But Why: A Podcast for Curious Kids

How Are Rocks Formed?

April 23, 2021

Jane [00:00:21] This is But Why: a Podcast for Curious Kids from Vermont Public Radio. I'm Jane Lindholm. On this show, we take questions from curious kids just like you and we find answers. Hold onto your seats, because today things are going to get rocky. That's right. We're answering questions about rocks.

Katherine [00:00:43] Hi, my name is Katherine and I'm eight years old and I live in Omaha, Nebraska. And my question is, how are rocks made.

Tyson [00:00:53] Hi. My name is Tyson. I live in Greenwich, Connecticut. My question is, how do rocks form?

Olive [00:01:01] Hi, this is Olive. I am seven years old. I live in Tacoma, Washington. And my question is, where do rocks come from?

Jane [00:01:13] We found someone very cool to help us out.

Hendratta [00:01:16] My name is Dr. Hendratta Ali.

Jane [00:01:18] Hendratta is not a medical doctor. She's a rock doctor. She studies rocks and teaches at Fort Hays State University in Kansas. She's a geologist. A geologist is someone who studies the solids, liquids and gases that make up the Earth, sometimes other planets as well. Hendratta Ali just studies Earth, though, and she says there's another title she goes by as well.

Hendratta [00:01:42] Yeah, I'm on Earth Scientist. That's what they called me because I look at everything that affects our life on Earth.

Jane [00:01:49] And she was thrilled to hear some of the great questions you've sent. I want to warn you before we get started, though, this episode is just a little bit longer than normal. So you might want to listen until we take a break about halfway through. Then you can take a break to spend a few minutes zooming around your yard or your room or apartment or classroom, get the wiggles out and then come back for the second half. OK, let's get right to it.

Harlan [00:02:14] My name is Harlan, I live in Aspen, Colorado, and I'm five. My question is, what are rocks made out?

Wyeth [00:02:23] Hi, my name is Wyeth and I live in Pennsylvania and I'm seven. And my question is, what are rocks made of?

Jane [00:02:34] What are rocks?

Hendratta [00:02:35] Rocks are really are the hard part of our earth, if you think about it, the really solid, hard part of our earth are rocks. They are generally very, very large. But usually what we see are the tiny bits that have been plucked from there, broken, shaped

and moved around. But if you took off all the trees and the dirt and the waters, what you would see would be an endless stretch of rocks that just covers all our earth.

Jane [00:03:11] But if you were peeling back the grass and trees and soil to see all that rock, it wouldn't necessarily all look the same. The earth is covered by different types of rocks, and the rocks on earth can move around.

Hendratta [00:03:27] Rocks move and change because of all the things that are on earth, because of our environment, our climate, water, the weather, heat cold. These are the things that would transform rocks from one type to another and give it the character that it gets where it is at any given time.

Booker [00:03:49] My name is Booker, I'm six years old, I live in Manhattan, Montana. I want to know how are rocks formed?

Vivian [00:03:57] Hi, my name is Vivian and I am six years old and I live in Portland, Washington. And my question is, how are rocks made?

Emily [00:04:08] Hi, my name is Emily. I'm seven years old. I live in Atlanta, Georgia. And my question is, how do rocks form?

Miles [00:04:18] I am Miles. And I live Evergreen, Colorado and five years old. My question is, how do rocks get made?

Jane [00:04:27] How are rocks made? How are they formed?

Hendratta [00:04:30] This is a most important question. Thank you all for asking! To know how rocks are made, maybe I have to tell you about the things that make these rocks, you know. So in a way, I want to talk about where and how rocks start their lives. If you think of them as having lives, then we talk about them starting their lives just like babies.

Jane [00:04:56] Although they aren't alive, just to be clear.

Hendratta [00:04:58] They are not alive. Yes, they are not alive.

Jane [00:05:01] OK, we've established that rocks are not alive. However, they do have different stages. And Hendratta says it's kind of easier to understand if you think about it a little bit like a life with different stages, like baby, child, older adult. And I hope you're not listening to this while you wait for breakfast or lunch or dinner or something, because the way Hendratta Ali describes the early stages of the three main types of rocks, well, it just might make you a little hungry, like take this first group of rocks.

