Natural Oil Seeps in South Eastern Alaska
Slides from Field Studies in 1993, 1994 and 1999
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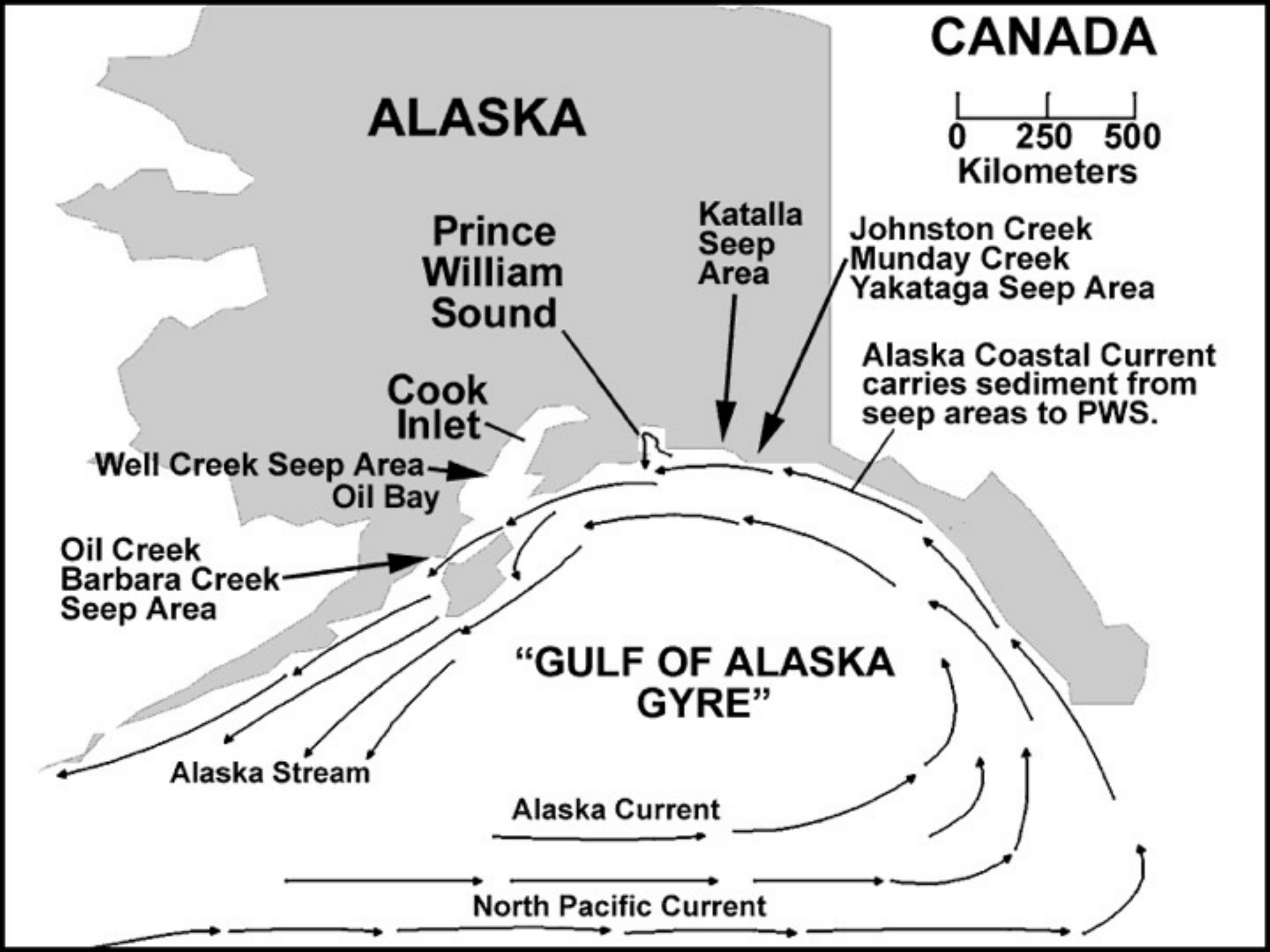
These slides are from field surveys we made in 1993, 1994 and 1999 to natural oil seeps in the Gulf Coast region of Alaska east of Prince William Sound (PWS) and at locations on the Alaska Peninsula. The oil seeps and eroding oil source rocks east of Prince William Sound contribute natural petroleum hydrocarbons to areas within the Exxon Valdez oil spill zone.

This work originally came about because of claims in the literature that petroleum hydrocarbons in seafloor sediments of Prince William Sound (PWS) came from the spill. These petroleum hydrocarbons were shown in 1993 to be related to oil seep areas east of PWS and not to the oil spill and that inputs of the natural background predated the 1989 oil spill. Recently, further claims followed that coal, not oil formed this natural hydrocarbon background in PWS and that our conclusions were wrong. This required additional field and lab work in 1999 to see if these claims were true. The 1993-1999 oil seep field programs collected samples of seep oil and shale to fully understand the sources of hydrocarbons that form the natural baseline in the region affected by the oil spill. Through hydrocarbon fingerprinting of these samples, mathematical least-squares analysis of the results and chemical mass balance constraints, we found that that eroding Tertiary petroleum source rocks and residues of associated seep oils are the dominant --->

–-> sources of the hydrocarbon background rather than area coals or residues from the Exxon Valdez oil spill. Mass balance constraints relate to the fact that coal is mostly carbon, with relatively small amounts of hydrocarbons relative to petroleum. PWS seafloor sediments have low total organic carbon contents and high hydrocarbon contents, consistent with petroleum, not coal. Results of this work indicate that recent claims in the literature that area coals are the major source of the background are wrong.

We found that hydrocarbons from natural oil seep areas east of PWS are the major source of hydrocarbons in subtidal sediments in Prince William Sound. In fact, oil seeps and eroding oil source rocks form the natural hydrocarbon background in many pristine areas in Alaska and have to be taken into account when doing oil spill studies in this region. The Alaskan Peninsula oil seeps shown here are Barbara Creek, Oil Creek and Well Creek. They are all associated with productive salmon streams monitored for numbers of salmon by the State of Alaska. Some of the streams that were visited are among the most productive salmon streams in their area. The oil seeps east of PWS shown here are Munday Creek, and Johnston Creek. Seep oil adsorbed onto fine sediment and eroded oil source rocks from these and other streams and rivers in this region are transported to PWS by the Alaska Coastal Current. The map on the next slide shows the general locations of the seep areas shown in these slides and the flow of the major ocean currents.


CANADA
ALASKA
0 250 500
Kilometers
Prince
William
Sound
Katalla
Seep
Area
Johnston Creek
Munday Creek
Yakataga Seep Area
Alaska Coastal Current
carries sediment from
seep areas to PWS.
Cook
Inlet
Well Creek Seep Area
Oil Bay
Oil Creek
Barbara Creek
Seep Area
"GULF OF ALASKA
GYRE"
Alaska Stream
Alaska Current
North Pacific Current

