

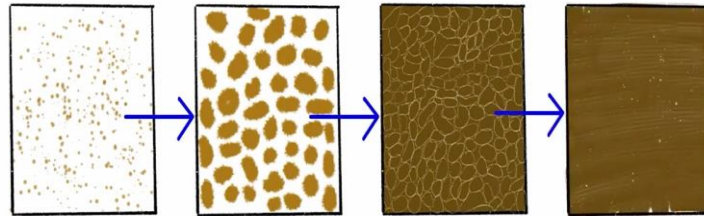
Evolution of the Earth and Life
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Rocks Full of Life

In the coursework so far, we have learned about various dating techniques, which let us estimate the age of rock. The next segment is a list of questions which might come from students who did not have enough hands on experience or experience of working in the field. So let us look at these questions and explore a few concepts to them.

Student: So do we randomly look for fossils in rock sections? If not, what is the method to go about it?

Professor: Well, the answer to that would be pretty low, if you just randomly go to a place and try to look for fossils. Fossils are remnants of ancient organisms, and they do not get preserved everywhere and anywhere.

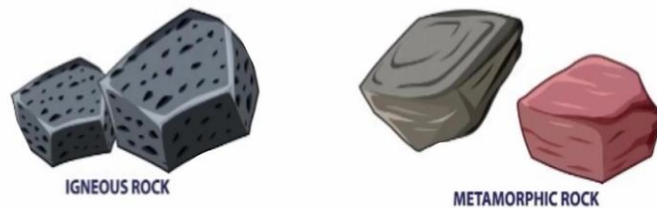
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Sedimentary rocks are formed
by sediment deposition
and compression

Specifically, we are finding them in rocks that have formed in relatively low temperature and pressure, we call them sedimentary rocks. So you can only expect to find fossils, in sedimentary rocks, in general. So the first challenge is to go to places where there are good sedimentary rocks.

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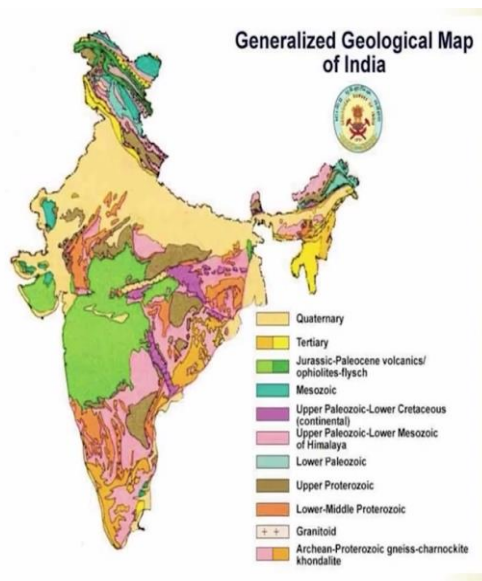


Igneous rocks form from molten rock and Metamorphic rocks undergo great pressure, heat, mechanical stress and stretch. Fossils do not usually survive these extreme conditions.

Pebbles vector created by brgfx - www.freepik.com/

Not all the sedimentary rocks are going to give you fossils, but other kinds of rocks such as igneous rocks, and metamorphic rocks, they are never going to give you fossils.

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So our first job is to look at geologic map, which tells us how the rocks are distributed in a particular place.

Student: So we need to study the geology to look for fossils. Also, we usually see these illustrations of fossils buried deep underground. So in order to excavate these fossils, do we always have to dig deeper?

Professor: No, it is not always the case. Well, it is true, to some extent that if the fossils are not buried, or in other words, if the life forms, the ancient creatures were never buried, they are never going to get preserved. But once buried, once they get preserved, these rocks can be uplifted and brought to the surficial level. So not always, you have to dig deep. And sometimes this digging can be done by natural processes such as rivers.