Hendratta [00:05:36] First rock, start their lives like very hard, runny, yummy, creamy soup. The soup is called magma. Makes me want to eat. OK, we'll do that later.

Jane [00:05:51] Yeah. You do not want to put magma in your mouth though.

Hendratta [00:05:53] No, don't do that. It is hot but we'll call it the runny, yummy, rock soup. OK, let's just call it the runny yummy rock soup. The second rock starts their lives in a different way, like tiny weeny candy bits. Don't eat rocks, but we call them sediments, like we're scientists so we call them sediments. I will call them tiny weeny rock bits because I just like it, right? And then the third type of rocks, they start a stretchy, bendy

play dough call protolith. So we'll just call them stretch bendy, rock dough. There, so those are the three ways that rock start their lives.

Jane [00:06:43] OK, so that's how the three main types of rocks start their development. We're going to learn more about each of these rock types, starting with the one Hendratta describes as soupy. These rocks are made from magma. That's the hot runny stuff she was talking about. The rocks that come from magma, once they have hardened, are called igneous rocks. Let's learn more about them, starting with that soupy stage.

Hendratta [00:07:09] The soup is really, really, very hot and it comes from deep inside the earth through a volcano, right? Comes through a volcano. When the rock soup comes to the surface, it starts to cool because it is not as hot on the surface, as it is deep, deep, deep inside earth. It becomes cool and it becomes thicker and it is not so runny anymore.

Jane [00:07:38] It will cool into a rock. These are volcanic rocks. They can be different colors and can actually develop bright, shiny crystals inside some of them. Again, all rocks made from magma are called igneous rocks and they're often formed deep inside the earth, although sometimes volcanoes will erupt above earth's surface and create new volcanic rocks right on top of the earth. The second group of rocks is made up of little rock bits, these are called sedimentary rocks. So sedimentary rocks are made up of sand and dirt and sometimes leaves and plants and even animals that get pushed together and over time with a lot of pressure, turn into rocks. You'll sometimes find shells of ancient animals inside sedimentary rocks. Here's how Hendratta describes them.

Hendratta [00:08:32] Teeny, weeny rock bits. Tiny, sometimes not so tiny too. But they're smaller than the big giant rocks. These rocks, I call these particles or this base from which the rocks form are called sediments because they are loose. You can pick them up, you can throw them around. They are just tiny little baby rocks that are smaller than the big rocks. When these baby rocks gather in a large part, sometimes this parasite in the lake, the river or even the ocean and the park and other tiny bits of rocks or particles or sediments begin to fall on them. They get buried. They get buried. And they go deeper and deeper and deeper inside the earth. And suddenly the weight of the other particles that are sitting on them begin to squash them and they become packed closer and closer together. And because they are in water the water also has glue that we call cement. And as these bits of particles get packed and glued together, they begin to form rocks that we call sedimentary rocks.

Jane [00:10:09] The force that's pushing all of those rock pieces together, along with the water, which acts like a glue or cement, is what binds those little rock pieces together into a new, much bigger sedimentary rock.

Hendratta [00:10:23] The interesting thing though, is that sometimes the glue is soft, just like paper glue, and so the rocks are not bind so hard. And sometimes the glue is really tough, like super glue and the rocks are stuck together, the sediment are stuck together and the rock is really hard. It just depends on what Mother Nature really wants to throw at us.

Jane [00:10:48] OK, so now we know about igneous rocks and sedimentary rocks. The third main family of rocks is called Metamorphic Rock, and that's what Hendratta calls stretchy, bendy, rock dough when it's in its early stages. And you know that when dough is cooked, it becomes something different, bread or a cookie or something like that. But different from when it was just dough, right? Well, that's key to metamorphic rocks.

Hendratta [00:11:18] This rock is a whole rock that does not break into particles, but it is morphed, right, like a dough into something different, which is a new rock. So you have an old rock like we called protolith that is heated because of the hot temperatures that are deep, deep underground. It makes it a little bit soft. And because of all the pressure that is under rock, the rock can be stretched, can be bent, can be squashed. It's kind of morphed into a new rock that we call a metamorphic rock. So this is this stretch of bendy rock because it does not really melt into a magma. It does not break apart into particles. It just as a big giant rock gets transformed into another rock because of temperature, high temperatures and pressure.

