events may be a part of the pan-African package. However, these issues will remain unresolved until more isotopic age data becomes available. It was felt that the combined laboratory facilities and resources of the assembled group (Electron microprobe, geochemistry, petrology and geochronology) would be able to address some of the issues raised during this field workshop if coordinated properly.

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HIGH WAVE ACTIVITY OF THE TAMIL NADU COAST IS DUE TO AFTERSHOCKS INDUCED SEICHING EFFECTS

Recently the seashores of Chennai, Ennoor, Thiruvotriyar, Cuddalore and Kanyakumari were lashed by high waves during the period from the late night of the full moon day on 19th to 22nd August 2005. The usual height of low tide and high tide waves observed along the coast are always between 0.2 m and 0.7 m respectively. During the high wave activity waves rose to the height of 1.0 to 1.3 m along the Tamil Nadu coast, unlike tsunami which rose to heights between 1.5 to 3 m. After the December 2004 tsunamigenic Sumatra earthquake, the subsequent train of aftershocks resulted in the agitation of sea water so as to form oscillatory waves known as seiches. Such oscillations in sea water generated at Sumatra-Andaman region were reaching the coastal regions of Tamil Nadu after one or two days as seiches.

A seiche is a standing wave and can be considered as the sum of two progressive waves, travelling in opposite directions. Seiches can occur in lakes or bays due to storms, landslides and also earthquakes. During the seiching effect at either side (or) coast of the lake or bay, water level is alternatively high and low, whereas in the middle water level remains constant. Seiching effect may persist across the basin for hours (even more than 11 hours) with periods of oscillation between 10-17 minutes. Sieches are shallow water waves capable of inducing high wave activities along the coasts (Brown, 1991; Radhakrishnan, 1997; Beer, 1997; Abbott, 2002; Spencer, 2003).

On 19th August 2005 at the Marina Beach of Chennai, near Vivekanantha Illam, the sea inundated the beach up to 1 km and formed a pond. Similarly inundation of 150 m at Cuddalore, 200 m at Thiruvotriyar, sea water entered into 100 houses at Sivagaminagar of Thiruvotriyar, erosion of metal road at Ennoor and deposition of 10 cm of sand on the Thiruvotriyar beach road due to high wave activities were reported. At Cuddalore, Devanampattinam Silver Beach, the high wave activity started at morning 8 AM on Saturday 20-8-2005. Sea rose more than 1 m high and again attained the normal state by 11 AM of that day and high wave activity persisted for 3 hours. Again on Monday morning 22nd August 2005, sea waves more than 1 m at Ennoor and Thiruvotriyar coastal areas with inundation of houses on coastal streets up to 200 m towards land. During the above period, the sea was rough at Kanyakumari coast, though there was no remarkable inundation, though erosional activity of the beaches was intense.

Following the aftershocks experience in Sumatra (Indonesia) and Andaman regions during 29th August to 2nd September (Table 1), another event of unusual high wave activity was observed at Chennai, Ennoor, Cuddalore and Kanyakumari coastal areas on 3rd (new moon day) and 4th September of 2005. At Marina beach, the sea receded 50 m while high wave activities were going on at Ennoor and waves rose to a height of more than a metre. It was also observed that after 18 hours of calmness, again the high wave activity started along the coast on early morning of 5th September 2005 and was active up to 8 AM of 6th September 2005. The inundation now was 40-60 m along

Fig.1. High wave activity on 29th June 2005 inundating a coastal settlement near Rayumanthurai village, Kanyakumari district of Tamil Nadu.

Table 1. Aftershock* events (M>4) and periods of high wave activity

M	Location: Latitude (degree)	Location: Longitude (degree)	Depth of epicentre (km)	Place of occurrence	UTC time h m s	Date	Days of high wave activity (HWA) IST
No earthquake (M>2 5) occurred on 4th September 2005							No HWA from 6th Sept 2005
5 1	3 808	102 653	98 9	Southern Sumatra	16 56 08	03-09-2005	
5 3	2 449	98 883	148 9	Northern Sumatra	08 04 05	02-09-2005	
4 7	1 076	97 390	22 3	Nias, Sumatra	01 15 44	02-09-2005	HWA from 8 pm
5 3	5 054	97 713	30 0	Northern Sumatra	16 42 39	01-09-2005	3-09-2005 to
4 7	2 818	96 026	30 0	Simeulue, Sumatra	10 39 12	01-09-2005	11 am 4-09-2005
5 0	2 659	128 251	58 5	Halmahera, Indonesia	09 56 15	01-09 2005	After 18 hours
4 5	-1 856	99 425	30 0	Kepulauan, Mentawai	21 28 05	30-08-2005	HWA started on
5 3	-1 715	99 548	30 0	Indonesia	20 59 09	30-08-2005	5th early morning
5 3	-2 348	138 230	39 3	Papua	19 53 55	29-08-2005	end at 8 am on
5 2	0 336	97 723	25 1	Nias	17 40 18	29-08-2005	6-09-2005
5 4	11 014	92 290	40 5	Andaman	14 44 48	29-08-2005	
No earthquake (M>2 5) occurred for the period 20-24 August 2005							No HWA after 22-08-2005
4 8	1 969	96 565	28 3	Nias region Sumatra	18 32 24	19-08-2005	No HWA on
5 4	2 634	128 072	61 9	Halmahera, Indonesia	15 48 20	19-08-2005	22-08-2005
No earthquake (M>2 5) occurred on 18-08-2005							No HWA on 21-08-2005
5 0	1 976	97 783	30	Nias region, Sumatra	07 43 48	17-08-2005	No HWA on
4 2	22 704	93 913	10	Myanmar India border region	06 25 14	17-08-2005	20-08-2005
5 0	-8 846	124 143	15	Kepulauan Alor, Indonesia	17 04 13	16-08-2005	
4 4	0 127	121 956	197 9	Minahasa, Indonesia	19 22 33	15-08-2005	No HWA on
4 7	1 050	97 156	20 0	Nias region, Sumatra	17 18 27	15-08-2005	19-08-2005
4 8	-3 957	140 356	35 0	Papua, Indonesia	10 49 39	15-08-2005	

