Mars: Crash Course Astronomy #15

Crash Course: Astronomy
https://youtube.com/watch?v=I-88YWx71gE
https://nerdfighteria.info/v/I-88YWx71gE

Hey folks, Iâ€™m Phil Plait and this is Crash Course Astronomy. You know, I canâ€™t think of any object in the sky thatâ€™s captured our imagination like Mars has. The Red Planet was once thought to be the god of war, and in more modern times has been the setting for a zillion science fiction novels, movies, TV shows, and more. And now that weâ€™ve gone there, landed there, roved there, itâ€™s become far more than a simple background for an alien invasion story: Itâ€™s become a world, a placeâ€¦ and maybe, one day, a destination. Mars is the fourth planet from the Sun, and the outermost of the terrestrial planets; that is, ones that are rocky and similar in size to Earth. It orbits on average a little over 200 million kilometers from the Sun. That puts it outside Earthâ€™s orbit, and it never gets much closer to us than about 60 million kilometers. Itâ€™s colder than us, too, with an average surface temperature of about 60 below 0 Celsius. Itâ€™s not a terribly big planet; itâ€™s only about half the size of Earth. Still, when itâ€™s closest to us in space it shines brightly in our night sky, a red beacon glowering like an angry eye. No doubt this is why ancient civilizations associated it with war! But it turns out Mars isnâ€™t red because itâ€™s bloody. Itâ€™s red because itâ€™s rusty. Literally. That red color you see comes from fine-grained dust on the surface, almost like ruddy talcum powder. The dust is rich in iron thatâ€™s oxidized, forming rust. The dust coats a lot of the surface, giving it a butterscotch or ochre coloring, and also gets blown into the atmosphere. A lot of the surface of Mars is also grey volcanic rock called basalt, and together with other minerals gives Mars its overall reddish look. We can get a decent view of Mars from Earth using telescopes, but small features are maddeningly difficult to tease out. The idea of a clement environment on Mars stuck with us, thoughâ€¦ at least until the 1960s and 70s, when we started send probes to the planet. They did not see a lovely, habitable world: Instead, what we got were photos of a dry, dead, forbidding planet. The surface geography of Mars is weird. Thereâ€™s a huge dichotomy between the northern hemisphere, which is mostly smooth plains, and the southern, which is cratered, hilly highlands. Apparently, Mars suffered a tremendous impact from an object hundreds of kilometers across eons ago. It left behind a vast basin near the north pole of the planet, which filled with lava. Topographic maps show the northern hemisphere has much lower elevations than the southern, and can be depressed by several kilometers. Walking from the south to the north pole is essentially all downhill! Another large feature is the Tharsis bulge, a huge plateau thatâ€™s home to the four biggest volcanoes on Mars, and the largest volcano in the solar system: Olympus Mons. Mars doesnâ€™t have plate tectonics today, but thereâ€™s evidence it once did. Tharsis was probably over a hot spot, a plume of hotter material rising up through the planetâ€™s mantle. Thatâ€™s what may have created the bulge, and as the plate slowly moved the plume punched through the crust to create the chain of three smaller (but still huge) volcanoes. But the grandest of the surface features on Mars is easily Valles Marineris; a canyon discovered when the Mariner 9 probe orbited Mars in the 1970s. Itâ€™s a gigantic crack in the surface of Mars 4000 kilometers long, 200 kilometers wide, and 7 kilometers deep. Thatâ€™s 10 times longer and 10 times wider than the Grand Canyon! Unlike the Grand Canyon, it wasnâ€™t carved by water; it may have formed when the Tharsis bulge rose up, creating the valley as a radial crack in the surface. Mars, like Earth, has polar ice caps. Both are mostly water ice, several kilometers thick, but they get seasonal coatings of dry ice, frozen carbon dioxide, that covers them from 1 to 8 meters thick. This happens in their respective winters; in the summer, sunlight thaws the CO2, turning it directly into a gas which then blows away from the pole, generating fierce winds. Speaking of which, Mars has an atmosphere, but itâ€™s thin. Pressure at the surface is less than 1% of Earthâ€™s, and the air is mostly carbon dioxide. In fact, as much as a third of the Martian atmosphere freezes out every winter to coat the polar ice caps! The air doesnâ€™t provide much of a shield from asteroid and comet impacts, so the surface is heavily crateredâ€"and it still gets hit today. The space probe Mars Reconnaissance Orbiter has been circling Mars so long, itâ€™s actually seen new craters from fresh impacts on the surface! However, the atmosphere is substantial enough to interact with the surface. Winds blow seasonally, filling craters with the ubiquitous dust. Thereâ€™s also sand on Mars, made of eroded basaltic rock, so itâ€™s grey. The wind blows this into beautiful dunes, including series of parallel ridges in crater floors, and barchan or horseshoe-shaped dunes. Mars also gets dust devils, towering vortices of wind similar to tornadoes. These dust devils have been seen from orbit, and when they blow the red dust around on the greyish basaltic plains, they can leave behind incredibly complex and beautiful curlicues. One of my favorite recent discoveries about Mars is that it has avalanches! There are lots of cliffs towering above the surface, and in the spring, when buried frozen carbon dioxide thaws, it can dislodge material, creating tremendous cascades of rock and dust. Several of these have been caught in the act by orbiting space probes. Mars has two moons: Small, potato-shaped rocks named Deimos and Phobos. Both are tiny; Phobos is about 25 kilometers across, and Deimos just 15. Both look very much like asteroids, and may indeed have been captured by Mars from the nearby asteroid belt. To be honest, though, itâ€™s not clear what their origins are. Phobos orbits Mars only 6000 km over the surface, and it moves so rapidly in its orbit that it orbits faster than Mars rotates; from the surface it appears to rise in the west and set in the east. Tides from Mars are altering its orbit, slowly lowering Phobos closer and closer to the surface. In a few million years, itâ€™s expected to drop low enough to actually enter the atmosphere and impact the surface. Thatâ€™ll be really exciting to watchâ€¦from a safe distance. Incidentally, from some locations on the surface, the moons can be seen to transit the Sun, passing directly across its face. The rovers on Mars have taken lots of pictures of these events, which is pretty cool. So Mars has rocks, air, weather, and volcanoesâ€¦ but what about water? If it has frozen water at the poles, what about the rest of the planet? We know thereâ€™s water ice at the mid-latitudes of Mars; some recent small asteroid impacts have white area around them; underground deposits of ice splashed out by the impact. Thereâ€™s no strong evidence of liquid water on the surface of Mars right now though. Some crater walls collapse a bit and have dark channels running down them, which look like they couldâ€™ve been carved by flowing water, but there are other possible sources too, so their cause still isnâ€™t certain. But in the past, things were different. Mars was once very wet. Thereâ€™s tons of evidence for flowing water on the surface long ago, including dry river beds, dry lakes, sedimentary layers, and minerals we know need water to form. Thereâ€™s even evidence Mars had oceans. But thatâ€™s all gone now. What happened? Itâ€™s not clear. Billions of years ago Mars was almost certainly warmer and had a thicker atmosphere. But for some reason, its internal dynamo shut down, and its magnetic field disappeared. This left it vulnerable to the solar wind, and over billions of years the Martian atmosphere was eroded away. The water went with it. This raises another obvious question: If it had air and water, could it have had life? That question wasnâ€™t taken terribly seriously just a few decades ago, but now weâ€™re very interested in it, enough to spend a lot of money sending probes to Mars to look at what conditions for life are like now and once were in the past. Itâ€™s still an open question, and we know life on Earth got its start not long after the surface cooled. Mars is smaller and cooled more quickly after its formation, so itâ€™s not crazy at all to wonder if life formed there, even before it did here. Intriguingly, the Curiosity rover detected simple organic molecules in a rock sampleâ€"this doesnâ€™t mean thereâ€™s life, but it means the ingredients were and are there. It also detected a brief spike in methane, a volatile gas that can be produced by lifeâ€¦ as well as by other, geologic processes. The evidence we have right now is maddeningly vague, but weâ€™re just starting out. Give it time! Mars isnâ€™t the same planet it used to be. But that doesnâ€™t mean itâ€™s off limits. Getting to Mars is hardâ€"over half the missions sent there have failedâ€"but not impossible. Weâ€™ve had amazing successes, including orbiters, landers, and

