Heather Doyle: So welcome everyone. This is Heather Doyle from the Solar System Ambassadors. And we're excited to have Brian Day here. I've personally met him and seen some of his videos and they are really wonderful so hopefully you can use a lot of these at your events. So just don't forget, please mute your phone. It's *6 to mute so that there isn't any background noise.

Brian Day is going to be our speaker. And he's the Director of Communication and Outreach for SSERVI. And in this role he coordinates programs with numerous internal and external partnering organizations focusing on providing opportunities for students and the public to directly participate in lunar science and exploration. So with that Brian if you'd like to get started we are excited to hear what you have to say.

Brian Day: Okay, thank you very much. Today we're going to be talking about one of the really exciting projects that we're doing here at the Solar System Exploration Research Virtual Institute. And that is our program of Solar System Track Portals for Lunar and Planetary Mapping and Modeling. Now I'm going to apologize in advance because I uploaded a really big power point and nine videos. And so hopefully you have all gotten that PowerPoint and have inserted the nine videos into the appropriate slots in the PowerPoint. And what we'll do is we'll march right through it. There's a lot of material here. But what we're talking about today is data visualization. So we've got a lot of data to work through.

So with that I have the PowerPoint up. Slide 1 is just the intro. So we'll move to Slide 2 which is an overview. And these again these online portals for lunar and planetary mapping and modeling are developed through NASA's SSERVI Institute. The development is actually done at JPL. These are tools for mission planning, scientific research and public outreach. They are Web based. There's nothing to install, nothing to buy. You just point sure preferably Chrome browser at the Web sites.

Moving on to Slide 3 some of you may have used our previous lunar portal the Lunar Mapping and Modeling Portal or LMMP. That has been replaced of this year with the new Moon Trek portal moontrek.jpl.nasa.gov a major new release, greatly improved navigation, 3-D visualization and flyovers. We will take a good close look at it today.

Moving on to Slide 4, an intro to Moon Trek it includes a variety of analysis tools, the ability for you to browse, search and actually download data products, visualization of these data products in 3-D and in flat map projection. These are stacked data products all georeferenced all co-registered from a variety of missions. It allows you to view the surface of the moon seen through a great many different instruments from a number of different spacecraft. We have over 700 different data layers.

Moving on now to Slide 5, this is the first of our movies, the Moon Intro Movie. And if we click this if we start this up you'll see how with Moon Trek we are able to zoom and pan across the surface of the moon. This is in a flat map projection right here. And we'll pan and zoom to the crater Tyco. One of the first things your audiences will typically ask is well how big is it? You can easily measure the size of features by using the line tool. We'll just draw a line across the diameter and you can see 83.76 kilometers. So we're able to very easily measure the size of the crater.

But what we can also do is we can calculate an elevation profile. So here we're going to draw another line across the crater. This line will extend on either side of the rim and we'll submit that. And you can see we get a beautiful graph showing the height of the rim, and the central peak measuring the depth of the crater.

You can export this to a CSD file. So if you want to have this in spreadsheets so you can really measure the heights of mountains and the depths of valleys and craters on the moon very easily. We can also then generate -- this is a lot of fun -- let's draw a rectangle around the crater. You can draw a rectangle around any piece of the surface you want. And with that we can generate either an SPL or OBJ file for your 3-D printer.

So at the end of this movie lets advance to the next slide here which is Slide 6. And here you can see an example of a 3-D print of the crater Tyco generated using Moon Trek -- very powerful. Slide 7 now we're back to a movie and back to the crater Tyco. If we start the movie you'll see that we now are moving into what we call 3-D mode. So instead of looking at a flat view of the moon we can drop down and we can use standard keyboard game controls to actually fly into the crater. In those areas where we have particularly high resolution data we can actually even go driving along the surface as we do here driving towards the central peak of Tyco crater.

Okay at the end of that movie we'll advance now to Slide Number 8. We can also draw a rectangle around any particular area and do a lighting analysis. This is done off line where you essentially specify an area, a start date, an end date, time intervals - in increments that is. And then you can then we'll advance to Slide 9 and see an example. Again this is a movie. This is the lighting movie. And you can see how here we have generated actually a series of lighting instances across the surface of the moon, in this case Tyco crater.