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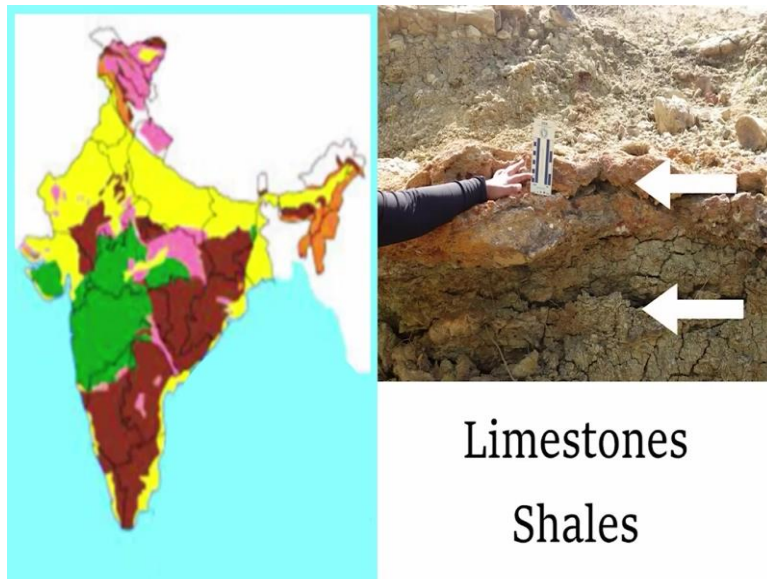
River erosion
exposed ancient
sea floor

The rivers can cut through rocks, exposing older rocks, and some of these older rocks can have fossils. So in that case, you do not even have to dig, you simply have to locate those areas where things are exposed at the level of the ground, and you simply are going to walk on those grounds where the fossils are exposed.

Student: So if we find fossils in a rock section, is it more likely to find more fossils in the same or surrounding outcrops?

Professor: Yes, we try to find areas which qualify all these things, such as they have sedimentary rocks. And depending on what kind of fossils I am interested in, I try to look at that sort of sedimentary rock. Just to give you an example, let us say I am interested in the ancient marine organisms, creatures that lived in the sea. In that case, I am trying to look at the sedimentary rocks which form under water.

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Limestones
Shales

And to locate those I will again look at the geologic map and try to find out which are the places where these limestones or shales are predominantly there.

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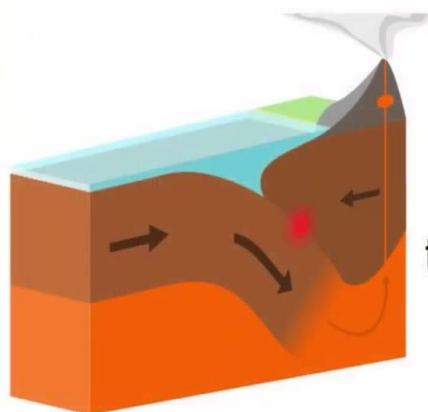


And then once we go there, often we try to look for these river cut sections, which exposed older rocks and attract some of these things to find out some fossils. Once we found one fossil, we try to locate nearby areas and try to search more thoroughly to check for fossils.

Student: You mentioned marine fossils. The first thought that comes to the mind is you would need to dive deep to find a sea floor and then excavate fossils from it. Is that how it is done?

Professor: Excellent, very interesting question and the answer is always no.

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Ancient seafloor is rarely preserved underwater due to subduction under the plate tectonics processes.



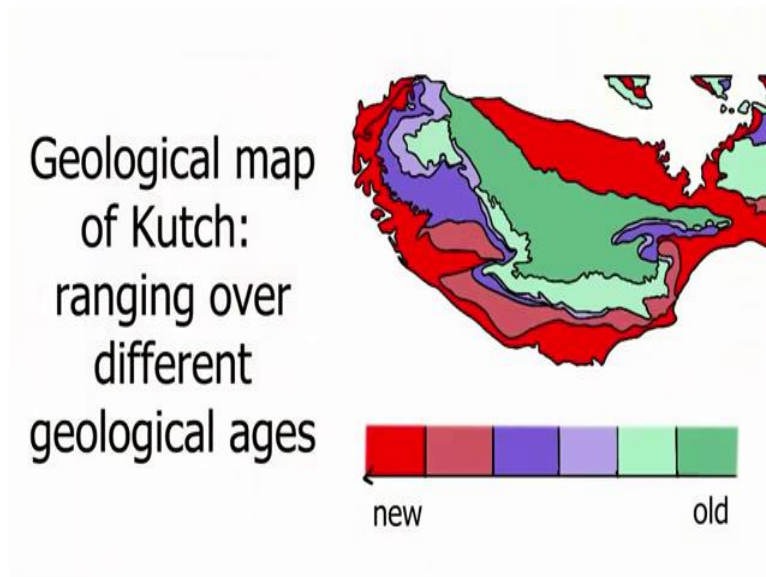
In fact, very rarely, marine seafloor are preserved under the ocean of today. In fact, most of the ocean floor are not that old. And majority of the marine fossils, as part of the marine seafloor, are often preserved in the left, so they have been uplifted and now they are part of the land record, and we find them. And for that we do not really have to dive down in the water. In fact, we can walk on the ocean floor, just by walking on the fossilized ocean floor that we find on the land.

