



California  
Department of  
Conservation

California Geological Survey Seismic  
Hazards | Tsunami Unit

# City of Alameda

## Tsunami Awareness and Preparedness

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## Tsunami Basics

## Tsunami Sources

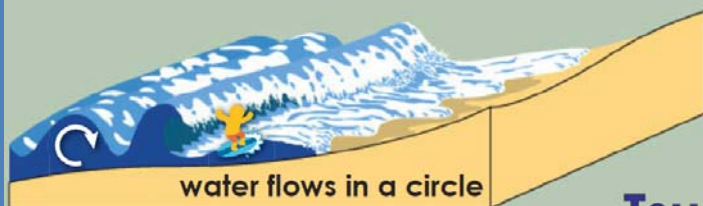
## California Tsunamis

## Tsunami Maps



## Regular Waves

- waves come and go without flooding higher areas



Can I surf a tsunami?

**No! Tsunami waves  
are very different than  
regular waves**

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## Tsunami Waves

- dangerous, unpredictable, and no face to surf
- waves flood the land like a wall of water



**A tsunami always has many waves/surges**

**This first wave is almost never the largest**

**The danger period can last 24 hours or more!**

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# What does a tsunami look like?



Caltrans

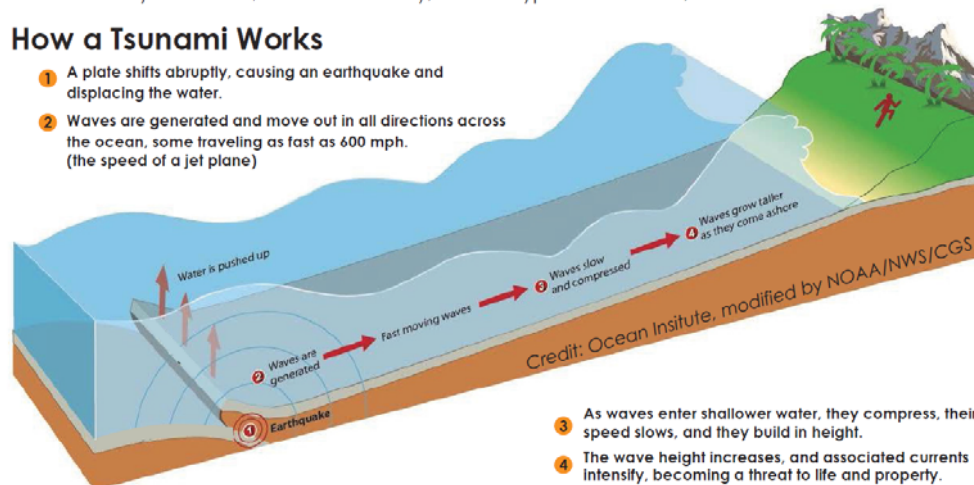
## Most tsunamis are caused by earthquakes below the ocean floor



Most tsunamis are caused by large earthquakes below the ocean floor, but they can also be caused by landslides, volcanic activity, certain types of weather, and asteroids or comets.

### How a Tsunami Works

- 1 A plate shifts abruptly, causing an earthquake and displacing the water.
- 2 Waves are generated and move out in all directions across the ocean, some traveling as fast as 600 mph. (the speed of a jet plane)

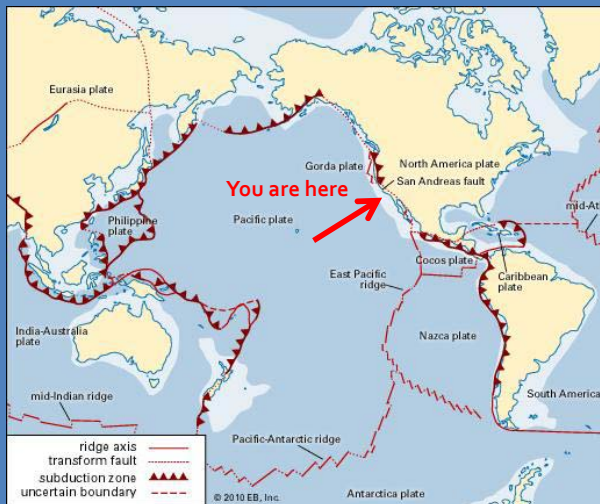


- 3 As waves enter shallower water, they compress, their speed slows, and they build in height.
- 4 The wave height increases, and associated currents intensify, becoming a threat to life and property.

