3	Indonesia	Sumatra	-2 500	101 500	40	7 7	1 00	0
1914	6	25	Indonesia	Indonesia	-4 500	102 500		7 5		0
1917	1	21	Indonesia	Bali Sea	-8 000	115 400	33	6 5		0
1921	9	11	Indonesia	S Java Sea	-11 000	111 000		7 5	2 00	0
1922	7	8	Indonesia	Lhoknga Aceh	5 467	95 233				0
1926	6	28	Indonesia	SW Sumatra	-1 500	99 500		6 7		0
1928	3	26	Indonesia	Krakatau	-6 102	105 423				0
1930	3	17	Indonesia	Java S, Java Indonesia	-6 100	105 400				0
1930	6	19	Indonesia	Java - S Java Sea	-5 600	105 300	33	6		0
1930	7	19	Indonesia	S Java Sea	-9 300	114 300	33	6 5		0
1931	9	25	Indonesia	SW Sumatra	-5 000	102 700	3	7 5		0
1935	12	28	Indonesia	SW Sumatra	0 001	98 250	60	7 9		0
1936	8	23	Malaysia	Malay peninsula	6 000	95 000	7 3			0
1941	6	26	India	Andaman Sea E Coast India	12 500	92 500	8 1	7 6		5000
1945	11	27	Baluchistan	Mekran Coast	24 500	63 000		8		4000
1948	6	2	Malaysia	Malay peninsula	5 500	94 000		6 5		0
1949	5	9	Malaysia	Malay peninsula	5 000	95 000		6 7		0
1955	5	17	Malaysia	Malay peninsula	6 500	94 000		7 2		0
1957	9	26	Indonesia	S Java Sea	8 200	107 300		5 5		0
1958	4	22	Indonesia	SW Sumatra	-4 500	104 000	33	6 5		0
1963	12	16	Indonesia	Java, Indonesia	-6 200	105 400	64	6 5		0
1964	4	2	Indonesia	Off Northwest Coast of Indonesia	5 900	95 700	133	7		0
1967	4	12	Malaysia	Malay peninsula	5 500	97 300	58	7 5	1 50	0
1981	12	31	Indian Ocean	Bay of Bengal						0
1982	2	24	Indonesia	Java Trench, Indonesia	4 370	97 700	52	5 4		0
1985	4	13	Indonesia	Bali Island, Indonesia	-9 200	114 200	99	6 2		0
1994	2	15	Indonesia	Southern Sumatra	-5 000	104 300	23	7		7
1994	6	2	Indonesia	Java, Indonesia	-10 500	112 800	18	7 2	2 50	238
2000	6	18	India	South Indian Ocean	-13 800	97 450	10	7 9		0
2002	9	13	India	Andaman Islands, India	13 040	93 070	21	6 7		0
2004	12	26	Indonesia	Off West Coast of Sumatra	3 316	95 855	10	9 3	9 00	230000
2005	3	28	Indonesia	Off West Coast of Sumatra	2 074	97 013	30	8 7		2000

