**What do we know about the origin of the earth's oceans? Is it more likely that they derive from icy comets that struck the young earth or from material released from the earth's interior during volcanic activity?**

https://www.scientificamerican.com/article/what-do-we-know-about-the/

**Tobias C. Owen of the Institute for Astronomy in Honolulu, Hawaii, offers this overview:**
"This is a very good question, because we do not yet have an answer that everyone accepts.

"The origin of the oceans goes back to the time of the earth's formation 4.6 billion years ago, when our planet was forming through the accumulation of smaller objects, called planetesimals. There are basically three possible sources for the water. It could have (1) separated out from the rocks that make up the bulk of the earth; (2) arrived as part of a late-accreting veneer of water- rich meteorites, similar to the carbonaceous chondrites that we see today; or (3) arrived as part of a late-accreting veneer of icy planetesimals, that is, comets.

"The composition of the ocean offers some clues as to its origin. If all the comets contain the same kind of water ice that we have examined in Comets Halley and Hyakutake- -the only ones whose water molecules we've been able to study in detail-- then comets cannot have delivered all the water in the earth's oceans. We know this because the ice in the comets contains twice as many atoms of deuterium (a heavy isotope of hydrogen) to each atom of ordinary hydrogen as we find in seawater.

"At the same time, we know that the meteorites could not have delivered all of the water, because then the earth's atmosphere would contain nearly 10 times as much Xenon (an inert gas) as it actually does. Meteorites all carry this excess xenon. Nobody has yet measured the concentration of xenon in comets, but recent laboratory experiments on the trapping of gases by ice forming at low temperatures suggest that comets do not contain high concentrations of the xenon. A mixture of meteoritic water and cometary water would not work either, because this combination would still contain a higher concentration of deuterium than is found in the oceans.

"Hence, the best model for the source of the oceans at the moment is a combination of water derived from comets and water that was caught up in the rocky body of the earth as it formed. This mixture satisfies the xenon problem. It also appears to solve the deuterium problem--but only if the rocky material out near the earth's present orbit picked up some local water from the solar nebula (the cloud of gas and dust surrounding the young sun) before they accreted to form the earth. Some new laboratory studies of the manner in which deuterium gets exchanged between hydrogen gas and water vapor have indicated that the water vapor in the local region of the solar nebula would have had about the right (low) proportion of deuterium to balance the excess deuterium seen in comets.

"The point to emphasize here is that this is a model, a working hypothesis that must be rigorously tested by many additional measurements. We need to study more comets. We also need to learn more about the water on Mars, where we have another chance to investigate the sources described above. On the earth, plate tectonics has caused oceanic water to mix considerably with material from the planet's interior; such contamination probably did not occur on Mars, where plate tectonics does not seem to occur. These investigations (and other related studies) are currently under way. This is an active area of research!"

**James C. G. Walker of the University of Michigan confirms that conclusion, adding his perspective:**
"The best current thinking is that volatiles (elements and compounds, including water, that vaporize at low temperatures) were released from the solid phase as the earth accreted. Thus, the earth and its oceans and atmosphere grew together.

"During accretion, the kinetic energy of the colliding planetesimals was converted into thermal energy, so the earth grew extremely hot as it came together. The material forming the earth was probably too hot for ice to have been a major carrier of water. Most of the water was probably present originally as water trapped in clay minerals or as separate hydrogen (in hydrocarbons) and oxygen (in iron oxides), rather than as ice.

"Since the end of the period of accretion, more than four billion years ago, there has been a continual exchange of volatile material--including water--between the surface of the earth and the planet's interior (that is, between the crust and the mantle). Volcanoes release water and carbon dioxide to the atmosphere and ocean. Subduction of sediments rich in volatiles takes place at deep ocean trenches. The sinking of oceanic crust at subduction zones carries water and carbon dioxide back into the mantle. These processes can all be seen at work today.

"In short, icy cometary material probably has not been important in providing water for the earth's oceans, but there is little sure knowledge in this field.

## Mystery of Earth's Water Origin Solved

**Instead of arriving later by comet impact, Earth's waters have likely existed since our planet's birth.**

By **Andrew Fazekas**, for National Geographic

http://news.nationalgeographic.com/news/2014/10/141030-starstruck-earth-water-origin-vesta-science/

The water that makes Earth a majestic blue marble was here from the time of our planet's birth, according to a new study of ancient meteorites, scientists reported Thursday.
Where do the oceans come from? The study headed by Adam Sarafian of the Woods Hole Oceanographic Institution (WHOI) in Woods Hole, Massachusetts, found that our seas may have arrived much earlier on our planet than previously thought.

The study pushes back the clock on the origin of Earth's water by hundreds of millions of years, to around 4.6 billion years ago, when all the worlds of the inner solar system were still forming.

Scientists had suspected that our planet formed dry, with high-energy impacts creating a molten surface on the infant Earth. Water came much later, went the thinking, thanks to collisions with wet comets and asteroids.

"Some people have argued that any water molecules that were present as the planets were forming would have evaporated or been blown off into space," said study co-author Horst Marschall, a geologist at WHOI.

For that reason, he said, scientists thought that "surface water as it exists on our planet today must have come much, much later—hundreds of millions of years later."

**Ancient Origins**
But no one was certain. To pin down the exact time of the arrival of Earth's water, the study team turned to analyzing meteorites thought to have formed at different times in the history of the solar system.

First, they looked at carbonaceous chondrite meteorites that have been dated as the oldest ones known. They formed around the same time as the sun, before the first planets.
Next they examined meteorites that are thought to have originated from the large asteroid Vesta, which formed in the same region as Earth, some 14 million years after the solar system's birth.

"These primitive meteorites resemble the bulk solar system composition," said Sune Nielsen of the WHOI, a study co-author. "They have quite a lot of water in them, and have been thought of before as candidates for the origin of Earth's water."

**Vestal Waters**
The team's measurements show that meteorites from Vesta have the same chemistry as the carbonaceous chondrites and rocks found on Earth. This means that carbonaceous chondrites are the most likely common source of water.

"The study shows that Earth's water most likely accreted at the same time as the rock," said Marschall.

"The planet formed as a wet planet with water on the surface."

While the authors are not ruling out that some of the water that covers 70 percent of Earth today may have arrived later, their findings suggest that there was enough already here for life to have begun earlier than thought.

"Knowing that water came early to the inner solar system also means that the other inner planets could have been wet early and evolved life before they became the harsh environments they are today," explained Nielsen.