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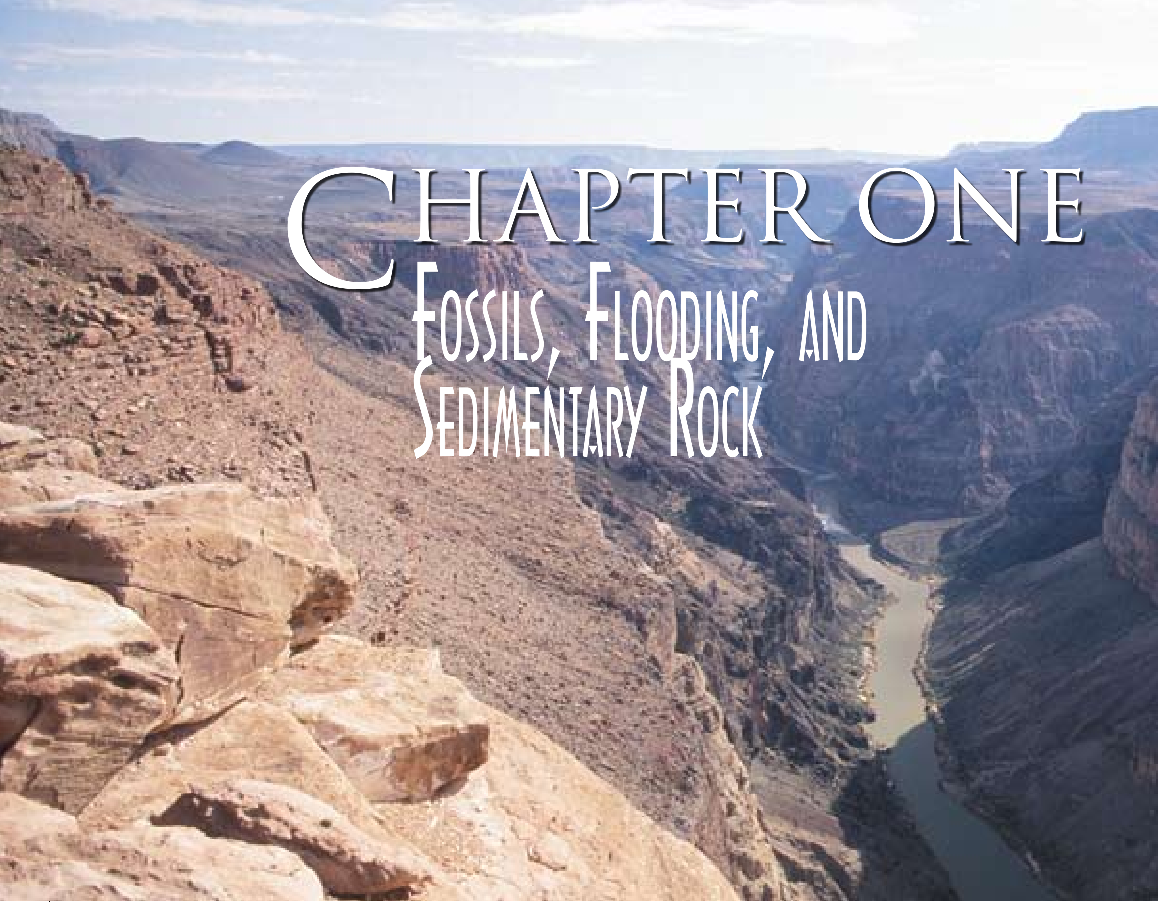


Chapter One
Fossils, Flooding, and Sedimentary Rock

Sedimentary strata

Finding fossils is fabulous fun (and a terrific career or hobby). Curious young people have probably been digging up and wondering about fossils for centuries, but scientists have been studying them for only about 200 years.

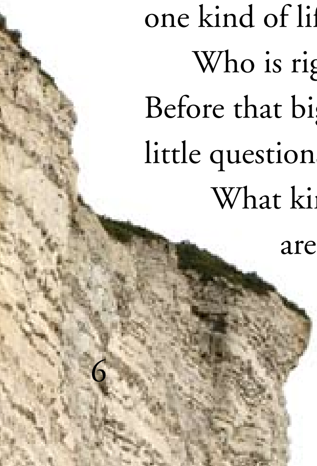
When 4C creationists and TCSD evolutionists began to debate the scientific evidence in the 1800s, paleontology (fossil study) was a young science. Creationists predicted that fossils would show complex and separate beginnings, followed by death, disease, decline, and worldwide disaster. Evolutionists predicted that layers of rock would contain only a few simple forms at the bottom and more complex and varied forms farther up, and that scientists would find the missing links required to show how one kind of life evolved into others.

