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REVIEW OF ANTARCTIC GEOMORPHOLOGICAL MAPPING

ABSTRACT: BARONI C., BRUSCHI G. & LÓPEZ-MARTÍNEZ J., *Review of Antarctic geomorphological mapping.* (IT ISSN 0391-9838, 1997).

271 geomorphological cartographic documents related to the Antarctic territory have been collected and analysed. The figures collected are a review updated to 1996 and have been gruped into various sets on the basis of size, type and amount of data represented, the hierarchy existing between text and cartographic document and of the criteria used by the authors to represent the landforms. Particularly have been distinguished the following sets of documents: geomorphological maps *sensu stricto (s.s.);* geomorphological thematic selected maps; geomorphological sketch maps; geomorphological sketches.

Although many geomorphological works have been carried out in Antarctica, up to now have been published only 10 geomorphological maps *s.s.*. Furthermore, the collected maps are highly discordant because they are conditioned by the geomorphological schools of the authors. The discrepancies found mainly lay in the definition of the legends, due to a different importance given to the activity of the morphogenetic processes, the structural characteristics of the investigated area and to the chronology of the events. The modalities of representation are also clearly conditioned, in the case of the geomorphological sketches and of the geomorphological sketch maps, by the landforms and deposits linked to the morphogenetic processes subject of the research.

In the last years the interests for the production of geomorphological maps of large territories has grown to testimony the important role that the geomorphological carthography has in Antarctica, both as a method of basic research, as a method of representation and analysis of the territory, as a support of other researches, as a base documents integrated in systems of geographical information (Gis). It is therefore necessary a deeper confrontation between the researchers working on the Antarctic geomorphology, for the convenience to utilize comparable if not compatible and integrated legends.

KEY WORDS: Geomorphology, Geomorphological maps, Antarctica.

RIASSUNTO: BARONI C., BRUSCHI G. & LÓPEZ-MARTÍNEZ J., *Repertorio della cartografia geomorfologica antartica.* (IT ISSN 0391-9838, 1997).

Sono stati raccolti ed analizzati 271 documenti cartografici di carattere geomorfologico relativi al territorio antartico. Gli elaborati raccolti costituiscono un repertorio aggiornato al 1996 e sono stati raggruppati in diversi insiemi sulla base delle dimensioni, del tipo e del numero di dati rappresentati, della gerarchia esistente tra testo ed elaborato cartografico e del criterio utilizzato dagli autori per rappresentare le forme del rilievo. In particolare sono stati distinti i seguenti insiemi di documenti: carte geomorfologiche *sensu stricto (s.s.);* carte geomorfologiche di tematismi selezionati; carte geomorfologiche schematiche; schizzi geomorfologici.

Nonostante i numerosi lavori geomorfologici esistenti, sono state fino ad ora pubblicate solo 10 carte geomorfologiche *s.s.* Inoltre, gli elaborati raccolti sono fortemente discordanti tra loro in quanto condizionati dalle scuole di provenienza dei ricercatori che li hanno prodotti. Le discrepanze emerse risiedono principalmente nella diversa impostazione delle legende, effetto di una diversa importanza attribuita allo stato di attività dei vari processi morfogenetici, alle caratteristiche strutturali delle aree investigate e alla cronologia degli eventi. Le modalità di rappresentazione sono anche nettamente condizionate, nel caso degli schizzi geomorfologici e delle carte schematiche, dalla prevalenza di forme e depositi legati ai processi morfogenetici oggetto di studio.

In questi ultimi anni sono nettamente aumentate le iniziative per la produzione di carte geomorfologiche di vasti territori, a testimonianza dell'importante ruolo che la cartografia geomorfologica ricopre in Antartide, sia come mezzo di ricerca di base, sia come strumento di rappresentazione e analisi del territorio, sia come supporto di altre ricerche, sia come documenti di base integrati in sistemi complessi di informazione geografica (Gis). Ne consegue la necessità di un maggiore confronto tra i ricercatori che lavorano sulla geomorfologia antartica, data la convenienza generale di utilizzare legende almeno confrontabili tra loro se non addirittura compatibili ed integrate.

TERMINI CHIAVE: Geomorfologia, Cartografia geomorfologica, Antartide.

INTRODUCTION

Antarctica is a privilegiate site for a comparison of systems of geomorphological representation adopted by the authors of various countries. This is due both to the wide distribution of the currently active morphogenetic systems and also to the large number of international scientific expeditions dedicated to the study of the continent. As regards cartography in a broad sense, numerous topographical, bathymetric, geological, geomorphological, glaciological, and geophysical maps have been published so far. If

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the great number of thematic sketch maps accompanying articles are added to this list the material available is huge, consisting of several hundred documents.

The aim of this work is to obtain, for the first time, a list of most of the existing geomorphological cartographic information, so as to illustrate clearly the degree of knowledge in this field. In addition, the objective is to underline the geographical distribution of the maps and draw attention to the geomorphological data spread throughout numerous articles which are not always easily accessible. Large format maps published as separate sheets were examined, and also the main reviews and volumes including works on Antarctic geomorphology. In particular, consideration was taken of all the geomorphological maps produced so far and those papers which, in our opinion, have a particular significance as regards the geomorphology of Antarctica. Even though 271 cartographic works were examined, some maps with some geomorphological content, interesting for a general view of an area are not quoted in the present article. For example, this is the case of geological maps of volcanic areas (*i.e.* Gonzalez-Ferrán & Katsui, 1970; Le Masurier & Thomson, 1990) that contain some structural geomorphological data have not been considered in this article. In addition, there was no analysis made of the numerous glaciological studies as the famous small scale maps of the whole continent (*i.e.* Drewry, 1983; Gaisler & Hermann, 1985), the recently produced satellite images and mosaics (Swithinbank, 1988; Nrsc-Farn, 1988; Usgs-Noaa-Nrsc, 1991), and the many glaciological maps produced in various Antarctic sectors (*i.e.* the Glaciological Map of Filchner-Ronne-Schelfeis, of Swithinbank & *alii,* 1989, at the 1:2,000,000 scale; the work of Wintges & Schmidt, 1990, in which a 1:250,000 scale Satellite Image Map is used to show the glaciological features of the area investigated; the Multispectral Digital-Image Mapping of Antarctic Ice-Features, Swithinbank & Lucchitta, 1986).

The cartographic works analysed were grouped into various sets, described in the following sections, on the basis of size, amount of data represented, the importance given to the text that accompain the maps and also depending on the criteria used by the authors to represent landforms.

Among the categories mentioned below, the geomorphological maps *s.s.* and the geomorphological thematic selected maps have previously been described in detail (Bruschi & *alii,* 1997). For the sake of completeness there is a summary of the main characteristics of the cartographic works analysed, so as to supply a more complete document of the data collected regarding the geomorphological cartography in Antarctica.

GEOMORPHOLOGICAL MAPS *SENSU STRICTO (s.s.)*

Only ten cartographic documents were classified in this category. Among these, two are defined morphocronological (1 and 2; fig. 1 and tab. 1), three are geomorphological-morphographic (7, 8 and 9), four are morphogenetic-morphodinamic (3, 4, 5 and 6) and one is defined as morphostructural (10). One of the maps analysed (4), even if not yet published (at the draft stage), have been included because they were consulted and will be published very soon.

The areas examined are located in different regions of Antarctica (fig. 1) and therefore regard geomorphological environments with different characteristics. Five of these regard East Antarctica (Victoria Land, Sôya Coast, Borgmassivet and the Yamato Mountains), two West Antarctica (South Shetland Islands), two the Subantarctic territory (South Georgia) and one includes almost all of the Antarctic continent.

Tab.1 summarizes the main characteristics of these maps. From this it results that most are maps with a scale variable from 1:20,000 to 1:50,000; one (5) has a medium

TABLE 1 - Characteristics of the geomorphological maps *s.s.* of Antarctica

n° in the text and Fig. 1	zone	Antarctic sector	scale	tipology	map area (km2)	legend entries	topographic data	supplementary information	authors nation	reference
1	Stromness Bay-CumberlandBay, South Georgia	Subantarctic Islands	1:50,000	morphocronological	1,021	51	contours, 200 feet	-	United Kingdom	CLAPPERTON (1971)
2	St. Andrews Bay-Royal Bay, South Georgia	Subantarctic Islands	1:50,000	morphocronological	721	46	contours, 200 feet	-	United Kingdom	CLAPPERTON & SUGDEN (1980)
3	Byers Peninsula, South Shetland Islands	West Antarctica	1:25,000	morphogenetic-morphodinamic	236	63	contours, 10 m	5 maps in the margin	Spain	LÓPEZ-MARTÍNEZ & *alii* (1995)
4	Deception Island, South Shetland Islands	West Antarctica	1:25,000	morphogenetic-morphodinamic	309	72	contours, 10 m	-	Spain	LÓPEZ-MARTÍNEZ & *alii* (In press a)
5	Mt. Melbourne Quadrangle, Victoria Land	East Antarctica	1:250,000	morphogenetic-morphodinamic	14,323	90	satellite immage, contours	2 maps in the margin glaciology meteorological informations	Italy	BARONI & *alii* (1996)
6	Northern Foothills, Victoria Land	East Antarctica	1:20,000	morphogenetic-morphodinamic	100	81	contours, 50 m	-	Italy	BARONI (1989)
7	Langhovde, Sôya Coast	East Artarctica	1:25,000	geomorphological-morphographic	205	51 (+5 in transp.)	contours, 10 m	2 maps in the margin 1 transparency	Japan	HIRAKAWA & *alii* (1984)
8	Mount Tyô, Yamato Mountains	East Antarctica	1:25,000	geomorphological-morphographic	104	48 (+40 in transp.)	contours, 10 m	2 mapsin the margin 1 transparency	Japan	IWATA & *alii* (1986)
9	Borgmassivet, Queen Maud Land	East Antarctica	1:50,000	geomorphological-morphographic	667	57	contours, 25 m	glaciology	Germany	BRUNK (1989)
10	West and East Antarctica	West and East Antarctica	1:15,000,000	morphostructural	-	28	spot heigts	-	Russia	MYAGKOV (1979)

