

QUEST #103: Origins

(Christine Young, Program Host) Maine has undergone a number of facelifts from glaciers. Powerful earthquakes have shaken Maine in the past and more big quakes are expected, and along with the changes geology has brought have come legacies, such as gemstones and natural spring water, but there also are some geological gifts we don't need.

I'm Christine Young. A New Way of Looking at Maine Geology. Next time on "Quest: Investigating the World We Call Maine".

Introductory music.

(Christine Young, Program Host) Coming up on "Quest," how glaciers, volcanoes, earthquakes, and other geological events have drastically altered how Maine looks. Our state has experienced much change over time. We hear how Maine at one time could have been basking on the equator; then go into a deep freeze with two-mile thick ice sheets on top of us. Geologists can also tell us what Radon, gemstones, blueberries, and natural spring water have in common, and there's some sophisticated technology being used in Maine potato fields, and in the Gulf of Maine for mapping our rocks and soils. Maine's origins, that's what this "Quest" is all about.

Maine's Public Television's Production of "Quest: Investigating the World We Call Maine," is funded through a Television demonstration grant from rural, economic, and community development, part of the USDA.

Music.

(Christine Young, Program Host) Hi, I'm Christine Young. If someone told you that parts of Maine look more like Europe than they do New England, what would you think? What if you were told that North America sits on a plate, and was sliding westward away from Europe and toward Asia at the rate of a half inch a year? Or that powerful damaging earthquakes are predicted for Maine. Well at this point you're probably saying it would be a good idea to consult some geologists. Well don't bother, we've already talked to some and asked them to explain all this to us. We begin this "Quest" with a big picture on Maine geology. Dana Hutchins has more.

(Dana Hutchins, Segment Host) Most of the time the earth seems like a predictable and stable kind of place. But at the core of our planet is a red hot caldron of molten rock running a temperature of 10,000 degrees Fahrenheit. The earth's crust is broken up into pieces that move around. That's why earthquakes and other such terrors can strike in Maine or anywhere else in the world. In both subtle and obvious ways the earth regularly rejuvenates and reinvents itself and as the earth has evolved, Maine also has taken on a number of facelifts. With a story as old as geology you'd think that scientists would know how all the parts fit together.

But when you consider geologists are asked to explain how Maine at one time was located at the equator. Then propelled northward and inundated with ice sheets, all the while being riddled with volcanoes and earthquakes you begin to appreciate the enormity of this story.

(David Kendall, Geology teacher, Author) Maine geology is complex. It takes a long time to unravel the history of any part of Maine, because the rocks have been so altered and changed in the mountain building process compared to what they were when they were first formed.

(Dana Hutchins, Segment Host) One of the most significant theories to shake up geologists surfaced in 1912. Continental drift gave geologists a whole new way of looking at why continents are moving around the globe

and how to predict earthquakes and volcanoes. The new theory was over powering at first. Fifty years after it was first proposed there was still some scientists who refused to believe it, but the evidence was too overwhelming to ignore.

Now an expanded theory called Plate tectonics is considered a geological milestone. Plate tectonics is to Geology what Darwin's theory on Evolution was to biology says the University of Maine's Mary Hubbard.

(Mary Hubbard, Geology, University of Maine) The theory was revolutionary, because for many people it was just hard to believe that the earth's crust could be so mobile, that continents could really have moved and traveled the distances they have.

(Dana Hutchins, Segment Host) Plate tectonics started out as a whole new approach to figuring the shape of continents as they change through time. Geologists now use the theory to match rock types, mountain ranges, even fossils from continents once joined, but now separated by vast distances.

(Mary Hubbard, Geology, University of Maine) People had recognized the similarity of fossils on the North American side and the European side, but didn't have a good explanation or not an explanation that was accepted and so that was a piece of the puzzle and once Plate tectonic theory was accepted, once the geophysical evidence came, then this puzzle piece was understood.

(Dana Hutchins, Segment Host) Plate tectonics is based on the idea that continents and oceans move together on broken up plates of the earth's crust. There are seven major plates and a number of smaller ones riding on the crust of the earth which is about thirty miles thick. The plates are on the move, because deep below the crust the earth's mantle is hot and turbulent. The heat released from the mantle can be felt on the surface and causes the huge plates of crust to slide around.

(Walter Anderson, Retired State Geologist) They move around like the froth on a boiling can of soup you know you get the froth and then the convection in the soup causes this froth to move around, well that's kind of a simple simplistic explanation. There's a series of plates and they all shift around over time, they move very, very, very slowly, and depending on how those convections in the mantle deep in the crust move, these plates will respond to that and there's either breaking apart or these plates come back together and collide with one another.

(Dana Hutchins, Segment Host) Yet Plate tectonics is more than continents and oceans moving around. They change their shape as well. As the plates move around some collide with one another, others become taffy-like and stretch apart.

On a global scale the plates that collide under the oceans usually form deep trenches and their edges get swallowed up. The collision of continents form mountain ranges and faults and causes earthquakes and volcanoes on the surface of the earth. In the areas where the plates stretch apart hot magma makes its way to the surface to fill the gap between plates. Ridges rise from crusts that's spreading under the oceans.

