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LETTER FROM SWITZERLAND

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The question of how the earth is shaped has fascinated man for thousands of years. Actually, no one ever believed it was flat, except for various kings and queens—the ones, after all, who financed the early excursions of such men as Cristoforo Colombo, Marco Polo and Vincenzo Bellini. These valiant explorers certainly believed that the world was round, but they were afraid to say so for fear that the reigning monarchs would consider them out of their minds and cut them off without a single lira or peseta.

Edmondo P. Mondo was one of the first students of the shape of the earth, a science which at that time was called "Mondologia" or, in English, "Earthology". This was, of course, before Galileo Galilei returned from his scientific expedition to the Middle East, where he was studying the saline content of an inland sea subsequently named after him. It was Galileo who first used the term "geodesy" when he wrote his preliminary study, *La geodesia facile*, or "Geodesy Made Easy".

Here again we must thank Galileo for his efforts to lead us out of the dark ages into the age of enlightenment. One day, while trying to invent the telescope, Galileo looked out of his kitchen window, which faced north, and saw what seemed to be a slight curvature in the horizon. He immediately realized that he was witnessing a strange magnetic phenomenon, one that could, if properly documented, prove that the earth was round.

But Galileo had had enough of this proving business. Every time he invented something—no matter what it was—he ran breathlessly to the authorities to describe to them the importance of his invention. It was all a waste of time, for, without fail, they took his invention away from him and told him to go home.

This is why it took twenty-five years longer to get the telescope invented—and the reason why at least thirteen telescopes were confiscated before Galileo found an official who was sympathetic and understanding. In the beginning, Galileo called his invention the "black cylinder". Only later, during a hitherto unchronicled visit to Switzerland, did he think of a better name.

Somewhere around the Lake of Lucerne, Galileo met up with Switzerland's national hero, William Tell, who was trying to figure out a way to save the country without killing his son. Galileo suggested the "black cylinder" which was still unpatented since no one in Italy believed that such an invention could really work. Tell took one look at it, and another look through it, and immediately sensed the importance of his new friend's invention.

"Listen, Galli," said Tell, "why don't you let me use this thing tomorrow when I shoot at that apple on my son's head? With this cylinder I'm sure to knock off the fruit without injuring my poor little boy."

"Excellent idea, old man," replied Galileo. "Go to it!"

And so it came to pass that William Tell, with the help of Galileo's "black cylinder", shot the apple off his son's head and rescued Switzerland. This is, of course, a well-known story. Generally unknown, however, is the fact that Galileo, overjoyed at the success of his invention, decided to name it after Switzerland's national hero. That is why, for so many years, Galileo's black cylinder was known as the "Williamscope".

Galileo was also interested in the earth's interior, and, while in Switzerland, decided to study the Alps. In a letter to his brother Gordon dated May 16, 1624, Galileo tells of his first experiences with the Alps:

"... When one thinks of how many strata of rock are necessary to create even one little Alp, then we can only stand in wonder before these creatures of Nature. It is my plan to study each of them, to examine every peak and every crevasse with my Williamscope and to note down for future generations some of my findings."

We know that Galileo prepared an exhaustive study of the Swiss Alps and that these papers would undoubtedly have advanced the fields of glaciology and volcanology by hundreds of years. Unfortunately, almost the entire collection was lost when a fierce southern wind known as the *Foehn* swept down from the mountains and blew Galileo's study all over Switzerland and even as far as the Black Forest. Galileo picked up as many papers as he could, but the rest were lost forever.

Today, it is interesting to roam the countryside looking for items of particular scientific value, in the footsteps, as it were, of the indomitable Galileo. Take the Aletsch Glacier, for example. Galileo described it in one of the papers not blown away by the *Foehn:*

"There are glaciers and glaciers. But wherever there are glaciers, there is none more imposing than the Aletsch. I have walked all over it—up and down it, across and back and around again. My first and most important discovery was that my feet got cold. This may seem somewhat prosaic, but what earthly good is a scientist whose feet get cold every time he walks around a glacier? So I proceeded to line my shoes with some of the other scientific papers I had rescued from that brutal wind. The next time I walked on the Aletsch, everything was fine. I believe that I have also invented the principle of convectional insulation, for my feet are now pleasantly warm, my toes as snug as ten bugs in a rug.

"The glacier itself consists mainly of ice, with several layers of snow on top. The latter can be accounted for by the severe and snowy winters of the Valais region. In any case, one layer of snow has not had a healthy chance to melt before another begins to build up.

"I started to dig through the layers of snow in order to examine the consistency of the ice as well as its crystalline structure. The first day—after fixing my shoes—I dug through forty-three layers. Layer twenty-two was the thickest—ninety-one centimeters thicker than layer number four, which was the thinnest. Most of the layers were of finely packed powder snow, the best kind for skiing and other winter sports. Unfortunately, even though I have been working on the problem, skiing is still completely unknown here, and most people, except for children, hate the snow and winter generally.

"After I had diligently dug through the forty-third snow layer, I came upon the ageless ice of the Aletsch. How perfect it was—hard and blue and cold, as ice should be. I chipped out a piece to study more carefully. I blew at it and the moisture in my breath froze at once. I licked at it and my tongue stuck to it. It was indeed a *very* cold piece of ice!

"That day I continued to chip away at the glacier. After a few more centimeters, though, I grew tired of this experiment and returned to camp for some sustenance. My study of the Aletsch may not be the most detailed in all of glaciology, but I hope it provides some information of use to scientists of the future."

Many years were to pass before the lessons learned from Galileo's glacial experiments could be utilized. For example, Galileo first verified the connection between low temperature and the formation of ice. The thermometer he carried happened to register —10° centigrade (14° Fahrenheit) and he noticed that water was always frozen at this temperature. Through a number of further tests Galileo was able, with a candle, to warm up the pieces of ice he took from the Aletsch and then let them freeze again, measuring each time the exact temperature as they froze.

He continued this series of experiments for four or five months. At the end of that time, he averaged the temperatures and concluded that the ice of the Aletsch glacier began to turn to water at 1° centigrade (33° Fahrenheit). Conversely, water began to show signs of becoming ice at a temperature of approximately 0° centigrade (32° Fahrenheit). Galileo's discoveries, although primitive by today's standards, have been extremely helpful to countless numbers of glaciologists the world over.

Galileo also recognized the relationship between altitude, atmospheric pressure and temperature. He knew that it became colder the higher one climbed, even if it was warm when one started. He knew, too, that the air became thinner and that pressure diminished. He devised the first successful formula for boiling eggs at high altitudes, one still used by many mountain hotels in Switzerland.

"The degree of albuminous viscosity of a boiling chicken egg," wrote Galileo, "is in large part determined by the height of the vessel in which it is being prepared. If the vessel is at sea level, the egg may be cooked to a pleasant degree of doneness in three to four minutes. However, for every hundred meters of altitude added, one must allow a further nine seconds of boiling to achieve the same result."

This document, "Ten Tasty Ways to Boil Eggs in a Mountainous Country", could not have been written had Galileo never visited Switzerland. Only here was he able to transport his boiling egg—step by step—from the depths of the valleys to the heights of the highest Alps. As a result, Galileo deduced that it takes the longest time to cook an egg when one is trying to do it on the highest mountain, like the Jungfrau or the Matterhorn. In addition, the constant winds keep blowing out the cooking flame, so that it often requires an hour or more to finish the job. This can, of course, lead to further complications if there are a lot of hungry people waiting for breakfast in the Alps.