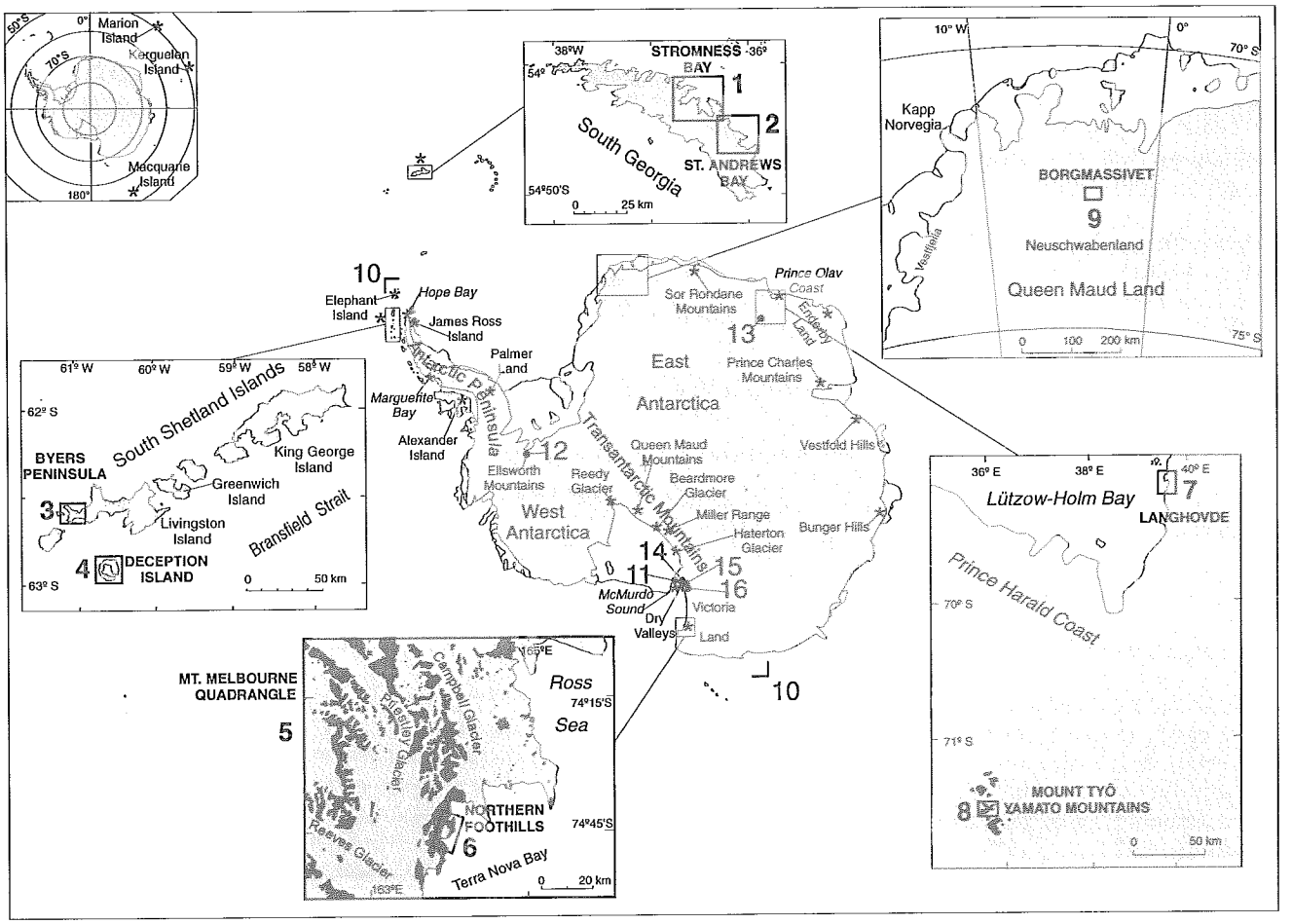

FIG. 1 - Location of geomorphological maps *s.s.* (squares, 1 to 10), geomorphological thematic selected maps (●, 11 to 16) and geomorphological sketches (*).

scale (1:250,000), whereas the morphostructural map (10) is small scale (1:15,000,000) and represents almost the whole continent. Excluding this last map, the total mapped areas amount to 17,686 km^2, which shows that only a very limited part of Antarctic territory (aprox. 0.126%) has been mapped from a geomorphological point of view. Also from tab. 1 it can be noted how the first large scale (1:50,000) Antarctic geomorphological map was only published in 1971. Later, other maps were supplied, but only in recent years have geomorphological maps been produced regularly, this in consideration of a possible systematic geomorphological survey of the Antarctic regions.

On the basis of the type of graphical representation and the importance given to the genesis of the landforms, morphology and lithology, the maps were grouped in the following way:

Morphostructural maps (10)

This category includes small scale maps, regarding the main morphostructures of the Antarctic continent. In particular this group refers to an extract of the «Geomorphological Map of Antarctica at 1:15,000,000», individually published by Myagkov (1979, 10, fig. 1, tab. 1). This map is of morphostructural type and takes into consideration subglacial and underwater relief forms of an extensive area of the Antarctic territory (the map is centered on the Ross Sea region). It consists of a single rectangular chart of small format without coordinates at the margin. The legend indicates 28 items of a clearly morphostructural nature (*i.e.* continental platforms, epigeosynclinal orogenic belts, rift zones) even if there are some geomorphological symbolic representations such as main glacial valleys and outer boundaries of ice shelves.

Morphochronological maps (1 and 2)

These constitute a group apart because a) there is no genetic classification of landforms (all the symbolic representation apart from the berms is in black; colours are used for chronological distinction between various depo-

sits) b) outcrops are indicated, but without lithological distinctions.

The main element of the map «Geomorphology of the Stromness Bay-Cumberland Bay area, South Georgia», (1, fig. 1, tab. 1; Clapperton, 1971) is the chronological distinction between the various deposits represented. Four tills are distinguished; present beaches are represented separate from raised beaches, which are then divided into upper and lower. The map is easy to read from the point of view of the areal extension of the processes, but above all, as regards the chronology of the main events occurring in this region.

The map «Geomorphology of St. Andrews Bay-Royal Bay, South Georgia» (2, fig. 1, tab. 1; Clapperton & Sugden, 1980) resembles the principles and symbolic representation of the map just described. Some small differences are due to the introduction of rock platforms, in order to give a more complete picture of coastal morphology, and of rock outcrops. The map is different from the previous one in the absence of isobaths and lack of some symbols (*i.e.* rock wall, lake shoreline).

Geomophological-Morphographic maps (7, 8 and 9)

These maps are clearly different from the others due to their genetic representation of landforms through areas of geomorphological processes and due to their morphographic representation. In practice, instead of using symbols representing landforms, coloured areas are associated with the geomorphological processes responsible for the relief evolution of these zones. Furthermore morphographic data are supplied in separate sheets or in inserts within the map itself.

The «Geomorphological Map of Langhovde» (7, fig. 1, tab. 1; Hirakawa & *alii,* 1984) consists of a main geomorphological map, two small scale thematic inserts (map of areas of geomorphological processes; slope classification map) and a separate transparent layer with classification in four slope categories, which can be superimposed on the geomorphological map. Some aspects of relative chronology are present to distinguish fluvioglacial deposits in older and younger. From the areas of geomorphological processes it is possible to recognize the areas influenced by geomorphological processes, but it is not possible to identify which forms these processes have modelled (*i.e.* some symbols such as glacial cirques or *roches moutonnées* are missing).

The «Geomorphological Map of Mount Tyô, Yamato Mountains» (8, fig. 1, tab. 1; Iwata & *alii,* 1986) presents an editorial appearance very similar to the previously described map. The main difference is that of the use of the superimposable transparent layer, in which there is the morphography and morphometry of the zone represented so as to constitute an independent morphographic map (40 items in the legend). One important difference with map 7 is the introduction of a genetic classification of landforms (termed «morphogenesis»). Areas of geomorphological processes are relegated to a small scale insert. Therefore, together with a very readable and detailed main map we have an areal representation of processes.

In the «Geomorphologic-glaciological Map Borgmassivet» (9, fig. 1, tab. 1; Brunk, 1989) the areas of geomorphological processes are mixed (areas of various superimposed processes are indicated) and there is a chronological differentiation between younger moraine fields and ridges and older mostly pitted moraine fields and ridges. The numerous glaciological data shown on this map are not indicated in a separate section but are spread among various items categories. In particular, data regarding ice thickness and velocity vectors are in the supplementary information.

Morphogenetic maps with chronological elements (3, 4, 5 and 6)

In these maps fundamental importance is given to morphogenesis, giving each morphogenetic system a certain colour with which all the associated deposits and landforms are represented (*i.e.* landforms originating from glacial processes are violet). In this type of map also the lithological nature of the substrate is shown, grouping the formations on the basis of their resistance to erosion. Morphography and morphometric classification of slopes is shown only in some cases, but is generally absent.

The legend of the «Geomorphological Map of Northern Foothills near the Italian Station, Terra Nova Bay, Antarctica» (6, fig. 1, tab. 1; Baroni, 1989) has a great number of item categories (81), which include also multiple landforms and deposits due to surface alteration and present glaciation. Chronology has a particular significance because, besides a chronological distinction of deposits, through different shades of the same colour (in order to respect the genetic principle), radiometric datings obtained in the area are shown on the map. Furthemmore, for the first time deposits associated with penguin colonies (subdivided in present and abandoned) are indicated, these giving most of the material used for the datings.

On the «Geomorphological Map of Byers Peninsula, Livingston Island» (3, fig. 1, tab. 1; López-Martínez & *alii,* 1995) there are seven small scale inserts (i.e. lithology, tectonic alignments, hydrology) which give a complete picture of the area examined. In particular, the insert of lithological representation, not shown on the main map, is of particular interest because it avoids crowding of the main map, above all in zones of highly diversified lithology. The grouping «submerged forms and deposits» is an innovation because not only are isobaths shown, but there are also precise landforms (submerged channel, submerged fluvial cone).

The data regarding submerged morphology are emphasized in the «Geomorphological Map of Deception Island» (4, fig. 1, tab. 1; López-Martínez & *alii,* in press a). The legend shows twenty items dedicated to these landforms. In particular, in addition to structural, glacial and fluvial data, there is also indication of type of deposit and relative granulometry. This map is of particular interest for its highly detailed mapping of structural forms, especially of those associated with volcanic morphology.

The Geomorphological and Glaciological Map of the Mount Melboume Quadrangle (5, fig. 1, tab. 1; Baroni & *alii,* 1996) is very much associated with the Italian geomophological school, but also includes the contribute of G.H. Denton (U.S.). In this way it is a cartographic product with characteristics different from those previously described. It is the first geomorphological map at a scale of 1:250,000 produced in Antarctica and is also the first to use a mosaic of satellite images. These elements, not present in other maps, indicate the experimental nature of the Mt. Melbourne map. Despite the medium scale, typical of thematic geomorphological maps, map 5 shows all the main morphogenetic environments of the area examined (90 items in the legend). Map 5, like map 9, is also a glaciological map in that there is representation of all the morphological and dynamic elements of present glaciation (ice types, glacial dynamic features, aeolian landforms). There are also some climatic graphs (temperature and wind direction) and a small scale insert with the pattern of wind circulation based on aeolian landforms (*i.e.* sastrugi, drift plumes) present on the glacial surface.

