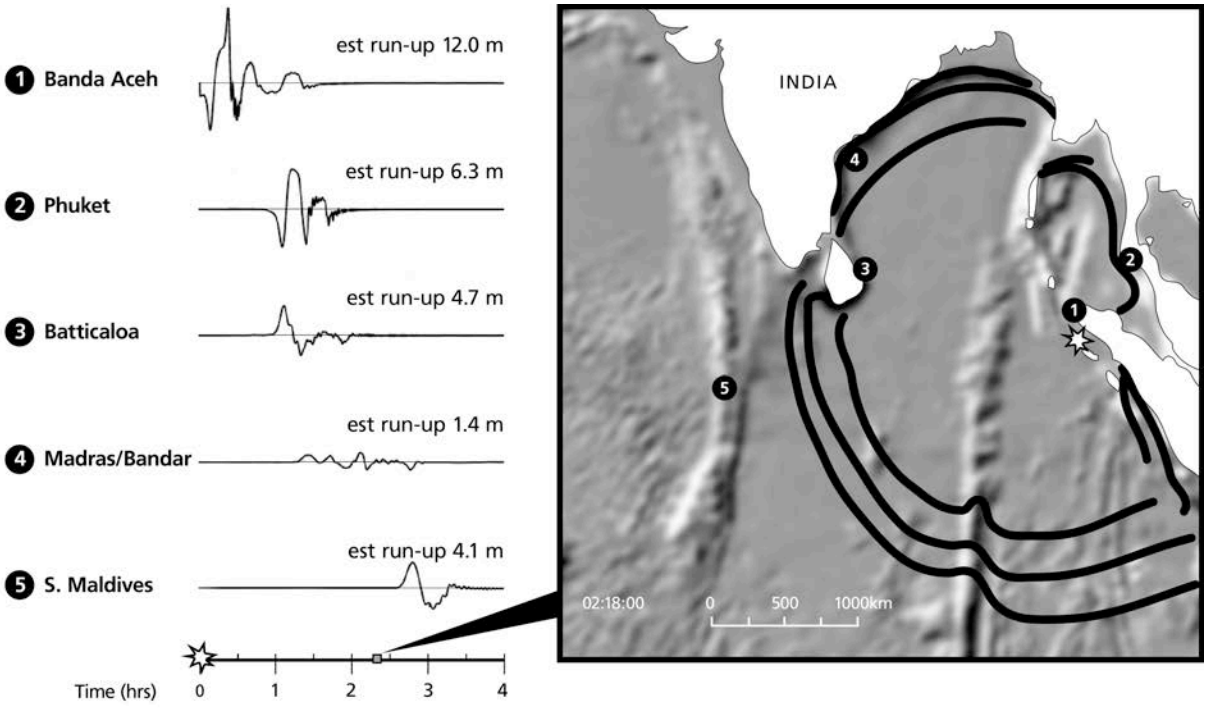
Question 1

The map below shows the area where the Boxing Day tsunami struck on the morning of December 26th 2004. Wave readings from weather stations located at major cities from the area are given on the left. From the recordings you can clearly see when the first wave struck each city. If the average speed of the tsunami in open water was 700 km h^{-1}, estimate where the tsunami originated.



1. Did your measurements indicate a single **point**, or an **area of origin**?

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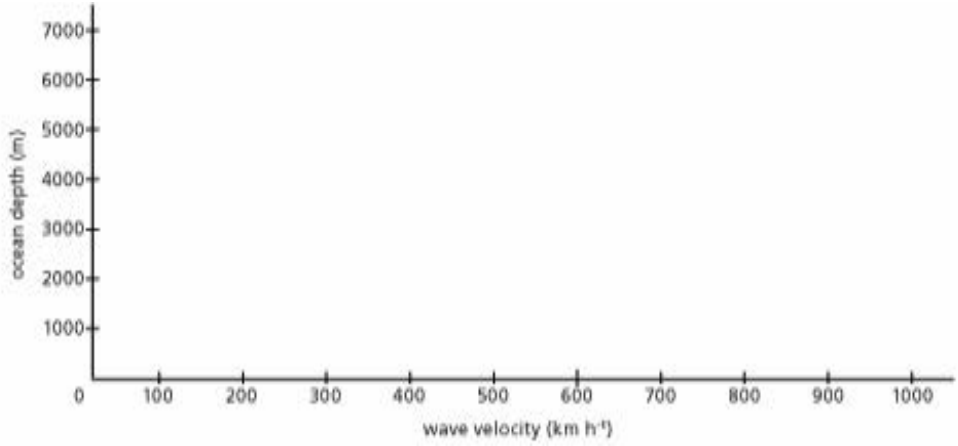
To correctly find where the tsunami started, we need to look at the nature of the wave. If it travelled at a constant speed we would be able to find the point of origin with just the information above. However, if its speed varied, things become more difficult.