Student: For these marine fossils, which can be found on the surface, can you put an Indian example for it, maybe a location where these are more likely to be found?

Professor: Well, there are many. But I would like to talk about one where we go almost regularly. And that is in the western part of India, in Gujarat, there is a place called the Kutch.

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And in Kutch you do find many fossils on the land. And in fact, many of these places, they show a variety of marine organisms in fossils of different ages, in this barren land of Kutch. So it was once upon a time, it was a shallow sea floor where it was thriving with life. And now we only have these rocks full of life.

Student: How do we recognize that the part of the rock that we see was part of the seafloor once?

Professor: Well, the fossils are really helpful in that. So I can actually show you a rock.

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This is a rock. And I think from a distance, it looks quite nondescript. But if you actually look at the sediments, the sediments look very similar to the sediments that you find in today's seafloor. So if you compare the sediments that you find from today's seafloor and look at this rock, you are going to see that they are made up of same sediments. On top of that, you also get to see organisms like that.

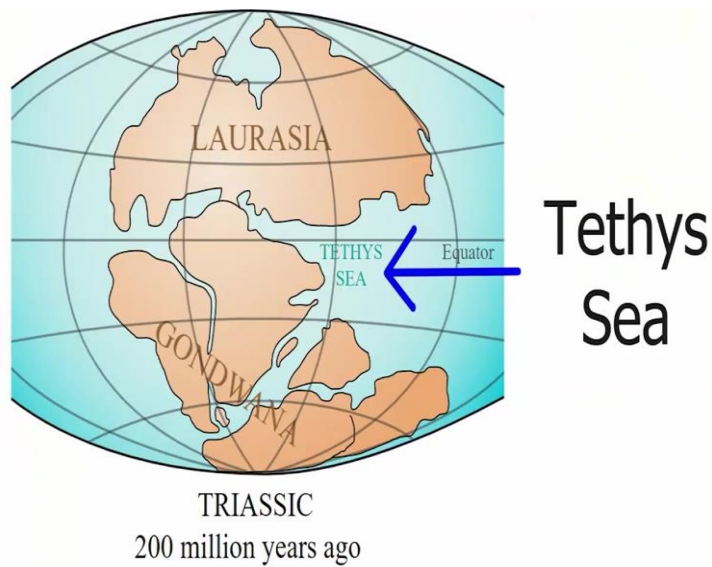
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So these are marine seashells, fossils of seashells, and these seashells are a clear indication that this was underneath the sea water at some point of time.

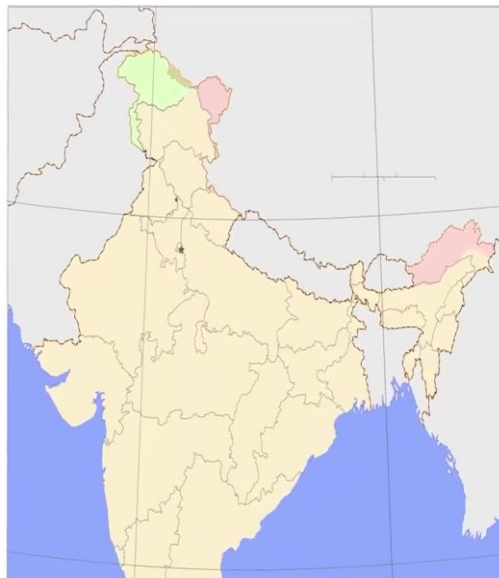
Student: But is Kutch the only place in India where you would find marine fossils?

