Astronomy Cast Episode 257 for Monday, March 19, 2012: Viking Orbiter

Fraser: Welcome to Astronomy Cast, our weekly facts-based journey through the Cosmos, where we help you understand not only what we know, but how we know what we know. My name is Fraser Cain; I'm the publisher of Universe Today, and with me is Dr. Pamela Gay, a professor at Southern Illinois University – Edwardsville. Hi, Pamela. How are you doing?

Pamela: I'm doing well. How are you doing, Fraser?

Fraser: Doing really well. We had a bit of a delay – apologize to everybody, but you were on a crazy conference.

Pamela: I was. So last week I was at the Lunar and Planetary Sciences Conference down in The Woodlands, TX, otherwise known as a rich part of Houston, and I was catching up on all that's new and amazing in space science, and I was reminded that we started almost 50 years ago from this recording (it was actually in April that it happened). We started putting spacecraft past other planets 50 years ago, April 2012, so doing this show makes perfect sense.

Fraser: And I would say that conference is one of the biggest news generators of the entire year. We are still digesting the news that poured out of that conference. There's some really interesting things that came out of it. Yeah…I know Nancy's got a list of articles that she's planning to write that's an arm long.

Pamela: Right, yeah, Emily does too, so check out Universe Today, Planetary Society blog, and I have a far smaller number (but long stories) on startstrider.com.

Fraser: That's great. Alright, let's get going then.

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Fraser: So Spirit, Opportunity and Curiosity get all the news now, but it was NASA's Viking missions that gave us our first close-up view of the surface

of Mars. This twin-mission Orbiter and Lander set the stage for the exploration of Mars, demonstrating that we can actually reach the surface and study the soil up close. Today, let's talk about the Viking I orbiter. So this is…I think a lot of people don't really realize when they talk about the Viking, they always think about the Viking lander, and they always think about that crazy spider-looking spacecraft with the big scoop that was digging up soil off the surface of Mars, searching for life, but really it was a two-part mission. And so we wanted to break it up into two pieces and talk about the intro part -- the orbiter -- that really helped capture some of the greatest pictures of the surface of Mars -- many that are still used today.

Pamela: So these are actually part of the Mariner spacecraft program. This is one of the confusing things. It's sort of like the auto industry sometimes renames a type of car, or switches branding along the way, and the Mariner program, which started with Mariner II, was the first successful one doing fly-bys of all the inner planets, eventually evolved to include Voyager I and II, the Cassini mission was also eventually based on the Mariner spacecraft – these are just upgrades on the spacecraft over time. These are basically beetle-shaped spacecraft that have four solar panels, an octagonal shape that allows instruments to go on the various sides. And with these Viking I and II missions, both dedicated to going to Mars, they weren't just the orbiter, they were also the lander as well, and what was neat is the whole kit & kaboodle headed off, and then it was once they got there they realized the landing sites they hadn't picked out necessarily they wanted to land because the wonderful images, that for the first time we were able to get, they realized that they were planning to drop Voyager I's lander into a rather dangerous part of the soil of Mars, so there's actually a fairly significant 16-day delay when we were able to put the Viking I lander on the soil, and the amount of "Oh, wow! That's not what we expected!" that these two missions encountered was really quite amazing.

Fraser: Yeah, I think a lot of people don't realize we talk about Cassini and Mariner and Viking and all of that, but it really was just this class of spacecraft, and we actually talked a bit about that in the Mariner program episode just how ambitious their plans were originally. Even the Voyagers are all part of the same class of spacecraft, and they had tremendous plans, which, of course, as always, get cut back, and you know, missions get renamed and all that, so…

Pamela: Well, these are really the land rovers of NASA. These are the spacecraft you load up with all of your instruments, and instead of taking off across the Gobi Desert with extra fuel tanks, you're taking off across the Solar System, occasionally with a radioactive thermal power source. So all of these different missions shared similar hardware, similar lay-outs, but with the Viking missions, I think, for the orbiters at least, the most amazing things that they had to contribute were their cameras. These were the spacecraft that caused scientists for the first time to wonder, "Did Mars once have rain?" and it wasn't actually until Phoenix went and revealed ice that we were finally able to end this argument. So Mariner 9 had orbited Mars for a good long time, and in fact, Valles Marineris was named after the Mariner spacecraft because, well, the one revealed the other. But it's one thing to reveal a giant canal…not canal – I mean, that's what Percival Lowell claimed it was…