Jane [00:12:23] And it's interesting because I think metamorphic if you go back and look at the history of that word, it means change, right? So this idea of this rock is that it's been changed, morphed, reshaped and changed over the course of its life, as you call it.

Hendratta [00:12:41] Yes, it's been morphed from an old rock into a new rock by the transformation, right? Now I want to go see it a metamorphic rock.

Jane [00:12:51] Well, good. I'm glad you said that, because we also got a question from Olivia, who's nine. Olivia lives in Virginia.

Olivia [00:12:59] And my question is, how did the rocks in my backyard originally form?

Jane [00:13:03] Now, Hendratta, I don't think you know exactly what rocks are in Olivia's backyard, but if we wanted to find out what kind of rocks we have in our landscape around us and how they were formed, how could we figure that out?

Hendratta [00:13:18] There are so many clues that geologists would use to figure out how the rock in your backyard formed. First, you look at the rock, you just look at it to see if it is made up of so many different types of minerals or bits and pieces. Then you look at if you can tell what types of minerals those are and how they are arranged in the rock, that is a big clue. We talk about texture. Just like the texture of a fabric, how it looks, how they are arranged and what color they have. Some rocks like igneous rocks crystallized the form crystals and you can see beautiful crystals that are tightly packed together. Sedimentary rocks because they are formed from bits that are put together. Sometimes they have tiny little bitty holes in them that we call pores. And so often if you even drop a bit of water on that rock, sometimes it might soak the water because of these tiny little bits of holes in them. So you would know that maybe this is a sedimentary rock. Metamorphic rocks, like I said, sometimes they're stretchy, bendy. So look at the minerals or the particles in the rock. Sometimes they're stretched, stretched in one direction or another, or they're just squashed into one big blob. So there are some clues that we look at. So I don't know what rocks are in her backyard. But also, if you just look at the history, sometimes you can just look at the history of a place and say this place, because it was a lot of water and sedimentary rocks mostly formed in water, chances are the rocks in this area are sedimentary rocks. So sometimes you kind of also have a best guess like that.

Lukie [00:15:26] Hi, my name is Lukie and I'm six years old. I live in Massachusetts. And my question is, how did how do big rocks get created?

Jane [00:15:39] Maybe we could talk a little bit about why some rocks are bigger than others or, you know, are are all rocks just pieces that have fallen off of bigger rocks, you know, is there a difference between a big rock and a small rock?

Hendratta [00:15:53] So do we get what we usually call rocks? When I say I have a rock, really what I'm saying is I have a piece of a rock, what we call a rock sample, right. It's a piece that has been taken from a bigger rock because the rocks are so big and large, we cannot really move them because that's what we are sitting on. So we cannot move these big giant pieces of rocks. We have to take samples. Sometimes we break bigger pieces, sometimes to break tiny pieces. So it depends on the piece that is broken from that rock. Sometimes it is not us, sometimes it's nature that breaks these pieces of rocks as well, right. They may fall off a cliff. They may be broken by wind, water or maybe this crash against each other. So it really it's really an interesting way to look at rocks.

Jane [00:16:48] So I guess, Lukie, the big rocks got created the way Hendratta was telling us earlier, through those natural processes, like for sedimentary rocks, lots of small particles being pushed down on and glued together by the pressure and water. And then smaller rocks are just chunks of bigger rocks. In just a minute, are all rocks hard know some rocks are so soft, you can draw with them. Take a couple minutes for a wiggle break and then come right back.

Jane [00:17:27] This is But Why: a Podcast for Curious Kids, I'm Jane Lindholm, and today we're learning all about rocks with geologist and Professor Hendratta Ali. We've been talking about how rocks are formed and we learned that there are three main types of rocks. But within those three types or families, there are so many different kinds and so many different ways they can look. I asked Hendratta to explain a little bit about how rocks can be so many different colors.

Hendratta [00:17:55] Rocks get their colors from the material that makes up the rock. And this material is called mineral, right? The minerals have different colors. They have different forms. They have different structures. So minerals are really the secret of rocks because all rocks are made of minerals and one single rock can be made of so many different minerals. And the different minerals together then gives the rock its texture and its appearance, the color that we see.