rovers. Iâ€™d say weâ€™ve learned as much about the Red Planet in the past couple of decades as we had in all the centuries of study before them. Still, all weâ€™ve sent are robots. Theyâ€™re good, and relatively inexpensive, but theyâ€™re slow. They can only cover so much ground. A human could do as much in a week as a rover could in yearsâ€¦ but humans are fragile. We need water, air, food; we arenâ€™t terribly tolerant of radiation or vacuum. But the idea of sending people to Mars isnâ€™t as nuts as it might have once been. Weâ€™re getting better at building rockets, and the tech needed for human exploration of Mars is being developed now. There are even discussions about landing sites, and where to build bases. One interesting idea is to use lava tubesâ€”underground caverns created by ancient lava flows, where the top of the flow cooled and created a roof. We know these exist on Mars because weâ€™ve seen holes in the roofs, called skylights, openings to the cavern below. This would provide shelter from solar radiation, protection from weatherâ€”Mars can get some pretty nasty dust storms in the springâ€”and could be sealed up and filled with air. From there, a lot of the planet could be explored, and in a few years weâ€™d once again dwarf everything weâ€™ve learned up to that point. I canâ€™t say when thisâ€™ll happenâ€”20 years from now, maybe 30 or moreâ€”but itâ€™ll happen. Eventually, there will be life on Mars. And itâ€™ll be us. Today you learned that Mars is smaller and colder than Earth. It has polar ice caps, and lots of rusty dust covering its surface. It also has the solar systemâ€™s largest volcano and valley. Itâ€™s dry now, but once upon a time was much warmer and wetter, with a thicker atmosphere. It may even have had life. Crash Course Astronomy is produced in association with PBS Digital Studios. Head to their channel to discover more awesome videos. This episode was written by me, Phil Plait. The script was edited by Blake de Pastino, and our consultant is Dr. Michelle Thaller. It was co-directed by Nicholas Jenkins and Michael Aranda, edited by Nicole Sweeney, and the graphics team is Thought CafÃ©.