Some Definitions

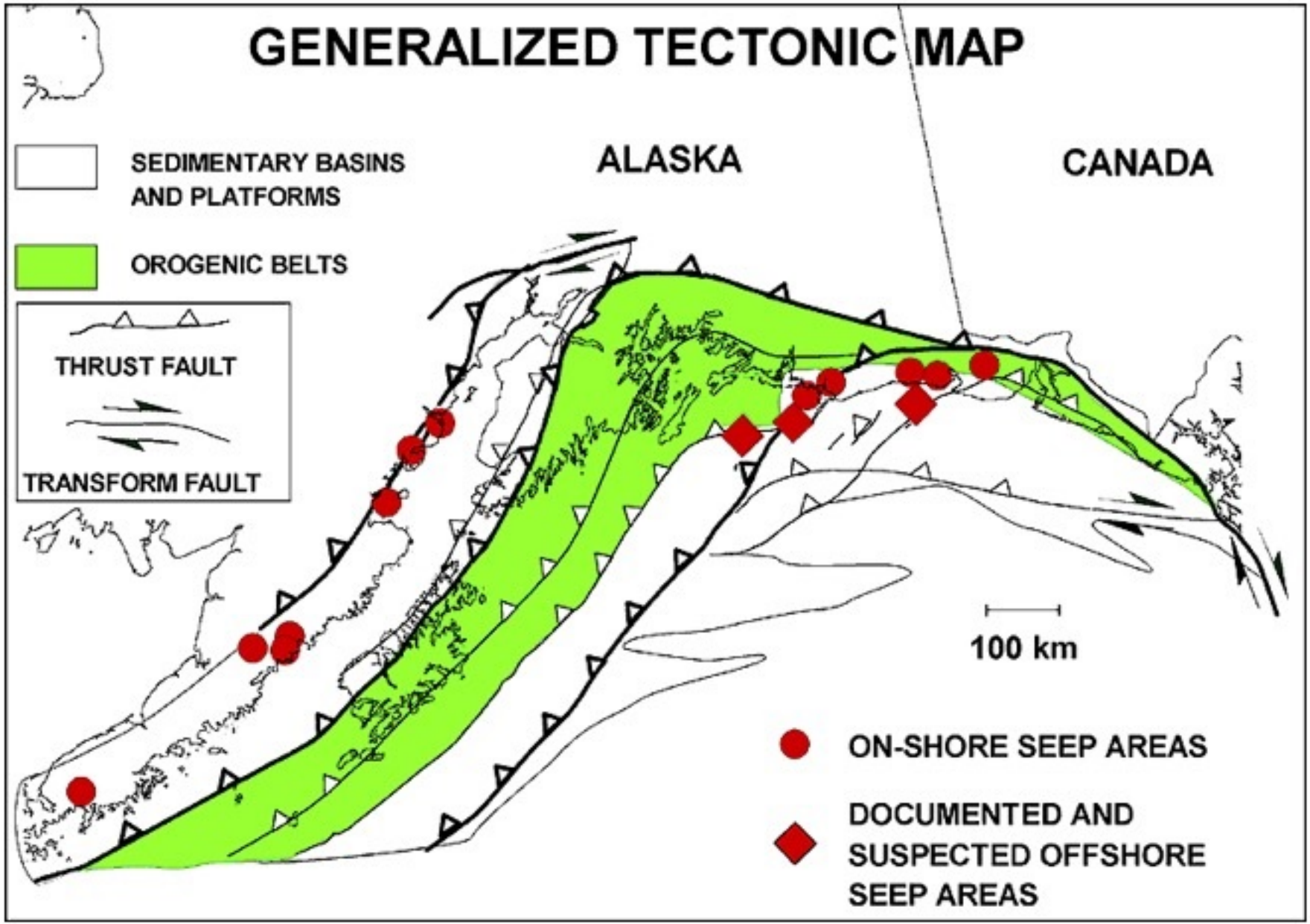
In petroleum geology, the term source rock refers to rocks from which hydrocarbons have been generated or are capable of being generated.

The Tertiary Period is the period of geologic time lasting from approximately 66 million to 2.6 million years ago.

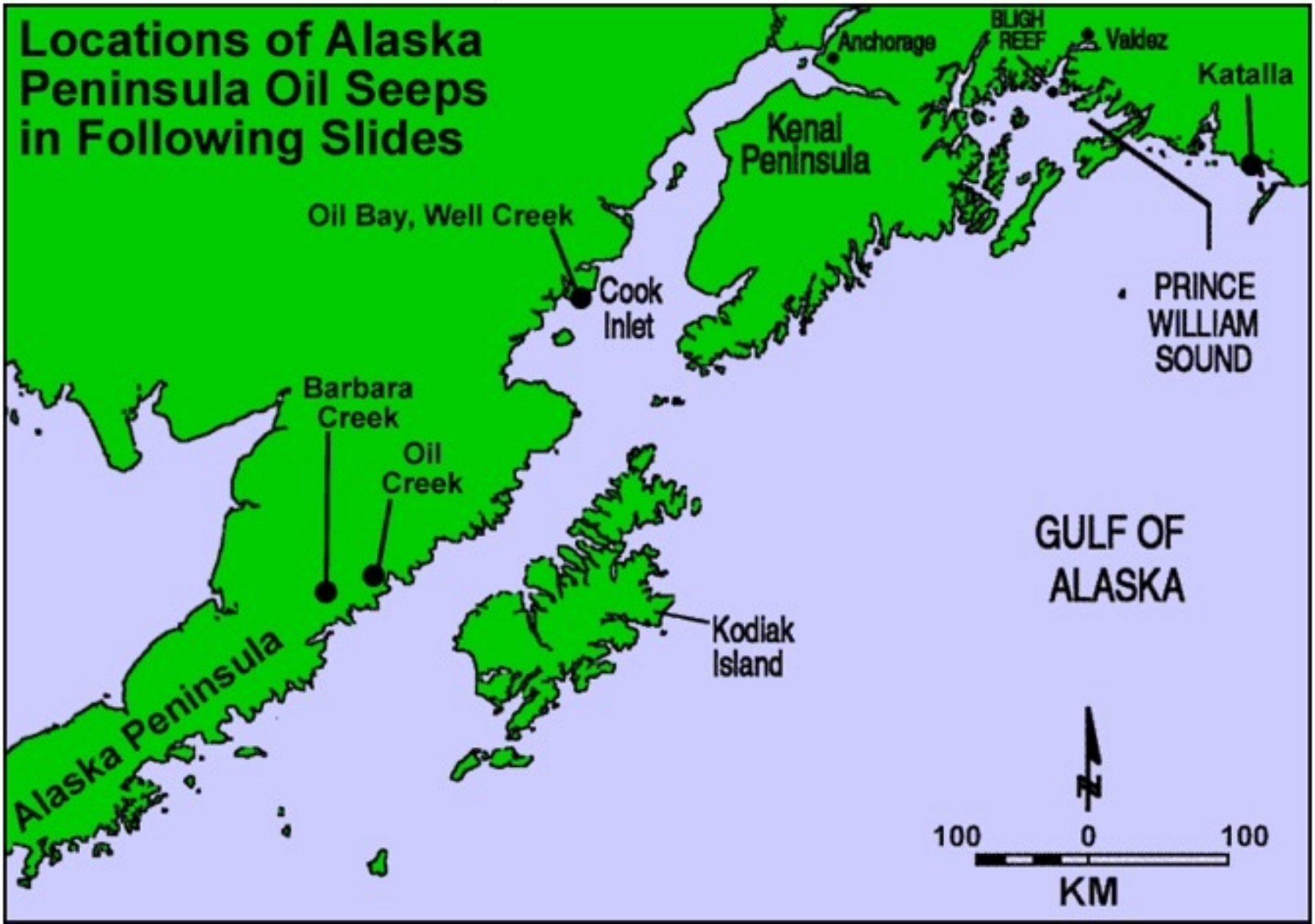
An orogenic belt forms when a continental plate crumples and is pushed up to form one or more mountain ranges.

A fault is a fracture along which portions of the earth's crust on either side have moved relative to one another parallel to the fracture. There are different types of faults. For example, a thrust fault occurs where compressive forces cause the upper block, above the fault plane, to moves up and over the lower block at a shallow angle, like pushing two wedges toward one another. A transform fault is a type of fault in which two tectonic plates slide past one another.

