TABLE DR-5. Average biotite compositions and grain sizes in selected crystalline rocks from the southern Black Hills S

	Sillimanite zone ---->						Staurolite zone ---->													
S/N	SI-23	SI-25	SI-47	SI-103	SI-107	KB-2	ST-5	ST-15	ST-17	ST-18	ST-42	ST-45	ST-47	ST-60	ST-61	ST-68	ST-77	ST-87	ST-88	ST-103
Wt. %																				
SiO2	34.236	34.671	34.821	35.136	35.019	34.503	35.532	34.505	34.688	35.173	35.057	34.990	35.050	35.280	36.271	35.309	35.396	35.682	35.380	34.279
TiO2	2.517	2.690	2.036	2.227	1.982	1.865	1.809	2.009	1.533	1.866	2.205	1.716	1.840	1.662	1.424	1.679	2.353	2.436	1.938	2.122
Al2O3	19.607	18.977	18.566	19.467	19.186	19.704	18.166	19.911	20.441	19.200	18.820	19.427	19.375	18.319	19.277	18.860	17.620	19.062	19.592	18.843
MgO	9.107	7.173	7.615	8.256	8.920	6.219	7.687	6.388	8.062	7.904	8.611	8.751	8.375	9.579	11.742	8.893	8.587	8.571	9.079	8.248
CaO	0.010	0.000	0.001	0.016	0.000	0.062	0.009	0.027	0.012	0.008	0.008	0.012	0.003	0.004	0.000	0.007	0.001	0.010	0.003	0.026
MnO	0.282	0.240	0.180	0.242	0.220	0.037	0.261	0.035	0.070	0.281	0.451	0.074	0.419	0.198	0.123	0.119	0.557	0.386	0.053	0.272
FeO	19.568	22.335	22.749	21.715	21.719	23.960	23.163	22.117	21.717	22.138	21.598	20.712	21.681	20.810	17.279	21.375	21.965	21.160	21.025	22.172
Na2O	0.151	0.133	0.148	0.132	0.168	0.290	0.071	0.224	0.356	0.110	0.112	0.337	0.198	0.272	0.357	0.218	0.068	0.116	0.242	0.236
K2O	9.843	9.794	9.344	9.684	9.596	8.651	9.540	8.497	8.657	9.560	9.657	8.645	9.309	9.403	9.083	9.239	10.042	9.646	9.378	9.015
BaO	0.027	0.016	0.072	0.078	0.050	n.d.	0.019	0.038	0.008	0.088	0.085	0.014	0.095	0.120	0.111	0.060	0.021	0.092	0.094	0.075
F	0.374	0.911	0.520	0.352	0.329	0.293	1.135	n.d.	n.d.	0.446	0.462	n.d.	0.473	n.d.	0.740	0.544	0.629	0.413	0.394	n.d.
Cl	0.006	0.529	0.003	0.014	0.007	0.045	0.001	n.d.	n.d.	0.012	0.015	n.d.	0.010	n.d.	0.014	0.005	0.009	0.004	0.010	n.d.
O = F	-0.143	-0.384	-0.219	-0.148	-0.138	-0.124	-0.478	n.d.	n.d.	-0.263	-0.195	n.d.	-0.199	n.d.	-0.312	-0.229	-0.265	-0.174	-0.166	n.d.
O = Cl	-0.001	-0.119	-0.001	-0.003	-0.002	-0.010	0.000	n.d.	n.d.	-0.003	-0.004	n.d.	-0.002	n.d.	-0.003	-0.001	-0.002	-0.001	-0.002	n.d.