Moving on to Slide 10 you can see that the output in addition to getting that movie you get the individual frames and you also will get plots of watts per square meter. So one of the things we've had a lot of students want to do is plan rover traverses across the surface of planetary bodies. And by doing this type of lighting analysis if you've got a solar powered rover you can figure out where your areas are going to be that are safe for a traverse in terms of power supply.

Moving on to Slide 11, we have right now the surface of the moon in varying resolutions. We're constantly increasing the amount of area that is in our highest mapped level resolution. But in those areas that are high resolution we can do some additional tools. So moving to Slide 12 you can see we have a slope tool. And again you can demark a certain area on the surface of the moon. And moving to Slide 13 you can actually generate in this case we have a contoured slope map.

Slide 14 you can see that there are actually a number of premade slope maps already available for you across the surface of the moon particularly in areas of what were the constellation regions of interest. And we're adding them for some of our polar regions of interest. Moving on to the 15th slide more analysis tools are coming soon. We will have machine learning implemented for crater detection in abundance, rock detection in abundance. We're also implementing an electric surface potential analysis and a path tool.

Moving on to Slide 16 you can see some sample output from the crater and rock detection. So here the system actually will go through and will recognize craters and boulders from high resolution images and will actually plot those out A in an image format. And then moving to Slide 17 you will also get graphical representations. Again this is very useful if you're going to be planning traverses across the moon's surface.

Slide 18 we talk about surface potential analysis. The plasma environment of the moon is very, very dynamic. And in shadowed areas you could have intensely negative charges. You can have positive charges in lit areas. And that can actually pose significant problems for rovers. You can potentially fry a rover by driving into an area with particularly strong surface potential differences.

Moving on to Slide 19 now we're going to advance to the North Pole of the moon. And what we'll do is we'll take a look at how all these different data layers within Moon Trek actually interact. So here we are looking at the North Pole of the moon. This is narrow angle camera image from the Lunar Reconnaissance Orbiter. This is around the crater Parry. And you can see that there are very prominent shadows wherever we look. And these shadows will shift around as the Sun moves around the horizon and azimuth. But there are always going to be very significant shadows when you're talking about the poles of the moon.

As we advance now to Slide 20 same area but now using lunar reconnaissance orbiter's LOLA laser altimeter. And you can see how that laser altimeter pierces rights through those shadows no problem and allows us to easily visualize the floors of what were previously shadowed craters.

Advancing to Slide 21 here's the same area but now we're looking using the diviner instrument aboard LRO to see a reading of average temperatures. And moving on to Slide 22, now we're looking at maximum temperatures again from the diviner instrument aboard LRO. So you can really gather a lot of different information through these different co-registered data layers.

Continuing on [slide 23] looking at that again same area there is a slope map, a pre-generated slope map for us.

And again moving on Slide 24 now we're adding in permanently shadowed regions. So not all shadows at the poles of the moon are necessarily bad. There are some areas that are permanently shadowed, areas where the Sun has not shown for perhaps billions of years. And these are areas of great interest to us in terms of the possible sequestration of volatiles including water ice. We have found deposits of water ice in these permanently shadowed regions. And the total budget of water ice at the poles of the moon could be in the billions of tons -- very, very exciting. So being able to map where those permanently shadowed regions are is certainly something very much of current interest.

Moving on to Slide 25, now we've switched to neutron spectrometry and we're looking at hydrogen abundance which is typically our key to looking for water. So that's a brief introduction of how these layers can interact. Let's try another example. And for that we're going to move away from the poles and we're going to go to - in Slide 26 the Marius Hills.

Now the Marius Hills represent probably one of the most spectacular concentrations of volcanoes on the moon. And as you look at this picture you are probably not overwhelmed by these spectacular volcanoes. They just aren't showing up at all. But what we can do is we can take advantage of the various data layers within Moon Trek. So moving on to Slide 27 we'll bring up our layers menu and we can see that there are actually thousands of things we can search for and that's pretty intimidating.

But in our search box Slide 28 we're going to enter LOLA L-O-L-A for the Lunar Orbiter Laser Altimeter. And that trims things down significantly down to only 11 layers. And what we'll do is we'll select the LOLA and TC stereo then merge. And now I'm moving to Slide 26. We can see that that same area that we were looking at now through this laser altimetry view is peppered with volcanic cones, the Marius Hills really stand out.

