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Comments on "GLACIO-MECHANICAL EFFECTS AROUND ISPARTA PLAIN (SW TURKEY): EVIDENCE FOR LOWER-ALTITUDE GLACIAL EXTENT?" by Ateş (Carpathian Journal of Earth and Environmental Sciences, August 2016, 11, 2, 415 - 426)

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Abstract: In a recent paper, Ateş (2016) attributed the presence of several karst related landforms to glaciation and claimed that at least 600 m thick ice sheet covered the high hills of Isparta Plain (~1000 m a.s.l.; *above sea level*) near the Taurus Mountains Range of Turkey. The author further claimed that "*the glacial sediments from the Isparta region must have partly ended in the Antalya Bay through the southern discharge route*". We think that the observations and ideas presented by Ateş (2016) are not based on solid field evidences and hence the interpretations derived from them contain vital mistakes that are totally unacceptable. In the following paragraphs, we will strive to elucidate the inconsistencies in the presentation of data and their interpretations. We will later give the current situation on the glacial context of neighbouring high mountains of southern Turkey, and explain why glaciers could not develop, at least during the last ice age, in the Isparta Plain where this study was undertaken.

Key words: Equilibrium Line Altitude, moraine, glacier, LGM, Turkey

1 & 2. INTRODUCTION & STUDY AREA DESCRIPTION

The purpose of the paper is stated as "*the investigation of glacio-mechanical effects in Isparta Plain of southwestern Turkey*". The author also hypothesized that glaciation affected the morphology and stress regime of the Isparta Plain and claimed that this study is first of its kind in recognizing field evidences on glaciations. Later, the author cites several works, including our published papers, from nearby mountains (several 100's km away) to strengthen his case.

Several mistakes exist under the introduction and study area description chapters. The first one is the fact that Muslu Valley is not on Mount Sandıras. In fact Mount Sandıras is the westernmost glaciated mountain of Turkey where moraines came down to altitudes as low as 1900 m, a.s.l. (Sarıkaya et al., 2008). Instead, Muslu Valley is located in the Mount Dedegöl (2992 m a.s.l.), 70 km to the east of Isparta (Zahno et al., 2009; Köse et al., 2017).

Second erroneous assumption is the comparison of Hacer Valley glacier in Mount Aladağlar (Zreda et al., 2011) with the study area. The Hacer Valley is an east facing, 17 km long and a U-shaped glacial valley. This valley was filled with a long outlet paleo-glacier that was fed by an ice cap (~10 km^2), developed at 3200 m a.s.l., towards the end of Late Pleistocene. However the Isparta Plain and surrounding hills are not higher than 1500 m and do not contain any glacial valleys (Fig. 1). The only nearby high mountain is Mount Davraz (2637 m a.s.l.), which is 20 km to the east, but its cirque area is very limited (less than 1 km^2), and therefore cannot produce large glaciers that can flow and reach the study area mentioned in Ateş (2016).

Last but not least, the author noted that the glacial sediments must have partly ended in the Antalya Bay, more than 100 km to the south. Even if glaciers existed in the study area, which did not, and considering that sea levels were ~120 m lower than today during the last glacial, the Mediterranean Sea should have been at least 200 km away from the study area. We therefore believe that this claim is not proven by solid data.

Figure 1. The Google Earth view of the study area (looking to southeast). It is evident that the Isparta Plain and the Söbü Hill were well below the last glacial ELA.

3. METHOD & RESULTS

In this section, the author lists large to smaller-sized supposedly glacial features encountered in the area. We think that none of the listed features are of glacial origin and follow the author's sub-headings for our short comments.

