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Supplementary information for manuscript "Middle-Late Permian mass extinction on land" by G.J. Retallack, C.A. Metzger, T. Greaver, A.H. Jahren, R.M.H. Smith, and N.D. Sheldon.

Table 1 New organic carbon isotopic and total carbon data, Portal Mountain, Antarctica

Level (m)	Specimen #	Field #	rock	$\delta^{13}C_{org}$	Organic C (%)
185.5	R3060	HU27	siltstone	-21.89	0.01
185.3	R3059	HU26=B11	siltstone	-23.56	0.08
180.4	R3058	HU25	sandstone	-21.47	0.02
180	R3057	HU24	sandstone	-20.98	0.01
162.5	R3056	HU23	sandstone	-24.18	2.46
146	R3054	HU22	sandstone	-23.86	67.54
145.9	R3053	HU21	log	-24.24	72.50
145.5	R3052	HU20	coal	-24.43	74.14
145.3	R3051	HU19	coal	-23.94	68.10
145.2	R3050	HU18	coal	-23.85	72.90
145.1	R3049	HU17	coal	-23.77	73.86
145	R3048	HU16	shale	-24.10	72.96
144	R3047	HU15*	shale	-23.27	21.25
140.5	R3046	HU15	shale	-23.07	17.52
139	R3045	HU14	coal	-25.42	75.59
135.3	R3044	HU13	sandstone	-22.68	1.85
134	R3043	HU12	sandstone	-22.30	1.44
129	R3042	HU11	sandstone	-23.23	4.58
122.4	R3041	HU10	shale	-23.06	0.92
116	R3040	HU9	sandstone	-22.42	0.27
112.6	R3039	HU8	sandstone	-23.07	2.3
106	R3038	HU7	siltstone	-22.62	1.29
101	R3037	HU6	Carbonized log	-23.46	5.41
96	R3036	HU5	siltstone	-22.99	7.96
91.8	R3035	HU4	siltstone	-22.63	0.39
87.6	R3034	HU3	sandstone	-23.21	3.52
84.5	R3033	HU2	sandstone	-22.93	10.65
80.2	R3032	HU1=H37	Carbonized log	-20.48	3.01
74.5	R3031	H38	sandstone	-23.28	12.33
72.5	R3030	H40	siltstone	-22.26	2.04
70.7	R3029	H39	sandstone	-21.90	0.64
67.6	R3028	H36	sandstone	-22.08	1.86
67	R3152	H35	siltstone	-21.86	1.83
66	R3027	H34	sandstone	-22.10	2.84
64.5	R3026	DC	coal	-22.68	16.59
63	R3025	H33	sandstone	-21.02	0.64
62.5	R3024	2.5B	siltstone	-22.26	9.76
59	R3023	H32	sandstone	-22.62	3.32
58.5	R3022	H31	sandstone	-22.68	8
55	R3021	H30	siltstone	-22.35	2.39
53.5	R3020	H29	sandstone	-21.65	0.95
51.6	R3019	H28	sandstone	-22.06	1.97
45.5	R3016	H23=H24=H25	Claystone breccia	-22.33	1.65
45.4	R3015	H21	siltstone	-21.85	1.31
45.4	R3151	H22	siltstone	-21.96	1.33
44.6	R3014	H20	siltstone	-21.78	1.33
43.8	R3013	B9	Claystone breccia	-21.84	0.46
42	R3012	H19	coal	-22.27	1.43
41	R3011	H18	siltstone	-22.28	0.32
40.1	R3010	H17	siltstone	-22.98	1.12
39.5	R3009	H16=B8	Claystone breccia	-23.25	1.29
39.4	R3008	H15	coal	-24.6	3.46
39.1	R3007	H14	coal	-25.42	29.74
37.1	R3006	H13	siltstone	-25.12	3.19

36.9	R3005	H12	siltstone	-25.05	1.93
36.8	R3004	H11	siltstone	-25.84	6.28
36	R3003	H10	siltstone	-26.18	5.7
35	R3002	H9	siltstone	-26.04	9.31
33	R3001	H8	siltstone	-22.95	1.77
32	R3000	H7	siltstone	-23.21	2.86
30	R2999	H6	siltstone	-22.68	1.19
28.5	R2998	H5	siltstone	-23.19	4.18
27.8	R2992	B2	sandstone	-23.24	0.55
27.7	R2993	B3	sandstone	-21.84	0.06
27.6	R2994	B4	sandstone	-22.56	0.05
27.5	R2995	B5	sandstone	-22.07	0.1
27.4	R2996	B7	sandstone	-23.27	0.25
27.3	R2997	B6	sandstone	-23.13	0.57
25	R2990	H4*	sandstone	-23.63	2.19
21	R2989	H4	siltstone	-21.17	0.06
19	R2987	H2	sandstone	-21.15	0.05
15.9	R2986	H1	sandstone	-22.04	0.07