Who is right — creationists or evolutionists? Before that big question can be answered, lots of little questions need answers: How did fossils form? What kinds of life are found as fossils? Where are they found?

Creationists and evolutionists usually agree on the answers to these smaller questions. Creationists can work on a "dig" side by side with evolutionists, agreeing on the little questions; then, around the campfire at night, they can discuss their different views about what these fossils tell us about the past, present, and future of life on earth.

What Is a Fossil?

Our word *fossil* comes from a word that means "something dug up." The term was originally applied to arrowheads, pottery fragments, Egyptian mummies, gems, and mineral ores. Today, however, products crafted by humans are called artifacts. The science that deals with human artifacts, and with things deliberately buried by humans, is called archaeology, not paleontology. Similarly, gems and minerals dug from the earth are studied by geologists, not paleontologists.



As paleontologists define it today, a fossil is the remains or traces of a once-living thing preserved by natural processes.

Digging fossils in sandy sediment

Sedimentary Rock

The vast majority of fossils are preserved in sedimentary rocks, such as chalky limestones (abbreviated ls), flaky shales (sh), or gritty sandstones (ss). Particles that settle out of air or water are called sediments. Dust on furniture and desert dunes are sediments transported (eroded) and dumped (deposited) by wind. Water is a much more powerful agent for sediment erosion and deposition. Water can break off, transport, and deposit sedimentary particles from clay size to sand, pebbles, and boulders. The same processes that erode and deposit sediment can also pick up, transport, and bury plants, animals, microbes, and people. As the sediment layers turn into sedimentary rock, at least some of the sedimentary remains of living things, especially the hard parts, can turn into fossils.

How do soft, loose sediments and the dead things, or "future fossils," buried in them turn into solid rock? Does it take heat and pressure for millions of years? Absolutely not! Sedimentary rocks form the same way concrete hardens. After all, concrete is just artificial rock. A concrete company breaks big rocks into sediment size and sells them in a bag with rock cement. The buyer adds water to the sediment/cement mix until just the right amount is present to make the cement mineral crystals grow around the bigger rock particles. Too much water will cause the "rock soup" to stay soft and squishy. Too little water leaves rock powder, instead of solid rock.

Pressure may help rocks to grow by squeezing out excess water, and the right amount of heat helps cement crystals to grow, but time never made a single rock. Under the right conditions, rocks form in minutes; under the wrong conditions, even millions of years

Fossil hunting among layers of hard, white limestone (ls) and gray, crumbly shale (sh)

Petrified logs

Fossilization of wood

won't form a rock. It's the proper conditions, not time, that form rocks and fossils.

The two most important conditions for turning sediments into rocks are water and rock cement in the right amounts. The two most common rock cements are calcium carbonate and silica. Calcium carbonate ($CaCO_3$) is the lime in limestone, the "rocks" that rattle around in an old tea kettle, the acid absorber in Tums and Rolaids, and the white powder in chalk.

Silicon dioxide (SiO_2) makes up quartz crystals, gritty white sand, and glass. Silica rock cement is SiO_2 in a form that rapidly absorbs water to form hard crystals. Little packs of silica gel get packed with electronic equipment in order to absorb any harmful moisture.

Fossils and Flood Conditions

Conditions that turn sediments into sedimentary rock also help turn dead things into fossils. Flood conditions are ideal both for eroding and depositing sediments and for producing fossils. The vast majority of fossils began forming when a plant or animal was suddenly trapped under a heavy load of water-borne sediment. Scientists agree on that, although they disagree on whether it was mainly one big flood at Noah's time or lots of smaller floods millions of years apart.

If a plant or animal dies in the woods, in a lake, or along a roadside, it is quickly eaten up by scavengers or destroyed by insects, fungi, or other decomposers. Wind and water currents can scatter it, and sunlight decomposes wood and bone. Even pets buried in the backyard are turned into soil by water and bacteria. Probably none of the bison (buffalo) slaughtered in America's move west ever fossilized, and waiting millions of years won't change that. It's not the passing of time but the right conditions that form fossils, and those conditions are provided by catastrophic flooding.

