Student questions: Harry McSween colloquium on "Dawn's Exploration of Vesta and Ceres"

10/14/15

Question 1: In the modeling of the Vesta core, which the core and crust part are symmetric? Is it reasonable to assume that this is symmetric? Does this mean the composition within their individual regions homogeneous?

Sorry, I don't understand what you mean by symmetric. In the models, the compositions within the crust or core are homogeneous.

Question 2: What are the differences between these metallic core, and basaltic crust in Vesta and that of our Earth systems in chemical compositions? If there are significant differents, what would this mean?

The cores in both bodies are iron-nickel, but likely the minor elements in the cores differ because of the huge difference in pressure, which affects how elements are partitioned. The crust of Vesta is basaltic, and the crust of Earth varies from basaltic under the oceans to granitic in the continents. The difference is result of plate tectonics on the Earth, which produces felsic magmas.

Question 1: Is there an estimate for how many protoplanets such as Vesta and Ceres existed before the accretionary period?

Millions, certainly, but I can't give you an actual estimate.

Question 2: Is there any evidence that Vesta or Ceres ever impacted Earth?

No, they are in stable orbits out there in the main asteroid belt.

Question 1: You mentioned that there are 3 footprint sizes (2735km, 685km, and 210km) of data taken for Vesta. If an average of the smallest (210km) footprints are taken to parallel the largest (2735km), would one get the same reflectance spectrum? In other words, is the instrument consistant despite the differences in sampling techniques?

Those numbers you quoted were not footprint sizes, but orbital distances for different phases of the mission. The footprint size, of course, decreases as the spacecraft orbit gets closer. The reflectance spectrum gets sharper as you get closer, but is otherwise similar.

Question 2: You showed a plot of BI vs. BI bands in reflectance spectra, where the howardite points overlapped with cumulite moreso than eucrites and diogenites. Why is this? Would not one expect the lithified regiolith that constitutes howardites to be of primarily basalt than gabbro?

The regolith of Vesta is not lithified, but instead its soil – pulverized mixtures of target rocks, in this case eucrite and diogenite.

Question 1: The linear depressions on Ceres was so different and not seen on Vesta. Do you have ideas on how they were made?

Nope, not yet. Perhaps change in body size as a liquid ocean solidifies?

Question 2: The craters on Ceres that have relaxed. Is that a result of the ice, gravity or some other factor?

Some craters have relaxed, others have not. Ice is easier to deform under the influence of gravity than rock, so it is a surprise that all of the craters have not relaxed.

Question 1: What order spherical harmonic gravity do you expect to get from Ceres?
We don't know yet – that information will come in the low altitude mapping orbit.
Question 2: What is the difference of relief between Vesta and Ceres?
Vesta has much more relief than Ceres.

Question 1: You mentioned that Vesta and Ceres were chosen because they are two very different bodies. Has anything been discovered that is surprisingly similar between the two?
Not really, they are still different as night and day.
Question 2: The linear features shown on Ceres look similar to collapsed lava tubes on other planets. Could liquid water produce the same sort of "tube" that liquid rock can?
You're right, they do sort of resemble collapsed lava tubes, but they are more likely opened fractures (rifts).

Question 1: How do you know the core of Vesta is iron? You mentioned that you use the gravitational pull on the spacecraft to find out the density but how do find out the exact composition of the core?
We assume the core is iron, because the cosmic abundance of iron is high, and it's the only dense element with high enough abundance to make cores.
Question 2: Is there a reason the two largest impacts were on the younger side of Vesta and so close to each other or is that just a coincidence?
It is perplexing, isn't it? We don't know.

Question 1: Why was xenon chosen for the propulsion?
Xenon is the heaviest element that exists normally as a gas, so it can be compacted into the spacecraft and its mass is necessary to provide an equal and opposite reaction when it is expelled.
Question 2: How long do crater rays last?
It probably varies with the body, but on the Moon and Mars they apparently last for a few million years.

