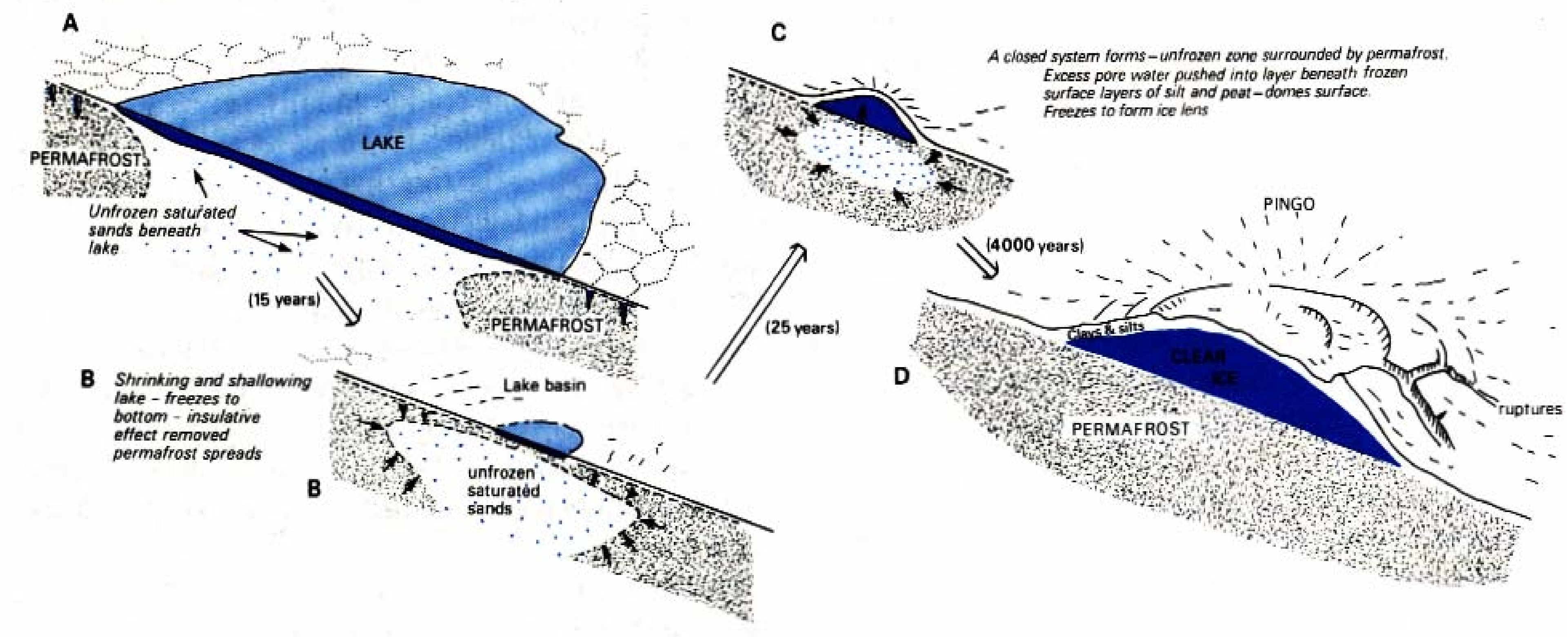
A2 Geography 4.2 Glacial Systems **Student Notes**

Pingo: an Inuit term for a domed, perennial ice-cored mound of earth formed in a periglacial environment. They can rise to 70m high. Two different methods of formation have been suggested.