When plants and animals are suddenly and deeply buried under catastrophic flood conditions, the heavy layers of mud, sand, lime, or ash protect the buried organisms by keeping scavengers away. The heavy sediment weight squeezes out excess water and encourages the growth of cement minerals that turn sediments into rock and the buried organisms into fossils. Fossilization or mineralization must begin quickly, before the embedded plants and animals decompose beyond recognition. Even then it's often only the hard parts, such as wood, bone, or shell, that are preserved as fossils.

Types of Fossils

Perhaps the most common type of fossil is a bit of wood, bone, or shell with its pore spaces filled with mineral — a permineralized fossil. The color of the fossil depends on the color of the mineral filling it and on any natural stains it absorbs. Permineralized fossils are usually much heavier than wood, bones, or shells that have not been fossilized.

The difference between a fossil and the remains of a modern (recently dead) plant or animal can often — but not always — be determined just by color and/or weight. KFC chicken bones tossed into a river, for example, may waterlog and fill with sand so they feel heavy, and they can pick up stain from the river water quickly, but they are not fossils. To tell whether a specimen

Petrified wood, cut and polished

is a true fossil or is modern, let it dry, then carefully hold a lighted match under it (a match test). A recent bone resulting from ordinary death (modern) will smell like burnt hair because much protein is still in it, but a fossil won't.

Permineralized wood has mineral in its pore spaces, but wood fibers are still there (and can sometimes be "peeled" away). Ground water oozing or percolating through permineralized wood may remove the wood and deposit mineral in its place, often mineral of a different color than the mineral filling the pores. The result (especially after polishing) can be a spectacularly beautiful piece of petrified wood (page 9), a fossil in which mineral has replaced wood but preserved the pattern in the once-living material.

"Fossilized" paper roses

Teddy bears suspended in a dripping fall of lime-rich water "fossilize" quickly.

Formation of the mineral crystals that preserve petrified and permineralized fossils can occur very rapidly. At Mother Shipton's Cave in central England, teddy bears suspended in a dripping fall of lime-rich water become thoroughly permineralized and quite hard — "fossilized" — in about three months (see photo left). Warm mineral springs can make "artificial fossils" of fence posts and paper roses in just a week or two (above). Petrified wood can be produced in the lab in about a week, not millions of years! Wood, bone, or other organic (once-living) material lying around for millions of years would rot away, of course, rather than fossilize.

Water without cementing minerals flowing through a fossil may actually remove minerals, a process called leaching. For example, a huge bone from a recently deceased elephant would normally need a person's two hands to hold it. The same bone, when leached, can be held in one hand because the heavy mineral in the bone has been leached out and only the light, spongy protein is left. Fossils exposed at the surface, or buried near the surface in sand or gravel, often have their minerals washed away and may easily crumble to dust. Such a specimen may require hardening chemicals and a plaster jacket for collection.

Because their shells are easily leached away, clams and snails are often preserved as molds or casts. Imagine a snail that has been swept up in an underwater landslide of mud or sand. As the animal dies, the weight above forces sediment into the emptying shell, and the growth of rock cement crystals hardens it in place. Since many snails and clams have shells that dissolve more easily than the rock cement, the shell dissolves away, leaving an internal mold. The size and shape of the original snail is preserved with its surface showing us how the inside of the snail looked. The cavity in the rock holding the original snail is an external mold, and it shows us whether or not the outside surface of the snail had any spines, ridges, or grooves. Even though none of the original animal is there, internal and external molds are excellent fossils that can tell us a lot about the once-living thing.

Sometimes an organism rots away completely, leaving a cavity in the hardened sediment that had buried it. Minerals in ground water oozing through the rock may crystallize in the cavity, forming a natural cast. Minerals deposited in the cavity formed by the external mold of a clam, for example, take on the size, shape, and features of the original clam shell. Some clam casts from Australia are made of a clear mineral that makes them look like beautiful glass!

Paleontologists may make artificial casts. Often using latex, they first form an external mold around the bone, tooth, shell, or other fossil they want to copy. After the mold firms up, they open it and remove the original. Then they fill the cavity with a tough substance that will take on the detailed features of the fossil. Heavy plaster was once used for casting, but lightweight plastics or fiberglass are more common now. Painted, the cast looks just like the original, and many casts of one specimen can be made and sold. That's why so many museums have skeletons of *T. rex* when only a few reasonably complete skeletons have ever been found. My wife has given the original of several special fossils to the state museum in Florida, and they have given her excellent casts in return. Thus the finder is rewarded, and the original is available for study by all paleontologists.