And the reason we weren't seeing them before is because volcanoes on the moon tend to be very subtle features. Lunar basalt when it was erupted typically is very low silicon content and therefore very low viscosity. Lunar basalt when it's erupted typically has the viscosity of olive oil at room temperature. It's really hard to build a mountain out of that but that's why we end up seeing very shallow low sloped volcanoes on the moon typically. And that's why I often times with regular photographic imaging they just don't show up. But by using advanced tools like laser altimetry we can get them to become very clear indeed.

Moving on to Slide 30, let's go ahead and measure the size of these cones. And we'll go ahead and do a distance calculation. Slide 31 we're going to select line. And then Slide 32 we have drawn a line across one of those cones. And Slide 33 we see that we get a distance back of 14.84 kilometers. That's not huge. When we look elsewhere in the solar system and we see basaltic volcanism one of the things we see are giant shield volcanoes.

Here on earth we have Mauna Loa and Mauna Kea, the largest mountains on the earth. On Venus, we have giant shield volcanoes. On Mars, we have the largest shield volcanoes the largest mountains we've found anywhere in the solar system. But on the moon, we just see these little pipsqueak cones. The question is- Where are the giant shields on the moon?

Moving on to Slide 34 we'll start investigating that. And we're going to select the option to calculate an elevation profile. Slide 35 we've drawn a line that transects right through the heart of that volcanic area, created an elevation profile and what we see is that all of those cones in fact sit on top of a very broad rise, a very, very subtle giant shield. And again, it is so subtle because the silica content and the viscosity of this lava that formed it was so very low. But using the tools of Moon Trek we can tease out those subtle features.

Continuing on to Slide 36 let's look at some of the options that are available for any layer that we've loaded. So you'll see under the layers menu on the right-hand side there's a series of icons. Slide 37 you can see we can toggle the visibility of the layer on and off. That's very helpful in blinking between different views of the same area. Slide 38 we can see how we can show information that shows up in Slide 39 so we can get essentially an abstract on the nature of the data product that we are looking at.

On Slide 40 we see there's a button the fly to position. And some data products in Moon Trek are global in nature but some are limited to specific areas. And if there are specific areas you might load that layer and then want to have Moon Trek take you to exactly where it is. That's what you can do with the fly to position button.

Next in Slide 41 we're looking at the ability to open and read metadata. So if you go to the Planetary Data System you'll find where a lot of this data comes from you'll find that we have yes the actual data products but we also have the metadata associated with those data products. It gives you the provenance of the data, tell you how it was acquired and tell you essentially the proper usages of that data.

Continuing on to Slide 42, you see we have the ability to actually download the data. If you have other tools that you want to use to massage and play with the data we can give you the data to play with. And then finally on Slide 43 you can see that you can remove any layer from your stack. So we've seen how we've stacked layers between the visible view and the laser altimetry view. Let's take that a step further.

So in Slide 44 we're going to do a search on the Kaguya space craft. And that's going to pull up several layers. And we will select from that the Kaguya Free-Air Gravity Map. So now in Slide 45 you can see how now we're looking at this area the Marius Hills but now we're doing it in form of a gravity map where blue represents low gravity and orange or red represents high gravity.

Moving down now to Slide 46 we can see again opening up the layer menu for that particular view we have a nice scale there a legend that shows us exactly what those gravity values are. And you'll notice we also have a slider bar that allows us to adjust transparency. So what we've done right now is we have loaded this gravity map on top of this stack of data. And the layer beneath it is that laser altimetry view. And so now moving on to Slide 47, if we adjust the transparency down in that top layer in that gravity map layer now we're able to see it and also see through it to that laser altimetry view. And so in Slide 48 now we have this blended view of both gravity map and laser altimetry.

And what we're able to do here is we're actually able to visualize the surface morphologies of this volcanic area then with the gravity map we're now looking down beneath the surface and we're able to visualize the now solidified un-erupted plug of magma beneath that volcanic complex. So by combining data layers and adjusting transparency between them you can actually get to data, get the information that is not available in any one data layer itself. You can blend them in ways that bring out new information. That's really powerful.

