Could Egeria have seen the "Parthenion" sea from the Top of Mount Sinai?

The Landscape Visibility from the Top of Mount Sinai climbed by Egeria

by Fabio Crosilla

A "viewshed analysis", applied to the raster Digital Elevation Model available from the US National Aeronautics and Space Administration (NASA) of the Sinai Peninsula, allowed to verify that Egeria, the IV century AD Spanish pilgrim, climbed Gebel Musa when she reached the top of Mount Sinai.

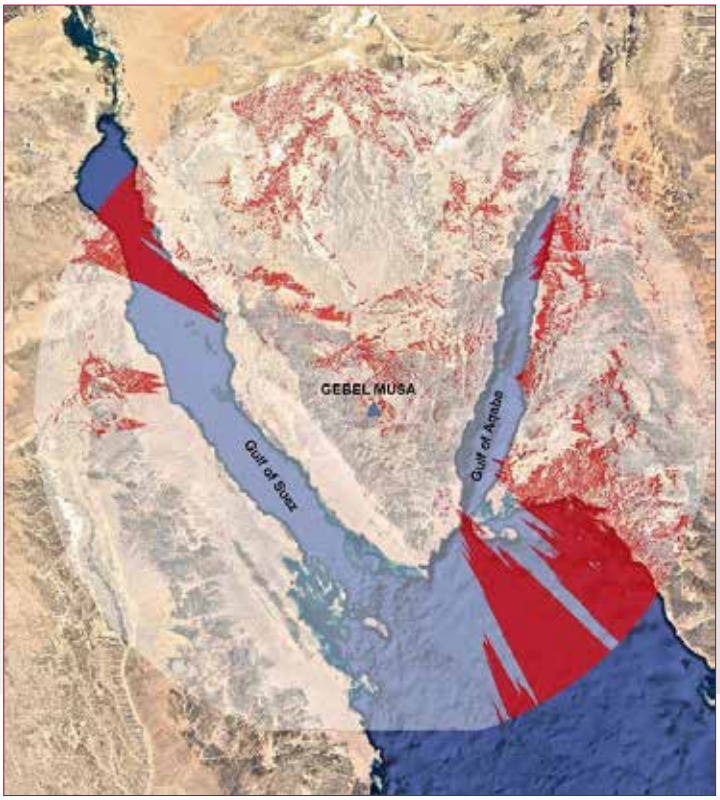

Fig. 1 - Viewshed analysis from the top of Gebel Musa. Some free visibility directions are available (in red). These agree with what reported by Egeria in her book, apart for the Parthenion Sea (Mediterranean).

At the meeting organized in Novara (Italy) by the Nuova Regaldi, on September 22nd 2022, entitled *"Emmanuel Anati's exodus proposal according to the publication of the Ennateuch in the holy language of Jerusalem Sanctuary"*, during my presentation I mentioned the book *"Diary of a Pilgrimage"*, by the IV century AD Spanish pilgrim Egeria. In this book, she describes, with wealth of details, her climb to the top of Mount Sinai.

In the subsequent discussion session, two hypotheses were raised about the location of Mount Sinai climbed by Egeria: Gebel Musa, in the South of the Sinai Peninsula and Har Karkom, in the Negev desert, proposed some decades ago by Emmanuel Anati.

In the following, considering the description offered by Egeria about the landscape visibility from the top of mount Sinai, an objective comparison on the two hypotheses (Gebel Musa and Har Karkom) will be carried out, so to define in a scientific way, the most probable location of the Mount Sinai described by the Spanish pilgrim.

ANALYSIS OF VISIBILITY FROM THE TOP OF MOUNT SINAI AS REPORTED BY EGERIA

Egeria writes in her book that: *"Egypt, Palestine, the Red Sea and the Parthenion Sea, that extends as far as Alexandria, and even the immense territory of the Saracenes: from up there we saw them so far below us, we could hardly believe it. And all these places, the Saints pointed out to us one by one"*.

As is well known, the (pseudo) spherical earth shape limits the earth surface visibility within a certain distance that depends on the terrestrial curvature ray, the observer height over the sea surface and the air refraction conditions.