Table 2. Levels of therapsid tusk carbon isotopic data of Thackeray *et al*. (1990)

Level (m)	UCT #	SAM or GS* #	$\delta^{13}C_{carb}$	$\delta^{18}O_{carb}$	Notes
3436	2918	B201	-13.2	-15.4	Boesmanshoek-Graaf Reinet district upper *Cistecephalus*-lower *Dicynodon* zone
3400	2923	JW31-83*	-14.6	-17.5	*Dicynodon* zone
3100	2917	K6089	-10.7	-15	*Cistecephalus* zone
3090	2926	K5433	-10.9	-16.6	*Cistecephalus* zone
3050	3027	10083	-10.4	-16.3	Collected by Boonstra from Dunedin in Beaufort West district upper *Tropidostoma* zone
3050	2925	C54*	-10.4	-16.1	*Cistecephalus* zone
3045	3028	K5130	-11.3	-17.1	*Cistecephalus* zone
3020	3029	K5086	-10.3	-16.2	*Cistecephalus* zone
2910	3025	B255	-14.7	-17.4	Specimen now SAM PK K 7374 Vleiplaats, Murraysburg district upper *Tropidostoma*-lower *Cisticephalus* zone
2910	3030	K6737	-8.5	-16.4	*Tropidostoma* zone
2880	2922	RMS97*	-8.7	-17.4	*Tropidostoma* zone
2860	3031	K6719	-6.2	-15.7	*Tropidostoma* zone
2840	2916	K6590	-9.7	-17.3	*Tropidostoma* zone
2835	2915	K6557	-7.9	-17.3	*Tropidostoma* zone
2800	2919	B140	-16.6	-16.9	Specimen now SAM PK K 7272 Kareebosch, Murraysburg district upper *Pristerognathus*-lower *Tropidostoma* zone
2770	3026	B144	-12.8	-15	Kareebosch, Murraysburg District collected at same time as B140 upper *Pristerognathus*-lower *Tropidostoma* zone
2710	3032	K6518	-7.5	-16.1	*Pristerognathus* zone
2600	3033	K6535	-8.9	-15.8	*Pristerognathus* zone
2280	2921	CDB38*	-7.8	-17.9	*Tapinocephalus* zone
1770	3034	B8	-11.1	-16	*Tapinocephalus* zone
1650	3035	K1	-10.9	-14.5	*Tapinocephalus* zone

