Volcanic Hot Spots and Continental Drift

What role do volcanoes play in shaping the face of the earth? Can volcanoes give us clues to how continents are moving?

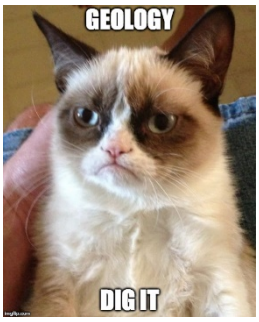
Our planet Earth is constantly changing. Over a time-span of millions of years new land-masses are being created while others disappear. Volcanoes are one of the most exciting and violent ways that new land masses are created. A volcanic hot spot is an area where heat from deep in the Earth escapes into the mantle (the layer of the Earth immediately below the surface). The high heat and pressure melts the rock into magma which can erupt through the surface of the Earth as a volcanic eruption. The large amounts of molten rock spewed forth cools forming new landmasses.

The Earth's crust is made up of giant tectonic plates which are constantly moving. As a tectonic plate moves over a volcanic hot spot, the intermittent eruptions create a chain of new lands. The Hawaiian Islands form just such a chain. **Geologists** can use radioactive dating to determine how old the ancient volcanic rocks are that make up each of the islands, then compare their age to how far apart the islands are to discover just how fast the underlying tectonic plates are moving!

Did you know?

The seven separate continents we see today were once part of a single super-continent called Pangea.

Pangea broke up into sections about 200 million years ago, and the continents have been drifting further apart every year since then.



The Problem: Tracking Hot Spots

Aim: Can you find out how fast a tectonic plate is moving?

Figure 1 shows a map of the Hawaiian islands that form a volcanic chain. The islands are remarkable in that the volcanic rocks that make up the islands are much younger than the surrounding ocean crust they sit on! The reason is this – the tectonic plates are moving, and this one has been moving above a hot spot from which magma (melted rock) spills out and forms the islands.

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If this is true, the islands should get older as we move along the chain, away from the currently active volcano Kilauea. The age of rock that makes up each island is given in Table 1. Your job as the resident geologist is to use this information to figure out exactly how fast the tectonic plate is moving.