This combination satellite and radar photo shows these ridges as well as all of the earth's outer crust, even that under the oceans. The longest mountain ridge on the earth is under the Atlantic ocean just to the east of us. The mid-Atlantic Ridge runs 7,000 miles from Iceland south all the way to the Antarctic ocean.

As the mid-Atlantic Ridge continues to spread Maine which now sits in the middle of the North American plate slides westward toward Asia and away from Europe. We're moving westward at the rate of half an inch a year, much slower than our finger nails grow. On the other end of the North American plate, the west coast is grinding up against the huge Pacific plate, creating dangerous faults like California's San Andreas. Maine and the North

American plate were once part of several mega continents, The last one was called Pangaea. Pangaea included North America, South America, Africa, Europe, and Asia. Maine was found in the middle of Pangaea near the equator where Ghana, Africa, is now located. 200 million years after Pangaea formed, the huge land mass was tearing apart at the seams.

(Dana Hutchins, Segment Host) Pangaea broke up into two continents. Maine was on the continent that moved northward and eventually became Europe and Asia. When Pangaea broke up the youngest ocean on earth the Atlantic was formed. North America and Europe went their separate ways. A part of Europe still remains on this side of the Atlantic. It's called Avalonia. Coastal Maine is a slice of Avalonia. The Massachusetts coastline and the Canadian Maritimes make up the rest of it. That's why rocks on the Maine coast are much like those found in Europe than North America.

(Bob Marvinney, Maine State Geologist) When the Atlantic Ocean started forming the assembled continent that Maine was part of broke at some other location rather than where the continents originally collided back several hundred millions of years ago. So, we end up having a sliver of what had been on the other side of some older ocean.

(Dana Hutchins, Segment Host) Also, fossils found in a Maine limestone quarry are more like fossils from Europe than North America.

As continents drifted around the earth volcanoes were abundant, even in Maine.

VOLCANO MUSIC !!!!!

(Dana Hutchins, Segment Host) Most of the lava is gone, having been eroded away, but there are still some thick large lava beds to be seen in several locations around Maine. This lava rock is found near Carrabassett Valley in Franklin County. There's more volcanic evidence left behind in Penobscot Bay, Downeast, and in the Northern part of Baxter State Park. Much of the volcanic rock eroded off the mainland and filled in underwater basins like Georges Bank.

(Walter Anderson, Retired State Geologist) Right on the continental margin are these large basins, The Georges Banks Basin for instance. The Georges Banks, the Scotian Shelf, when you go up along the continental shelf, when this erosional process was taking place along the margin of the coast all the sediment over millions of years was discharged off the land mass into and filled these basins.

(Dana Hutchins, Segment Host) Much more apparent is what glaciers did to Maine. We weren't far from the center of the ice sheets in Labrador and when the last set of glaciers came about 25,000 years ago the entire landscape of Maine was altered. Most states can't say that.

(Harold Borns, Geology, University of Maine) Of course the ice pulverized material left it as fine grain stuff, but occasionally in the case of granite which is very tough material big blocks were picked up and moved around and left in peculiar places and one of the classic ones that everybody knows about is the balanced rock on the Bubble Mountains down at Acadia National Park adjacent to Jordan Pond. It's just sitting there, it's about the size of my two car garage. It's sitting up there and it was just dumped there by the ice and found stability, didn't roll down the hill, and it just got left there.

(Dana Hutchins, Segment Host) During the ice ages glaciers up to two miles thick moved through Maine. The ice completely covered Mt. Katahdin. It extended out to sea beyond Georges Bank, Martha's Vineyard, and Nantucket to Long Island, the Ohio River Valley into the east side of the Rockies. Glaciers are made up of compacted snow when too much of it accumulates to melt completely. An ice sheet is many glaciers combined. The ice sheets that

covered Maine were so thick and heavy the land was weighted down almost a mile.

(Harold Borns, Geology, University of Maine) It's analogous to having a balloon and pushing your finger into the blown up balloon, it depresses, you take your finger off, and the thing pops up to where it was before.

(Dana Hutchins, Segment Host) Each time the glaciers melted and retreated, the landscape remained sunken and the sea rushed in. At one time the coastline of Maine was much farther inland than it is today. Millinocket, Bingham, Livermore Falls, all were under water. The landscape is still springing back today. Maine was a much different place after the glaciers. Rivers had to reestablish drainage systems after the glaciers melted. That's why we can thank the glaciers for our many scenic lakes.

(Harold Borns, Geology, University of Maine) Moosehead appears to be a lake formed by the scooping out of bedrock. For example, Sebago seems to be a lake formed by blockage by sediments, looks like there was a large ice block in there and the sediments deposited around the edge and the ice disappeared and left this big basin blocked up by the sediments to the south and hence, we have Sebago Lake.

(Dana Hutchins, Segment Host) The new river systems also created many waterfalls. In many ways the glaciation led to New England becoming an early economic power. This was the only area in colonial times which had water power for mills.

(Harold Borns, Geology, University of Maine) That comes about as a result of deranging the pre-glacial river systems so, when the rivers reestablish after glaciation they don't flow in the same courses. They're blocked, they're modified, and they flow wherever they can flow, and in places they flow over ledges which produced waterfalls.

(Dana Hutchins, Segment Host) A carpet of glacial sand and crushed rock was deposited all over the surface of the state of Maine. Blueberry growers in Maine know how berries flourish in glacial gravel. These are young soils, compared to those in southern states.

