TABLE DR1: RAW OXIDE RESULTS

Sample	Type	Core Depth (m)	Depth Relative to Paleosol Surface (cm)	Al_2O_3 (Wt%)	BaO (Wt%)	CaO (Wt%)	Fe_2O_3 (Wt%)	K_2O (Wt%)	MgO (Wt%)	MnO (Wt%)	Na_2O (Wt%)	P_2O_5 (Wt%)	SiO_2 (Wt%)	SrO (Wt%)	TiO_2 (Wt%)	Total (Wt%)
ep895	Sandstone	272.80	104.14	0.94	<0.02	0.03	<0.02	0.23	0.09	0.00	0.03	<0.05	93.70	<0.02	0.00	95.1
ep896	Sandstone	273.10	73.66	0.59	<0.02	0.02	<0.02	0.07	0.04	0.00	0.04	<0.05	99.00	<0.02	0.03	99.9
ep897	Sandstone	273.41	43.18	1.64	<0.02	0.04	13.40	0.46	0.17	0.01	0.05	<0.05	74.30	<0.02	0.10	90.3
ep898 3"	SS/Pal	273.79	5.08	14.50	<0.02	0.39	15.70	4.55	2.13	0.03	0.05	<0.05	48.00	0.02	3.10	88.5
ep898 5"	Paleosol	273.84	0.00	15.50	0.01	0.23	18.70	7.35	1.83	0.03	0.06	0.13	47.40	0.05	2.76	94.1
ep899	Paleosol	274.02	-17.78	16.10	0.01	0.23	14.50	8.36	2.10	0.02	0.02	<0.15	49.50	0.02	3.20	94.2
ep900	Paleosol	274.32	-48.26	14.60	0.01	2.26	17.10	6.83	2.70	0.04	0.05	1.44	43.60	0.01	2.88	91.5
ep901	Paleosol	274.62	-78.74	14.50	0.01	2.93	15.90	7.53	2.17	0.05	0.06	1.94	45.60	0.01	3.08	93.8
ep902	Paleosol	274.93	-109.22	13.80	0.01	2.79	13.90	7.59	1.99	0.03	0.03	2.13	45.20	0.01	3.47	91.0
ep903	Paleosol	275.23	-139.70	13.90	0.02	2.37	16.30	7.59	2.14	0.04	0.06	1.70	46.40	0.01	2.94	93.5
ep904	Paleosol	275.54	-170.18	14.70	0.01	2.60	13.20	7.94	1.80	0.01	0.08	1.68	48.70	0.01	2.82	93.6
ep905	Paleosol	275.84	-200.66	13.10	0.02	2.33	15.80	7.48	2.08	0.02	0.06	1.26	49.40	0.01	2.19	93.8
ep906	Paleosol	276.15	-231.14	13.70	0.02	1.94	14.80	7.93	2.15	0.04	0.02	1.26	47.60	0.01	2.71	92.2
ep907	Paleosol	276.45	-261.62	13.30	0.02	4.68	12.00	8.50	3.41	0.07	0.03	1.49	45.20	0.01	3.33	92.0
ep908pal	Paleosol	276.70	-286.00	10.20	0.02	9.81	11.90	6.84	6.25	0.20	0.04	1.11	36.20	0.01	2.49	85.1
ep908sap	Paleosaprolite	276.76	-292.10	13.50	0.03	3.85	9.83	8.48	3.42	0.06	0.01	1.34	49.10	0.01	3.55	93.2
ep909	Paleosaprolite	277.06	-322.58	12.90	0.04	5.88	10.90	7.77	4.41	0.09	0.02	1.44	44.00	0.01	3.23	90.7
ep910.5	Paleosaprolite	277.52	-368.30	14.60	0.05	4.53	10.90	6.91	3.21	0.08	0.02	2.10	45.80	0.01	3.84	92.1
ep911.5	Paleosaprolite	277.83	-398.78	11.50	0.03	7.86	10.30	7.18	5.07	0.12	0.01	1.52	39.10	0.01	3.49	86.2
ep912 1.5"	Paleosaprolite	278.02	-417.83	9.26	0.03	9.08	9.74	6.29	5.81	0.17	0.04	1.16	38.40	<0.02	2.72	82.7
ep913	Paleosaprolite	278.28	-444.50	11.40	0.04	5.57	9.01	6.86	4.18	0.12	0.04	0.97	49.40	<0.02	3.04	90.7
ep914	Metagabbro	278.59	-474.98	13.30	0.08	3.82	14.60	1.65	2.49	0.16	1.99	1.22	48.20	0.04	3.46	91.0
ep915	Metagabbro	278.89	-505.46	11.80	0.06	7.55	18.00	1.41	3.31	0.26	2.30	1.16	46.20	0.02	3.34	95.4
ep916	Metagabbro	279.20	-535.94	11.90	0.07	7.08	18.70	1.67	3.41	0.28	2.27	1.08	46.10	0.02	3.13	95.7
ep917	Metagabbro	279.50	-566.42	12.60	0.06	7.70	17.70	1.41	3.45	0.26	2.65	1.29	47.10	0.03	3.29	97.5
ep918	Metagabbro	279.81	-596.90	12.60	0.05	7.60	17.20	1.31	3.22	0.25	2.66	1.18	50.60	0.03	3.19	99.9
ep920	Metagabbro	280.42	-657.86	11.00	0.07	5.99	21.00	3.05	4.37	0.25	1.29	1.73	45.90	<0.02	3.88	98.6
ep929.9	Metagabbro	283.43	-959.61	12.70	0.02	8.88	19.90	1.70	4.19	0.31	2.29	1.75	41.70	0.02	4.09	97.6
ep950	Metagabbro	289.56	-1572.26	11.90	0.07	8.55	19.70	1.62	3.97	0.29	2.32	1.75	46.00	0.02	3.81	100.0
ep1000	Metagabbro	304.80	-3096.26	12.30	0.07	7.60	17.70	1.65	3.33	0.26	2.62	1.41	50.30	0.03	3.09	100.4

