

SAMPLE	Depth (m)	Depth Thick- ness(m)	La	Ce	Nd	Sm	Eu	Tb	Nb	Si	Y	P	REO
C2101	1.5	4.7	1594	3597	1202	141.30	30.40	4.90	50.0	1736	246	1112.0	8205.6
C2102	4.7	10.2	1806	3187	906	111.80	25.90	17.60	266.0	7227	150	5728.0	7458.9
C2103	10.2	15.2	2652	6034	1892	250.60	49.30	21.70	302.0	6998	278	6763.0	13452.4
C2104	15.2	21.6	1412	2512	1723	98.90	22.50	25.90	466.0	9430	125	7690.0	5913.4
C2105	21.6	26.6	2284	5237	1589	201.40	36.60	18.70	262.0	6554	207	5173.0	11523.4
C2106	26.6	31.8	3289	7272	2059	249.00	43.20	21.00	98.0	2479	379	4184.0	16035.5
C2107	31.8	36.7	2905	5629	1577	201.90	40.00	16.90	293.0	9220	226	7541.0	12745.8
C2108	36.7	41.6	2330	4733	1328	173.50	34.10	0.05	322.0	9973	216	7268.0	10608.8
C2109	41.6	46.5	3610	6812	1753	214.20	38.50	7.10	426.0	9069	261	8892.0	15275.4
C2110	46.5	50.3	1928	3541	1001	128.70	27.00	0.05	410.0	10545	154	9920.0	8153.3
	(10 Samples)		2388	4854	1397	176.90	34.89	14.50	299.1	7477	222	6548.1	10935.8
C2201	1.0	6.8	3871	5711	1237	168.90	35.00	7.70	629.0	7733	264	5787.0	13576.7
C2202	6.8	10.8	1210	2180	556	82.00	16.00	1.50	454.0	6537	141	6265.0	5039.1
C2203	10.8	14.5	1431	2870	670	97.50	19.50	0.05	320.0	11837	147	7911.0	6306.6
C2204	14.5	19.3	1591	3082	731	102.20	21.40	0.60	391.0	7950	142	5664.0	6827.7
C2205	19.3	24.6	3951	6913	1758	227.10	40.00	14.50	450.0	10988	270	7409.0	15842.9
C2206	24.6	29.5	1256	2399	651	89.80	18.30	0.05	667.0	9983	130	6756.0	5468.8
C2207	29.5	32.7	573	1298	294	47.50	9.40	2.60	273.0	10205	50	6986.0	2741.4
C2208	32.7	37.0	2414	4442	738	84.70	14.30	18.50	335.0	5054	166	2506.0	9493.8
C2209	37.0	43.9	1641	2709	696	97.20	18.50	2.70	595.0	6901	129	4457.0	6364.2
C2210	43.9	47.7	3322	4808	914	117.20	18.40	14.50	331.0	2214	108	952.0	11777.7
C2211	47.7	50.2	1972	2816	629	87.70	16.70	0.80	662.0	7183	119	5362.0	6777.7
	(11 Samples)		2203	3718	851	114.92	21.84	5.98	478.7	7896	160	5454.5	8510.2
C2301	9.6	12.6	229	380	144	27.20	5.50	0.05	152.0	1381	45	4231.0	998.3
C2302	12.6	17.4	424	700	224	30.20	7.90	0.05	152.0	2068	49	4460.0	1724.6
C2303	17.4	20.6	407	667	209	32.10	6.60	1.20	325.0	5038	35	3689.0	1630.9
C2304	20.6	22.0	589	959	300	50.80	11.80	4.60	1935.0	3315	69	5430.0	2383.9
C2305	22.0	27.2	370	584	198	36.50	8.20	6.20	177.0	6729	49	4174.0	1503.2
C2306	27.2	34.0	581	971	280	44.30	9.60	0.05	326.0	7013	57	3534.0	2335.3
C2307	34.0	41.2	390	527	203	30.10	9.10	0.30	169.0	8085	49	3990.0	1572.2
C2308	41.2	44.8	529	886	261	40.90	10.60	2.10	363.0	7042	56	4043.0	2146.1
C2309	44.8	49.7	567	941	304	49.00	11.40	0.90	158.0	8976	56	4047.0	2317.3
C2310	49.7	50.1	577	946	258	33.30	7.90	0.05	581.0	5487	43	981.0	2241.8
	(10 Samples)		455	748	235	37.25	8.96	1.42	286.5	6105	51	4018.5	1847.5
C2401	3.0	6.2	500	921	474	144.10	36.00	0.05	309.0	2404	124	1906.0	2635.4
C2402	6.2	12.3	638	1075	293	53.20	15.80	0.05	332.0	4488	88	2330.0	2601.9
C2403	12.3	17.4	1122	1712	375	73.50	17.60	5.20	349.0	1907	96	1753.0	4089.2
C2404	17.4	21.4	78	149	57	16.90	3.40	0.05	96.0	10079	30	5326.0	402.6
C2405	21.4	24.1	1096	1439	247	41.10	9.90	0.05	348.0	2752	77	2151.0	3497.7
C2406	24.1	29.2	536	809	206	28.70	10.20	5.80	408.0	1256	66	1745.0	1998.0
C2407	29.2	34.2	582	1158	356	68.40	17.40	3.60	328.0	733	97	1514.0	2747.8