Caltrans

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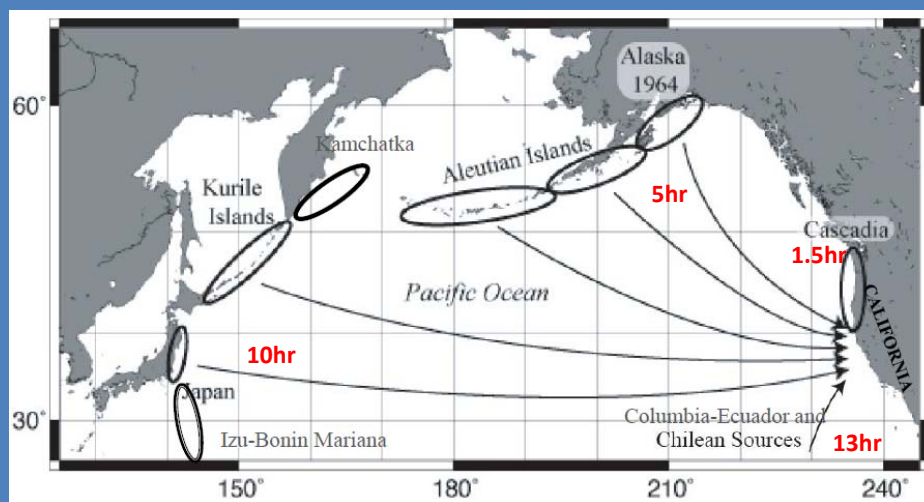
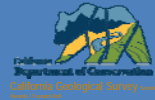
# Where do tsunamis come from?



*Distant source tsunamis*  
*Local source tsunamis*

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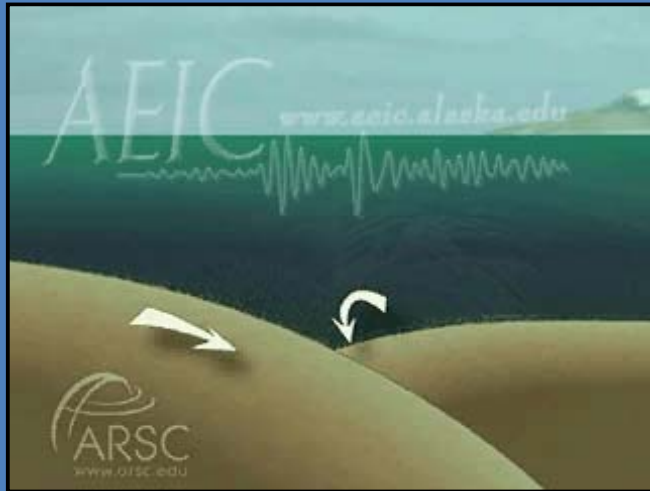
## Distant Source Tsunamis Travel times to City of Alameda



California Department of Conservation Communication Center



## Distant Source Tsunamis



Large subduction fault zones produce tsunamis strong enough to cross ocean



## Distant Source Tsunamis



Earthquake will not be felt

Tsunami will arrive in 5-13 hours

There will be official notifications

**Action: partial to full evacuations**

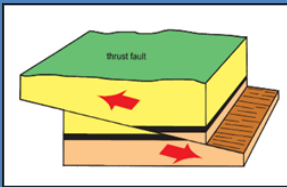




## Local Source Tsunamis



Tsunamis can be generated by sudden upward or downward movement along underwater faults.

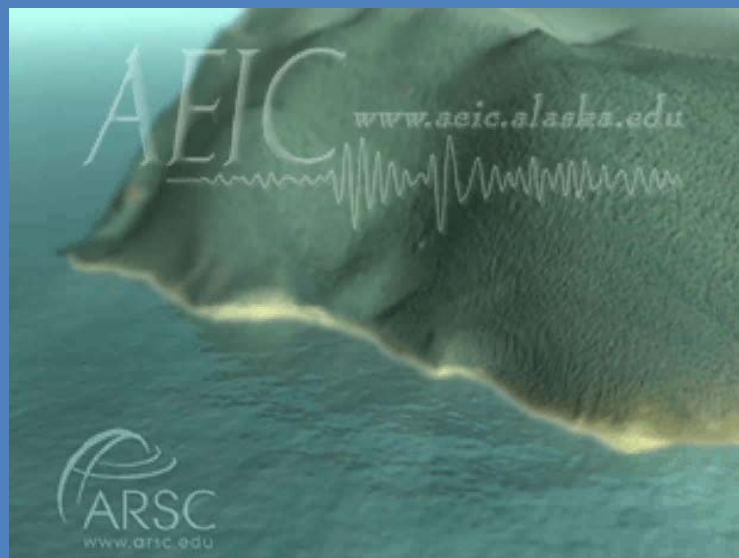


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## Local Source Tsunamis



Earthquake triggered submarine landslide



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## Local Source Tsunamis



Earthquake will be felt

A tsunami could arrive in minutes

There will be no official notifications

**Action: Go to higher ground or go inland**



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## Significant Historical Tsunamis in California



Eight significant distant source tsunamis over past 70 years

1946, 1952, 1957, 1960, 1964, 2006, 2010, and 2011

Each of these events caused damage in California.

1946, 1960, and 1964 caused on land inundation.

Local tsunami events are less common but the most significant one was 1700 Cascadia (no written US record).