Table 3. Occurrences of Karoo Basin pollen and spores

No.	Taxon	Occurrences
1	*Granulatisporites papillosus* Hart 1965a	*Granulatisporites papillosus* of MacRae (1988-KNP8 150, base)
2	*Striatopodocarpites fusus* (Balme & Hennelly) Potonié 1958	*Striatopodocarpites fusus* of MacRae (1988-KNP8 140, 148, 150, base)
3	*Fimbriaesporites densus* Falcon 1978	*Fimbriaesporites densus* of MacRae (1988-KNP 150)
4	*Circulisporites parvus* de Jersey 1962	*Circulisporites parvus* of MacRae (1988-KNP 150)
5	*Verrucosisporites naumovae* Hart 1963	*Verrucosisporites naumovae* of MacRae (1988-KNP8 150, base)
6	*Protohaploxypinus hartii* Foster 1979	*Protohaploxypinus hartii* of MacRae (1988-KNP 150)
7	*Guttulapollenites hannonicus* Goubin 1965	*Guttulapollenites hannonicus* of Falcon (1975a-70')
8	*Lophotriletes novicus* Singh 1964	*Lophotriletes* sp. cf. *L. rarus* of Falcon (1975a- 165', 148', base); *Lophotriletes novicus* of MacRae (1988-KPN8-150)
9	*Jugasporites* sp. indet	*Jugasporites* sp. indet. of Falcon (1975a-110', 95')
10	*Striomonosaccites* sp. indet.	*Striomonosaccites* sp. indet. of Falcon (1975a-165', 70', base)
11	*Striatopodocarpites rarus* (Bharadwaj & Salujha) Balme 1970	*Striatopodocarpites rarus* of Falcon (1975a-165', 70', base); *Striatopodocarpites rarus* of MacRae (1988-KNP8-140, 148, 150, base)
12	*Spinosporites spinosus* Falcon 1975a	*Spinosporites spinosus* of Falcon (1975a- 165', 70', base)
13	*Punctatisporites intrareticulatus* Falcon 1978	*Punctatisporites granulatus* of Falcon (1975a- 165', 70', base); *Punctatisporites intrareticulatus* of Falcon (1978);
14	*Striatopodocarpites cancellatus* (Balme & Hennelly) Hart 1965a	*Striatopodocarpites cancellatus* of Falcon (1975a-165', 148', 110', 95', 70', base); *Striatopodocarpites cancellatus* of MacRae (1988-KNP8-140, 148-150)
15	*Protohaploxypinus globus* (Hart) Hart 1964	*Protohaploxypinus globus* of Falcon (1975a-165', 148', 110, 95', 70', base)
16	*Protohaploxypinus diagonalis* Balme 1970	*Protohaploxypinus diagonalis* of Falcon (1975a-165', 148', 110', 95', 70', base); *Protohaploxypinus diagonalis* of MacRae (1988-KNP8 150, base)
17	*Marsupipollenites striatus* (Balme & Hennelly) Foster 1975	*Marsupipollenites striatus* of Falcon (1975a-165', 148', 110', 95', 70', base)
18	*Densipollenites indicus* Bharadwaj & Salujha 1964	*Densipollenites indicus* of Falcon (1975a-165', 148', 110', 95', 70', base)
19	*Striatopollenites octostriatus* (Hart) Falcon 1975	*Striatopollenites octostriatus* of Falcon (1975a-165', 110', 95, 70', base)
20	*Vittatina minima* Janonius 1962	*Vittatina minima* of Falcon (1975a-165', 70')
21	*Apiculatisporis minutus* Falcon 1978	*Apiculatisporis minutus* of Falcon (1975a-165'. 110'. 70')
22	*Laevigatosporites colliensis* (Balme & Hennelly) Bharadwaj 1962	*Laevigatosporites colliensis* of Falcon (1975a-165'. 184', 110', 70', base)
23	*Cycadopites nevesii* (Hart) Hart 1965b	*Cycadopites nevesii* of Falcon (1975a- 148', 70', base)
24	*Concavisporites mortonii* (de Jersey) de Jersey 1962	*Deltidoispora lukugaensis* of Falcon (1975a, 110'. 70'); *Acanthotriletes* (laevigate) of Anderson (1977-OW337', OW312'); *Concavisporites mortonii* of MacRae (1988-KNP8-150, base)
25	*Striatoabietites multistriatus* (Balme & Hennelly) Hart 1964	*Striatoabietites multistriatus* of Falcon (1975a- 165', 70'); *Vittatina multistriata* of Anderson (1977-OW337', base)
26	*Gondisporites braziliensis* (Pant & Srivastava) Anderson 1977	*Gondisporites braziliensis* of Anderson (1977-OW337', OW312', base)

