Brains On (APM) | Brains On! How do volcanoes erupt? (Encore) 1QDE6EM7FG276N1S3Y4M33Z39W

MOLLY BLOOM: Hello, brainiacs. What you're about to hear is red hot. It's an encore episode all about volcanoes. At the end, there will be an eruption of newly added names to the Brain's honor roll. Listen in. Plus an all new Moment of Um! answering one of your questions. So let's dive in.

CREW: You're listening to *Brains On!,* where we're serious about being curious.

CREW: *Brains On!* is supported in part by a grant from the National Science Foundation.

[THEME MUSIC]

MOLLY BLOOM: Today on brains on, we're answering a question from six-year-old Rupert Kong from Toronto.

DESTINY RODRIGUEZ: He emailed us with this question-- how do volcanoes erupt?

MOLLY BLOOM: There are volcanoes all over the world.

DESTINY RODRIGUEZ: Alaska and Hawaii.

MOLLY BLOOM: Washington and California.

DESTINY RODRIGUEZ: Guatemala and Costa Rica.

MOLLY BLOOM: Italy and Iceland.

DESTINY RODRIGUEZ: Japan and the Philippines.

MOLLY BLOOM: And there's more.

DESTINY RODRIGUEZ: But you get the point. There's a lot of them.

MOLLY BLOOM: To find the answer to Rupert's question, we're going to travel to the center of the Earth.

DESTINY RODRIGUEZ: And we'll meet a robot who's going on a very special volcano mission.

MOLLY BLOOM: We've got an explosively fantastic song.

DESTINY RODRIGUEZ: And, of course, there's the mystery sound. Keep listening.

[MUSIC CONTINUES]

MOLLY BLOOM: You're listening to *Brains On!* from American Public Media. I'm Molly Bloom, and my co-host today is 14-year-old Destiny Rodriguez from Los Angeles. Hi, Destiny.

DESTINY RODRIGUEZ: Hey.

MOLLY BLOOM: For the first stop on our quest to figure out how volcanoes erupt, we're going to pay a visit to an old friend.

EARTHWORM: Hi, I'm Earthworm. You may remember me from my winning appearance on the game show Name the Thing. You can hear that on the Soil episode if you missed it. I'm back because *Brains On!* asked me to take my surface knowledge of the Earth. Get it, surface, like soil-- [LAUGHS]

Anyway, they've asked me to take my surface knowledge of the Earth and go deeper-- way deeper-- to the center of the Earth to find out how volcanoes form. The soil where I hang out is the top part of the Earth's crust. The closer you get to the center of the Earth, the temperature and pressure both rise. So in order to travel there, I've been given this amazing Terra craft that is resistant to high temperatures and pressures. Let's go!

CREW: There is currently no craft that would be able to withstand the pressures and temperatures at the center of the Earth. Earthworms also cannot talk and do not compete on game shows.

EARTHWORM: All right, all buckled in. Let's start at the center. Hyperdrive activate!

[ZAPPING AND WHIRRING]

Here we are at the Earth's core, a solid ball of iron.

EARTH'S CORE: Hi! I'm the Earth's core.

EARTHWORM: Whoa. Hi! Wow, the pressure here is intense.

EARTH'S CORE: I know. Even though it's so hot, the pressure here is so intense that I don't melt. I stay solid.

EARTHWORM: That's totally "hard core" of you. Get it? Hard core-- like the core of the Earth.

[LAUGHTER]

EARTH'S CORE: Oh. Ooh. Hey, hey. That joke is "solid." See what I did there?

EARTHWORM: Well, I can't take this pressure much longer. Let's start moving to the surface. Later.

[ZAPPING]

EARTHWORM: A little cooler here, but not much. This is the outer core. It's a layer of liquid iron. It's still suffocating down here. Let's get a move on.

Ah! Now, we're rising up through the mantle. We're going to keep driving through this and get to the upper mantle.

