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GLACIERS

GLACIERS and ice fields in Persia. Due to Persia's location in the very center of the arid dry belt, stretching from North Africa in the west to Central Asia in the east, and also due to its very specific topography, glaciers and/or permanent ice fields are restricted and concentrated in a very few locations. The admittedly hypothetical reconstruction of the recent snow line for Persia (Figure 1) reveals an average height of approximately 4000 m in northern Persia and about 5000 m in the southwest of the country. Mountains and mountain ranges, however, reach more than 4000 m in only a very few places.

The combination of snow line and topography explains why glaciers and ice fields are very rare in Persia; they are found mainly in the Zagros and Alborz ranges. Small and isolated occurrences have been described for the volcanoes in northwestern Persia.

Glaciers in general may be defined as masses of ice which, in an ideal case, move slowly down a slope from above the fictitious snow line under the force of gravity. They owe their existence to the snowfall which is pressurized into granular ice or, under conditions of continued pressure over long times and great depth of the layers, into clear ice. From the originating snow fields glaciers may extend well below the snow line forming those typical tongue-shaped forms that are so characteristic of many high mountain areas of the

world.

The combination of Persia's present day hypothetical snow line and the country's topography is the cause of the very specific forms of glaciers, ice fields, and related glaciological phenomena. Their overall characteristics can be summarized as follows: (1) regional concentration in a very few locations; (2) very limited spatial extents and consequently only rudimentary forms; and (3) an intricate combination with other glacial and periglacial phenomena. On the whole, there are three areas of glacier occurrence in Persia: the Alborz, the volcanoes of northwest Persia, and the Zagros ranges.

Glaciers and ice fields in the Alborz. Topography and climate in the Alborz are the decisive factors for only a very limited number of glaciers and ice fields. According to Hans Bobek (1937, 1953, 1957), the only remarkable existence of a glacier is to be found near the ʿAlam Kuh (4,840 m) in the Taḵt-e Solaymān massif in the central Alborz. Bobek (1957, p. 243) mentions a glacier tongue of approximately 4 km in length as well as eight to ten small ice fields, most of them in the form of small cirque glaciers. Furthermore, there seems to be a small glacier north of Hazārčam Pass near Laškarak. On the basis of these observations, Bobek suggests the height of the recent snow line to be approximately 4000 m, with a depression of about 700 m during the last ice age and a correspondingly larger net of glaciers, originating in the Taḵt-e Solaymān massif.

In spite of its much greater height, Mount Damāvand (5,678 m, q.v.) has no glaciers, although more or less permanent ice fields have been described. This is especially true for the summit crater of the isolated volcano, where permanent snow and ice fields have developed, under the influence of high radiation and evaporation, into "*nieve ve los penitentes*," a specific forms of snow ablation (Schweizer, 1969). Otherwise, Pierre Bout et al. are right in their statement that " the existence of real ice field seems to be possible only at one of the barrancos..." (p. 77).

Glaciers and ice fields in northwest Persia. In contrast to the exposed mountain ranges of the Alborz, the mountain masses of northwestern Persia, especially in the province of Azarbaijan, are characterized by more pronounced occurrences of glaciers and snow fields. This is especially true for the massif of the Kuh-e Sabalān (4,740 m), where Gunter Schweizer (1970, p. 168) has identified and documented altogether seven glaciers with a maximal length between 400 and 900 m and maximal width between 150 and 650 m. Most of these glaciated areas are, like those of the Taḵt-e Solaymān group, in a northerly exposition. Originating in heights between 4,250 m and 4,700 m, the lowest occurrence of blank ice is 3,980 m. This means that the (hypothetical) snow line is at an elevation of around 4,200 m. The question remains whether these occurrences should be termed "glaciers" or it would be more appropriate to call them ice fields. This, however, is an academic question. The fact is that glaciation in northwestern Persia during the Pleistocene period reached a much larger extent than at present. Schweizer (1972) suggests a Quaternary snow line depression of more than 800 m.

Glaciers and ice fields in the Zagros. Due to the overall northeast-southwest direction of the mountain ranges and their exposition to westerly air masses with winter rain, precipitation is comparatively high in the Zagros. It is therefore not surprising that high winter snowfall accumulates to form snow fields and ice fields, some of which still develop into glacier-like structures in the highest sections of the mountain range, especially in the Zarda/Zard Kuh area of the central Zagros, although the main peak (4,221 m) is considerably lower than the highest reaches of the Alborz and the mountains in the northwest.

The number and extent of recent glaciations are rather limited. Christoph Preu (pp. 268-69) summarized that there are several small cirque glaciers in a northeast position at the Kuh-e Čalang, with a maximum glacier thickness of approximately 8 m. In other sections of the Zarda Kuh main peak, Preu (p. 269) mentions cirque glaciers "in the valley heads of the drainage systems of the Ab-e-Sefid and the Ab-e-Zardeh Kuh." In addition, he reports several perennial firn patches and what he calls snow glaciers. In line with earlier observations, the snow line in the Zagros is determined by Preu (p. 271) "at a height of 4,100 m to 4,200 m above mean sea-level, i.e. going to the limit of the height of the

Zardeh Kuh-massif." The development of small patches of glaciers and ice fields, therefore, can be understood only as a combination of a great number of extremely favorable conditions.

In all the areas discussed, there are a number of other periglacial phenomena that are closely connected with glaciers and ice fields and constitute part of the present and past glaciological history of the country. They include penitentes, rock-glaciers, solifluction, and glacial slope formation. In spite of the overall limited extent of these phenomena, glaciers and ice fields are at least regionally of some importance: They are the reservoirs of potentially available water resources for local mountain people and for nomads and their flocks. In some rare cases ice and snow is collected, stored and/or sold in the valley settlements (Planhol, esp. pp. 82-92, 305-7). Glaciers and ice fields are also the sources of quite a few rivers which have their origins in the upper reaches of the mountains described and provide water to settlements and rural economies downstream.

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