(Harold Borns, Geology, University of Maine) In other words, the ice started to move back left the soils, the atmosphere, and the biology of the soils developed into the growing soils of today. So, the soils of New England, basically are less than 13,000 years old.

(Dana Hutchins, Segment Host) All around Maine it's easy to see some of the other impacts of the ice sheets. The glaciers move from the northwest to southeast. Most grooves and scratches from the ice will show that.

Hills and mountains all over Maine are asymmetrical. Their north sides are sanded down, but hills are craggy and steep on south facing sides. David Kendall wrote a popular geology guide for Maine, "Glaciers and Granite."

(David Kendall, Geology Teacher, Author) "Glaciers and Granite" that is to say that bedrock is in large part granite and the granite has been sculpted by the glacier that came through. The last one melted way about 10 or 12,000 years ago. That combination of resistant rock and the sculpting force of the glacier created the landscape that we see.

(Dana Hutchins, Segment Host) There are several mountain basins also known as cirques created by the ice. Shaped like half bowls cirques are scooped out at the head of glacially carved valleys. Chimney Pond on Mt. Katahdin is a prime example of one of these cirques. The ice ages may have left another legacy in Maine. Earthquakes. Except for the St. John uplands or what's referred to as the Alagash most regions in Maine experience mild shocks on a regular basis. There are zones where earthquakes occur in clusters. These zones are around Passamaquoddy Bay and downeast Maine, Lewiston/Auburn, and Milo. Few of the quakes are strong enough to interfere with daily life. Yet there are a few exceptions. Even long-term residents of Milo, the most seismically

active area of the state seldom notice the tremors, but 98 year old Pearl Hamlin remembers one quake in particular:

(Pearl Hamlin, Resident, Milo) The shadowbox was on the wall of the dining room and the shaking was violent enough so it came off the wall and it broke this plate and the little figurine that was down in one of the corners.

(Dana Hutchins, Segment Host) There is a potential for earthquakes herein Maine. Earlier in this century an earthquake registering 5.8 on the Richter scale was centered just off the coast in downeast Maine. The largest quake ever recorded in New England measured 6.0 in Cape Anne, Massachusetts, in 1755. That tremor leveled every chimney in Boston and caused some chimney damage in Portland, but in terms of the number of earthquakes we experience it's seismically quieter here than California. It takes 100 years for us to record the same number of earthquakes California experiences in just one year. John Ebell of Boston College's Weston Geophysical Observatory is considered the expert on New England earthquakes. He figures Maine can see a 6.0 quake every 300 to 400 years on average. We can expect a 5.0 quake every 50 years, but earthquakes here can be more damaging, because they are felt over much wider areas than in California. That's because the crust here is more rigid and tremors don't get dampened as much. Shock waves spread much farther before they die out. For example, last years north ridge quake near Los Angeles was not felt in San Francisco, just 400 miles away away.

A similar sized quake here would be felt as far away as Minneapolis, nearly 1,500 miles away. Certain soils can amplify the shaking and damage from quakes. Artificial fill, river valleys, and mud flats are the worst for earthquakes.

(John Ebell, Boston College Weston Observatory) If you were to take two quite different objects, say for instance you were to take a stone and you were to take some jello and put them both in a bowl and shake them. The stone doesn't shake very much whereas the jello shakes a lot. It amplifies the ground shaking and certain kinds of surficial geology formations also amplify the ground shaking.

(Dana Hutchins, Segment Host) Geologists disagree on why Maine experiences as many quakes as we do. Many think that the earth's crust is still rebounding from the glaciers. This theory states that the tremendous weight of the glaciers pushed parts of the underlying mantle offshore, creating a bulge that is now working it's way back under Maine. Walter Anderson and many other Maine geologists believe this fore-bulge theory, as it's called, makes sense.

(Walter Anderson, Retired State Geologist) As that fore-bulge comes in the theory goes is causing putting a strain field on the crust and once in awhile you get a creak, a groan, a break in the crust causing the earthquake.

(Dana Hutchins, Segment Host) There's other cutting edge study going on in Maine. Geologists are beginning to think the movement of plates and climate could be interrelated. Plate tectonics could lead to ice ages or vice versa ice ages could cause plates to move. If that's true, there would be away to connect all of these colossal geological events.

Music

(Christine Young, Program Host) Geologists will continue putting together the pieces if you will, of how glaciers and continents have moved around the face of the earth over the ages. In the meantime some of us in Maine make a living off what we've inherited from the monumental geological events of the past, but there are some legacies we wish nature had not left behind. If the work of geologists can help us unearth extraordinary discoveries like valuable stones and gems, it can also show us where poisons may lie hidden in our rocks. Poisons like radon and arsenic. Kate Arno describes the full sweep of Maine's geological gifts.

(Kate Arno, Segment Host) When Arthur Hussey is not teaching Geology at Bowdoin College he's out in the field making maps. Geological maps of Maine. Using a Boston Whaler, he drifts down rivers scanning the banks for outcrops and other rocks he wants to take a closer look at.