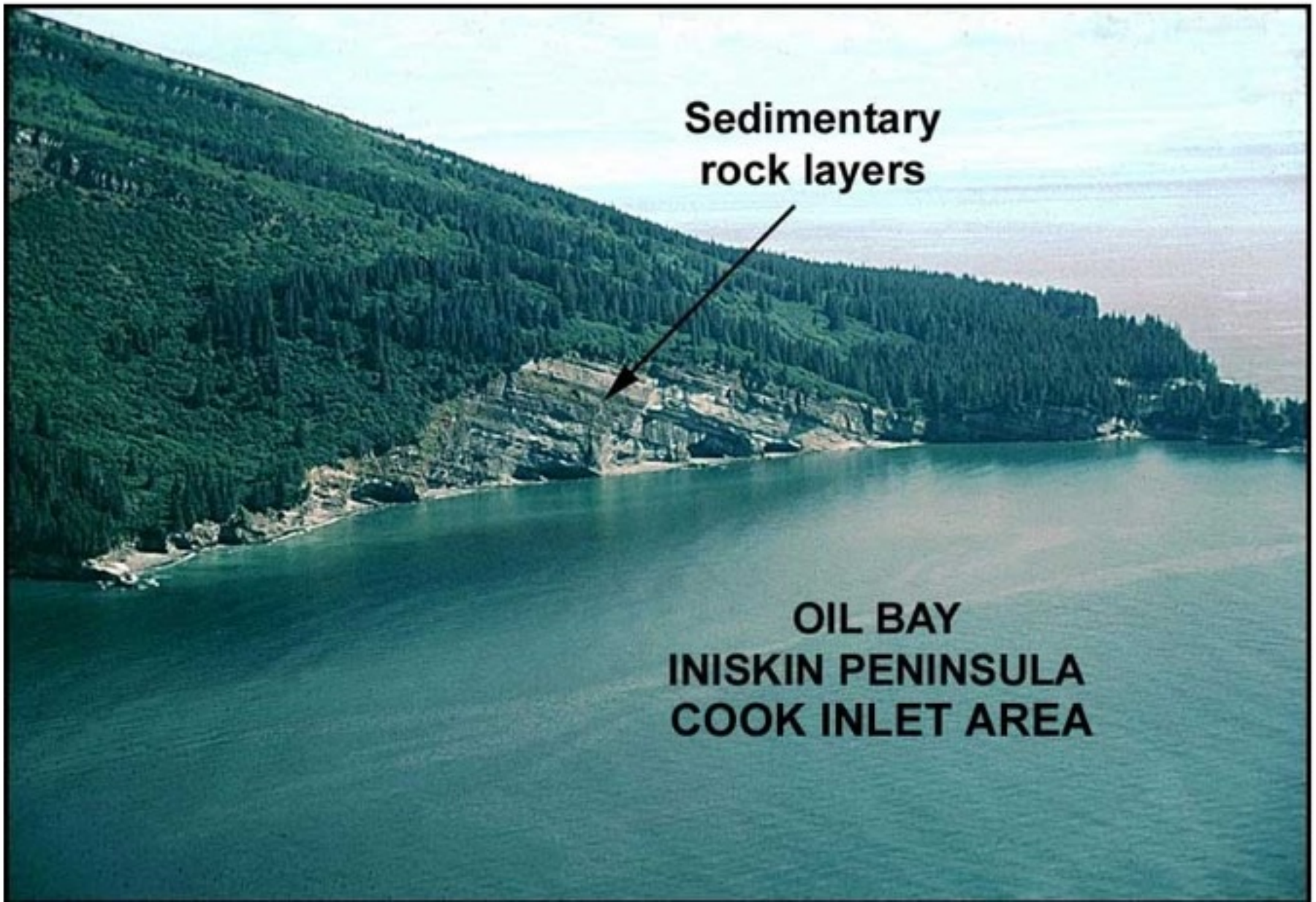
Oil seeps occur where thrust faults expose oil - bearing sedimentary rock formations



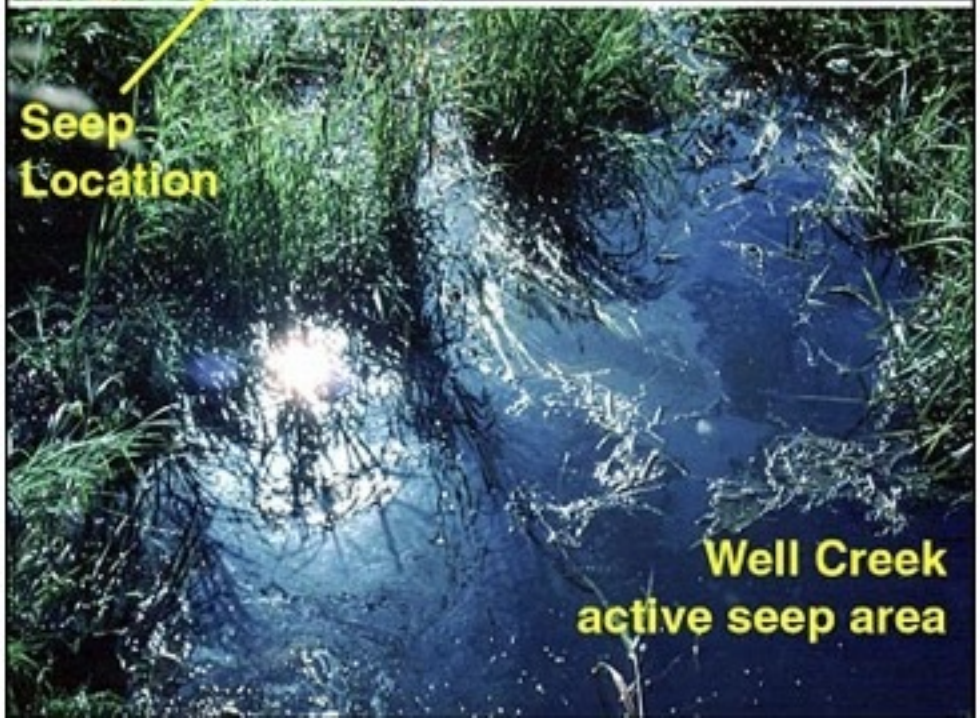
The next set of slides shows three of the many natural oil seeps on the Alaska Peninsula