Flat specimens, such as fish and leaves, may be preserved as carbon films. Pressed between layers of the sediment that buried it, the organism decomposes, just leaving a "grease spot" or layer of carbon preserving the outline and some features of the once-living thing, like the fern leaves pictured below.

From a practical point of view, the most important fossils are spores, pollen, sponge spicules, and the microscopic shells of one-celled organisms and the very young stages of clams, snails, and arthropods like shrimp. These microfossils can be found in cylinders of rock brought up in drilling (well cuttings), and they can be used to map underground rock

Fern leaf impressions: carbon films (above left) and concretion pair (above) layers in the search for oil, coal, earthquake fault lines, and other geological interests. (See pages 48-49.)

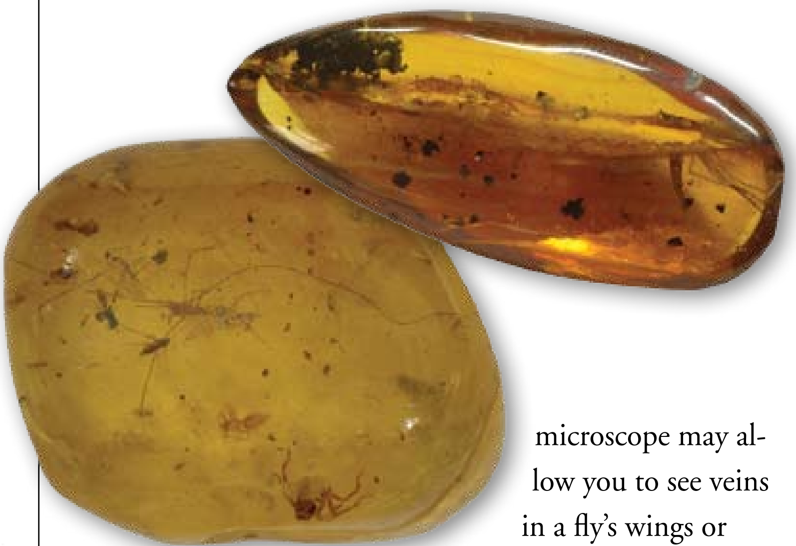
Special Types of Fossils

Most fossils are either shells, hard parts like bone or wood, or impressions, but under special conditions, the whole creature, soft parts and all, may be preserved.

Most famous of these special fossils are varieties of elephants, called mammoths and mastodons, preserved in ice. Partial and sometimes nearly complete remains of these specimens are strewn across Siberia and Alaska. Obviously, a rapid, colossal catastrophe is required for such preservation, perhaps related to the gigantic storms and ice sheets that built up after Noah's flood.

Smaller but even better preserved are insects trapped in tree sap that hardens to form amber. Amber can be polished as jewelry, and a magnifying glass or microscope may allow you to see veins in a fly's wings or bristles on an ant's leg! Most amber sold today is either Baltic (near the Baltic Sea) or Dominican (near the Dominican Republic).

Insects trapped in amber (hardened tree sap)



Dendrites (pseudofossils)

You may think a mummy is an ancient Egyptian wrapped in bandages, but paleontologists use the word mummy for fossils formed when a creature dries out completely, like a piece of beef jerky or dried fruit. It's interesting that water is essential for life, yet it also breaks down dead tissue. So, extreme drying (desiccation) acts as a preservative.

Tar, basically extra thick and dirty oil, is also a preservative. Parts of saber-toothed cats, mammoths, giant vultures, and people are all preserved in the famous La Brea Tar Pits in downtown Los Angeles.

Pseudofossils are false fossils — things that look like fossils but really aren't. (Pseudo means "false.") Certain minerals (manganese dioxide, MnO_2) form crystals, called dendrites, that look like little moss plants. Dendrites in polished agate are called moss agates.

Extra cement in some parts of a sandstone can form interesting shapes that people may mistake for apples, hearts, or little "people" called loess dolls. Our son once found a chunk of sandstone that looked like an elephant or dinosaur leg bone; even in the lab we never decided whether it was a cast (a real fossil) or just a pseudofossil.

