

GLACIOMORPHIC LAND FORMS IN PARTS OF SCHIRMACHER OASIS, CENTRAL DRONNING MAUD LAND, EAST ANTARCTICA

M.P.Gaur, Amit Dharwadkar and R.Asthana
Antarctica Division, Geological Survey of India,
NH-5P, N.I.T., Faridabad -121 001

ABSTRACT

A part of Schirmacher Oasis was studied during XVIII Indian Antarctic Expedition and various landforms documented in the area are briefly described in this paper. The prominent features comprise the differential relief, broad 'U' shaped deglaciated valleys, moraines, development of pattern ground and lakes. Levels of glaciations have been inferred and the features associated with deglaciation have also been described. Evidences of palaeostrand line have been found in the northern periphery of the oasis.

INTRODUCTION

The Schirmacher Oasis located between $70^{\circ} 46' 40''$ and $70^{\circ} 43' 50''$ S latitude and $11^{\circ} 22' 40''$ and $11^{\circ} 54' 25''$ E longitude is an ice-free coastal nunatak within the central Dronning Maud Land region. It is bounded towards South by the continental ice sheet and towards North by shelf ice. It is situated 80 km away from the Antarctic coastline in the India Bay region. The area exposes Precambrian high grade gneisses and early to late basic and acidic intrusives. This region was the subject of geological studies focussed mainly on petrology, structural geology, geochronology etc. The geomorphological studies were initiated in 1985-86 to study the retreat of Antarctic ice sheet during the recent past and the resultant glaciation / deglaciation in the area giving rise to various erosional and depositional landforms. (Srivastava et al. 1986, Ravindra 1999)

During the XVIII Indian Antarctic Expedition, geomorphological studies have been carried out in the central part of Schirmacher Oasis between lat $70^{\circ} 43' 30''$ to $70^{\circ} 43' 30''$ S and longitude $11^{\circ} 25'$ to $11^{\circ} 48'$ E. An attempt has been made to summarise the geomorphological features of an area of 20 sq. km and present them in a map of the area on 1:25000 scale (Fig. 1).

Land forms

The area exhibits low lying, undulating, rugged topography. Periglacial Features are developed on ice-free, rounded hills and deglaciated valleys. Broad 'U' shaped deglaciated valleys, patterned ground and numerous lakes are the most common geomorphic features. The different types of landforms observed in the area are classified as follows:

1. Erosional land forms: i) hills and valleys, ii) cliffs/escarpment, iii) striated surface
2. Depositional Land forms: i) Terraces ii) patterned ground, iii) moraines, iv) erratic, v) lakes vi) palaeo-strand line.

A. Erosional Land forms

Hills & Valleys:

Numerous 'U' shaped valleys criss - cross in the area (Fig. 2). These are in various stages of maturity. The more mature valleys show a broad 'U' shaped form with flat floors occupied by lakes, patterned ground etc. These are generated due to the erosional activity of the glaciers over the bedrock. Smaller, hanging valleys draining into the main valley are frequently observed. Many of the main valleys run towards ENE direction indicating most favoured movement of the glacier. The walls of the mature valleys are steep to vertical. The more resistant rock masses occur as hills and modify the course of the fabric of underlying bed rock which trends ENE - WSW. Most of the hills and ridges trend E - W and have subrounded to flat topped relief. The hills usually exhibit steeper slopes toward northern side (leeward) as compared to southern side.

Cliffs/escarpment

The walls of the valleys occurring in the area stand out as escarpment. The cliff surfaces show glacial polish. Much of the northern periphery of Schirmacher Oasis occurs as a cliff about 50-100m high, and forms a prominent geomorphic feature. This cliff is broken where the glaciated valleys enter in to the shelf.

Striated surface:

The exposed bedrock in Schirmacher Oasis shows glacial polish and striations indicating the direction of the most recent movement of ice over the bed rock (Fig. 3). At places super imposition of two sets of striations can be observed. The striations are smooth towards the direction of movement and rough against. The Trishul top is the oldest surface showing glacial polish and striations indicating movement of glacier towards north.