The system of mapping in detail all the landforms present in an area emerging from the analysis of the maps belonging to this group, means that these maps are base documents for future studies, of various types. They are also very readable in that the smallest and least common landforms become less relevant because they are indicated with lower frequency. Furthermore, giving a single colour to each morphogenetic system makes an areal vision of the processes easier.

GEOMORPHOLOGICAL THEMATIC SELECTED MAPS

These were classified differently from the geomorphological maps *s.s.* because they show a limited number of geomorphological themes, often only one, generally glacial morphology. The map is evidently oriented towards the study of the particular theme represented. These documents are not treated in the same way as the geomorphological sketches due to their larger format, the use of colours and the innovations they present. Generally, these maps do not give lithological indications except for showing areas free of glaciers and altitudes are not represented by contours but by spot heights, as is often the case in geomorphological sketches.

In this group there are two particularly significant documents:
– Ross sea Drift and associated features (11, fig. 1. tab. 2; Stuiver & *alii,* 1981).
– Selected glacial geologic features, Ellsworth Mountains (12, fig. 1, tab. 2; Denton & *alii,* 1992).

Chronology is a fundamental aspect of the first map. It also includes subdivision of the various glacial deposits using different colours; indications of dating sample sites (the ages are shown in a table in the text) and reconstruction of the floating ice platforms with indication of age obtained from radio carbon dating and historical data.

The map of the Ellsworth Mountains is an experimental map in which the thematic character already mentioned for the previous map is emphasized. There is cartography only of some selected landforms of glacial morphology: erosional forms. Its experimental nature is illustrated by some very interesting innovations: the base consisting of a satellite image and trimlines with relative heights in meters.

Maps belonging to this group are the Geomorphic Map of Yamato Mountains (13, fig. 1, tab. 2; Yoshida, 1961) containing symbols exclusively relative to glacial geomorphology (glacial cirque, moraine on ice, land cliff), considered one of the first geomorphological representations of Antarctica, and the geological maps in which glacial geology is extensively represented. Of particular importance are three recently produced maps at a scale of 1:50,000, published by the Institute of Geological and Nuclear Science of New Zealand, which are part of a wider and thorough geological cartography project regarding the Dry Valleys:
– Geology of Convoy Range Area, Southern Victoria Land, Antarctica (14, fig. 1, tab. 2; Pocknall & *alii,* 1994);
– Geology of the Bull Pass-St. Johns Range Area, Southern Victoria Land, Antarctica (15, fig. 1, tab. 2; Turnbull & *alii,* 1994);
– Geology of the Olympus Range Area, Southern Victoria Land, Antarctica (16, fig. 1, tab. 2; Chinn & *alii,* in press).

These last three maps contain a well-structured representation of glacial deposits and some specifically geomorphological and glaciological symbols in the legend under geological symbols and topographic reference.

TABLE 2 - Characteristics of the geomorphological thematic selected maps of Antarctica

n° in the text and Fig. 1	zone	Antarctic sector	scale	main infornation	authors nation	reference
11	McMurdo Sound	East Antarctica	1:250,000	distribution of Ross Sea Drift	U.S.A.	STUIVER & *alii* (1981)
12	Ellsworth Mountains	West Antarctica	1:500,000	glaciar erosion	U.S.A.	DENTON & *alii* (1992)
13	Yamato Mountains	East Antarctica	1:100,000	glacial geomorphology	Japan	YOSHIDA (1961)
14	Convoy Range, Dry Valleys	East Antarctica	1:50,000	glacial geology	New Zealand	POCKNALL & *alii* (1994)
15	Bull Pass-St. Johns Range, Dry Valleys	East Antarctica	1:50,000	glacial geology	New Zealand	TURNBULL & *alii* (1994)
16	Olympus Range, Dry Valleys	East Antarctica	1:50,000	glacial geology	New Zealand	CHINN & *alii* (In press)

TABLE 3 - Characteristics of the geomorphological sketch maps of Antarctica

n°	zone	Antarctic sector	approx. scale	legend entries	topographic data	reference
1.	Mt. Menzies Nunatak, Prince Charles Muntains	East Antarctica	1:113,000	18	spot heights	DERBYSHIRE & PETERSON, 1978
2.	Ablation Point Massif, Alexander Island	West Antarctica	1:51,000	30	spot heights	CLAPPERTON & SUGDEN, 1983a, fig. 2
3.	Victoria Valley, Dry Valleys	East Antarctica	1:20,000	-	-	MIOTKE, 1985
4.	Johnsons Dock, Livingston Island	West Antarctica	1:5,000	38	spot heights	MARTÍNEZ DE PISON & *alii*, 1991
5.	Deception Island	West Antarctica	1:100,000	29	-	CRIADO & *alii*, 1992, fig. 2
6.	Johnsons Dock, Livingston Island	West Antarctica	1:12,000	26	spot heights	LÓPEZ-MARTÍNEZ & *alii*, 1992a, fig. 2
7.	Hurd Peninsula, Livingston Island	West Antarctica	1:50,000	25	spot heights	LÓPEZ-MARTÍNEZ & *alii*, 1992b, fig. 2
8.	South Bay coast, Livingston Island	West Antarctica	1:15,000	24	spot heights	LÓPEZ-MARTÍNEZ & *alii*, 1992b, fig. 3
9.	James Ross Island	West Antarctica	1:345,000	23	spot heights	STRELIN & MALAGNINO, 1992, pag. 35-36
10.	Deception Island	West Antarctica	1:160,000	19	-	RISSO & *alii*, 1992, fig. 2
11.	Hope Bay, Antarctic Peninsula	West Antarctica	1:15,000	24	spot heights	BIRKENMAJER, 1993, fig. 2
12.	Dry Valleys	East Antarctica	1:454,000	17	contours	DENTON & *alii*, 1993, fig. 18
13.	Wright Valley, Dry Valleys	East Antarctica	1:64,000	42	-	HALL & *alii*, 1993, fig. 5
14.	Bartley Glacier, Dry Valleys	East Antarctica	1:13,000	42	oblique view	HALL & *alii*, 1993, fig. 6
15.	Meserve Glacier, Dry Valleys	East Antarctica	1:12,000	42	oblique view	HALL & *alii*, 1993, fig. 7
16.	Hart Glacier, Dry Valleys	East Antarctica	1:15,000	42	oblique view	HALL & *alii*, 1993, fig. 8
17.	Goodspeed Glacier, Dry Valleys	East Antarctica	1:16,000	42	oblique view	HALL & *alii*, 1993, fig. 9
18.	Nibelungen-Jotunheim-Njord Valleys, Dry Valleys	East Antarctica	1:40,000	29	-	MARCHANT & *alii*, 1993a, fig. 4
19.	Sessrumnir-Koenig Valleys, Dry Valleys	East Antarctica	1:40,000	29	-	MARCHANT & *alii*, 1993a, fig. 5
20.	Arena Valley, Dry Valleys	East Antarctica	1:40,000	31	spot heights	MARCHANT & *alii*, 1993b, fig. 7
21.	Lions Rump-Sukiennice Hills, King George Island	West Antarctica	1:10,000	22	heights beaches	BIRKENMAJER, 1994, fig. 3
22.	Edmonson Point, Victoria Land	East Antarctica	1:30,000	21	-	BARONI & OROMBELLI, 1994b, fig. 3
23.	Half Moon Island, South Shetland Islands	West Antarctica	1:13,000	21	spot heights	MARTÍNEZ & MASSONE,1995, fig. 3
24.	Hurd Peninsula, Livingston Island	West Antarctica	1:38,000	26	contours	PALLÁS & *alii*, 1995, fig. 2
25.	Wright-Taylor Valleys, Dry Valleys	East Antarctica	1:480,000	21	contours	SUGDEN & *alii*, 1995, fig. 2
26.	Evans Cove, Victoria Land	East Antarctica	1:70,000	65	spot heights	SALVATORE & *alii*, in press
27.	Byers Peninsula, Livingston Island	West Antarctica	1:154,000	12	-	LÓPEZ-MARTÍNEZ & *alii*, in press b, fig. 2
28.	Half Moon Island, South Shetland Islands	West Antarctica	1:13.000	23	-	SERRANO & LÓPEZ-MARTÍNEZ 1997, fig. 3
29.	Coppermine Peninsula, Robent Island	West Antarctica	1:15.000	29	-	SERRANO & LÓPEZ-MARTÍNEZ submited, fig. 2
30.	Deception Island	West Antarctica	1:83,000	14	-	SMELLIE & *alii*, in press

GEOMORPHOLOGICAL SKETCH MAPS

Many notes and volumes contain geomorphological sketch maps. They are detailed sketches, generally of a scientific relevance, which take into account the whole of the geomorphology of a certain area. They are generally in black and white and are different from the geomorphological maps due to their smaller size and the absence of well-organised basic topography. In some cases they were intended as intermediate stages for the publication of geomorphological maps *s.s.*, as in the case of some geomorphological sketch maps of the Terra Nova Bay area (Baroni & Orombelli, 1994b; Salvatore & *alii,* in press). These last two maps, while produced with the same criteria as other geomorphological maps *s.s.* of the area, lack a detailed basic topography and represent limited sections of territory.

This category includes documents with varying content and graphical representations. The individual characteristics of surveyed zones and diverse study aims have influenced authors in terms of the solutions adopted. Overall, 30 figures with detailed legends referring to various regions of the Antarctic continent were analysed (tab. 3).

In this category a distinction can be made between documents of a more general nature and a group of maps produced typically by the American school, the glacial geology and surficial deposits maps. The latter (*i.e.* Denton & *alii,* 1993, Hall & *alii,* 1993; Marchant & *alii,* 1993a; 1993b) are aimed at the classification of glacial deposits and supply a quantity of solid data on the reconstruction of the glacial history of the Transantarctic Mountains. Furthermore, they introduce a new geomorphological approach for landscape analysis of the Dry Valleys region.

A particular case is represented by a series of oblique view productions, referred to the Dry Valleys (Hall & *alii,* 1993). These are documents based on a support consisting of oblique aerial photographs, and with a great number of legend entries. However, there is a lack of topographical control, quantitative information cannot be obtained and prospective modify the scale of the geomorphological elements represented.

