GLACIOLOGICAL PATH

Stop 1: Acqua Bianca

The territory of the Alta Valsesia Natural Park is characterized by a glacial geomorphology.

The purpose of the Glaciological Path is to explain the evolution of a glacier through the observation of the erosional and accumulation landforms, due to its geomorfic modeling and through the direct view of the existing glacial masses

The geomorfic evidence left by the glaciers during their pulsations are highlighted along the path by easy reading panels located at point of observations or of significant interest ; each point was numbered and reported on the topographic map.

PAST CLIMATE CHANGES

Planet earth is 4.6 billion years old. different climates have characterized long history particulary in the Quaternary period, with long-term cold intervals alternating to very warm ones.

The geological epoch most affected by glaciations (in our regions, in the northern emisphere) was the Pleistocene; it was characterized by a trend towards climatic cooling. In the last million years, in fact, four main glacial phases have occurred in the Alps, named from the oldest to the youngest GUNZ - MINDELL - RISS - WURM.

During these phases the global glacial masses occupied 45 million Km2, 1/3 of the total surface of all continents.

Huge glacial tongues flowed from the Alpine mountains towards the plains, which did not melt into a single cap, but deeply shaped the crossed mountain relief. The valleys eroded by glaciers became wider and deeper; the rock blocks and debris, torn away from the sides of the mountains and transported downstream by the glaciers, were accumulated at the edge of the plains, giving rise to imposing huge moraine deposits.

Starting from the end of the last expansion, locally occurred 14,000 years ago, the glaciers began to retreat until they assumed the current setting through the Holocene.
During this time there were several climatic oscillations: the temperature rose gradually until reached the climatic optimum between 8,000 and 7,000 years ago, during which glaciers had to be smaller than the current ones; the warming phase was followed by an further glacier expansion occurred between 5,300 and 2,800 years ago.
The last major advance of the glaciers occurred from 1350 until 1850 AD: it was the largest expansion of the Holocene (started in 8,300 BC) and is called "Little Ice Age".

Stop 2: Caldaie del Sesia and Ponte delle Pile

GORGES AND FALLS

The glacial erosion creates a stepped landscape dominated by the alternation of shoulders and incisions, due to the way of carving of the glacier which tends to increase and enhance the difference in height of the already existing morphological steps.
Shoulders and glacial terrasses placed at different altitudes are generally linked up by spectacular waterfalls that can reach heights of hundreds of meters.
The steps, initially engraved by the subglacial streams (which flow under pressure at the base of the glacier and therefore possess a high erosive capacity), after deglaciation they are further engraved at different extent by the surface streams; depending on the hardness of bedrock material, more or less deep gorges are formed.

Point 3: Alpe Pile

ABRASION AND GLACIAL EROSION

A glacier is not a stable rigid mass of ice anchored to the ground but, on the contrary, it is a plastic mass that flows slowly downstream, due to the effect of gravity, thus affecting and fragmenting the bedrock on which it flows.

Its erosional action is often compared to that of a sandpaper that rubs long and hard on a compact surface.

ROCHES MONTONNEES

These are one of the most common evidences of the presence of a glacier in a currently deglaciated area.
They appear as dome-shaped rocks, polished and smoothed with various dimensions (from 1m to a few hundred meters long), elongated according to the flowing direction of the glacier.
Their longitudinal profile (see drawing) is rounded upstream, steeper downstream and with a fragmented surface.
The photograph evidences the erosional grooves created by the rock fragments transported by the glacier and compressed under its enormous mass.

GLACIAL POTHOLES

They are erosional landforms with a round and smooth shape, carved into the rock on which the glacier flowed.

During the hot season part of the ice melts and forms the epiglacial streams that flow on the surface of the glacier until they meet a crevasse into which they fall.
The water then collects in subglacial streams, which can flow under high pressure (due to the thickness of ice) between ice and rock as if they flew in forced conduits.
Where circular currents form whirpools, the debris transported by the subglacial streams erode the underlying rock, carving large potholes in a short lapse of time.