[ZAPPING]

Ah, yes. Here we are, the upper mantle. Pretty close to the surface but not quite.

Hoo! It's steamy in here. That's because we're in a hot spot. This is the spot where rocky material is warmed up from heat from deeper in the Earth. The more this stuff heats, the more it rises. The more it rises, the less pressure it feels, and the hotter it gets.

It's a cycle. And the result is magma-- melted rocks. Hey, here's some hot rocks right now.

ROCKS: Hey, nice terra craft.

EARTHWORM: Thanks. Where are you guys headed?

ROCKS: We're so hot, we're busting out of here to the surface. There's less pressure up there. And with less pressure, we can relax. We just want to get our melt on, you know?

(PITCH RISING) Check it out. That's starting to happen now. We're becoming less dense. So we rise. Hey, we got to go

EARTHWORM: Hey, I'm coming too! Wait for me!

[ZAPPING]

OK. I'm here now where the upper part of the mantle meets the lower part of the crust. This is where magma can group together into large clumps. Any minute now, our melted rock magma friends from below should be rising up to this level.

ROCKS: Yeah. Here we are.

EARTHWORM: Wow, you guys aren't rocks at all anymore. You're totally a liquid. Just like you said.

ROCKS: Yeah. Now we are officially magma-- red, hot, liquid rocks. We're pretty hot stuff, you know? Team magma.

EARTHWORM: This place we're in is called the magma chamber. It's where magma gathers just below the surface of the Earth.

ROCKS: Hey, more magma just arrived. Woo! It's a magma pool party.

EARTHWORM: As this chamber fills with more and more magma, this molten hot stuff will get closer and closer to the Earth's surface. Gas will start bubbling up out of the magma and the pressure from the gas bubbles will rise to the top of the chamber and crack the rocks around it. Once the pressure in the magma chamber gets high enough, the magma will bust through the Earth's surface in an eruption! If that happens again and again in the same place, it'll make a volcano.

ROCKS: Oh, and just so you know, once we erupt on the surface, we like to be called lava. Hot lava-- that's us. Time to make our moon. Time to erupt. Watch out, lava coming through.

EARTHWORM: Looks like this volcano is about to blow. We're going with the flow-- the lava flow. Back to you, Molly.

MOLLY BLOOM: Thanks, wormy. Now, before we go any further, strange sounds abound.

DESTINY RODRIGUEZ: Huh?

MOLLY BLOOM: That means it's time for the mystery sound.

CREW: Shh.

CREW: Mystery sound.

MOLLY BLOOM: Here it is.

[STRANGE NOISE]

Any guesses?

DESTINY RODRIGUEZ: An airplane.

MOLLY BLOOM: Good guess. While you're puzzling over that one, we have a song in honor of famous volcanoes through history. Take it away Holly and Johnny.

HOLLY: (SINGING) The volcanoes are everywhere. Some of them blow smoke in the air. Mount St. Helens, full of power, spewing ash at 300 miles per hour. The other ones you might not see are like Yellowstone because you're looking at trees. But don't worry, the scientists agree the next time it goes will be 10003.

[EXPLOSION]

Magma is hot. Most of them have funny names, like the one in Iceland I can't say. Even the syllables hurt my head, so I decided to call Bjork instead. Mauna Loa rhymes with Krakatoa, and both created massive lava flows. I was about to give up on Vesuvius when my pal [INAUDIBLE] explained lagubrious which means melancholy or sad. E-Y-J-A-F-J-A-L-L-A-J-O-K-U-L-L A-K-A-J-O-R-K

Mount Paley collapsed in 1903. Almost as impressive as Nevado del Ruiz. Sera Tambora put on quite a show. Pinatubo created massive mudflows. And volcanoes are everywhere. Hot as hot as super hot solar flare. Rending the hot and liquid Earth crusty out of the wave and covered in dust. Magma is hot.

DESTINY RODRIGUEZ: That was the song "Magma is Hot" by Holly and Johnny.