A typical example of a map of a more general nature is that by Clapperton & Sugden (1983a) in a paper regarding the geomorphology of Ablation Point Massif. The 1:70,000 scale figure presents a very detailed legend including 30 items. The various mophogenetic systems of the area are considered *(i.e.* glacial, periglacial, gravitational); glacial deposits are grouped in seven depositional units, topographical data are represented only by spot heights.

GEOMORPHOLOGICAL SKETCHES

Almost all the papers relative to geomorphological and geological-glacial studies regarding the Antarctic territory, for whatever reason they are carried out, inevitably contain morphological indications necessary for the localization of study sites. An example is the identification of a stretch of coastline together with spits and ice platforms present in the area. Therefore, it is often difficult to differentiate between some glaciological and geomorphological sketches which contain aspects of present glaciation.

For this reason particular attention was paid to the sketches used to summarize the content and results of research work. In some cases these documents can have more than a simple exemplary schematic significance and are nearer in content and details shown, to the geomorphological sketch maps.

Tabs. 4, 5 and 6 list numerous documents, grouped into purely indicative categories, it being difficult to set rigid objective limits.

Thematic sketch maps

In sketch form these take into account only some geomorphological elements depending on the theme of the drawing. They can be further divided into (1a) if single landforms are considered and (1b) if they represent landforms and deposits relative to a morphogenetic agent. In the first case, an extreme example is the sketch by Aniya & Welch (1981), in which only the glacial cirques of the Victoria Valley system are shown. In the second case there are many sketches, generally at large scale, showing coastal geomorphology (*i.e.* John & Sugden, 1971, figs. 3 and 4), glacial geomorphology (*i.e.* Hirakawa & *alii,* 1988, figs. 2 and 3), periglacial geomorphology (Zhang, 1989, fig. 4) and also some examples referred to aeolian geomorphology (Adamson & *alii,* 1988, fig. 4). These sketches have a great number of symbols and details referring to the various morphogenetic processes studied, even if, to make reading easier, there are often other geomorphological symbols present next to the main area containing data.

Location sketch maps with geomorphological information

These are small sketches used to identify study areas. To compensate for lack of contour lines there are generally indications of main elements of the landscape (*i.e.* glaciers, ridges) and in some cases also areal data relative to outcrops, glacial deposits or other geomorphological aspects. These location maps are used by some authors to indicate the objective of their research and in this case they become documents of a certain importance. This grouping also includes small scale sketches which contain little and very different geomorphological information, but which are clearly location maps.

Morphographic sketch maps

The absence of large scale topographic maps of the Antarctic regions has recently stimulated the compilation of cartographic documentation by means of remotely sensed data (*i.e.* Biasini & *alii,* 1992; Biasini & Salvatore, 1993). This group includes the morphographic sketches which supply essentially information on the configuration and geometry of the surfaces being studied. The morphographic representation is satisfactory for preliminary analysis as it outlines many of the characteristics of the land identifiable only by means of aerial photography (Biasini & Salvatore, 1993). There is representation of linear elements such as ridges, slope intersections, breaks of slopes, change of slope referring to both ice-covered and ice-free areas. In addition, these maps also show lithology.

CONCLUDING REMARKS

In all, 271 cartographic documents were collected and classified. They supply more or less detailed and complex representations of the landforms which characterize the Antarctic landscape, with indications relative to surface deposits and the processes that have modelled the relief and which are at present active in the deglaciated areas. Besides geomorphological maps *s.s.,* there was also analysis of cartographic figures of geomorphological relevance, not published as maps in themselves, but accompanying scientific articles.

Most of the documents analysed refer to coastal areas, even if there are various maps of deglaciated areas inland (*i.e.* nunataks). The collection of maps presented here includes most of the existing material on the subject and should represent a review of those documents which, in our opinion, supply a significant contribution to the characterization of landforms in Antarctica. This is with particular reference to the identification of currently active processes, relict landforms and surface deposits, so forming a picture of recent geological history. The following sets of documents were distinguished:

– geomorphological maps *s.s.:* from which information can be obtained on the size, geometry, origin and, if possible, on the age of mapped landforms, together with the nature of the deposits; these documents are generally published as independent sheets, present a well-organized basic topography and have a large or medium format (up to 100x80 cm); they are generally accompanied by explanatory booklets, may contain inserts which illustrate particular themes;

– geomorphological thematic selected maps: which represent a limited number of geomorphological elements and morphogenetic environments (*i.e.* glacial);

– geomorphological sketch maps: these are detailed small scale documents which take into consideration the whole of the geomorphology of a certain area;

– thematic-, location-, morphographic sketch maps: used to sketch out the content of geomorphological research, they often accompany publications.

Of the ten geomorphological maps *s.s.* analysed (scale variable from 1:20,000 to 1:15,000,000; tab. 1, fig. 1), only geomorphological maps 8 and 9 (tab. 1, fig. 1) represent inland mountainous areas (Yamato Mountains and Borgmassivet), whereas all the others refer to coastal zones. Also six large format maps were considered, although distinct from the geomorphological maps *s.s.* due to the limited number of geomorphological themes shown. These six maps were named «geomorphological thematic selected maps» and include, besides the selected thematic maps, also some geological maps which make widespread reference to glacial geology.

Although almost the whole continent is covered by ice, only two mixed geomorphological-glaciological maps have

TABLE 4 - Thematic-, location- and morphographic sketch maps (West Antarctica and Subantarctic Islands)

