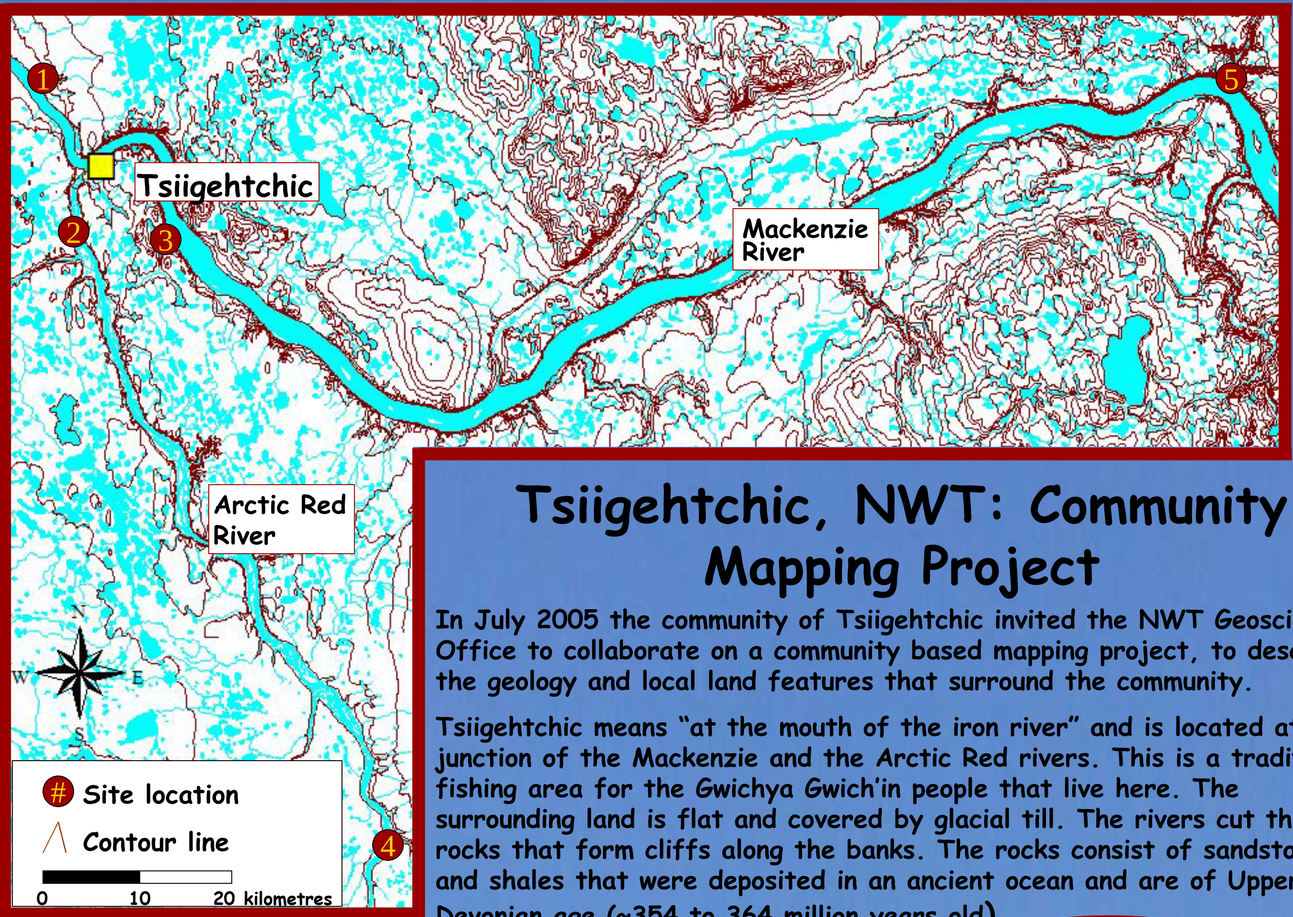


Tsiigehtchic, NWT: Community Mapping Project

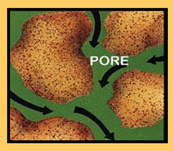
In July 2005 the community of Tsiigehtchic invited the NWT Geoscience Office to collaborate on a community based mapping project, to describe the geology and local land features that surround the community.

Tsiigehtchic means "at the mouth of the iron river" and is located at the junction of the Mackenzie and the Arctic Red rivers. This is a traditional fishing area for the Gwichya Gwich'in people that live here. The surrounding land is flat and covered by glacial till. The rivers cut through rocks that form cliffs along the banks. The rocks consist of sandstones and shales that were deposited in an ancient ocean and are of Upper Devonian age (~354 to 364 million years old).

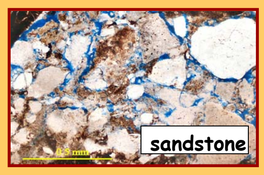
Aren't rocks solid?