* *All the earthquake data is from USGS source (http //earthquake usgs gov)*

the Tamil Nadu coast Since there was no report on meteorological disturbances like strong winds/storms (Baba, 2005) and generation of tsunami waves (Narayana and Tatavarti, 2005), we surmise that these abnormally high wave activity (i) from 19 to 22 August 2005 and (ii) from 3 to 6th September 2005 were due to seiching effect produced by aftershocks events from Sumatra-Andaman regions (Table 1).

It is well known that seiches may develop at great distances from epicenters of earthquakes It is our conjecture that the aftershocks events highlighted in Table 1 could be the cause for the freak wave activity (seiches) on the Tamil Nadu coast for the following reasons

1. During this period no major meteorological disturbance/no strong wind activity/no tsunami generation were reported.
2. The time of occurrence of high waves is consistent with the seiches produced with time lag of one or two days after the aftershocks in Andaman-Sumatra regions
3. Sea level rise and fall, i e inundation and recession are due to the oscillatory action of the seiching phenomenon.
4. The periodicity of high waves were of the order of 10-15 minutes and activated for about 3-24 hours duration. More than 10 tsunami waves for a seismic event are not common.
5. Similar high waves aslo formed on the days between full moon and new moon also I,e (i) 10-11 March, (ii) 17th-27th May, (iii) 29-30th June,(Fig 1) and (iv) 25-27 July of the year 2005.
6 During high wave activity water rose more than 1 m along the coastal belt of Tamil Nadu.
7 Sea recession (40-90 m) was also witnessed at

Tuticorin, Thiruchendur, Marina of Chennai and Kanyakumari during the period of high wave activity in other areas

8 The high wave activity were also reported from the west coast of India and also from Sri Lanka, Andaman and Sumatra regions for the above periods

9 Aftershocks followed by the generation of coastal sea high waves (Seiches) are demonstrably correlatable

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NEED TO INVESTIGATE COASTAL MARINE SEDIMENTS TO STUDY THE IMPACT OF TSUNAMI

This note intends to draw the attention of marine geoscientists towards the potential of coastal marine sediments in understanding the impact of tsunami associated with Sumatra earthquake A series of travelling ocean waves generated by the geological changes near or below the ocean floor create a tsunami The ground surface gets displaced due to tremors underneath The slosh on the ocean floor sets off the tsunami Such displacement sends the water radially outward in circles from the epicenter which gets translated into a deep wave, that travels horizontally at extremely high speeds and attains great heights As the waves approach the shore, they rise further and engulf the coastlines with enormous power (energy) Such high energy waves also recede as quickly as they had surfaced The catastrophic Sumatra earthquake created destructive tsunami waves on the Sunday (December 26, 2004), that devastated coastal areas far and wide

South and Southeast Asia including the southern and eastern coasts of India were hit by massive sea waves reaching up to 30 ft in height The Andaman and Nicobar area (Car Nicobar, Katchel and Campbell island) were severely affected by the tsunami surge This massive surge and the gigantic walls of water smashed into the coast line, washing away every thing in their path This resulted in the inundation of the coastal settlements and a reduction in the beach stretch of the island The back wash must have dragged and eroded sediments from beach/coastal regions

Such a higher energetic event might have caused significant changes in the marine environment in general and of coastal regions in particular Such physico-chemical changes must have been preserved in the coastal marine sediments as well Some reports speculate that bigger and deadlier tsunamis often known as mega-tsunamis occur every 1,00,000 years and the last one occurred around 1,10,000 years ago thereby hinting that another mega tsunami might take place any time in the coming 10,000 years Similarly in a recently published report (*Nature*, 20th January, 2005), it has been warned that there is a possibility of further powerful earthquakes both to the north and south of the event that occurred on 26th December, 2004, perhaps within a decade which may cause another tsunami These speculations do not allow us to feel relaxed

Following Hutton's principle "Present is key to past and past is key to future" the study of the impressions left over by the killing waves (tsunami) on the coastal marine sediments looks significant first to understand In the quest for such signals and information, geological investigations