27	*Gondisporites echinatus* Anderson 1977	*Gondisporites echinatus* of Anderson (1977-OW337, OW312', base)
28	*Gondisporites raniganjensis* Bharadwaj 1962	*Gondisporites raniganjensis* of Anderson (1977-OW337', OW312', base)
29	*Gondisporites punctatus* (Hart) Anderson 1977	*Gondisporites punctatus* of Anderson (1977-OW337', OW312', base)
30	*Microbaculispora medio-granulata* Anderson 1977	*Microbaculispora mediogranulata* of Anderson (1977-OW337', OW312', base)
31	*Microbaculispora plicata* (Maheshwari & Bose) Anderson 1977	*Microbaculispora plicata* of Anderson (1977-OW337', OW312', base)
32	*Microbaculispora finegranulata* Anderson 1977	*Microbaculispora finegranulata* of Anderson (1977-OW337', base)
33	*Vestigisporites rudis* Balme & Hennelly 1956a	*Vestigisporites rudis* of Anderson (1977-OW337', OW312', OW170', base)
34	*Marsupipolllenites triradiatus* Balme & Hennelly 1956b	*Marsupipollenites triradiatus* of Falcon (1975a- 165', 148'. 110', 95', 70'), *Marsupipollenites* sp. of Falcon (1975a-165'. 110'. 70'); *Vittatina triradiata* of Anderson (1977-OW337', OW312', OW170', OW159', base)
35	*Cirratriradites australensis* Hart 1963	*Gondisporites splendens* of Anderson (1977-OW337', OW312', OW170', OW159', base)
36	*Didecitriletes ericianus* (Balme & Hennelly) Venkatachala & Kar 1965	*Microbaculispora ericiana* of Anderson (1977-OW337', OW312', OW170', OW159', base)
37	*Granulatisporites trisinus* Balme and Hennelly 1956b	*Microbaculispora trisina* of Anderson (1977-OW337, OW312', OW170', OW159', base)
38	*Polypodiisporites detritus* (Leschik) Anderson 1977	*Polypodiisporites detritus* of Anderson (1977-OW377', OW312', OW170', OW159', base)
39	*Granulatisporites micronodosus* Balme and Hennelly 1956b	*Microbaculispora micronodosa* of Anderson (1977-OW337', OW312', base)
40	*Lueckisporites nyakapendensis* (Hart) Hart 1969	*Lueckisporites nyakapendensis* of Falcon (1975a-165', 148'. 110', 95', 70'); *Lueckisporites nyakapendensis* of Anderson (1977-OW337', OW312', OW170', OW159', OW94, base')
41	*Alisporites potoniei* (Lakhanpal, Sah & Dube) Somers 1968	*Sulcatisporites potoniei* of Falcon (1975a-165'148', 110', 95', 70', base); *Vesicaspora* sp A and B of Falcon (1975a-165', 148'. 110', 95', 70'); *Pityosporites maximus* of Anderson (1977-OW337', OW312', OW170', OW159', OW94', base); *Alisporites potoniei* of MacRae (1988-KNP8 140, 148, base);
42	*Horriditriletes ramosus* (Balme & Hennelly) Bharadwaj & Salujha 1964	*Acanthotriletes* (baculate) of Anderson (1977-OW337', OW312', OW170', OW159', OW94', base); *Acanthotriletes* sp. indet. (second) of Horowitz (1990); *Horriditriletes ramosus* of MacRae (1988-KNP8 148, 150, base)
43	*Alisporites tenuicorpus* Balme 1970	*Pityosporites tenuicorpus* of Anderson (1977-OW337', OW312', OW170', OW159, OW94', base)
44	*Lueckisporites neohannonicus* Anderson 1977	*Lueckisporites neohannonicus* of Anderson (1977-OW337', OW312', OW170'. OW159', OW94', base)
45	*Labiisporites nectus* Venkatachala & Kar 1968	*Pityosporites nectus* of Anderson (1977-OW337', OW312', OW170', OW159', OW94', base)
46	*Praecolpatites sinuosis* (Balme & Hennelly) Bharadwaj & Srivastava 1969	*Gnetaceaepollenites sinuosis* of Anderson (1977-OW337'. OW312', OW170', OW159', OW94', base); *Gnetaceaepollenites sinuosis* of MacRae (1988-KNP8 150, base)
47	*Lueckisporites asulcus* (Bose & Kar) Anderson 1977	*Lueckisporites asulcus* of Anderson (1977-OW337', OW312', OW170', OW159', OW94', base)
48	*Plicatipollenites gondwanesnis* (Balme & Hennelly) Lele 1964	*Vestigisporites gondwanensis* of Anderson (1977-OW337'. OW312', OW170', OW159', OW94', base)
49	*Cannanoropollis janaki* Potonié & Sah 1960	*Vestigisporites karharbarensis* of Anderson (1977-OW94', base); *Cannanoropollis janaki* of MacRae (1988-KNP8-148, base)
50	*Striatopodocarpites communis* (Wilson) Hart 1964	*Striatopodocarpites communis* of Falcon (1975a-165', 110', 70'); *Pityosporites varimicros* of Anderson (1977-OW94');
51	*Polypodiisporites mutabilis* Balme 1970	*Thymospora pseudothiesseni* of Falcon (1975a- 165', 70', 1975b); *Polypodiisporites mutabilis* of Anderson (1977-OW94')

