Geomorphology
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Lecture - 36
Shoreline Platform

So friends welcome to this lecture series of Geomorphology and today we are going to discuss about Shoreline Platform in this class. So if you remember our last class, we are talking something about wave action, tide action and wind action and finally due to wave action we have created 2 types of topography, one is cliff another is called this platform. Cliff it is a steep bedrock on this surface.

And platform it is around 1 degree or less than 1 degree. So mostly this shoreline platform it indicates the intertidal zone and either it will be for thin sediment cover or it will be completely of bedrock that depends upon the degree of erosion, the ability to erode this rock by this sea waves and so. So finally we will today discuss about this geology and geomorphology of this shoreline platform.

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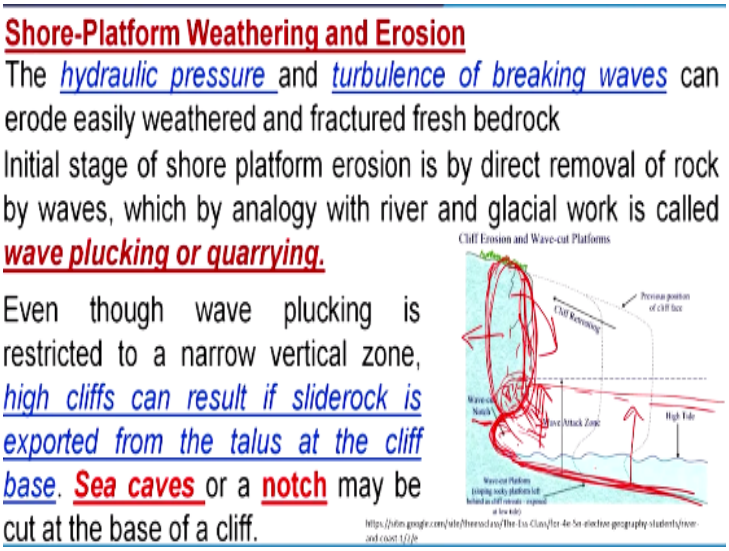

So if you see this figure here this is a cliff and this is shoreline platform. See how wide the shoreline platform will be and what should be this geomorphology either it is a plane or it will be wavy or it will be sediment fill or less of sediment that will depends upon the wave action and this degree of erodibility of this cliff rock. So the hydraulic pressure and

turbulence of the breaking wave can erode easily weathered rock fracture or fractured rock or the fresh bedrock also.

So there are 2 types of pressure or 2 types of activities by the wave. One is hydraulic pressure another is turbulence of breaking wave. Either of this case there will be removal of this rock material from this cliff and in early days suppose for example if this is the cliff surface and this is the cliff surface and we are increasing the sea level like this. So the sea will be of this level.

For example, if the sea is at this level so these area with rocks were fractured and there is fragmented. So those rocks will easily be removed by this wave. So these type of activities of removal of fractured rocks, fractured bedrocks that is called hydraulic plucking or wave plucking or quarrying. So wave plucking and a plucking or quarrying it is a general term used both for river, for glacier and for wave.

So it is for wave it is wave plucking or it is a glacial plucking or it is a river plucking. So plucking nothing it is plucking is simply removal of fractured rock as it is from this main source or rock body this is plucking. So now you see when we are increasing the sea level of this so wave is directly interacting the rocks of this region. So that means here there will be fractured rocks will be removed back. So this is called wave plucking or quarrying.

Even though wave plucking is restricted to a narrow vertical zone, high cliffs can result if slide rock is exposed from this talus and it is this cliff base that is sea caves or notch may appear. For example, if you see here once we are removing the material. Suppose this due to removal of this material here we are creating notch. So once notch we are creating here due to the wave action these part of this cliff will not stable.

So here the term comes again the role of mass wasting. So that will either freefall here that is topple or it will simply fall rocks will be fall from here. So finally if this type of erosional system occurs that is there will be mass wasting so that means there will be retreat of sea cliff towards the land mass. So mass wasting it plays important role here to retreat the sea cliffs.

But to make it available for this to make it convenient for this mass wasting this notch is playing important role for formation of the notch it is due to this wave action and due to the

wave action this material is removed this part becomes gravitationally unstable and finally it falls down.

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So here 2 photographs are shown how these notches are formed. You see these are the notch and finally due to notch finally this pillar if it is removed then this part of this material will easily fall into the system. This is the result of this cliff retreat and due to this notch formation.