n°	zone	approx. scale	typology	main information	legend entries	topographic data	authors
1.	Neny Fjord Thumb, Marguerite Bay	1:280	thematic sketch map (1a)	raised beaches, geology	8	cross section	NICHOLS, 1960, fig. 7
2.	Northeast Glacier, Marguerite Bay	-	thematic sketch map (1a)	glaciology	-	-	NICHOLS, 1960, fig. 12
3.	Stonington Island, Marguerite Bay	-	thematic sketch map (1a)	snow drifts	-	-	NICHOLS, 1960, fig. 13
4.	Puerto Soberana, South Shetland Islands	1:17,800	thematic sketch map (1b)	coastal morphology	12	-	FUENZALIDA, 1964, fig. 1
5.	Guesalage Peninsula, Greenwich Island	1:4,500	thematic sketch map (1b)	coastal morphology	15	spot heigts	ARAYA & HERVÉ, 1965, fig. 7-1
6.	Bascope Point, Greenwich Island	1:4,500	thematic sketch map (1b)	coastal morphology	16	spot heigts	ARAYA & HERVÉ, 1965, fig. 7-2
7.	Cape Lookout, Elephant Island	1:7,500	thematic sketch map (1a)	beaches, moraines	7	-	ARAYA & HERVÉ, 1966, fig. 2-2
8.	Potter Cove, King George Island	1:25,000	thematic sketch map (1b)	glacial and coastal morphology	12	spot heights	ARAYA & HERVÉ, 1966, mapa 1
9.	Half Moon Island, South Shetland Islands	1:100,000	thematic sketch map (1b)	coastal morphology	14	-	ARAYA & HERVÉ, 1966, mapa 3
10.	False Bay-Hurd Peninsula, Livingston Island	1:770,000	thematic sketch map (1b)	glacial morphology, beaches	12	-	EVERETT, 1971, fig. 3
11.	Marian Cove-Potter Cove, King George Island	1:100,000	thematic sketch map (1b)	coastal morphology, moraines	20	platforms heigts	JOHN & SUGDEN, 1971, fig. 3
12.	Byers Peninsula, Livingston Island	1:107,000	thematic sketch map (1b)	coastal morphology	22	spot heights	JOHN & SUGDEN, 1971, fig. 4
13.	Fildes Peninsula, King George Island	1:107,000	thematic sketch map (1a)	melt water channels	6	spot heights	JOHN & SUGDEN, 1971, fig. 14
14.	Maxwell Bay, King George Island	1:263,000	thematic sketch map (1a)	residual beaches	2	beaches heigts	JOHN & SUGDEN, 1971, fig. 18
15.	Barnard Point, Livingston Island	1:26,000	thematic sketch map (1b)	coastal morphology, moraines	14	cross section	JOHN & SUGDEN, 1971, fig. 23
16.	South Shetland Islands	1:2,200,000	location sketch map	raised beaches	-	beaches heigts	JOHN & SUGDEN, 1971, fig. 27
17.	Keller Peninsula, King George Island	1:80,000	thematic sketch map (1b)	coastal morphology, moraines	11	beaches heigts	JOHN & SUGDEN, 1971, fig. 37
18.	Maxwell Bay, King George Island	1:158,000	thematic sketch map (1a)	raised beaches, cliffs	7	-	JOHN, 1972, fig. 2
19.	Fildes Peninsula, King George Island	1:54,000	thematic sketch map (1b)	coastal morphology, channels	8	-	JOHN, 1972, fig. 5
20.	Barton Peninsula, King George Island	1:69,000	thematic sketch map (1a)	moraines, beaches	10	beaches heigts	SUGDEN & JOHN, 1973, fig. 3
21.	Deception Island	1:107,000	thematic sketch map (1b)	structural morphology	12	spot heigts	IGARZABAL, 1974
22.	South Georgia Island	1:2,500,000	location sketch map	raised beaches, moraines	6	-	CLAPPERTON & *alii*, 1978, fig. 3
23.	Marion Island	1:266,000	thematic sketch map (1a)	striae directions	1	-	HALL, 1979/80, fig. 1
24.	Marion Island	1:235,000	thematic sketch map (1a)	moraines	5	-	HALL, 1979/80, fig. 2
25.	Marion Island	1:150,000	thematic sketch map (1b)	glacial morphology	7	-	HALL, 1979/80, fig. 8
26.	Keller Peninsula, King George Island	1:11,000	thematic sketch map (1a)	moraines, blockfields	6	spot heigts	BIRKENMAJER, 1980, fig. 2
27.	Keller Peninsula, King George Island	1:11,000	thematic sketch map (1a)	neoglacial moraines	8	spot heigts	BIRKENMAJER, 1980, fig. 3
28.	Potter Cove, King George Island	1:125,000	thematic sketch map (1b)	glacial morphology, beaches	10	spot heigts	CURL, 1980, fig. 35
29.	Keller Peninsula, King George Island	1:37,000	thematic sketch map (1a)	beaches, platforms, moraines	7	contours	CURL, 1980, fig. 60
30.	Ablation Point, Alexander Island	1:153,000	thematic sketch map (1b)	glacial morphology	9	spot heights	SUGDEN & CLAPPERTON, 1980, fig. 2
31.	Batterbee Mountains, Palmer Land	1:62,500	thematic sketch map (1b)	glacial morphology	9	-	SUGDEN & CLAPPERTON, 1980, fig. 3
32.	Point Hennequin, King George Island	1:100,000	location sketch map	quaternary deposits	2	-	BIRKENMAJER, 1981, fig. 2
33.	Point Hennequin, King George Island	1:5,700	thematic sketch map (1a)	moraines, stormridges	6	cross section	BIRKENMAJER, 1981, fig. 3
34.	Ablation Point Massif, Alexander Island	1:55,000	thematic sketch map (1b)	glacial morphology	18	spot heights	CLAPPERTON & SUGDEN, 1982, fig. 3
35.	Batterbee Mountains plateau, Palmer Land	1:40,000	thematic sketch map (1b)	glacial morphology	10	spot heights	CLAPPERTON & SUGDEN, 1982, fig. 4
36.	Striation Valley, Alexander Island	1:28,500	thematic sketch map (1a)	moraines	6		CLAPPERTON & SUGDEN, 1982, fig. 10
37.	Moraine Fjord, South Georgia	1:80,000	thematic sketch map (1a)	moraines	8	spot heights	CLAPPERTON & SUGDEN, 1983b, fig. 2
38.	Ablation Valley, Alexander Island	1:62,500	thematic sketch map (1a)	moraines	10		CLAPPERTON & SUGDEN, 1983b, fig. 3
39.	Ezcurra Inlet, King George Island	1:42,000	thematic sketch map (1b)	glacial and coastal morphology	13		MARSZ, 1983, fig. 1
40.	Ezcurra Inlet floor, King George Island	1:100,000	thematic sketch map (1b)	submerged morphology	15		MARSZ, 1983, fig. 3
41.	Kerguelen Island	1:384,000	location sketch map	cirques, erratics, striations	5	contours	HALL, 1984, fig. 2
42.	Arctowski Station, King George Island	-	location sketch map	Quaternary cover, beaches	6	spot heigts	BIRKENMAJER, 1985, fig. 2
43.	Fildes Peninsula, King George Island	1:62,500	thematic sketch map (1b)	coastal morphology	4	-	BARSCH & MÄUSBACHER, 1986, fig. 4
44.	Nordenskjöld Glacier, South Georgia	1:18,700	thematic sketch map (1b)	moraine ridges	2	-	GORDON, 1987, fig. 1
45.	Stony Creek, Macquarie Island	1:10,000	thematic sketch map (1b)	aeolian morphology	10	-	ADAMSON & *alii*, 1988, fig. 2
46.	Stony Creek, Macquarie Island	1:2,000	thematic sketch map (1a)	sandy floors	6	cross section	ADAMSON & *alii*, 1988, fig. 3
47.	Finch Creek, Macquarie Island	1:8,300	thematic sketch map (1b)	aeolian morphology	8	-	ADAMSON & *alii*, 1988, fig. 4
48.	Bauer Bay, Macquarie Island	1:8,300	thematic stetch map (1b)	coastal morphology	15	cross section	ADAMSON & *alii*, 1988, fig. 5
49.	Cumberland Bay, South Georgia	1:250,000	thematic sketch map (1a)	moraines	4	spot heights	CLAPPERTON & SUGDEN, 1988, fig. 4
50.	Cumberland Bay, South Georgia	1:117,000	thematic sketch map (1b)	glacial morphology, beaches	18	contours	CLAPPERTON & *alii*, 1989a, fig. 1
51.	South Georgia	1:625,000	thematic sketch map (1a)	moraine limits	5	spot heights	CLAPPERTON & *alii*, 1989a, fig. 2
52.	Cumberland Bay, South Georgia	1:130,000	thematic sketch map (1a)	holocene moraines	5	contours	CLAPPERTON & *alii*, 1989b, fig. 3
53.	Antarctic Peninsula	1:11,500,000	location sketch map	nunataks	3	contours	PAYNE & *alii*, 1989, fig. 1
54.	Fildes Peninsula, King George Island	1:55,000	thematic sketch map (1b)	periglacial morphology	8	contours	ZHANG, 1989, fig. 4
55.	Ablation Valley, Alexander Island	1:43,000	thematic sketch map (1b)	glacial morphology	16	spot heights	CLAPPERTON, 1990, fig. 15
56.	Fildes Peninsula, King George Island	1:5,000	morphographic sketch	morphographic data	9	contours	SCHMIDT & *alii*, 1990, fig. 1 (c, d)
57.	Whisky Glacier, Jarnes Ross Island	1:13,000	thematic sketch map (1b)	glacial morphology	13	contours	CHINN, 1991, fig. 13
58.	Fildes Peninsula, King George Island	several	morphographic sketch	morphographic data	17	contours	MÄUSBACHER, 1991, 9 maps
59.	Fildes Peninsula, King George Island	-	thematic sketch map (1a)	types of coasts	8		GENGNIAN & *alii*, 1992, fig. 1
60.	Cook Glacier, South Georgia	1:25,000	thematic sketch map (1a)	moraines	5	-	GORDON & TIMMIS, 1992, fig. 7
61.	Ross Glacier, South Georgia	1:43,000	thematic sketch map (1a)	raised beaches, glacial features	10		GORDON & TIMMIS, 1992, fig. 10
62.	Muschelbach Valley, King George Island	1:10,000	morphographic sketch	morphographic data	9	-	MÄUSBACHER, 1992, fig. 2
63.	Punta Hespérides, Livingston Island	1:18,000	thematic sketch map (1b)	coastal and glacial morphology	16	-	LÓPEZ-MARTÍNEZ & *alii*, 1992b, fig. 4
64.	Byers Peninsula, Livingston Island	1:100,000	thematic sketch map (1b)	coastal morphology	13	platforms heigts	LÓPEZ-MARTÍNEZ & *alii*, 1992b, fig. 5
65.	Livingston Island	1:370,000	thematic sketch map (1a)	glacial basins and flows	8	-	MARTÍNEZ DE PISÓN & *alii*, 1992, fig. 3
66.	Livingston Island	1:550,000	location sketch map	main glacial units	16	-	MARTÍNEZ DE PISÓN & *alii*, 1992, fig. 4
67.	Nord East James Ross Island	1:80,000	thematic sketch map (1b)	coastal morphology	8	platforms heigts	STRELIN & MALAGNINO, 1992, fig. 13
68.	Fildes Peninsula, King George Island	1:142,000	location sketch map	major glacier traces	7	-	YOUYU & ZHIJIU, 1992, fig. 4
69.	Hope Bay	1:16,000	thematic sketch map (1a)	distibution of large blocks	-	spot heigts	BIRKENMAJER, 1993, fig. 3
70.	Cape Shirreff, Livingston Island	1:30,000	thematic sketch map (1b)	coastal morphology, moraines	17	platforms heigts	VILAPLANA & *alii*, 1993, fig. 1
71.	Lions Rump, King George Island	1:12,000	thematic sketch map (1a)	moraines	9	-	BIRKENMAJER, 1994, fig. 4
72.	White Eagle Glacier, King George Island	1:30,000	thematic sketch map (1a)	moraines	5	-	BIRKENMAJER, 1994, fig. 6 (a, b, c, d)
73.	Three Sisters Point, King George Island	1:7,000	thematic sketch map (1a)	moraines, beaches	7	-	BIRKENMAJER, 1995, fig. 2
74.	Three Sisters Point, King George Island	1:7,000	thematic sketch map (1a)	moraines, beaches	9	-	BIRKENMAJER, 1995, fig. 3
75.	Byers Peninsula, Livingston Island	1:8,000	thematic sketch map (1a)	channels, lakes and pools	5	-	LÓPEZ-MARTÍNEZ & *alii*, 1996, fig. 4.1
76.	Byers Peninsula, Livingston Island	1:8,000	thematic sketch map (1b)	glacial morphology	10	-	MARTÍNEZ DE PISÓN & *alii*, 1996, fig. 6.1
77.	Byers Peninsula, Livingston Island	1:5,000	thematic sketch map (1b)	periglacial morphology	14	spot heights	SERRANO & *alii*, 1996, fig. 7.5
78.	Byers Peninsula, Livingston Island	1:140	thematic sketch map (1b)	periglacial morphology	10	cross section	SERRANO & *alii*, 1996, fig. 7.10

TABLE 5 - Thematic-, location- and morphographic sketch maps (Victoria Land and Transantarctic Mountains)

