Deep Sea Drilling Project, Vol. 71. Washington, D.C.: U.S. Government Printing Office.

DeFelice, D. R. 1979. Morphological comparison of *Coscinodiscus lentiginosus* Jansich and *Coscinodiscus obovatus* Castracane. *Antarctic Journal of the U.S.*, 14(5) 127–129.

Gombos, A. M., Jr., and P. F. Ciesielski. 1983. Late Eocene to early Miocene diatoms from the southwest Atlantic. In W. J. Ludwig, V. Krashninnkov, et al., (Eds.), *Initial Reports of the Deep Sea Drilling Project*, Vol. 71. Washington, D.C.: U.S. Government Printing Office.

McCollum, D. W. 1975. Diatom Stratigraphy of the Southern Ocean. In D. Hayes, L. A. Frakes et al. (Eds.), *Initial Reports of the Deep Sea Drilling Project*, Vol. 28. Washington, D.C.: U.S. Government Printing Office.

Schrader, H. S. 1976. Cenozoic marine planktonic diatom biostratigraphy of the Southern Pacific Ocean. In M. Talwani, G. Udintseu, et al. (Eds.), *Initial Reports of the Deep Sea Drilling Project*, Vol. 35. Washington, D.C.: U.S. Government Printing Office.

Weaver, F. M., and A.M. Gombos, Jr., 1981. Southern high latitude diatom biostratigraphy. In J. E. Warme, R. G. Douglas, E. L. Winterer (Eds.), *DSDP: A decade of progress.* (Special Publication 32.) Tulsa: Society of Economic Paleontologists and Mineralogists.

Webb, P. N., D. M. Harwood, B. C. McKelvey, J. H. Mercer, and L. D. Stott. 1983. Late Neogene and Older Cenozoic Microfossils in high elevation deposits of the Transantarctic Mountains: Evidence for marine sedimentation and ice volume variation on the east antarctic craton. *Antarctic Journal of the U.S.* 18(5).

Webb, P. N., D. M. Harwood, B. C. McKelvey, J. H. Mercer, and L. D. Stott. In press. Cenozoic marine sedimentation and ice volume variation on the East Antarctic craton. *Geology.*

Glacial geology and soils in Beacon Valley

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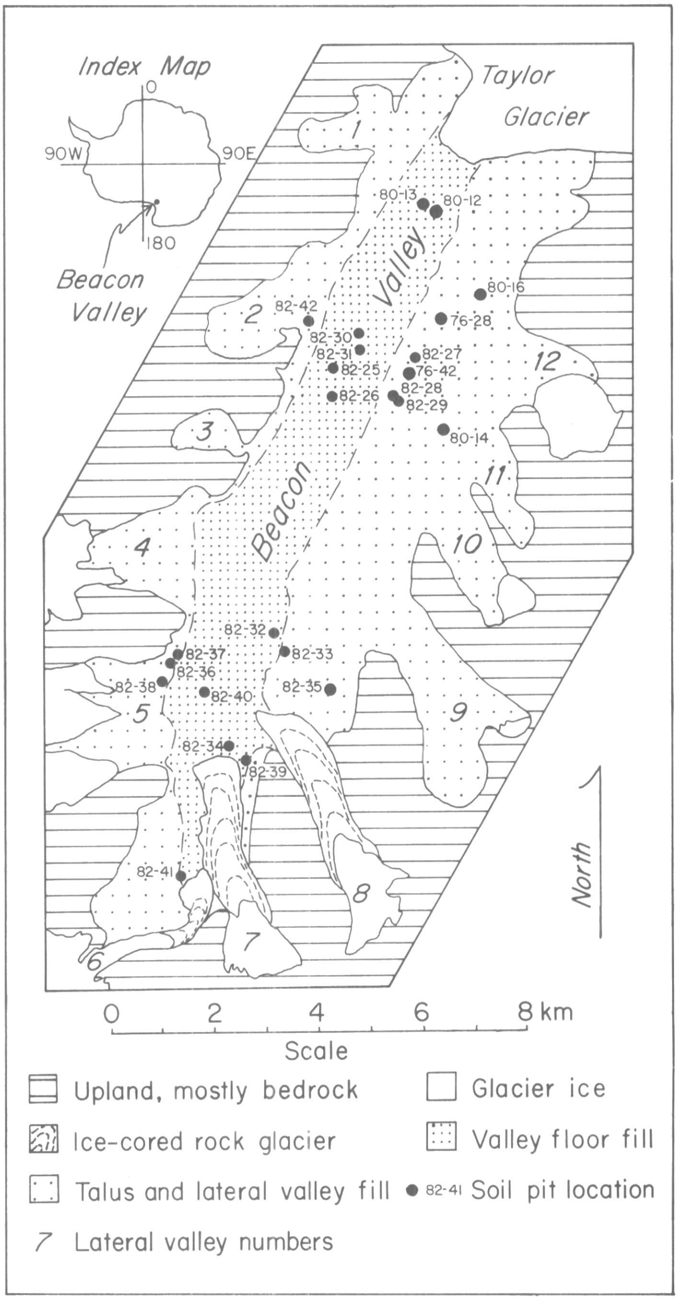
During the 1982–1983 field season, we spent 6 weeks examining the glacial history and soils of Beacon Valley (77°53'S 160°40'E), as part of G. H. Denton's and J. G. Bockheim's project to investigate the glacial history of the McMurdo Sound region. Our major objectives were: (1) to map glacial features and determine the chronology of glacial events using soils as relative age indicators, (2) to study fluctuations of Taylor Glacier where it has entered lower Beacon Valley, and (3) to study the behavior of alpine glaciers and ice-cored rock glaciers that originate in tributary lateral valleys (LV) (see figure) and mantle the main valley floor. We excavated, described, and sampled 18 soil pits and collected 57 samples for soil chemical analysis. In addition, we collected 57 samples from shallower excavations for particle size and mineralogical analysis. Surface boulder weathering counts were performed on a minimum of 100 boulders larger than 25 centimeters near each soil pit and on rock glacier lobes in LV 6 and 7.