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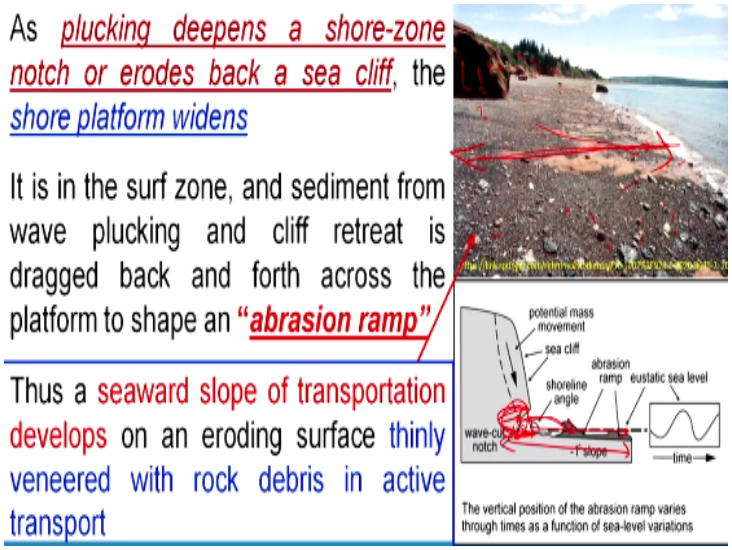

As plucking deepens the shore-zone notch or erodes rock or the sea cliff the shore platform widens. Why because you see once suppose for example when this sea level was here so this notch was not formed. So this width of the platform was this much. As notch formed that

means this much width is added to this. So that is why with more and more notch, more and more deeper the notch so this area if it is notch back.

So this sea platform that will widens. So if it widens so that means this sea level is increasing and increasing. So if this sediment is removed from here it will be remain here during high tide it will move up during low tide it will move down. So there will be to and fro action of this eroded sediments. So this eroded sediment either it will be here or it will move along this sea platform to the deeper level of the sea that depends upon the strength of this waves.

So it is the surf zone and sediment from wave plucking and cliff retreat is dragged back and forth across the platform to sharpen the abrasion ramp. So this platform is called abrasion ramp. Ramp if you see it is a flat surface. So this is gently dipping one degree or so or less than one degree. Now you see whatever the sediments removed from this region now they are lying here.

Thus, a seaward slope of transportation develops on an eroding surface thinly veneered with rock debris of active transport. Now see the grain size will decrease from this landward to seaward and finally this size or this width of this sea ramp or abrasion ramp that depends upon how much sediment we are eroding here and how much we are transporting it to the sea.

So if the transportation is up to too depth so that means it will not come again by the wave action. So that means in that case we are losing sediments from the sea abrasion ramp. Otherwise, there will be to and fro movement along this abrasion ramp and finally we are getting thin sediment cover on this abrasion ramp.

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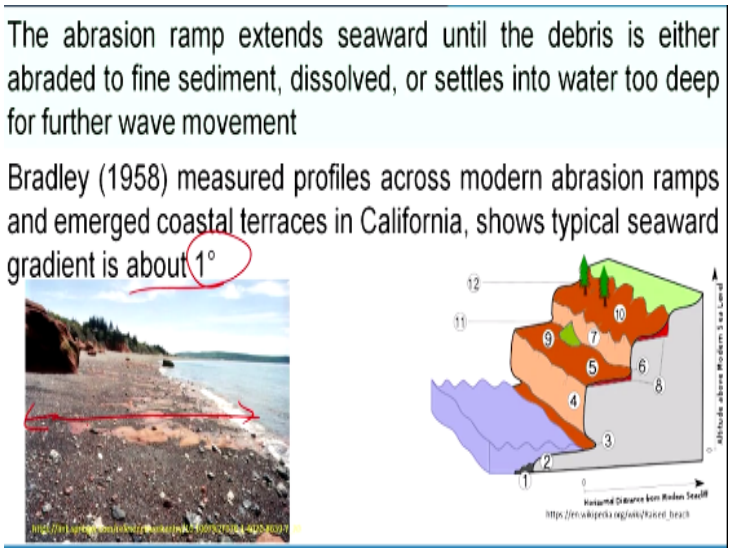

The abrasion ramp extends seaward until the debris is either abraded to fine sediment, dissolved or settle into the water too deep to further wave movement that means here it is said that if it is the sediment is gone up too deeper part of the sea and would never come back due to this wave action that means we are losing the sediment. Otherwise, we have sediment and gradually we are reducing the grain size by to and fro motions.

