

PLEISTOCENE MOUNTAIN GLACIATION IN ETHIOPIA

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ABSTRACT. During a field survey in High Semyen, northern Ethiopia, two moraine complexes were mapped, the lower one extending down to around 3 750 m. Glacial morphology is best developed in the north-western and western quadrants. Moraines are deeply weathered and carry abundant vegetation. For Mounts Badda, Cilalo, Cacca and Enguolo in southern Ethiopia, possible moraines are inferred from air photographs; there are indications for more pronounced glaciation in the western quadrant, and moraines seem to extend further down than in High Semyen. Highest moraines at Mount Elgon in northern Kenya/Uganda were found to be below 3 600 m. Major moraine complexes in the mountains of Ethiopia and East Africa suggest some spatial correlation in elevation and appearance, but absolute dates are absent.

RÉSUMÉ. *Glaciation pleistocène en montagne en Ethiopie.* Au cours d'une expédition dans le Haut Semyen, dans le Nord de l'Ethiopie, on a cartographié deux complexes morainiques, le plus bas descendant presque jusque vers 3 750 m d'altitude. La morphologie glaciaire est surtout développée dans les quadrants Nord-Ouest et Ouest. Les moraines sont profondément érodées et supportent une abondante végétation. Pour les monts Badda, Cilalo, Cacca et Enguolo, dans le Sud de l'Ethiopie, on déduit la possibilité de moraines à partir de photographies aériennes; il y a des indices pour une glaciation plus prolongée dans le quadrant Ouest, les moraines semblent descendre plus bas que dans le Haut Semyen. Les moraines les plus basses au Mont Elgon dans le Nord du Kenya/Ouganda ont été trouvées jusqu'en dessous de 3 600 m. Les principaux complexes dans les montagnes d'Ethiopie et de l'Est Africain suggèrent une certaine corrélation spatiale entre l'altitude et leur apparition, mais on manque de datations absolues.

ZUSAMMENFASSUNG. *Pleistozäne Gebirgsvergletscherung in Äthiopien.* Während einer Forschungsreise in Hoch-Semyen, Nord-Äthiopien, wurden zwei Moränenkomplexe kartiert, deren tieferer sich bis auf etwa 3 750 m herab erstreckt. Glaziale Formen sind am besten in den nördlichen und westlichen Quadranten entwickelt. Die Moränen sind stark verwittert und tragen üppige Vegetation. Aus Luftbildern lassen sich mögliche Moränen an den Bergen Badda, Cilalo, Cacca und Enguolo in Süd-Äthiopien feststellen: sie weisen auf eine ausgeprägtere Vergletscherung im westlichen Quadranten hin; die Moränen scheinen tiefer herabzureichen als in Hoch-Semyen. Die tiefsten Moränen am Mt. Elgon in Nord-Kenia und -Uganda wurden unterhalb von 3 600 m gefunden. Größere Moränenkomplexe in den Gebirgen von Äthiopien und Ostafrika lassen eine gewisse räumliche Korrelation in der Höhenlage und im Erscheinungsbild erkennen, doch fehlen absolute Daten.

INTRODUCTION

The fossil glacial morphology of Ethiopia has received renewed attention in a recent issue of the *Journal of Glaciology* (Potter, 1976). Evidence of former glaciation is of interest in paleoclimatic reconstructions especially in spatial context with the high mountains of East Africa, where interpretation is facilitated by the continuity with the present glaciers. Field work in the Ethiopian mountains is further hampered by limitations in air photographic coverage and topographic maps. Yet, the present knowledge of Pleistocene mountain glaciation in Ethiopia is somewhat less incomplete than may appear from Potter's note. Foremost targets for the field inventory of glacial landforms are mountains around and above 4 000 m (Fig. 1). Some of these will be discussed in the following.

HIGH SEMYEN

The highest mountain area of Ethiopia was chosen for a field survey during December 1973, since optimal development of Pleistocene glacial morphology was expected here, and because a topographic map at scale 1 : 50 000 (Werdecker, 1968) is available in addition to excellent air photography. Glacial morphology was mapped for the area of Ras Dashan and the two next highest mountain massifs of High Semyen. For the results of this field study and a detailed bibliography of earlier work, reference is made to Hastenrath (1974). A brief summary will suffice here.