In lower Beacon Valley, differences were observed in soils developed on deposits left by the various advances of Taylor Glacier. The least-developed soils occur on transverse moraine ridges on the main valley floor (2–4 kilometers from Taylor Glacier) and are presumably the youngest of the Taylor ad-



(Right) Sketch map (not a geologic map) showing locations of soil pits in Beacon Valley.

vances into Beacon Valley. Soils of intermediate development occur on a high Taylor lateral moraine on the southeastern valley wall, as well as on moraine fragments in LV 2. Depths of oxidation, coherence, ghosts, visible salts, and depth to ice-cement increase considerably between soils on the valley floor transverse moraines and those associated with the higher Taylor lateral moraines (table 1). Our soil morphologic data on these deposits is similar to that of Bockheim and Ugolini (1972) and Linkletter, Bockheim, and Ugolini (1973) from Beacon Valley. The percentage of boulders planed to the surface, ventifacted, pitted, fractured, and horned and hollowed is greater on the higher Taylor lateral moraine compared with the valley floor transverse moraine (table 2). Surface boulder frequency is higher on the transverse moraines than on the higher lateral moraine.

Soils on the valley floor transverse moraines and the higher lateral moraines in lower Beacon Valley are similar to soils on the Taylor II and III moraines in eastern Taylor Valley (Bockheim 1977; Pastor and Bockheim 1980), respectively. It is likely that Taylor IV ice advanced into Beacon Valley, as it did into nearby Arena Valley (Bockheim 1982), but in Beacon Valley it left behind very little drift—no Taylor IV moraines or soils have yet been found there.

In addition, we have mapped numerous features within the valley and on adjacent mountains that we believe are the result of erosion and deposition by overriding ice as noted elsewhere in the dry valley region (Denton, Kellogg, and Kellogg, *Antarctic Journal*, this issue). Denton postulates that an overriding ice sheet existed in the dry valleys area and flowed diagnally across the mountains and valleys in a southwest to northeast direction. Features we have mapped include abraded stoss sides of sandstone ridges, lee cliffs, and slopes eroded by subglacial meltwater to produce pothole-like features, megaripples, and dolerite-rich boulder trains derived from local peaks and smeared across lateral valleys.

