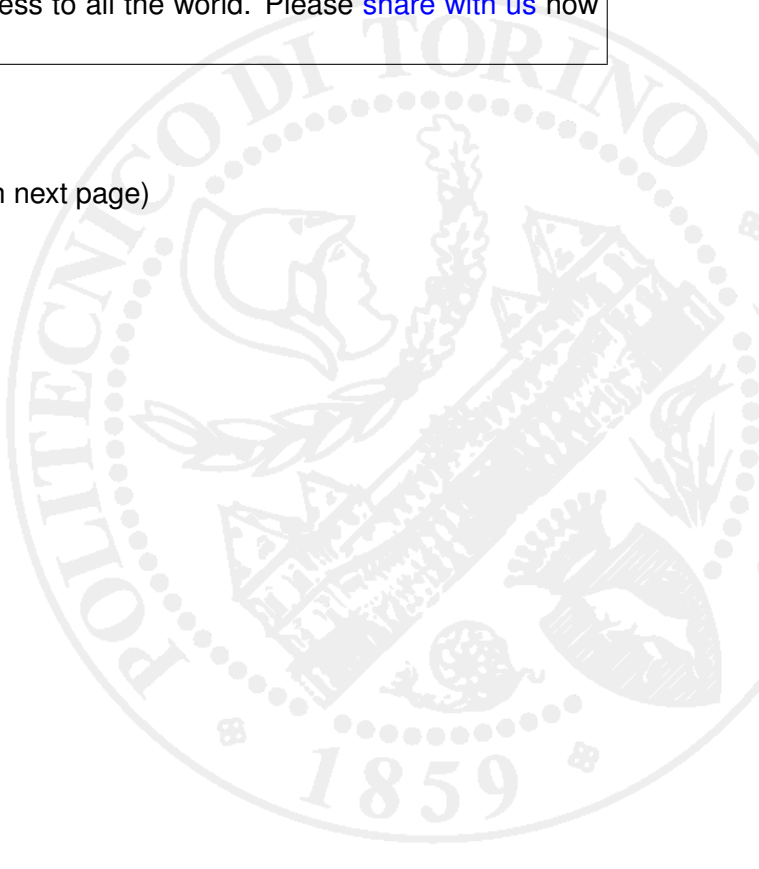

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Rock glaciers on Mars viewed with Google Earth

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Abstract

Several glacier-like landforms have been identified on Mars. We can view some of them with Google Earth and its virtual Mars planet. In the images of Ismeniae Fossae glaciers, the flow lines of these landforms are clearly visible too.

Keywords: Mars, Google Earth, Satellite Imagery

Article body

Ice is a substance which is common in the solar system. Even Mercury, the planet closest to the Sun, is hosting ice, as observed by a NASA spacecraft that provided the first optical images of it in the shadows of a crater [1]. Ice is also covering moons of Jupiter and Saturn and comets are made of it, mixed with rocks, dust and frozen gases such as carbon oxides, methane and ammonia [2]. Besides water ice, the solar system possesses many other types of frozen substances, not only in the comets. The poles of Mars for instance contain frozen carbon dioxide, the deposition of which, during a pole's winter, is caused by low temperatures. In fact, 25–30% of the Martian atmosphere is deposited into slabs of CO2 ice (dry ice) [3].

Mars has two permanent polar ice caps, which consist primarily of water ice [4,5]. However, besides in its polar caps, the planet has ice in several glaciers [6-8]. A particular concentration of them had been found in the Ismenius Lacus region [6]. At mid-Martian latitudes, the current models of Martian atmosphere are showing that ice should not be stable if exposed [9]: it is supposed therefore, that most glaciers must be covered with a layer of rubble or dust that can prevent the transfer of water vapour in the sublimation of ice into atmosphere [10]. The atmospheric pressure on Mars is so low that ice simply evaporates, if it is not well protected under a thick layer of dust. As told in [6], because Martian glaciers are contain substantial proportions of debris, they could be better described as rock glaciers [11-14].

Satellites orbiting over the planet had been used to identify the Martian rock glaciers [15]: with the radar measurements made by the NASA Mars Reconnaissance Orbiter, the presence of ice had be determined and measured. In this manner, a research team of the University of Copenhagen has recently estimated the total volume of water ice present in massive belts of glaciers at the mid-latitudes of Mars, concluding that this volume is a very important water reservoir of this planet [16]. The belts of glaciers are located around Mars between the latitudes of 30 and 50 degrees, on both northern and southern hemispheres.

