**Examine the role of erosional processes in the development of glacial landforms. (Jan 2010) [25 marks]**

This essay will examine the role of erosional processes in the development of a variety of glacial landforms, including cirques, roche moutonees, crags and tails, and knock and lochan landscapes.

One landform created by glacial erosional processes is a cirque. A cirque is a massive, amphitheatre shaped hollow in a mountainside, with a steep backwall and smooth rock lip, usually covered with striations (scratches). Cirques are macro-scale landforms, often larger than 1km in size, and are found in upland areas. An example of a cirque is the Iceberg Cirque in Montana, USA.

The formation of a cirque starts off with snow collecting in a small hollow in a mountainside. Cirques often form on the NW side of a mountain, where it is sheltered from the wind and sun, and the snow is more likely to remain in the hollow without being disturbed or melting. Over time, the hollow is enlarged by a process called nivation, which involves a combination of freeze-thaw weathering and sheetwash. Freeze-thaw weathering occurs when water enters cracks in the rock. When it freezes, the water expands by 9% of its volume, and pushes the rock apart. When the water melts, it is able to move deeper into the rock and the process happens again. With repeated cycles of freezing and thawing, eventually the rock breaks apart and fragments start of rock begin to form. Sheetwash is where water running down the slope along the ground surface flows into the hollow and washes away the rock fragments. Later snowfalls then cause the snow in the hollow to become compressed and increase in density. After one year, the snow turns to neve (“last year’s snow”), and after ten years, the snow turns into glacial ice, and forms a niche glacier.

Eventually, as the size of the glacier increases, the shear strength – the downslope force due to gravity – is overcome, and the glacier can begin to rotate inside the hollow, further increasing the rate of erosion. As the backwall of the hollow becomes steeper due to freeze-thaw weathering and plucking (where the rock fragments created by the freeze-thaw weathering freeze to the ice and are removed), and abrasion (the sandpaper-like effect created when rocks contained with the ice are dragged over the bedrock) deepens the bottom of the cirque (known as the rock basin), the hollow is known as the cirque.

Sometimes, many cirques can form close together, creating other erosional landforms. One is an arête, which is a knife-edge ridge of rock created when two cirques form back to back e.g. Crib Goch in Snowdonia National Park, Wales. Pyramidal peaks are also formed where there are three or more cirques that have formed back to back, such as the Aiguille du Midi.

A second landform created through glacial erosion is a roche moutonnee. A roche moutonnee is a meso-scale landform found in both upland and lowland areas. Roche moutonnees are large, asymmetrical masses of bedrock with a steep, rough side (lee side), and a gentle, smooth side (stoss side), which may have striations indicating the direction of ice movement. Roche moutonnes are typically 20-30m in length and 5-10m in height, but can be much larger.

When a glacier passes over a mass of resistant bedrock, it creates an area of high pressure on the stoss side. The high pressure encourages melting, and the meltwater flows around the bedrock to the lee side where the pressure is much lower. This process of melting and freezing in response to changes in pressure is known as regelation. Often the meltwater will seep into cracks in the bedrock and freeze, expanding and pushing the rock apart via freeze-thaw weathering. As the ice continues to advance, the loose rock will be picked up by the glacier, leaving behind a steep, jagged surface. Pieces of rock already incorporated into the glacier will also be dragged over the surface of the bedrock, smoothing and polishing it through abrasion, sometimes producing striations.

A third glacial landform produced by erosional processes is a crag and tail. A crag and tail is a macro scale landform which can be found in both upland and lowland areas, consisting of a hard, resistant rock forming the ‘crag’, and soft, unconsolidated material on the lee side, forming the ‘tail’. Crag and tail landforms form when a glacier is forced to flow around a mass of hard, resistant rock such as a volcanic plug, which is more resistant to erosion than the surrounding sedimentary rocks. As the glacier flows around the hard rock, it erodes the softer sedimentary rocks on each side of the hard rock, resulting in overdeepening on both sides of the hard rock, which may eventually be filled in with water to form a ribbon lake. Over time, a crag and tail forms, with a mass of hard rock (the crag) and a ridge of weak, unconsolidated material (the tail) behind it which was partially protected from glacial erosion by the crag, producing a steep stoss side and a gentle lee side. An example of a crag and tail is the Edinburgh Castle crag and tail, with Edinburgh Castle situated on top of the crag, which is formed from a volcanic plug.

Another glacial landform formed from erosional process is a knock and lochan landscape. Knock and lochan landscapes are macro-scale landforms found in lowland areas, consisting of small, rounded hills lacking vegetation (knocks) and small lakes (lochan), formed by intense glacial erosion by an ice sheet. The knocks are formed from masses of resistant rock which were smoothed and polished by glacial erosional processes such as abrasion, but were not completely eroded. Small lakes or lochan can be found between the knocks where the ice sheet has eroded weaker rocks and caused overdeepening, with the depressions later being infilled by water. An example of an area with a knock and lochan landscape is the Isle of Harris, Outer Hebrides, Scotland.

In conclusion, a variety of complex erosional processes are required to form many different glacial erosional landforms, including abrasion, which erodes and smooths rock surfaces, plucking, which removes large chunks of rock, producing rough rock surfaces and steep sides.