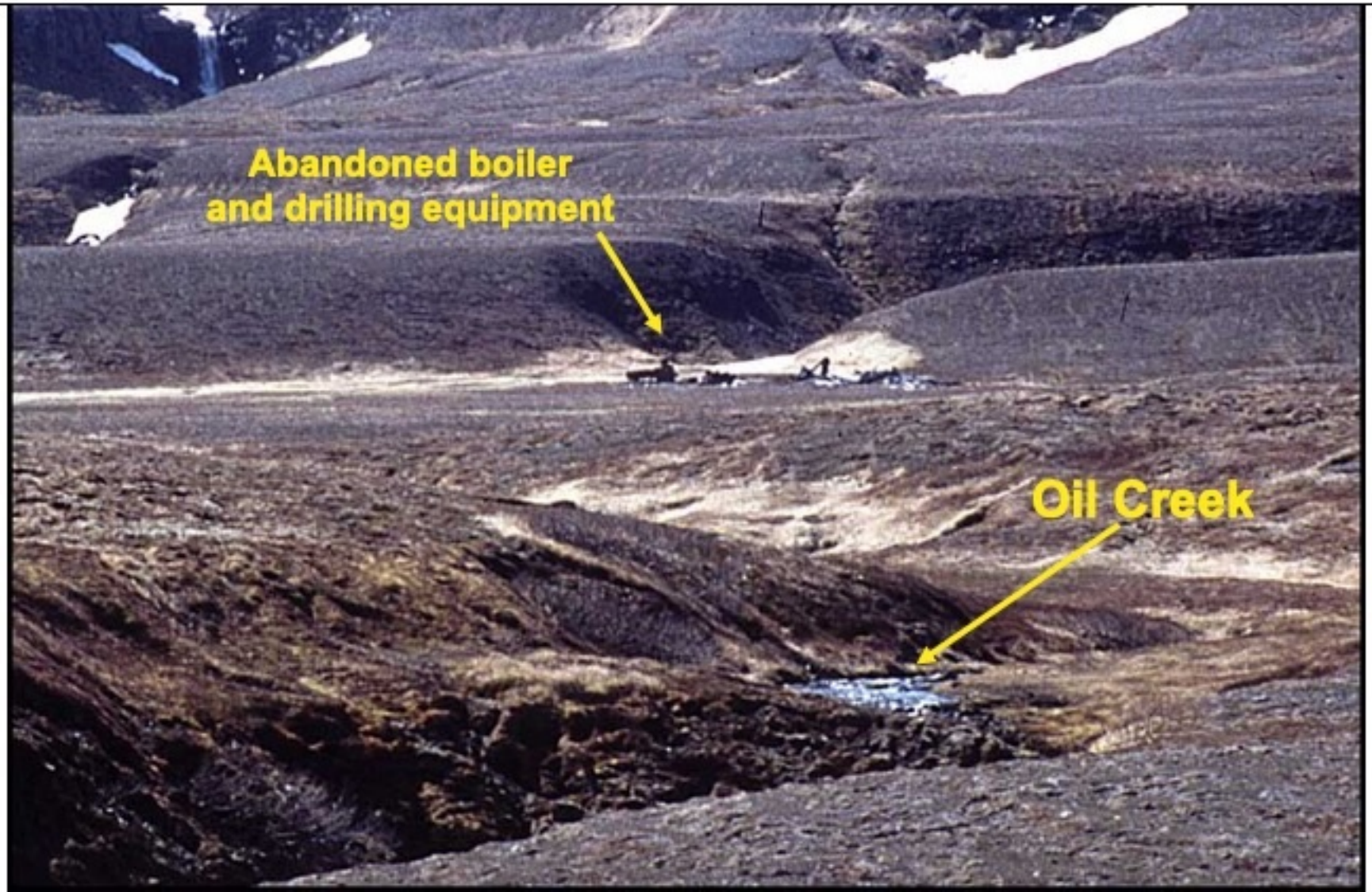
Dark layers of organic-rich shale are visible in the exposed sedimentary formation at Oil Bay near the Well Creek seeps on the west side of Cook Inlet.



The Well Creek/Bowser Creek seeps drain into Oil Bay on the Iniskin Peninsula on the west side of the Alaska Peninsula at the mouth of Cook Inlet. This is an area of early oil exploration and exploratory wells were drilled in this area - hence the name Well Creek. The seep area is at the base of a ridge by the large meadow shown at the left. Note the sheen on the water in the lower left frame. The meadow is flooded by a beaver dam. Fish were observed in the creek at the seep area.



The Oil Creek area in the uplands above Puale Bay on the Alaska Peninsula west of PWS. An old boiler and drilling equipment is visible in the distance. Great human effort went into prospecting for oil in the old days. Before modern oil exploration methods became available, they often drilled in regions of active oil seepage.



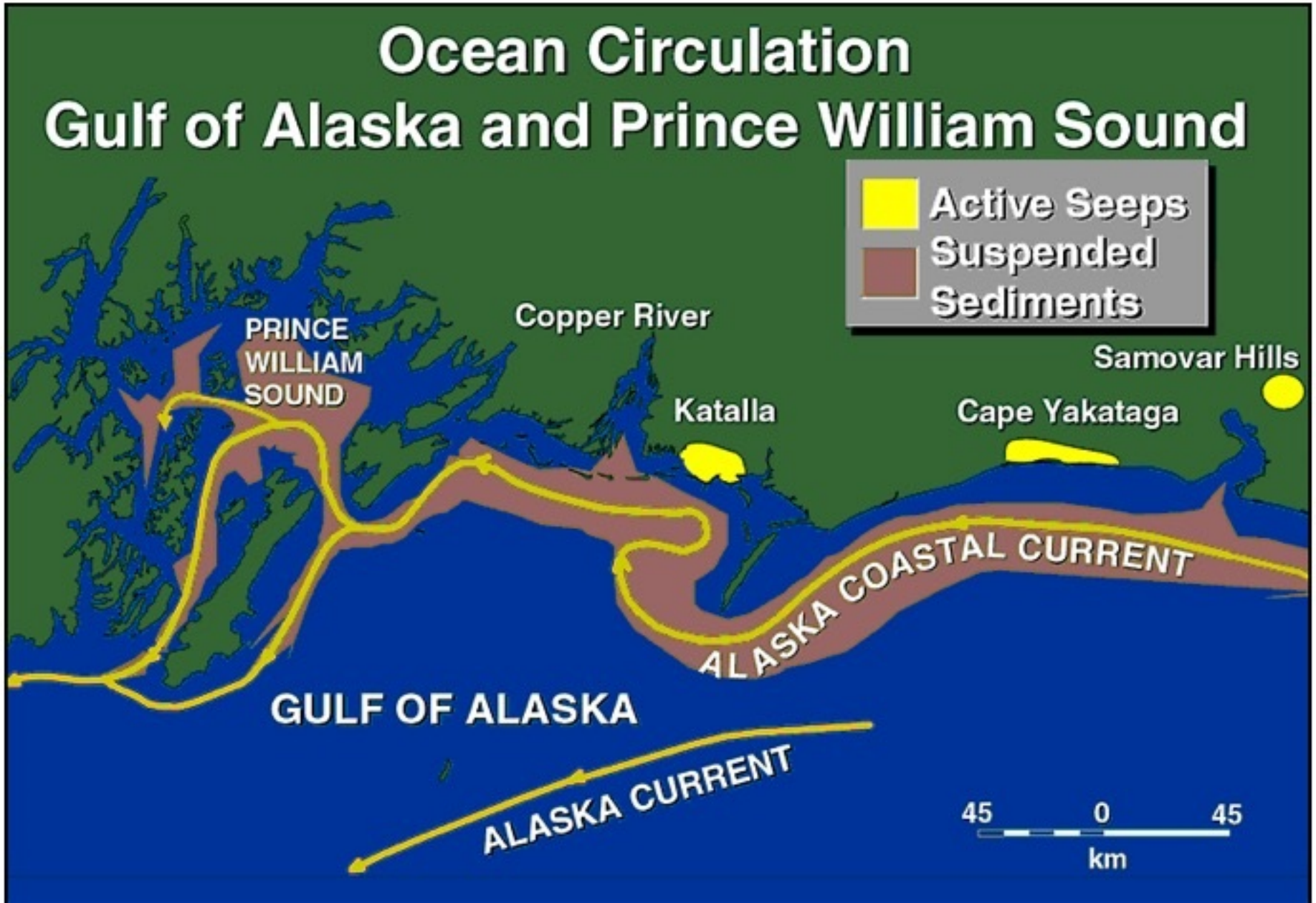
Oil and gas seepage is visible throughout the watersheds of many creeks on the Alaska Peninsula. These are also productive salmon streams

Brown oil and natural gas (fizzy bubbles) comes out of this hole in the ground continuously. There are several oil creeks in Alaska - not a very original name. This particular oil creek feeds into Puale Bay on the western side of the Alaska Peninsula. There is continuous seepage of oil into the creek throughout its upper part. The lower part is a salmon spawning area where salmon runs are counted by the State of Alaska.

