GLACIAL FEATURES AND SNOW-LINE TREND DURING THE LAST GLACIAL AGE ON ALBANIAN AND GREEK MOUNTAINS

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ABSTRACT

In the region stretching from Albania as far as Crete, many traces of glacial modelling are preserved on reliefs higher than 2,200 m. These traces, like glacial cirques and morainic deposits, are all attributable to the last glacial age (Würm). The position of frontal moraines allows snow-line altitude (ELA) to be reconstructed.

ELA reached about 1,400 m a.s.l. on the northern side of the examined area, and was characterized by a regular increase from North to South. This increase was of about 100 m per degree of latitude from Albania to Crete.

INTRODUCTION

Knowledge of Würmian and Late-Glacial activity in the regions stretching from Albania to the island of Crete (Greece) allows the general Equilibrium Line Altitude (ELA) trend to be reconstructed. The area involved has a width of 6° in latitude (from about 36° N to about 42° N).

In this region glacial traces characterize only reliefs higher than 2,200 m. There we have used data either personally gathered or from bibliographic sources about the following mountains: Jezerce $(2,693\ m)$, Radohimës $(2,570\ m)$, Kunora e Lurës $(2,121\ m)$, Smolika $(2,637\ m)$, Timfi $(2,480\ m)$, Parnaso $(2,457\ m)$, Aroania $(2,340\ m)$, Taigheto $(2,404\ m)$, Leuka $(2,452\ m)$ and Idi $(2,456\ m)$.

ELA has been calculated by means of Kurowski's method, i.e. making the average between the maximum height of collector basin and the minimum height of each frontal moraine. This method, though not completely precise, is nevertheless the only one applicable without excessive subjectivity. Otherwise, no comparison of the ELA would be possible.

GLACIAL TRACES AND ELA FROM ALBANIA TO CRETE ISLAND

In the region from Albania to Crete (Greece), the northernmost data concern the Albanian Alps. Here, in the Scutari district, at about $42,30^{\circ}$ latitude N, several cirques and morainic arcs have been recognized (Castiglioni, 1949). The most important of these are preserved in the "Përroi i That" basin which originates from Mt. Radohimës (2,570 m). Moraines were found down to 500 m of altitude, and allow the maximum Würmian expansion ELA to be calculated at about 1,400 m. Successive stages during glacial retreat indicate an ELA at about 1,600/1,700 m and finally at about 1,800 m.

At the same latitude, from M.t Jezerce (2,693 m) showing wide glacial cirques, originates Valbona Valley where large morainic deposits are well

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preserved (Castiglioni, 1949). The lowest moraines are located at about 350 m of altitude (morainic arcs of Selimaj). In Valbona valley, ELA can be estimated, first at about 1,400/1,500m and then, during the glacial retreat, at 1,650, 1,800 and 2,100 m respectively.

Between 42° and 41° latitude N, the situation during the last glacial period is well shown on Mount Kunora e Lurës (2,121 m). On the slopes of this mount, several researchers (Nowack, 1929; Sestini, 1941; Castiglioni, 1949; etc.) recognized glacial cirques and morainic deposits. These allow ELA to be estimated lower than 1,800 m, probably about 1,650 m, during maximum Würmian expansion. One successive retreat stage is witnessed at about 1,900 m.

From 41° to 40° latitude N, Smolika Massif (2,637 m), in Northern Greece, has been recently studied (Boenzi and Alii, 1992). It shows large glacial cirques and, between 900 and 2380 m of altitude, well preserved morainic deposits (fig. 1). The latter allow the ELA to be calculated at about 1750 m during maximum Würm expansion, and at about 1,800, 1,870, 2,100, 2,350 and 2,450 m during following retreat stages.

From 40° to 39° N, near Smolika, is located Mt.Timfi (2,480 m). On this mount many glacial circues and morainic deposits are well preserved (fig. 2). There, ELA, lowered at about 1,700 m of altitude, rose afterward at 1,800, 1,900, 2,000 and 2,200 m a.s.l. (Palmentola and Alii, 1992).

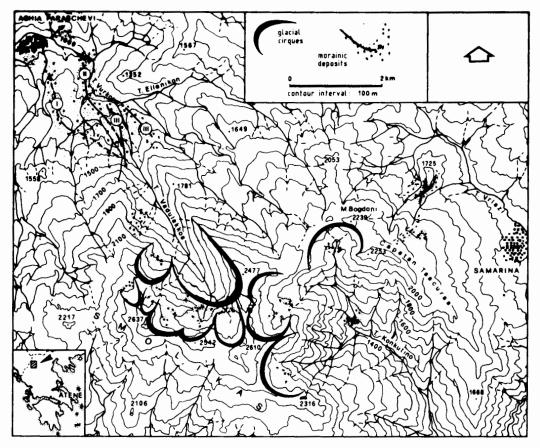


Fig.1: Geomorphological sketch of the Smolika Massif. I, II and III indicate the succession of the moraines of Aghia Paraschevì.



Fig.2: Geographical position of the glacial landforms on the Timfi Massif.

Between 39° and 38° N, Mt. Parnaso (2,457 m), which has been recently reviewed, is bordered by precipitous 900 m high slopes. For this reason it has not retained traces referable to maximum expansion, and perhaps neither to those of the first successive stage. Here, lateral moraines have been recognized (Palmentola and Alii, in press) as far as the precipice brink, at about 1,300 m of altitude; morainic arcs are located between 1,500 and 2,140 m a.s.l.. Therefore, ELA, moved as low as 1,800 m during maximum expansion, then retreated, subsequently at about 1,900/1,950 m, 2,100 m and 2,250 m.