Some of the Martian glaciers can be viewed with Google Earth and its virtual Mars planet (maps of Google Earth are of a higher resolution than those on the browser version of Google Mars). On the Mars virtual globe, we can find some very-high-resolution images coming from the Mars Reconnaissance Orbiter's HiRISE camera (HiRISE means High Resolution Imaging Science Experiment). To see the glaciers, let us consider the region of Ismeniae Fossae. In the Figure 1A, we can see an elevation map (Google Maps) of this region and, in 1B, the same region in Google Earth. The Context Camera (CTX) on board NASA's Mars Reconnaissance Orbiter (MRO) spacecraft has taken the images we find in 1B (Location: 40.59°N 42.08°E, acquired on January 28, 2007; Location: 40.46°N 43.48°E, acquired on February 8, 2007; Location: 41.77°N 44.11°E, acquired on November 19, 2006). HiRISE images are also available. In the Figure 2, we can see details from the image taken by the Mars Reconnaissance Orbiter at location 40.59°N 42.08°E, on January 28, 2007. The visibility of flow lines is enhanced using Gimp Retinex [17,18]. In both panels of Figure 2, we have the merging of two valleys in which ice, according to the local slope, is flowing.

The streamlines we clearly see in the images are interpreted to represent ice-flow features, as told in [19]. In any case, using Google Earth, we can easily make comparison to glaciers on Earth: in the Figure 3 for instance, the flow lines of glaciers in Alaska are shown.