Moving on to Slide 49, once you have done this kind of adjustment one of the things you might want to do is save that information and share it. And it's very easy to do because there's an option down in the lower right there generate a URL web link. Remember that this is all done on the Web. So if you click that button you will generate a URL that encodes everything that you have done. You can then send that URL to a friend. They'll just load that URL into their browser. It'll bring up Moon Trek, pan and zoom to the area you wanted and load the various layers and adjust for transparency to re-create your visualization. That's really powerful.

Moving on to Slide 50 mineralogy is represented in Moon Trek. You will not see yet the data from the Moon Mineralogy Mapper on Chandrayaan because there was a problem with that data and it has not yet been correctly georeferenced. And again, having all our data directly georeferenced so that it can be stacked and referenced correctly between individual data products is very important. However, we do have a number of other mineralogy layers. We are going to be adding additional mineralogy. And when the M-Cubed data is corrected we will be integrating that.

Moving on to Slide 51, let's take a look again at some more layer views of what Moon Trek has to offer. So here's just a L rock wide angle camera mosaic of the Sinus Medii area. Moving on to Slide 52 the same area using diviner to look at the Christiansen feature for mineralogy. Slide 53 we've got a rock abundance mosaic. Slide 54 surface temperature mosaic.

And that surface temperature is really interesting because one of the things we're planning to add in the future is the ability to do a time series look across this data, across a variety of time, a range of time. And one of the things we want to do with that is to take a look at that diviner temperature data there's actually a wonderful huge data set looking at the temperature of the moon over the entire surface over 5-1/2 years at half degree resolution and 15-minute time intervals. So, if you really want to see the temperature history of the moon we will be able to give that to you in excruciating detail.

On to Slide 56, looking at how digital elevation model quality has evolved over time. We started out with Version 4 of the LOLA Lunar Orbiter Laser Altimetry. And here we're looking at the Hortensius Domes again some of those very flat volcanoes on the surface of the moon.

Now we'll go to Slide 57, that same area but version 6 of LOLA. And you can see how things have gotten much clearer, how those volcanic shields are really showing up much better now. And now advancing to Slide 58, we have the LOLA and Kaguya trained cameras stereo merge. You can see now that the detail is absolutely phenomenal. So things are getting a lot better. Slide 59 shows some data products that we've been developing specifically working with the Resource Prospector Mission, our next rover to the surface of the moon and developing data products for the polar areas.

Slide 60 here you can see an example of actually one of the Apollo landing sites. This is the Apollo 11 landing site. You can see the lunar module. And if you look carefully you'll see some dark squiggly lines extending above and to the left and off to the right and down a little bit towards those little dots are ALSEP [Apollo Lunar Surface Experiments Package] instruments. Those dark squiggly lines are the actual footprints of Neil and Buzz.

And one of the things that we are really excited about is that we're working with the Astromaterials Curation Office. You may be aware of how NASA has a program that loans actual samples of the moon rocks, Apollo moon rocks out to teachers and librarians. This is a very, very exciting program. And also researchers can get samples of Apollo moon rocks to study.

Now when you get one of these rocks it always has an associated catalog number. And what we are working with the Astromaterials Office at JSC to do is to get their database online and machine readable so that if you get one of these Apollo moon rocks you'll be able to just enter in to Moon Trek the catalog number for that rock and have Moon Trek take you to the place where that rock was retrieved from. Not only will you be able to study the rock in your own lab or classroom but you will also be able to study the context from which it came from. Moving on to Slide 61, you could be pairing that with the link to the Virtual Microscopes Apollo Samples Program where they have thin samples, thin sections of lunar samples. And you can even rotate the polarimetry, very exciting. So it'll give you a lot of neat ways to study the lunar surface and materials returned from it.

Okay in Slide 62, we're going to move on from the moon and where heading to Mars. This is Mars Trek, marstrek.jpl.nasa.gov. And a number of the things that we saw in Moon Trek are also available for Mars. So again, viewing the surface of Mars through many different instruments aboard many different spacecraft, visualization and flyovers. We're about to come out with a major new release of Mars Trek. And so in this view I'm going to give you a view of existing features as well as a preview of some of the exciting things to come.

So moving on to Slide 63, I'll just show you that with the release of Mars Trek we got a lot of publicity, a lot of coverage. My favorite was actually from the Register in the United Kingdom and their statement that NASA opens a big can of red planet whoop ass with Mars Trek. I didn't know that whoop ass was British vernacular but had a lot of fun with this.