n°	zone	approx. scale	typology	main information	legend entries	topographic data	reference
1.	Davis Bay, McMurdo Sound	1:11,000	thematics ketch map (1b)	delta and terraces	5	spot heights	SPEDEN, 1960, fig .8
2.	Gneiss Point, McMurdo Sound	1:16,000	thematic sketch map (1a)	snowdrift-ice slabs, beaches	-	spot heights	NICHOLS, 1961, fig. 3-7
3.	Scheuren River, McMurdo Sound	1:7,000	thematic sketch map (1a)	raised and pitted beaches	-	beach heights	NICHOLS, 1961, fig. 3-10
4.	Gneiss Point, McMurdo Sound	1:14,000	thematic sketch map (1a)	wave-washed surfaces, beaches	-	spot heights	NICHOLS, 1961, fig. 3-13
5.	Cape Roberts, McMurdo Sound	1:15,000	thematic sketch map (1a)	wave-washed surfaces, beaches	-	spot heights	NICHOLS, 1961, fig. 3-15
6.	Spike Cape, McMurdo Sound	1:30,000	thematic sketch map (1a)	raised beaches	-	spot heights	NICHOLS, 1961, fig. 3-16
7.	Surko River, McMurdo Sound	1:15,000	thematic sketch map (1a)	raised beaches	-	spot heights	NICHOLS, 1961, fig. 3-24
8.	Marble Point, McMurdo Sound	1:15,000	thematic sketch map (1a)	raised beaches	-	spot heights	NICHOLS, 1961, fig. 3-27
9.	South River, McMurdo Sound	1:15,000	thematic sketch map (1a)	raised beaches, outwash	6	spot heights	NICHOLS, 1961, fig. 3-32
10.	Inexpressible Island, Victoria Land	1:107,000	thematic sketch map (1a)	raised beaches, platforms	4	contours	CLARIDGE & CAMPBELL, 1966, fig. 1
11.	Marble Point, McMurdo Sound	1:19,000	thematic sketch map (1a)	distribution of raised beaches	-	spot heights	NICHOLS, 1966, fig. 16
12.	Marble Point, McMurdo Sound	-	thematic sketch map (1a)	location raised beaches	-	spot heights	NICHOLS, 1966, fig. 21
13.	Gneiss Point, McMurdo Sound	1:17,000	thematic sketch map (1a)	wave-washed surfaces, beaches	-	spot heights	NICHOLS, 1966, fig. 23
14.	Miller Range	1:375,000	thematic sketch map (1a)	glacial surfaces	6	spot heights	GRINDLEY, 1967, fig. 4
15.	Quartz Hills, Reedy Glacier	1:160,000	thematic sketch map (1b)	glacial geology	10	-	MERCER, 1968, fig. 2
16.	Caloplaca Hills, Reedy Glacier	1:186,000	thematic sketch map (1b)	glacial geology	9	-	MERCER, 1968, fig. 3
17.	Camp Reedy-Olentangy Glacier, Reedy Glacier	1:312,000	thematic sketch map (1b)	glacial geology	14	-	MERCER, 1968, fig. 4
18.	Gneiss Point, McMurdo Sound	1:17,000	thematic sketch map (1a)	wave-washed surfaces, beaches	-	spot heights	NICHOLS, 1968, fig. 4
19.	Cape Roberts, McMurdo Sound	1:20,000	thematic sketch map (1b)	coastal morphology	-	spot heights	NICHOLS, 1968, fig. 9
20.	Spike Cape, McMurdo Sound	1:32,000	thematic sketch map (1a)	wave-washed surfaces, beaches	-	spot heights	NICHOLS, 1968, fig. 10
21.	Scheuren River, McMurdo Sound	1:8,000	thematic sketch map (1a)	raised and pitted beaches	-	spot heights	NICHOLS, 1968, fig.12
22.	Surko River, McMurdo Sound	1:16,000	thematic sketch map (1a)	raised beaches	-	spot heights	NICHOLS, 1968, fig. 17
23.	Marble Point, McMurdo Sound	1:20,000	thematic sketch map (1a)	raised beaches	-	spot heights	NICHOLS, 1968, fig. 20
24.	South River, McMurdo Sound	1:20,000	thematic sketch map (1a)	outwash	7	spot heights	NICHOLS, 1968, fig. 23
25.	Broad Delta Bay, McMurdo Sound	1:13,000	thematic sketch map (1a)	raised beaches	-	beaches heights	NICHOLS, 1968, fig. 24
26.	Wright Valley, Dry Valleys	1:555,000	thematic sketch map (1b)	glacial geology	5	-	CALKIN & BULL, 1972, fig. 1
27.	Marozumi Range-Helliwell Hills, Victoria Land	1:1,000,000	thematic sketch map (1a)	glaciology, ice-cored moraines	9	contours	MAYEWSKI & *alii*, 1979, fig. 3
28.	Evans Névé, Victoria Land	1:1,000,000	thematic sketch map (1a)	glaciology, ice-cored moraines	6	contours	MAYEWSKI & *alii*, 1979, fig. 4
29.	Victoria Valley system, Dry Valleys	1:323,000	thematic sketch map (1a)	glacial cirques	2	cirques heights	ANIYA & WELCH, 1981, fig. 4
30.	Terra Nova Bay	1:468,000	thematic sketch map (1b)	glacial morphology, beaches	9	spot heights	STUIVER & *alii*, 1981, fig. 7.22
31.	Victoria Land coast	several	thematic sketch map (1a)	coastal typology	6	-	GREGORY & *alii*, 1984, fig. 5-11
32.	Transantarctic Mountains	1:8,000	location sketch map	indicators of ice movement	4	-	MAYEWSKI & GOLDTHWAIT, 1985, fig. 12
33.	Scott-Amundsen Glaciers, Queen Maud Mts.	1:500,000	thematic sketch map (1b)	glacial geology	5	-	MAYEWSKI & GOLDTHWAIT, 1985, Map A1
34.	Shackleton Glacier, Queen Maud Mts.	1:500,000	thematic sketch map (1b)	glacial geology	6	-	MAYEWSKI & GOLDTHWAIT, 1985, Map A2
35.	Beardmore Glacier	1:500,000	thematic sketch map (1b)	glacial geology	6	-	MAYEWSKI & GOLDTHWAIT, 1985, Map A3
36.	Rennik Glacier-Talos Dome, Victoria Land	1:2,850,000	locabon sketch map	trimlines	5	contours	DENTON & *alii*, 1986, fig. 2
37.	Rennick Glacier, Victoria Land	1:370,000	thematic sketch map (1a)	glacial features, trimlines	10	contours	DENTON & *alii*, 1986, fig. 3 a, b, c, d, e, f
38.	Wright Valley, Dry Valleys	1:550,000	location sketch map	tills, moraines	4	-	CAMPBELL & CLARIDGE, 1988, fig. 2
39.	Hatherton Glacier	1:600,000	location sketch map	drifts	10	contours	BOCKHEIM & *alii*, 1989, fig. 1
40.	Hatherton Glacier Area	1:200,000	thematic sketch map (1b)	drift sheets and moraines	13	spot heights	BOCKHEIM & *alii*, 1989, fig. 3
41.	Darwin Mount, Hatherton Glacier Area	1:120,000	thematic sketch map (1b)	drift sheets and moraines	16	spot heights	BOCKHEIM & *alii*, 1989, fig. 4
42.	Terra Nova Bay	1:330,000	location sketch map	debris-covered glaciers	5	-	CHINN & *alii*, 1989, fig. 1
43.	Boulderclay Glacier, Victoria Land	1:25,000	thematic sketch map (1b)	supraglacial morphology	10	-	CHINN & *alii*, 1989, fig. 3
44.	Beardmore Glacier	1:2,000,000	location sketch map	drifts	5	spot heights	DENTON & *alii*, 1989a, fig. 1
45.	Meyer Desert, Beardmore Glacier Area	1:110,000	thematic sketch map (1b)	drift sheets and moraines	14	spot heights	DENTON & *alii*, 1989a, fig. 2
46.	Buckley Island, Beardmore Glacier Area	1:80,000	thematic sketch map (1b)	drift sheets and moraines	8	spot heights	DENTON & *alii*, 1989a, fig. 10
47.	Lizard Point, Beardmore Glacier Area	1:50,000	thematic sketch map (1b)	drift sheets and moraines	9	spot heights	DENTON & *alii*, 1989a, fig. 12
48.	The Cloudmaker, Beardmore Glacier Area	1:66,000	thematic sketch map (1b)	drift sheets and moraines	7	spot heights	DENTON & *alii*, 1989a, fig. 15
49.	Arena Valley, Dry Valleys	1:37,000	thematic sketch map (1a)	moraines, drifts	5	-	DENTON & *alii*, 1989b, fig. 10
50.	Ross Embayment	1:23,000	location sketch map	raised beaches, grounded ice	2	-	DENTON & *alii*, 1989b, fig. 13
51.	Outback Nunataks, Victoria Land	1:1,470,000	thematic sketch map (1a)	ice-flow directions	-	-	HÖFLE, 1989, fig. 2
52.	Frontier Mountain, Victoria Land	1:57,000	thematic sketch map (1a)	ice-flow directions	-	spot heights	HÖFLE, 1989, fig. 7
53.	Roberts Butte, Victoria Land	1:60,000	thematic sketch map (1a)	ice-flow directions	-	contours	HÖFLE, 1989, fig. 8
54.	Evans Névé, Victoria Land	1:384,000	location sketch map	steep slopes, erratics	-	-	HÖFLE & *alii*, 1989, fig. 2
55.	Hells Gate Ice Shelf, Terra Nova Bay	1:250,000	location sketch map	moraines	-	spot heights	BARONI, 1990a, fig. 1
56.	Hells Gate Ice Shelf, Terra Nova Bay	1:20,000	thematic sketch map (1b)	supraglacial debris	14	spot heights	BARONI, 1990a, fig. 7
57.	Strandline Glacier, Terra Nova Bay	1:2,200	thematic sketch map (1b)	glacial deposits	13	spot heights	BARONI, 1990b, fig. 1
58.	Transantarctic Mountains	-	location sketch map	Sirius Formation	1	-	CLAPPERTON & SUGDEN, 1990, fig. 4
59.	Beardmore-Mill Glacier	1:125,000	thematic sketch map (1b)	drift sheets and moraines	8	contours	CLAPPERTON & SUGDEN, 1990, fig. 10, 2 f
60.	Hatherton Glacier	1:125,000	themahc sketch map (1b)	drift sheets and moraines	7	spot heights	CLAPPERTON & SUGDEN, 1990, fig. 11, 2 f
61.	Inexpressible Island, Terra Nova Bay	1:100,000	thematic sketch map (1a)	raised beaches	5	-	OROMBELLI, 1990, fig. 1
62.	Terra Nova Bay	1:770,000	thematic sketch map (1a)	trimlines, stiations	2	contours	OROMBELLI & *alii*, 1990, plate 1
63.	Terra Nova Bay	1:400,000	thematic sketch map (1b)	glacial morphology, beaches	10	spot heights	OROMBELLI & *alii*, 1990, fig. 7
64.	Terra Nova Bay	1:830,000	thematic sketch map (1b)	coastal morphology	10	spot heights	OROMBELLI & *alii*, 1990, fig. 23, 2 map
65.	Terra Nova Bay	1:1,130,000	location sketch map	ice shelves	2	contours	BARONI & *alii*, 1991, fig. 1
66.	Nansen Ice Shelf, Terra Nova Bay	1:312,000	thematic sketch map (1a)	boundary ice shelf	-	-	BARONI & *alii*, 1991, fig. 4
67.	Hells Gate Ice Shelf, Terra Nova Bay	1:62,500	thernatic sketch map (1a)	boundary ice shelf	-	-	BARONI & *alii*, 1991, fig. 6
68.	Boulderclay Glacier, Victoria Land	1:33,000	thematic sketch map (1b)	supraglacial morphology	10	-	CHINN, 1991, fig. 10
69.	Amorphous Glacier, Victoria Land	1:8,000	thematic sketch map (1a)	ice-cored drift features	12	-	MENEGHEL & *alii*, 1991, fig. 4
70.	Mt. Emison, Victoria Land	1:62,000	morphographic sketch	morphographic data	27	spot heigts	BIASINI & *alii*, 1992, fig. 6
71.	Outback Nunataks, Victoria Land	1:1,380,000	thematic sketch map (1a)	ice flow directions	4	-	HÖFLE & *alii*, 1992, fig. 3
72.	Frontier Mountain, Victoria Land	1:57,000	thematic sketch map (1a)	ice flow directions	-	spot heights	HÖFLE & *alii*, 1992, fig. 5
73.	Roberts Butte, Victoria Land	1:62,500	thematic sketch map (1a)	ice-flow directions	-	contours	HÖFLE & *alii*, 1992, fig. 6
74.	Northern Victoria Land	1:7,629,000	thematic sketch map (1a)	striations	3	spot heights	VAN DER WATEREN & VERBERS, 1992, fig. 1
75.	Prince Albert Mountains, Victoria Land	1:1,130,000	location sketch map	nunataks, ice-cored moraines	-	contours	VERBERS & VAN DER WATEREN, 1992, fig. 1
76.	Morris Basin, Victoria Land	1:357,000	thematic sketch map (1a)	ice-flow directions, moraines	8	spot heights	VERBERS & VAN DER WATEREN, 1992, fig. 4
77.	Mt. Levick, Victoria Land	1:45,000	morphographic sketch	morphographic data	22	-	BIASINI & SALVATORE, 1993, fig. 3
78.	Transantarctic Mountains	1:8,600,000	location sketch map	distribution Sirius Formation	2	-	DENTON & *alii*, 1993, fig. 4
79.	Dry Valleys	1:770,000	thematic sketch map (1a)	planation surfaces	9	-	DENTON & *alii*, 1993, fig. 14
80.	Dry Valleys	1:2,000,000	location sketch map	Sirius Group	-	-	HALL & *alii*, 1993, fig. 1
81.	Wright Valley, Dry Valleys	1:55,000	thematic sketch map (1a)	till distribution	8	-	HALL & *alii*, 1993, fig. 2
82.	lower Arena Valley, Dry Valleys	1:35,000	thematic sketch map (1a)	moraines	4	-	MARCHANT & *alii*, 1993b, fig. 10
83.	Taylor Valley, Dry Valleys	1:117,000	location sketch map	glaciers	-	-	WILCH & *alii*, 1993, fig. 2
84.	Rohne Platform, Dry Valleys	1:41,000	thematic sketch map (1b)	surficial deposits, drifts	11	-	WILCH & *alii*, 1993, fig. 7
85.	Victona Land coast	1:5,000,000	thematic sketch map (1b)	coastal morphology	6	-	BARONI, 1994, fig. 1
86.	Victoria Land coast	1:5,000,000	location sketch map	distribution penguin rookeries	-	contours	BARONI & OROMBELLI, 1994a, fig. 1
87.	Terra Nova Bay	1:100,000	thematic sketch map (1a)	raised beaches, moraines	4	spot heights	BARONI & OROMBELLI, 1994b, fig. 2
88.	Dry Valleys	1:800,000	thematic sketch map (1a)	main landscape types	8	-	SUGDEN & *alii*, 1995, fig. 4