In topographic surveying, a simple formula (referred to the so called "*lighthouse problem*") allows us to calculate with enough approximation the maximum visibility distance at the sea surface level given the terrestrial curvature ray, the observer height and the atmospheric refraction parameter. With a simple extension of the formula, it is also possible to compute the maximum visibility distance between two points at different height over the sea level, because of the (pseudo)spherical shape of the earth. Applying these formulations, the maximum visibility distance value, to which Egeria could have seen the landscape around the top of Mount Sinai, has been computed. For instance, at the height of Gebel Musa (2285 m. a.s.l.), with air refraction conditions relative to the roman "*Hora quarta diei*" (between 9 AM and 10AM solar time), i.e. the time in which Egeria reached the top of Mount Sinai, for a terrestrial curvature ray equal to 6378 Km, a visibility maximum distance of 184 Km can be obtained. Applying the same formula at the top of S. Caterina Mount height 2629 m a.s.l., very near to Gebel Musa, the maximum distance of visibility at the sea surface level increases to 197 Km.

Let us now consider observation directions without visibility obstacles, so as not to interfere with the line of sight corresponding to the maximum visibility distance. Egeria climbed Mount Sinai in December 383 AD, according to P. Devos and P. Maraval, ("Egeria", Journal of voyage, ed. P. Maraval, Paris, 1982). On a clear winter day, because of the earth shape curvature, it is possible to see the Egyptian territory, the Negev hills, the Read See and the land of the Saracens (Arabia), mentioned by Egeria in her book. On the contrary, it is not possible to affirm that Egeria could see the Parthenion Sea (the Mediterranean), which is approximately 270 km from Gebel Musa. It is clear that this distance would persuade the observer to imagine seeing what he could not actually see. As for Har Karkom, at a height of 847 m asl, the maximum visibility distance at the sea surface level, due to the earth's sphericity, is 112 km. From the top of Har Karkom, located in the Negev desert, you are faced with a morphological situation completely different from Gebel Musa. Prof. Anati reports in his book Exodus: Between Myth and History (Atelier, 2018) that Har Karkom is characterized by a plateau 4 km long, 2 km wide, at a height of 847 m asl, dominating the Paran desert. Figure 65 on p. 126 of this book shows that the maximum visibility along the north, west and south directions reaches 30 km, while along the east sight is extended up to the mountains of the Transjordan chain, about 60-70 km from Har Karkom. The situation is therefore completely different from that described by Egeria in her book.

LOOKING FOR OBSERVATION DIRECTIONS WITHOUT VISIBILITY OBSTACLES

To consider reliable the visibility reported by Egeria in her book, it is necessary to verify for the mountainous landscape around the top of Gebel Musa, the presence of observation directions without visibility obstacles.

To this end, a systematic visibility analysis by a tour of the horizon of 360° degrees around Gebel Musa, was performed. For this purpose, the plug-in "Viewshed analysis" by Geo Guru, available in QGIS3, a very popular open source Geographic Information System software, has been used. This plug-in considers also the terrestrial curvature and the atmospheric refraction along the path.

In particular, "Viewshed analysis" is a computational process that delineates a viewshed, i.e. the area that is visible (on the terrain surface) from a given location. In a raster environment, to determine visibility from a particular cell (pixel), the analysis uses each cell elevation value, i.e. the so-called Digital Elevation Model (DEM). The viewshed is created estimating the difference of elevation from one cell (the view point cell) to the next (the target cell). To determine the visibility of a target cell, each cell between the view point and the target one is examined for a line of sight. Where cells of higher altitude are between the viewpoint and target cell, the line of sight is blocked. In this case, the target cell is determined not to be part of the viewshed. On the contrary, if the line of sight is not blocked, it is included in the viewshed *(see Kim Young-Hoon, Rana Sanjay, Wise Steve, 2004, "Exploring multipleviewshed analysis using terrain features and optimization techniques", Computer & Geosciences, 30 (9), 1019-1032*).

The raster Digital Elevation Model (DEM) used is the one available from the USA National Aeronautics and Space Administration (NASA). Obtained by the Shuttle Radar Topography Missions (SRTM), (see for instance *Farr T.G. Kobrick M., 2000, "Shuttle Radar Topography Mission produces a wealth of data", Amer. Geophys. Union Eos, vol 81, 583-585*), it was originally carried out in 2000 with a theoretical cell resolution of 90 m., updated in 2015 with a theoretical cell resolution of 30 m. The real cell resolution of this experiment is 50 m.