Question 1: Now that you have seen this data, what instruments or data would you like to see from any follow-up missions?
I wish we had carried a magnetometer, and could bring back samples.
Question 2: What do you mean by "crater relaxation" and what causes it?
A bowl-shaped crater relaxes when it becomes shallower, eventually flattening out and becoming invisible. It happens when the floor rebounds after being compressed.

Question 1: How likely does the Vesta may formed by residual a terrestrial planet?
Not likely.
Question 2: Does the effect of carbonaceous chondrite matter the sample from the surface of two protoplanet?
The carbonaceous chondrite in the regolith was from the impact of a carbonaceous chondrite asteroid into Vesta.

Question 1: How can it be determined that a meteorite originated on Vesta and not a similar asteroid?
Tough, but there are enough similarities between HED meteorites and Vesta to make a strong case. There are very few other asteroids with similar spectra, except for the vestoids which are pieces of Vesta itself ejected by a large impact.
Question 2: Do the impacts on Ceres not cause the ice to melt into liquid form?
Melt or vaporize.

Question 1: Can you get a spectra of the types of salts composing the bright spots?
We are working on it, but no clear answer yet.
Question 2: Did Vesta lose its water throughout time or did it just have very little water when it formed?
We think it formed dry as a bone.

Question 1: How long is Dawn going to stay at Ceres? Will there be an extended science phase or is Ceres the last stop?
Forever, it will die there.
Question 2: Is the ratio of relief a measure of the average or deepest relief point in the numerator? Or neither?
Average.

Question 1: Were there other considerations when it came to powering Dawn? If so, what were they?
The ion propulsion system was the only system we could afford, given the constraints on the total cost of the mission imposed by NASA.
Question 2: Its amazing how we can determine the crustal density and geological mapping of Ceres and Vesta without stepping foot on them. Do you think it's possible-using the same technology as the Dawn Mission- to accomplish this on other planets in our solar system?
Sure, it's already being done.

Question 1: Are there any fly-by plans of other asteroids for Dawn mission, after it finishes the visit to Ceres? If yes, what are the possible targets?
Nope, Ceres is the end of the line – out of fuel.
Question 2: Vesta and Ceres are thought to have formed in very different paths. Does the exploration of Dawn strengthen or weaken this point of view? How?
One body formed by accreting rock, the other by accreting rock plus ice.

Question 1: On Ceres, if you find landslides, could you use them to estimate the depth of the regolith?
Yes, good observation – we used that on Vesta, but have not found many landslides on Ceres.
Question 2: Can you use models of impactors on Europa or other well-studied ice covered bodies to simulate the topography you'd expect to see immediately and long after an impact on Ceres?
Yes, we make those comparisons all the time.

Question 1: Why are the solar panels designed to fold out into wings, is this just to maximize storage before the panels are deployed, or does this orientation have other benefits like maximized collection of light?
You can't launch the spacecraft from Earth without folding up the solar panels. If deployed, they would be broken off in passing through the atmosphere.
Question 2: You mentioned that the carbonaceous chondrites were overlooked because no one knew to check for them the first time. Is it very labor intensive to look for them if you do not expect them, or are they just so small they can be misinterpreted easily?
Yes, it's labor intensive. Sometimes you see only what you're looking for.

Question 1: What is the ratio of relief and how do we go about measuring it?
Average difference in elevation (high – low) divided by mean radius of the body.
Question 2: What's the main reason for difference in internal structure of Vesta and Ceres? Particularly the size of their cores.
More iron and rock (Vesta) versus less iron and rock(Ceres).

Question 1: What depth can you find the cummulate eucrite meteorite on vesta?
We don't know that.
Question 2: How do the solar panels on Dawn deploy?
They are spring loaded, and deploy when an actuator releases them.