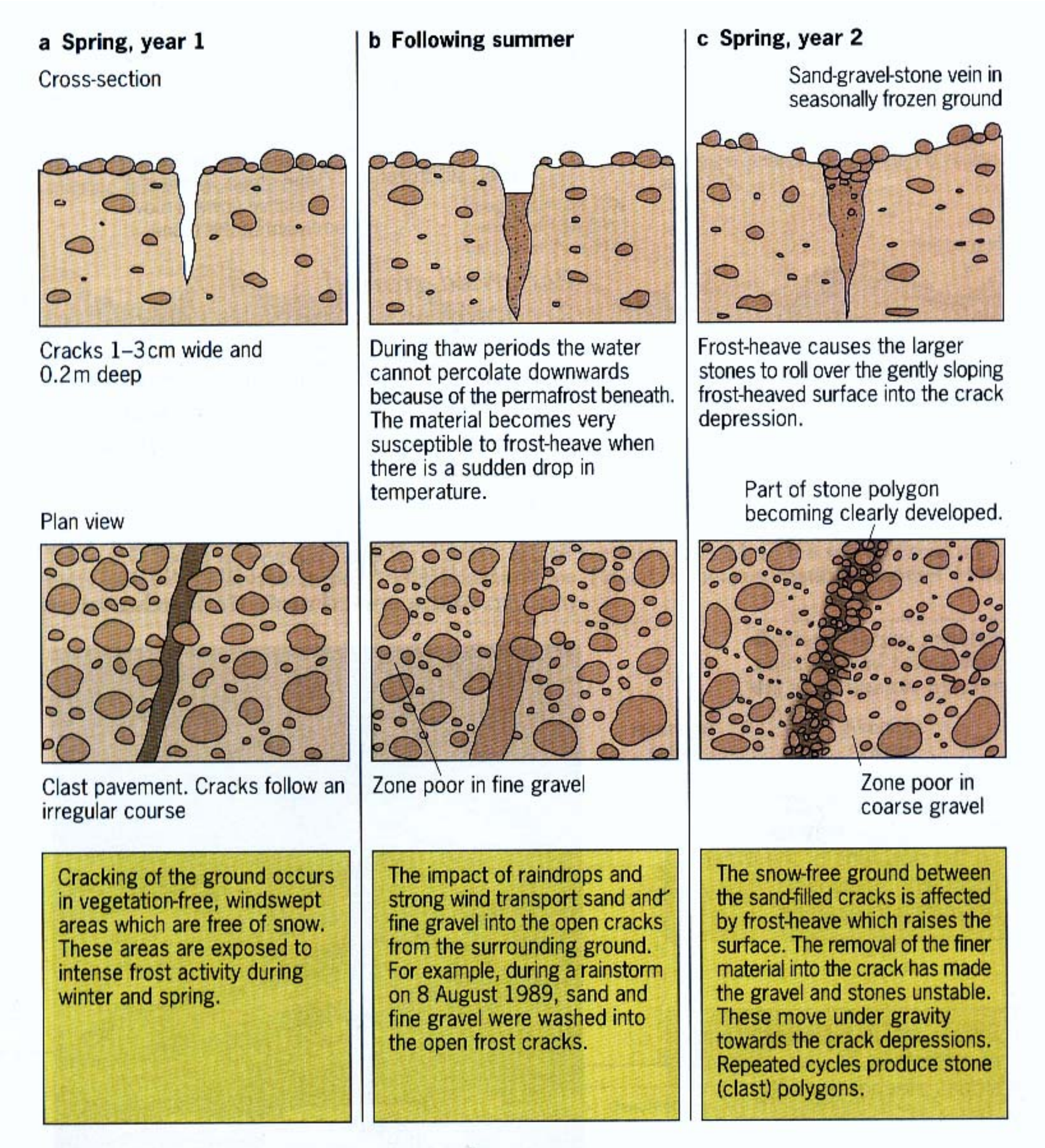
(i) The freezing of a body of trapped water within a silted or vegetation filled lake in a permafrost zone to create a massive ice-core, which domes the lake sediments as it expands forming a *closed system* pingo. Examples can be found on the Mackenzie Delta in Northern Canada.

(ii) The second method, known as the artesian concept refers to the groundwater flowing under artesian pressure below the permafrost, or in *talik* within permafrost. The water eventually freezes as it forces its way upward, therefore causing an ice core that heaves the surface into a dome. Such pingos are open system pingos and examples can be found in East Greenland. Ultimately, doming leads to dilation cracking of the overlying material. The exposed ice-core will thaw leading to a collapse of the mound's centre.



The growth of a closed system Mackenzie pingo

Patterned ground: a collective term for the approximately symmetrical forms that are characteristic or areas prone to intensive frost action. Patterned ground requires moist conditions with regular freezing and thawing. It is usually found in areas with little vegetation. Examples include *stone nets*, *stone polygons*, *stone circles*, *steps* and *stone stripes*.