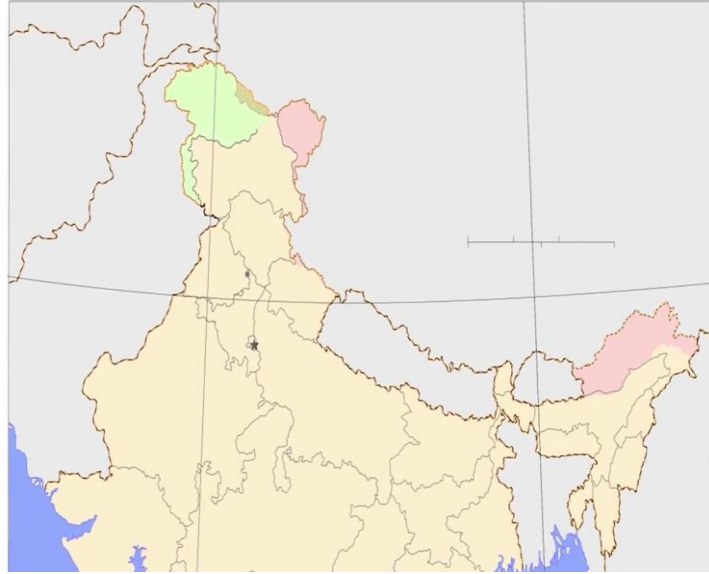
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Professor: So we do find quite a bit of marine fossils all over India. In fact, long ago, there was an ocean in the northern part of India and it used to be called Tethys and this remnant of the steppin ocean and the creatures which lived on the ocean floor are found in the northern part of India, where we find the Himalayas today.

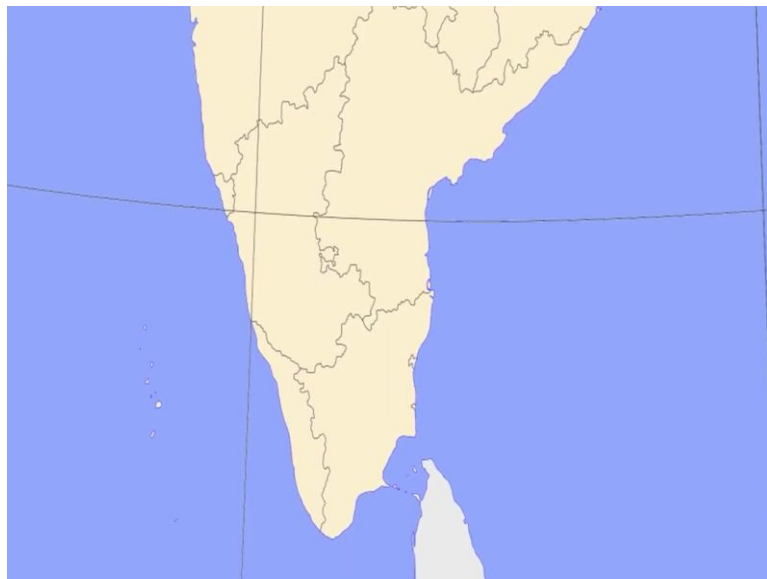
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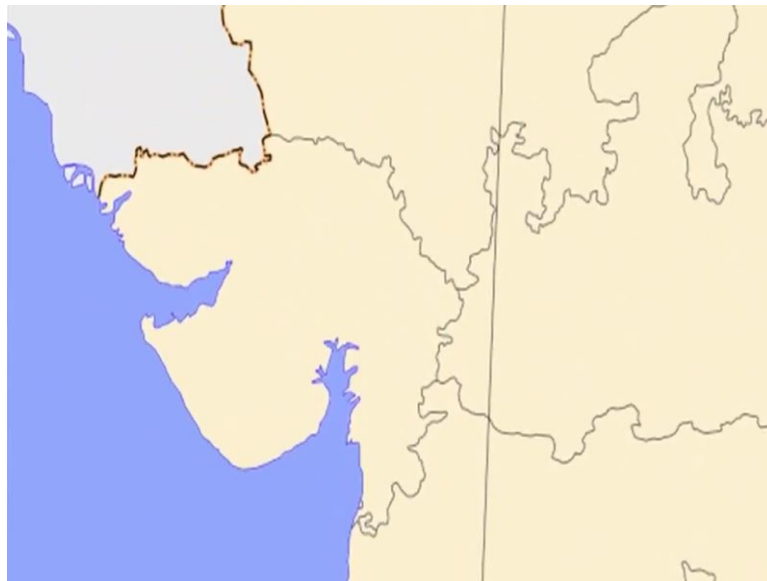
The rocks of Himalayas, a significant portion of the rocks of Himalayas are actually marine rocks, and they do contain a diverse amount of fossils.