Ray [00:18:38] Hi, my name is Ray. I'm five years old. I live in Brooklyn, New York, and I want to know how do rocks get hard?

Hendratta [00:18:51] Rocks are hard because of the minerals that are in them. So when you hold a rock and you can throw it, don't hit anybody, please, and you can play with it. That's because it is hard, right? You can feel it. The hardness depends on a few things. And let me list them for you. The first is the type of mineral that is in the rock. So every mineral has a hardness. It's actually organized on a scale, what we call a Mohs Scale from the hardest mineral, that is diamond, to the softest mineral that is talc. If you have been a baby and all of us have been babies, we've probably have talc on our bottoms, right?

Jane [00:19:34] Yes. We think of it as talcum powder: baby powder. That's just talc.

Hendratta [00:19:38] Baby powder. That is just talc because it is the softest mineral, it's so soft we want to put it on our bodies and rub it. That is a soft mineral. Then the hardest mineral is diamond. So diamond can crush almost any other mineral, right. We cannot easily crush diamond.

Jane [00:19:58] In fact, diamonds are used in a lot of tools. People think of diamonds and jewelry and fancy things, but diamonds are sometimes used in tools because they are so hard,

Hendratta [00:20:07] Because they are so hard.

Jane [00:20:08] Want to know more about diamonds? Rosie does. Rosie is six and lives in Providence, Rhode Island.

Rosie [00:20:14] And my question is, how are diamonds formed?

Jane [00:20:18] Diamonds are formed deep in the earth where there is heat and high pressure. This can be as deep as 100 to 150 miles inside the earth. Most of the diamonds in the world are formed in special rocks called kimberlites, that form from magma. The heat and pressure in the magma caused the carbon inside the magma to crystallize. That means to grow crystals and make diamonds. Diamonds are not really rocks. There are minerals that are formed from just one element carbon. Diamonds are pretty interesting and precious, as Hendratta said, they are the hardest naturally occurring mineral on Earth. They are also all very, very old. Every naturally occurring diamond on earth is more than a billion years old. Some are more than three billion years old. But if diamonds were formed so long ago and so deep below the earth's surface, how do we get them today? No one is digging 150 miles into the earth to get them out. These diamonds have mostly been brought up closer to the earth's surface over the ages by volcanic explosions. Which brings us to something else neat about diamonds. You know how we've been talking about the different kinds of rocks, igneous, metamorphic and sedimentary. Sometimes you can find examples of all three of those processes in the same rock area. Diamonds, as I said, are metamorphic minerals. They were made when carbon was put under extreme pressure and heat and these diamond crystals formed mostly within vertical tubes of igneous rock. And those igneous rock tubes are often found in larger sedimentary rocks. Pretty cool, huh? One more thing on what might make a rock hard or soft beyond just the individual minerals that are kind of like the ingredients of the rock.

Hendratta [00:22:15] The second thing that can make a rock, hard or soft, are the amount of tiny, bitty holes or spaces that are found in the rocks. Sometimes they are really tiny. We cannot see them with our eyes, but they are there. Like I said, one way you can test that is to drop a little bit of water on a piece of rock and see if it soaks the water. If that rock soaks the water, says that it has pores it has tiny spaces in it. So if a rock has a lot of pore spaces, it will be softer than a rock that does not have a lot of pore spaces.

Jane [00:22:51] Here's a question from Kiah that has to do with hardness and softness too. Kiah lives in West Linn, Oregon, and is 10 years old.

Kiah [00:22:59] Why can you draw with the rocks?

Jane [00:23:02] Why can you draw with some rocks?

