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TALK OF THE stars

with Professor Donald Kurtz

It snows in Hawaii. Strange as that sounds, the highest point of this tropical paradise, on the "Big Island" of Hawaii itself, is the dormant volcano, Maunakea, which stands 4,207m above sea level, where storms can produce snow in deep drifts and the brave can go skiing.

The summit of Maunakea is one of the world's best sites for astronomy and there are now 13 telescopes there, including the giant 8m Japanese "Subaru" telescope, which I have used for my own research observations.

Once I was working at the summit in June (northern summer!) when there was significant snow on the ground.

By some reckoning Maunakea is the highest mountain on Earth. While the peak of Mt Everest is 8,848m above sea level, far higher above sea level than Maunakea, Everest rises from the continent of Asia. Maunakea rises 9,330m from the seabed, making its "dry height" greater than that of Mt Everest. Maunakea and its neighbouring peak, Maunaloa, make up the most massive mountain on Earth.

But even that is small compared to the real champion mountain of the solar system, Olympus Mons on Mars (named after the mountain where the Greek gods lived), which stands 21,229m above the surrounding plains — more than twice the height of Everest or the dry height of Maunakea.

How do these massive mountains form? Why aren't they even bigger?

When the solar system formed 4.6-billion years ago, the planets Earth and Mars were created by the crashing together of asteroids. That created so much energy that the planets were initially molten. The heavy elements, iron and nickel, settled to the core, and lighter elements floated on top with oxygen and silicon making up 74% of the crust. The most common type of sand, such as on our beaches here in Port Alfred, is made of quartz — silicon dioxide, SiO2.

MARTIAN MOUNTAIN: Olympus Mons on Mars, the biggest mountain in the solar system — 600km across, 21,229m high. The apparently 'tiny' cliffs seen at the summit and at the base are 3,000m high — the size of the Drakensberg here in SA. ***Picture: EUROPEAN SPACE AGENCY – MARS EXPRESS***

The iron-nickel core of the Earth makes up half is diameter and is still molten in its outer part. The inner core is solid because of high pressure, 3.6 million atmospheres, even though it has a temperature of 6,000°C — as hot as the surface of the sun! Some of that heat is left over from the original time of formation — primordial heat — and the rest comes from radioactive decay of uranium, thorium, and potassium.

All that heat slowly works its way out so that the current interior heat losses at the surface are 47 TeraWatts, that is 47 million million Watts! That heat powers continental drift, volcanoes, earthquakes, and geothermal energy. The country of Iceland generates 8 GW (a GigaWatt is a billion Watts) from geothermal energy.

Compare that to the 1.9 GW that SA's Koeberg nuclear power station generates. And Iceland has only 364,000 people.

They live off the interior heat of the Earth.

As heat from the core of the Earth works its way up through the mantle, which lies between the molten core and solid crust, there are hot rising columns of rock that are "plastic" (deformable) under the extreme heat and pressure. Those rising columns push the continents around on "tectonic plates"; hence we have continental drift.

Below the Pacific Ocean, there is a rising column of hot mantle that has generated a "hot spot" in the crust under the Pacific Plate for tens of millions of years. That hot spot creates magma that erupts through the crust to build a volcano that eventually reaches to the ocean surface, then continues to grow higher and higher.

The Pacific plate is drifting to the northwest, so eventually the volcano is pulled away from the hot spot and become dormant, with the magma then erupting in a new spot and creating a new mountain and island.

All of the Hawaiian islands have been created this way. The garden island of Kauai is 5 million years old, then Oahu (home of Honolulu and Pearl Harbour), Molokai, Maui and the Big Island are progressively younger. Maunakea is now dormant, but Maunaloa is still active, and on its slope, Kilauea is one of the most active volcanoes on Earth. But they, too, will eventually shut down and a new Hawaiian island will break through the ocean surface. That is currently the Loihi seamount, 3,000m above the sea floor with another 1,000m to reach the surface.

So, Maunakea and Maunaloa have reached their maximum size. They are drifting off the hot spot. They have the maximum size a hot spot volcano gets here on Earth.

Mars is different. Because Mars is only half the size of Earth, its interior is not as hot, a mere 1.400°C. Mars loses its heat faster than the Earth does. This is a simple result of size.

Mars has more surface area compared to volume than the Earth does, so Mars cooled quickly after its formation. The result is that it does not have enough internal heat to drive plate tectonics — continental drift. But it does have enough heat for some hot spots that have generated huge volcanoes, with the biggest of all being Olympus Mons. In the absence of continental drift, it continued to grow and grow to its current height of 21,229m, but it is no longer active, has reached its maximum height.

Nonetheless, Olympus Mons is the current king of the mountains of the solar system and is likely to remain so.

● *Donald Kurtz is extraordinary professor at North-West University in Mahikeng. He has an A-1 rating from the SA National Research Foundation, its highest rating. He also holds appointments in the UK of emeritus professor at the University of Central Lancashire and visiting professor of astrophysics at the University of Lincoln. He was previously professor of astronomy at the University of Cape Town, where he worked for 24 years. Kurtz has more than 500 professional publications and was awarded the 2022 service award of the Royal Astronomical Society for a lifetime of public outreach and for his service on many international committees.*