Figure 1 shows the viewshed analysis for the top of Gebel

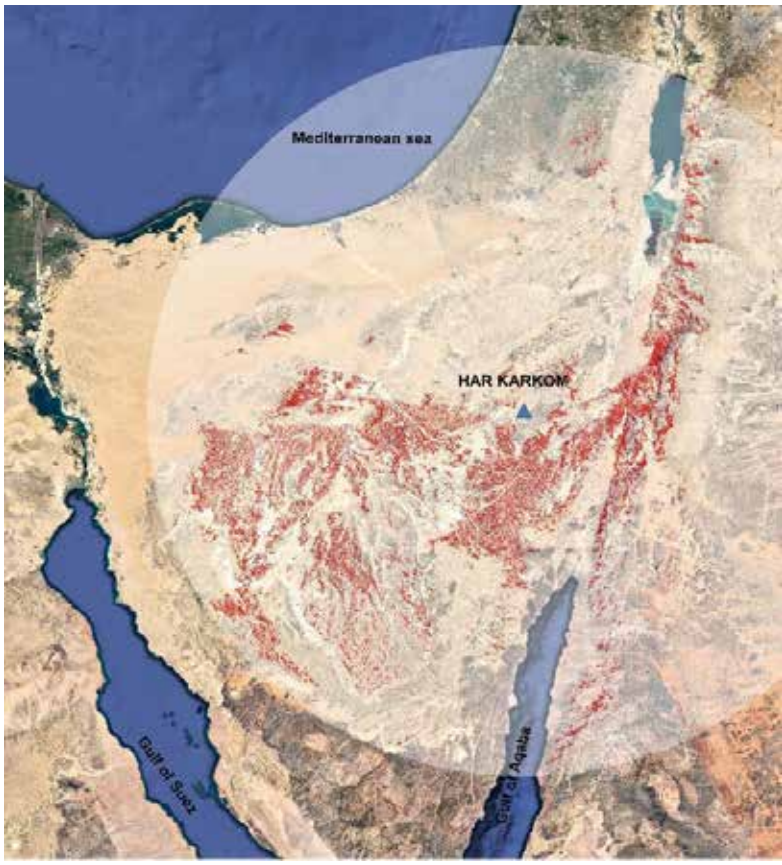

Fig. 2 - Viewshed analysis from the top of Har Karkom. Some free visibility areas are available (in red): the Paran desert, the Trans Jordan chain, some hills of the Jebel El Tih desertic plateau.

Musa (view point) extended up a the distance of 180 Km. As it is possible to see, despite the mountainous morphology of this area, there exist some directions of free visibility.
In particular, some directions towards the Gulf of Suez and the Egyptian coast, the northern part of the Gulf of Aqaba and the Jordan coast, the Red Sea and part of Arabia in the south- western direction from Gebel Musa have free visibility, satisfying that reported in the book of Egeria.
Furthermore, from Figure 1 it is possible to note some limited visibility areas in correspondence of the hills of the Negev desert, in the direction of Har Karkom. It is noteworthy that, the visibility along the North direction from Gebel Musa allows seeing the Jebel El Tih desertic plateau, characterizing the central part of the Sinai Peninsula. Of course, It is noteworthy that, Egeria could not see the Parthenion Sea (Mediterranean), 270 Km from Gebel Musa.
Moving on to the Har Karkom, we are faced with a completely different situation. Figure 2 shows that from the top of Har Karkom it is possible to have a wide vision of the Paran desert, located at the south- southeast of Har Karkom. Also the mountains of the Trans-Jordan chain, placed east of the Aravà valley, are visible, from the Gulf of Aqaba until the Dead Sea.
Furthermore, from Har Karkom there is a good visibility of the hills of the Jebel El Tih desertic plateau, in the central part of the Sinai Peninsula. The visibility situation is therefore completely different from what reported in the Egeria's book.