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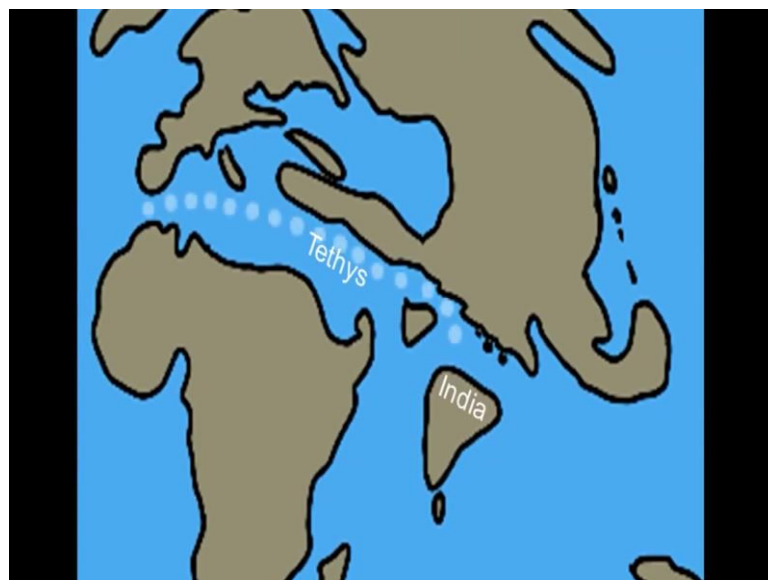
Similarly, if we look at the southern part of India, there are places in Kerala, in Tamil Nadu, where we do find quite a bit of sea fossils and marine rocks.

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But my interest in Kutch is because of a completely different reason. You see in Earth and climate science, especially when we are talking about geological experiments, rarely do we get a chance to do an experiment. Unlike other disciplines, here, the experiment has already been done and we are looking at the outcome in order to understand what went on during the vast span of time. Now, the Kutch actually gives us a natural experiment, where a seaway changed its course.

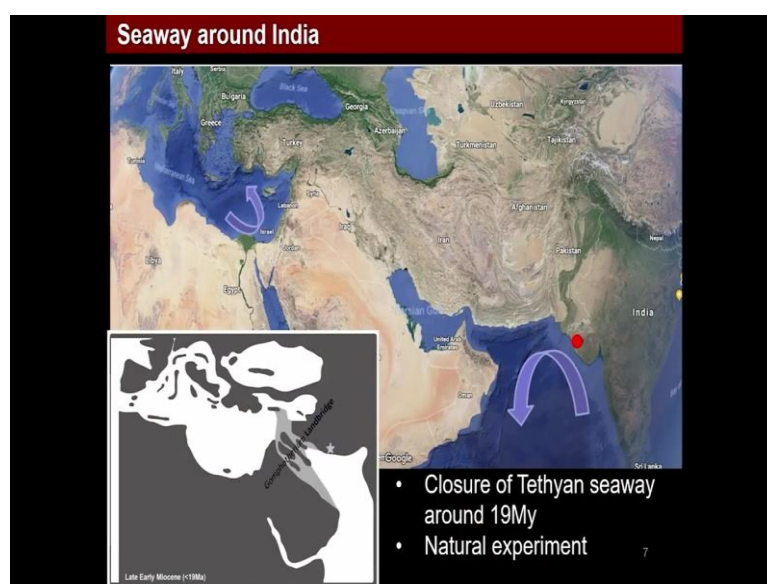
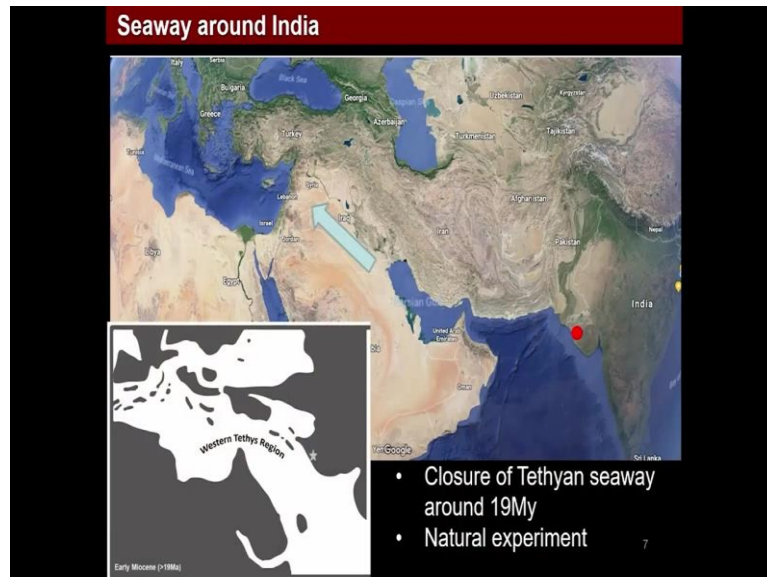
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So if we go back in time, there was a time when the Tethian sea, starting from the northern part of India, went all the way to Mediterranean, it was a continuous seaway. So if one is to