Because they tell something about the conditions of burial, preserved physical features such as ripple

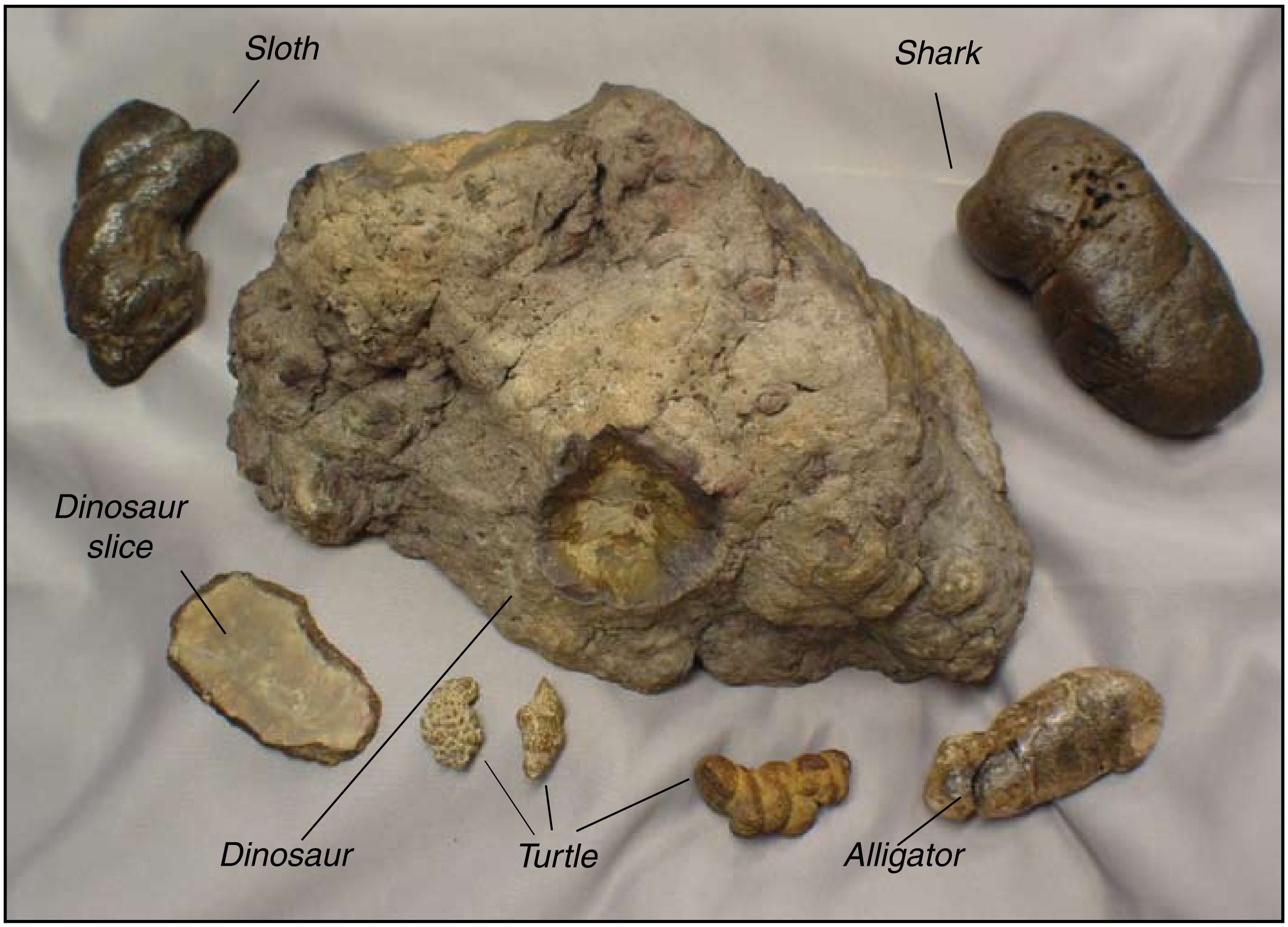
Gastroliths: stomach stones

marks, mud cracks, raindrop impressions, and even cylinders of fused sand (fulgarites) that show where lightning struck are interesting to paleontologists. None of these are true fossils, because they are not the remains or traces of once-living things.

Trace fossils are not remains of plant or animal parts, but show evidence of once-living things. Some trace fossils that tell something about conditions of burial are worm burrows. Escape burrows are taken as evidence that a worm was desperately trying to dig up through sediment piling up very rapidly. Tracks or footprints are trace fossils usually preserved only in cement-rich sediment that hardens rapidly. (Human footprints are unlike those of any other known creature, and have been very useful in disproving claims about human evolution.)

Many animals swallow stones, which they use to help grind up their food. These gizzard stones or stomach stones, called gastroliths, become highly polished and even look wax-coated, making them nifty fossils (shown above left).

Perhaps the neatest trace fossil of all, however, is a coprolite — fossilized animal droppings. As with the size and shape of fresh droppings, size and shape of a coprolite can help identify an animal (below).