Moving on to Slide 64, here we can see that there are a variety of tools that will be added to Mars Trek that will allow you to do all kinds of exciting things, many of the things similar to what we saw in Moon Trek. Slide 65, something that is coming, it's not there right now but it's coming with the new release is integration of Mars exploration films. And it's October of 2015, NASA hosted a meeting of people from around the world to start proposing where the first human landing sites on Mars should be. And we've got approximately 47 of them that we are studying. And we are now loading detailed data of those into Mars Trek. Here you can see the distribution of some of those sites across the surface of Mars.

Slide 66, we're zooming in towards the Valles Marineris area and getting a closer view at some of those exploration zones. The zones are characterized by 100-kilometer radius circles. And within those are marked areas of interest or regions of interest both for science and for resources. [Slide] 67 zoom in up further getting a closer up view of a couple of these exploration zones within Valles Marineris.

Slide 68, we're moving to a movie again. This is the movie labeled VM. And if we play that we're going to fly into Valles Marineris. We start out with regular camera view, switch from there to a laser altimetry view. As we continue in we will now switch to a THEMIS view, the THEMIS instrument on Mars Odyssey. This is the infrared imagery. Continuing down we're in 3-D mode. You can see we'll pan up. We can lower ourselves down and actually go flying into the canyon and see it in great detail.

Now we've switched to CTX view of the context camera on MRO. And we're flying across the floor of the canyon. You can see it in great detail. You can see sedimentary deposits from ancient paleo lakes. You can see individual sand dunes. And you can see that 8000-meter north wall of Valles Marineris. If this ends up being a place where you or students end up living or working it's going to be a very spectacular view indeed.

Okay at the end of that movie we will now advance to Slide 69. And here's a view again within Valles Marineris taken with a CTX camera aboard MRO. And what we'll do in the next few slides so moving on to 70 we're just going to throw in overlays of mineralogy coming from the CRISM instrument. So here we're looking at bound water poly-hydrated sulfates. So a lot of these minerals on the floor there could be sources of water, hydrated minerals.

Moving on to Slide 71 we see chloride deposits. Slide 72 iron minerals. And in Slide 73 we step back and look at a more global view of hydrous mineral distributions across the surface of Mars. [Slide] 74, we switch to a geologic map. Slide 75, we can see a list of they're all kinds of mineralogy. And we're going to be adding to that constantly as we get more and more information. So this is important because as we go to Mars, if we send humans to Mars it's far enough away that they are going to have to depend on resources there. They're going to have to live off the land. We can't bring all their resources from Earth. And so doing this kind of investigation in advance is important.

Moving on to Slide 76 we're looking at some of the few fresh objects on the surface, the recurring slope lineae where we actually see liquid water flowing just centimeters beneath the surface, new craters that have just excavated into the ground, ice filled craters and active gullies. So these are areas that are also represented in Mars Trek or will be in this next release.

Valley networks seeing where water once flowed that's Slide 77. And Slide 78, this is a laser altimetry view of the Kasei Valles, one of those giant outflow channels. And here you can see dramatically where water once flowed across the surface of Mars. And it doesn't take much imagination to figure out which way the water was flowing. You can see how it sculpted the terrain and the flow of that water.

Moving on to Slide 79, we're looking at again some of the Mars exploration zones. And those of you who enjoyed the book, *The Martian,* will recognize this area. This is Mawrth Vallis. And the regions around Mawrth Vallis featured in the story, *The Martian*, are actually definitely under consideration for human exploration on Mars. So Andy did a really good job in researching his book.

Continuing on Slide 80, we can see representations of dune fields. Dune fields could be important for resources but they are also traps. We lost Spirit, the Spirit rover to a dune field. So we want to definitely have those mapped out. In Slide 81 we can see actually how this map of dunes fields corresponds to the Bagnold Dunes at Gale Crater and see that combined with the path of the Curiosity rover as it made its way around the Western end of those dune fields.

So speaking of Gale crater in Slide 82, we have another movie. And with this we can fly down into Gale Crater. So starting the movie you start out with a regular visual view and then we will switch to this is a DTX view. We can see layered deposits and flow features on the central peak. And then going to the high rise view we can actually go flying down the slope of the mountain through one of those wash features and see how it was definitely carved out in a very spectacular way and fly all the way down toward the region where Curiosity is currently operating.