MOLLY BLOOM: Just a quick note-- there was a little bit of artistic license in that song. Lava is very, very hot, but solar flares are way, way hotter.

[UPBEAT MUSIC]

You ever had one of those questions that keeps you up at night? The kind that roll around in your brain day after day? The ones no one else seems to be able to answer? We love those questions. If you have one, send it to us at hello@brainson.org. That's how we got this gem from Annabelle in Louisville, Kentucky.

ANNABELLE: How do ballerinas stay on their toes?

MOLLY BLOOM: How do ballerinas stand on their toes? We'll answer that at the end of the episode. Stay tuned.

You know, you can also send us drawings-- we love them-- mystery sounds-- they're the best-- and high fives to that same address, hello@brainson.org. We're also planning an episode on the sleep wake cycle. And we want to know, which do you think is better-- being a morning person or a night person? Send us your answers to be part of that show. Now, let's get back to volcanoes.

You're listening to *Brains On!* from American Public Media. I'm Molly Bloom.

DESTINY RODRIGUEZ: And I'm Destiny Rodriguez. Today, we're talking about volcanoes.

MOLLY BLOOM: And it is hot stuff. So far, we found out how volcanoes form. And now, it's time to learn more about how--

DESTINY RODRIGUEZ: --and why--

MOLLY BLOOM: --they erupt. The guide for the next part of our journey is none other than our co-host here, Destiny Rodriguez.

DESTINY RODRIGUEZ: Yeah, I visited NASA's JPL in Pasadena to find out.

MOLLY BLOOM: So JPL, that's the Jet Propulsion Laboratory. But I thought they studied space. What are they doing studying volcanoes?

DESTINY RODRIGUEZ: Well, they don't only study space. They study everything from Earth science to ice to volcanoes to anything really.

MOLLY BLOOM: OK. So they study space and Earth as well.

DESTINY RODRIGUEZ: Yes.

MOLLY BLOOM: And who did you talk to there?

DESTINY RODRIGUEZ: I spoke with Carolyn Parcheta. She's a volcanologist at JPL.

CAROLYN PARCHETA: A lot of people think of volcanoes as your typical single mountain that explodes from the top. But a volcano is actually a landform, and it could be either a positive landform, like Mount Fuji that sticks up above the ground, or it could be a negative landform, like Yellowstone which actually is a caldera or a depression in the ground.

MOLLY BLOOM: Carolyn says these depressions or caldera volcanoes usually form when magma bursts out of the ground in a big, violent explosion.

DESTINY RODRIGUEZ: The ground usually sinks to fill in that space where the magma used to be. That's why it's called a depression.

MOLLY BLOOM: But if there's no explosion, if the magma bubbles up slowly, it builds on itself layer by layer, and it can grow into a mountain. That's the classic volcano most of us think of.

CAROLYN PARCHETA: You can either have an eruption where magma comes out of the ground, into the air, and then falls back to the ground, and it all starts to gel together and make a layer that eventually flows. Or you can just have a very weak eruption where magma comes to the ground surface and then flows across the ground. There's no explosion in there. That's the more common way to produce lava flows.

DESTINY RODRIGUEZ: When I think of lava, I think red and orange. And are they all red and orange? Are there different colors?

CAROLYN PARCHETA: Yeah. That's a great question. Color can tell us a lot about lava, and they all pretty much start erupting as red, orange, yellow in that color scheme. The warmer colors, the yellow, and on occasion maybe even approaching white, is really hot. We're thinking 1,200 degrees Celsius which is almost 2,200 degrees Fahrenheit.

And then, as it cools, it changes from that yellow color to the orange, and then the orange to the red, and finally red to black. And the red to Black indicates essentially that it's cooled to the glass transition where it's going from a liquid to a solid and where the lava is basically turning into glass.

DESTINY RODRIGUEZ: So what exactly makes a volcano erupt?