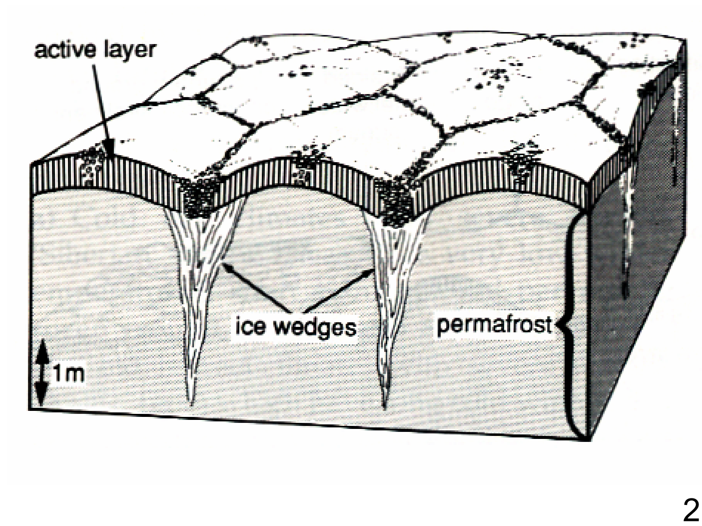


The Evolution of frost cracks and sorted polygons.

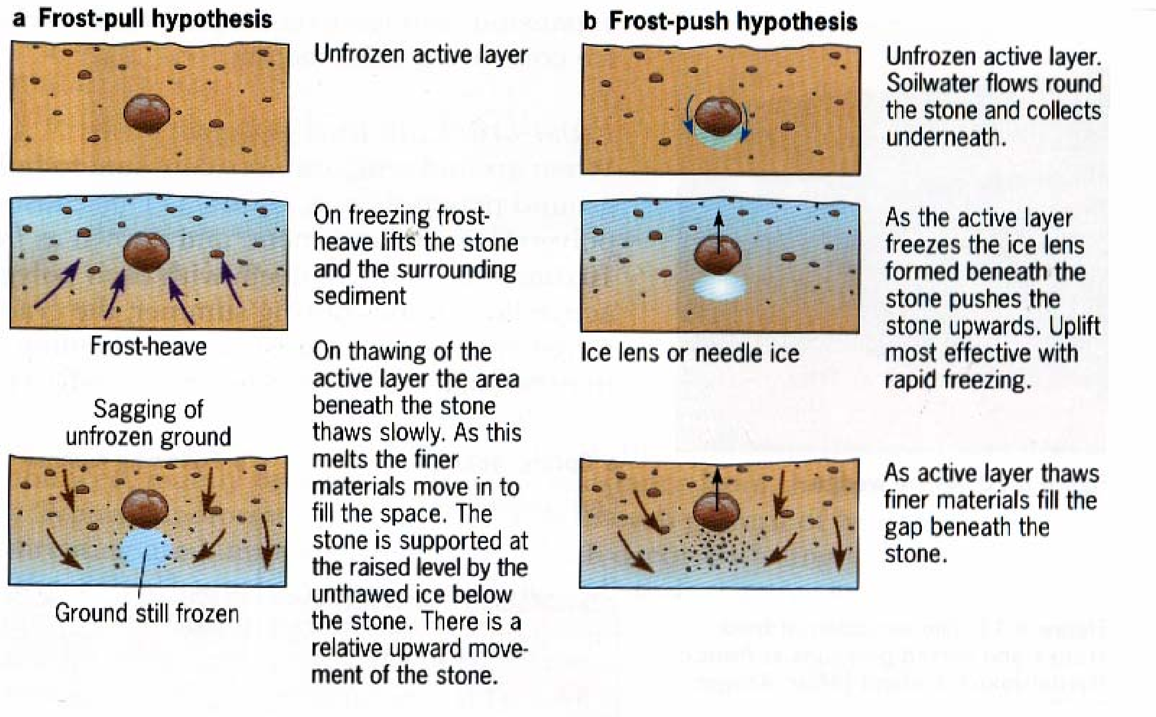
Frost crack: a fissure opened-up in the soil by the development of an *ice-wedge*.