Major oxides were determined for bulk samples using a Perkin-Elmer Optima 5300 inductively coupled plasma atomic emission spectrometer.

TABLE DR2: NORMATIVE MINERAL ANALYSIS

Depth Relative to Paleosol Surface (cm)	Pyrite (wt%)	Apatite (wt%)	Dolomite (wt%)	Calcite (wt%)	Hematite (wt%)	Hematite-Associated Phosphorus (wt%)	Illite (wt%)	Quartz (wt%)	Titanium Oxides (wt%)
104	0.00	0.11	0.00	0.00	0.02	0.00	3.57	92.35	0.00
74	0.01	0.11	0.00	0.00	0.02	0.00	0.29	98.58	0.03
43	30.44	0.11	0.00	0.00	3.27	0.00	6.22	71.94	0.10
5	18.99	0.11	1.07	0.00	9.38	0.00	55.02	27.15	3.10
0	2.83	0.30	0.19	0.00	17.76	0.00	58.82	25.11	2.76
-18	0.00	0.34	0.11	0.00	14.50	0.00	61.09	26.35	3.20
-48	0.00	3.28	1.20	0.00	17.10	0.00	55.40	22.60	2.88
-78	0.00	4.42	1.23	0.00	15.90	0.00	55.02	24.75	3.08
-109	0.00	4.85	0.00	0.00	13.90	0.00	52.37	25.35	3.47
-139	0.00	3.87	0.43	0.00	16.30	0.00	52.75	26.41	2.94
-170	0.00	3.83	1.27	0.00	13.20	0.00	55.78	27.56	2.82
-200	0.00	2.87	2.21	0.00	15.80	0.00	49.71	30.56	2.19
-231	0.00	2.87	0.92	0.00	14.80	0.00	51.99	27.90	2.71
-261	0.00	3.40	8.94	0.00	12.00	0.00	50.47	26.07	3.33
-286	0.00	2.53	27.45	0.00	11.90	0.00	38.71	21.53	2.49
-292	0.00	3.05	6.86	0.00	9.83	0.00	51.23	29.69	3.55
-322	0.00	3.28	13.10	0.00	10.90	0.00	48.95	25.45	3.23
-368	0.00	4.79	5.80	0.00	10.90	0.00	55.40	24.80	3.84
-399	0.00	3.46	19.26	0.00	10.30	0.00	43.64	22.56	3.49
-418	0.00	2.64	24.83	0.00	9.74	0.00	35.14	25.08	2.72
-444	0.00	2.21	14.12	0.00	9.01	0.00	43.26	33.01	3.04