CAROLYN PARCHETA: Somewhere inside the Earth, the solid rock that makes up our planet has to become a liquid. And eventually that accumulates and is buoyant, and it starts to rise. And when it gets to the volcano, then it can do a couple of things. And the first is that we'll see the gas start to come out of solution. So inside the ground, it's all one fluid and the gases are dissolved.

But when it hits a certain point below the surface, the gases say, never mind, I want to be a gas not in the liquid, and they start to form bubbles. And these bubbles start off very small, but they grow pretty rapidly. And so, naturally, as you come up towards the surface, you're decreasing the amount of rock that's over it. So you're decreasing the pressure. And as you decrease the pressure, the bubbles can get larger.

And so, the bubbles are getting bigger and bigger. So these bubbles are acting like little balloons inside the magma, and they're pushing the magma up. So the ones like Hawaii, the bubbles can sometimes separate from the liquid enough that they just rise to the surface and pop, and the magma is left below. But when you get a lava fountain, you have a bunch of medium-sized bubbles that all want to get out together, and it's like a traffic jam. And so, they just start pushing the lava out of the ground.

DESTINY RODRIGUEZ: Carolyn Parcheta and her team of engineers created a special robot to explore the insides of volcanoes. It's called VolcanoBot.

MOLLY BLOOM: That's probably what I'd call a volcano-exploring robot. What does VolcanoBot look like?

DESTINY RODRIGUEZ: VolcanoBot looks like-- well, to me, at first glance, it kind of looked like a loaf of bread [LAUGHS] with two wheels at the side.

MOLLY BLOOM: But it's small. So it's as small as a loaf of bread?

DESTINY RODRIGUEZ: Give or take. Maybe one third of a loaf of bread.

MOLLY BLOOM: Wow. So that's a tiny little robot.

DESTINY RODRIGUEZ: Yeah. It has a camera in the middle, and the camera is used to film the inside of the volcano. The wheels are spiky for traction so that they can grip.

MOLLY BLOOM: Wait, so it can climb up walls?

DESTINY RODRIGUEZ: Yes, it can climb up walls.

MOLLY BLOOM: And did you get to drive it?

DESTINY RODRIGUEZ: Yes, I did. That was an awesome experience.

MOLLY BLOOM: You had a remote control?

DESTINY RODRIGUEZ: Yes, I did. And I moved it forward, and backward, and side to side. But it was very stressful too because Carolyn was wearing sandals and flip-flops, so I didn't want to run over her toe or anything. So that was pretty stressful.

MOLLY BLOOM: Yeah, with those spiky wheels that would probably hurt.

DESTINY RODRIGUEZ: Right.

MOLLY BLOOM: And what are they going to do with VolcanoBot?

DESTINY RODRIGUEZ: Carolyn plans to send VolcanoBot into a fissure that appeared on Kilauea in Hawaii.

MOLLY BLOOM: And a fissure is a crack in the Earth?

DESTINY RODRIGUEZ: Right.

CAROLYN PARCHETA: Yeah. So we want to know the shape of this fissure this crack that erupts magma. It's the most common style of eruption on Earth and in the solar system. And we don't actually know much about it. Because after the eruption happens they get clogged, and we can't access them.

So this one, for whatever reason-- we don't know-- didn't get clogged. And that's one thing we hope to find out-- why not? The other thing is what is the shape. Because the shape is probably very similar in all these eruptions, and we can understand how the eruption actually works if we can document the shape.

MOLLY BLOOM: So that's what VolcanoBot will do. It will climb down to the fissure so we can better understand these important volcano features. And Destiny, you're very interested in NASA and perhaps hope to work there one day. What was it like to visit?

DESTINY RODRIGUEZ: That was a really awesome place. We saw the control room. That's where all the missions are controlled from-- all the space missions. And we got to see a replica of the Mars Rover.

MOLLY BLOOM: Nice. That's awesome.

DESTINY RODRIGUEZ: If there were ever a zombie apocalypse, that would be the best place to go to.