Ice wedges: a narrow crack or fissure in the ground unfilled with ice, which might extend below permafrost level. The V-shaped phenomenon starts as an ice vein. It is caused by contraction, caused by frost cracking, followed by filling of the initial crack by summer meltwater creating a vein which after many seasons becomes enlarged forming a wedge. Fossil ice wedges can be found where the wedge becomes infilled with sediments, once the ice has melted.

The development of ice wedges beneath the active layer occurs on gently sloping or flat land in the ice rich sediments



The two hypotheses for the upward movement of stones in permafrost.



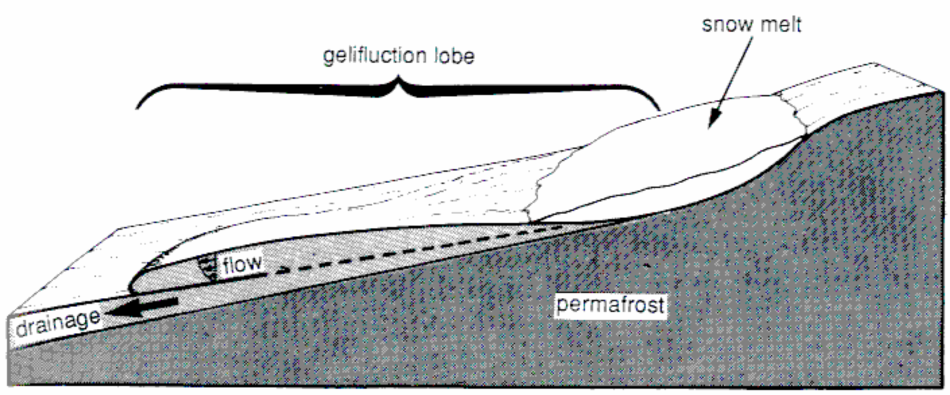
Stone Circles: a type of patterned ground on slopes of 3^{O} or less.

Stone Nets: a type of patterned ground on slopes of 3^{O} or less whose mesh is neither polygonal nor circular.

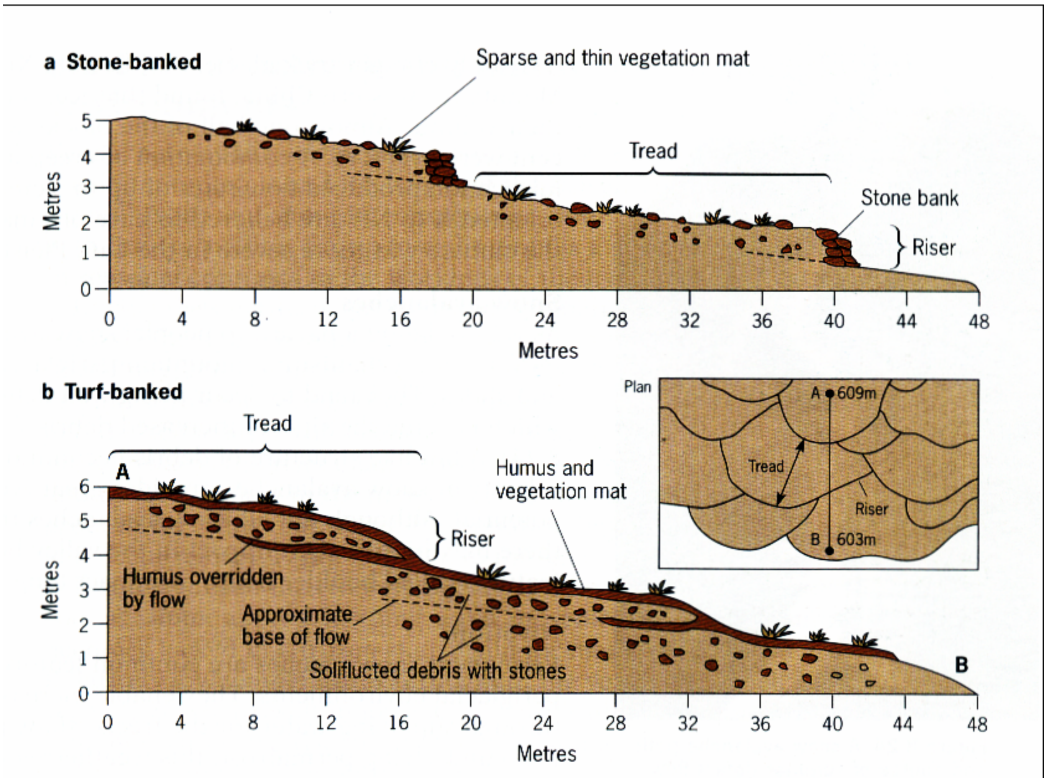
Stone Polygons: a type of patterned ground forming a collection of many sided geometric stone shapes. Sorted polygons have a border of stones, surrounding an area of fine material. Non-sorted polygons lack the border of stones. Their borders may be raised above a low centre but, more commonly, there will be a border furrow around a slightly domed centre of finer material. The formation of polygons is likely to be a combination of processes including desiccation cracking, dilation cracking, frost cracking and frost heaving.