Question 2

OCEAN DEPTH (m)	WAVE VELOCITY (km h^{-1})	WAVE LENGTH (km)
7000	943	282
4000	713	213
2000	504	151
200	159	48
50	79	23
10	36	10.6

The table above shows data collected from another tsunami. Use this data to plot the following graphs on the axes given below:

Ocean depth vs. wave velocity.



Ocean depth vs. wavelength.

What do your graphs tell you about how ocean depth influences the wave?

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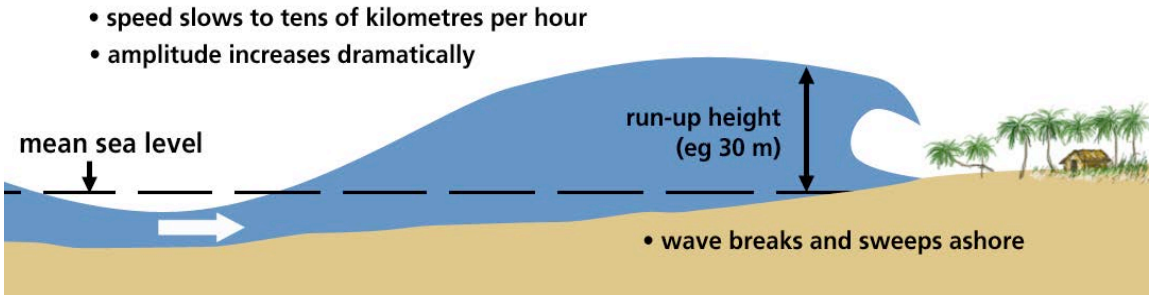
Question 3

The diagram below shows that **run-up** is the height of a wave as it reaches the shore.



3a. Run-up is caused by a decrease in water depth. What happens to the speed of a wave as the water depth decreases?

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3b. Assuming that total energy in a wave remains the same as it moves into shallow water, can you explain how the wave 'piles up' in the run-up as it slows down.

(HINT: Think about a pendulum and how the total energy is equal to the sum of the kinetic energy and the potential energy, $E_T = E_k + E_p$)

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3c. Is it reasonable to assume that a wave will not lose any energy in the situation described above? Explain your answer.

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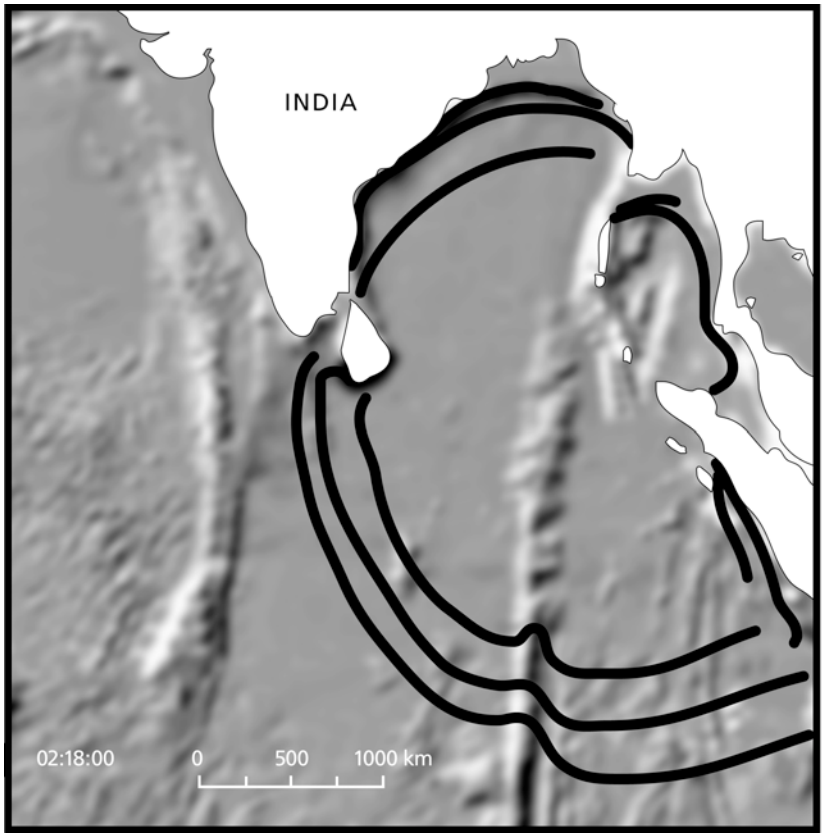
Question 4