take a boat and sail towards the west, he or she could actually go all the way to Mediterranean without taking a break. But then something changed.

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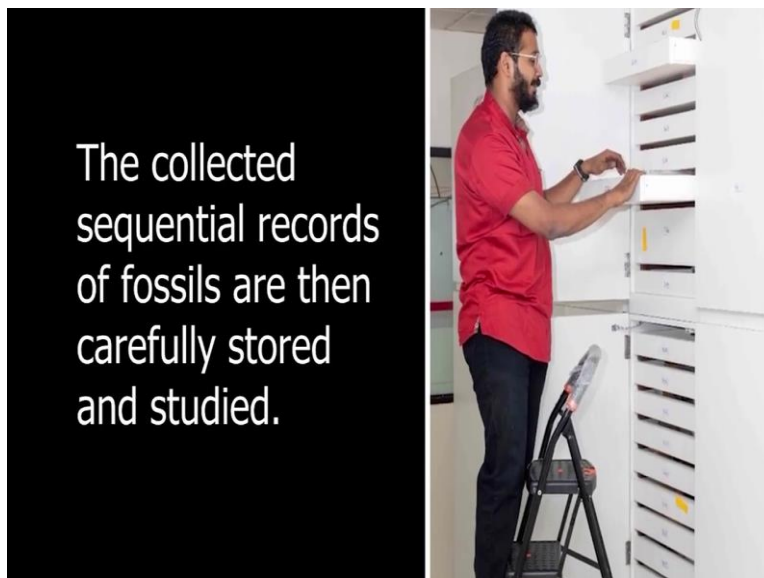


The Arabian peninsula where we see it, it moved and finally we see a land which emerged and connecting Africa, Arabian Peninsula and the Europe. And during this time, the Mediterranean got disconnected from the water body what we call the Arabians sea. Now the question is, if we want to know what happens to marine organisms, when you change the seaway? What happens if you disconnect them? What happens if they are segregated? All of these questions can be addressed by looking at the fossil record of before and after this formation of this land bridge, as it is called.

Student: When you say, studying fossils for research purposes, I imagine it is something continuous, like a record and not isolated specimen. So can you elaborate a little on that?

Professor: Yes, I think many of the cases, we simply look at it as from a collectors point of view, where you get a nice little tiny fossil, and we get excited. But in order to use them as data points, we need a lot of them.

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And what we try to go for is a place where there is a sequential arrangement of these fossils and we collect it sequentially, to look at how groups changed over time, especially in this specific time, where seaway have closed, and therefore Kutch is another very nice place, because it has these sequential preservation of fossils, ranging from somewhere around 25 million years, to all the way 50 million years, which is relevant for addressing this particular question when the land bridge happened, and the Seaway got disconnected, all of these things happened around 90 million years ago.