Stone Stripes: a type of patterned ground orientated downslope in an area dominated by frost heaving on slopes of 3^{O} to 30^{O}. Some are more sorted than others. Sorted stripes consist of parallel lines of stones and intervening strips of finer material. Any tabular stones tend to be towards the edge and stone size decreases with depth. Non-sorted stripes consist of zones of vegetation-covered ground alternating with stripes of exposed rock fragments.

Solifluction lobe: a lobe of soil that has accumulated towards the base of a slope as result of solifluction processes. See *stone-banked terraces* and *turf-banked terraces.*

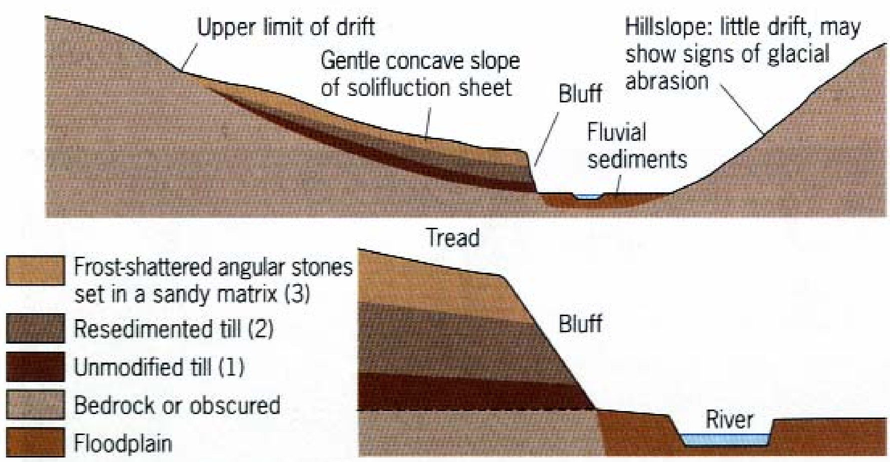


Goletz terraces: terraces formed on hill slopes by a combination of freeze-thaw and solifluction under periglacial conditions. They may extend for several kilometres and may be stone, or turf banked. (See *stone-banked* and turf *banked terraces*).



Stone-banked terrace: a hill-slope terrace consisting of fine solifluted material flanked by coarser material as part of a stepped hill-slope profile. The terraces have lengthy "treads" (30m apart) with steep (3-5m) "risers" occurring on slopes of 10^{O}-25^{O}. It has been suggested that the stones are brought to the surface by frost heaving. Thy then tend to travel downslope faster than the slow owing finer material. At certain places, the movement of the stones will be stopped by gradient changes, vegetation or rock exposures, forming a growing pile of stones, against which the finer material builds up.

Turf-banked terrace (turf-baked lobe): a hill slope terrace consisting of fine, soliflucted material, resembling a stone-banked terrace in shape, but differing in its cover of turf. The origin is similar to stone-banked terraces but the turf takes the role of the stones as a means of resisting downslope movement. They tend to be found on slopes of 2^{O}-20^{O} (less steep than stone-banked terraces). Where the turf cover ruptures, a flow of fine soil, which can spread like a small fan onto the next terrace. Some turf-banked terraces sometimes override the vegetation.