(Arthur Hussey, Geology, Bowdoin College) Geology is a field-oriented science and the basic information comes from studying the rocks in their natural habitat, right in the outcrop. I went through outcrops like this and I simply note the rock type, usually take off a fresh sample with a hammer, and I don't like to take it where it's going to be too noticeable, but take a little bit off of right in here. I always wanted to get a fresh sample of the material.

(Kate Arno, Segment Host) While a lot of Maine has been mapped, many areas were never mapped, and others are only mapped in a general fashion.

(Arthur Hussey, Geology, Bowdoin College) These are volcanic rocks. It tells us that there was around this area a totally different environment when these rocks were deposited than there is now.

(Kate Arno, Segment Host) It has been 12,000 years since the last big geological event: the retreat of the last glaciers which completely covered Maine. Oddly enough, perhaps the most important commodity left behind by the glaciers was sand and gravel.

The ice sheets pulverized landscapes, and in their wake left soil perfect for blueberry growing. Everyone producing blueberries commercially in Maine grows their fruit on glacial gravel. Sand and gravel itself is of commercial value. One reason is because southern New England has depleted its supply of it.

(Harold Borns, Geology, University of Maine) If you added up the mineral wealth of Maine each year, you would find out in 1994 for example, 26 million dollars was made in the gravel industry in this state. That accounts for the greatest income in the mineral extraction world in Maine.

(Kate Arno, Segment Host) There are sizable deposits of sand and gravel in Maine, but they are not always easy to get to, and many people don't think sand pits make good neighbors.

(Harold Borns, Geology, University of Maine) There are lots of reasons for not extracting gravel. The blueberry industry in Maine for the most part is in this general area, and the blueberries prefer growing on sand and gravel deposits, so if you remove this stuff, you've killed the blueberry industry forever for all practical purposes.

(Kate Arno, Segment Host) Most other kinds of mining have seen better days though. By far the most profitable rock mined here over the years was granite. At its peak at the turn of the century, there were more than 150 quarries operating in Maine.

(Kate Arno, Segment Host) Most of the quarries were along the coast on islands or along rivers to take advantage of water transportation to markets and rail heads like New York City. In 1901 Maine ranked number one in the nation in the value of granite being produced. The demand for Maine granite was big due to the high quality of its grain and color.

(Walter Anderson, Retired State Geologist) There are many, many structures, buildings, facades, architectural features of all sorts all over the United States built with Maine Granite.

(Kate Arno, Segment Host) Tons of our granite also are in cemeteries, dry docks, breakwaters, curbs and pavement throughout the United States.

Maine certainly doesn't have a monopoly on granite. It is the most abundant rock in the crust of the earth. It is easiest to find in area where erosion and glaciers have stripped off the rock cover. Mainers discovered there also was much granite for the taking just below the surface. Gibran Buell of Sullivan is one of a handful of Mainers that still own a working quarry. His Camwood granite quarry has produced salt and pepper colored granite since the 1800s. Buell's family has owned it for several generations.

(Thump, thump, thump)

(Kate Arno, Segment Host) Most other quarries have closed down because there is so little demand for granite. Most granite orders now are usually just for decorative stone or monuments. Yet, there is still plenty of Maine granite left to sell.

(Gibran Buell, Camwood Granite, Sullivan) People are now finding that the materials are still beautiful and haven't eroded away at all and it just lasts forever. I think the future looks pretty good.

(Kate Arno, Segment Host) Limestone also is quarried along the Maine coast. Here at Dragon Products in Thomaston, limestone is turned into cement. Once blasted out of the ground, the limestone is made into a slurry blend. Silica, a common crystal-like compound, sand, and iron ore are added to the slurry. Then the mixture is heated in large kilns to make cement.

Sea gull noise

(Kate Arno, Segment Host) However, many quarries sit dormant across the State. Maine has a number of small deposits of good grade metals such as copper, zinc, silver, and gold. Broken Hill Properties, or BHP, is one of two mining corporations still with offices in the state. BHP knows where it can find copper, zinc, and silver, but it is not mining now.

(Chris Mattson, Geologist, Broken Hill Properties) As an example, the Alder Pond deposit we had spent six million dollars and about six years work, and then we knew, based on our cost estimates, that to open up that mine would have been almost a 70 million dollar expenditure. With those costs in mind and the small size of the deposit, it just makes it, you know, uneconomic at today's metal prices and in today's environment.

(Kate Arno, Segment Host) Ground water contamination is more of a problem here than in the west where the climate is drier. Here, there is much less evaporation and more waste water to dispose of. So, are Maine minerals worth the wait for companies like BHP?

(Chris Mattson, Geologist, Broken Hill Properties) We feel that the future is—you know—that there could be deposits located that are currently unfound and exploration work that we plan to do in the future will hopefully identify those deposits and bring about a new discovery, and it will have to be large enough to bear the costs of some of the environmental considerations that would be required here in Maine.

(Kate Arno, Segment Host) There are many other mineral deposits in Maine we don't even know are there. They are called blind deposits because they are covered with thick glacial deposits. Magnetic tests done by planes flying over landscapes can detect general locations for prospective mines. Geologists also are hoping to find other ways of looking through soils to find minerals.

(Walter Anderson, Retired State Geologist) There are new techniques coming out every day especially in the area of geophysics, and geophysics is the technology that allows us to look down into the earth. As the sound waves pass down into the earth these reflected sound waves come back and give us a picture of what is under us.