Hendratta [00:23:04] Oh, why can you draw with some rocks? That has to do with the hardness of the minerals that that in the rock. So let me say this again. The things that make rocks soft because we can only draw with rocks literally soft and sleek, which means that they are soft that the minerals in those rocks are also smooth and shiny so that when we draw with them, we can actually see it, right. So the softness of the rock, and that depends on the minerals that make up the rock. So, for example, say talc, maybe calcite,

what other minerals are slippery and smooth so that when you pull it on a surface, it can leave your mark and also whether the mineral has a color that you can distinguish from what you are drawing on. So if a rock has all of these three properties, then you can draw with it. And an example is chalk, right. You know, about each other that you use in the in school. But there's a rock that is called chalk. It is made of a soft mineral that we call calcite. But these are really tiny, tiny microorganisms that died a long time ago. And you can draw with it. But another mineral that we don't even think about, that we draw with it every day. That is, it is soft, it is slippery, it is smooth, is graphite. If you had a pencil, you'd probably used a mineral to draw. OK, it is dark. The color is really dark and black. So when you write on a white sheet of paper, you can see it because it's shiny. So yeah, that is, that's my favorite mineral because I use it every day.

Jane [00:25:07] So we are writing with rocks every day.

Hendratta [00:25:10] We are writing what minerals, not rocks, with minerals, the mineral is graphite and the graphite can make a rock. Actually graphite is really interesting because the same substance that makes up graphite is the same substance that makes up diamond. Can you imagine you can go from graphite and become as hard as diamond.

Sahara [00:25:35] My name is Sahara and I'm five years old and I live in Nairobi, Kenya. And my question is, how do rocks shine?

Jane [00:25:50] Sahara wants to know something that you were kind of just talking about with graphite. Why are some rocks shiny and how do they shine?

Hendratta [00:25:58] This is the most fascinating question I have ever had, Sahara. This question makes me think. So rocks shine because of the way minerals reflect light. I use the word reflect is a big word, but really what I'm trying to say is just a way light bounces off of a surface and gets into our eyes so we can see. So some surfaces and some minerals, they are so smooth and slick that they bounce the light off in a very uniform way, in a smooth way. And that makes us see things as shiny like the mirror. And then some things, the surface is not very smooth, even though it may look smooth, but it's a little bit rough if we really look close. So they bounce the light in a scattered manner and that doesn't give us the shine.

Jane [00:26:56] While we're talking about shiny things, we have a couple of questions about shiny rocks, other shiny rocks.

Esther [00:27:04] Hi, my name is Esther, I live in Arlington, Massachusetts, I'm six years old, and my question is, how are rocks made? Oh, how are geodes made? How are geodes and crystals made?

Hendratta [00:27:27] Oh, I could use the "o rocks".

Jane [00:27:32] The o rocks?

Hendratta [00:27:33] Yes, geodes are rocks that often look like Os, right, because they're enclosed, so the o rocks and they often have crystals in them. So they are really exciting. I like geodes. If you take an old geode and you break it, you may see crystals. The crystals are made because remember I said sometimes rocks have really tiny, bitty holes on them. So when do geode, the O rock that has this cavity inside has tiny holes in them, water soaks into the geode and this water brings with it chemicals that start to grow as crystals. It

takes a really long time because the crystals take their time because they want to be beautiful. They really do take their time. They grow slowly and over time as more water seeps, and soaks into the O, the crystals grow and grow. And someday they are big enough that if we take it and break it, then we see the crystals. So the older the geode, the larger the crystals, because this has had time to form nice and long, and they're usually very beautiful colored minerals. So it's not just one kind of mineral that is in the geode, right. You get several different colors, several different crystal forms, because so many different minerals can get in through that water.

Jane [00:29:07] I spent a lot of my childhood using a hammer to break every round rock that I found in the hopes that I would find a geode. But I didn't usually find, well, I don't think I ever found a geode inside any of the rocks I smashed.

Hendratta [00:29:21] Oh, but you found some other things, right?

Jane [00:29:24] Uh huh.

Hendratta [00:29:25] That is good. However, kids, if you're going to break a rock, please do get an adult.

Jane [00:29:30] Good point.

Hendratta [00:29:31] Some geodes are really hard. Remember, we talked about hardness? Some can be really hard that you hit it and you hit it and you hit it and it doesn't break. And you need an adult to come help you.

Jane [00:29:45] And when you're breaking rocks, especially if you don't know how hard the rock is, you should wear protective eyewear so that you don't hurt your eyes.

Hendratta [00:29:52] Wear protective eyewear, wear gloves, put the rocks in a sock, maybe so that it doesn't scatter splinters all over. Just be careful.