B. Depositional Landforms.**Terraces:**

These are benches or levels cut in the bedrock during the course of events and are marked by deposition of morainic levels (Fig. 4a, b). Altogether 6 episodes of glacier shrinkage are identified from the highest point (Trishul top 213m) to the shelf marking lowest point in the area. The present vertical exposure of each terrace varies from 1.5m to 3 m comprising frame work supported subangular to sub rounded. Clasts ranging in size from pebble to boulder in variable proportion clast to matrix ratio varies from place to place usually between 80:20 to 65:35. The terrace deposits do not show any internal stratification or preferred orientation of the clasts. The levels representing shrinkage of the Glaciers are shown below.

TG	86-82m
T5	83-85m
T4	103m
T3	108-110m
T2	117-120m above msl
T1	130m above msl

Patterned ground

This is one of the prominent landform of Schirmacher Oasis. It is formed on the flat, low lying floors of valleys and is characterized by polygonal structures. They are usually developed in the supraglacial till covering glacial masses of vanishing ice. These polygons are highly irregular initially (Fig. 5a) but become more and more regular as the land form matures (Fig. 5b, c). The polygons developed on slope are elongated in shape with longer axis parallel to the dip direction of the slope. They are usually unsorted texturally but some polygons show coarse grained clasts in the centre surrounded by finer grain size along the borders. The size of the polygons varies from place to place depending on the level/height of the patterned ground. Patterned grounds are a result of repeated freezing and thawing of valley floors due to permafrost behavior. The lack of textural heterogeneity reflects that convective mechanism has played a important role in their development.

Moraines:

Moraines occur throughout the area reflecting repeated glaciation and deglaciation during the past. Lateral moraines occur along the sides of glacial valleys where as terminal moraines of various glacial episodes are sporadic in occurrence. A very well preserved E-W trending end moraine close to the polar ice margin comprises highly variable admixture of clasts ranging in size from granules to boulder with a small

amount of matrix (Fig. 6). Bigger clasts are usually subrounded to subangular in shape with few well-rounded and polished boulders. This indicates the long transport in glacial environment. The clasts are randomly oriented and do not exhibit bedding etc. However, in case of the terminal moraine present along the southern margin of Schirmacher hills the longer axis of some boulders is parallel to the polar cap front (Fig. 6). Average composition and size distribution of clasts in the moraine is shown in Table 4,

Table -1: Average composition and size distribution of clasts.

SIZE	COMPOSITION
Boulders > 60 %	Gneisses: 80%
Cobbles: 15%	Granite : 10%
Pebbles: 15%	Mafic/basic: 3%
Granule/sand : 20 % (fine matrix)	Others - 7%

Erratics:

Erratics are perched blocks and boulders of foreign rock placed over (usually) smooth and polished bedrock by the retreating glacier (Fig. 7). Erratics of granite, basic and ultrabasic rocks are quite common in the Schirmacher Oasis. Some erratic blocks are of local origin. The subrounded to subangular boulders have traveled long distance while those of local origin are subangular to angular in shape.

Lakes:

The study area is dotted with numerous intermontane fresh water lakes usually occupying the valley floors (Fig. 8). These shallow lakes are variable in shapes and depths. The bottom of the lakes is made up of fine sediments. Fast outlines of the lakes can be marked by the occurrence of such fines along the periphery. The lakes in Schirmacher Oasis freeze during the cold winter and thaw in summer. They are fed by melt water channels originating from the polar ice front. At some places sand pockets can be observed at higher levels than the present level, along the banks of some lake suggesting that the lakes have receded in time.

Palaeostrand line:

The northern periphery of Schirmacher Oasis forms the grounding line for the ice shelf where undulatory pressure ridges are developed due to wave action. A palaeo shore line (strand line) has been demarcated at 25m to 30m above present msl. Deposition of beach sands occur on the terraces and interspaces of boulders usually on the leeward side. Winnowing action of sea waves is represented by distribution of mostly

granular sediments on the surface and better sorted sediments in the lower reaches. The latter sediments are finer grained, clean sand without silt or clay fractions. Preliminary investigations have revealed a significant amount of saltation population and minimal traction load. This suggests a significant reworking or contribution by eolian agents.

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EXPLANATION TO THE FIGURES.

Fig. No .