(Kate Arno, Segment Host) Gem miners have as difficult a time finding minerals as anyone these days. In the last five years, there has been much more interest in gem mining because of several large finds.

(Kate Arno, Segment Host) In 1993 there was the largest amethyst discovery in state history. The second largest in the United States. More than two tons of amethysts have been taken out of that pocket so far by Intergalactic Mining Company. Tourmaline is another Maine favorite. It was first found here in 1820, the year Maine became a state. It is found in a variety of colors in Maine: rose, pink, green, blue green and light to dark blue. Of the more than 200 different minerals found in the rocks of Maine, at least a dozen are classified as gemstones like topaz, jasper, agate, and beryl.

(Woody Thompson, Maine Geological Survey) During the last five or six years, there has been a real stampede of sorts to prospect and mine for gemstones in the hills of western Maine, particularly in Oxford County.

(Kate Arno, Segment Host) Most of the gems are found in southwestern Maine in coarse granite known as the pegmatite belt. Many are found in cavities formed as molten rock cooled 300 million years ago. There is so much variety among gemstones because they crystalize from different magmas under different conditions.

(Woody Thompson, Maine Geological Survey) Well, these pegmatite veins are generally thought of as being the last part of the granite magma to cool and solidify, and in the process of crystallizing they become enriched in rare elements that formed the gemstones everybody is looking for.

(Kate Arno, Segment Host) The finest of the Maine gems found during the 1800s are now in Europe as part of Royal collections. Others are on display at the Smithsonian in Washington or Harvard's Peabody Museum. Much of the gem mining now is done by hobby collectors and tourists. They are making their finds by sifting through the dumps and spoils of commercial miners. Many of them also find time to stop at Perham's in West Paris, the oldest of a growing number of mineral shops along Route 26 between Oxford and Bethel. Ten thousand people a year stop here. Perham's offers hobbyists a free map of the area and also will identify the rocks they find for free.

(Jane Perham, Retailer, Perham's of West Paris) There's many collectors who collect worldwide specimens who don't feel that without a sleet of specimens from Western Maine, their collection is really not complete.

(Kate Arno, Segment Host) Perham's has seen a resurgence of commercial and hobby miners, thanks to the good luck they're having in recent years.

(Jane Perham, Retailer, Perham's of West Paris) It's a lot like fishing: to find something really spectacular you have to be very, very lucky, but you can find some excellent reference specimens and some excellent pieces to add to a collection.

(Kate Arno, Segment Host) There are plenty of places to look for gems in Maine, and judging from the recent finds, there may be many more buried here, but not even geologists know for sure.

(Woody Thompson, Maine Geological Survey) We have no idea how many deposits are concealed beneath the surface of the earth, either deep in the rock where we can't see them or, perhaps, covered by a veneer of glacial deposits, so we're pretty much limited to what we can find on the ground's surface, but there are many people looking. Deposits are still being found and I think we can look forward to more discoveries in the future.

(Kate Arno, Segment Host) Another geologic legacy left behind by the glaciers which benefits Maine's economy is spring water. There are more than a dozen companies in-state which are bottling Maine's water, and it's a

growing industry because of the perception that we have pristine spring water. Nationally, bottled water sales are growing faster than any other type of beverage. Sales have been growing 10 to 15% a year since the late 1980s. Helping to fuel these sales have been panics in East Coast cities over the contamination of water supplies, and some people don't like the taste of chlorinated water and prefer to drink spring water instead.

(Kathy Harney, Summit Spring Bottled Water, Harrison) This spring was considered to have very, a lot of healing qualities by the Native Americans, which is why this water was put up in spruce barrels way back in the 1800s. I mean, who needed to buy bottled water in 1800s, right? It was thought to have some sort of therapeutic value. I certainly wouldn't stake my reputation on saying that it did, but then these old folk tales sometimes have something to them.

(Kate Arno, Segment Host) In some states spring water bottlers' claims of purity have been disputed, but not here in Maine. That's because Maine bottlers give careful attention to quality control and that applies even to Maine's giant bottler, Poland Spring Water, which is owned by a multinational giant, Perrier of France.

(Kristin Gregory, Poland Spring Bottled Water, Poland Spring) 'Way back in 1792, when the Rickers first came here to farm, the soil was too rocky to farm and they started, several of them started drinking out of the spring and actually felt like they were cured of gout and dyspepsia, which is acid indigestion, and so the spring became kind of a notoriety because of so many people getting well from the spring. Actually, what they were getting well from is drinking good, potable water.

(Kate Arno, Segment Host) After a sprawling and lavish resort was built in 1875, many more people came to enjoy the water.

(Kristin Gregory, Poland Spring Bottled Water, Poland Spring) The Prince of Wales used to come here. Presidents used to come here. Ulysses S. Grant drank only Poland Spring water when he was in the White House, and Poland Spring Bottling Company would ship the water to the White House for Ulysses S. Grant.

(Kate Arno, Segment Host) As late as 1980 twelve employees could still bottle all the spring water the company could sell. Not any more: now Poland Spring has a bottling facility with a staff of more than one hundred working around the clock to keep up with the demand, but large and small bottlers alike seem to have the same concerns for maintaining the reputation of Maine's spring water.