Question 1: The two protoplanetary objects which you discussed today, Vesta and Ceres, accreted from the same protoplanetary disk as Earth. Is there any theory as to why these relatively large objects were never consumed by even larger protoplanets or is it just the luck of the draw, so to speak?
Just lucky.
Question 2: You mentioned that Ceres is a dwarf planet. Are there any compositional similarities between Ceres and the saddest member of the dwarf planet family, Pluto?
They are both ice-rich and probably have some similarities in the rocky cores.

Question 1: Is the fact that xenon is the heaviest gas why it's the best choice for ion propulsion? Does that make it expensive?
Yes, it's the mass of xenon that makes it good for propulsion – equal and opposite reaction when it's expelled. I don't know what xenon costs, but it's probably not cheap.
Question 2: What causes the central uplift of most impact craters in the universe?
Rebound after being compressed by the impact. Similar to rebound on Earth once glaciers melt.

Question 1: If the bright spots on Ceres is water outgassing, why does it light up?
I don't think the bright spots are ice, but more likely salts. If ice was there and sublimates, that could cause outgassing. The salts are light colored.
Question 2: Were there ever any lava flows on Ceres, or has it always been a big ball of ice and rock?
Probably flows of salty water, if that qualifies as lava.

Question 1: Is it known what type of body caused the Rheasilvia impact?
Unfortunately, no. We think the other big crater, Veneneia, may have been the carbonaceous chondrite.
Question 2: What caused Vesta and Ceres to maintain their large size relative to other asteroids?
They were not broken up by impacts.

Question 1: Do we have an idea of how big the object was that formed Rheasilvia?
Possibly, you should ask Erik Asphaug at ASU, who did the modeling.
Question 2: Do you expect to find an abundance of organics on Ceres?
Yes, but we won't be able to identify them with the tools at hand.

Question 1: You mentioned that a couple of instruments originally planned for the Dawn spacecraft had to be left off due to financial constraints. What were those instruments and what contributions might they have potentially made to our recent understandings of Vesta and Ceres?
A magnetometer, for measuring the magnetic field, and a laser altimeter, to measure accurately the elevations on the surface.
Question 2: If Dawn had a significantly greater reservior of fuel available to it, are there any other objects in the asteroid belt in particular that would be worth visiting after Ceres? Why?
Sure, any number of other kinds of spectrally distinct asteroids would be wonderful targets.

Question 1: How efficient is the ion propulsion system used on Dawn in powering much larger spacecraft?
It should work fine.
Question 2: With the GRAND instrument having such a large resolution, will it be able to get accurate data from Ceres? Is it just expected to take general measurements?
Yes, but it works best for average Ceres composition, because of its poor spatial resolution.

Question 1: For the cryo-volcano on Ceres, is there a mechanism to differentiate salts and eject them from a cryo-volcano?
Possibly sublimating ice away, leaving the salts behind. I'm not sure what would eject the salts.
Question 2: Is there any way to test the age of the ejecta on the Cryo volcano on Ceres? The bright white parts seem to have older greyer counterparts from the same volcano. I just couldn't stop staring at that bright patch.
If we get high enough camera resolution, we could count craters on the bright patch or volcano, which would provide a relative age.

Question 1: How do you go from a gravity measurement to a differentiated body?
Gravity can be constrained by the way it interacts with orbiting spacecraft.
Question 2: What does terrane softening on Ceres say about the differing petrologic evolutions of the two protoplanets?
The more ice, the easier to soften the terrane. Rock is stiffer.

Question 1: Given the proportionally large size of the Rheasilvia Basin on Vesta, does that help or hurt an impact origin theory for the formation of the hemispheric dichotomy on Mars?
It helps, I'm sure that why there is such a dichotomy.
Question 2: Can crater counting density be as effective for determining relative ages on Ceres if you have to take in to account potential basin relaxation from ice?
If we cannot account for relaxation, crater counting won't give an accurate age. I suspect that all the ages will be too young.