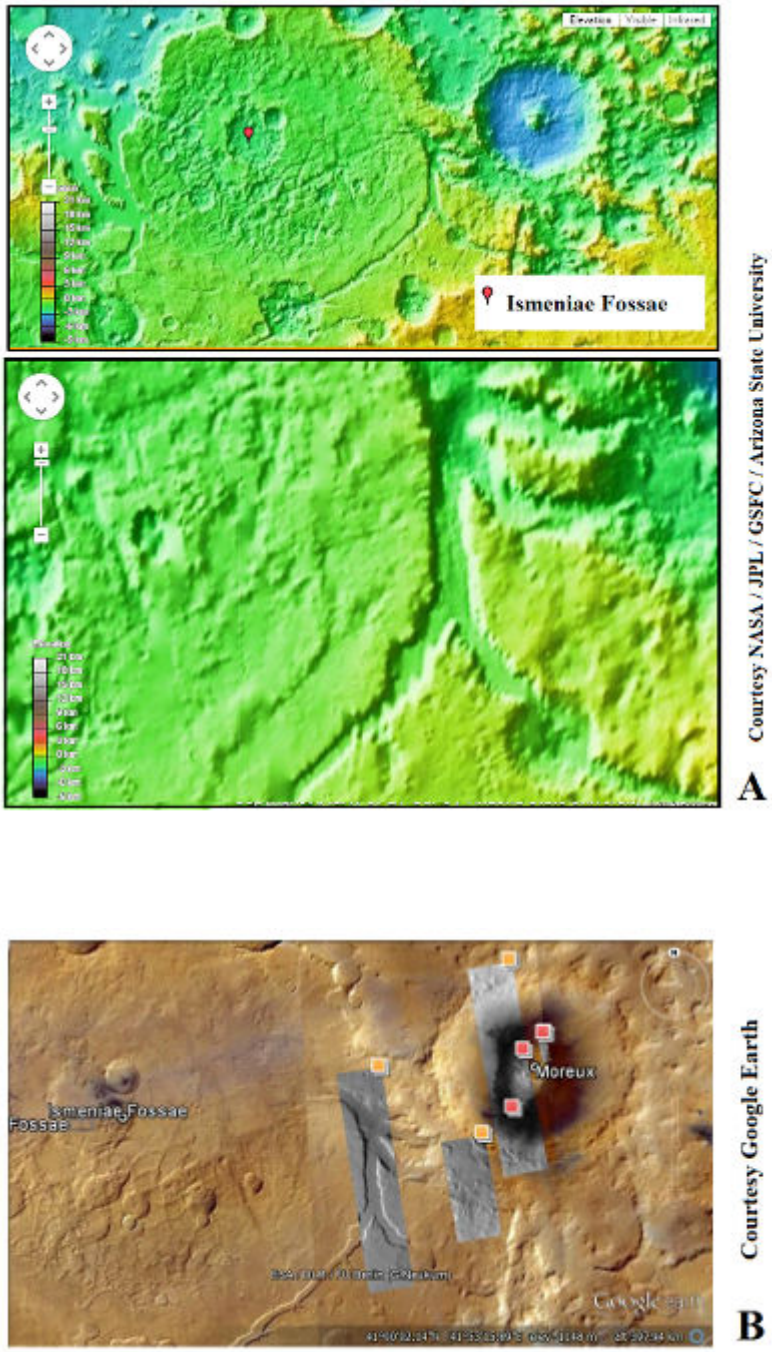

Figure 1: A) Elevation maps (Google Maps) of Ismeniae Fossae region. B) The same region in Google Earth. We can see images taken by the Context Camera (CTX) on board NASA's Mars Reconnaissance Orbiter (MRO) spacecraft. Location: 40.59°N 42.08°E, acquired on January 28, 2007. Location: 40.46°N 43.48°E, acquired on February 8, 2007. Location: 41.77°N 44.11°E, acquired on November 19, 2006. HiRISE (High Resolution Imaging Science Experiment) images are also available. Note the merging of two valleys in the image at location 40.59°N 42.08°E.