So it gives us the flexibility to check how the fauna was before 19 million years ago, and after 90 million years ago. And in order to do that, we need to collect a lot of specimens.

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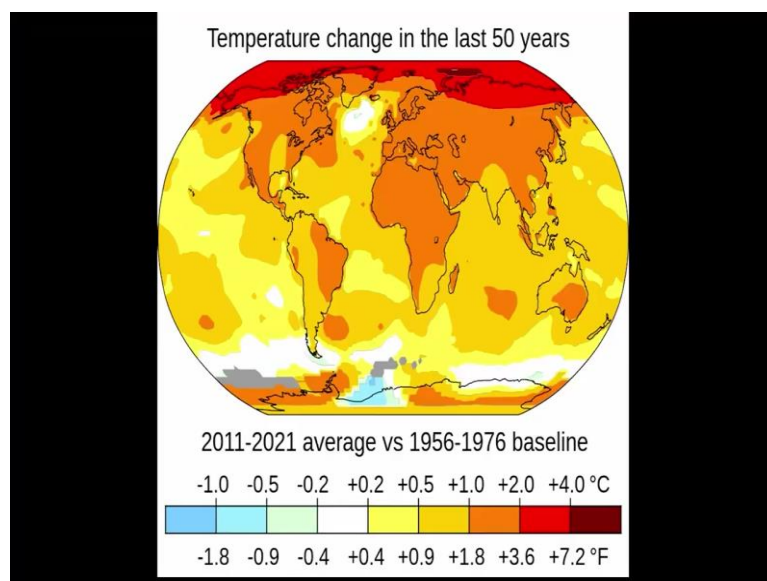
And along with my students, I go there every year, to collect specimens and finally to reconstruct what is called a stratigraphy and to see how things are changing with time, although that time has long passed.

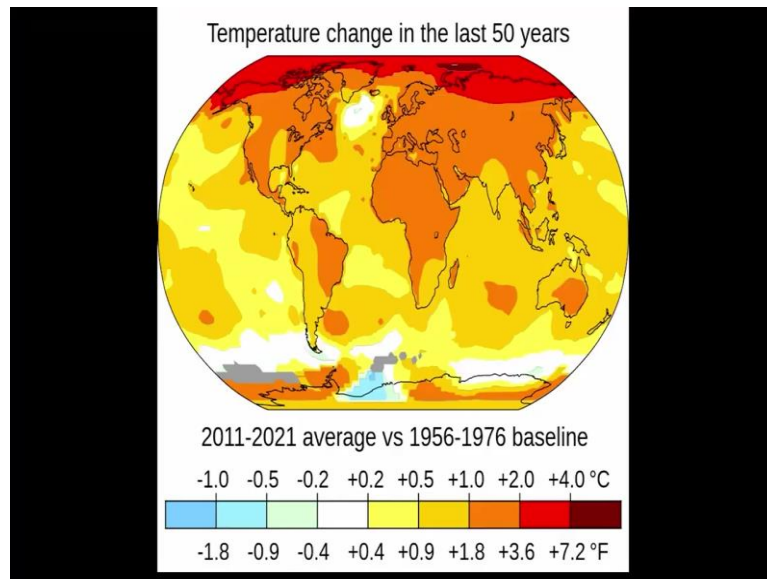
Student: As in all I understand the curiosity to study fossils. But why explore and study fossils so extensively? What are the possibilities of studying them?

Professor: I think the understanding that the fossils provide us is a valuable one. Very importantly, because many of the changes that the biology experiences, are in the larger timescale, or in timescale larger than human timescale and there is no way we can record it, or we can understand it, how a group evolves, how a group changes when the change is taking place in really large timescales and the only way to study it is to look back and look at

the fossil record, because those are the testaments of how groups changed in response to the environmental change.

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And with the modern perspective of imminent environmental changes, and the changes in climate, it becomes even more critical to understand how groups changed as a response to the changes in their environment. So one way to think about it is it is essential to look back in order to understand our present and to plan for the future.

Student: So studying the past helps us predict the future scenarios.

Professor: Absolutely. That is the theme for conservation paleobiology.

Student: Thank you Devapriya for your time and addressing some of our curiosities about fossils.