This gentlemen Bradley in 1958 measured the profile across modern abrasion ramps and emerged coastal terraces in California shows typically seaward gradient is about 1 degree that we have already discussed. It is a very gentle slope and it is 1 degree or so. So if the angle of repose is more like this so there will be easy removal of this sediment, but as it is 1 degree or less than 1 degree.

So that means it is not easy removal of the sediment from the surface that is why sediment passes long time on this abrasion ramp and finally due to this long duration of stay and frequent action of this wave by to and fro motion their grain side reduction occurs their sorting increases. So that is why in a shore-zone we will get highly sorted sediments as compare to this pure fluvial environment.

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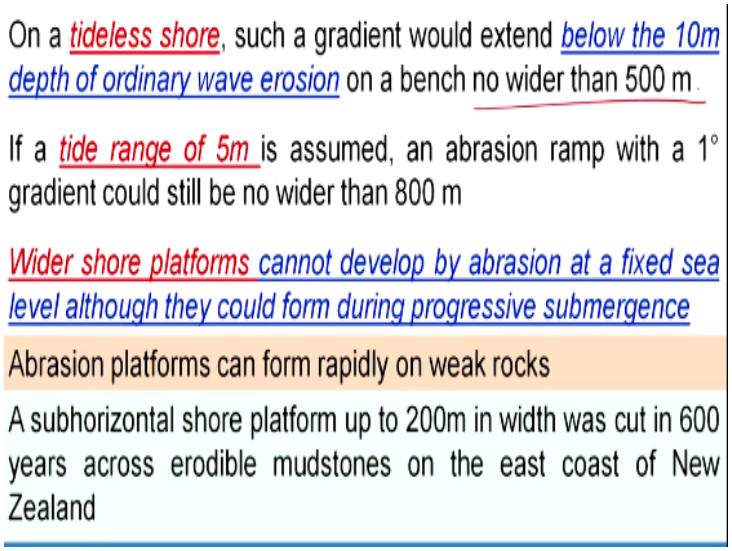

On a tideless shore such gradient would extend between 10 meter depth of the ordinary wave erosion and bench becomes no wider than 500 meters. So if it is not tide no tide is there tideless shore that means sediment will remain idle it will not transport significant transport would not occur. So if significant transfer is not occurring towards seaward that means our seaward platforms, seaward ramp becomes narrow.

But if due to tidal action the sediment is transported into the seaward that means we are getting wide sediment ramp is there. If the tidal range is about 5 meter it assumed as abrasion ramp with about 1 degree gradient could still be water depth about 800 meters. So that means if we have 1 degree slope is there and tidal range it was 5 meter still we are getting an abrasion ramp of width about 800 meters.

So that means tide here plays an important role what should be the width of an abrasion ramp. If it is tideless that we are getting narrow zone and all the sediment will be stuck up here and there will be less sorting, fixed sediment cover and this will be about 500 meters or so, but due to tide action even if 1 degree ramp is there that means we are getting the sediments transported up to 800 meter and finally there will be sorting and so.

So wider shore platforms cannot be developed by abrasion at a fixed sea level although they could form during progressive submergence it is very important here to understand. If we have idle sea level, that is fixed sea level. Fixed sea level that means there will be not much transport, there will be not much wave action, much wave tide action. So that means here this platform this abrasion platform will not develop very finely.

So if we have to develop a wide abrasion ramp so that means we have to either increase or decrease the sea level that means like this we have to make the system dynamics rather than static. So abrasion platforms can form rapidly on weak rock that is very important. Weak rocks that create very rapidly abrasion platform. The sub-horizontal shore platform up to 200 meter width was cut to 600 years across erodible mudstones on the east coast of New Zealand.

This is an example is given that this mudstone was there and mudstone this is weak mudstone is a weak rock. So abrasion platform of 200 meter width cut in 600 years across erodible mudstones, but had it been on granite, had it been on khondalite or basalt this 200 meter it might have taken 2 million years or so. So due to this presence of weak rocks this width of this abrasion ramp increases very rapidly.