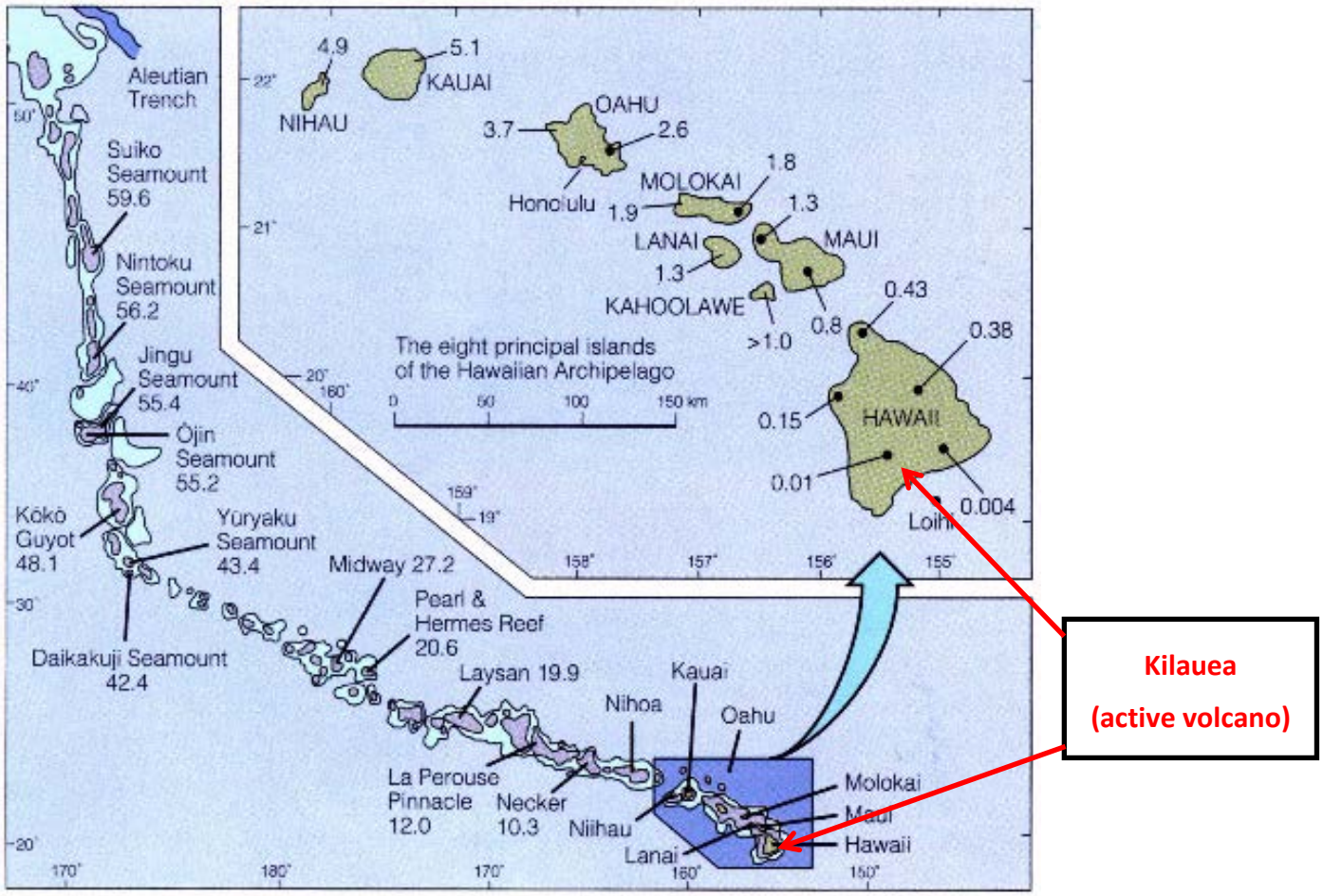
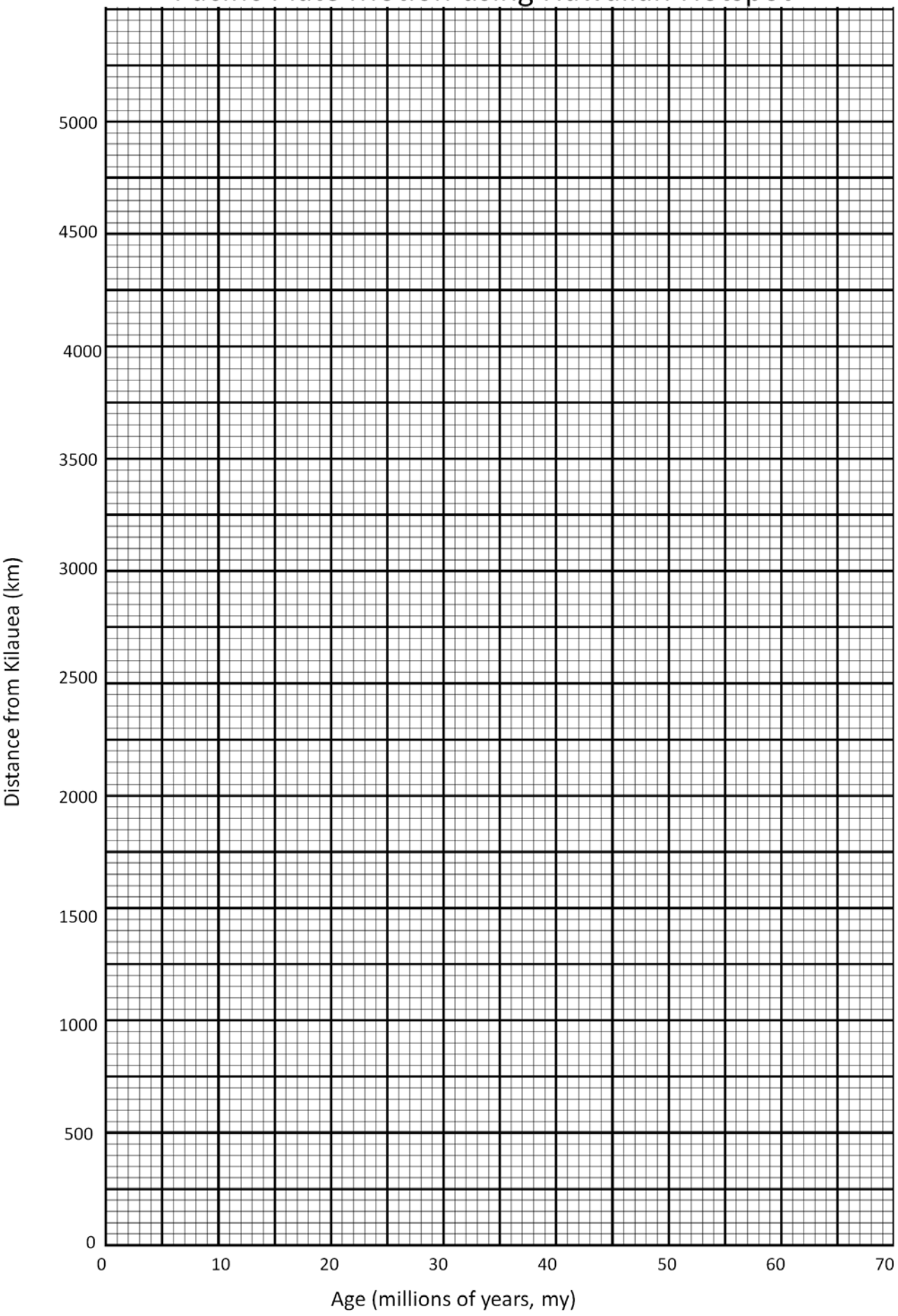


