



## A didactic model of a mountain glacier

Francisco Lopes, Lúcia Dias, Ana Bonifácio, Gonçalo Corigo, Tomás Ramos, and Marcos Rodrigues  
Escola Secundária de Albufeira, Albufeira, Portugal (lopesfmv@gmail.pt / Fax: 00351 289 586 892)

The study of glaciers is part of the Geology discipline in the 12th grade of secondary school. Our school is located in the south of Portugal, where the sun is a constant presence, and the ice is always absent. This climatic condition makes the glaciers an unknown reality for our students. This is why our students decided to create a model to exemplify how mountain glaciers move. By doing it they need to study, not only how they move, but also their nature and how they are formed.

Glaciers are streams or sheets of recrystallized ice that last all year long. Geologists distinguish between two main categories: mountain glaciers and continental glaciers. The mountain glaciers (also called alpine glaciers) exist in or adjacent to mountain regions. Continental glaciers (also called ice sheets) are vast layers of ice that spread over thousand of kilometers of continental crust. Presently, continental glaciers are found only on Antarctica and Greenland.

When we look at a glacier we think that it doesn't move, but we couldn't be more wrong. Measurements reveal considerable variation in glacier velocities. Surface velocities range from less than 2 meters per year to more than 8 kilometers per year (Smith & Pun, 2006).

Glacier movement makes them a very important agent of erosion and transport of sediments. When alpine glaciers move along the valley they transform the "V" shape of rivers valleys in a "U" shape. This movement transports sediments and the accumulation of them in bodies called moraines. Depending of their location they can be: lateral moraine (along the margin of the glacier), medial moraine (where two lateral moraines merge), ground moraine (at the bottom of the glacier) and end moraine (deposited at the end of the glacier).

To simulate the movement of a glacier and the formation of moraines, the students have built a model representing the morphology of a two valley mountain glacier. In the construction of the model we used simple materials used in the daily life - an acrylic base over which we shaped the morphology of the glacier with newspaper and white glue. To give texture and make the finishing we applied paper towels with white glue, and, in the end, to give colour to the model, we used acrylic paints (brown, gray and white). To simulate the glacial ice, we have prepared a solid material that flows - we have mixed 200 ml of hot water with 5 tea spoons of sodium borate in a container; then, in a plastic container, we placed transparent liquid glue and mingled it with our hands, with the mixture of sodium borate, to obtain a solid mass. On the model we spread fine sediments in the valleys. With the model and the "ice" prepared, we placed the "masses of ice" at the head of each valley and let it flow. To control the movement of the glacier we have stuck some pins aligned transversely.

After a few minutes, we could see that the pins on the sides moved more slowly than those at the center, due to sidewall friction on the ice mass just as it happens in a real glacier. Due to the movement of the "glacier", the sediments transported laterally (lateral moraines) formed a median moraine when the two glaciers joined themselves. The pins used on the sides have also become part of the median moraine. A ground and a terminal moraine were also formed during the process.