And will get very wide abrasion platform like in east coast there is a place in Orissa and Bengal border that is called Digha. You will find this abrasion platform wide abrasion landform during low tide you can move up to kilometer distance and during high tide the whole system is somewhat standard this is due to the khondalite sediment is there. So that means if it is weak rock we are getting a wide abrasion platform within a less time period.

But same east coast where there khondalite is exposed will not get abrasion platform more than 50 meters or so, but in Digha we are getting a kilometers or more than kilometers. So this is due to this rock characteristics.

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Then another type of weathering is called water level weathering. This term was given by Wentworth 1938. It seems to be dominant process that widens and flatten shore platform on non-carbonate rocks that is called water level weathering. It seems to be the dominant process that widens and flatten shore platform on non carbonate rock because carbonate rocks they are more prone to chemical weathering than mechanical weathering but this water level weathering due to this action of water. So this is mostly at noncarbonated rocks.

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There are pools in the intertidal zone we are getting some pools and separated by a ridge similarly there are pools and separated by a ridge. So here you are getting some salt spray that means this photography you see there will be a salt depositing on the surface of this rocks due to evaporation of water. So if you remember when we are talking about weathering and erosion so in that case we are talking about a term that is called Tafoni.

This Tafoni is the characteristics feature of physical weathering by this salt action. So, due to salt overgrowth or precipitation of salt. Similarly, if you see here the intertidal pools you see these are the intertidal pools and salts spray on abrasion ramp or in the wave plucked notches promote weathering in this zone just above this permanent saturation. This is the zone of permanent saturation.

This is open sea this side, open sea this side. So here the intertidal zone that means during high tide we are get water this level or low tidal will be this level. Similarly, during high tide this total system will be submerged. So in that case what we will get generally the intertidal pools and salt sprays.

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So the spray zones just above normal high tides is a zone of especially active chemical weathering. You see here normal high tide beyond this normal high tide because during tide the salt will dissolve and remove, but once the area remains above the high tide so there will be permanent salt accumulation zone and salt accumulated on the surface of the rock they will promote chemical weathering.

Similarly, this terminology we have already discussed in our weathering class there is Tafoni or honeycomb weathering form rapidly in the zone of spray and drying. So these are this boxwork/ honeycomb structures these are the characteristic feature of salt erosion or salt spray erosion.

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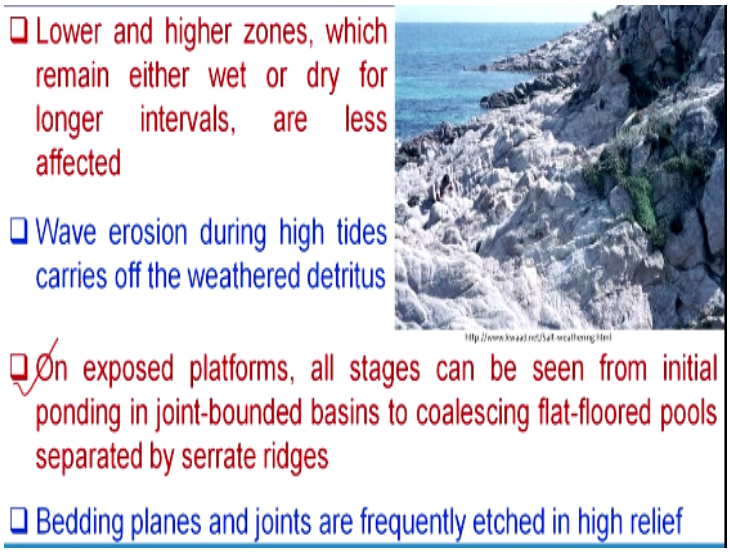

Then some salient features about this lower and higher zone which remain either wet or dry for long intervals are less affected here. So, that means the intermediate zones are more affected, the lower zones which are under permanent water cover that will be less affected. The higher zones which are above this permanently above the water zones they remain unaffected or relatively more stable.

However, the intertidal zones these zones are mostly affected by this type of weathering activity. Wave erosion during high tides carries off the weathered debris. So whatever the debris we are creating during weathering during high tide the whole product will move back to the sea. On exposed platform, all stages can be seen through initial ponding in joining this bounded basins or joint bounded basins to coalescence of flat floor separated by this serrate of ridges.