The most strongly developed, and presumably oldest, soils in Beacon Valley, occur on parts of the central and upper valley floor and along the southeastern flanks where not disturbed by frost processes. We believe these soils represent drift from the overriding ice (tentatively named Altar drift), because they show a considerable increase in development compared to Taylor II and III soils. The depths of ghosts and visible salts, salt morphogenetic stage, and color of the B2 horizon are greater in soils on Altar drift than in those on Taylor II and III drifts (table 1). In addition, Altar soils have a silty, pulverulent nature which is not exhibited in Taylor II and III soils, and may suggest that extremely thick, wet-based ice deposited this material. Unlike the Taylor drifts, Altar drift commonly has many well-preserved buried ventifacts mixed within the solum.

Small alpine glaciers occupy 8 of the 12 lateral valleys (figure). We believe that these alpine glaciers are fed entirely by wind-blown snow carried by katabatic winds that blow from southwest to northeast around and over Mount Feather at the head of the valley and deposit snow in lee cirques. Mass loss from these glaciers is predominantly by sublimation. In some cases (LV 4 and 5), these glaciers are surrounded by ice-cored moraines that stand above the present glacier surface. In other lateral valleys (LV 6, 7, and 8), the alpine glaciers are transitional downvalley to still-active ice-cored rock glaciers, 1–3 kilometers long, on which a debris mantle that overlies clean ice becomes progressively thicker downvalley from 2–30 centimeters.

In at least one lateral valley (LV 5), both rock glaciers and clean alpine glacier lobes have formed at different times. The clean-ice lobes have left alpine lateral moraines that cross the rock glaciers

Table 1. Soil morphologic characteristics of different aged drifts in Beacon Valley

Profile number	Depth of oxidation[a]	Depth of visible salts[a]	Salt stage	Depth of ghosts[a]	Depth of coherence[a]	Field texture[b] (subsoil)	Depth to ice cement[a]	Munsell color (B2)
Youngest								
80–12	7	0	encrustations	0	7	S	48	10YR 5/4
80–13	5	0	encrustations	5	5	S	>70	10YR 5/4
Intermediate								
76–28	22	0	encrustations	0	22	S	>90	7.5YR 6/4
76–42	35	0	encrustations	35	10	S	>85	7.5YR 6/4
82–27	19	19	flecks	16	19	S	>105	10YR 6/6
82–28	20	20	flecks	20	20	S	>100	10YR 6/6
82–42	18	18	flecks	90	18	S	>100	10YR 6/6
Oldest								
80–14	30	25	patches	85	30	S	>110	5YR 5/8
80–16	28	28	flecks	68	93	LS	>93	10YR 6/6
82–26	36	19	weak pan	25	53	LS	53	7.5YR 5/6
82–29	87+	36	weak pan	38	87+	LS	>87	7.5YR 5/6
82–30	37	20	weak pan	32	37	S	89	7.5YR 5/6
82–31	34	20	weak pan	72	34	LS	86	7.5YR 5/6
82–33	85+	85+	strong pan	0	85+	LS	85	5YR 5/6
82–34	30+	14	weak pan	6	30	LS	30	7.5YR 5/6
82–35	22	11	weak pan	35	60	LS	60	7.5YR 5/6
82–39	26	13	weak pan	0	47	LS	47	7.5YR 5/6
82–40	60+	60	strong pan	58	60	LS	60	5YR 4/6

[a] In centimeters.

[b] "S" denotes sand; "LS" denotes loamy sand.