52	*Vittatina africana* Hart 1966	*Vittatina africana* of Falcon (1975a-165', 70'; 1975b); *Vittatina densa* of Anderson (1977-OW94')
53	*Calamospora aplata* Bharadwaj & Salujha 1964	*Calamospora aplata* of Anderson (1977-OW337'. OW312. OW170', OW159', OW94')
54	*Inapertisporites vesiculatus* (Anderson) Falcon 1978	*Inaperturosporites vesiculatus* of Anderson (1977-OW337', OW312', OW170', OW159', OW94')
55	*Partimtactosporites verrucosus* Anderson 1977	*Partimtactosporites verrucosus* of Anderson (1977-OW337', OW312', OW170', OW159', OW94')
56	*Altitriletes densus* Venkatachala & Kar 1968	*Altitriletes densus* of Anderson (1977, base); *Altitriletes densus* of Horowitz (1990)
57	*Platysaccus radialis* (Leschik) Clarke 1965	*Platysaccus radialis* of Falcon (1975a-165', 148', 70', base*);* *Alisporites plicatus* of Falcon (1975a-165', 148'. 110'. 95', 70'); *Alisporites radialis* of Falcon (1975b); *Pityosporites nucleoparvus* of Anderson (1977-OW94'); *Platysaccus radialis* of MacRae (1988-KNP9-148, base); *Vitreisporites pallidus* of Horowitz (1990);
58	*Microbaculispora virkkiae* (Tiwari) Anderson 1977	*Microbaculispora virkkae* of Anderson (1977-base); *Microbaculispora virkkiae* of Horowitz (1990
59	*Florinites eremus* Balme & Hennelly 1956a	*Florinites eremus* of Falcon (1975a-165,148', 95', base); *Perisaccus granulatus* of Horowitz (1990)
60	*Gondisporites parvus* Anderson 1977	*Gondisporites parvus* of Anderson (1977-OW337', OW312', OW170', OW159', OW94', base); *Gondisporites parvus* of Horowitz (1990)
61	*Deltiodospora directa* (Balme and Hennelly) Norris 1965	*Deltiodospora directa* of Falcon (1975a-165', 148'); *Microbaculispora directa* of Anderson (1977-OW337', OW312, OW170, OW159'. OW94', base); *Leiotriletes* sp. indet. of Horowitz (1990); *Deltoidospora directa* of MacRae (1988-KNP8 148, base)
62	*Apiculatisporis cornutus* (Balme and Hennelly) Høeg & Bose 1960	*Apiculatisporis cornutus* of Anderson (1977-GrR, base)
63	*Reticuloidosporites wardianus* Balme 1970	*Reticuloidosporites warchianus* of Steiner et al (2003-0)
64	*Granulatisporites microgranifer* Ibrahim 1933	*Acanthotriletes* (granular) of Anderson (1977-OW337', OW312', OW170, OW159', OW94', Kb, Lkf; base); *Acanthotriletes* sp indet. (first) of Horowitz (1990); *Granulatisporites microgranifer* of MacRae (1988-KNP8 148, base)
65	*Acanthotriletes tereteangularis* Balme and Hennelly 1956b	*Acanthotriletes teretangularis* of Falcon (1975-165'); *Acanthotriletes* (spinate) of Anderson (1977-OW337', OW312', OW170', OW159', OW94', GrR, Kb, Lkf, base); *Acanthotriletes teretangularis* of MacRae (1988-KNP8-140,150)
66	*Apiculatosporis levis* (Balme & Hennelly) Segroves 1970	*Apiculatisporis levis* of Falcon (1975a-165', 148', base); *Apiculatisporis bulliensis* of Anderson (1977-GrR, Kb, Lkf, base); *Apiculatisporis levis* of MacRae (1988-KNP8 140, 148)
67	*Calamospora plicata* (Luber & Waltz) Hart 1965	*Calamospora sinesignis* of Anderson (1977-Kb, Lkf, base)
68	*Cyclogranosporites bharadwaji* (Hart) Anderson 1977	*Cyclogranosporites bharadwaji* of Anderson (1977-OW337', OW312', OW170', OW159', OW94', Kb, Lkf, base)
69	*Inapertisporites inapertus* (Anderson) Falcon 1978	*Inaperturosporites inapertus* of Anderson (1977-OW337', OW312'. OW170', OW159'. OW94'. GrR, Kb, Lkf, base)
70	*Laevigatisporites vulgaris* (Ibrahim) Ibrahim 1933	*Laevigatisporites vulgaris* of Anderson (1977-Kb, Lkf, base); MacRae (1988-KNP8 150, 140, base)
71	*Lueckisporites cancellatus* Balme & Hennelly 1956a	*Pityosporites cancellatus* of Anderson (1977-OW337'. OW312', OW170', OW159', OW94'. GrR, Kb, Lkf, base)
72	*Protohaploxypinus amplus* (Balme & Hennelly) Balme 1970	*Protohaploxypinus amplus* of Falcon (1975a-165', 148', 110', 95', 70'); *Pityosporites amplus* of Anderson (1977-OW337', OW312', OW170', OW159', OW94', GrR, Kb, Lkf, base); *Pityosporites* sp. indet. of Horowitz (1990);
73	*Protohaploxypinus goraiensis* (Potonié & Lele) Hart 1964	*Protohaploxypinus goraiensis* of Falcon (1975a-165', 148', 110', 70'); *Pityosporites goraiensis* of Anderson (1977-OW337'. OW312', OW170', OW159', OW94', GrR, Kb, Lkf, base); *Taeniosporites* sp. indet. of Horowitz (1990); *Protohaploxypinus*