3.1. Cirques

Although the existence of several cirques is mentioned, the only cirque shaped area presented in the paper is a crescent shaped hill (his figure 4) that starts at an elevation of 1170 m and ends at Isparta Plain at 1035 m a.s.l. This crescent shaped hill is not a cirque as it is too low to support any glacier in the past. It also faces S-SW and therefore receives full solar energy, which is not an ideal situation for a glacier to develop at this geographic setting. Most of the mountain glaciers in the Taurus Range and in Turkey face N, E and/or NE with few exceptions like on Mount Bolkar (mid-Taurus Range) where a S-facing glacier also developed due to the high elevation and presence of a large accumulation area (Çiner, 2004; Çiner & Sarıkaya, 2017; Sarıkaya & Çiner, 2017).

3.2. Blocks of abraded slabs being pressed into the base rocks

The author claimed that surface rocks were compressed into the base bedrock as a result of compressive stress of the glacial loading giving the appearance of laid-out flooring tiles (his figure 5). We however think that these blocks of slabs are nothing more than karstic decomposition of the surface. In fact the karstification of carbonate rocks may result in a variety of large- and small-scale features both on and under the surface. It should also noted that glacio-karst is one of the best-developed characteristics of the Taurus Mountains (e.g., Bayrakdar, 2012; Sarıkaya et al., 2014, 2017; Çiner et al., 1999, 2015) but at much higher altitudes.

3.3. Ice-margin channels

Similarly, we also interpret the co-called ice-margin channels (his figure 6) as the product of differential erosion of carbonate rich rocks. These large-scale features are also known as limestone pavements.

3.4. Grooves on base rocks, and block formation

All grooves presented in the paper (his figure 7) are in fact small-scale karstic features and are called flutes or karrens. They form when slightly acidic surface waters flow on the cracks or bedding planes of exposed carbonate bedrock. Through time these fractures will become wider and eventually a preferential drainage system will develop giving rise to the development of these karstic features.

3.5. Blocks

The presence of various sized blocks (5 to 15 cm in diameter) is attributed by the author to differential stress generated by the action of an ice sheet. Additionally, these blocks (his figure 8) are presented as the "*most convincing evidence of glaciation in the study area*". Figure 8 actually shows different sized boulders from Söbü Hill related to hill slope processes. This situation is very clear especially in his figure 8B where the slope is obvious.

3.6. Stirae

Few millimetres deep small grooves and scratches on the bedrock surface presented in figure 9 of the paper are correctly interpreted as karrens by the author himself. However "*white long scratches with distinct start-stop locations*" presented in the same figure are attributed to the erosion of "*in-ice debris during repeated ice movements*". As these white long scratches are parallel to karrens but did not carve into the bedrock, it is possible that they represent the initial stages of karren developments. A 600 m thick ice-sheet, as proposed by the author, would not produce such small-scale features anyway.

3.7. Rocks chips and glacial till

Rock chips (5 cm and less in size) in the central plain (his figure 10), as presented by the author, are interpreted to result from frost weathering but carried and deposited by glacial melting. We think that these rock chips are nothing more than part of the sedimentary continuum where blocks (5 to 15 cm in diameter) occupy foothills and smaller pebbles are found in flatter areas.

The author also presents a picture (his figure 11), where he shows the heterogeneous mixture of sub-rounded and sub-angular limestone clasts and soil found at the toe of Söbü Hill. He attributed these features to a glacial till originated from this flat-topped mountain (Söbü Hill) where there is no cirques present. We think that the mixture of soil and rock fragments has nothing to do with a glacial till and simply represents a soil layer including some blocks. Actually typical tills developed on the Taurus Mountains are often observed within well-defined moraines. These glacial tills mostly lack soil horizons, as the surface runoff is practically inexistent, because of the well-developed karst that facilitates underground water flow. We present here a picture from nearby Mount Akdağ (Sarıkaya et al., 2014) for comparison purposes (Fig. 2).

Figure 2. A lateral moraine ridge from Mount Akdağ. The glacial till made up of unsorted and unstratified limestone blocks and finer grained matrix is typical along the Taurus Mountain Range.

4. DISCUSSION

In the discussion section the author reviews his data and concludes that all the claimed features are the product of an ice sheet at least 600 m thick. To reach such a conclusion, he uses the highest elevation (1500 m) of Söbü Hill and subtracts from the lowest point (900 m) of the Isparta Plain. We think that all these interpretations are immature and not based on solid data and prefer not to comment any further on the repeating inconsistencies contained in this section.