Coprolites: fossilized animal droppings

With a rock saw, it is even possible to cut and polish a coprolite, look at it under a microscope, and see what the animal ate.

Coprolites recently showed dinosaurs ate grass before textbooks said grass evolved.

Fossil Fuels: Coal and Oil

Coal is classified as a sedimentary rock, but it is also called a fossil fuel. Coal is a fuel because it burns, and a fossil because it is the charred remains and carbon atoms of once-living plants. Some of the stems, leaves, roots, spores, and cells are well preserved and can be identified.

Most people have been taught that coal forms slowly in swamps over millions of years. Science tells us that nothing could be further from the truth! Many plants found in coal would not grow in swamps. Compressed swamp material is a chaotic jumble of plant remains; coal comes in neatly separated layers. The roots, stems, leaves, and pollen of swamp plants tend to stay together; plants in coal are torn apart and separated into different layers — so much so that roots, stems, leaves, pollen, and seeds in coal were given separate scientific names before scientists, after many years, discovered they were really the shredded and separated remains of the same plant! There are lots of swamps and peat bogs in the world, but nowhere are they turning into coal. Scientists don't even know how they could turn into coal — unless perhaps they were suddenly buried under a heavy load of sediment in a colossal flood!

Volcanic eruption of Mount St. Helens

Coal stratification

Coal mining in Australia

Based on years of coal research, creationist geologist Dr. Steve Austin proposed that coal formed from huge mats of vegetation, ripped up in violent storms, torn apart by wave and current action, and deposited in layers along with other sediments. Weight of the sediments above (overburden) would squeeze out excess water, keep oxygen out, and raise the temperature of the buried plants. At a critical point, affected by clay minerals, the plants would begin to burn incompletely or char, turning into coal, similar to how we make charcoal today.

The volcanic eruption of Mount St. Helens in Washington State on May 18, 1980, provided dramatic support for Dr. Austin's theory. Nearly 1,300 feet (400 m) were blasted from the snow-covered peak, producing the largest landslide ever caught on film. The steam and ash blast ripped apart trees in the surrounding forest, separating trunks, branches, leaves, and roots. As the landslide plunged into Spirit Lake, it produced a huge wave that reached over 860 feet up the mountainside through the devastated forest. As the waters receded, they washed the broken trees, including approximately one million logs, back into Spirit Lake.

Rock fragments, ash, and waterlogged plant parts began to settle on the bottom of Spirit Lake at the base of the volcano: pollen and spores at one level, bark sheets in another, with various mineral layers — similar to the pattern seen in coal. The logs floated at first, of course, but as they became waterlogged, one end would get heavier first and the log would sink down, sometimes almost vertically through several layers, like tree trunks so often found in coal deposits. In just months, Mount St. Helens and Spirit Lake produced a coal-like sediment pattern once thought to take millions of years to form.