So with the end of that movie we will move to Slide 83. And this will be another movie. This time we're going to explore Gusev Crater which was the site of the Spirit rover. And we'll follow the Ma'adim Vallis a river valley as it emptied into the large Gusev Crater there and even left a delta deposit. Now a closer view going into the Columbia Hills which is the region of operation for the Spirit rover. And we can actually even look at the path of the Spirit rover and look at highlighted way points along the way, see where it stopped, read about what it found at the various locations. Continuing on to Slide 84, we have a movie of Jezero Crater. And we're going to here follow again an ancient riverbed as it passes through a low point into Jezero Crater. Jezero Crater was once a giant crater lake. And we can see again here a wonderful delta deposit. This area is of great interest. This is a prime candidate for the March 2020 rover and it is also a candidate site for human exploration.

Okay at the end of that movie we'll advance now to Slide 85. And here we see a nice close up view of Victoria Crater which was along the path of the Opportunity rover. And you can see the path of the Opportunity rover here in green. We'll drop down lower in Slide 86 to get essentially of rover's eye view. Now interestingly this picture was not taken by the rover. This picture was taken from orbit looking straight down. But by combining the imagery plus the digital elevation model of Mars you can essentially re-project all of that and put yourself on the surface of Mars as seen from any angle. So again, using the 3-D view allows you to do some pretty spectacular things.

Let's move on to Slide 87. And speaking of the 3-D view we will now fly into McLaughlin Crater. So we have a video here McLaughlin and start that. And you can see we're again starting out with a visual view flying into McLaughlin Crater. This actually used to also be a crater lake but there are no river valleys flying into it. This was actually fed by up welling groundwater. So this is very, very different, very interesting.

Look at that dark area on the floor of the crater. We'll get a closer view of that coming up here. What that actually is this is a field of Barchan sand dunes marching across the floor of the crater. There are carbonate deposits on the floor of the crater here that show that this crater lake persistence for a very long period of time. And it had a very moderate amount of acidity. So it would've been quite frankly could've been very comfortable for life there way, way back when this was at crater lake.

Advancing now to Slide 88, we see another layer depiction here. We're seeing the distribution of mid-latitude glaciers across Mars. Mars not only has ice at the poles, it not only has extensive deposits of subsurface permafrost but it has great bands of mid-latitude glaciers both North and South of the pole. There's a lot of ice locked in those glaciers.

As a matter of fact, if you took the ice just in those mid-latitude glaciers and spread it out evenly across the surface of Mars you would cover the entire surface of Mars 1 meter thick in ice. So that's just from the mid-latitude glaciers. Let's take a closer view so advancing to Slide 89. We are looking at a couple of the proposed exploration zones in the Deuteronilus Mensae region which is in that area again in this region of the mid-latitude glaciers. Moving to Slide 90 we have a video. And we're going to fly into that Deuteronilus Mensae area.

So we start out here, this is the laser altimetry view heading into an ancient degraded crater. And the floor of it looks more or less normal but look at that kind of billowy structure around the edge. We've switched to an infrared view from the THEMIS instrument aboard the Mars Odyssey spacecraft. And now we can see a really interesting tongue of material sticking out through a gap in the mountains. This is a classic example of a Piedmont glacier.

In 3-D mode will fly down even closer. And now we'll switch to the CTX camera and take a look at that bulbous amount of ice sticking out. You'll notice the color. And now here's a valley glacier. You can see the striations and flow features. These are all debris covered glaciers. There covered in dust and rocks. We also can take a look at a lobate debris apron around a mountain. This is another type of glacier. And you can see great ice cliffs in the glacier there surrounding that peak. And you can even see a giant crevasse where the ice is pulling away from the side of the mountain peak.

So that’s at the end of the Deuteronilus video in Slide 90. We’ll advance and there in Slide 91. We get another really interesting view. This is in the southern hemisphere, north of Mawrth Vallis and we see another one of those lobate debris aprons again a dust and rock covered glacier kind of flowing down from the mountain heights in the distance. And in the foreground, we can see something called a rampart crater, more or less on normal impact crater but notice the debris apron around it, the ejecta blanket that is actually looks different than what you see in a lot of other impact craters.