104 to 5 cm : Mt. Simon Sandstone
0 to -286 cm : Elk Point paleosol
-292 to -444 cm : Elk Point paleosaprolite

A normative mineral analysis was performed to determine partitioning of oxides in minerals determined by XRD. All oxide weight percents were initially converted to mole proportions. S was attributed to pyrite, and Fe molar proportions were decreased accordingly. P was attributed to apatite, and Ca was reduced accordingly. Remaining Ca was attributed to dolomite and Mg reduced accordingly, unless Mg contents were too low, in which case all Mg was attributed to dolomite and Ca was reduced accordingly. Remaining Ca (if present) was attributed to calcite. Fe was attributed to hematite. Remaining P (if present) was attributed to hematite-associated P. All Al was attributed to illite, and K and Si were reduced accordingly. All remaining Si was attributed to quartz. Ti was attributed to titanium oxides. The main purpose of the normative mineral analysis was to determine the partitioning of P in soil minerals. Additional mineralogy was used to ensure that the calculations were balanced (total wt% of minerals was ~100%).

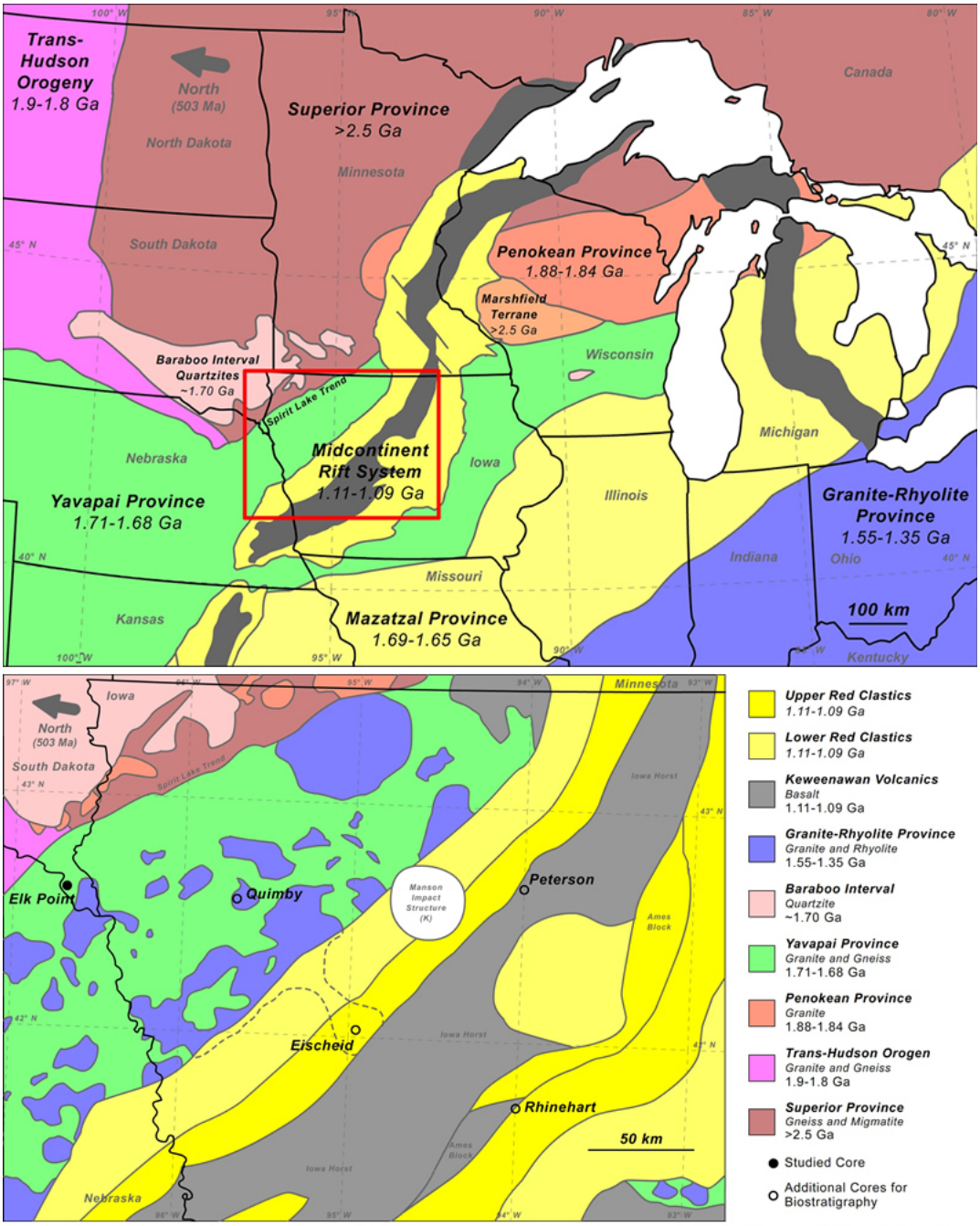

Figure DR1: Map of the study area and its associated subsurface geology. Modified from Iowa Geological Survey digital map OFM-06-7 (Anderson 2006) and figures in Van Schmus (2007) and Whitmeyer (2007).

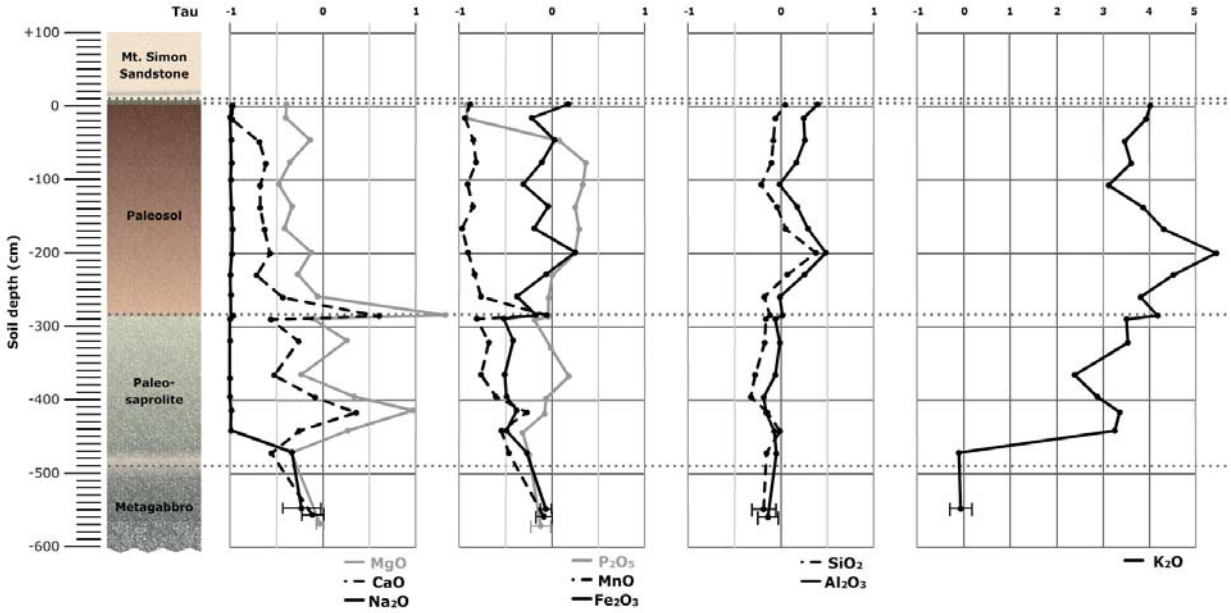

Figure DR2: Oxide enrichment and depletion for the Elk Point core, normalized to Ti. Tau values were calculated using soil element-mass-transfer equations (Brimhall and Dietrich, 1987; Anderson et al., 2002), where -1 indicates 100% loss and +1 indicates 100% enrichment. Bottommost point is an aggregate of all metagabbro data (n = 8). The deepest sample at 3096 cm below the soil surface was used as the reference for comparisons.