		goraiensis of MacRae (1988-KNP8-150, base)
74	*Alisporites ovatus* (Balme & Hennelly) Jansonius 1962	*Sulcatisporites ovatus* of Falcon (1975a-165', 148', 110', 95', 70'); *Sulcatisporites splendens* of Falcon (1975a-165', 148', 110', 95', 70', base); *Pityosporites ovatus* of Anderson (1977-OW337', OW312', OW170', OW159', OW94', GrR, Kb, Lkf, base)
75	*Vestigisporites balmei* Hart 1960	*Vestigisporites balmei* of Anderson (1977-OW337', OW312', OW170, OW159', Kb, Lkf, base)
76	*Vittatina magma* (Bose & Kar) Anderson 1977	*Vittatina magma* of Anderson (1977-OW337', OW312', OW170', OW159', OW94', KB, Lkf, base)
77	*Weylandites lucifer* (Bharadwaj & Salujha) Foster 1975	*Vittatina lucifera* of Anderson (1977-OW337', OW312', OW170', OW159', OW94', GrR, Kb, Lkf, base); *Weylandites lucifer* of MacRae (1988-KNP8-148, 140, base)
78	*Pteruchipollenites indarraensis* (Segroves) Foster 1979	*Alisporites gracilis* of Falcon (1975a-165'. 148', 70'; 1975b); *Pityosporites indarraensis* of Anderson (1977-OW159', OW94', Kb, Lkf); *Alisporites* sp indet.of Horowitz (1990); *Pteruchipollenites* sp. 1 of MacRae (1988-KNP8 140, base)
79	*Vittatina ovalis* Klaus 1963	*Vittattina nonsaccata* of Horowitz (1990); *Vittatina ovalis* of Steiner et al. (2003-10.6, 33.35);
80	*Lueckisporites singhi* Balme 1970	*Lueckisporites singhi* of Steiner et al (2003-33.35)
81	*Triplexisporites playfordi* (de Jersey & Hamilton) Foster 1979	*Triplexisporites playfordi* of Steiner et al (2003-0, 33.35)
82	*Protohaploxypinus jacobi* (Jansonius) Hart 1964	*Protohaploxypinus jacobi* of Steiner et al (2003-26.6, 33.35)
83	*Protohaploxypinus limpidus* (Balme & Hennelly) Balme & Playford 1967	*Protohaploxypinus limpidus* of Falcon (1975a-165', 148', 110', 95', 70'); *Protohaploxypinus micros* of Falcon (1975a-165', 148', 110', 95', 70'); *Pityosporites micros* of Anderson (1977-OW337', OW312', OW170', OW159', OW94', GrR, Kb, Lkf, base); *Protohaploxypinus limpidus* of MacRae (1988-KNP8-150, 148, 140, base); *Protohaploxypinus limpidus* of Steiner et al (2003-0, 26.8, 38.3)
84	*Limitisporites monstruosus* (Luber & Waltz) Hart 1965b	*Vestigisporites ventrisaccatus* of Anderson (1977-OW337', OW312', OW170', OW159', Ow04', Kb, Lkf, base); *Limitisporites* sp. of Steiner *et al.* (2003-48.5); *Falcisporites zapfei* of Stapleton (1977)
85	*Falcisporites stabilis* Balme 1970	*Falcisporites stabilis* of Steiner *et al.* (2003-0, 48.5)
86	*Guthoerlisporites cancellosus* Playford & Dettmann 1965	*Guthoerlisporites cancellosus* of Steiner *et al.* (2003-0, 26.6, 38.3, 52.64, 54.34)
87	*Densoisporites complicatus* Balme 1970	*Densoisporites complicatus* of Steiner *et al* (2003-0, 52.64, 54.34)
88	*Punctatisporites gretensis* Balme & Hennelly 1956b	*Punctatisporites gretensis* of Anderson (1977-OW337'. OW312', OW170, OW159'); *Punctatisporites* sp. indet of Steiner et al. (2003-0, 55.5)
89	*Protohaploxypinus varius* (Baradwaj) Balme 1970	*Protohaploxypinus varius* of Steiner et al (2003-0.35, 10.6, 33.35, 38.3, 52.64, 54.34, 55.5)
90	*Laevigatosporites callosus* Balme 1970	*Laevigatosporites callosus* of Steiner *et al.* (2003-26.6, 55.5)
91	*Lunatisporites transversundatus* Jansonius 1962	*Lunatisporites transversundatus* of Steiner *et al*. (2003-58.64, 58.75, 59)
92	*Lundbladispora brevicula* Balme 1970	*Lundbladispora brevicula* of Steiner *et al*. (2003-58.75, 58.8)
93	*Lunatisporites* sp. indet.	*Lunatisporites* sp. indet. of Steiner *et al*. (2003-58.8)
94	*Lunatisporites noviaulensis* Leschik 1956	*Taeniosporites noviaulensis* of Falcon (1975a-110',95'); *Lunatisporites noviaulensis* of Steiner *et al*. (2003-58.4, 58.7, 58.75, 58.95, 59, 59.04)
95	*Kraeuselisporites* sp. indet.	*Kraeuselisporites* sp. indet. of Steiner *et al*. (2003-58.64, 58.7, 58.75, 58.8, 59, 59.04)
96	*Kraeuselisporites cuspidus* Balme 1963	*Kraeuselisporites cuspidus* of Steiner *et al*. (2003-58.64, 58.7, 58.8, 59.04)
97	*Platysaccus papilionis* Potonié &	*Platysaccus papilionis* of Stapleton (1977); *Platysaccus papilionis*

