

IN SEARCH OF THE BIGGEST IMPACT

Earth-Moon collision takes the prize

by Graeme Addison

If you're fascinated by impact craters I have bad news for you: there is no sign of the biggest-ever impact in the Earth's history. When our planet was forming, another half-formed planet came wandering by – our future Moon. The two bodies are thought to have collided and virtually remade each other. That's one prominent theory anyway. Another (highly unlikely) theory is that the Moon may have pulled away from the Earth as a giant chunk of matter, hurled off by centrifugal forces. Still another (more likely) theory is that the two bodies formed together as a twin planet out of space dust coalescing with the force of gravity.



To return to the first idea, which is widely embraced. If there was a giant impact, it happened very early in the period between 4.5 billion and 4.4 billion years ago when the Earth's major bulk grew from the accumulation of planetismals (including meteorites and asteroids). So did the Moon, and as the two bodies approached each other their mutual attraction led to the mightiest of all collisions. There is no sign of the impact today because basically the two planetismals reformed with new surfaces.

The Earth retired with heavy elements such as its molten iron core, along with lighter rocks forming the tectonic plates capped by continents. These plates float about on the surface crashing into each other and subducting back into the lava below. Meanwhile the Moon spun off having similar chemistry to the Earth, with many lighter rocks collectively called the regolith on its crust.

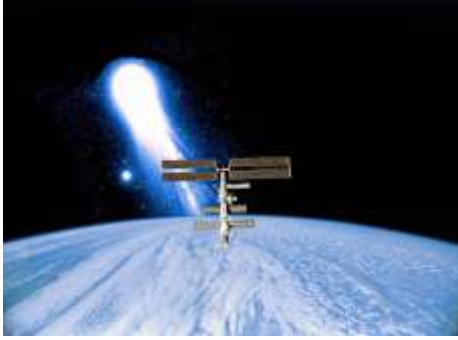
That's an impact theory of note, and the most likely explanation for the Moon's existence. But there are others. Did you ever think that maybe the Moon broke away from the Earth - and could have done so at Vredefort? It's a far-fetched theory indeed. Yet I can remember British popular astronomer Patrick Moore on a visit to Vredefort saying in a TV series that it was possible that the Moon had broken away from the Earth here. The huge plug of granite forming the Dome, he suggested, was evidence for the pulling-away of a large space body. That was in the sixties or seventies and I have never heard it mentioned again.

"By understanding lunar history, we may better understand the history of Earth", says Dr. Jennifer Edmunson in a 2009 [slide presentation](#).

The planetesimal collision theory is just that, a theory, but of all the explanations for the existence of the Moon it seems the most convincing because based on rock-hard evidence. Another theory was that the Moon was itself a planet that got captured by the Earth although it never hit. But that would not explain why the satellite is steadily pulling away from us (which the collision theory does help to account for). The Moon as a mini-planet probably hit the Earth a glancing blow and then spun off into orbit, moving steadily away as it continues to do today.

There is no sign of an Earth-Moon impact either on Earth or on the Moon. But actually we do have evidence of what could have happened, in the form of the Moon rock which was brought back by the Apollo astronauts in the 1970s. Much Moon rock is the same as the lighter rocks on Earth (ie our continents) and from this we can infer that as the re-

formed planetesimals broke apart, the smaller, lighter Moon drifted away carrying large amounts of Earth's surface and leaving the heavier bits - including the Earth's iron core - behind.



The heavier elements of the Earth's makeup sank towards the middle, becoming molten due to the heat from all the impacts, and friction caused by gravity. The theory that the Moon was expelled from Earth by a blast or centrifugal forces – the original Moore supposition – has limited plausibility. If a giant rock were to be shot out of the Earth (the theory of the “Verneshot”) it could not have been the size of the Moon.

Today if we look at the Vredefort scar it is certainly the biggest on Earth that we can see, some 230km across at its widest today (though it has been eroded down and might have been about 360km originally). This is far too small to have formed our Moon. Also, the Vredefort event occurred only 2.023 billion years ago – relatively late in the day – long after major bombardments by asteroids and comets had brought our seas and sculpted our mobile continents. The reason we can still see the enormous Vredefort crater so well is that it sits in the middle of a huge, rather inert shield of rock called the KaapVaal Craton. It has not been subducted under the continental plates like many other craters.

But its dates just do not tie up with the dating of the Moon rocks, so there is absolutely no foundation for a belief that the Moon broke away here. In any case, the crater (large as it is) is way too small to have been the womb of the Moon.

Still, the general theory that maybe the Earth expels huge chunks of itself in gas blasts is still very much around. I have been watching the work of the Kiel University planetary and geological scientists led by Prof Jason Phipps Morgan. Morgan hit the headlines in 2004 by announcing the theory of Verneshots named after science fiction writer Jules Verne who had speculated that it might be possible to shoot a rocket to the Moon out of a sort of cannon.

The Kiel group suggested that the Earth has been doing this, blasting bits out in mighty belches of gas. This is a more sophisticated version of the old “cryptoexplosion” theory that did the rounds for many decades to explain Vredefort. The Verneshot cannon principle was revived by scientists at the Geomar earth science institute at Kiel to explain mass extinctions. They speculate that 65 million years ago a huge eruption of gas took place from beneath the crust. This was not a volcanic event but a release of pressure.

Read about the theory of what may REALLY have killed the dinosaurs here and more about Jason Phipps Morgan [here](#). For an amusing take on the Verneshot theory go to the ExitMundi site, [here](#). The picture above is from ExitMundi. Incidentally, if planets produce their own meteors that hurtle out into space, how else could it happen except from megavolcanoes or Verneshots?

The Kiel group did not mention Vredefort but dealt with the extinction of the dinosaurs, which has mostly been associated with the Chicxulub impact 65 mya. So we can speculate that the hole in the crust that occurred at Vredefort may not have come from outside but from within it.

Though a Verneshot creating the Moon at Vredefort is certainly ruled out, the debates about what made the Moon – and Vredefort Dome – continue. There is 99% certainty that the Vredefort structure was caused by an asteroid impact, but still a 1% shade of doubt that it might have been a cryptoexplosion of some kind.

Though a cryptoplosion did not produce the Moon, such an explosion could have lobbed large chunks of Earth rock into space and caused mayhem on our planet itself, sending a shock wave around the Earth and creating vast

tsunamis in the seas. The “fingerprints” of such a blast could well resemble those of an asteroid impact, particularly if parts of the rock that were blasted out fell back to Earth forming a crater.

For a century past, it was thought that the Vredefort Dome was volcanic in origin, or caused by a blast from within the Earth. Only in the mid-1990s did geologists more or less reach consensus about it's being an impact crater or astrobleme (lovely word meaning *star scar!*).

Meantime, the Moon's origins are also being probed. It's amazing how much new research and informed inference is appearing about the Moon. Recently I've been subscribing to a Google news alert about the moon and it's fascinating how interest in our satellite has revived, with new research released almost daily. If using a Google search, make it for “The Moon” (not just “moon” because you pick up all sorts of junk about pop groups, restaurants and romantic nothings).

The Moon is back in focus probably because various Moon missions are being planned by the Chinese among others and there is currently a debate in the US as to whether to return to the Moon or go to Mars or the asteroids (or all of them, using the Moon as a staging base). Space tourism may well take numerous paying passengers to the Moon during the 21st century though I wouldn't bank on it before 2040 at least.