Total	95.584	96.966	95.834	97.167	97.056	95.494	96.912	93.752	95.544	96.518	96.881	94.677	96.625	95.648	96.109	96.077	96.980	97.403	97.018	95.284
Cations per 24 O,OH																				
Si	5.247	5.338	5.388	5.329	5.318	5.351	5.462	5.386	5.302	5.378	5.345	5.376	5.345	5.405	5.428	5.400	5.423	5.383	5.341	5.305
Al(iv)	2.753	2.662	2.612	2.671	2.682	2.649	2.538	2.614	2.698	2.622	2.655	2.624	2.655	2.595	2.572	2.600	2.577	2.617	2.659	2.696
Total tetra.	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
Al(vi)	0.789	0.782	0.773	0.808	0.751	0.953	0.753	1.048	0.984	0.839	0.727	0.894	0.828	0.713	0.828	0.799	0.604	0.772	0.827	0.741
Ti	0.290	0.311	0.237	0.254	0.226	0.218	0.209	0.236	0.176	0.214	0.253	0.198	0.211	0.192	0.160	0.193	0.271	0.276	0.220	0.247
Mg	2.081	1.646	1.757	1.867	2.019	1.438	1.762	1.486	1.837	1.802	1.957	2.004	1.904	2.188	2.620	2.028	1.961	1.928	2.043	1.903
Fe	2.508	2.875	2.943	2.754	2.758	3.107	2.977	2.886	2.776	2.831	2.754	2.661	2.765	2.666	2.162	2.733	2.814	2.669	2.654	2.870
Mn	0.037	0.031	0.024	0.031	0.028	0.005	0.034	0.005	0.009	0.036	0.058	0.010	0.054	0.025	0.016	0.015	0.072	0.049	0.007	0.036
Total octa.	5.667	5.615	5.710	5.683	5.754	5.716	5.701	5.661	5.782	5.685	5.691	5.767	5.708	5.783	5.771	5.754	5.651	5.645	5.745	5.796
K	1.924	1.924	1.844	1.873	1.859	1.711	1.871	1.692	1.688	1.865	1.878	1.694	1.811	1.837	1.734	1.802	1.962	1.856	1.806	1.780
Na	0.045	0.040	0.044	0.039	0.049	0.087	0.021	0.068	0.106	0.033	0.033	0.100	0.059	0.081	0.104	0.065	0.020	0.034	0.071	0.071
Ca	0.002	0.001	0.004	0.005	0.003	0.000	0.001	0.005	0.002	0.005	0.005	0.002	0.006	0.001	0.007	0.004	0.001	0.005	0.006	0.005
Ba	0.002	0.000	0.000	0.003	0.000	n.d.	0.001	0.002	0.001	0.001	0.001	0.001	0.000	0.007	0.000	0.001	0.000	0.002	0.000	0.005
Total interl.	1.972	1.964	1.893	1.919	1.911	1.799	1.894	1.767	1.796	1.904	1.918	1.797	1.876	1.926	1.844	1.872	1.984	1.897	1.883	1.860
Cations total	15.640	15.579	15.603	15.602	15.665	15.515	15.595	15.428	15.577	15.589	15.608	15.564	15.583	15.709	15.615	15.625	15.635	15.542	15.627	15.655
Fe#	55.0	63.8	62.8	59.9	58.0	68.4	63.1	66.0	60.3	61.4	59.0	57.1	59.7	55.2	45.4	57.6	59.5	58.5	56.6	60.4
Mg#	45.0	36.2	37.2	40.1	42.0	31.6	36.9	34.0	39.7	38.6	41.0	42.9	40.3	44.8	54.6	42.4	40.5	41.5	43.4	39.6
ppm																				
Sr	11.4	16.9	14.5	16.0	20.8	n.d.	17.3	8.3	9.6	8.2	10.8	11.3	12.2	12.9	22.5	11.5	11.1	11.2	7.1	10.7
Ba	673	298	932	820	854	n.d.	748	483	676	874	1010	639	962	1230	1340	707	686	691	896	771
La	10	3	14	6	5	n.d.	24	6	15	5	12	8	3	15	24	13	10	20	9	11
Zr	34	62	109	123	68	n.d.	84	45	93	76	55	75	62	98	120	67	56	127	88	79
Y	3.0	4.6	7.6	4.6	6.8	n.d.	9.3	10.9	9.2	5.4	7.2	4.2	4.7	5.6	9.6	11.8	8.6	n.d.	n.d.	n.d.
Yb	1.2	0.3	0.9	1.3	0.9	n.d.	1.3	2.3	1.9	1.0	1.2	1.0	1.0	1.1	1.3	2.5	1.4	n.d.	n.d.	n.d.
Cr	287	222	196	267	220	n.d.	156	189	194	190	172	204	149	149	236	179	123	245	341	148
Sc	38	15	16	20	21	n.d.	19	15	17	14	18	21	16	14	19	17	9	20	20	18
V	266	165	142	223	177	n.d.	147	154	163	154	159	209	138	166	316	156	77	179	214	126
Cu	58	41	75	22	104	n.d.	34	140	11	12	80	16	48	101	224	55	60	113	21	33
Mn	2060	2070	1670	1480	1670	n.d.	1620	98	549	1610	2550	651	2340	1220	1330	1210	3300	548	468	1390
Li	362	1010	294	233	140	n.d.	874	248	n.d.	544	n.d.	n.d.	n.d.	168	206	177	187	111	159	207
Diam (mm)	0.428	0.245	0.393	0.515	0.365	0.310	0.460	0.205	0.398	0.112	0.096	0.715	0.224	0.203	n.d.	0.185	0.163	0.102	0.190	n.d.
StdErr (mm)	0.088	0.028	0.035	0.058	0.041	0.058	0.033	0.023	0.044	0.009	0.009	0.090	0.022	0.023	n.d.	0.018	0.015	0.010	0.017	n.d.
Thickn (mm)	0.065	0.115	0.048	0.100	0.045	0.083	0.078	0.078	0.110	0.054	0.020	0.160	0.020	0.039	n.d.	0.038	0.029	0.021	0.048	n.d.
StdErr (mm)	0.006	0.011	0.004	0.013	0.006	0.014	0.011	0.011	0.006	0.003	0.004	0.040	0.003	0.003	n.d.	0.004	0.002	0.002	0.004	n.d.