MOLLY BLOOM: Why?

DESTINY RODRIGUEZ: Because they can build something so that you survive, and there's a Starbucks in there.

MOLLY BLOOM: That sounds like--

DESTINY RODRIGUEZ: So, you know.

MOLLY BLOOM: --the perfect place to be during a zombie apocalypse.

DESTINY RODRIGUEZ: Of course.

MOLLY BLOOM: Well, thanks so much, Destiny. It sounds like an awesome trip.

DESTINY RODRIGUEZ: It was. It was an awesome trip.

CREW: Ba ba ba ba ba ba ba ba ba ba ba ba Brains On!

MOLLY BLOOM: Quick note, since this episode aired, that volcano researcher, Carolyn Parcheta, has left NASA's Jet Propulsion Laboratory. Now, she's an operational geologist at the Hawaiian Volcano Observatory. She says it's her dream job. VolcanoBot, on the other hand, isn't doing much at all these days. It's still functioning, but it's waiting for a new mission. Hang in there, buddy.

CREW: Brain's On!

MOLLY BLOOM: So you ready to go back to that mystery sound? Let's hear it one more time.

[STRANGE SOUND]

Any final guesses?

DESTINY RODRIGUEZ: Not really. I'm going to stick to my--

MOLLY BLOOM: Stick to airplane?

DESTINY RODRIGUEZ: Yes. For the answer, here is infrasound specialist Milton Garces.

MILTON GARCES: That was the infrasound from magma jumping out of the Pu'u O'o crater at Kilauea volcano. My name is Milton Garces. I'm with the University of Hawaii, and I listen to very deep sounds from the Earth.

Infrasound is sound below the hearing threshold of the human ear which is about 20 cycles per second. And it's produced by very large things that either move or explode-- so big things that blow up. And one of its advantages is that it can go very far, thousands of kilometers sometimes.

MOLLY BLOOM: Milton speeds up the sound so that our ears can hear them.

MILTON GARCES: They give you early Warning of large threats-- meteors, volcanoes, tsunamis. They'll have a unique acoustic signature. And if you can recognize it, that's your cue to run.

So we have a global network that picks up a lot of this continuous vibrations of the atmosphere, and we look for anomalies. We look for transients from big things. We're essentially gathering information at the speed of sound.

MOLLY BLOOM: Have you imagined what it would be like to live next to that volcano Kilauea? We talked to someone who knows what it's like.

K PERRY: I am [INAUDIBLE] Perry and I am 11 years old. I live in Volcano, Hawaii. I live about two miles away from it, and it's not that great of an effect on our daily lives. The only real thing that could endanger us, so to speak, is the volcanic gases that come from the volcano. And they give you headaches, and it's terrible.

It smells like rotten eggs. I mean, you just kind of have to be mindful that it's there and it can give you a headache. And it's not like it'll physically hurt you, but it is very uncomfortable to have a headache all day because of the volcanic gases.

MOLLY BLOOM: Lava flows not too far from [INAUDIBLE] house. But it's not exactly the flow you might be picturing.

K PERRY: Most people think of a volcano is exploding with lots of ash being thrown up into the air, but our volcano is more of something just kind of flowing out slowly. It's not like a runny river of orange stuff. It's more of a black creeping hand that sort of reaches out over the forest and burns whatever is in its path.

MOLLY BLOOM: Pele is the Hawaiian goddess of the volcano, and she plays a very important part in Hawaiian culture.

K PERRY: Normally, you ask for permission via a chant to enter the crater or the area that you're going to. And then when you leave, you have to thank her for letting you come.

MOLLY BLOOM: Milton Garces has actually named some of the sounds he's recorded from the volcano Pele's chants.

MILTON GARCES: It's a sound that is very harmonious and very melodic. And some volcanoes are horrible singers. They sound really rough, and it's just not a very nice sound. But Halema'uma'u, from THE moment it was born, it had a really nice harmonic content. And it just goes on continuously.