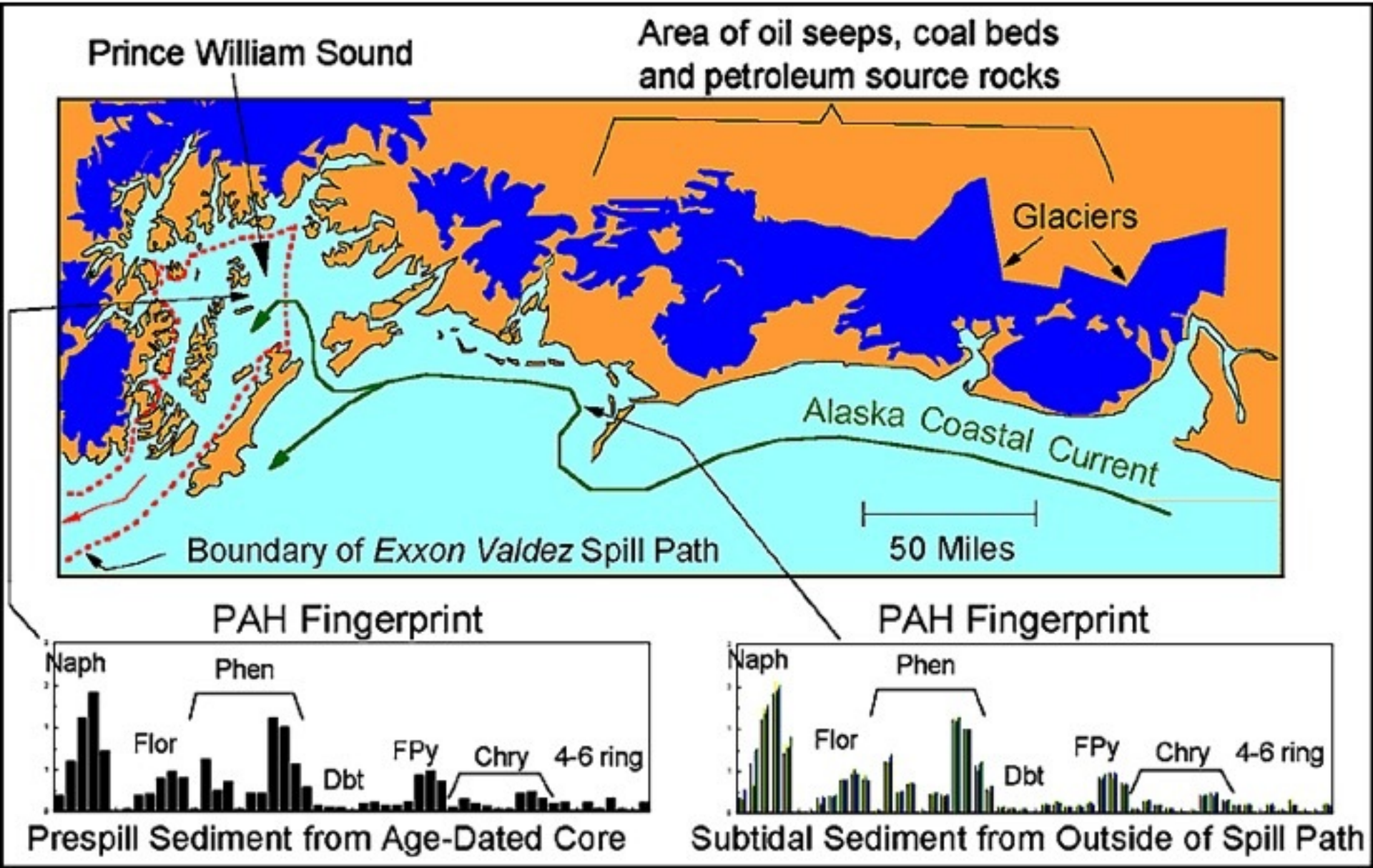
Throughout the upper reaches of Oil Creek, you can see continuous seepage, shown by the sheen in this picture, of oil from places like this one along the banks. Except for the seep oil, it looks like a typical upland Alaskan stream.

Barbara Creek is one of many oil and gas seeps in the Blue Creek/Becharof Lake region of the Alaska Peninsula. These large creeks are major red salmon spawning areas. It is an area where oil exploration took place in the early part of the 1900's. Remains of the oil camps can be seen in the wilderness today.

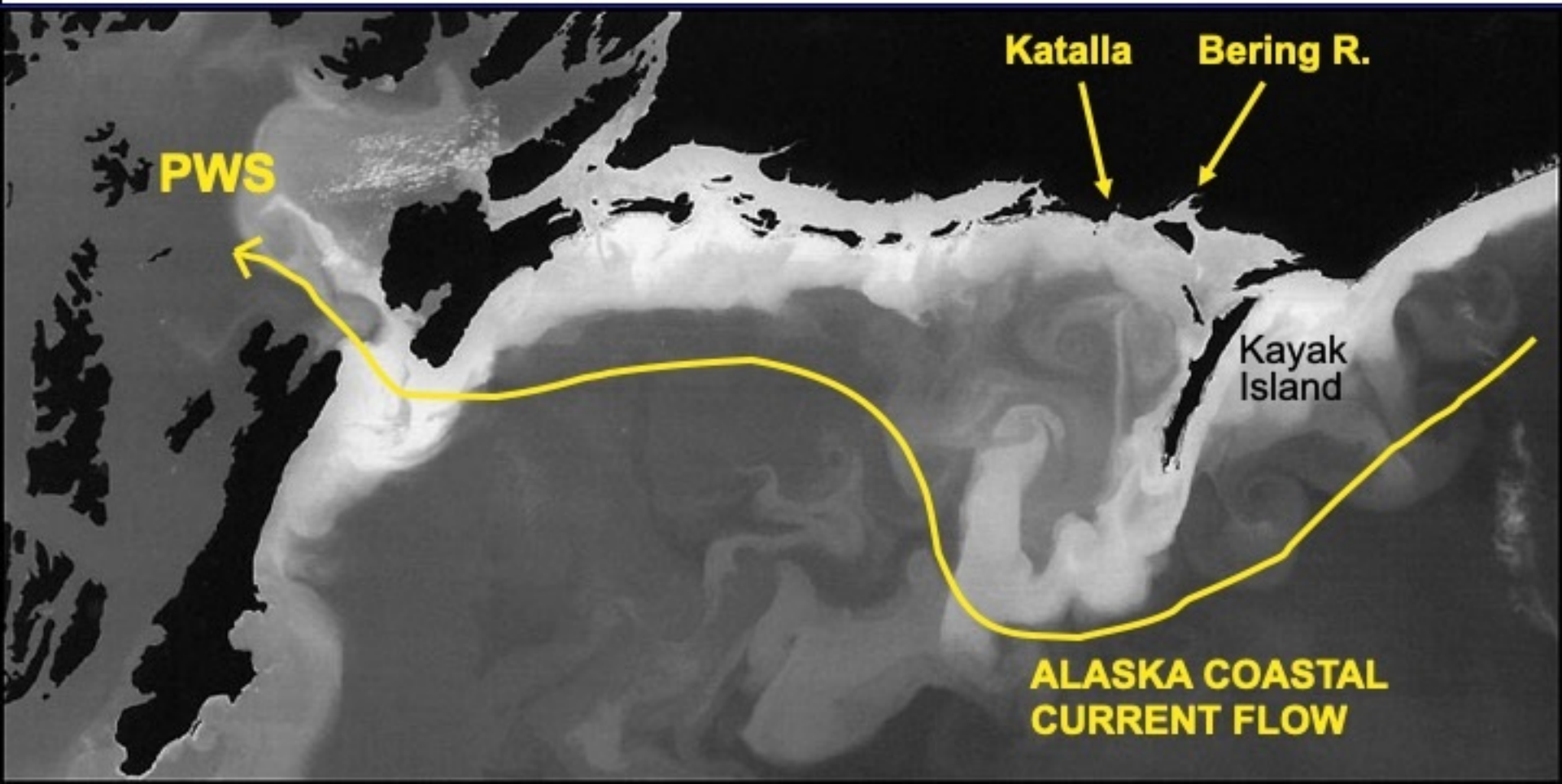
Seafloor sediments in PWS originate from eastern seep area sources and carry with them petroleum hydrocarbons from natural inputs.



