Dual Drill Designed for Jupiter's Europa Ice

April 15 2010, by Jeremy Hsu

In February 2009, ESA and NASA selected a future flagship mission to the outer solar system - a new project to explore Jupiter and its four largest moons called EJSM. Credit: NASA/ESA

NASA and the European Space Agency are sending a mission to study Jupiter and its moon Europa in 2020. There may be life in the moon's ocean, but to find out a mission will have to be able to drill down through the overlying ice shell.

A mole-like thermal drill designed to cut through the icy surface of Jupiter's moon Europa could be on a future mission slated for launch in 2020.

Such a device would represent the best of both worlds by using heat to melt through the ice and rotating drill blades to clear away rocky

material. The drill would be nestled inside a larger penetrator probe that would burrow itself into Europa's icy shell.

"Penetrators are the most feasible, cheapest and safest option for a landing on Europa today, and the knowledge to build those is there," said Peter Weiss, a post-doc now at the National Center for Scientific Research (CNRS) in France. He and his colleagues at the Hong Kong Polytechnic University worked with other researchers at the Institut fuer Weltraumforschung in Graz, Austria on a study detailed in the January issue of the journal Advances in Space Research.

NASA and the European Space Agency (ESA) have teamed up on the Europa Jupiter System Mission (EJSM), with both Russia and Japan also showing interest. The mission could be composed of several orbiters peering down at Europa, but Russia has its eyes on a possible lander — and the Russians have already built penetrators for past missions, such as the failed Mars 96 mission.

"A thermal drill could be the 'nose' of a penetrator, to taste the ice of Europa," Weiss explained.

Thermal drill with rotating drill blades. Credit: Hong Kong Polytechnic University

Drilling gets hot

Any landing probe that wants to search for signs of life on Europa must go deeper than two meters into the surface ice, because heavy radiation and particle bombardment would have erased any biological traces in the top layer.

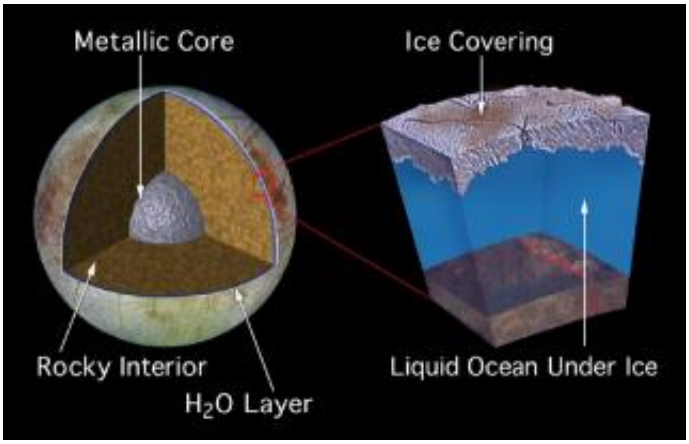
Having a robotic lander make a soft landing before preparing to drill would be a more complicated and expensive task compared to a penetrator, Weiss said. A thermal drill could simply deploy from the side of the penetrator after impact, and begin drilling through the pristine ice below to sample material at depths of up to 10 meters.

Estimates for the thickness of Europa's ice shell vary between a few kilometers and tens of kilometers, but Weiss says it doesn't make sense to go much deeper than 10 meters because of the current state of technology. For instance, the drill would be tethered to the penetrator by a communication cable, and the length of cable would be limited based on how much the probe could carry. This cable would allow data collected from the drill to snake back to the main scientific instruments in the penetrator, and then the data would get beamed up to an orbiter.

Lab experiments showed how a thermal drill design fared much better in dealing with the combined challenge of ice and regolith, as opposed to a melting probe such as the Cryobot that relies upon heat alone.

Inner pressure inside the hole is expected to increase and allow for liquid

water once the initial borehole has refrozen. That would allow the drill to sample water by using a micro-pump, but the refreezing hole would also protect the pristine ice against possible contamination from the outside.



A model of Europa's interior, including a global ocean. If a 100 kilometer-deep ocean existed below Europa's ice shell, it would be 10 times deeper than any ocean on Earth and would contain twice as much water as Earth's oceans and rivers combined. Credit: NASA/JPL

Forget the submersibles

Some concepts of a submersible exploring the supposed ocean depths of Europa have appeared in past years, and NASA has tested robotic subs in the frigid lakes of Antarctica.

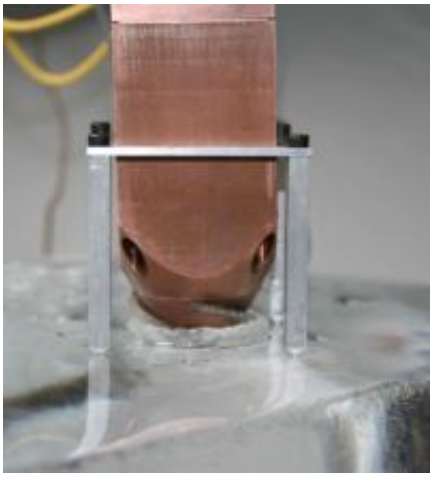
But Weiss, who draws upon several years working with sub-sea robotics, said that current technology cannot deploy a submersible on Europa. Just packing in all the cabling that would connect a submersible to the main landing craft would represent a problem. While the ice shell is thought to be at least several kilometers thick, no one knows exactly how far down the ocean may be - there could be a thick layer of slush between the ice

shell and ocean. Another question is the distance down to the ocean floor.

"The ocean beneath — if existent — could be 100 kilometers deep," said Weiss.

Robotic subs on Earth have reached ocean depths of 11 km (6.8 miles), but weighed several tons and required huge surface support ships. That doesn't work for a mission to Europa that needs to travel light.

"Institutes that pretend to develop sub-sea robots 'to explore the bottom of Europa's ocean' should be financed by Hollywood, not NASA," Weiss said.



Drill cuts through ice in a laboratory test. Credit: Hong Kong Polytechnic University.

Waiting for a call

The researchers have so far tested their drill in both pressure and

vacuum environments, but still want to boost its efficiency. A next logical step might test how well a thermal drill survives impact aboard a penetrator.

Whether or not a thermal drill or any sort of landing probe gets a shot at Europa's icy surface remains up in the air. But even as the different space agencies figure out their roles and budgets, Weiss says there's a sense of urgency to find out what's going on with Europa.

A mission that consisted of only orbiters might find more interesting evidence that supports the possibility of life on the Jovian moon, but would not have the ability to go down and find proof. And a follow-up mission might not even launch until the 2040s — good reason for the current generation of scientists to want some surface explorer element.

"Otherwise, we won't have any confirmation on astrobiology on Europa — or maybe even in the solar system — during our lifetime," Weiss said.

Source: Astrobio.net, by Jeremy Hsu