Notes: Major- and minor-element abundances (oxide wt.%) determined by Cameca SX-50 electron microprobe housed at Indiana University, Department of Geological Sciences (analysts: M. Dorais, T. Sinha, and P. Dahl).
Minor- and trace-element abundances (ppm) determined by Instrumentation Laboratories ICP spectrometer housed at Kent State University, Department of Geology (analysts: S. Feldmann, D. Wehn, and P. Dahl).
Fe# = [Fe/(Mg+Fe)]*100; Mg# = [Mg/(Mg+Fe)]*100. Mean grain sizes determined in thin section from 10 representative grains, as measured by M. Pomfrey.
Abbreviations: S/N = sample number; Diam = mean diameter; Thickn = thickness; StdErr = standard error of the mean; tetra. = tetrahedral; octa. = octahedral; interl. = interlayer.

TABLE DR-5. Continued

ST-106	ST-107	ST-112	ST-116	T-27A	PR-1	IN-12	IN-21	IN-24	IN-25	Garnet zone GZ-85
36.029	37.024	36.014	35.540	35.723	34.975	34.722	35.338	35.109	34.989	33.443
1.689	1.320	1.745	1.566	1.612	1.841	1.552	1.251	1.279	1.323	2.122
19.172	18.920	18.650	18.826	16.004	19.523	20.142	19.735	19.895	19.808	17.862
9.768	14.152	11.052	9.388	14.779	8.891	6.905	6.003	6.005	6.088	8.683
0.018	0.013	0.010	0.007	0.021	0.010	0.005	0.004	0.006	0.014	0.033
0.490	0.215	0.266	0.127	0.148	0.047	0.013	0.187	0.155	0.148	0.251
18.195	14.443	18.426	20.603	16.108	21.325	23.757	23.732	23.599	23.950	22.518
0.190	0.268	0.235	0.182	0.194	0.190	0.252	0.125	0.106	0.103	0.133
9.413	9.750	9.423	9.389	9.098	8.623	8.690	8.886	8.766	8.837	9.137
0.076	0.117	0.124	0.154	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
n.d.	0.707	0.544	0.663	0.512	0.231	0.427	1.509	1.386	1.369	0.460
n.d.	0.010	0.009	0.024	0.028	0.028	0.012	0.005	0.004	0.008	0.068
n.d.	-0.228	-0.229	-0.279	-0.215	-0.097	-0.180	-0.635	-0.584	-0.576	-0.193
n.d.	-0.003	-0.002	-0.005	-0.006	-0.006	-0.003	-0.001	-0.001	-0.002	-0.009
95.039	96.708	96.266	96.184	94.005	95.581	96.295	96.137	95.725	96.058	94.508
5.470	5.453	5.426	5.419	5.465	5.341	5.329	5.468	5.446	5.422	5.269
2.531	2.547	2.574	2.581	2.535	2.659	2.671	2.532	2.554	2.578	2.731
8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
0.899	0.737	0.737	0.802	0.351	0.855	0.972	1.066	1.083	1.040	0.586
0.193	0.146	0.198	0.180	0.185	0.211	0.179	0.146	0.149	0.154	0.251
2.211	3.107	2.482	2.134	3.371	2.024	1.580	1.385	1.389	1.406	2.040
2.311	1.779	2.321	2.627	2.061	2.723	3.049	3.070	3.061	3.104	2.967
0.063	0.027	0.034	0.016	0.019	0.006	0.002	0.025	0.020	0.019	0.034
5.677	5.769	5.738	5.743	5.968	5.814	5.780	5.667	5.682	5.704	5.844
1.823	1.832	1.811	1.826	1.775	1.680	1.701	1.754	1.734	1.747	1.836
0.056	0.076	0.068	0.054	0.057	0.056	0.075	0.037	0.032	0.031	0.041
0.003	0.007	0.007	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.005	0.002	0.002	0.001	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1.887	1.917	1.888	1.890	1.833	1.736	1.776	1.791	1.766	1.778	1.876
15.563	15.686	15.627	15.633	15.801	15.550	15.556	15.458	15.448	15.483	15.720
51.8	36.8	48.7	55.3	38.2	57.4	65.9	69.1	68.9	68.9	59.5
48.2	63.2	51.3	44.7	61.8	42.6	34.1	30.9	31.1	31.1	40.5
16.6	13.9	17.4	10.8	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
924	948	53	1230	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
12	11	12	12	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
74	89	76	86	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
172	175	201	232	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
20	24	19	22	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
189	145	254	267	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
500	22	33	24	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2520	1800	390	1220	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
219	229	177	208	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
0.228	0.254	0.410	0.620	0.180	0.243	0.158	0.136	0.186	0.177	0.101
0.026	0.027	0.054	0.036	0.022	0.003	0.022	0.013	0.051	0.033	0.013
0.035	0.070	0.149	0.096	0.038	0.031	0.068	0.053	0.074	0.056	0.033
0.002	0.007	0.018	0.013	0.006	0.003	0.015	0.005	0.025	0.011	0.003