Time: 2 h 18 min 00 s from the tsunami trigger event

The diagram above is based on a satellite photo taken two hours and 18 min after a huge earthquake triggered the 2004 Boxing Day tsunami. Heavy lines show waves as they spread across the Indian Ocean.

4a. Work out the point or area where the tsunami began and mark it on the map.

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4b. In the diagram the waves have been spreading out for two hours and 18 min. Using the distance scale provided, estimate the speed of the tsunami in open water (e g heading SW).

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4c. What appears to happen to the speed of a tsunami as the ocean becomes shallower?

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4d. From videos of tsunami events we know that a human can sometimes outrun a breaking tsunami wave. How does this compare to the average speed in the open ocean?

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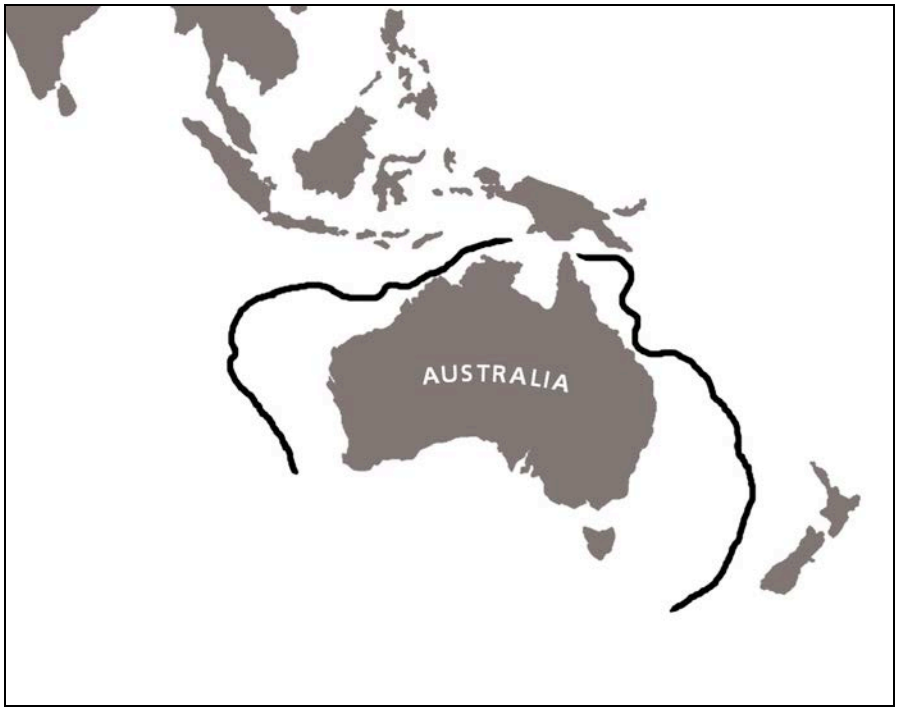
Question 5

The diagram below shows a line off the eastern and western coasts of Australia. The line represents the 90-minute warning line; that is, if a tsunami crosses that line it will strike the coast 90 min later.



5a. Explain why the line is not a constant distance from the coastline.

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5b. What does the shape of the line tell you about the speed of the wave and ocean depth?