Cheviot solifluction sheet, showing characteristic morphology (*Source:* Harrison, 1993)

Coombe rock: a structures mass of unstratified rubble, consisting of flints, broken chalk fragments, mud and sand. It was produced by solifluction during cold phases during the Pleistocene and has accumulated in great thicknesses in the valley bottoms of the chalklands of southern England.

Other Common Periglacial Landforms

Involutions: a term used to describe the deformation of unconsolidated surface material by frost action.

Muskeg: a moss-covered soil or bog in sub-Arctic regions of Canada and Alaska

Palsa: a mound or ridge of peaty earth containing perennial ice lenses and core of permafrost. Open fissures caused by frost-cracking often break its surface. They are thought to be caused by differential frost-heaving linked o the thermal conductivity of the peaty soils. They are found in boggy areas of discontinuous permafrost. They differ from pingos by the presence of peat. Palsas also have separate ice lenses rather than a core of clear ice.

Slush flow: a flow of water-saturated snow along a stream course, caused by rapid snowmelt. It can transport surface sol and may resemble a mudflow.

String bogs, Strangmoore: areas of muskeg that consist of ridges of peat inter-dispersed with water filled ponds. The peat ridges contain ice lenses. Their origins are uncertain but solifluction processes, hydrostatic pressure rupturing the bog surface and frost thrusting raising ridges may all play a part.

Scree: an accumulation of angular fragments on, or at the base of a slope as a result of high levels of mechanical weathering on an exposed rock face.

Talus: an apron-like landform created from *scree*, which accumulates at the base of a slope

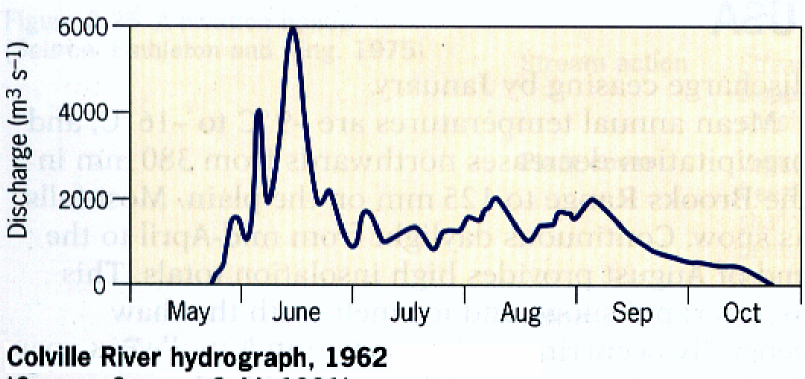
The Influence of Wind

Löess, Limon: a fine grained, homogeneous, wind blown (aeolian) deposit that has been blown away from exposed outwash deposits to accumulate in great thicknesses elsewhere. Found in China, Central Europe, USA and Russia. Soils that form in löess deposits are of the highest quality.

Orientated Lakes: a grouping of lakes exhibiting parallel alignment, which have been formed from complex selective deflation by wind. Many are in Arctic latitudes and are possibly due to differential thawing of permafrost under the influence of prevailing winds.

The Influence of Meltwater

Braids. Some rivers are supplied by large loads of sand and gravel which are transported as bedload. Such rivers usually experience extreme discharge regimes, such as rivers in arid areas, which experience flash floods, or rivers in cold climates, which as swollen by spring melting snow or glacial meltwater. In both environments, vegetation cover is thin allowing rapid erosion providing a large load. In such channels deposition occurs in the form of gravel of sand islands that divide the channel into smaller channels, or braids, in its attempt to find its way through its own disproportionately large bedload. Braided channels occur where the gradient is steep, the load is plentiful and coarse and the discharge fluctuates daily or annually. Compared with meanders, braids are very mobile and may shift their positions rapidly.