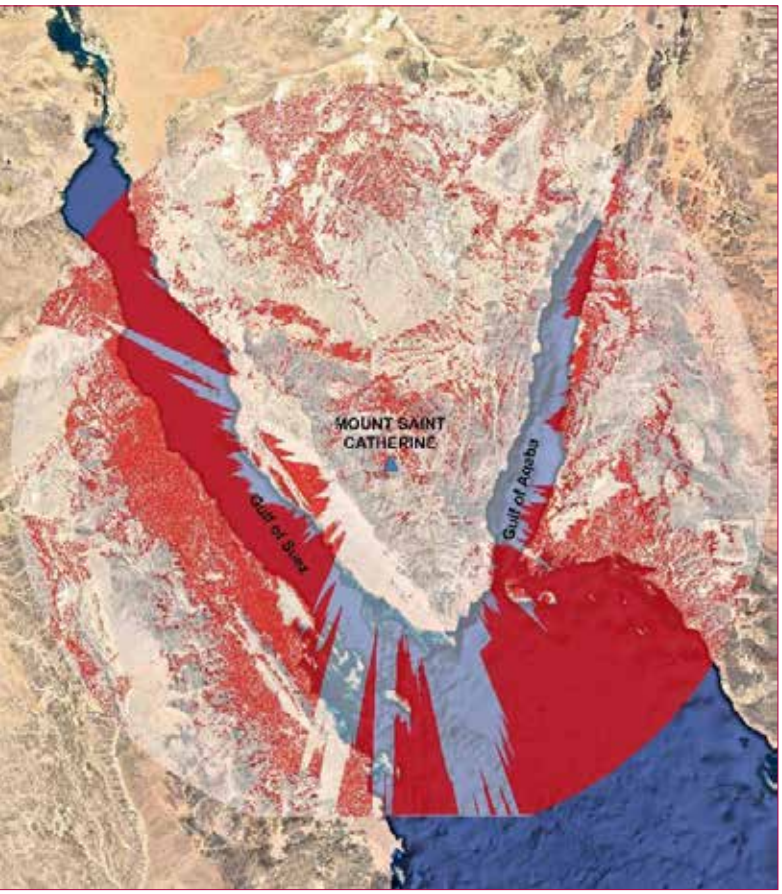

Fig. 3 - Viewshed analysis from the top of mount S. Caterina. Many free visibility directions are available (in red). These agree with what reported by Egeria in her book, apart for the Parthenion Sea (Mediterranean).

CONCLUSIONS

According to the previous results, it clearly emerges that the mountain climbed by Egeria is Gebel Musa and not Har Karkom, an assumption that can be scientifically shown considering the landscape visibility from the top described by Egeria. However, it cannot be said from the other descriptions offered by the pilgrim about the approach to the mountain, its climb and descent, that have induced some to think that Egeria, in reality, did not climbed Gebel Musa.
In any case, some descriptions of the climbing to the top of mount Sinai by Egeria are analogous to those reported by frà Niccolò da Poggibonsi, an italian Franciscan of the XIV century, who travelled to Holy Land in the years 1345-1350 and that had the opportunity to climb the top of Gebel Musa and and Mount S. Caterina. The story of his travel was reported in the "*Libro d'Oltremare*", written by the friar after his return to Italy and subsequently published by Alberto Bacchi della Lega, in Bologna in 1881. In reference to the landscape visibility from the top of the mount S. Caterina, frà Niccolo writes in his book "*From this place you can see Mount Sinai, and also the Red Sea, where the people of Israel passed and where the Pharaoh and his army were submerged; and also Arabia and the land of Egypt. On the top of the mountain we sang aloud: Salve Regina*.
Figure 3 reports the viewshed analysis from the top of mount S. Caterina, 400 m. higher than the Gebel Musa, but very near to it. Despite the greater height of mount S. Caterina and consequently the wider visibility from its top, we can state that there is a good correspondence with the landscape visibility of Gebel Musa, described by Egeria in her book.
Therefore, limiting the discussion to the landscape visibility offered by the top of the mountain, and reserving discussion of other aspects for another occasion, it reaffirms, for now, with good probability, that Egeria climbed Gebel Musa and not Har Karkom.

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Abstract

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In the subsequent discussion session, two hypotheses raised about the location of Mount Sinai climbed by Egeria: Gebel Musa, in the South of the Sinai Peninsula and Har Karkom, in the Negev desert, proposed some decades ago by Emmanuel Anati, as an alternative location hypothesis of Mount Sinai.
In the following, considering the description offered by Egeria about the landscape visibility from the top of mount Sinai, an objective comparison on the two hypotheses (Gebel Musa and Har Karkom) will be carried out, so to define in a scientific way, the most probable location of the Mount Sinai described by the Spanish pilgrim.

Keywords

Ancient Topography; GIS; QGIS; Viewshed analysis; Egeria

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