Instead of a fine powder of pulverized rock this looks very cohesive almost like the sploosh you would get if you threw a rock into a big puddle of mud. That’s actually pretty much what happened here. We see an impact into an area that was rich in water or subsurface ice so the ejecta blanket came out quite frankly very wet, cohesive. One of the interesting things to notice here is that the glacier is actually overlying that ejecta blanket. So we can see that the glacier here is actually younger than this impacts.

Moving on to Slide 92, we are in the process of adding HRSC (the High Resolution Stereo Camera) data from the Mars Express Orbiter. So we’re working with the German Space Agency and the European Space Agency in integrating mosaics of that data. That will be very, very exciting to have. Moving on to Slide 93, we’re planning on integrating in the future- Mars weather. So climate and weather data and the ability to have time series again that will give you essentially weather satellite views of Mars.

Going to Slide 94, the third and final Web portal that I'll talk about today is Vesta Trek, vestatrek.jpl.nasa.gov. So what we did with the moon and Mars we've also done with the asteroid Vesta courtesy of NASA's Dawn mission. Moving on to Slide 95, here you can see a 3-D view of Vesta itself. This particular layer is showing hydrogen abundance. If you look closely at Vesta, you'll see that it looks more or less round when it formed. It was actually big enough to achieve hydrostatic equilibrium. It would've been a nice perfect sphere. It's no longer a nice perfect sphere. A good chunk of the southern polar region is missing from a giant impact. You can use Vesta Trek to explore the details of that impact. It almost destroyed Vesta.

Moving on to Slide 96, we've now flown down to the surface of Vesta and are looking at an example of what we called pitted terrain which is just north of the Crater Marcia. If you look kind of just below center you can see collection of very small pits, rimless pits. And of what this seems to represent is an area where there was actually subsurface ice. And the impact that formed the crater Marcia generated enough heat to vaporize that ice beneath the surface and cause it to erupt out of the surface forming this pockmarked rimless pitted terrain. If we switch to a mineralogy view as seen in Slide 97, you can see how that pitted terrain really stands out.

Slide 98, what you've looked at here so far have been our Web portals. These are our Web clients. The real magic to this whole system is the backend. And we have a variety of different clients that can attach to it and display the data. We're working right now on virtual reality clients, touch table clients and also the ability to send data through APIs to a variety of outside systems and venues including notably planetariums.

So in Slide 99, we take a look at some of the outreach that we've been doing. We are an infrastructure portion of the Science Mission Directorate's STEM

Activation Program. We are providing data to the Hayden Museum at the American Museum of Natural History and the California Academy of Sciences. We have a variety of crowd sourced applications where we actually have the communities out there actually working with our data and creating new tools. There's a lot of outreach potential in this.

So finally let's see Slide 100, I invite you to play with these portals, help us improve them. If you know of neat data products, let us know. We'd love to make these stronger, more robust, more useful products for the mission planning communities, the science communities and the education and outreach communities. So with that thank you. Again our URL's in the final slide there and the email address for me and for me my colleague, Emily Law down at JPL. With that if I haven't put you all to sleep I'll be happy to entertain any questions you might have.

Man: Okay. A question I have is, is there any way to integrate data from the lunar meteorites, and the HED meteorites and the Smith meteorites from Mars into those programs?

Brian Day: Well the thing about the lunar meteorites is they are much more accessible but we don't know their provenance. We do not know where they came from.

Man: Yes, where they're from. Right, okay.

Brian Day: Trying to tie a lunar meteorite to an area on the surface is now strictly guesswork. For the HEDs and Vesta we can do a little bit better in that we can talk about them. And I frequently do talk about them in concert with using Vesta Trek to visualize the Rheasilvia and Veneneia impact basins because that's what gave rights to those. In terms of Mars there has been some suggestion that the shergottite meteorites that we get from Mars may have actually arisen from the crater Mojave on the surface of Mars. So it's highly appropriate to show Mojave when you're showing off the shergottite meteorite however keep in mind that, that association is not at all accepted by everybody it remains controversial. But it is potentially worth discussing. Good question.

Man: How do you spell it M-O Mojabe?

Brian Day: It be M-O-J-A-V-E.

Man: Oh Mojave oh okay. And what other question. Will there be a Ceres Trek in the near future?