It'll be like a chant. It just tells a story. It's a a long story. I think it has to do with their vocal chords. Just like with humans, some volcanoes have the right plumbing in there to make them some nice, and some just don't. Also depends of the processes too.

There's a difference between a song and a scream, right? And a shriek. Volcanoes erupting very violently, it's pretty much shrieking and screaming. It's hard to make that sound nice. A volcano that's bubbling contentedly, that's more of a humming kind of rumble going on.

So if you think of voice, it's a voice. Each volcano has its own vocalization-- some voicing. And because Halema'uma'u and Kilauea in general has a gentle type of eruption, I think it comes out as it's more sonorous.

[EARTH SOUNDS]

[THEME MUSIC]

MOLLY BLOOM: Volcanoes form when heat inside the Earth melts rock far below the surface.

DESTINY RODRIGUEZ: The melted rock is called magma.

MOLLY BLOOM: When enough magma builds up and gas starts bubbling out--

DESTINY RODRIGUEZ: --the pressure increases, and the volcano erupts.

MOLLY BLOOM: But since we can't go inside volcanoes, there are still many mysteries left for scientists.

DESTINY RODRIGUEZ: And VolcanoBot!

MOLLY BLOOM: That's it for this episode of *Brains On!*

DESTINY RODRIGUEZ: This episode was produced by Sanden Totten, Mark Sanchez, and Molly Bloom.

MOLLY BLOOM: *Brains On!* Is funded in part by a grant from the National Science Foundation. We had production help this week from Marcus Arswald, Lauren Dee, and John Lambert.

Now, let's answer that question from earlier. It's time for our Moment of Um!

[CHORUS OF UM'S]

ANNABELLE: I'm Annabelle from Louisville, Kentucky. My question is, how do ballerinas stay on their toes?

PENELOPE FREEH: I'm Penelope Freeh, and I'm an independent contemporary ballet dancer and choreographer. I teach ballet and composition at the University of Minnesota, and I've been here since 2009.

[CLASSICAL PIANO]

Pointe shoes are designed to help dancers go onto their toes so they don't go on their toes without these supportive shoes. In fact, it's dangerous to do that. And the idea is that their toes are straight and not curled under inside the shoe. Typically, girls get the go ahead to go on pointe around the age of 11, assuming they've built up appropriate muscles. They're at a place in terms of their development where their bodies can handle it. We look for strong ankles, a dancer's ability to fully have their knees straightened, and then strength of the foot as well.

Some bodies are lined up so well that when a person is on point, that's actually incredibly comfortable for them. And it's quite safe actually because of the support of the shoes. The shoes are created in a paper mache fashion. So it's layers of fabric and glue and fabric and glue to make them hard.

What's interesting about that is those do then break down so they sort of melt or "die" as we say. But in that process, they conform to the foot really nicely. So there's the sweet spot in the middle of breaking in a shoe where the dancer feels completely supported because the shoe has softened around their foot and is very much supporting it.

MOLLY BLOOM: I'm going to pirouette and chassé my way through this list of names. These are the kids who keep this show going with their energy and ideas. It's time for the most recent group to be added to the Brain's Honor Roll.

[LISTING HONOR ROLL]

CREW: (SINGING) Brains Honor Roll. High five.

MOLLY BLOOM: Thanks to Jess Horowitz, Sam [INAUDIBLE], Eric Wrangham, Lyman Perry, Tamar Elias, Anna Halpern, John Gordon, Colin Campbell, Albert Rodriguez, and Holly and Johnny.

DESTINY RODRIGUEZ: To hear more episodes, head to our website brainson.org.

MOLLY BLOOM: While you're there, you can subscribe to our newsletter to find out about new episodes and other fun stuff. Find us on Facebook and follow us on Instagram and Twitter at Brains_On.

DESTINY RODRIGUEZ: Thanks for listening.