(Kristin Gregory, Poland Spring Bottled Water, Poland Spring) We have a big concern, 'cause Poland Spring is 150 years old this year and we plan to keep Poland Spring another 150 years: so it's very important that we always keep it a renewable resource.

(Kate Arno, Segment Host) Maine's spring water is so pure because of glacial sediments dating back to the ice ages. The sand and gravel left by flooding in the southern part of the state were washed clean by the glaciers' melt water. Some of these clean sediments are now beneath the surface and act as filters for rain water and melted snow.

(Kathy Harney, Summit Spring Bottled Water, Harrison) Our process is extremely simple. What the earth does is probably as complicated as the human body. You know, it's so complicated, it looks simple.

(Kate Arno, Segment Host) Ground water can become a spring if it flows to the surface. This can happen in a variety of ways.

(Kristin Gregory, Poland Spring Bottled Water, Poland Spring) It all depends on different kinds of geologic conditions. It percolates. It can go up gradient. It can go sideways, vertical, lateral. It depends on how it: it's really simple.

Spring water percolates through the ground and it finds its cracks and crevices and comes to the surface.

(Kate Arno, Segment Host) Some smaller bottlers are critical of larger companies like Poland Spring for not bottling their water directly from the spring. Poland Spring collects spring water using bore holes in a pond fed by a number of springs.

(Walter Anderson, Retired State Geologist) The definition of "spring" these days is rather, rather vague. The old definition was it was something that had to come out onto the surface. The terminology has since been expanded these days into tapping into aquifers, if you will. An aquifer is cracked with water, tapping into one of those through the drill.

(Kate Arno, Segment Host) There are some geological legacies which we wish our earth hadn't left us. The number one radiation problem in the United States is radon. Medical and environmental studies tell us that radon can be a health risk, particularly as a cause for lung cancer, but radon is a gas that you can't see or smell. It comes from uranium minerals in our granite.

There are pockets of high radon in the air and water of every county of the state. Portland, Augusta, the mountains of the southwestern part of the state and Washington County have the highest levels.

It was first discovered in Maine in 1958 by a boy using a toy Geiger counter in Gray. It was that part of the state that first brought radon to the attention of Mainers.

When the air in Gray schools was tested about five years ago, three schools were found to have the highest levels in the nation. Jim Quinn was Director of Maintenance for the schools at the time and was responsible for fixing the radon problem.

(Jim Quinn, Former Maintenance Staff, Gray Public Schools) The first thing we did do when we found out that the level were so high was to put an ad in the paper, the local paper, saying that we do have levels that are high and we're having a town meeting at the Town Hall if any interested people would like to come and discuss it. After they tested they put pipes in the ground in certain wings, pumping it out with exhaust fans and going into each classroom. The second thing that they did was upgraded the ventilation system and bringing in outside air.

(Kate Arno, Segment Host) Health officials believe radon ranks just behind smoking as a leading cause of lung cancer. Radon atoms cause lung disease by attaching to the lungs and punching right through the lining of cells.

(Bob Stillwell, Maine Bureau of Health) Our bodies are great. They can repair just about anything. However, when the damage is done to the DNA there's a good chance that it may not repair itself quite right, since the DNA tells your cells what to do. Sometimes you have cells that don't get fixed right and don't do what they're supposed to do, and that can, down the road, lead to a cancer.

(Kate Arno, Segment Host) Radon is midway in a chain of radioactive transformations that begin with uranium. As uranium decays radon and a chain of other elements are produced in a natural, spontaneous process. An atom of one element breaks down to form another element. This is done by shedding atomic particles. In the case of radon once its atomic particle is released the newly formed atom recoils, just as a high powered rifle recoils when a bullet is fired. This recoiling action is how radon escapes from the grains of rocks as a gas. The recoiling also allows radon and its daughter elements to punch their way through the cells of lungs.

(Bob Stillwell, Maine Bureau of Health) The alpha particles, like the radioactive equivalent of a cannon ball, when it doesn't go very far, but it packs a real good wallop. The alpha particle won't go through a piece of paper, through your skin, or anything like that, but your lungs really don't have any protection, so when an alpha particle

is released in close proximity to your lungs, tissues inside, it can destroy the cells real easily.

(Kate Arno, Segment Host) But, there is much controversy in the scientific community over radon. Much of the dispute centers on how the Environmental Protection Agency and health officials link low-level radon exposure and lung cancer death. So far, health risks have been based on studies of people who have been exposed to high levels of radiation, such as Japanese atomic bomb survivors or uranium miners. A definitive study for low level exposure has never been done.

(Charles Hess, Physics, University of Maine) Those numbers, then, come from the workplace. We don't know how dangerous the radon is in homes because the cost of doing a home study at the lower levels of radon ... we know there's radon in homes, but the cost of doing that type of study with people that live at home and get exposed to the radon would be very high, because the rate of cancer is lower and because there is many other things like smoking and asbestos and other things that could conflict with the study, so you have to have a very, very large study over a long time, and the people that generally get the cancer from these carcinogens are people that use those carcinogens in the workplace or are exposed in the workplace. The workplace for radon turned out to be mining.

(Kate Arno, Segment Host) Hess likens the dispute over radon health hazards to early studies on smoking. Thirty years ago there were numerous cigarette studies all showing the dangers of smoking, but it took years for the message to be accepted. Hess thinks definitive study will still show radon is dangerous.