On the other hand, we would rather prefer to explain to the interested readers the current situation concerning the Late Quaternary glaciations in the Taurus Mountain Range. As mentioned in a recent synthesis concerning the glaciations in the Mediterranean mountains, Hughes & Westwood (2017) stated that "*the glacial geomorphology of the mountains of Turkey is one the best-dated records of its kind in the world*". Indeed the last 10 years has witnessed several major publications containing terrestrial cosmogenic nuclide (TCN) surface exposure ages from moraines in Turkey (see Sarıkaya et al., 2011; Sarıkaya & Çiner, 2015 and references therein). While carbonate rocks of the Taurus Mountain Range are ^{36}Cl TCN dated, quartz-bearing lithologies of the northern part of the country are mostly ^{10}Be and ^{26}Al TCN dated (e.g., Akçar et al., 2007, 2008, 2014, 2017; Dede et al., 2017; Reber et al., 2014).

The results indicate a synchronous development of Last Glacial Maximum (LGM: ~20.000 years ago) in the Taurus Mountains and in Turkey in general (Sarıkaya et al., 2009; Sarıkaya & Çiner, 2011, 2015). Several other glacial periods such as Late-glacial and Younger Drays were also reported (e.g., Sarıkaya et al., 2014; Çiner et al., 2015) but in the case of the Taurus Mountains at the peak of glaciation, during LGM, glacial deposits represented by different types of moraines are found between ~1800 to 2000 m a.s.l., depending on the aspect of glaciers.

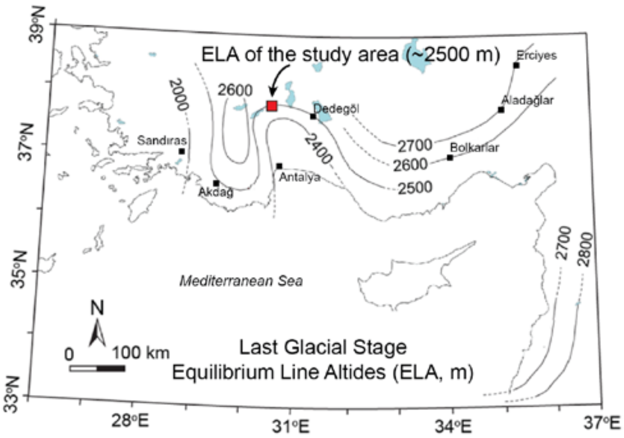

Figure 3. The last glacial stage Equilibrium Line Altitudes (ELA) of the Eastern Mediterranean (from Sarıkaya & Ciner, 2015).

Furthermore, the Equilibrium Line Altitude (ELA) of a paleo-glacier is the key factor describing the presence of a glacier. ELA represents the boundary between the accumulation and ablation area of a glacier on which the mass balance is equal to zero. In other words, below this limit there could be no accumulation of ice/snow. During the LGM, the ELA was around 2500 m in the study area (Fig. 3) (Messerli, 1967; Erinç, 1952, 1977; Hughes et al., 2006; Sarıkaya & Çiner 2015). Today the ELA is much higher (~3500 m a.s.l.), which explains the absence of glaciers even in high peaks such as Mount Davraz (2637 m a.s.l). Considering that the highest altitude is only 1500 m in the study area, it is evident that a glacial development is out of question during the Late Quaternary. Therefore, we believe that this information alone is sufficient to discredit all glacial hypotheses put forward by Ateş (2016).

5. CONCLUSION

As a concluding remark we believe that any scientific work should be based on sound field observations and also fulfil the basic principles of physics. Failing to do so will result in imaginary glaciers that never existed. In a country where glacial deposits are considered to be one of the best studied and TCN dated in the world (see Hughes and Woodward, 2017), this is obviously undesirable.

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