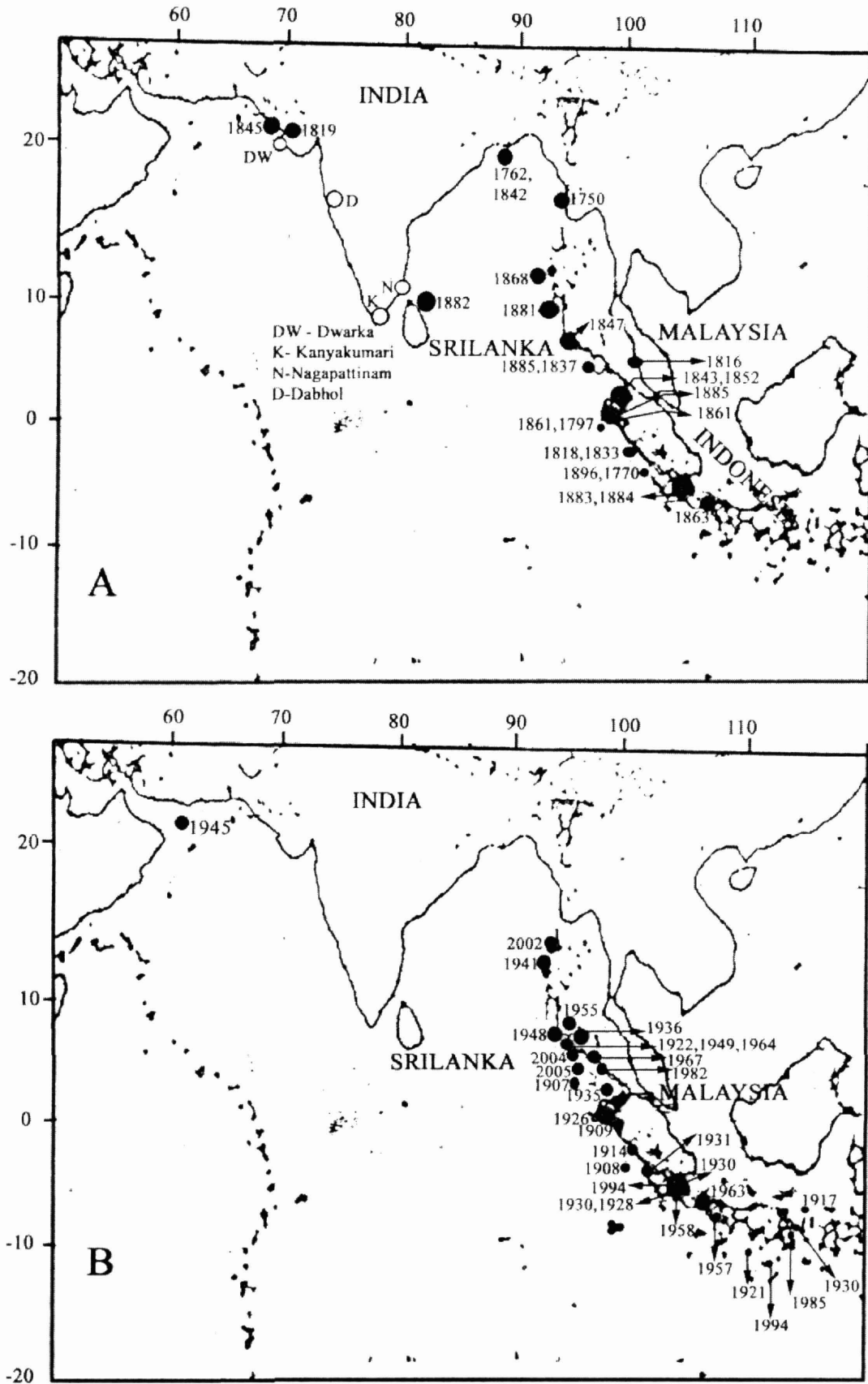


Fig.1. Locations of various tsunamigenic events in Indian Ocean are given. (A) Tsunamis before 1900. (B) Tsunamis after 1900.

on 26<sup>th</sup> June 1941 ruptured the Andaman plate boundary and caused much loss of life along the east coast of India. Part of Cellular Jail, a large masonry structure, near Port Blair, collapsed. Slumping, liquefaction and sand venting were recorded by eyewitnesses.

The earthquake that originated in the Oman sea off the coast of Baluchistan on November 27, 1945 created 12 m high waves along the Mekran coast and struck even Mumbai (1600 km far) where the waves rose 2 m high. This also affected the coasts of Sri Lanka and Malagasy Islands. Recently on 26<sup>th</sup> December 2004, a destructive tsunami of Indian Ocean was generated due to the second largest earthquake of the world ever recorded since 1900 (Mw 9.3), occurred off the west coast of Northern Sumatra. The tsunami generated waves up to 3-10 m high and inundated upto a distance of 0.1-4 km in coastal countries of Indian Ocean. A weak tsunamiogenic but the second largest earthquake in the world since 1964 (M 8.7) occurred on

March 28, 2005 at shelf region of western coast of Northern Sumatra. Only a weak tsunami of 3 m high wave hit the Simeulue Island. It would be beneficial to research and study the descriptions of past tsunamis from the rich literary works of Indian languages, court records and related ancient writings and also conduct field checks where necessary to build up a more reliable chronology of Indian Ocean tsunamis.

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## Announcements

### NATIONAL SEMINAR ON HYDROLOGY

The Association of Hydrologists of India in collaboration with the Department of Applied Geology, AC College Campus, University of Madras, is organizing the above seminar during 24-25 August 2006 at Chennai to coincide with its Silver Jubilee Celebrations. A special colloquium devoted to the topic of 'Impact of Heavy Rain Flows on Rural, Urban and industrial establishments and civic facilities' will form a part of the national seminar. For further details, please contact Prof. P.N. Ballukraya, Department of Applied Geology, University of Madras, AC College Campus, Guindy, Chennai - 600 025. **Phone:** 044 22200573 ext. 240 (O), 24956324 (R), **Email:** ballukraya@yahoo.com with CC: ahivisakha@hotmail.com

### ADVANCED TRAINING PROGRAMME ON MINERAL DEPOSIT MODELLING

A DST sponsored short-term training programme on Mineral Deposit Modelling is scheduled during 12-27 September 2006 at the Department of Geology, University of Jammu, Jammu. For details, please contact Dr. Pankaj K. Srivastava, Course Coordinator, Department of Geology, University of Jammu, Jammu - 180 006. **Phone:** 0191 2472850 (R), **Email:** srivastav\_pk@rediffmail.com, mdm\_geol@rediffmail.com. **Website:** [http://www.jammuuniversity.in/wd/Mineral doc](http://www.jammuuniversity.in/wd/Mineral%20doc)

### INTERNATIONAL CONFERENCE ON GEO-ENVIRONMENT: CHALLENGES AHEAD

The Jammu University Geology Alumni Association and the Postgraduate Department of Geology, University of Jammu are organizing the above conference during 23-25 April 2007 at Jammu to commemorate the centenary of the Geology Department. For further details, please contact Dr. G.M. Bhat, Organising Secretary, International Conference, Postgraduate Department of Geology, University of Jammu, Jammu - 180 006. **Phone:** 0191-2456497, 2452987, Fax: 0191-2452987. **Email:** bhatgm@jugaa.com, jugaa@jugaa.com. **Website:** <http://www.jugaa.com>