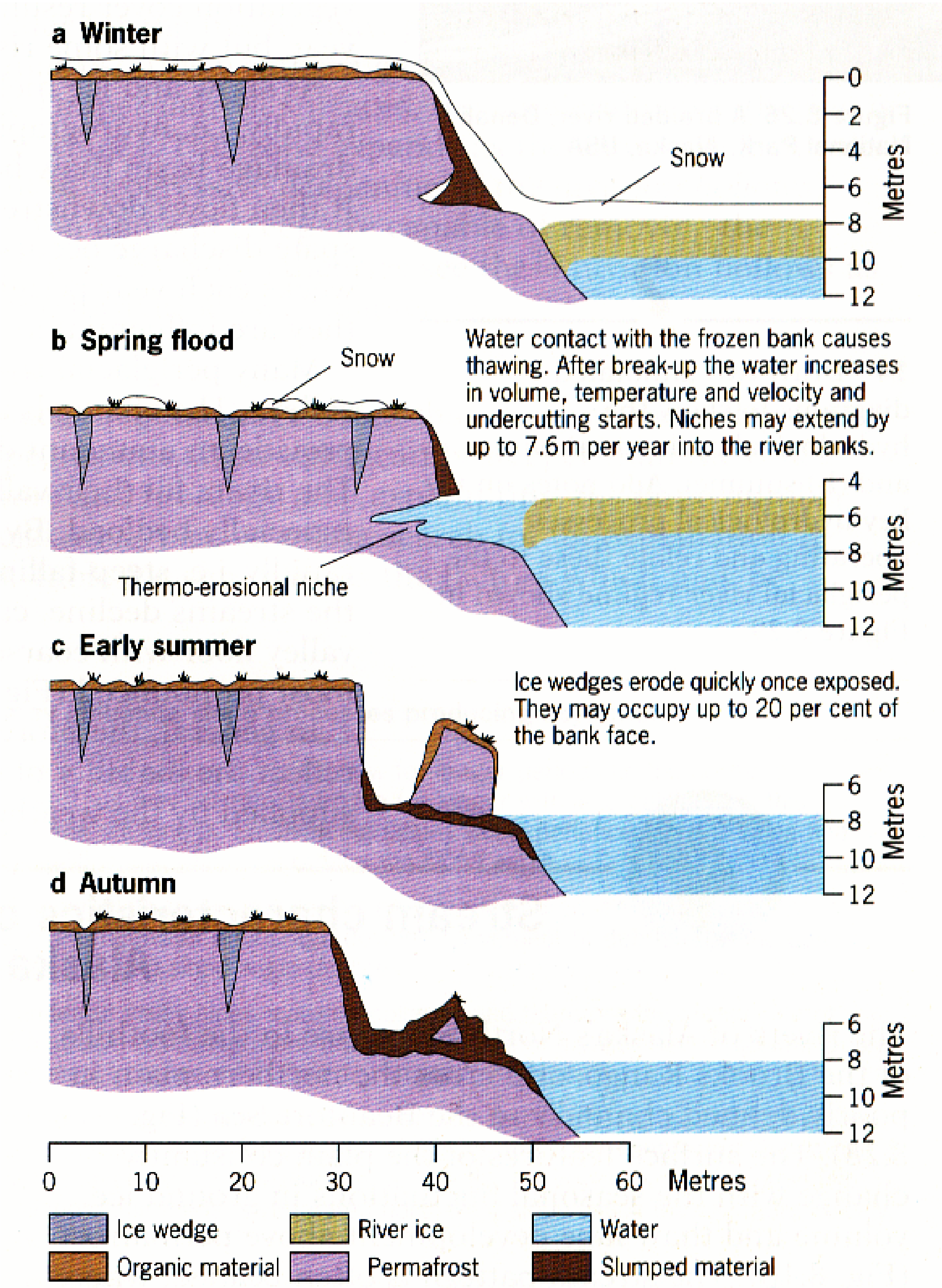


Colville River hydrograph, 1962
(*Source:* Summerfield, 1991)

River erosion in periglacial areas such as the North Slope of Alaska is influenced by both permafrost and extreme hydrographs. Rapid thawing in the spring leads to flood water and the thawing of the active layer as shown in the hydrograph of the River Colville in North Alaska

From mid-May, the river ice breaks up and water levels rise 5m in less than 10 days. The active layer thaws. The bulk of the erosion takes place in June.

Sudden collapse can occur when melting ice-wedges are exposed. Bank failures can occur when the water level begins to drop. Erosion rates can exceed 2m a year.



Riverbank erosion on the Colville River
(*Source:* Richie and Walker)