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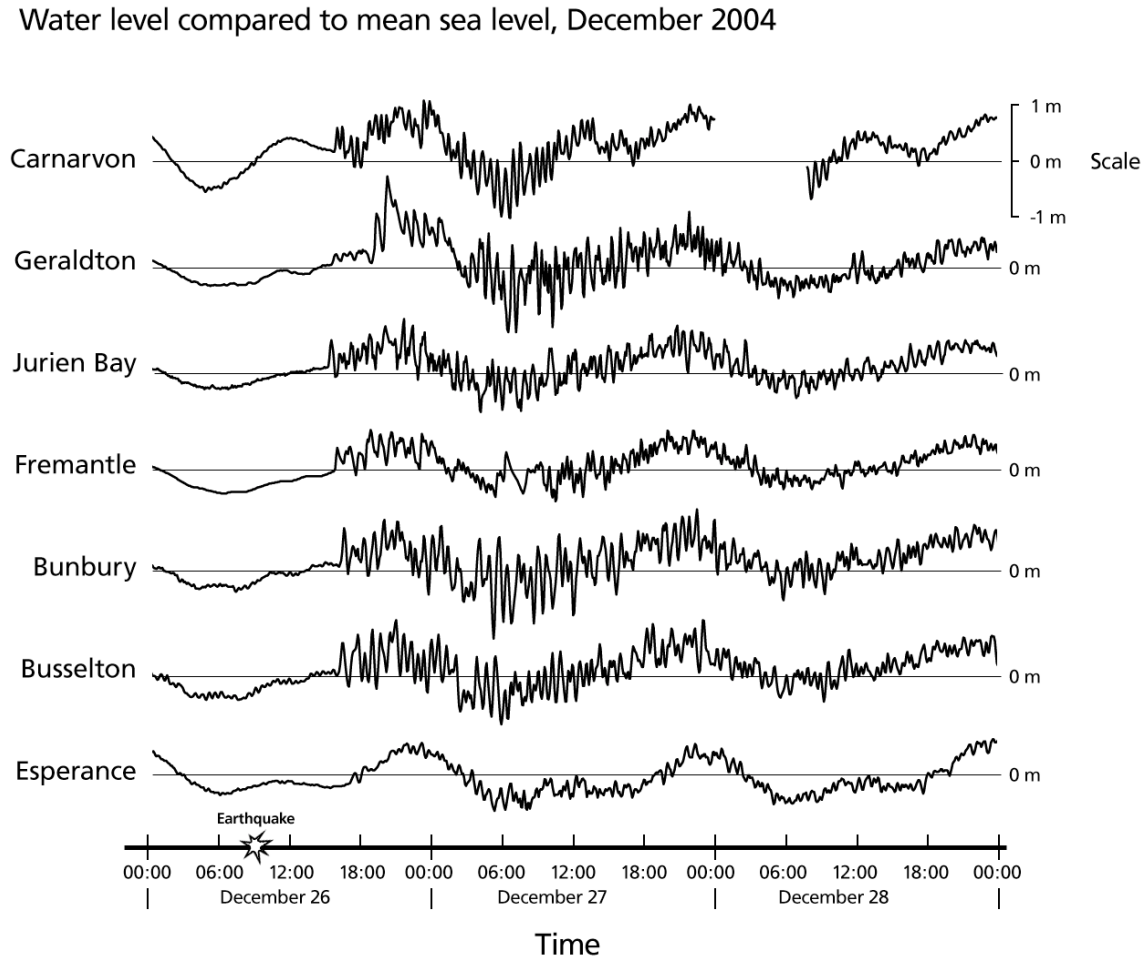
Question 6

The following diagram represents data from ocean-level gauges at a number of coastal towns across Western Australia.



6a. What do you notice about times when the waves hit these towns?

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6b. Is there a pattern to the arrival times? Is there an odd one out? Can you explain this observation?

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Question 7

A large number of tsunamis occur every year and many reach the Australian coastline. Infrequently, they do major damage and when a very large ones occurs, as one did on Boxing Day in 2004, they can kill large numbers of people and do enormous damage to towns, cities and economies.

7a. In what ways could scientists help to reduce the impact of large tsunamis?

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7b. How can governments assist scientists in this work?

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