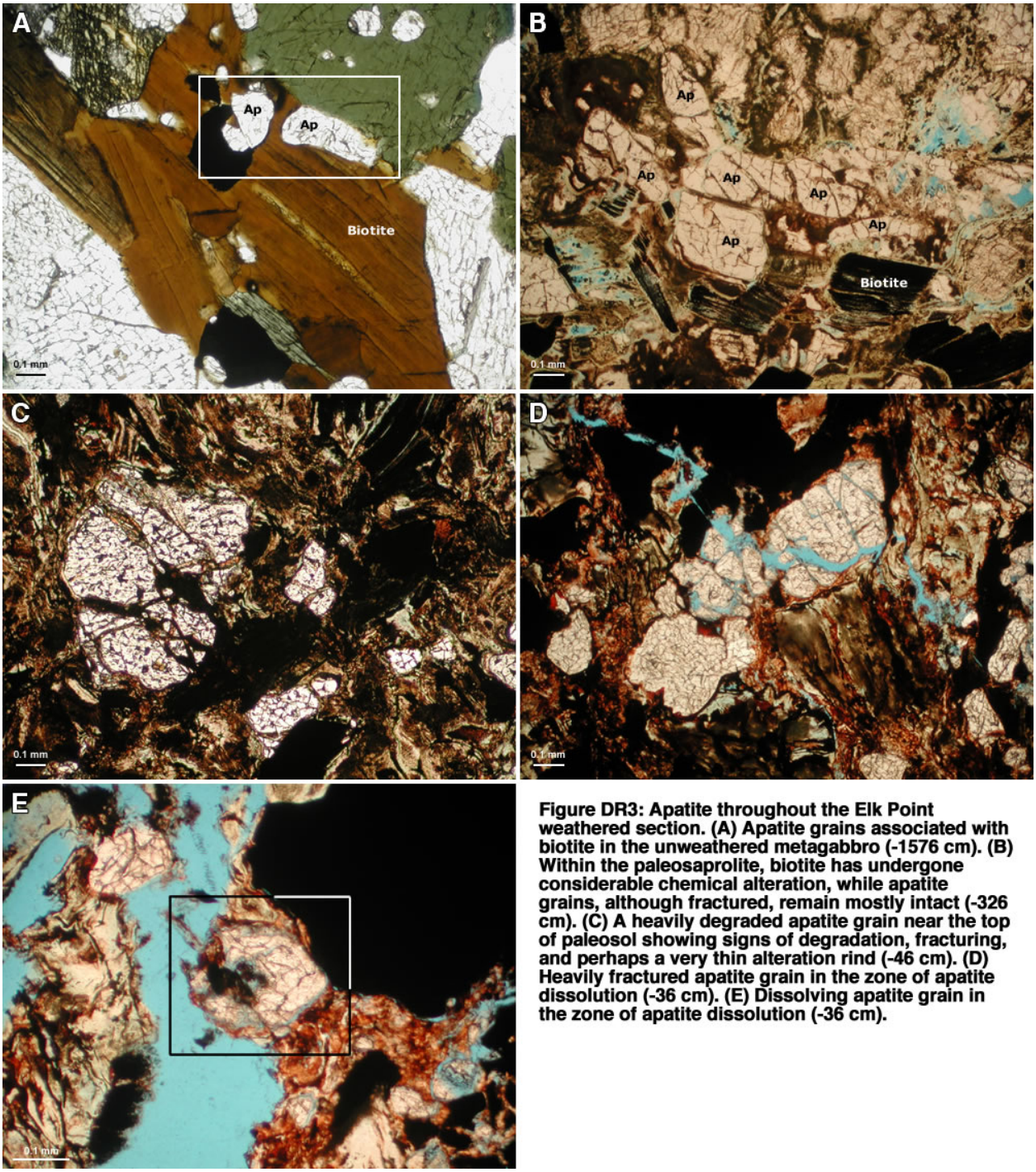

Figure DR3: Apatite throughout the Elk Point weathered section. (A) Apatite grains associated with biotite in the unweathered metagabbro (-1576 cm). (B) Within the paleosaprolite, biotite has undergone considerable chemical alteration, while apatite grains, although fractured, remain mostly intact (-326 cm). (C) A heavily degraded apatite grain near the top of paleosol showing signs of degradation, fracturing, and perhaps a very thin alteration rind (-46 cm). (D) Heavily fractured apatite grain in the zone of apatite dissolution (-36 cm). (E) Dissolving apatite grain in the zone of apatite dissolution (-36 cm).