So, bedding planes and joints are frequently etched at higher relief. So that means these areas on exposed platform all stages can be seen. So whatever we are talking about either in the permanent zone, permanent dry zone and permanent wet zone or intermediate zone all those platform all those activities can be shown in wherever there is a cliff section there will be vast erosional platform is there these areas that can be well studied here. Bedding planes and joint are frequently etched in high relief why because these are the weak planes, joint bedding planes these are the weak planes.

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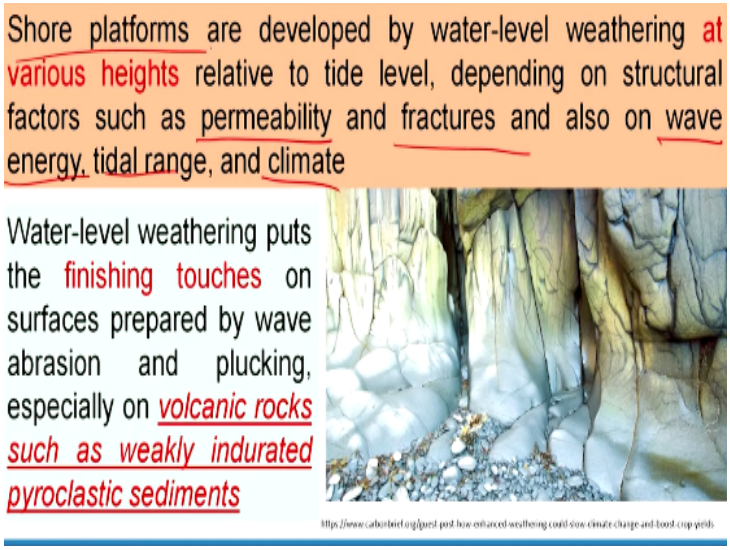

Then shore platforms are developed by water level weathering at various heights relative to tide level depending upon these structural factors such as permeability, fractures and also on wave energy, tidal range and climate. So these are this parameters the permeability if the rock is more permeable so that means it will allow the rock pass through it. So, more permeable rock will weathered fast as compared to less permeable rocks because free movement of water will be there.

Then similarly fractures, fractures that provides the avenue to pass through this rocking inside then wave energy how energetic wave is. If it is wave is highly energetic that will forcefully enter into the rock force, then tidal range if this tidal range is low or tidal range is high and the climate if it is wet climate, it is dry climate. So these are the parameters tidal range, climate, wave energy, then fracture, permeability that depends the shore platform how the shore platform will develop.

What should be the nature of this shore platform that depends on all this factors and the rock types also? Water level weathering puts the finishing touch on surface prepared by wave abrasion and plucking especially volcanic rock such as weakly indurated pyroclastic sediments. This is very important to understand here this water level weathering that means water remains at the particular level either it is increasing slowly or decreasing slowly.

So this water level weathering it keeps the finishing touch that means it polishes the rock. So during hydraulic plucking, during mass wasting, we are creating a rock surface and that rough surface is gradually polished by this type of hydraulic action where it is water level

weathering and mostly it is affected by volcanic rocks because we know in our weathering classes this volcanic rocks they form in a different kind of temperature and pressure conditions.

Once they are interacting with this level that is this geomorphic agents surface geomorphic agent they becomes more unstable as compared to the sedimentary rocks which form at this surface temperature and pressure conditions. So that is why the volcanic rocks such as weakly indurated pyroclastic sediments they are more affected. So pyroclastic sediment where we will get we will get at the volcanoes.

So in oceanic surface we get number of volcanoes like if you go to this specific chain of volcanic islands are there in Iceland along this mid-oceanic ridges we have thousands of volcanoes as circum-Pacific belt so we have thousands of volcano. In Indian context we have in Andaman and Nicobar we have this volcano this barren island. So that means those volcanic rocks especially the pyroclastics. They are mostly affected by this type of weathering as compared to others or that create this type of shore platforms.