From 38° and 37° N, only Mt. Aroania (2,340 m), in Northern Peloponnisos, shows glacial remains (fig. 3). Small cirques and morainic

arcs are recognizable between 1,680~m of altitude and the top. The position of moraines allows the ELA to be calculated lowered at about 2,000~m and then retreated at about 2,200~m, and maybe even at 2,270~m (Mastronuzzi and Alii, in press).

Between 37° and 36° N, glacial remains are preserved only on Mt. Taigheto (2,404), Southern Peloponnisos (fig. 3). Here, on the easthern slope, lowest glacial traces are represented by "moutonnées" surfaces at about 1,740 m of altitude, and by a little morainic arc located at about 1,840 m. Other moraines are present at an altitude of about 1,550 m, at the foot of the steep northern slope of Sidirokastro peak (2,346 m). It has been calculated (Mastronuzzi and Alii, in press) that ELA lowered at about 1,950 m during maximum expansion, and retreated at 2,100 m of altitude during a following stage.

Between 36° and 35° N are located the imposing mountains of the island of Crete: Leuka Mountains (2,452 m) and Mt. Idi (2,456 m). On the first, Poser (1957), Bonnefont (1971) and Boenzi & Palmentola (1982) did not note any glacial shape. On nearby Mt. Idi, Fabre & Maire (1983) recognized a little cirque and a little morainic arc at an altitude of 1,945 m. This altitude indicates that ELA was located at about 2,200 m. The Authors referred these shapes to the Late-Würm, justifying their opinion with recent uplift of the island (see, for the uplift, Angelier, 1979). But this attribution is not coherent with the situation of the Eastern Mediterranean region, which would induce us to relate the moraines to the Würm maximum expansion.

In conclusion, the estimated ELA on mountains from Albania to Crete during Würm maximum and successive Late- Glacial stages are shown in the following Table 1.

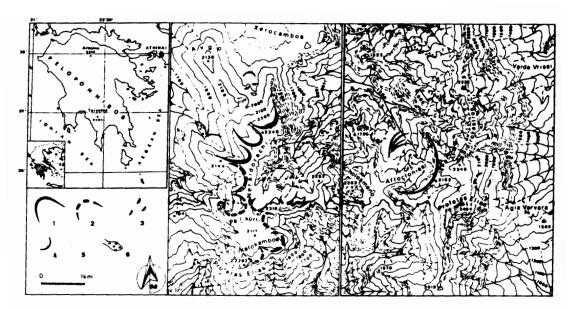


Fig.3: Location of glacial landforms on the Mt. Aroania and on Mt. Taigheto.
1. Cirque; 2. Cirque-like form; 3. Roches moutonnés; 4.Moraine arcshaped; 5. Shapeless morainic deposit; 6.Debris-flow tongue.

Table 1

	Latitude		Altitude meters a.s.l				
		Würm maximum	Late	1			
Jezerce	42°28'	1500	1650	1800	2100	-	-
Përroi i That valley	42°25'	1400/1500	1600/1700	1800	-	-	-
Kunora e Lurës	41°47'	1650	?	1900	-		-
Smolika	40°06'	1750	1800	1870	2100	2350	2450
Timfi	39°58'	1700	1800	1900	2000	2200	-
Parnaso	38°32'	<1800?	1900	2100	2250	-	-
Aroania	37°59'	2000?	2200	-	-	_	_
Taigheto	36°56'	1950	2100	-	1	-	-
Leuka	35°20'	-	-	-	-	_	-
Idi	35°18'	2200?	-	-	-	-	-

DISCUSSION

Despite some differences due to erosion, to exposure of slopes, and to different sources of data, some features can be summarized about the region from Albania to Crete:

- On the whole, the region shows evidences of six stages of Würmian age. The first related to maximum glacial espansion; the rest, to successive Late-Glacial retreat. On the contrary traces of former glacial periods have still not been recognized. On this subject, new fresh outcroppings of the clastic deposit of Vournassa, that Brunn (1956) recognized near the village of Tourniki in Macedonia and referred to a Rissian morainic deposit, allow us to relate it with landslide deposit.

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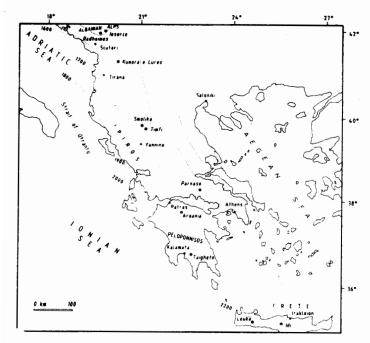


Fig.4: The geographical position of the examined mountains; dotted lines approximate trend and values of ELA during glacial maximum expansion.

ELA lowered at about 1,400 m a.s.1. on the northern side of the area, and at 2,200 m on the southern one (fig. 4).

- During Würm maximum espansion, ELA shows a regular increasing from North to South of about 100 m per degree of latitude; complexively, about 800 m in 7°10' of latitude. This value does not change even when excluding the uncertain situation of M.t Idi, Crete: in this case, infact Albania from tο Peloponnisos, ELA increases of about 500 m in 5°32' of latitude.
- During first successive retreat stage, ELA trend does not change sensibly.
- Trend of ELA became most irregular during

successive stages: in fact, glaciers survived only on the highest mountains, where orographic conditions were particularly favourable.

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