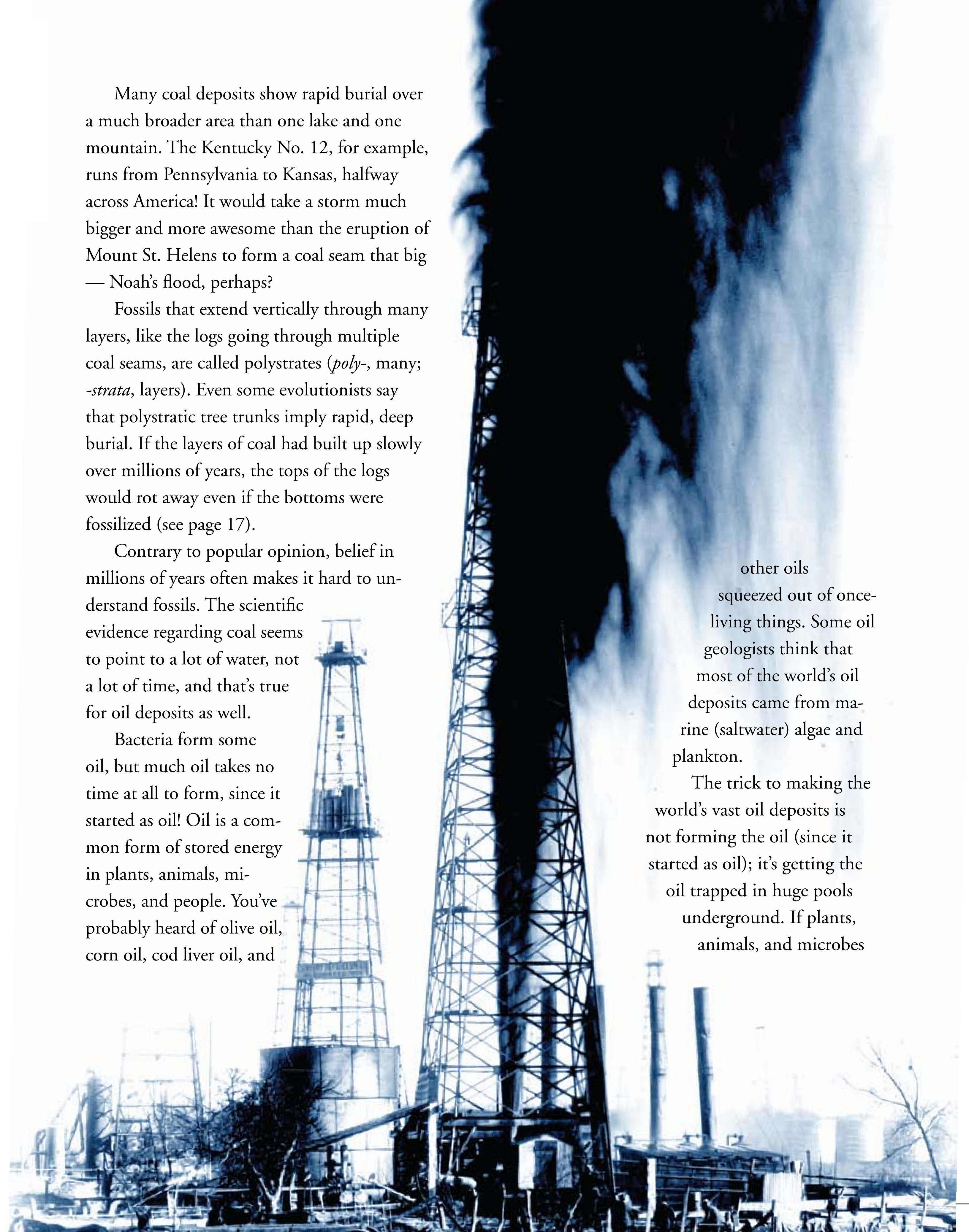
Many coal deposits show rapid burial over a much broader area than one lake and one mountain. The Kentucky No. 12, for example, runs from Pennsylvania to Kansas, halfway across America! It would take a storm much bigger and more awesome than the eruption of Mount St. Helens to form a coal seam that big — Noah's flood, perhaps?

Fossils that extend vertically through many layers, like the logs going through multiple coal seams, are called polystrates (*poly-*, many; *-strata*, layers). Even some evolutionists say that polystratic tree trunks imply rapid, deep burial. If the layers of coal had built up slowly over millions of years, the tops of the logs would rot away even if the bottoms were fossilized (see page 17).

Contrary to popular opinion, belief in millions of years often makes it hard to understand fossils. The scientific evidence regarding coal seems to point to a lot of water, not a lot of time, and that's true for oil deposits as well.

Bacteria form some oil, but much oil takes no time at all to form, since it started as oil! Oil is a common form of stored energy in plants, animals, microbes, and people. You've probably heard of olive oil, corn oil, cod liver oil, and other oils squeezed out of once-living things. Some oil geologists think that most of the world's oil deposits came from marine (saltwater) algae and plankton.

The trick to making the world's vast oil deposits is not forming the oil (since it started as oil); it's getting the oil trapped in huge pools underground. If plants, animals, and microbes