Point 4: Alpe Pile

GLACIERS OF VALSESIA

The steep orography of the Valsesia head, mainly due to the gneissic nature of the bedrock, the lack of large feeding areas of the glaciers at altitudes above

3000 m. and the southern exposure of the slope of Monte Rosa make limited extension of glaciers in this valley, despite the 4554 m. of maximum elevation of the basin.
The limit of permanent snow is influenced not only by these factors but also by the amount of precipitation. It is, in fact, the contribution of snowfalls that effects the continuous feeding of the glaciers.
The study of glaciers is not only of scientific interest, but also of practical use; the ice, in fact, represent a large reserve of fresh water and constitute an effective system for regulating summer water flows, influencing the hydrogeological balance of the entire basin.
The monthly distribution of fresh snow in Alagna Valsesia, from data collected between 1932 and 1989, highlights the dependence with the thermal regime, being in fact the maximum in January, in conjunction with the lowest temperatures.

The evolution over time of Alagna's annual rainfall totals shows an apparent twenty-year cyclicity.

Point 5: Bridge over the Bors stream

LARGE SCALE GLACIAL EROSION

During long cold periods, the valleys previously cut by rivers are invaded by glaciers, which remould them by rectifying their morphology. They become wider and rectilinear, being adapted to the need to transport the largest volume of ice. The cross section of a glacial valley has the typical U-profile.
the bedrock hosting the glacier is always extremely crushed due to the continuous action of the moving glacier and "freezing and thawing" of the infiltration waters. When freezing, they increase in volume, exerting a continuous pressure inside the fractures, thus isolating even large rocky blocks (plucking process).

HANGING VALLEY

The main glacier has a greater erosional capacity than tributary glaciers, consisting of lower thickness masses. All this affects the erosional landforms and the valley bottom that are located at different levels; the valley floor of a tributary glacier, in fact, is perched above the one of the main valley.
During the retreat phase the glacier leaves the thresholds of the tributary valleys at higher altitudes, thus they become “HANGING VALLEYS". They join the main valley at rocky steps generally characterized by spectacular waterfalls.

Point 6: Alpe Bors

GLACIAL CIRQUE

One of the most common elements of the glacial landscape is the so-called CIRQUE. It is defined as a large bowl-shaped depression with a flat and slightly inclined bottom, surrounded by vertical rockwalls. Towards the valley, before the step connection to the main valley, the circque often has a counterslope of roches montonnées or a moraine deposit which can determine the formation of a small lake.

GLACIOLACUSTRINE BASIN

During the late-glacial phase (which occurred about 12,000 years ago) the main glacier deposited a large lateral moraine ridge barring the Bors valley. This moraine deposit is still partially preserved between Alpe Fondecco and Alpe Bors and gives evidence to how large the glacier was at that time.
Due to changes in climatic conditions, the glacial tongue of Bors Valley was reduced to a circle glacier whose melting originated a lake.
While the lake bottom hosted depositional processes, the emissary stream eroded the moraine ridge until it broke through, causing a rapid emptying of the lake.

Point 7: Fondecco Moraine

MORAINE DEPOSITS

At the glacial terminus and on the edges of a glacier, where ablation processes prevail, all the materials transported by the glacier(either those torn off from the rocky bottom, i.e. debris of sublacial or endoglacial origin, or those deposited over the ice surface by other phenomena, such as landslides and avalanches), return to the light.

All these materials are called MORAINE deposits. Their characteristics are:

- poor sorting of the size of debris that compose them (unlike what happens with other geomorphic agents, such as, for example, water and wind); in fact granulometry ranges from large boulders, pebbles (clasts) to sands, silt and clays (matrix)
- lack of stratification, within a chaotic mixing of clasts and matrix components
- very varied lithological composition: types of rocks from very distant areas within the glacial basin can be found
- pebbles can be either angular or smoothed and striated
- often the elongated pebbles are arranged in one prevailing direction

The moraine deposits are classified based on their position relative to the glacier and according to the glacial phases.

Thus, lateral, frontal, median, transported moraines are recognized.