Multiple moraine complexes and cirques are embedded in valleys in the northerly and westerly quadrants of Ras Dashan, Buahit and Silki-Abba Yared. Moraines are deeply

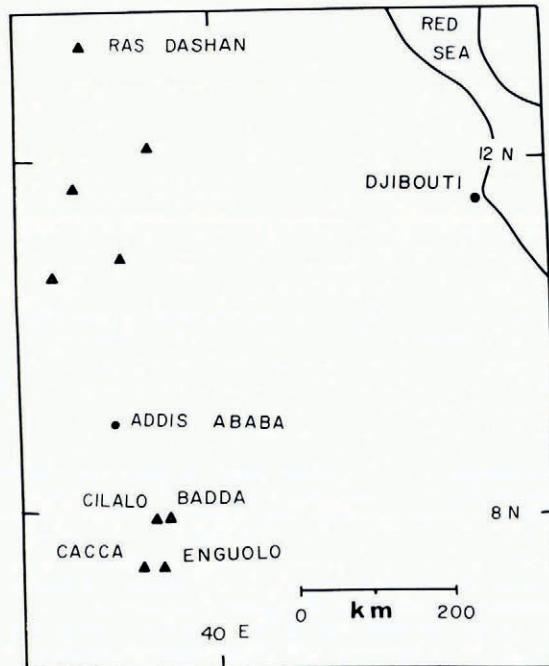


Fig. 1. Orientation map. Mountains near and above 4 000 m are shown by triangles.

weathered and carry abundant vegetation. Cirque bottoms lie around 4 200–4 300 m. Multiple smaller moraines are found in the upper parts of valleys around 4 100–4 200 m. Ends of a lower moraine complex reach down to below 4 000 m, and in the massif of Silki-Abba Yared even to about 3 750 m. From the adjacent area on the west side of Silki and Baroj Wuha, which I did not visit, Minucci (1938) likewise reported moraines down to 3 800 m. This contrasts with a lowest moraine limit of 4 100 m for High Semyen stated by Potter (1976).

MOUNTS BADDA AND CILALO

Nilsson (1940) studied this area, although he apparently confused Badda with Cacca. Potter (1976) visited the south-western quadrant of Badda and inferred glacial morphology in other parts of the mountain from air photographs. He described evidence for the strongest glaciation on the west side of Badda, with terminal moraines reaching down to 3 650 m. In context it must be noted, however, that he gave an elevation of 4 350 m for the peak of Badda, a figure more than 200 m higher than that appearing on available maps.* At any rate, Nilsson (1940) reported moraines on the west side of Badda reaching down to nearly 3 300 m.

Figure 2 is a sketch of possible moraine features of Mounts Badda and Cilalo as interpreted from air photography. Air photographs are a powerful tool in but no substitute for field observations. Therefore, some of the features identified on the sketch maps in Figures 2–4 are on ground verification likely to be found of non-glacial origin. In order to avoid complication, no distinction has been made in Figures 2–4 between the more safely recognizable and the more dubious features.

* Pneu Michelin, 1973; U.S. Army. Corps of Engineers, 1962.

