

## Western Mediterranean and North Atlantic tsunamis: inventory and analysis of tide gauge data

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## Tsunamigenic events studied

Date	Place	Time	Source Localization	Magnitude
01/11/1755	LISBONNE (Portugal)	10h16 (TU)	still controversial	8.7
26-27/08/1883	KRAKATOA ( Indonesia)	Among main explosions: 26/08, 17h00 (TU+7) 27/08, 05h28 (TU+7) 27/08, 06h36 (TU+7) 27/08, 09h58 (TU+7)	volcanic eruption 06°06' 07" S 105°25' 23" E	
18/11/1929	GRANDS BANCS (Terre Neuve)	20h32 (TU)	44,69°N 56,00°W	Mw = 7.2
25/11/1941	ACORES -GIBRALTAR line	17h04 (TU)	37,40°N 19,00°W	8.2
22/05/1960	VALDIVIA (Chili)	19h11 (TU)	38,29°S 73,05°E	9.5
28/02/1969	ACORES -GIBRALTAR line	02h40 (TU)	south of the Gorringe Bank	8.0
07/09/1972	ILE D'OLERON (France)	22h26 (TU+1)	45°55' N 01°13' W	5.7
26/05/1975	ACORES -GIBRALTAR line	unknown	35,9°N 17,5°W	7.9
26/12/2004	SUMATRA (Indonesia)	00h59 (TU)	03°30' N 96°00' E	9.1

#### Table 1: tsunamigenic events studied for the North-East Atlantic

Date	Place	Time	Source Localization	Magnitude
21/08/1856	DJIJELLI ( Algeria)	not well known	300 km east to Algiers	7.2
23/02/1887	RIVIERA ITALIENNE (Ligurian sea)	05h21 (TU)	43°42' N 08°03' E	6.5
28/12/1908	MESSINE (Sicilia)	between 05h20 and 06h00 (local time)	Messine strait	7.2
09/09/1954	ORLEANSVILLE (Algeria)	01h07 (TU+1)	not well determined	6.7
19/07/1963	LIGURIAN SEA	05h46 (TU)	80 km off San Remo	
16/10/1979	NICE	13h57 (TU+1)	airport landslide	
10/10/1980	EL ASNAM (Algeria)	12h25 (TU)	36° 17' N 01° 41' E	7.3
27/10/1985	CONSTANTINE (Algeria)	19h35 (TU+1)	not well known	5.9
21/05/2003	BOUMERDES (Algeria)	18h44 (TU)	36°43' N 03°47' E	6.7

Table 2: tsunamigenic events studied for the West Mediterranean

#### Methodology Data Treatment Processing Data analysis Results Frequency analysis Time-Frequency Analysis Tsunami Main Comparison to Data search (French Archives) Quality control Digitalization Detiding (Morlet Wavelets) Characteristics modelling **Analogical Data Digitalization of mareograms (Nunieau software)** Coupling Frequency analysis and Time-Frequency Analysis colour recognition (pixel) of the curve interest: discriminating tsunami oscillations from other phenomena Tide ladder observations oscillations. characteristics: - sampling rate = **1min** - length = [J-1, J+1 or end of the tsunami] Example of Nice signal following estimation of the digitalization quality the landslide of the airport on No significant tsunami oscillatior October 16th, 1979. No significant tsunami oscillatior No significant tsunami oscillatior No significant tsunami oscillatio Mareograms ...or numerical data (since 1998) Représentation Temps/Fréquence du signal filtré de la surcote representative of the **tsunami** Mark on shelter near tide gauge and Metadata: mareogram scales, 1,902 m Constitution of well referenced series time zone and time scale resetting (UTC or UTC+1) instrumentation. specificities, Zero NGF « île du Planier » altimetric resetting (chart datum) using meta data localization of the tide gauge within Secondary frequency = 2 mHz representative of ship induced the harbour, configuration of the comparison to predictions, meteorology, correction 15 20 Temps [h] à partir du 16 Oct 00:00(TU+1) harbour, ... of time shifts and drifts. Tide gauge zero after April 1964

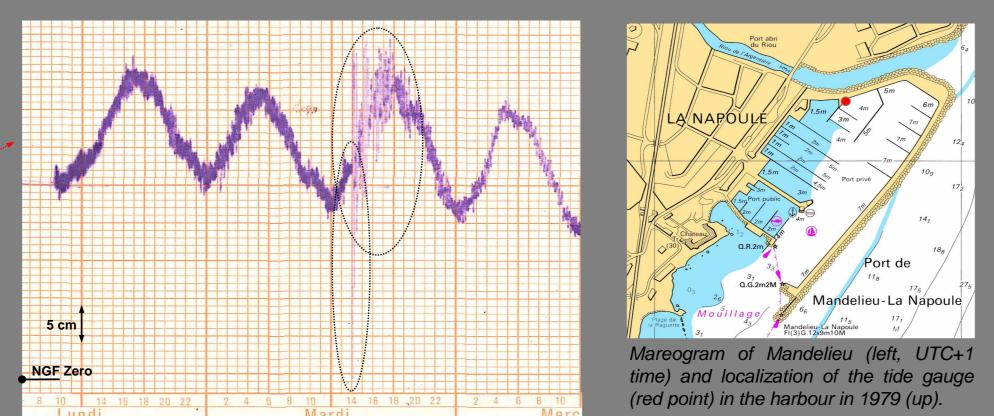


(October 16th, 1979).