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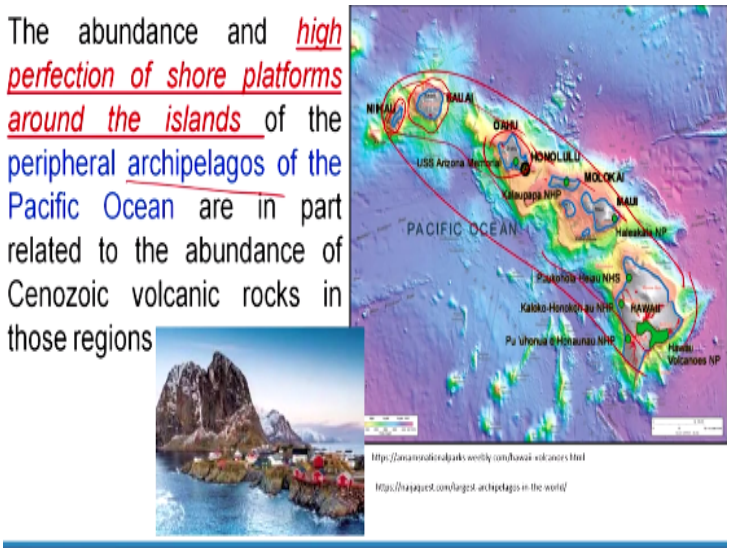

The abundance and higher perfection of shore platform around the Islands of this peripheral archipelagos of this Pacific Ocean are in part related to abundance of Cenozoic volcanic rocks in this regions. So that means here we have number of volcanoes are there. So at this periphery of this volcanoes at this periphery of this volcanoes this type of weathering, this type of geomorphological features they are mostly found.

And these are this an example is given archipelagos this specific archipelagos means it is a group of Islands this is called archipelagos that is genetically related and these are related to this hot spot and here in the hot spot and this is the oldest one, this side is the youngest one and finally we are getting along this periphery this type of shore platforms are there.

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Then another type of platform which is called solution platform, so far we are discussing about this weathering of non carbonate rocks of this wave action or the non carbonate rocks. Here we will talk about the carbonate rocks. So in carbonate rocks in shore zone solution is so common that a special class of solution platform is distinguished. Solution platform it may be very smooth or may be very rough depending upon the degree of weathering and erosion.

These are the most complex shore platform to describe because their origin involves both chemical, biological solution and deposition. So this platform either there will be a solution that is removal and there will be deposition by algal action. So that means here we are getting undulating rolling topography type features. So removal is due to this chemical action and deposition mound formation is due to biological actions.

So that means solution platforms are generally intertidal. In this intertidal range we are getting this type of solution platform because when there will be a high tide there will be interaction of water around this rock and there will be algal accumulation and finally there will be mound type of development landforms are developed there.

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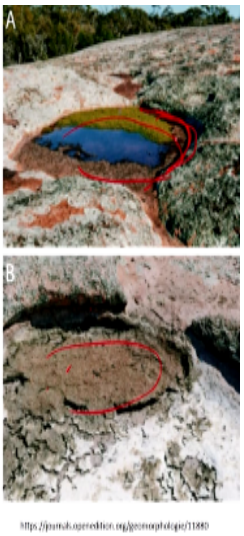
Small pools alternate with low domes and ridges, often formed by living carbonate-secreting algae

Their surfaces are flat and smooth but not abraded

At the landward edge of a solution platform may be a horizontal ***solution notch*** as deep as 3 m



Small pools alternate with low domes and ridges often formed by living carbonate secreting algae. So this type of pools will be there and this type of domes will be there and this dome and pools are due to this carbonate rocks. Their surface are flat and smooth, but not abraded. At the landward edge of the solution platform maybe horizontal solution notches as deep as 3 meters.

So here we are getting this solution notches. So solution notches like wave cut notches they are cutting into this landmass and finally makes the upper rock unstable gravitational unstable and that will promote this mass wasting. So due to this biological action, due to this solution activity and related to solution activity what are the notches are there and there will be mass wasting. So, complete package is there. So there will be modification of this landform is due to chemical action as well as mass wasting.