Fraser: Chasm…

Pamela: But chasm – to reveal a giant chasm…and it's another thing to say that looks like the Grand Canyon enough that we think it was probably created by water. So with Mariner 9, we're getting back images sufficient to say, "Oh, wow! Large volcano! Oh, wow! Large something broken into the soil that looks like a giant canyon!" but when Viking I and II got there, they were able to, in some cases, get images with 8-meter resolution, and this resolution was sufficient to, unfortunately, not end the "Face on Mars" debate -- that would have to wait until modern spacecraft got there, but it was sufficient to start doing things like revealing what looked like islands with tear-dropped land behind them that could have been formed by water racing across the surface, and causing erosion around slightly harder soils. The images from Mariner were sufficient to see that there were craters that appeared to have run-off that cut channels through the crater walls. It was sufficient even to reveal craters that looked like they might have formed in mud. Now, this opened a whole lot of debates about fluvia vs. aeolian factors, which is a fancy way of saying, "Was it water, or was it wind that created these things?" It was kind of amazing to watch all the way up until 2005, scientists jump through amazing hoops to try and blame all of these things on the wind.

Fraser: At the time that I'm recording this, actually, I'm just writing an article about something…a really strange weather pattern on Mars that can only be formed by the wind, so the wind is the thing that's still going – very

powerful wind on the surface of Mars, and it's still transforming the landscape of Mars, but it's this whole idea that a long time ago, you had ancient oceans, ancient rivers, lakes, really active water going on on the surface of Mars, and the question was really, "Did that really happen, and when did it switch over?" So this was this problem: you had all of this spacecraft that just… it gave you half of the story, but it wasn't conclusive.

Pamela: And what was interesting is as they kept looking at the surface of the planet, they kept revealing new features that left them "verklempt" (for lack of a better word). There's this amazing terrain, and we re-use this phrase a lot for different bodies – it's called chaos terrain. You hear about the chaos terrain on Europa. This is areas where the ice structure is all blocked up and jumbled together, and it really looks like someone took the surface, hit it with a sledge hammer, and shook it in a pan, and then left it there in this broken, shattered, chaotic formation. And it's one thing to see how this would happen with ice, and there's some great research explaining that it's just hydraulic forces break it up, it breaks and shatters, and it literally does the "shake it around in a pan" thing, and re-freezes, but when you're looking at dirt that did that, this is a bit harder. This was something that has actually led to a lot of struggling, so with the chaos terrain that was revealed by Viking, scientists had to start jumping through amazing hoops, and one of the ideas was that you had this region of soil that is underlaid with ice, and something comes along, melts all that ice, and the terrain that was on top of the ice collapses down, and in the process, because different [missing audio] melt at different rates, the terrain that was on top of the ice gets entirely jumbled up in this process. But then there were people trying to figure out how to explain what melted the ice.

Fraser: Right, and so then, what was the, sort of, overall plan for the missions? You know, where did it come from because, as I said, it was the Mariners, and there was this whole Mariner program, so when did it become…what turned it into the Viking missions?

Pamela: Well, so the name "Viking" really came about because, well, first of all, there was a gap in time between the Mariner mission and the launching of the Viking missions, so gaps in time allow you to rename things occasionally. There was also differences in how Congress funded it, which is for instance why the Voyager missions got renamed. The Voyager missions were actually very, very scaled back from what had originally been planned as part of Mariner, so rather than give the name Mariner to these

vastly scaled-back projects, they just renamed them Voyager. So the gap in time and then slight changes in technology all led to the renaming of it, which basically got people all excited that this is something new, when really it's just something old that has been tweaked, but the reason for it was largely all the discoveries made by earlier Mariner missions. With Mariner 9, we saw these cracks, we saw these volcanoes, we saw these ice caps, and this gets people excited. This was a world that had weather. That was another one of the problems the Mariner missions ran into is they got there and discovered dust storms – can't see the surface of the planet.

Fraser: That was unexpected!

Pamela: Imagine – you launch your spacecraft, it spends ten months getting there, you're so excited, and your first image comes back, and you're looking at dust storms, and you can't see the surface through the dust storms. This is what scientists went through, but this made us realize, "Wow! This is a world with weather," and we wanted to know just how diverse, how possible for life is it. And we're going to talk about this more in the next episode, but one of the primary goals of the Viking mission was to stick landers on the ground and look for life. With the orbiters, well, they were one part communication satellite, so information was going from the landers, through the orbiters, back to Earth, they were one part weather satellite, they were one part crater mapper. They were looking at water, looking for storms…they were playing the role of, basically, think space satellite combined with weather satellite here on planet Earth.