# El Asnam earthquake (1980)



## **Examples on the Mediterranean Coast**



Amplitudes of tsunami oscillations recorded by tide gauges are weak (less than 10 cm), excepted for Mandelieu where 30 cm heights can be read on the mareogram. However, the entrance of the corresponding harbour (South East) is not in the direct propagation way of the tsunami (North West), and the localization of the tide gauge in the harbour is quite sheltered.

analysed by classical

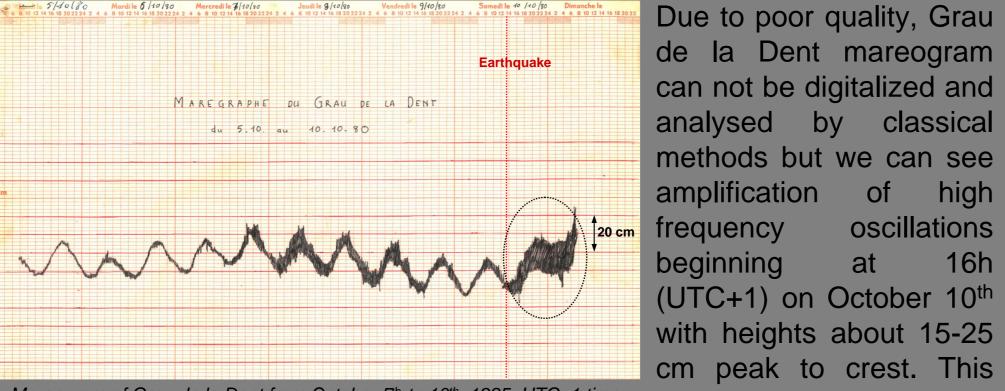
methods but we can see

amplification of high

(UTC+1) on October 10th

with heights about 15-25

oscillations



cm peak to crest. This Mareogram of Grau de la Dent from October 5th to 10th, 1985. UTC+1 time. observed arrival time is in good agreement with the travel time calculation estimated by ray tracing (>160 hours). None of the other French usable data (Nice, Mandelieu, Ile du Planier) shows a tsunami mark. Yet, we know that this tsunami has been recorded on the Spanish coast with significant peak to crest heights (15-70

## Azores earthquake (1975)

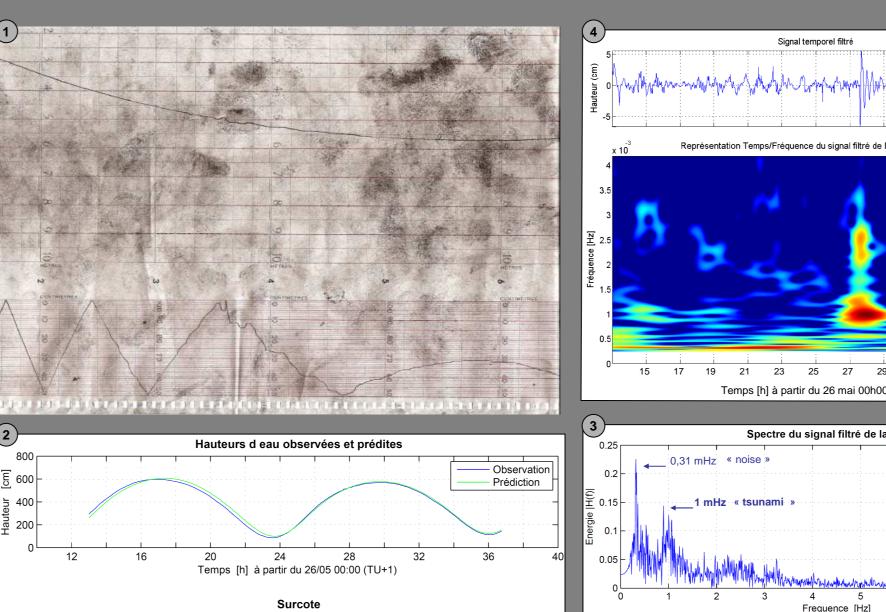


May 26<sup>th</sup>, 1975.

Among French available data, only La Rochelle tide gauge has recorded high frequency oscillations (period of 16-17 minutes) at 03h50 (UTC+1) on May 27th following the earthquake which occurred on May 26<sup>th</sup>,1975. The amplitudes are rather small (less than 10 centimetres) and the perturbation lasted less than two hours. The record has been done with a St Chamond-Granat tide gauge, which is a very precise instrument since it benefits from a double recording at a centimetric scale. Dated comments from the tide gauge observer have been found and have enabled to validate time and height settings of the sheet.

Unfortunately, as the hour of the earthquake is unknown, we can not deduce an observed travel time which could be compared to modelling results (travel time calculations).

### **Example on the Atlantic Coast**



detided serie, high pass filtered serie. (3) Frequency analysis. (4) Time-frequency analysis. (5) Map of the harbour with

localization of the tide gauge (red point). (6) (7) Tide gauge in place during May 1975.

20 24 28 Temps [h] à partir du 26/05 00:00 (TU+1) waythan main wardy and water and the same the same the same of the

emplacement du marégrapha Echelle: 15007

Analysis of the tide gauge observation in La Rochelle harbour following the Azores earthquake of May 26th, 1975. (1) Original nareogram (source : SHOM). (2) Analysis of the digitalized time serie : comparison to tide predictions, calculation of the

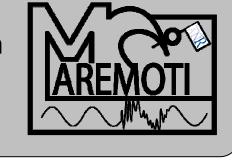
## Outcomes

- Giving an overview of the valuable potential of historical data of sea level observations for tsunami application.
- Improving French tsunami databases adding tide gauge observations to their historical reports and
- Supplying specific tables of tide gauge observations for the future French tsunami warning system to numerical models and pre computed
- Providing tide gauge data to discuss source parameters in case of seismic events.

#### Acknowledgements

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