Brian Day: We do have a prototype for Ceres Trek. However the prioritization that we have gotten from headquarters is that our next portal is to be Phobos Trek. So we will be generating a portal for Mars's largest moon that is in concert with Japan's planned MMX mission to the moons of Mars.

Man: Oh okay. All right, thank you.

Brian Day: Any others?

Adrienne Provansano: Yes hi. This is Adrienne Provansano, Solar System Ambassador. So I had a couple questions. One the slide you had kind of early on to me they looked very much like modern art. This was like in the 52 to 54 slide. And have you had any arts applications usage with the programs?

Brian Day: That is a wonderful, wonderful observation. As a matter of fact, sometime back SSERVI actually before it became SSERVI we were the NASA Lunar Science Institute. And we put out a booklet called the Lunar Gallery. And if you're interested in that I can get it for you. But what it was, was scientific images of the moon chosen for their artistic value. And that booklet actually became part of the VIP Package sent out at President Obama's inauguration. And since then we've gotten a lot more wonderful data. And so, I have been thinking that quite frankly it would be appropriate to come out with the new updated version of that booklet. And now that we're putting this power in the hands of essentially anyone, an interesting idea might be to open that up to eventually the world at large and go ahead and use this tool to go and explore the surface, capture images you find particularly interesting and, you know, tell us why you find them to be beautiful, why you find them to be of great interest? And then we'd kind of collect from those to create the next edition of the book. It's an idea we're playing with. And if you think that, that has value I'd like to get feedback from you.

Adrienne Provansano: Sure definitely. I'll follow-up. I see that your emails on the PowerPoint. I was also wondering is there a particular grade level this is geared towards like high school and up or are younger students using it and do you have any sort of database that shows curriculum of how it's been applied?

Brian Day: So we do not develop curricula. That's something that is very implicit upon us here at NASA. But we do provide tools that then educators can use to develop curricula. And they have been doing that.

An example is something called the Student HLS2 Project. And HLS2 refers to that meeting I was talking about back in Houston in 2015 where people from around the world got together and they proposed landing sites and they presented them and debated them. And what has been really exciting is some schools and afterschool programs have gotten together and created their own student version of the process. And for two years now, for two years in a row we've had students who will research on the Web and use Mars Trek to come up with their own proposed human landing sites on Mars. And then they get together and they debate them and they have a down select. And there is much gnashing of teeth and shedding of tears as there was in Houston. But eventually you come down with a down selected version of oh let's say I think we had this last time we had I think it was 15 or 16 sites. And then we had the students actually come to NASA Ames and present their sites here. And we filled the Space Science auditorium with students and their parents as well as a number of scientists. So it was really exciting. The students ranged in age from kindergarten through high school. So it's a real wide range. One of my favorite moments was having a fifth grader citing research done by NASA scientist Chris McKay. When one of our staff heard that happening she went running down the hall, grabbed Chris, dragged him back in to hear it. And you should have seen that fifth-graders eyes bug out when he saw Chris McKay walk into the room. It was really pretty spectacular.

Adrienne Provansano: I see. That's amazing. Thank you for sharing that.

Andrea: This is Andrea. Brian I just wanted to jump on with a few things. First of all I love the idea of a publicly sourced moon as art or Mars as art any space object as art sort of the program. And I wanted to mention that LRO also put together a moon as art collection which is on the LRO Web site. And in case you're not familiar with it the LRO camera recently put together an exhibit that was on display at the National Air and Space Museum. And it should be touring the country. But at the moment you can go to the LRO camera Web site or the National Museum of Air and Space and download all of the high-resolution images. And they are both scientifically interesting and gorgeous as well.

Brian Day: That's right. They are fantastic to see.

Heather Doyle: I think I found a lunar gallery and I've already uploaded it to the Solar System Ambassadors telecon page where they found your PowerPoint and as well as a found a nugget that you did for the Student HLS2 project and put that there as well so they can see those two projects.

Brian Day: You are so on top of things it's scary. That's great. Thank you.

Heather Doyle: Sure.

Brian Day: Anything else? With that then I will again thank you very much for allowing me to present to you and I will invite you to again play with these tools and share them with your public audiences.

Heather Doyle: Thank you so much Brian. This is great, it's a lot to absorb.

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