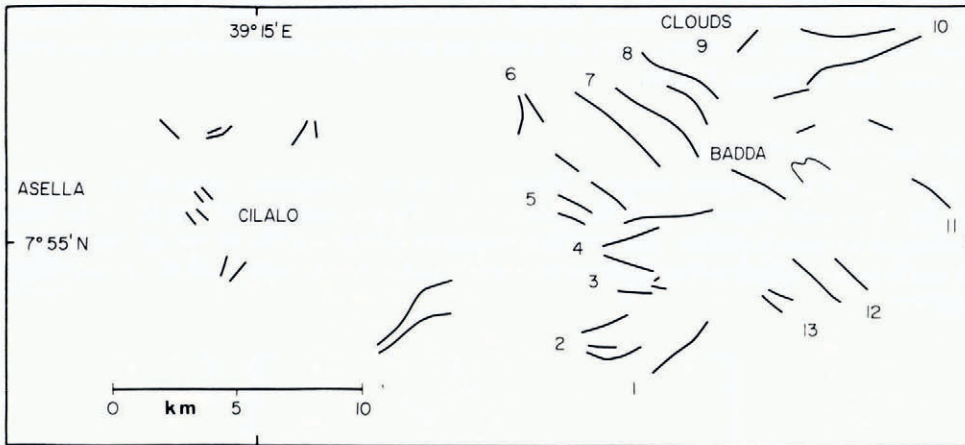


Fig. 2. Sketch map of Mounts Badda and Cilalo. Possible moraines as interpreted from air photographs are shown as bold lines.

Valleys 1-4 of Mount Badda in Potter's (1976) sketch map are entered for comparison at the presumed locations; the remaining valleys in his sketch are numbered 5-13 in a clockwise sense. However, there is a considerable tolerance margin in the correlation of valleys; the general area where valley 9 of Potter's sketch presumably lies is obstructed by clouds in the air photographs.

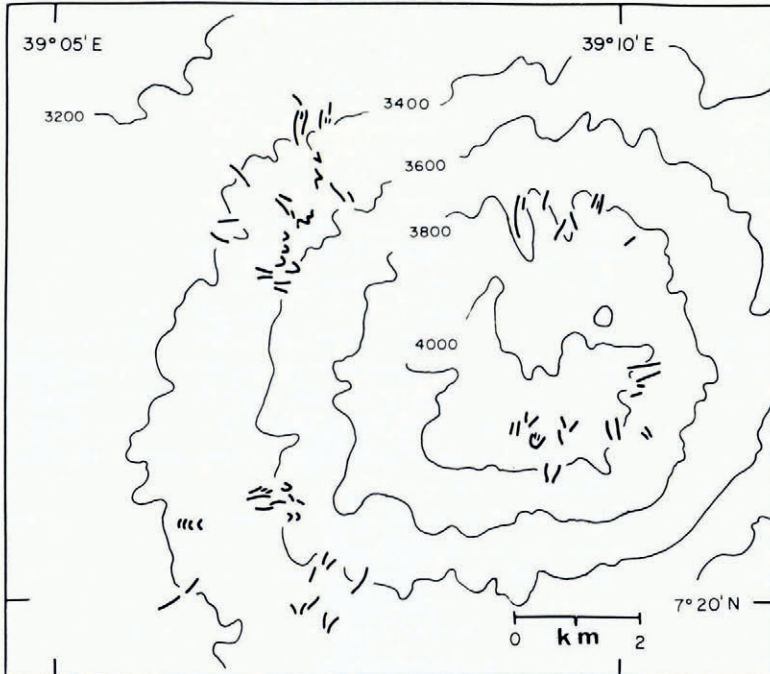


Fig. 3. Sketch map of Mount Caeca. Possible moraines as interpreted from air photographs are shown as bold lines; approximate contours (in m) are shown as thin lines.

Consistent with Potter's (1976) suggestion, the more pronounced glacial morphology appears on the western flank of Mount Badda, whereas the north versus south sides display no pronounced contrasts. Similarly, there are some features of possible glacial origin, particularly on the west side of Mount Cilalo.

MOUNTS CACCA AND ENGUOLO

Figures 3 and 4 are sketch maps of Mounts Cacca and Enguolo, respectively. At Mount Cacca, the west side seems to have been more strongly glaciated, with moraine-like features descending to around 3 400 m; and possible moraines extend further down on the north than on the south side. Moraine-like features around 3 200 m on the east flank of Mount Enguolo are dubious.