Prince William Sound (PWS) sea floor sediments have high levels of polycyclic aromatic hydrocarbons (PAH), carried in on suspended sediments from seep areas east of PWS. The fingerprints of PWS sea floor sediments are the same as those from offshore areas to the east.



This satellite image shows plumes of suspended sediment in water flowing from east to west. The sediment load in the water is heaviest (lightest in color) near the shore. Eddies and swirls of suspended sediment are visible west of Kayak Island. When this photo was taken, the tide had turned and a portion of the Alaska Coastal Current with its sediment load can be seen entering Prince William Sound through Hinchinbrook Entrance (to the right and below the letter "S" in PWS). It is this natural sediment transport that links oil seep and source rock sources in the east to the natural subtidal petrogenic hydrocarbon background in Prince William Sound in the west.



Alaska's first producing oilfield was at Katalla, where the many natural oil seeps attracted the attention of petroleum geologists. Between 1902 and 1934, when the refinery at Katalla burned, 154,000 barrels of crude oil were produced. All of this oil was used in Alaska. The wells were on a hillside and the oil flowed by gravity through the pipeline in the photo to the refinery .

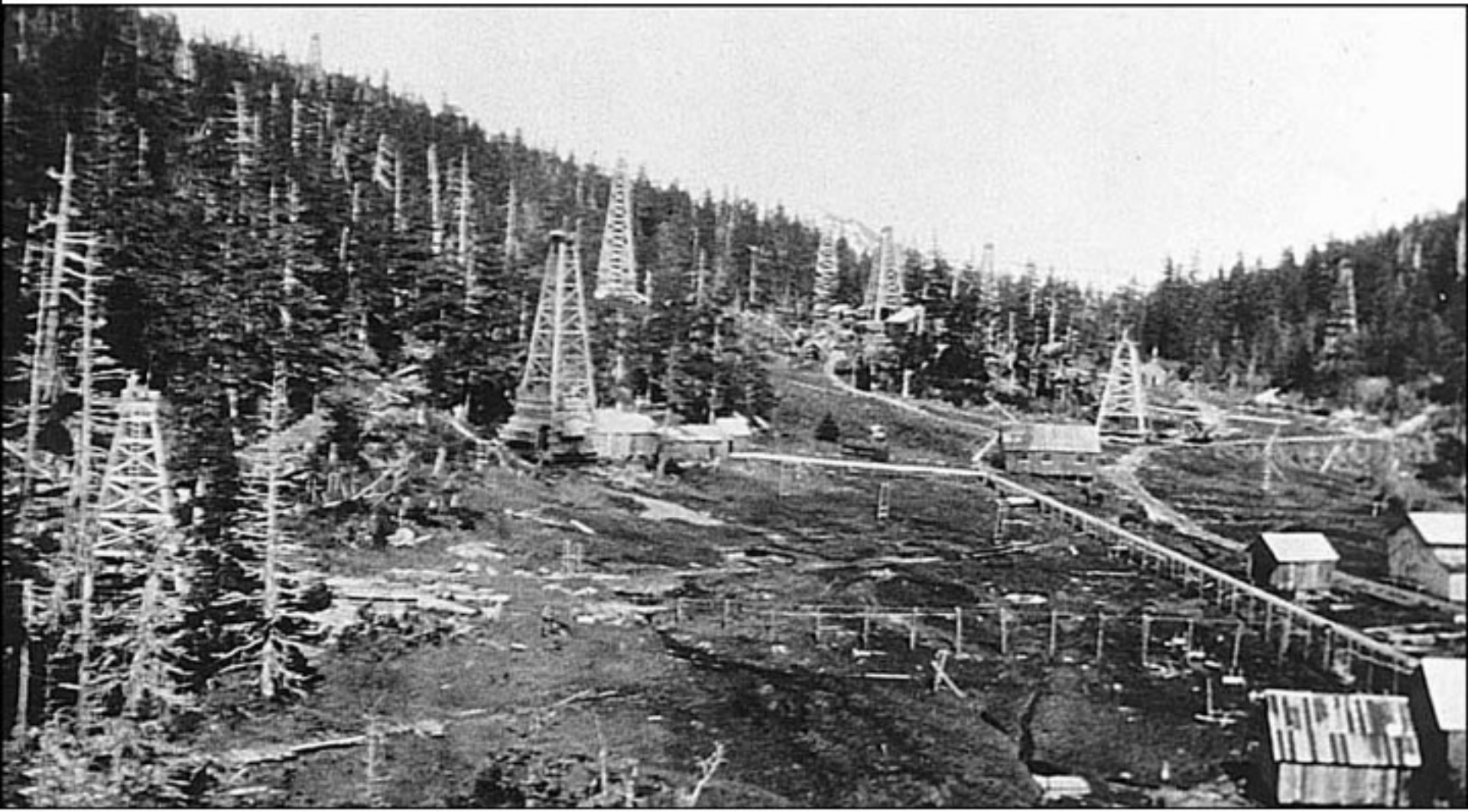
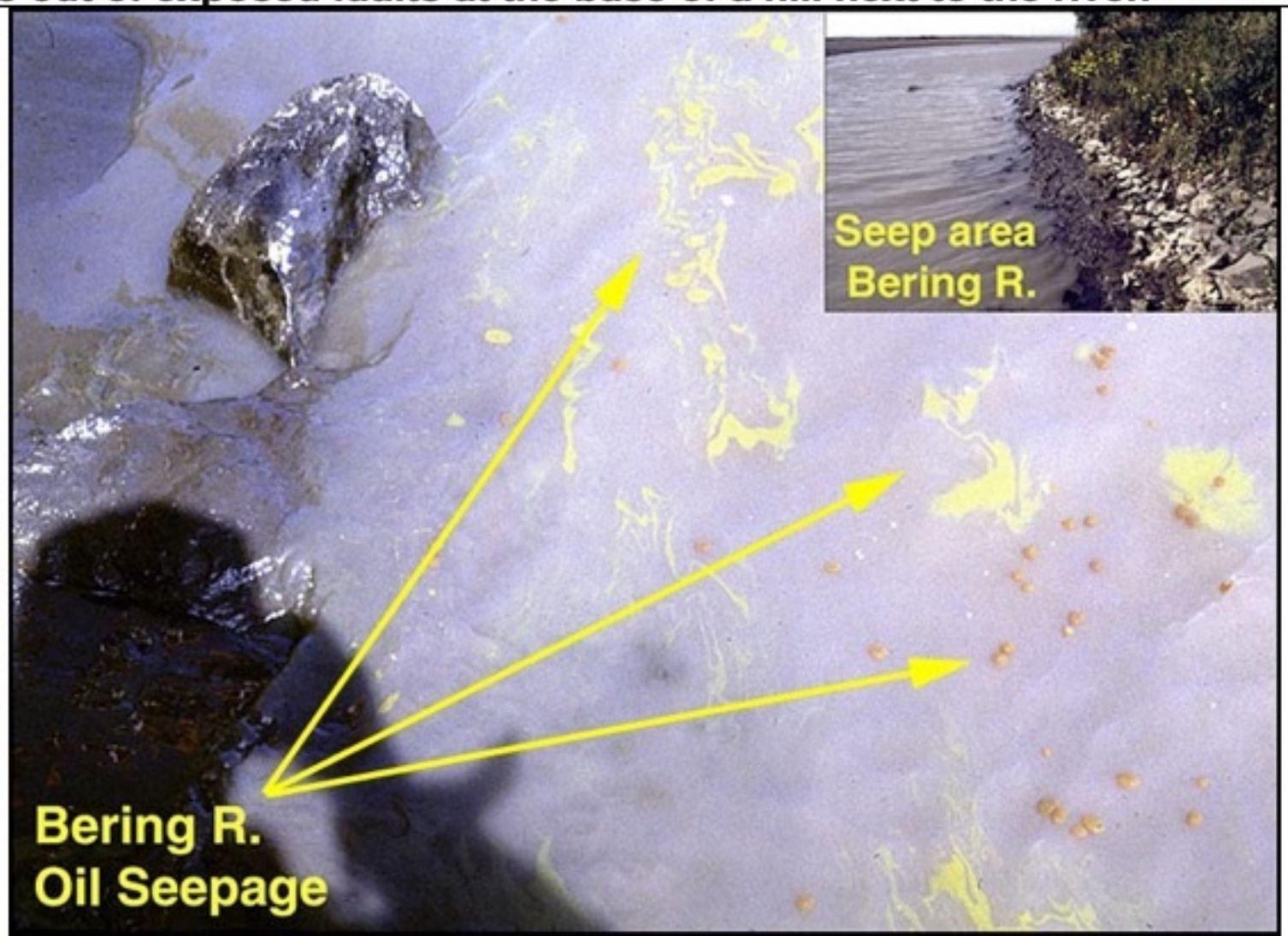
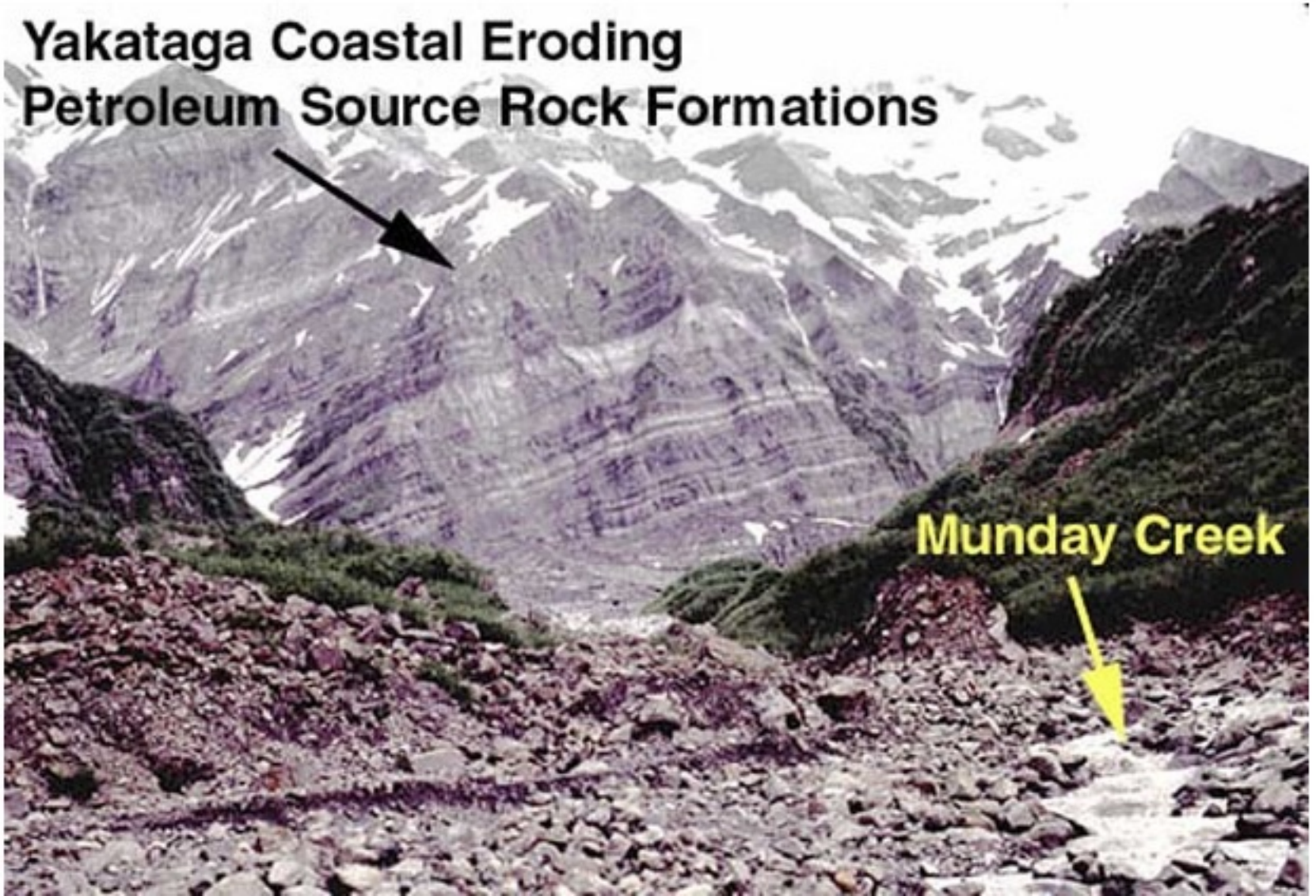