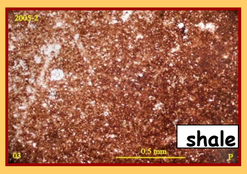
Porosity and permeability

Pore spaces between individual grains in a rock allow fluids to be held in the rock (porosity). Interconnected spaces, or pores, allow these fluid to move through the rock (permeability).

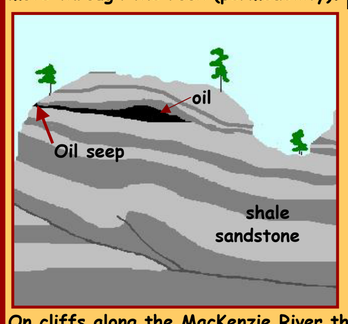


These pictures show slices of rock cut so thin (~.03 mm) that you can look at them through a microscope.

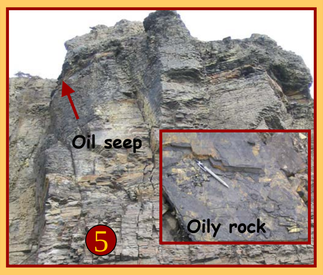




Coarse grained sandstones found around Tsiigehtchic have good porosity and permeability. Blue dye was added to show where the pore spaces are interconnected. Shales do not have much spacing between the fine-grained particles – the dye could not move between the grains.



On cliffs along the MacKenzie River there are many places where fluids seep through the sandstone. An example of an oil seep can be seen at site # 5; the rocks here are black and smell like diesel fuel. The rocks at site #5 have been folded, or bent slightly to form pockets of porous rock that hold the oil. Non-porous shale layers cap the porous sandstone. Where the shale has been eroded away, the sandstone layer that contains the oil filled pocket is exposed on the surface, allowing the oil to escape, or seep.



Water and Oil Seeps

Oil and gas (hydrocarbons) seeps are natural springs where liquid and gas leak out of the ground. In the same way that freshwater springs are fed by underground pools of water, oil and gas seeps are fed by natural underground accumulations of oil and gas.

Water Power

Water is a powerful force – it can scour river banks, move massive amounts of silt and sand, remove and replace islands, and reshape a river. Different water levels are recorded along the river bank pictured on the right.

Ice flows in the spring can jam the river and cause flooding. Flood waters deposit silt and muds along the river banks, supplying nutrients for plant and animal life. Driftwood, useful for firewood, is replenished by the spring floods.

Glacial features

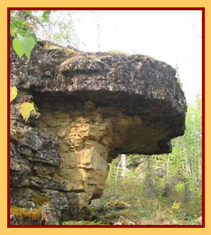
The last of the massive glaciers (ice sheets) scoured the land about 10,000 years ago leaving behind tell-tale features of their presence……

This boulder was transported by glacial ice. It is called an **erratic** because it is a different rock type from that found locally.

Rounded boulders are a sign of a high energy environment where the rocks were moved and pounded against each other in fast moving water like a glacial river.

Erosion and Weathering

At the Wolverine site (#4 on the map), sandstone layers form dramatic shapes. Some sandstones are harder than others, and the softer rock erodes away faster, creating the interesting shapes pictured below and to the right.



When water freezes inside cracks in the rock, the ice expands and enlarges the cracks. Over time these cracks create what look like giant claw marks carving the rocks.

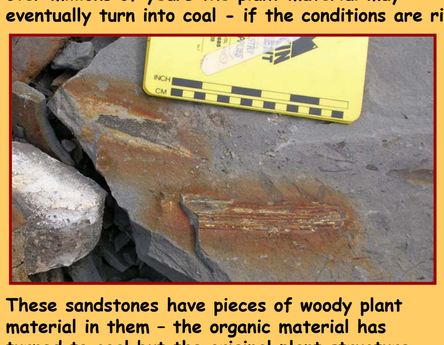
Can you see the face in the cliffs?

Some rock types are more resistant to weathering than others. The sandstones around Tsiigehtchic are very porous. As water moves through the rock, it can dissolve the minerals that cement the rock together. This process, along with wind, ice, rain, and plant growth break down the rock into smaller pieces. Shales are less porous since they are made of fine clay particles, which tend to break down faster than sandstones. These rocks have eroded away at different rates creating unique shapes and forms, such as the profile of a face pictured below.

Are those plants in the rocks?

Yes! Plant materials (organic debris) get washed into the sands at the edge of the water or accumulate in a low-oxygen setting like a peat bog. As sediments continue to be deposited, the material is buried deeper and deeper. Burial must be quick to avoid exposure to oxygen (otherwise it will just rot away). Pressure and temperature increase with depth, and over millions of years the plant material may eventually turn into coal – if the conditions are right!

The arrow points to a layer of peat deposited in a sedimentary sequence. Peat is an accumulation of compressed, partially decayed vegetation that forms in wetlands or muskeg. The close-up picture shows the preserved plants.



These sandstones have pieces of woody plant material in them – the organic material has turned to coal but the original plant structure can still be seen.

The reddish halos around the plant material are iron-oxide (hematite) stained from leaching by ground water.