	Klaus 1954	of MacRae (1988-KNP8 148, base); *Platysaccus papilionis* of Steiner *et al*. (2003-58.7),
98	*Cycadopites follicularis* Wilson & Webster 1946	*Cycadopites follicularis* of Stapleton (1977); *Cycadopites follicularis* of MacRae (1988-KNP8-148, base)
99	*Platysaccus leschicki* (Hart) Hart 1965	*Platysaccus leschicki* of Falcon (1975a-165', 148', 110', 95', 70'); *Platysaccus leschicki* of Stapleton (1977); *Platysaccus leschicki* of Steiner *et al*. (2003-58.64, 58.7, 58.95);
100	*Falcisporites zapfei* (Potonié & Klaus) Leschik 1956	*Falcisporites zapfei* of Stapleton (1977); *Falcisporites zapfei* of Steiner et al (2003-0, 0.35, 26.5, 38.3, 52.64, 54.34, 55.5)
101	*Klausipollenites schaubergeri* (Potonie & Klaus) Jansonius 1962	*Klausipollenites schaubergeri* of Steiner *et al.* (2003-0, 0.35, 10.6, 23.6, 48.5, 54.34); *Striatisaccus goswicensis* of Stapleton (1977)
102	*Protohaploxypinus microcorpus* (Schaarschmidt) Clarke 1965	*Striatites microcorpus* of Stapleton (1977); *Illinites kosankei* of Stapleton (1977); *Protohaploxypinus microcorpus* of Steiner *et al*. (2003-0, 0.35, 10.6, 23.6, 33.35, 52.64, 54.34, 55.5);
103	*Strotersporites richteri* (Klaus) Klaus 1963	*Striatites richterii* of Stapleton (1977); *Protohaploxypinus richteri* of Steiner *et al*. (2003-0, 10.6, 23.6, 38.3, 54.34);
104	*Protohaploxypinus samoilovichii* (Jansonius) Hart 1964	*Striatites samoilovichii* of Stapleton (1977); *Protohaploxypinus samoilovichii* of Steiner *et al.* (2003-0, 23.6, 33.35);
105	*Lunatisporites pellucidus* (Goubin) Balme 1970	*Taeniasporites pellucidus* of Stapleton (1977); *Lunatisporites pellucidus* of Steiner *et al*. (2003-58.64, 58.7, 58.95, 59)
106	*Densoisporites playfordii* (Balme) Dettmann 1963	*Densiosporites playfordi* of Stapleton (1977); *Densoisporites playfordii* of Steiner *et al.* (2003-0, 0.35)
107	*Spinotriletes senecioides* Mädler 1964	*Spinotriletes senecioides* of Stapleton (1977)
108	*Triadispora staplinii* (Jansonius) Klaus 1964	*Triadispora staplinii* of Stapleton (1977)
109	*Alisporites australis* de Jersey 1962	*Alisporites australis* of Stapleton (1977); *Striatites minor* of Stapleton (1977)
110	*Endosporites hexareticulatus* Klaus 1963	*Endosporites hexareticulatus* of Stapleton (1977)