Fraser: They were really just vastly ambitious. When you think about the capability and what these spacecraft did, it seems like it's from the far future that they were able to image the planet at this amazing resolution, that they were able to land there with the enormous delays. I mean, now we just take all this stuff for granted that we just use computers to land this spacecraft and have them make decision stuff, but they had computers that were no more powerful than your pocket calculator, so it's just phenomenal what they were able to get done. So then, when did…what was the order of the Viking missions? Who went first and who got there?

Pamela: This is one of those times where number of mission actually matches number of everything else. So Viking I launched on August 20, 1975; it entered orbit on July 19, 1976. Viking II launched September 9, 1975; entered orbit August 7, 1976, and they sent back data for years. And

in fact, it was with Viking I -- it kept going, basically, until they finally started to run out of fuel, and they adjusted its orbit to make sure it wouldn't crash into the planet. Viking II, actually had some fuel issues and it ran out of fuel earlier than expected, so they bumped it also into an orbit to protect it from landing on the planet, but in the interim, between getting there, and doing their, in the case of Viking II, over 700 orbits, in the case of Viking I, over 1400 orbits -- in the case of doing all of these different orbits, they changed their orbit multiple times, which allowed them to change how long it took them to get around, which sounds kind of trivial, but that actually means that they get to change the illumination angles, they get to change when they're closest to the planet, when they're furthest out (because these were often elliptical orbits), and this allowed them to see the surface under different illumination conditions, to see the surface when they're closer at higher resolution, when they're at higher altitudes, see it at lower resolution, but also get those landscapes where it appears like you're actually flying over the various huge volcanoes that they have. All of this yielded different science.

Fraser: Right, and so this is going to be hard to kind of explain on audio, but with…when you actually see the spacecraft, you can really see, as you said, they've got these four solar arrays, there's all of the scientific instruments on top of it, then underneath is this carrier shell that's like a clam and so it's holding on to the actual lander, and so there was two…both of these spacecraft had this same configuration: they flew, they had the orbiter part then underneath, they had this descent module, and so they were actually orbiting Mars for quite a while before they released their landers?

Pamela: It actually wasn't that long. That was one of those things that NASA has gotten really good at doing across all of its different missions. So, for instance, with Viking I, it entered orbit on June 19, 1976. The original plan had been to land the lander on the Fourth of July because, well, NASA likes to land things on U. S. holidays -- there's a surprising number of mission events that have happened on the Fourth of July. But when they got there this was the mission where they realized we can't land where we want, so they delayed it all of 16 days landing on July 20, so they were basically in orbit for one month before they dropped that first lander. And the story for Viking II was very similar, so they just got to business as quickly as they could, getting their landers on the ground, getting their orbital data going, imaging, imaging, imaging, and trying to make sense of this alien surface.

Fraser: So what would you say are the major discoveries that the Viking orbiters help make?

Pamela: The biggest discovery was all of this evidence that there was some sort of a surface erosion process. This is the up-until-recently "water vs. wind" argument. They saw the chaos terrain that I explained, they saw these water-swept dunes, they saw craters that appear to be formed in mud, and this opened up the debate for trying to understand: how do you get liquid water on the surface of Mars? So this was what [missing audio] theorists tried to think out: was it heavy bombardment by comets that covered the planets in oceans? Was it ice underneath the surface that got violently melted through volcanoes? Was it ice under the surface that got melted when craters impacted? And people continue to struggle to understand: where did all of this water come from? It also opened up ideas to look for shorelines, and this was something we'd never thought of…wasn't the Mariner 9 data wasn't good enough to start imagining, well, oceans on Mars?

Fraser: And there are these features that are so clearly produced by water. I mean, they look like if you've ever seen…like, from up from space you can see these rivers passing and they've cut away these little islands inside the river, and they have this really familiar teardrop shape. There are features on the surface of Mars that are clearly looking like that, and so to say that that was wind is, you know…I can see why that was a fight.

Pamela: It's really amazing what the desire…there was a lot of water denial going on, and so listening to talks, you'd hear things like "differential hardness of surface…" so what you're actually seeing is an area where you have a gully of easy…more easily-eroded material and that's sweeping around things that are harder in material, and they're trying to show examples of features like this out in the American southwest, and then trying to figure out how to model, well, all of these different things, but the other set of models that people continue to argue over is the "slow vs. fast." Was there a period of millions of years during which there was water, or was there simply one great event during which Mars basically suffered from Noah's Flood, and the entire Valles Marineris got cut away in a matter of days, months, years vs. a longer period of time? And it's kind of weird listening to some of these arguments, especially if you've ever listened to any of the "Genesis revealed" people because it's just like there's people

that try to argue that the Grand Canyon was formed very quickly. These are huge features, and it's interesting to see the gymnastics that has occurred trying to prevent rainfall from occurring on Mars and blame it all on melting ice from catastrophic brief-term events.