This sandstone has coal fragments in it but the plant textures are no longer visible – the organic material may have been subjected to higher temperatures and pressures than the plants pictured on the left, destroying the original texture.

Why do the rocks look rusty?

Because they are!

Iron rich minerals in the rocks react to the air and water to form rust – just like a vehicle.

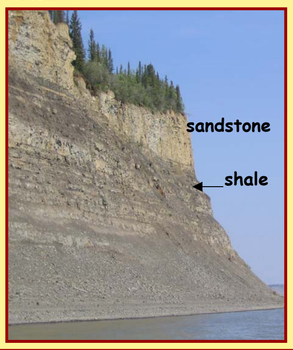
Red ochre - the hill is stained with iron oxide (hematite) – also called red ochre. First Nations people have used the hematite for thousands of years –as a pigment and in ceremonies. We must be respectful of these sites when visiting them.

Concretions:

These rounded rocks are found in the sandstone layers or lying on the beaches around Tsiigehtchic. **How are they formed?** When the sand was being deposited on an ancient beach, organic material (small pieces of shell or twigs) was trapped in the sand. Groundwater moving through the sandstones contains dissolved iron compounds that were deposited onto the organic 'nucleus'. The deposited minerals act like a cement between the grains of the original rock making it harder. This build-up of iron continued for millions of years, layer by layer. Concretions are later released from the surrounding softer rock through the weathering process.

Depositional environment

The types of rocks present in an area reveal what kind of environment the sediments were deposited in. Shale forms in deep quiet water where fine clays and mud sink through the water column to the sea bottom. Sand grains are larger and settle near shore where they are often rolled back and forth by wave action. The layers of sandstone and shale reflect changes in water depth and wave energy.



Will the sand and mud of the river bank today become the sandstone and shale of the future?

They could – the build up and burial of sediments over time (millions of years), could change these sediments to rock at some point in the future. Compare the unconsolidated sand and mud along the river bank(below left) with the ancient, solidified sandstone and shale (below right).

Modern mud and sand

Ancient mud and sand – now sandstone and shale

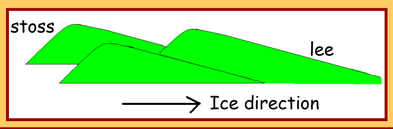
The flat layering, or bedding planes of these rocks makes them useful for building. This is the fireplace from the old Arctic Red mission house.

Drumlins are streamlined mounds of glacial till (unsorted sand, gravel and clay) that form at the base of moving glaciers. The steep end (stoss) faces the direction from which the ice advanced. The gentle tapered end points down ice. The glacier that formed this drumlin moved from left to right.

Why do spruce trees grow on the stoss (steep) side and jack pine grow on the lee side?

Jack pines are able to grow in harsh conditions. The tops of the drumlins are exposed to the winds and are dry (water drains quickly from the sand and gravel) and have little organic material and therefore poor soil.

Spruce trees require more moisture and less exposure to the elements. On the steep side erosion from the top of the drumlin may deposit finer soil particles and allow build-up of organic material (pine needles, mosses etc). This material could hold in the moisture needed to support spruce tree growth.



Houses on stilts and drunken forests?

When soil and rocks remain frozen all year round it is called permafrost. Permafrost can contain large lenses of ice. If the ice melts, the ground becomes soft. If the permafrost melts below a house, the foundation may buckle.

The houses in Tsiigehtchic are built on stilts to allow heat to escape from them without melting the permafrost. Stilt houses are common in permafrost regions of Canada.

Vegetation is also susceptible to permafrost. Trees in the north have shallow root systems as they must draw their nutrients from the top layer of soil. Over time, organic material builds up from the trees themselves and begins to retain heat in the soil, melting the permafrost layer. As the soil sags, the trees begin to tilt and appear "drunken".

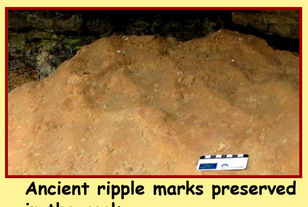
Shorelines and river banks can also be affected by melting permafrost. Slope instability occurs if the bank is eroded and ice is exposed to the elements. When the ice melts, the soil slumps down into the river, dragging trees and materials along with it. That's a good reason not to build a house too close to the edge!

Tales of the Past

Sole marks are structures preserved on the bottom of shale or sandstone layers. They form from impressions made in the surface of soft mud by the scouring of a current, or by objects carried by the current. Sand deposited over the mud fills in the sole marks and they are preserved in relief on the bottom of the sandstone bed. The sole marks are generally aligned parallel to the direction of the original current, and are used to identify flow directions in ancient rivers and sea beds.

Other features that we see on the shore each day may also be preserved in the rock record. Look for ripple marks, mud cracks and even rain drop impressions.

Ripple marks along the river bank



Ancient ripple marks preserved in the rock

Recommended citation:

Schreiner, D., Azar, B., Andre, S., Cardinal,G., 2005. Tsiigehtchic, NWT: Community Mapping Project; NWT Geoscience Office, NWT Educational Publication 2006-1. 1 poster.

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