Jane [00:30:03] Our last question comes from Monroe.

Monroe [00:30:06] I was born in New York City and I moved to Los Angeles, California. I'm six years old. And my question is, why do some rocks have gems in them and others rocks don't?

Jane [00:30:22] Why do some rocks have gems in them and other rocks don't? So we've talked about geodes, but there are also rocks like a rock that I used to look for a lot in Maine that had little flecks of garnet inside it. And garnet is a gemstone. It wasn't a big honkin' garnet piece, but it was a rock that had gemstones in it. So why do some rocks have gems and some don't?

Hendratta [00:30:46] The way I want to answer this question is some rocks have gems in them because rocks are like cookies. There are so many types of rocks, and like so many types of cookies. Sometimes they have goodies in there. It may be chocolate chips, it may be M & Ms. It maybe nuts. Whatever Mother Nature chooses to put in these rocks can create gems, right? Gems are minerals that have bright colors, beautiful crystal forms, shiny. So they have characteristics that we enjoy. So if you see a rock that have these minerals, then that rock has gems sometimes an igneous rock would have minerals that have gemstone in them. Sometimes you have a sedimentary rocks, sometimes you have a

metamorphic rock. So it really is not one particular type of rock. It's just the kind of minerals that makes that particular type of rock. And it depends on what was in the yummy soup, what type of particles or bits came together or how the rocks were stretched and bend to put those gems together. So it's it's not one particular type of rock. And also, let me just say something. I think gems depend on who is looking at them. So sometimes if you see a rock that has really beautiful crystals, minerals that you like and enjoy. That's your gem. It's precious to you. There are some that we all agree because we all can see that there are shiny and that they look beautiful, but some that are very unique to each person and that is OK too.

Jane [00:32:41] A gem in a rock might not look as shiny as you'd see it in a piece of jewelry, right, because it's not been smoothed and polished. So it's not necessarily going to blind you when it catches the sunlight in the way a piece of jewelry might.

Hendratta [00:32:55] It's like dressing up, right? You have to put some effort into it to make it look really nice. So instead of just being in your pjs and then by the end of the morning, you're so dressed up and you look so flashy and beautiful and handsome, however you want to look, that's the same things that we have to do with gems. We have to take them and polish them up for, fire them, bring out the shinyness and the smoothness, help them reflect light better so that we can appreciate them.

Jane [00:33:31] Well, so now every day when I get up and I brush my teeth and I put on my clothes and put on my glasses, I'm going to walk around and say, now I am a gem.

Hendratta [00:33:40] Yes, indeed. That's what I want everybody to think about. When you get up and you get ready for the day, think of yourself as a gem. You're a gem to the world

Jane [00:33:51] And all of you are gems too. Thank you so much to Hendratta Ali for answering all of our many rock questions. She's a professor of Earth Science at Fort Hays State University in Kansas.

Jane [00:34:04] Oh, and before we go, Hendratta taught us how we can make diamonds first, take something with carbon in it, buried deep inside the earth so there's no oxygen, then put enough heat and pressure on the substance to make it become soft. Third, Hendratta told us, make sure there's not too much heat to melt it all together and over time with all that pressure, you might start making graphite. Remember, graphite is also made of carbon. It's the softer mineral that's in our pencil tips. But if there's enough heat and pressure over time, you'll get a diamond. All right, I think you've probably guessed that you can't actually do that yourself. That is a naturally occurring process that happened billions of years ago to make the diamonds that we have today in our tools and in our jewelry. There are people who are making synthetic or artificial diamonds. But all of those natural diamonds came through that long ago and deeply involved process. Still, it's kind of neat to think about how diamonds are made in that simple way and maybe to imagine we could make them ourselves.

Jane [00:35:16] OK, that's it for today. If you have a question about anything, have an adult record it for you. Tell us your first name, where you live and how old you are, and then what your question is. You can e-mail your question to questions@butwhykids.org. Our show is produced by Melody Bodette and me, Jane Lindholm at Vermont Public Radio. Our theme music is by Luke Reynolds, were distributed by PRX. We'll be back in two weeks with an all new episode. Until then, stay curious.