1946 – Half Moon Bay

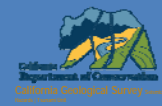


1960 – Crescent City

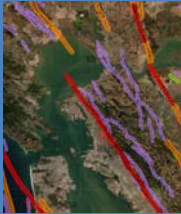


1964 – Crescent City

## Notable Historical Tsunamis in the San Francisco Bay Area



- Local Source -  
Earthquake and tsunami  
together



- Distant Source -  
Tsunamis without felt  
earthquakes



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Date	Magnitude-Source area	Tsunami location	Run-Up/Amp	Remarks
2/15/1856	M5.5 - SF Bay (possible submarine landslide)	San Francisco	3 ft	"...water in the bay is exceedingly thick...by throwing up of mud and sand at bottom of bay..."
8/13/1868	M8.5 - Chile	SF-Fort Point	1 ft	NR
10/21/1868	M6.8 - Hayward Fault (possible submarine/subaerial landslide)	SF-Cliff House	OBS	"...decided commotion in the ocean...wave sent inland..."
3/31/1898	M6.2 - Hayward-Rodgers Creek Fault crossing Suisun Bay	Oakland	1 ft	"churned" water may be from storm activity, not tsunami
4/1/1946	M8.8 - Aleutian Islands	SF-Presidio	1 ft	NR
11/4/1952	M9.0 - Kamchatka	San Francisco	2 ft	NR
		Alameda	1 ft	NR
3/9/1957	M8.6 - Aleutian Islands	San Francisco	1 ft	NR
5/22/1960	M9.5 - Chile	San Francisco	2 ft	San Francisco ferry service disrupted by a current "running like the Mississippi River"
		Alameda	1 ft	NR
		San Francisco	4 ft	NR
		Alameda	2 ft	NR
3/28/1964	M9.2 - Alaska	Oakland	4 ft	NR
		San Rafael	4 ft	Multiple docks damaged; boats sunk and damaged
		Sausalito	6 ft	Docks/boats damaged; minor inundation on dry land
2/27/2010	M8.8 - Chile	San Francisco	1 ft	NR
		San Francisco	2 ft	Two piles broken; boats heeled over
		Alameda	2 ft	4-6 knot currents but no damage reported
3/11/2011	M9.0 - Japan	Berkeley	2 ft	\$80K in damages to docks and piles
		Richmond	1 ft	5-6 knot currents with buoys displaced
		Sausalito	4 ft	Minor damage to house boats and marinas

## Tsunami Inundation Maps

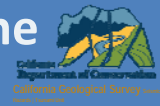


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## Tsunami Source Scenario Model Results for the San Francisco Bay Area



	TSUNAMI SOURCES	Approximate Travel Time	Pacifica	Ocean Beach	Black Point-Aquatic Park	Candlestick Park	Alcatraz Island	Treasure Island	Yerba Buena Island	Redwood City	Alameda	Richmond	Mare Island	Sausalito	Bollinas
<b>Local Sources</b>	M7.3 Point Reyes Thrust Fault	10-15min	7	6	4	3	4	3	3	4	4	4	3	6	8
	M6.6 Rodgers Creek-Hayward Fault	10-15min	2	2	2	2	2	2	2		3	3	3	3	
	M7.1 San Gregorio Fault	10-15min	4	4	3	3	3	3	3		4	3	3	3	
<b>Distant Sources</b>	M9 Cascadia-full rupture	1hr	4	5	3	3	3	4	3		4	3	3	4	4
	M9.2 Alaska 1964 EQ	5hr	13	12	7	4	6	5	6		9	7	3	8	10
	M9.3 Alaska-East Aleutians	5hr	26	26	13	6	12	10	8	5	15	11	4	13	24
	M8.9 Central Aleutians I	5hr	9	11	6	4	6	5	4	4	9	7	3	7	7
	M8.9 Central Aleutians II	5hr	5	6	5	3	5	4	4		5	4	3	5	7
	M9.2 Central Aleutians III	5hr	18	22	11	6	10	8	7	5	16	10	4	10	19
	M8.8 Kuril Islands II	9hr	3	3	3	3	3	3	2		5	3	3	4	3
	M8.8 Kuril Islands III	9hr	4	4	3	3	3	3	3		4	3	3	4	5
	M8.8 Kuril Islands IV	9hr	5	5	3	3	3	3	3		4	3	3	4	5
	M8.8 Japan II	10hr	5	5	4	3	3	3	3		6	3	3	3	4
	M8.6 Marianas Trench	11hr	3	3	3	3	3	3	3	4	3	3	3	6	3
	M9.5 Chile 1960 EQ	13hr	5	6	3	3	3	3	3		5	4	3	5	5
	M9.4 Chile North	13hr	4	5	4	3	4	4	4		6	3	3	4	5
<b>Maximum Runup - Local Source</b>			8	6	3	3	4	4	4	4	5	4	3	7	9
<b>Maximum Runup - Distant Source</b>			20	24	12	6	12	10	9	6	18	10	4	11	22
<b>UPDATED Maximum Runup - Distant Source</b>			31	32	14	6	13	11	9	6	18	11	4	14	27

## Official Inundation Maps



tsunami.ca.gov  
myhazards.caloes.ca.gov  
TsunamiZone.org

Local  
Evacuation  
maps

Counties/cities/tribal areas  
create their own evacuation maps

# Be Tsunami “Tsmart”



*Thank you!*

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