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Glaciation and Sea Level Change

When we are working along the West Coast, we have of course the interplay between the land and the ocean. Basically, we talk about sea level a lot and people probably wonder how it is that sea levels go up and down and what are the factors involved.

First of all, we have to think about glaciation – the relationship between glaciation and the oceans. At the time of maximum glaciation, there is an extraordinary amount of water that is actually stored in the glaciers and that water has to be derived from somewhere. The water comes from the oceans, so there is a corresponding drop in ocean level that agrees with the timing of glaciation. We see this interplay going on, of course, throughout the Pleistocene repeatedly. Whenever there is a glaciation, sea levels are lower. The maximum drop of sea level in the last glaciation was probably on the order of 130 meters. So we are talking about a major drop in sea level here.

So let's categorize some things here. First of all, when we are talking about worldwide changes in sea level, we call that eustatic changes. There have been these eustatic changes in sea level. No problem there - it's a very straightforward phenomenon.

When ice was present, however, in the Lower Mainland for example, or along the rest of the British Columbia coast, the mass of that ice also has to be considered. The ice weighed a lot. If you've ever picked up a bucket of water you realize that water is pretty heavy, actually. Despite the fact that it is made of just hydrogen and oxygen, a bucket of water is still pretty heavy. And so the mass of the ice sheets themselves (we had ice here perhaps two kilometers thick) the mass of the ice sheets in the Lower Mainland would have caused the land to be depressed. And so that's another phenomenon we've got, relating to buoyancy, I guess, is the best thing to relate it to in your mind. If we add mass to this region we see the depression of the land downward. Now that's called isostatic depression.

So there's eustatic change and also isostatic change. Now think of the relationships here – we're getting complicated. The ocean levels have gone down, but because there is ice present, the land levels have also gone down. And it's the interplay between the two that might give us some very complicated relationships in terms of local apparent sea level, or relative sea level. The actual position of a beach, then, could be a very complicated matter, in terms of its interpretation. If the land was depressed when the ice advanced and brought mass to this area then, you can imagine too that when the ice retreated the land started to rebound. So these factors make the study of relative sea levels a very complicated issue.

But wait – there's more! In the British Columbia area, we also have some very complicated tectonic settings. That's a third geological factor that we have to think about. Tectonism is basically mountain-building or deformation processes, such as

folding and faulting. In our region we do have a lot of evidence for folding and faulting. And tectonic changes, instead of just causing regional ups and downs, might cause areas to tilt. Some areas get uplifted more in one area and down dropped in another area. That means that as the land is going up and down or rebounding it is also being rotated in response to these tectonic forces. So we've got a third factor, and there is a fourth factor.

The ice itself actually influences the local gravitational forces in an area. Of course, land masses influence gravitational forces – ice masses also do that. And so the ice masses would be exerting a gravitational force upon the nearby water. And that might be a factor in modifying the water level a little bit, too.