LATERAL MORAINE

These are elongated ridge of debris located at the edges of the current glaciers or at the sides of the formerly glaciated valleys; they have an asymmetrical transverse profile with the inner side steeper than the outer one. These landforms are created during a phase of glacial expansion: usually larger dimensions means greater extent of glacial phases.

FRONTAL MORAINE

These are arch-shaped ridge debris outlining the position of the glacial terminus in its maximum expansion. They are formed by the material pushed forward by glaciers with a bulldozer-like action.

Frontal moraines are very interesting from a scientific point of view as they allow us to reconstruct the exact extension of a glacier; the intense erosive action of the glacial streams fragments them into isolated sections.

Lichenometry

It is the discipline that studies the dimensions of lichens developing in a given area, starting from its deglaciation.

Since the growth of a lichen occurs mainly as a function of time (even if it is influenced by other factors such as: exposure, altitude, lithology of the bedrock, etc.) there is a clear relationship between the size of each lichen thallus and its age .

By measuring the diameter of the lichens and knowing the growth time of a given area, we can establish the ages of the moraine deposits and glacial erosion surfaces.

Point 8: Alpe Fondecco

ICE FORMATION

Part of the snow that falls during the cold season remains on the ground even in the summer months and is covered by new snowfall the following year.

The limit above which the snow does not melt is called the “snowline”; it varies according to altitude, latitude and sun exposure.

After the snow falls to the ground or settles on the glacier, its gradual transformation begins, which consists essentially of a variation in shape and reduction of the air spaces between crystals (due to increased pressure by snow accumulation), partial melting and recrystallization.

The set of these transformations is called METAMORPHISM.

Over time, fresh snow, containing about 90% of air, turns first into grainy snow, then into FIRN (after about a year) and finally into ice, losing much of the contained air.

THE GLACIER

A glacier can be defined as a mass of ice, constantly moving under its own weight, resulting from the metamorphism of the snow.
An active glacier is composed of two main zones: the accumulation zone and the ablation zone.

ACCUMULATION ZONE

It is the zone of a glacier where more snow and ice is accumulated in winter than lost in summer. It represents the feeding area of a glacier, where snow and avalanches accumulate almost all year round.
The ice of the accumulation zone is cut by a few crevasses, it is usually white because it is covered by snow and has no surface moraines.

ABLATION ZONE

It is the zone of a glacier where most snow and ice are lost in summer than accumulated in winter. It is located below the accumulation zone, separated by the Equilibrium Line Altitude (ELA). The Equilibrium line altitude is located where the snow and ice added to the glacier during a year is exactly equal to the amount of snow and ice that is lost in that year.
Ablation processes prevails in the ablation zone, that means that snow and ice are removed from the body of the glacier by melting, sublimation and collapse of ice sectors reducing its mass.
In summer the ice of the ablation zone has a green-gray color and is intersected by numerous crevasses; it is also covered by moraine debris which, over a certain thickness, protect the underlying ice by absorbing the thermal energy from solar radiation.

DYNAMICS OF A GLACIER

A thick glacial mass generates enormous pressure; this makes a glacier behaving like a semi-plastic mass, slowly flowing downstream due to the effect of gravity.

The speed and dynamics of a glacier depends on various factors such as: slope of bedrock, thickness of ice and temperature.
Along a transverse profile of a glacier the speed also varies with the distance from the surface and from the bedrock shape, due to the effect of friction and pressure.

CREVASSES AND SERACS

Crevasses are fractures of the surface layer of glaciers, produced by the tensile stresses resulting from the movement of the ice mass.
They develop where the ice meets a bumpy, uneven bedrock or changes in slope.
The intersection of several crevasses causes the isolation of a series of blocks of ice (even more than 10 meters high) called seracs.

You have thus reached the end of the Glaciological Path. While returning downvalley, we invite you to observe " by your own" the scientific contents we have shown you in the display panels.
During the way uphill you walked on moraine deposits, you "climbed" the threshold of suspended valleys, you met glacial cirques, potholes and roches montonnés.
Now, have a look around in your descending path and you will find out that glaciers have left unmistakable signs of their passage more or less everywhere.