

*LANDSCAPE DEVELOPMENT
AND VEGETATION
OF THE
VESTFOLD HILLS,
EAST ANTARCTICA*

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Ph.D. thesis 22 November 1984



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Ph.D. Thesis - John Pickard -

"Landscape Development and Vegetation of the Vestfold Hills, East Antarctica"Errata Sheet.

p. 10/line 2	of East
10/ 12	Geomorphological
10/ 14	to Cainozoic
17/ 2	Insert - Liverworts are also present on the Antarctic Peninsula.
32/2	(Figure 18)
36/32	(Figure 24b)
39/3	Ventefacts (dolerite cobbles) at ...
42/2-4	c) flattened pavement, d) patterned ground ...
57/12	number
79/4	omit - oriented north east-south west
81/6	quadrant
89/19	PRESENT STATE OF
92/8	north
92/14	described
101	insert - Goldthwait, R.P. (1973) Till deposition versus glacial erosion, pp. 159-166 in Fahey, B.D., and R.D. Thompson (eds) Research in polar and alpine geomorphology. (Geo Abstracts Ltd: Norwich)
134/7	results
138/15	(1981)
139/19	calendar
139/22	instruments
180/18	Phytogeographic
186/14 & 15	east
192/13	insert - "elsewhere in" after "from"
192/22	Sørøsdal
195/14	geomorphic
195/26	artifact
315/5	calendar
316/9	insert "Apart from Chlamys tuftsensis," all the macro fossils ...
335/7	1977
361/12	... Anderson Lake and Ellis Fjord ...
378/10	hundreds
379/3	end
408/Fig. to legend	fully

Landscape development and vegetation of the Vestfold Hills,
East Antarctica.

Thesis submitted for the degree of Doctor of Philosophy in the
School of Biological Sciences, Macquarie University by John
Pickard B.Sc.Agr.(Sydney) M.Sc.(Sydney).

Supervisor Dr. D.A. Adamson.

Based on field work whilst a member of the Australian National
Antarctic Research Expeditions to Davis Station 1978-79, 1979-81;
and employed by the Antarctic Division of the Australian
Department of Science and Technology from 1978 to 1981.

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Sub glacies quod tegitur, dum nix perit,
omne videtur.

When the ice melts, all that is hidden
is revealed

Medieval Latin proverb

"You fail to understand" he said,
"why must you even try"

Bob Dylan 'Drifter's Escape'

SUMMARY

The Vestfold Hills (68° 35'S 78° 00'E) are a 400 km² ice-free oasis on the coast of East Antarctica. Low hills of Archaean gneisses are draped with Holocene till. The area is bounded in the east by the ice sheet and in the south by the Sørødal Glacier. Present geomorphic processes are variable across the Hills from the coast to the ice sheet. Active melt processes have been measured on the ice margins and on an ice-cored moraine. Rivers flowing through the Hills carry meltwater from the ice sheet and glacier via a series of lakes to the sea. The Druzhby River system is one of the largest externally-draining systems in Antarctica. Pingos occur on the ice-cored moraine, the only-known site in the Southern Hemisphere. Freeze/thaw activity is high across the Hills, but periglacial landforms are not uniformly distributed.

Vegetation is sparse overall but most abundant in a zone a few kilometres from the ice sheet, due to the interaction of windblown salt, water, and nutrient availability. The Hills belong to the Coastal Zone of the Continental Antarctic Region. Within a single moss bed, chance is important in determining distribution. Mosses are among the oldest Holocene fossils in the Hills. Problems with moss taxonomy severely retard ecological and physiological research.

Tertiary marine sediments mark the location of a Late Miocene coast remarkably close to the present coastline, during an interglacial period with climate similar to the present. The terminal Pleistocene expansion of the ice sheet (Vestfold Glaciation) swamped the Hills under > 1 000 m of ice. Holocene ice retreat has exposed the Hills. Retreat is documented and radiocarbon-dated by abundant marine fossils above hypersaline lakes. Marine inlets isolated by isostatic uplift became chains of lakes with complex Holocene histories. All Holocene marine fossils are extant species with wide ecological tolerances. Holocene climates in the Hills were little different from present. Fossil mosses and stromatolites indicate unusual lakes which have changed from marine to fresh and vice versa.

Low altitude makes the Hills an excellent site for the preservation of evidence bearing on the Holocene collapse of the antarctic ice sheet.

DECLARATION OF ORIGINALITY

I hereby declare that the data and information in this thesis have not been submitted elsewhere for any other degree.