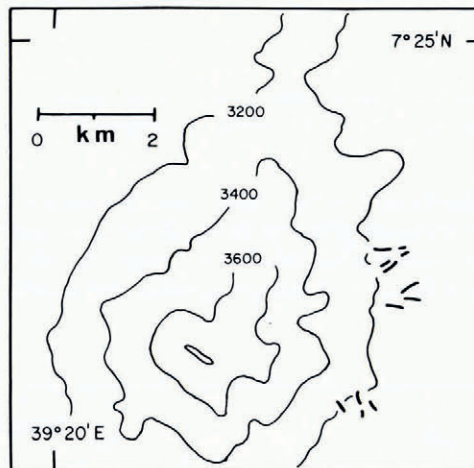


Fig. 4. Sketch map of Mount Enguolo. Symbols as in Figure 3.

CONCLUSIONS

Since drastic climatic events must have affected all of eastern Africa on a large scale, evidence of former glaciations in Ethiopia should be viewed in perspective with the better-explored glacial history of East Africa. For the lower moraine complex in the peak areas of High Semyen, a correspondence with Baker's (1967) "Younger Maxima I A-D" at Mount Kenya and Humphries' (1972) "Fourth (Main) Glaciation" at Kilimanjaro has been suggested (Hastenrath, 1974) from elevation and general appearance; and the higher complex of Semyen moraines has been tentatively correlated with Baker's (1967) "Stages II-IV" and Humphries' (1972) "Little Glaciation". Interpretation of the highest Semyen moraines as features of the nineteenth century has been ruled out, a conclusion also shared by Potter (1976) for the moraines of Mount Badda.

The moraines on the mountains of southern Ethiopia seem from their appearance (Potter, 1976) and elevation comparable to those of High Semyen, although the termini are apparently somewhat lower. By way of spatial comparison, it should be pointed out that I have found moraines at Mount Elgon, northern Kenya/Uganda, a mountain of comparable elevation, down to below 3 600 m. Thus, the lowest moraine limits identified for Mounts Badda, Cilalo, Cacca and Enguolo appear broadly consistent with those in mountain areas adjacent to the north and south, respectively. The indication of possibly somewhat lower-reaching moraines on the mountains of southern Ethiopia is noteworthy. Claims for an older glaciation

extending to well below 3 000 m have been advanced for both northern Ethiopia and East Africa (review in Hastenrath (1974)), and merit further attention in the field. Absolute dating as a basis for spatial correlation of major moraine complexes remains an important task in the reconstruction of the Pleistocene and early Holocene glacial history in eastern Africa.

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REFERENCES

- Baker, B. H. 1967. Geology of the Mount Kenya area. *Kenya. Geological Survey. Report No. 79.*
- Hastenrath, S. 1974. Glaziale und periglaziale Formbildung in Hoch-Semyen, Nord-Äthiopien. *Erdkunde*, Bd. 28, Ht. 3, p. 176-86.
- Humphries, D. W. 1972. Glaciology and glacial history. (In Downie, C., and Wilkinson, P., ed. *The geology of Kilimanjaro*. Sheffield, Geology Department, University of Sheffield, p. 31-71.)
- Minucci, E. 1938. Ricerche geologiche nella regione del Tana. (In *Missione di studio al Lago Tana*. Vol. 1. Roma, Reale Accademia d'Italia, p. 37-46. (Reale Accademia d'Italia. Centro Studi per l'Africa Orientale Italiana, 2.))
- Nilsson, E. 1940. Ancient changes of climate in British East Africa and Abyssinia. *Geografiska Annaler*, Årg. 22, Ht. 1, p. 1-79.
- Pneu Michelin. 1973. *Michelin carte A 1/4 000 000*. 154. Afrique nord-est. Paris, Pneu Michelin.
- Potter, E. C. 1976. Pleistocene glaciation in Ethiopia: new evidence. *Journal of Glaciology*, Vol. 17, No. 75, p. 148-50.
- U.S. Army. Corps of Engineers. Army Map Service. 1962. *Dalle, scale 1: 500,000*. (East Africa, Zone H, Sheet NB 37/2, Series Y401, edition 5-GSGS. Reproduced by War Office. Reprinted from fifth edition EAT No. 1738, 1946.)
- Werdecker, J. 1968. Das Hochgebirgsland von Semyen. *Erdkunde*, Bd. 22, Ht. 1, p. 33-39.