Photo: Anchorage Museum of History and Art Special Collections.

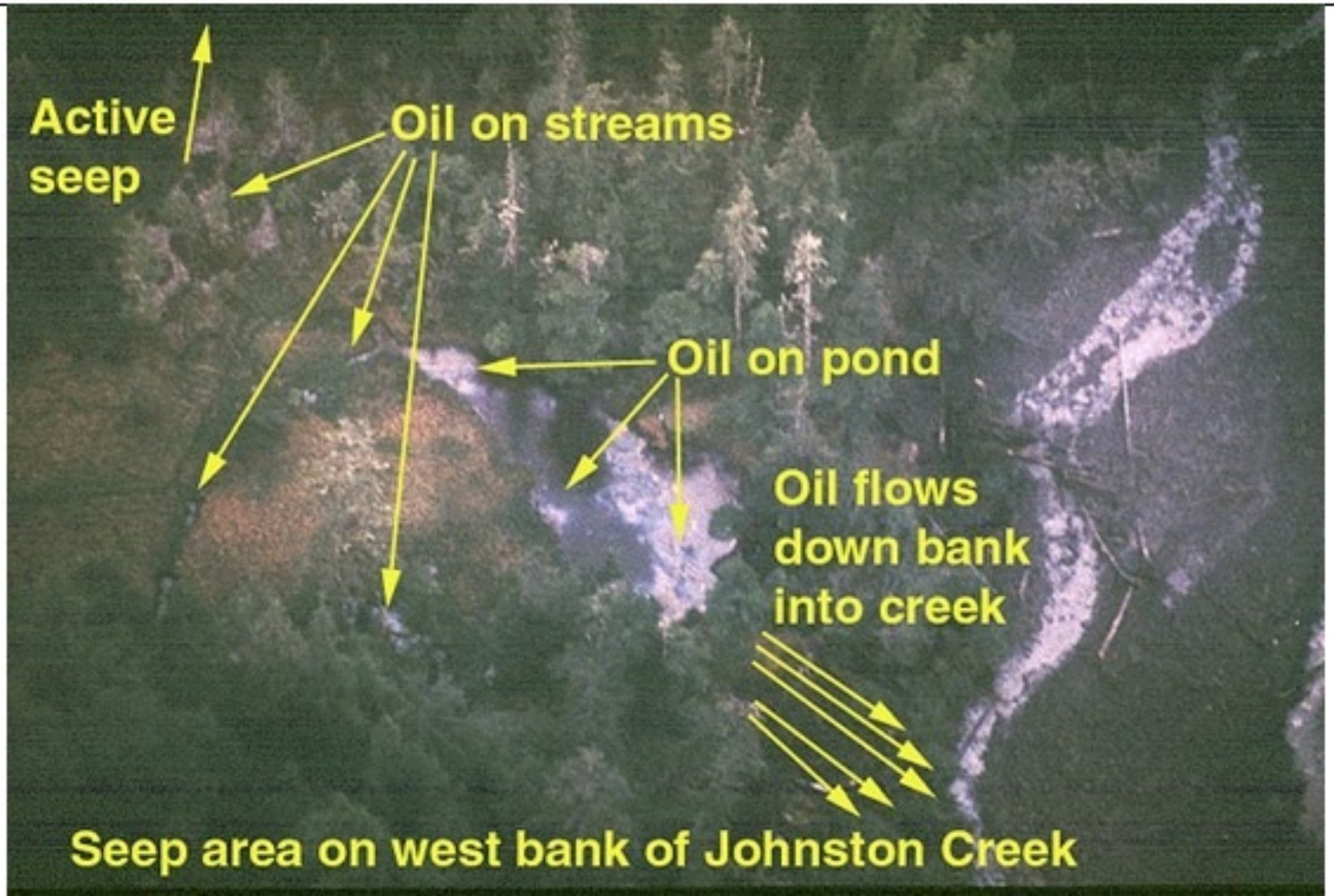
The Bering River/Katalla region was Alaska's first oil-producing region and had many wells and a refinery in operation before World War II. The Katalla formation oil is very paraffinic and is a clear liquid with a light orange clear color and a "piney" smell. It was valued as lamp oil because of its light, paraffinic properties. Along the west shore of the Bering River near the ruins of the village of Chilkat, oil seeps out of exposed faults at the base of a hill next to the river.