Table 2. Weathering of boulders on different aged drifts in Beacon Valley

Profile number	Number (per 314 square meters)	Diorite/ diorite + sandstone (%)	Pitted (%)	Spalled (%)	Desert varnish (%)	Venti- facted (%)	Planed to surface (%)	Fractured (%)	Horned and hollowed (%)	Scratched (%)	Depth to clean ice (in centimeters)
Youngest											
80–12	660	98	14	27	100	0	0	7	0	0	—[a]
Intermediate											
82–27	1036	92	26	23	100	65	2	20	0	0	—
82–28	837	92	12	23	100	63	4	30	0	0	—
82–42	289	87	23	59	93	12	8	26	11	0	—
76–42	285	97	43	45	93	12	9	5	0	0	—
(Avg.)	(612)	(92)	(26)	(38)	(97)	(38)	(6)	(20)	(3)	(0)	
Oldest											
82–26	547	100	30	33	98	57	18	30	3	0	—
82–30	412	96	17	47	100	66	8	24	5	0	—
82–31	511	100	30	32	100	75	6	24	2	0	—
82–33	465	100	40	45	100	86	1	9	2	0	—
82–34	887	98	44	35	100	74	4	20	8	0	—
82–40	200	100	49	16	100	57	29	36	4	0	—
80–16	365	81	23	17	100	3	16	33	6	0	—
(Avg.)	(484)	(96)	(33)	(32)	(100)	(60)	(12)	(25)	(4)	(0)	
LV 6 Rock Glacier											
(1)[b]	421	95	1	0	100	0	0	1	0	7	2
(2)	358	100	4	37	99	0	0	1	1	15	11
(3)	254	93	12	38	98	1	0	6	0	1	14
(4)	543	100	14	53	82	0	0	15	0	0	—
(5)	427	100	15	61	100	31	3	7	13	0	—
82–41	845	100	17	80	100	31	1	23	15	0	—
LV 7 Rock Glacier											
(6)[b]	85	99	8	3	81	0	0	1	0	3	2
(7)	455	100	29	0	90	0	0	1	0	19	2
(8)	292	100	12	15	100	2	0	3	0	0	13
(9)	807	100	18	22	100	0	0	2	0	0	18
(10)	887	100	27	66	100	2	0	4	8	0	17
82–34	887	98	44	35	100	74	4	20	8	0	—

[a] "—"denotes no data available.

[b] (1) through (5) and (6) through (10), youngest to oldest.

but disappear on the valley floor apparently because there was not sufficient debris on them to produce moraines at their termini. Where these alpine moraines disappear, we find soils that indicate a much greater antiquity of the rock glacier surface than that of the lateral moraines, suggesting that alpine ice advances over older rock glacier surfaces with little disturbance of the underlying soils. We are in the process of examining the various factors that may produce clean alpine glaciers under some conditions and rock glaciers under other conditions in the same valley.

Soils and surface boulders on the relatively young, still-active, ice-cored rock glaciers in LV 6, 7, and 8 show slight but progressive weathering downvalley. Weathering features such as percentage of boulders varnished, spalled, horned and hollowed, and planed to the surface show a perceptible increase with greater distance from the alpine glaciers in LV 6 and 7 (table 2). Percentage of boulders ventifacted, pitted, and fractured increases significantly from the youngest to oldest part of the rock glaciers. The debris mantle on these rock glaciers, once established, substantially reduces sublimation of ice and allows it to persist for long times while adjacent clean glaciers might retreat.

There is a sharp contrast between the soils associated with these relatively young ice-cored rock glaciers that have well-defined ridges, furrows, and lobes and older deposits immediately downvalley from them (table 2). Much of the broad floor of Beacon Valley that slopes 2–3° toward the northeast is mantled by deposits that we believe are older, now inactive, ice-cored rock glaciers that extend the length of Beacon Valley and beneath Taylor Glacier.

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References

Bockheim, J. G. 1977. Soil development in the Taylor Valley and McMurdo Sound area. *Antarctic Journal of the U.S.*, 12(4), 105–108.

Bockheim, J. G. 1982. Properties of a chronosequence of ultraxerous soils in the Trans-Antarctic mountains. *Geoderma*, 28, 239–255.

Bockheim, J. G., and F. C. Ugolini. 1972. Chronosequence of soils in the Beacon Valley, Antarctica. In W. P. Adams, and F. M. Helleiner (Eds.), *International Geography*, 1: 301–303.

Denton, G. H., D. E. Kellogg, and T. B. Kellogg. 1983. Ice sheet overriding of the Transantarctic Mountains. *Antarctic Journal of the U.S.*, 18(5).

Linkletter, G., J. Bockheim, and F. C. Ugolini. 1973. Soils and glacial deposits in the Beacon Valley, southern Victoria Land, Antarctica. *New Zealand Journal of Geology and Geophysics*, 16, 90–108.

Pastor, J. and J. G. Bockheim. 1980. Soil development on moraines of Taylor Glacier, lower Taylor Valley, Antarctica. *Soil Science Society of America Journal* 44, 341–348.