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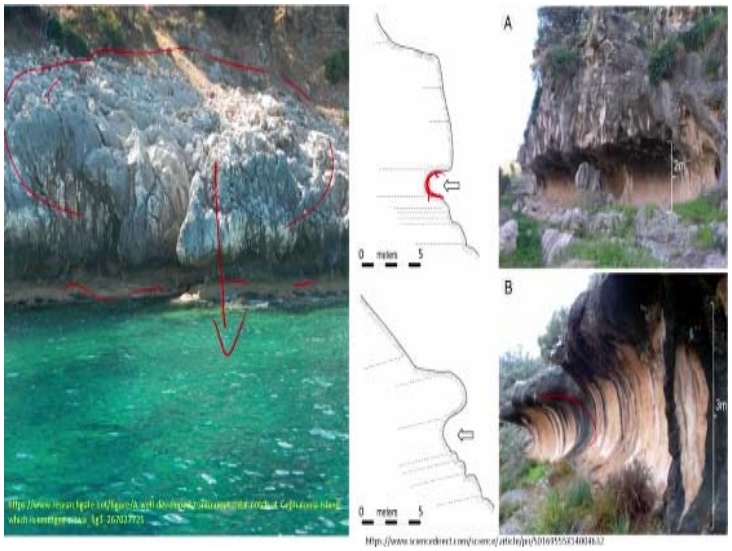

And here some of this photograph if you see this is chemical notches due to this reaction with water this type of notches are formed and finally these are these notches and this upper rocks becomes unstable and finally they fall down into the system and then this slope degradation or slope retreat occurs and finally the hill slope evolution whatever we are talking about this during our mass wasting class this procedure again follow due to this wave action.

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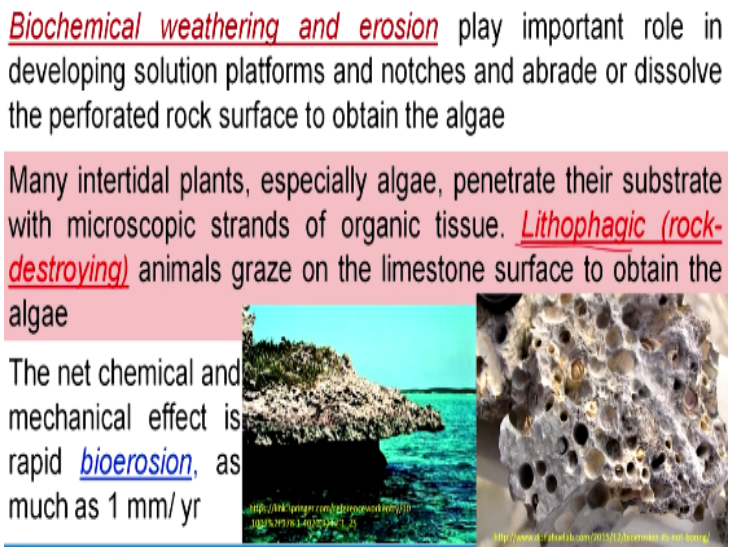

Biochemical weathering and erosion plays an important role in developing solution platforms and notches and abrade or dissolve this perforated rock surface to obtain the algae. Many intertidal plants especially algae penetrate their substrate with microscopic strands of organic tissues that is litho-phasic that is called rock destroying animals, graze in limestone surface to obtain this algae. So now we have algal erosion or algal met that is development of mounds.

And this some of this animals are there they graze for their food and finally there will be physical weathering. So the net chemical and mechanical effect is rapid and it is called bio-erosion as much as 1 millimeter per year. So irrespective of their nature bio-erosion that means activities of biological activities algal activities and those animals and all those biological systems they contribute together it is called bioactivity and the bioactivity plays an important role for reducing this coastal landform and developing a coastal landform and especially to modifying the coastal landforms.

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- Boring sponges have been reported to erode 23 kg/m^2 yr from reef limestone
- Biochemical solution of 6.5 kg/m^2yr was measured on reef limestone in Hawaii (Hallock, 1988)
- A limestone surface would be lowered at rates of 2.5 to 8.5 mm/yr by such processes
- Comparable subtidal bioerosion rates of 2 to 10 mm/yr have been estimated for calcareous mudstones in California (Warme and Marshall,1969).

Some of this salient features are here, boring sponges has been reported to erode 23 kg per meter square per year from this reef limestone. Biochemical solution of 6.5 kg per meter square per year was measured on reef limestone at Hawaii. A limestone surface would be lowered a rate of 2.5 to 8.5 millimeter per year by such type of bio-erosional process. Comparable subtidal bio-erosion rates 2 to 10 millimeter per year have been estimated for this calcareous mudstones in California.

So that means I want to say this biological erosion this bio-erosion for this carbonate rocks and this noncarbonated rocks this wave actions, this mass wasting, this tidal action they totally they are acting together to shape the landscapes along this coastal landforms. So I think we will stop here and will meet in the next class. Thank you very much.