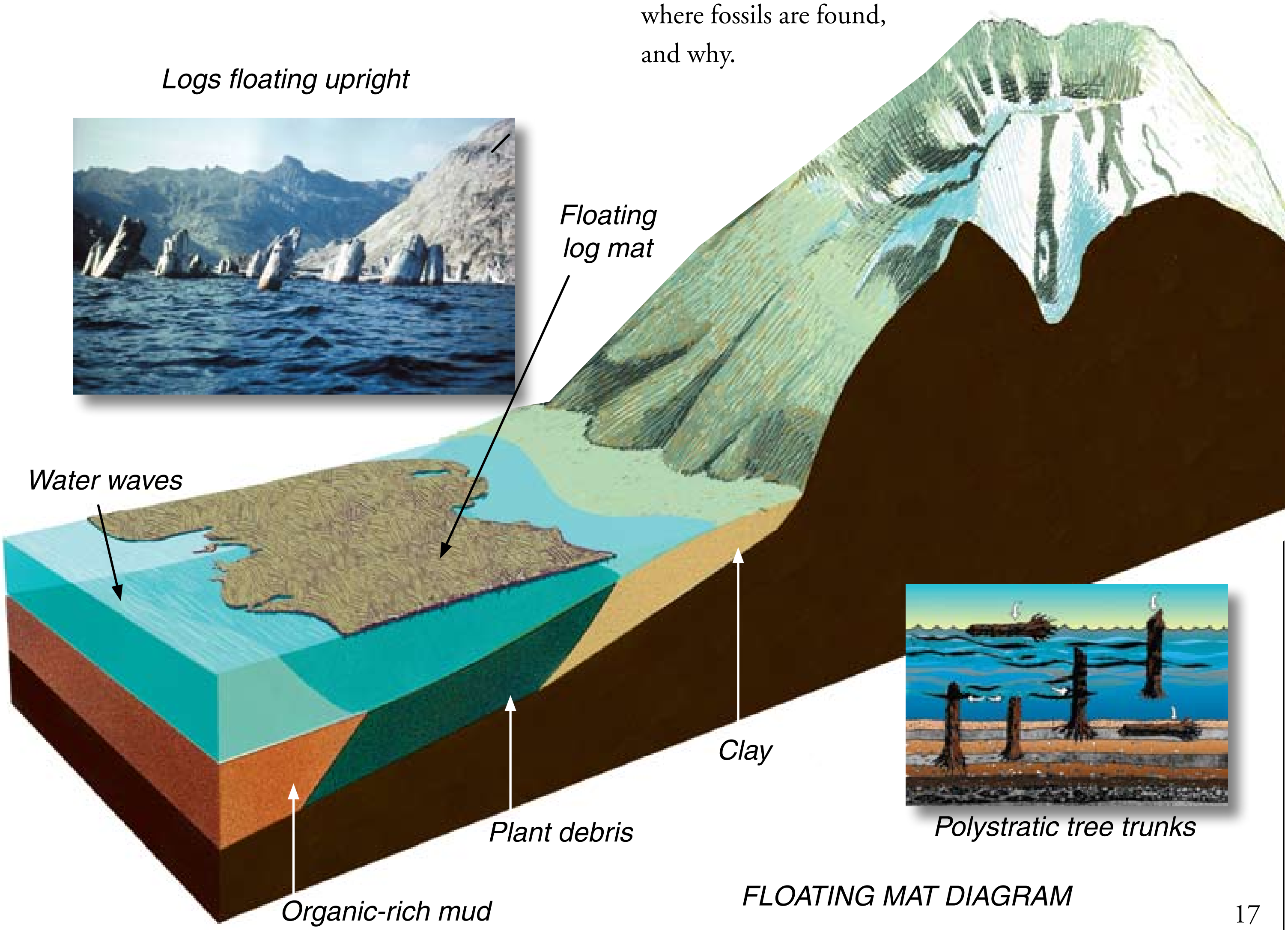


just die in the water, on the surface of the ground, or in shallow graves, the oil gets eaten up by scavengers and decomposes, so no big pools of oil are formed. Imagine that countless numbers of plants, animals, and microbes get buried suddenly under heavy loads of sand, mud, and clay sediment during Noah's flood. The weight of water-borne sediment squeezes the oil out of the once-living things. Since oil and water don't mix, the oil rises to the top of the water, but remains trapped under the sediment layers.

The rising oil usually moves fairly easily through spaces between sand, lime, and shell particles, but a dome (upside-down bowl) of shale may trap the oil oozing up from the crushed bodies below, forming a huge underground pool of oil. The oil is under great pressure, so often when the drill pokes a hole in the oil chamber, BOOM — up comes this gusher of "black gold" or "Texas tea."

In fact, the pressure in oil wells is so great that scientists have calculated that all of the world's oil reserves would have leaked to the surface in less than 200,000 years, but there's a lot of oil left, which means the earth's crust must be no more than thousands of years old, not millions! So, oil deposits are "young" (thousands, not millions of years old), and they must have formed rapidly in a great catastrophe to get trapped underground at all. As we'll see over and over again, science makes it hard to believe in millions of years of slow evolution and easy to believe what the Bible says about a six-day creation and Noah's flood!

Now that you know how fabulous and how important fossils are, how they formed, and what types there are, let's find out where fossils are found, and why.



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