Table 4. Meter levels in composite section for Karoo pollen and spore samples

Level (m)	Source and explanation
3700	Katberg Formation samples of Stapleton (1978) from near Steynsburg
3654.54	59.04 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3654.5	59 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3654.45	58.95 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3645.3	58.8 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3654.25	58.75 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3654.25	58.7 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3654.14	58.64 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3651	55.5 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3649.84	54.34 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3648.14	52.64 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3644	48.5 m Sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3622.8	38.3 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3628.25	33.35 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3622.1	26.6 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3619.1	23.6 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3606.1	10.6 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3595.85	0.35 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3595.5	0 m sample at Carlton Heights of Steiner *et al.* (2003) scaled to levels of Retallack *et al.* (2003)
3600	LKf sample in stromatolitic laminites of upper Estcourt Formation near Bergville of Anderson (1977)
3550	Kb sample from lower *Dicynodon* zone near Harrismith of Anderson (1977)
3050	GrR sample in *Cistecephalus* zone near Graff Reinet of Anderson (1977)
2600	Uraniferous (Poortjie) sandstone samples of Horowitz (1976) from near Beaufort West
2550	OW94' sample in Old Welkom bore of Anderson (1977) scaled to upper sandstone correlated with sandstone of Normandien Formation below *Rhachicephalus magnus* (=*Cistecephalus* zone of Groenewald, 1989) and with Poortjie Sandstone near Beaufort West (Rubidge, 1995)
2400	OW159' sample in Old Welkom bore of Anderson (1977) scaled as for OW94'
2380	OW170' sample in Old Welkom bore of Anderson (1977) scaled as for OW94'
2280	OW312' sample in Old Welkom bore of Anderson (1977) scaled as for OW94'
2200	OW337' sample in Old Welkom bore of Anderson (1977) scaled as for OW94'
612	-70' sample of Falcon (1975a) scaled to*Tapinocephalus* fauna in carbonate at -30' (Lepper *et al*., 2004) and Ecca Group at -200 '
494	-95' sample of Falcon (1975a) scaled as for -70' sample
424	-110' sample of Falcon (1975a) scaled as for -70' sample
245	-148' sample of Falcon (1975a) scaled as for -70' sample
165	-165' sample of Falcon (1975a) scaled as for -70' sample
40	140 m sample in bore KNP8 of MacRae (1988) 40 m above Ecca Group
32	148 m sample in bore KNP8 of MacRae (1988) 32 m above Ecca Group
30	150 m sample in bore KNP8 of MacRae (1988) 30 m above Ecca Group

Table 5. Karoo vertebrate genera (from Ward *et al*. 2005)

Taxon number	Genus
111	*Patranomodon*
112	*Eodicynodon*
113	Genus uncertain
114	*Australosynodon*
115	*Tapinocaninus*
116	*Galeops*
117	*Broomia*
118	*Anteosaurus*
119	*Titanosaurus*
120	*Jonkeria*
121	*Robertia*
122	*Glanosuchoides*
123	*Alopecodon*
124	*Pristerognathus*
125	*Eunotosaurus*
126	*Bradysaurus*
127	*Embrithosaurus*
128	*Tropidostoma*
129	*Rhachiocephalus*
130	*Platycyclops*
131	*Gorgonops*
132	*Endothiodon*
133	*Cistecephalus*
134	*Aulacocephalodon*
135	*Pareiasaurus*
136	*Pristerodon*
137	*Dinanomodon*
138	*Clelandia*
139	*Dinogorgon*
140	*Spondylolestes*
141	*Anthodon*
142	*Millerosaurus*
143	*Millereta*
144	*Diictodon*
145	*Emydops*
146	*Oudenodon*
147	*Pelanomodon*
148	*Dicynodon*
149	*Lycaenops*
150	*Cynosaurus*
151	*Prorubidgea*
152	*Leontocephalus*
153	*Rubidgea*
154	*Broomicephalus*

155	*Ictidosuchoides*
156	*Theriognathus*
157	*Homodontosarus*
158	*Promoschorhynchus*
159	*Procynosuchus*
160	*Cynosaurus*
161	*Nanictosaurus*
162	*Tratracynodon*
163	*Moscorhinus*
164	*Proterosuchus*
165	*Oliveria*
166	*Scaloposaurus*
167	*Thrinaxodon*
168	*Galesaurus*
169	*Myosaurus*
170	*Procolophon*
171	*Lystrosaurus*

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