(Charles Hess, Physics, University of Maine) I think the problem will be that there is so much apathy, that was the big problem. Although we knew, no one did anything. We're going to look back and say, "Well, we knew about that 10 years ago. Why didn't we do something about it?"

(Kate Arno, Segment Host) State officials suggest the safest course is to test our homes for radon. Less than 5% of all homes in the country have been tested. Because radon that enters buildings usually comes from the upper few feet of earth's surface, knowing radon levels of just below the surface is important. Geologic maps show where uranium can be found in rocks. Other indications of a high potential for radon are well drained and dry soils, thin soils with bedrock close to the surface, a site located on a hill or slope, and high levels of indoor radon reported in a county or a neighborhood.

There's been another recent geological discovery which may be just as troubling to Mainers. Arsenic is a highly poisonous substance used in weed killers and insecticides. It's a naturally occurring metallic element found in both bedrock and soil deposits, and like radon, you don't know you have it until you test for it.

(Kate Arno, Segment Host) Arsenic is of concern to Mainers because it frequently occurs in well water. This Maine geological survey map shows the state's highest concentrations of arsenic in red. State officials were alarmed two years ago when elevated levels were found in the well water of several southwestern Maine communities, including Buxton, Hollis, Scarborough and Dayton. It was widely used in orchards and on blueberry fields until it was banned about 20 years ago. Arsenic is still used in embalming and as a wood preservative to treat wood. But why it has been found in such high concentrations in southwestern Maine is a mystery to scientists. The Maine geological survey is hoping its research will tell us where it's coming from.

(Bob Marvinney, Maine State Geologist) We began an investigation to try to understand. Is this naturally occurring arsenic, or is it a consequence of some human activities, and in doing that investigation, first focusing on southwestern Maine, we also looked at the distribution of arsenic from data records over the entire state, and we found out that it's not only in the southwestern part of the state, but it's, in fact, a problem just about anywhere that you look for arsenic in ground water, we found it.

(Kate Arno, Segment Host) Arsenic can be harmful to us by drinking water contaminated with it. It can cause cancer of internal organs, skin cancer, stomach or intestinal problems, and restricted blood flow to arms and legs. None of these health effects have been documented in Maine. That could be because it takes 30 years for symptoms to appear.

(Lani Graham, Director, Maine Bureau of Health) I think it's important to have your well water tested, if you have a private well, for arsenic and other things such as lead, you know, that might be found in water, because that's from a prevention point of view where we'd like to be going. We'd like to be preventing problems before they occur.

(Kate Arno, Segment Host) What bothers geologists is that arsenic is found in Maine more randomly than radon.

(Bob Marvinney, Maine State Geologist) With radon we know that the source is definitely uranium-bearing minerals that tend to form in granites and there's a number of places in the state where we know that exists. With arsenic just about any type of rock would be suspect, such as some of these layered rocks over in this area here.

(Kate Arno, Segment Host) The presence of arsenic and radon in Maine is a reminder of how ominous geology can be to us. To better deal with these dangers and to more fully appreciate the gifts our geologic past has given us we continue to look for new ways to understand our geology.

Music

(Christine Young, Program Host) Remember how Arthur Hussey was mapping the geology of Maine from the Ballad of Boston whaler on the Damariscotta River? These days when we want to learn more about the rocks and soils that make up our state there are many more mapping methods for us to choose from. Technology now allows us to make instant maps of our lands if we want to, and as we hear in this story by Diana George Chapin we can even take a look at what's at the bottom of the ocean.

(Diana George Chapin, Segment Host) Matt Farnham of Caribou maps farm fields by satellite. His company, ProGro, is one of a half-dozen companies in Maine on this new frontier. Particularly in farming there aren't many people like Farnham who turn to the skies to get a better picture of our geology and our lands. Using a Department of Defense satellite system private companies like Farnham can make maps of farmlands from 11,000 miles up. By knowing exactly where they are in the farm fields satellites automatically tell the tractor when and where to release fertilizer and how much. Satellite navigation in farm fields is expected to save money and reduce pollution because it can reduce over-spraying and over-fertilizing. Potato growers were the first to sign on with this new high tech farming method.

(Scott Irving, Potato Farmer, Caribou) It's very important now in these economic times that we get every bit of potential out of a piece of ground. Through ProGro's global positioning system and through their soil election, it helps us to require every bit that the ground has to offer us.

(Diana George Chapin, Segment Host) Aerial spraying is still the prevailing means to fertilize and apply chemicals in Maine's farm country, but if Farnham has his way, gone will be the days when farmers dropped white cards with streamers or rely on farm hands to hold flagpoles to mark a plane's last pass.

(Matt Farnham, ProGro, Caribou) Aerial spraying is done mostly in the west. What the satellite systems are helping them do is, it's a better way of tracking where they've been in the field so they're not over-spraying.

(Diana George Chapin, Segment Host) ProGro is part of an emerging industry called remote sensing. Remote

sensing is an umbrella term for obtaining information over an area from a distance. It includes satellites, radar, and aerial photography. The string of 24 satellites that Farnham and other Mainers have access to is the global positioning system. Other private companies and some state and federal agencies in Maine also use satellite navigation and imagery. The U.S. Fish and Wildlife Service is one such agency.

