Q&A: What touching an asteroid can teach us

October 20 2020, by Mikayla MacE

NASA's UArizona-led OSIRIS-REx mission is the agency's first attempt to bring back a sample from an asteroid. Credit: NASA

The University of Arizona-led OSIRIS-REx mission will make NASA's first attempt at collecting a sample from an asteroid on Oct. 20. The sample, which will be returned to Earth in 2023, has the potential to shed light on the origins of life and the solar system.

As the spacecraft prepares for its Touch-and-Go, or TAG, maneuver at asteroid Bennu, UArizona News spoke with Dante Lauretta, the mission's principal investigator and a professor of planetary science at the UArizona Lunar and Planetary Laboratory, about the significance of the mission and it impact on science and society.

Q: We often hear that the mission will shed light on the origins of life and the solar system, but how will it do that?

A: Bennu is a fragment from the earliest stages of solar system formation. It escaped the fate of so many other asteroids by not becoming a piece of a planet. Earth itself formed from asteroids like Bennu; Bennu just happened to survive that process. So, Bennu is like a fossil from a time in the solar system before life or Earth even formed.

Since life as we know it is made from DNA, we want to know if the building blocks of DNA are on Bennu. If the building blocks that make up DNA formed early in the solar system and were preserved in carbon-rich asteroids, then they could have been delivered to Earth, Mars, Europa, Titan and all these other places we're looking for life. It would mean the seeds of life were not unique to the Earth, so our search for life in the solar system gets more exciting.

If we don't find them on Bennu, it might mean that those life-seeding molecules had to form in Earth's early environment.

Also, we think water plays a key role in that life-forming chemistry. For example, advanced life first took hold in the oceans before moving to land, and we now know that Bennu is a water-rich asteroid. So, we think that the water that made Earth habitable came from asteroids like Bennu. If that's the case, then other planets, like Mars and definitely the icy worlds in the outer solar system, can trace their water linage and organic chemistry in the same way.

Q: One thing I hear a lot about is how pristine these samples will be. Why is that so important? Am I wrong in thinking that just because you burnt the pancake doesn't mean you can't scrape it off and eat it?

A: We have hints at the chemistry of the early solar system from meteorites, which are fragments of asteroids that land on Earth. The problem is that they are immediately contaminated: Bacteria crawl on them and eat the carbon-rich meteorites; people handle them and don't collect them in the cleanest way in the field. So, it's not just burning the pancake; it's like mixing dirt into the batter once it's on the surface.

So, when we say "pristine," we are removing that level of contamination from the problem. I like to compare it to a forensic investigation; you're trying to convince the jury in a court of law that this DNA was from a crime scene, but if that evidence wasn't in your control that entire time, the defense would say it could have been contaminated and you can't link to the crime scene. In our case, if we want to say the organic molecules from the sample came from the asteroid and aren't contaminants, then we have to control the full chain of history, from asteroid to sample return capsule to lab.

Q: What are you expecting to find in these samples that we haven't already found in meteorites that fall to Earth?

A: A bunch of our new published research is finding that the rocks on Bennu look different than meteorites in a couple of ways. Bennu's rocks are actually really weak, unlike meteorites found on Earth that you have to whack with hammer. Only the strongest fragments survive the fall to Earth, so what we collect from Bennu will be the material that would have likely burned up on entry. Back to the pancake analogy: The pancake could have had caramel glaze that went up in smoke and you wouldn't know. We're hoping to find something more delicate and fragile that's not in the meteorite collection.

Another really exciting thing we found are these veins of carbonate minerals—the white stuff that forms around faucets—on Bennu. These are like a meter long and tens of centimeters thick. We do find them in meteorites but they're tiny, like strands of hair. This material forms by the precipitation by hot water, similar to when a tea kettle boils water off and leaves behind white crud at the bottom. That white crud was dissolved minerals, like what we found on Bennu. If we can get these back in a sample, we speculate—and hope—that we might find pockets of water trapped inside. In any case, we'll have a detailed record of the chemistry of water on Bennu.

Q: This all touches on why sampling Bennu is important for science, but why is this important for society?

Dante Lauretta is the OSIRIS-REx principal investigator and a UArizona professor of planetary science. Credit: University of Arizona

A: There are two big reasons. The first is that Bennu is a potentially hazardous asteroid. Pre-launch analysis showed that there was a 1 in 2,700 chance that Bennu will impact Earth in 150 years. It's still a low-likelihood event, but it's of big enough consequence that we should be mitigating and characterizing the risk. By 2135, when Bennu makes its next close approach between the Earth and the moon, we will be able to confirm that it won't hit. Should any asteroid pose an impact threat to Earth, data about the asteroid, like the data we've collected at Bennu, would be valuable to prepare. We've set the standard for characterizing the properties of an asteroid. This is like our gift to the future.

The second is the asteroid mining angle. The No. 1 commodity is water. You can break it into liquid oxygen and hydrogen to make rocket fuel. We've proven the value of Bennu as an ore deposit and water resource, and Bennu is very accessible from the Earth. It could eventually become a gas station in space.

Q: What is most exciting to you about the mission?

A: Sample science is my background, so I'm most excited to be transitioning to the sample science phase of the mission. Now, I get to think about all the fun things we're going to do with the sample once it's back on Earth and partnering with labs all over the world. I think of this as the third science campaign of OSIRIS-REx: The first was astronomy, where we determined its size, shape and orbital path. Then, we arrived and began remote sensing; the recent six papers are culmination of that work. Now, we're in the sample science phase. So, from telescope to spacecraft to microscope, it's a cool arch, scientifically and career-wise, to go through.

I'm also excited to think about what's next. I'm still three years out from sample return, but I'm starting to think about what I might do after OSIRIS-REx. I haven't had that thought for 20 years.

And, lastly, I'm excited to inspire the next generation, and I think we really nailed that. I'm proud of the students who grew up in this program. Some have even been hired on after graduation. And there's a lot of value to the education of school-age kids following along with this mission.

Provided by University of Arizona