Fraser: But don't they think now that the Valles Marineris is more of an uplift from some of the volcanic processes going on? Yeah…Mars is cracking open from the volcanoes.

Pamela: That's a really complicated one, so...

Fraser: OK.

Pamela: There are the canyon features, there are the uplifting features, there are the places where water has run out of it and carved things, so it doesn't have one single explanation, although some people will try and blame it on one single explanation.

Fraser: But now we're at the point with Spirit and Opportunity where the evidence that past water on Mars is now conclusive, that it was there acting on the surface for a long time, so all of those mysteries -- if we could transfer back to 1976 and talk about these missions, these would all be the big mysteries, and this is the great thing about science. Now here we are, we know a lot of the answers to these questions that must have just kept Carl Sagan up at night.

Pamela: And what's amazing is, yeah, so we've defeated the Face on Mars, we have high-resolution images. It's just a cool out-cropping. We have figured out, yes, there was water for some period of time that allowed all of these things to form. Yes, there was most likely rain, and we can even start to figure out where the rain occurred and likely for how long, based on the different craters. All of these different things…and I think HiRISE data has actually gone in some ways further for creating whole planet weather models than anything else.

Fraser: Well, that's pretty much the most powerful telescope pointed at a planet in space, like, away from the Earth. It's an unbelievable instrument.

Pamela: It's fabulous. LRO is competitive with it, but let's face it, the Moon is not as cool as Mars when it comes to having so much dynamics on

the surface, but Viking opened the door for all of these debates and discoveries.

Fraser: So what was the life of the missions? What…how long did they last, and how were they finally shut down?

Pamela: Well, the thing that really got me is I didn't realize how long they had lasted. So Viking I it launched in August 1975 (August 20 if you want to get specific), and then just three days short of five years later, they terminated it operations on August 17. This mission remained the longest orbital mission going around another planet up until the late '90s, so it just had this amazingly long, rich career of just taking orbit after orbit, and they started to get daring with it through its life, dropping it down to a height of 300 km above the surface, which is roughly 2/3 of the altitude that the space shuttle orbits at, so that's pretty amazing. With Viking II, as I said, it didn't survive quite so well because it did have this problem with…they have to make orbital adjustments, and it ran out of fuel to make orbital adjustments for as long as they expected, so before it accidentally bit the dust, they put it into a parking orbit that would keep it safe. So it got to Mars on August 7, 1976, and they kept it going until July 1978, so again, it had a multi-year mission, sent back tons of data across those multiple years, and with these two different spacecraft, they were also able to do other daring and interesting things where they adjusted the orbit of Viking I to allow it to get nice, close-up shots of Mars' moon, Phobos, and with Viking II, they did the same thing, but instead went after Deimos. So they did what they could to expand the science from just looking down to also, I guess, looking sideways, so looking at the moons as well, trying to understand this odd system that appears to have captured two asteroids, instead of forming its own moon like we did here at Earth.

Fraser: It's quite an amazing mission, I gotta say, and this is one of the ones that I barely remember as a kid – I was like five when it got there.

Pamela: I actually have no memory of this mission. I have strong memories of the Voyager missions, and not sure why I missed this one, but yeah…

Fraser: I'm two years older than you, so I have these vague memories of them. Cool! OK, so next week, then, we're going to talk about the actual landers and what they discovered, and in fact, controversy that remains to this day that…but finally, again, we're going to get an answer to it this

summer with the landing of the Curiosity rover, which will then be able to finally try to push that argument to the next step.

Pamela: Yeah, you're optimistic.

Fraser: I am? You think I'm too optimistic? You don't think…? I think Curiosity is …

Pamela: I think people are going to keep arguing this until they've like combed the whole planet.

Fraser: Of course, people are going to keep arguing. Right, of course, but I do think that Curiosity is equipped with the right gear to at least give people a little more evidence one way or another.

Pamela: If it's there, and we can say yes. If it comes back with a null result, they're just going to keep arguing.

Fraser: That's true. That's true, so I guess they'll keep arguing. Let's just predict it now. Alright, fine, fine…but that's how science works. That's the whole point. We can close the book on this. Alright. Well, thanks a lot, Pamela. .

Pamela: It's my pleasure.

Fraser: We'll talk to you next week.

Pamela: OK. Bye-bye.