Eroding source rock is a major source of suspended sediment in this region. The dark bands in the exposed mountainside are shale containing organic matter in varying stages of maturity. The fresh face on the hillside attests to the constant erosion. Not visible are glaciers between the vegetated hills in the foreground and the mountains in the background.



Johnston Creek has one of the more spectacular seeps in eastern Alaska. It is on a hillside west of the creek. A stream flows from the seep carrying oil to a series of marshy areas and upland ponds. Oil sheen is clearly visible on these ponds and streams in the picture. The flow is downhill from the upland area to Johnston Creek. In the seep area, the 3-4 meter high bank has many cascades of oil and tar. The edge of the main body of Johnston Creek is visible on the far right side of the photo.



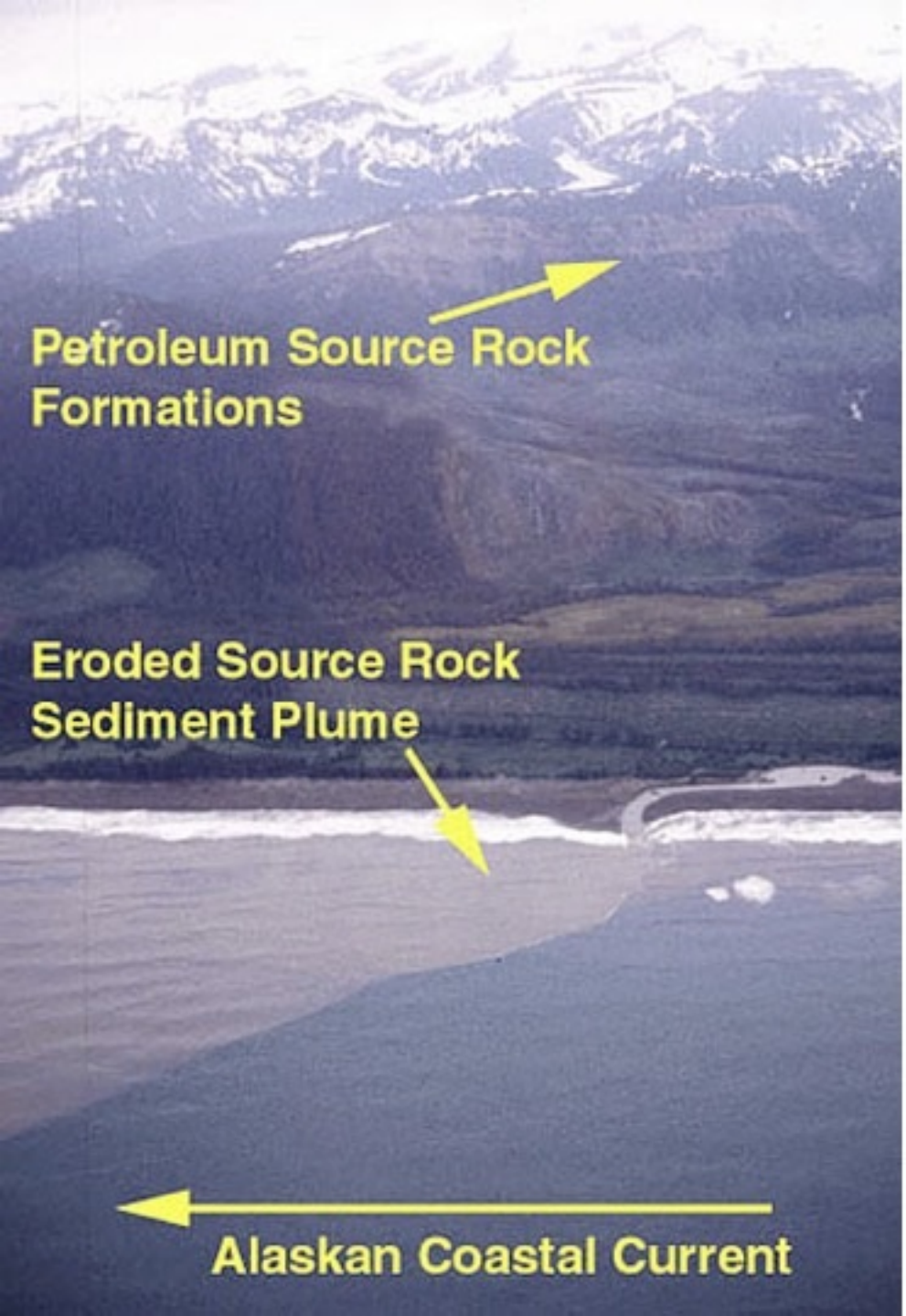
Seep oil can be seen entering Johnston Creek along a stretch of the western shore below the active seep area. The water in the creek carries eroded oil-bearing source rocks as finely divided glacial flour. These creeks are fed by small glaciers. The light and dark bands in the hills in the background are sedimentary deposits. The dark shale bands include organic-rich shale that has petroleum-related material included in it. While watching the seep oil flowing down stream, the turbulence rapidly mixes the seep oil with the water. The seep oil rapidly adsorbs onto the finely divided sediment in this fast-moving creek. This process goes on continuously.

This is in the upland area where the seep oil flows from its source(s) down to Johnston Creek. The seep is on the western hillside above the creek about 1 mile in from the sea. Seep oil enters Johnston Creek via runoff and streams from the seep area and from the Sullivan Fault that underlies the Yakataga coast and is the source of the oil-producing formations. An early exploration well, Sullivan #1, can be seen next to the creek on its east shore, opposite the seeps.

Seep oil continuously enters along the west shore of Johnston Creek and associates with the heavy suspended sediment load and is carried out to sea. The Alaska Coastal Current carries it westward toward Prince William Sound.

This pond is on the hillside above and to the west of Johnston Creek. There is a heavy layer of natural seep oil on the pond giving it a brown/dark color. The flow from the pond runs over the bank to the creek about 4 meters below. The creek can be just seen as the horizontal light line in the upper middle of the photo.

Munday Creek is another active seep area on the Yakataga forelands. The seeps are on a hillside east of the creek about 12 meters above the creek bed. Oil can be seen seeping from exposed parts of the Sullivan Fault and running down the bank to the creek. Except for the oil seeping from the ground, this looks like any other coastal area in southeast Alaska.



All along the Yakataga coast, creeks and rivers carry sediment from eroding oil source rock formations and active oil seeps into the Gulf of Alaska. The sediment plume here is easily visible. The Alaska Coastal Current flows from east to west, toward Prince William Sound. The effect of the current can be seen in the way the sediment plume is pushed to the west. Some of this sediment will eventually wind up on the seafloor of Prince William Sound.