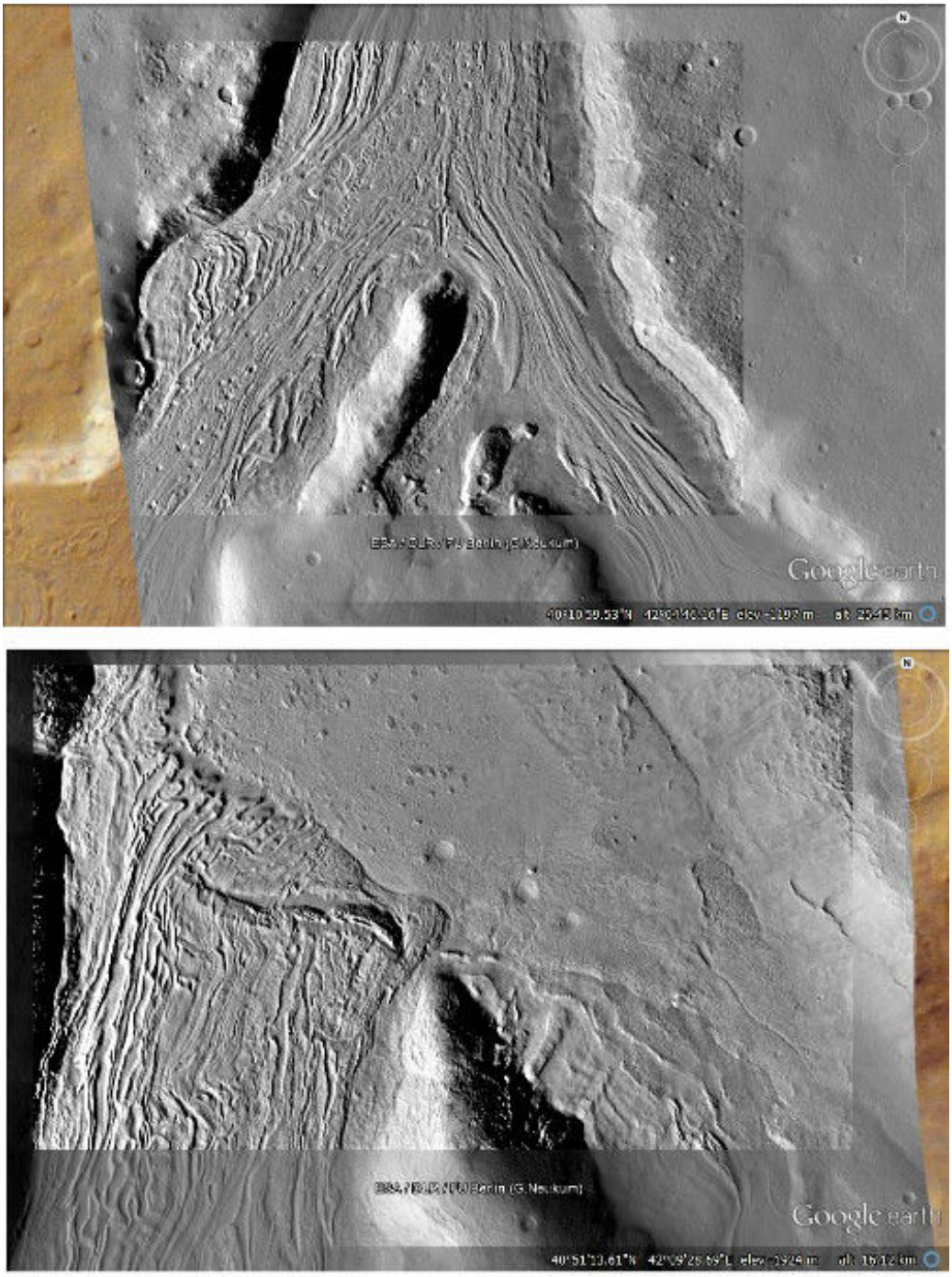

Figure 2: Two details from the image taken by the Context Camera (CTX) on board NASA's Mars Reconnaissance Orbiter (MRO) spacecraft. Location: 40.59°N 42.08°E, acquired on January 28, 2007. The visibility of flow lines is enhanced using Gimp Retinex [17,18]. Note the behaviour of glaciers at the merging of two valleys. Glaciers are flowing according to the local slope.

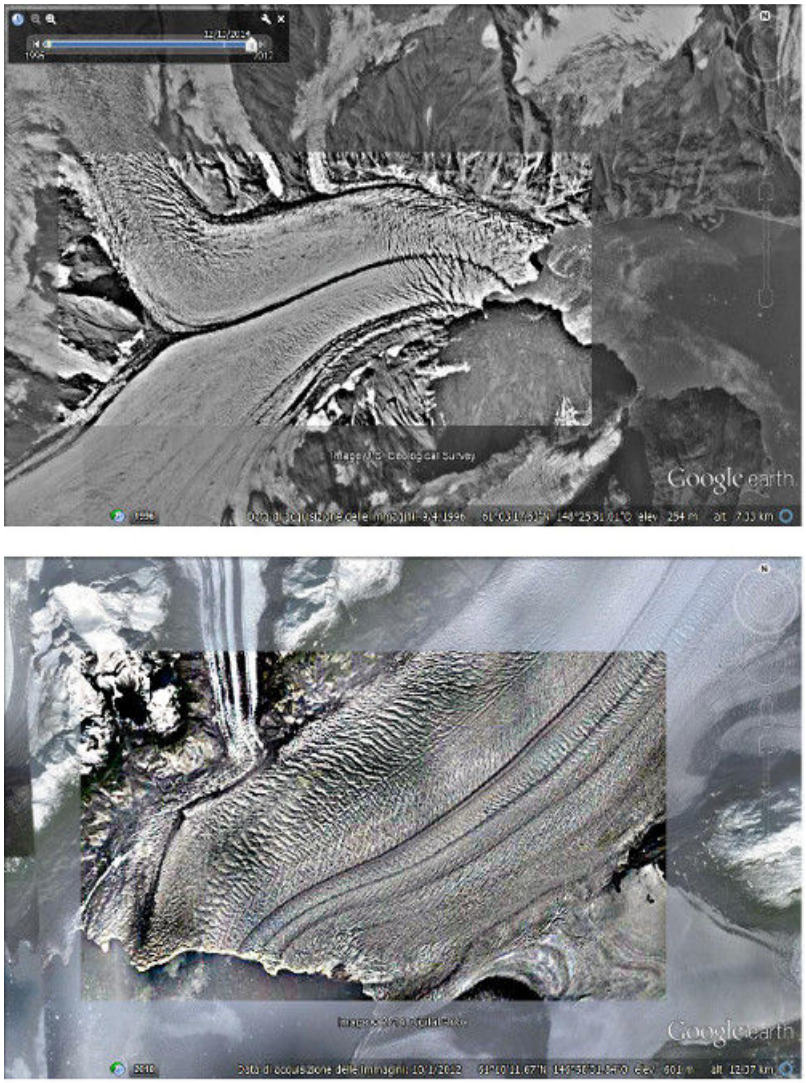

Figure 3: Two images of glaciers in Alaska for comparison. The visibility of flow lines is enhanced using Gimp Retinex [17,18].

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