TABLE 6 - Thematic-, location- and morphographic sketch maps (East Antarctica except Victoria Land and Transantarctic Mountains)

n°	zone	approx. scale	typology	main information	legend entries	topographic data	reference
1.	Sør Rondane	1:83,000	location sketch map	moraines, glaciers, drainage	5	spot heights	VAN AUTENBOER, 1964, fig. 3
2.	Sør Rondane	1:83,000	thematic sketch map (1a)	bluice, snow dunes, windscoops	3	spot heights	VAN AUTENBOER, 1964, fig. 7
3.	Alexander Humboldtfjella, Queen Maud Land	1:322,000	thematic sketch map (1b)	glacial morphology, glaciology	18	contours	BARDIN, 1972, fig. 1
4.	Vestfold Hills	1:250,000	thematic sketch map (1b)	glacial and marine morphology	11	-	ADAMSON & PICKARD, 1983, fig. 1
5.	North Masson Range, Vestfold Hills	1:40,000	thematic sketch map (1a)	glacial features	9	spot heights	PICKARD & ADAMSON, 1983, fig. 1
6.	Yamato Mountains	1:500,000	thematic sketch map (1b)	glacial morphology	9	spot heights	YOSHIDA, 1983, fig. 3
7.	Yamato Mountains	1:2,000,000	thematic sketch map (1a)	bare ice distribution	2	-	YOSHIDA, 1983, fig. 4
8.	Lützow-Holm Bay	1:2,000,000	thematic sketch map (1a)	ice conditions	-	-	YOSHIDA, 1983, fig. 5
9.	Sinnan Rocks, Prince Olav Coast	1:105,000	thematic sketch map (1a)	beaches, glacial features	8	-	YOSHIDA, 1983, fig. 7
10.	Langhovde	1:83,000	thematic sketch map (1b)	morphography, deposits	10	-	YOSHIDA, 1983, fig. 9
11.	Skarvsnes, Lützow-Holm Bay	1:100,000	thematic sketch map (1b)	morphography, deposits	10	-	YOSHIDA, 1983, fig. 10
12.	Skallen, Lützow-Holm Bay	1:90,000	thematic sketch map (1b)	morphography, deposits	10	-	YOSHIDA, 1983, fig. 12
13.	Sôya Coast -Prince Olav Coast	1:1,000,000	location sketch map	ice movment by glacial striations	-	-	YOSHIDA, 1983, fig. 16
14.	Vestfold Hills	1:263,000	location sketch map	periglacial landforms	6	-	ZHANG, 1983, fig. 1
15.	Vestfold Hills	1:215,000	location sketch map	glacial and interglacial deposits	6	-	ZHANG & *alii*, 1983, fig. 1
16.	Vestfold Hills	1:250,000	location sketch map	periglacial landforms	-	-	ZHANG & PETERSON, 1984, fig. 6
17.	Vestfold Hills	1:180,000	thematic sketch map (1a)	terraces	6	-	ZHANG & PETERSON, 1984, fig. 8
18.	Vestfold Hills	1:357,000	location sketch map	surficial deposits	6	-	ADAMSON & PICARD, 1986, fig. 3.3
19.	SE quadrant of Vestfold Hills	1:125,000	thematic sketch map (1a)	drainage system, moraines	10	-	ADAMSON & PICARD, 1986, fig. 4.10
20.	NE corner of Vestfold Hills	1:50,000	thematic sketch map (1a)	shear zone of ice-sheet	9	-	ADAMSON & PICARD, 1986, fig. 4.14
21.	SE corner of Vestfold Hills	1:58,000	thematic sketch map(1a)	gullyes, cliffs, glaciology	8	-	ADAMSON & PICARD, 1986, fig. 4.16
22.	Sorsdal Glacier, Vestfold Hills	1:294,000	location sketch map	glacial features	9	contours	ADAMSON & PICARD, 1986, fig. 4.18
23.	Sorsdal Glacier, Vestfold Hills	1:71,000	thematic sketch map (1a)	glacial features, moraines	9	-	ADAMSON & PICARD, 1986, fig. 4.20
24.	Vestfold Hills, 4 maps	1:625,000	location sketch map	weathering, ventifacts, sand, salt	-	-	ADAMSON & PICARD, 1986, fig. 4.26
25.	Sør Rondane Mountains	1:300,000	thematic sketch map (1b)	glacial morphology	8	contours	HIRAKAWA & *alii*, 1988, fig. 2
26.	Mefiell and Menipa, Sør Rondane Mountais	1:280,000	thematic sketch map (1b)	glacial morphology	8	contours	HIRAKAWA & *alii*, 1988, fig. 3
27.	Vestfold Hills	-	thematic sketch map (1b)	periglacial morphology	6	-	ZHANG, 1989, fig. 2
28.	Mt. Riiser-Larsen Area, Enderby Land	1:100,000	thematic sketch map (1b)	glacial morphology, beaches	11	contours	AKIYAMA & *alii*, 1990, fig. 1
29.	Mt. Riiser-Larsen Area, Enderby Land	1:85,000	thematic sketch map (1b)	glacial morphology, beaches	13	contours	HAYASHI, 1990, fig. 2
30.	Brattnipene, Sør Rondane Mountains	1:110,000	thematic sketch map (1b)	glacial morphology	6	contours	HIRAKAWA & MORIWAKI, 1990, fig. 2
31.	Lunckeryggen, Sør Rondane Mountains	1:55,000	thematic sketch map (1b)	glacial morphology	6	contours	HIRAKAWA & MORIWAKI, 1990, fig. 3
32.	Vestfold Hills	1:330,000	thematic sketch map (1a)	eskers	5	-	FITZSIMONS, 1991, fig. 2
33.	Sor Rondane Mountains	1:1,800,000	location sketch map	moraine fields	3	contours	MORIWAKI & *alii*, 1991, fig. 1
34.	Sor Rondane Mountains	1:800,000	location sketch map	till distribution	-	contours	MORIWAKI & *alii*, 1991, fig. 2
35.	Bunger Hills	1:330,000	location sketch map	sea ice, snowbanks	4	-	ADAMSON & COLHOUN, 1992, fig. 2
36.	Bunger Oasis, Bunger Hills	1:330,000	thematic sketch map (1b)	glacial morphology	21	spot heights	ADAMSON & COLHOUN, 1992, fig. 3
37.	Geographers Island, Bunger Hills	1:100,000	thematic sketch map (1a)	raised beaches, moraines	4	contours	COLHOUN & ADAMSON, 1992a, fig. 3
38.	Thomas Island, Bunger Hills	1:100,000	thematic sketch map (1a)	raised beaches, moraines	5	contours	COLHOUN & ADAMSON, 1992a, fig. 8
39.	Charnockite, Bunger Hills	1:100,000	thematic sketch map (1a)	raised beaches	3	contours	COLHOUN & ADAMSON, 1992a, fig. 15
40.	Cape Surovyi, Bunger Hills	1:100,000	thematic sketch map (1a)	beaches	3	contours	COLHOUN & ADAMSON, 1992a, fig. 16
41.	Fish Tail Bay, Bunger Hills	1 :100,000	thematic sketch map (1a)	raised beaches, moraines	5	contours	COLHOUN & ADAMSON, 1992a, fig. 19
42.	Bunger Hills	1:330,000	thematic sketch map (1b)	glacial morphology	18	spot heights	COLHOUN & ADAMSON, 1992b, fig. 2
43.	Kapakon and Transkriptsii inlet, Bunger Hills	1:100,000	thematic sketch map (1a)	raised beaches, moraines	5	beaches heigts	COLHOUN & ADAMSON, 1992b, fig. 3
44.	central Sør Rondane Mountains	1:100,000	location sketch map	supraglacial moraine fields	5	contours	HASEGAWA & *alii*, 1992, fig. 1
45.	Bergersenfjella, Sør Rondane Mountains	1:45,000	thematic sketch map (1b)	glacial morphology	7	cross section	HASEGAWA & *alii*, 1992, fig. 3
46.	Mefjell, Sør Rondane Mountains	1:100,000	thematic sketch map (1a)	ice lobe, moraine fields	5	contours	HASEGAWA & *alii*, 1992, fig. 8
47.	Fisher Massif, Prince Charles Mountains	1:200,000	thematic sketch map (1b)	glacial morphology	6	-	MABIN, 1992, fig. 2
48.	Fisher Massif, Prince Charles Mountains	1:66,000	thematic sketch map (1b)	glacial morphology	6	contours	MABIN, 1992, fig. 3
49.	Nils Larsenfjellet, Sør Rondane Mountains	1:100,000	thematic sketch map (1b)	glacial morphology	7	contours	MORIWAKI & HIRAKAWA, 1992, fig. 3
50.	Wideroefjellet-Viking Valley, Sor Rondane	1:100,000	thematic sketch map (1b)	glacial morphology	9	contours	MORIWAKI & HIRAKAWA, 1992, fig. 5
51.	Vikinghøgda, Sør Rondane Mountains	1:100,000	thematic sketch map (1b)	glacial morphology	9	contours	MORIWAKI & HIRAKAWA, 1992, fig. 6
52.	Otto Borchgrevinkfiellet, Sør Rondane Mts.	1:100,000	thematic sketch map (1b)	moraine fields, moraine ridges	7	contours	MORIWAKI & HIRAKAWA, 1992, fig. 7
53.	Tanngarden & Pingvinane, Sor Rondane Mts.	1:100,000	thematic sketch map (1b)	moraine fields, moraine ridges	7	contours	MORIWAKI & HIRAKAWA, 1992, fig. 8
54.	Sør Rondane Mountains	1:1,160,000	location sketch map	moraine fields	3	contours	MORIWAKI & *alii*, 1992, fig. 1
55.	central part of Sør Rondane	1:454,000	thematic sketch map (1a)	moraines, crevasses	6	-	PATTYN & *alii*, 1992, fig. 3
56.	Langtovde	1:75,000	thematic sketch map (1a)	deposits distribution	6	contours	HAYASHI & YOSHIDA, 1994, fig. 3
57.	Skarvsnes, Lützow-Holm Bay	1:85,000	thematic sketch map (1a)	deposits distribution	5	contours	HAYASHI & YOSHIDA, 1994, fig. 4
58.	Maudheimvidda, Queen Maud Land	1:1,640,000	thematic sketch map (1a)	glaciology, nunataks, cirques	6	spot heights	HOLMLUND & NÄSLUND, 1994, fig. 2
59.	Central Sor Rondane	1:555,000	thematic sketch map (1a)	moraines	7	contours	MORIWAKI & *alii*, 1994, fig. 1