Figure 1: Map of the Hawaiian-Emperor Volcanic Chain.

Table 1: Ages of the Hawaiian islands compared to Kilauea, and distance from Hawaii (along the chain) of selected islands from the Hawaiian-Emperor Volcanic Chain.

ISLAND NAME	Number of years older than Kilauea (Millions of years)	Distance from Hawaii (km)	ISLAND NAME	Number of years older than Kilauea (Millions of years)	Distance from Hawaii (km)
Hawaii	0	0	Gardner Pinnacles	12.3	1435
Maui	1.3	221	Laysan	19.9	
Kauai	5.1		Midway	27.2	2432
Nihoa	7.2	780	Daikakuji	42.4	3493
Necker	10.3	1058	Nintoku	56.2	4452
Brooks Bank	13	1256	Suiko	59.6	4860

Absolute Plate Motion –
Pacific Plate Motion using Hawaiian Hotspot



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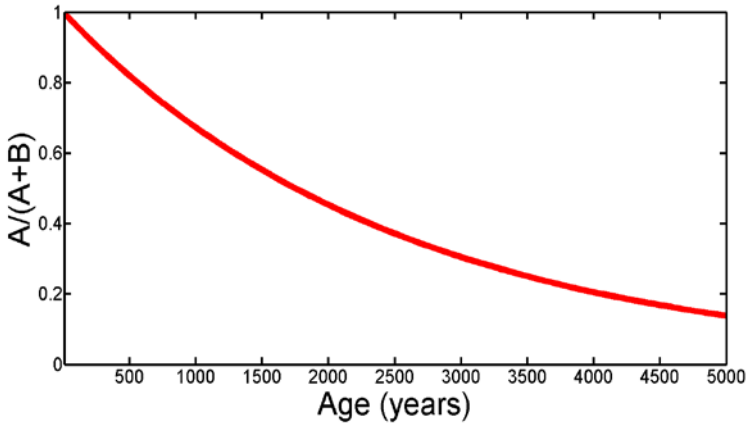
Want to watch and underwater volcano erupt?

Check out http://www.youtube.com/watch?v=hmMlspNoZMs

Challenge



Geologists and archaeologists use special techniques to figure out how old things are. One method is using "decay" – the changing of element A into element B over time. A common example is "carbon dating". By plotting the ratio $\frac{A}{A+B}$ with time, we get a "decay curve" like in the graph above.

An Egyptian mummy, identified as King Tutangowout, has just been unearthed, and it is up to you to figure out how long ago he was mummified. The embalming chemicals originally contained element A but no element B. An analysis today shows that there is now 3 parts of element B for every part of element A. Using the above decay curve, how old is the mummy? Hint: first find the ratio A/(A+B).

Puzzle

A young fellow goes to a bank with a cheque for $200 and says to the cashier: "Give me some one-dollar coins, ten times as many twos and the balance in five dollar notes!". What combination of coins and notes will the cashier give the fellow?

To gain **EXP** and level-up your mathematician, email your answers to the **Challenge** and **Puzzle** questions to Dr Greg at Gregory.Boyle@my.jcu.edu.au.

Q: What did one tectonic plate say when it bumped into another tectonic plate?

A: "Sorry, my fault!"