(Jed Wright, U.S. Fish & Wildlife Service) So, this is looking at the estuary, I believe, of the Machias River.

(Kate Arno, Segment Host) For Jed Wright the fastest and cheapest method to manage Atlantic Salmon Habitat is with satellite imagery. Wright has found he can call up all kinds of images on his desktop computer. Satellites and GPS help him pinpoint potential problems in watersheds from runoff to other sources of pollution.

(Jed Wright, U.S. Fish & Wildlife Service) Say for example, we identified that the entire watershed was clear-cut bare soils. We know that that's going to have a very different impact on the stream quality than if it's in a natural vegetative state, so what we're really doing is trying to use it as a method to quickly assess the landcover within a watershed.

(Diana George Chapin, Segment Host) On the other hand, timber companies in Maine are still waiting for satellite technology to improve. Bowater, Great Northern Paper in Millinocket, still uses aerial photography to map forest lands because it's better than anything else available. Bowater is working with the University of Maine to use satellite images and new mapping methods to analyze its reforestation efforts. As with other Maine industries, foresters need more detail and satellite images. Bowater thinks the pictures are not sharp enough to discern the height, density, or type of trees.

(Dan Boss, Bowater/Great Northern Paper) Every little piece of information on a satellite image is 30 meters square, okay. It doesn't get smaller than that. Thirty meters on the side covers quite a big piece of an acre of land: almost a half an acre.

(Diana George Chapin, Segment Host) Blueberry grower, Ragnar Kamp of Cherryfield Foods used satellite imagery when he worked in the forest industry in Canada. He doesn't use it now in his Maine blueberry fields, but in another five years or so he predicts he and other blueberry growers will be buying satellite time, provided the resolution or detail of the images improves.

(Ragnar Kamp, Cherryfield Foods) I think I would find it very useful then because then you could have a map like the ones I have on the wall here, with a complete overview too, all on a photograph base, in color. It would be a fantastic tool as far as I'm concerned.

(Diana George Chapin, Segment Host) In the meantime, he continues to use aerial photography to help identify new wild blueberry fields.

(Music)

(Diana George Chapin, Segment Host) Another component of this new wave of mapping is the management of data. It's one reason why the cost is still too high for some Maine industries. A state agency called the Geographical Information Systems, or GIS, is a data broker for private and government clients. The state GIS agency collects new map data from every source imaginable, including satellites. It also converts existing paper maps into digital form for future computer use. The Maine Geological Survey used a GIS program to computerize its data for maps on arsenic concentrations.

(Dan Walters, Maine Geographical Information Systems) Generally speaking, people are very visual learners. Very easy to assimilate information when viewed visually. The map based format, the graphical user interface provided

by GIS, provides a real easy tool for people to view information and make decisions.

Here we go...

(Diana George Chapin, Segment Host) Being able to see the floor of the Gulf of Maine is becoming a specialty of a couple of state agencies. The Department of Marine Resources and the Geological Survey are in the process of updating their maps of Maine's offshore lands. In many respects it's like mapping the surface of the state, except it's all underwater. Being able to see the geology of the ocean bottom will allow scientists to get a better grasp of the many different fish habitats.

(Rich Langton, Maine Department of Marine Resources) We're particularly interested in defining nursery areas for ground fish and defining areas that are biologically important in terms of the natural resources, the marine resources of the state, and, obviously, as I said, that's the biology superimposed on the geology.

(Diana George Chapin, Segment Host) This should lead to a better understanding of how to protect critical marine species. Many species are cannibalistic, so fish habitats are more than sources of food, they're places to avoid predators, too. The best maps the state has now are navigational charts. They only show what kind of sediments sit on the bottom, not what the bottom looks like. For the last 10 years the technology has existed to get three dimensional pictures of the ocean bottom. Seismic sound reflection devices are used along the bottom to show thickness of rocks. Submersibles also carry cameras that scan the surface and equipment to take core samples from the sea bed. Three dimensional ocean maps will tell us much more than we know now about the geology of the bottom of the ocean. There is interest in other parts of the world in underwater mining of precious metals and diamonds.

(Dan Belknap, Geology, University of Maine) There are many parts of the world that are presently exploited for offshore mining. There are placer deposits of gold and diamonds in South Africa, offshore.

(Diana George Chapin, Segment Host) Geologists don't think there's much chance of finding precious metals in Maine waters, but there also may be natural gas deposits in Penobscot Bay and other offshore areas. There is only a small chance the natural gas will become commercially viable. Of course, any kind of marine mining would be in direct conflict with our well-entrenched fishing industry. Many Mainers hope we will never have to make difficult choices like fishing versus mining in the waters of Maine.

(Christine Young, Program Host) Of course, mining is only one of many uncertainties facing Maine fisheries. There are a number of issues challenging this cherished way of life here in Maine. Next month we'll see why scientists and fishermen have not been on the same wave length when it comes to the Gulf of Maine. The mysteries of our fisheries is our next "Quest." Until then, thanks for joining us. I'm Christine Young.

(Narrator) Maine Public Television's production of "Quest: Investigating the World We Call Maine" is funded through a television demonstration grant from rural, economic, and community development, part of the USDA.