I also declare that except where expressly acknowledged to the contrary in the text or below, all the work is my own.

The following list summarises my contribution to the nine joint papers in the body of the thesis.

Physiography of the Vestfold Hills. Antarctic oasis. (Academic Press) (D.A. Adamson & J. Pickard) In press

50% of conception, 50% of writing.

Perennially frozen lakes at glacier/rock margins. pp. 470-472 in Oliver, R.L., James, P.R. & Jago, J.B. (eds) (1983) Antarctic earth science. (Australian Academy of Sciences: Canberra) (J. Pickard & D.A. Adamson) 1983

75% of conception, 90% of writing.

Holocene occurrence of the moss Bryum algens Card. in the Vestfold Hills, Antarctica. Journal of Bryology 13: 209-217. (J. Pickard & R.D. Seppelt) 1984

Conception, analysis, 80% of writing.

Phytogeography of Antarctica. Journal of Biogeography 11: 83-102. (J. Pickard & R.D. Seppelt) 1984

Conception, analysis, 80% of writing.

Late Quaternary ice movement across the Vestfold Hills, Antarctica. pp. 465-469 in Oliver, R.L., James, P.R. & Jago, J.B. (eds) (1983) Antarctic earth science

(Australian Academy of Sciences: Canberra) (D.A. Adamson & J. Pickard) 1983

50% of conception, 20% of writing.

Late Tertiary marine sediments and coastline of East Antarctica. (J. Pickard, D.A. Adamson, D.M. Harwood, G.H. Miller, P.G. Quilty & R.K. Dell) In preparation.

Conception, coordination of identifications, 50% of writing.

Holocene climates of the Vestfold Hills, Antarctica and Macquarie Island. Palaeoecology of Africa (Balkema: Rotterdam) (J. Pickard, P.M. Selkirk & D.R. Selkirk) In press

50% of conception, 75% of writing, presentation at symposium.

Holocene fossil stromatolites from the Vestfold Hills, East Antarctica. (J. Pickard & P.A. Broady) Geomicrobiology Journal Submitted.

Conception, 75% of analysis, 75% of writing.

The evolution of Watts Lake, Vestfold Hills, East Antarctica, from marine inlet to freshwater lake. (J. Pickard, D.A. Adamson & C.M. Heath) Palaeogeography, Palaeoclimatology, Palaeoecology Submitted.

Conception, 75% of writing.

Specific contribution of joint authors:

D.A. Adamson: contribution as supervisor to all phases of the study, use of radiocarbon dates supported by Australian Research Grants Scheme and Macquarie University Research Grants, and assistance with some field work.

P.A. Broady: identification and knowledge of cyanobacteria.

R.K. Dell: identification and knowledge of antarctic molluscs.

D.M. Harwood: identification and knowledge of antarctic diatoms.

C.W. Heath: data on chemistry and biology of Watts Lake.

G.H. Miller: amino acid racemisation measurements.

P.G. Quilty: identification and knowledge of foraminifera.

D.R. & P.M. Selkirk: knowledge of palynology of Macquarie Island.

R.D. Seppelt: identification and knowledge of antarctic bryophytes and lichens.

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30 October 1984.

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The Antarctic Division of the Australian Department of Science and Technology employed me as a Biologist with the Australian National Antarctic Research Expeditions from 1978 to 1981 so I could fulfill a life-long dream about working in Antarctica. The dream was a pale imitation of the reality. The Division also allowed me the freedom to pursue what I perceived as interesting research. Scientists within the Division helped me before and after my two trips to Antarctica. Rod Seppelt and I spent many cold days searching for the elusive antarctic moss in the Hills, and he gave freely and generously of his knowledge.

The School of Biological Sciences, Macquarie University under two Heads of School (Professors G.B. Sharman and D.W. Cooper) gave me space and excellent working conditions from 1982 to 1984. Peter Hughes initiated me into the computing system on campus and spent many hours helping me with various analyses. Patricia Selkirk advised me on many aspects of bryophyte ecology.

The Australian Department of Education awarded me a Commonwealth Post Graduate Research Award which helped support me.

The 20 expeditioners with whom I lived at Davis in 1980 were family that year. They may have been atypical of expeditioners, and asocial to outsiders, but they offered me life-long friendships. In the field they endured cold and bitter conditions supporting many aspects of my research.

Last and not least, my thanks to Nan, who helped me go south; and to Heidi who introduced me to Patagonia.

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1:50 000 scale topographic map of the Vestfold Hills
(in pocket at back)

which has been used to generate the