1. Geomorphological map of central part of Schirmacher Oasis, E. Antarctica.
2. A deglaciated valley. In the far end 'Shivling' is visible.
3. Striations on polished rock surface.,
- 4 a. Depositional Terrace near Maitri Station. Note randomly oriented boulders embedded in fine matrix.
- 4 b. Three different levels of Terrace.
- 5(a,b,c) Development of pattern grounds.
6. Terminal morainic ridge extending more than a kilometer, west of Maitri Station.
7. Erratic boulders and blocks perched on hill crest.
8. A bird's eye view of Lakes in Shirmacher Oasis.

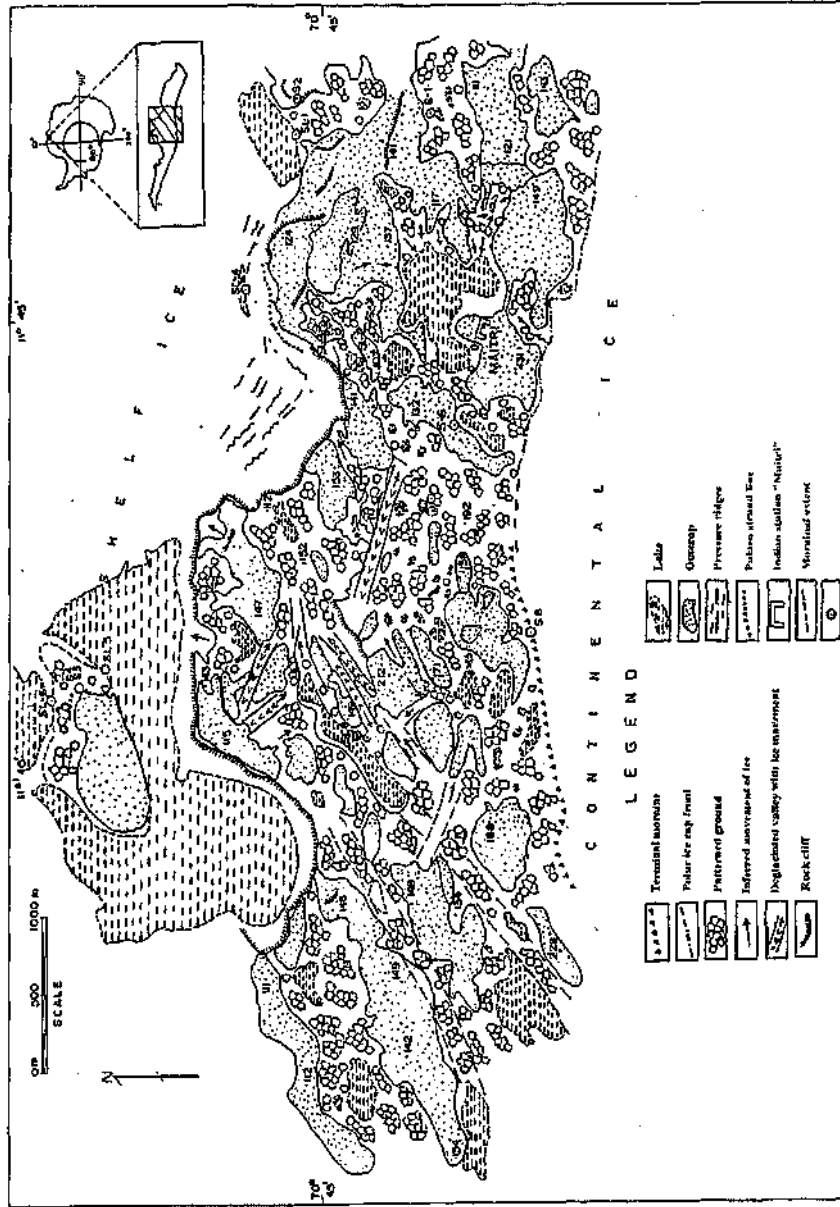


Fig. 1. Geomorphological map of central part of Schirmacher Oasis, E. Antarctica.

Glaciomorphic land forms in parts o f Schirmacher Oasis



Fig. 2



Fig. 3



Fig.4a



Fig. 4b



Fig. 5a





Fig. 5c



Fig. 6

Glaciomorphologic land forms in Parts of Schirmacher Oasis



Fig. 7



Fig.8