been published (5 and 9, tab. 1, fig. 1), even if numerous maps, not considered here, have a glaciological theme.

The main discrepancies emerging from comparisons in criteria used for the production of geomorphological maps are those mainly regarding the means of representation, the importance given to landform genesis and the indication or otherwise of lithology and morphography. These differences reflect the points of view of various geomorphological schools, and are also a function of scale of representation and local characteristics of the areas surveyed. As regards this last point, it was noted that some methods of geomorphological representation applied in Antarctica cannot easily be used in areas with different characteristics. In other words, some maps are excessively specialised, being in some ways similar to geomorphological thematic selected maps.

The Antarctic geomorphological maps are generally accompanied by booklets with supplementary text regarding the mapped features. They are useful documents to better understand the interrelationships between various mor-

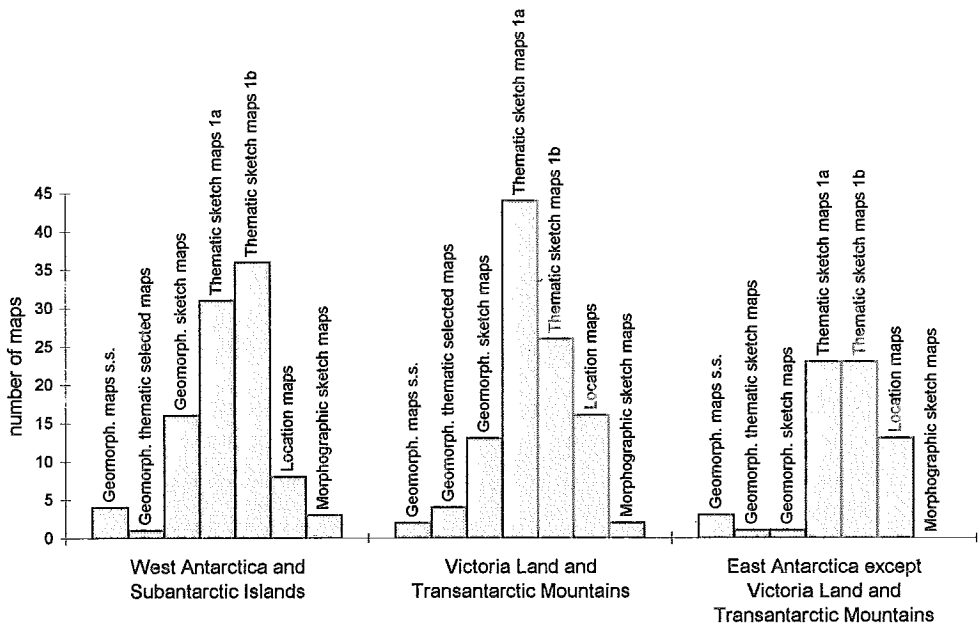

FIG. 2 - Geographical distribution of the Antarctic geomorphological cartography. 1a) single landforms are considered; 1b) landforms and deposits related to a specific morphogenetic agent.

phogenetic systems and the geomophological and geological evolution of an area. Geomophological maps offer an areal representation useful to emphasize adequately the interpretations from studies of Cenozoic geology (*i.e.* landscape analysis, distribution and dating of glacial drift, lake sediment studies). On the other hand, it is interesting to integrate geomorphological maps with data useful for the dating of landforms and deposits, for recognition of soil chronosequences, for the characterization of landscape evolution and glacial history. Some maps and booklets contain additional information relative to ^{14}C and other radiometric ages, to lichen thalli diameter, to raised beach altitudes and also include photographs of landscape features.

Observing fig. 2, (which summarizes the number of documents grouped according to omogeneus landscape areas) it can be noted, despite the numerous geomorphological papers existing, that very few geomorphological maps have been published. This merits reflection as regards the future role of geomorphological cartography in Antarctica, both as a method of basic research and as a technique of representation and analysis of the territory. It is important that various nations have produced geomorphological maps of different areas of the continent (*i.e.* Italy, Germany, Japan, Spain, United Kingdom) and that new research on geomorphological analysis of the landscape is in course (*i.e.* U.S. and New Zealand research in the Dry Valleys).

In noting the geographical distribution of the geomorphological maps and sketch maps, it is evident that there is a relation with nearby scientific bases and their logistic facilities. However, the contrary is not always true, that is that the presence of bases has determined the production of geomorphological maps.

If we consider small individual areas, there is a greater concentration of documents in those zones where there are questions to be answered and still scientific debate between different schools of thought, so proving that the geomorphological contribute has a significant role in the Antarctic scientific research. However geomorphological maps have an evident scientific significance as base documents for numerous research projects. A good example is that of the Dry Valleys-McMurdo Sound area, which presents the greatest number of documents. Even though no geomorphological map *s.s.* of this area has been published, there are many geomorphological thematic selected maps and geomorphological sketch maps, which in a certain sense make up for the lack of documents of a more general nature. Other areas, however, such as the South Shetland Islands and Terra Nova Bay, present a varied geomorphological documentation and the available data have been further summarized in smaller scale geomorphological maps *s.s.* In the Bunger Hills and Vestfold Hills numerous documents have been produced, but summary documents are lacking, including geomorphological thematic selected maps or geomorphological sketch maps. There are also areas such as South Georgia where production of geomorphological maps *s.s* began about 25 years ago, but then ceased.

In general, there is relatively widespread geomorphological research in Antarctica, even if there are discrepancies between cartographic products, above all as regards geomorphological maps *s.s* and thematic maps. This is in relation to the different periods of production (between the 1960s and 1996, fig. 3) and above all to the different geomorphological schools producing the maps.

Particular significance must be given to the recent possibilities offered by satellite images for landscape analysis and computer techniques for geomorphological map production. Geomorphological maps seem to be acquiring

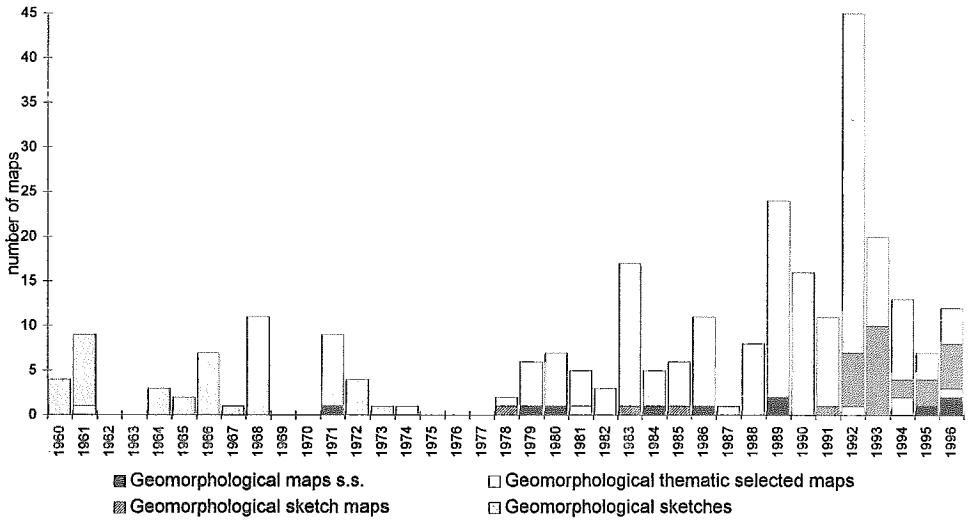

FIG. 3 - Geomorphological cartographic production between 1960s and 1996.

ever increasingly the role of base documents integrated in complex systems of geographical information (Gis), which include also other thematic maps, such as, for example, geological maps. With this in mind, it is particularly useful to consider the individual items of the map legends as levels of information of an Antarctic Gis, which will become richer in information as new maps are produced. For the future it is to be hoped that there will be extensive collaboration between the researchers working on Antarctic geomorphology. There is evidently great convenience in using comparable, and possibly even compatible and integrated, legends. It is our hope that this paper will serve as a document of synthesis of the data available and stimulate discussion and comparison between the various geomorphological schools.

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