C2408	34.2	39.2	384	770	256	59.80	17.00	3.50	298.0	8348	93	2295.0	1905.7
C2409	39.2	44.2	358	699	184	32.70	8.20	0.05	291.0	4923	65	1371.0	1613.0
C2410	44.2	50.3	463	910	269	62.10	15.20	3.00	350.0	5383	87	1571.0	2162.7
	(10 Samples)		564	963	269	55.58	14.77	2.35	315.1	4266	82	2130.0	2345.2

SAMPLE	Depth (m)	Depth Thick- ness(m)	La	Ce	Nd	Sm	Eu	Tb	Nb	Sr	Y	P	REO
C2501	2.9	7.2	1918	2751	771	147.40	36.20	4.50	417.0	7589	174	7048.0	6966.1
C2502	7.2	11.8	1324	2017	741	156.40	39.80	2.10	378.0	5252	162	4343.0	5329.6
C2503	11.8	15.1	3381	5139	1430	235.40	53.50	9.70	392.0	6389	268	5118.0	12630.5
C2504	15.1	18.4	814	1535	728	155.00	37.90	15.40	418.0	4166	141	3373.0	4109.1
C2505	18.4	23.2	685	1420	848	199.20	53.30	11.30	348.0	5527	208	3981.0	4106.0
C2506	23.2	27.6	822	1512	633	127.50	33.70	7.40	537.0	3241	154	2052.0	3950.0
C2507	27.6	33.9	1543	2905	1902	424.00	96.10	28.50	429.0	15334	290	14132.0	8599.2
C2508	33.9	40.7	751	1344	527	122.90	32.60	6.30	507.0	4174	149	3190.0	3522.6
C2509	40.7	47.0	1065	1978	838	203.80	52.50	10.20	311.0	3517	177	3593.0	5189.1
C2510	47.0	50.1	1088	1794	633	125.70	29.80	9.20	508.0	4754	145	5592.0	4592.4
	(10 Samples)		1271	2162	922	197.87	48.62	10.89	422.1	6235	139	5447.8	5759.7
C2601	2.0	6.4	1936	3566	1944	373.20	86.70	21.90	266.0	8256	334	6111.0	9899.4
C2602	6.4	11.4	1495	2727	1078	246.20	64.00	18.70	785.0	5971	316	4399.0	7141.9
C2603	11.4	15.0	1878	3108	1053	226.40	57.10	17.30	613.0	7606	310	6192.0	7989.7
C2604	15.0	18.9	1957	5822	3574	565.80	113.00	29.20	187.0	7286	422	5784.0	14969.0
C2605	18.9	26.3	2622	4674	1705	291.60	77.00	19.90	469.0	6584	456	5509.0	11845.5
C2606	26.3	28.2	999	3838	2219	309.10	52.40	4.00	0.5	1295	180	534.0	9124.7
C2607	28.2	33.2	2208	5622	2966	517.60	118.10	28.00	428.0	7320	470	5653.0	14318.5
C2608	33.2	36.1	2440	4727	1957	358.60	86.20	8.80	406.0	9078	413	6740.0	11999.2
C2609	36.1	43.5	2018	4759	2463	371.50	76.90	24.90	437.0	3357	361	2799.0	12090.1
C2610	43.5	47.9	1131	4907	3612	443.90	77.30	18.70	36.0	2747	216	1858.0	12464.3
C2611	47.9	50.2	664	2826	1881	241.20	42.60	5.90	364.0	2424	212	1800.0	7047.6
	(11 Samples)		1893	4362	2229	363.59	80.18	20.05	395.2	5795	358	4483.6	11168.3
C2701	1.5	6.5	1138	2014	664	124.40	34.20	10.00	118.0	5138	137	5760.0	4951.7
C2702	6.5	10.7	754	1121	336	51.20	15.90	1.70	172.0	5544	83	5420.0	2838.0
C2703	10.7	14.3	951	3111	1417	195.10	42.10	6.20	248.0	4147	119	4489.0	7021.4
C2704	14.3	18.6	2096	3660	1047	210.50	62.50	18.70	182.0	7482	209	6597.0	8777.4
C2705	18.6	25.0	433	778	322	52.60	15.60	2.20	742.0	3495	76	5115.0	2016.9
C2706	25.0	31.8	386	691	239	40.30	14.40	16.50	72.0	4597	52	4101.0	1728.5
C2707	31.8	37.5	1063	4224	2224	294.40	59.20	29.30	54.0	2663	223	2058.0	9754.2
C2708	37.5	43.3	463	972	383	50.80	16.50	1.20	103.0	3988	82	3879.0	2366.9
C2709	43.3	47.0	941	2712	1401	178.60	40.40	6.05	14.0	6551	125	4263.0	6480.5
C2710	47.0	50.2	450	720	245	45.30	13.30	18.10	329.0	3343	57	2530.0	1853.1
	(10 Samples)		829	1919	798	119.79	30.41	10.31	210.2	4573	115	4410.9	4591.2
C2801	1.8	6.8	1462	3251	1516	247.60	63.50	15.00	372.0	7282	149	2177.0	8042.1
C2802	6.8	11.8	1828	3808	1692	270.50	65.80	22.50	405.0	6425	137	2541.0	9383.2
C2803	11.8	16.0	905	1756	730	104.40	31.00	7.40	385.0	695	93	407.0	4352.7
C2804	16.0	21.7	1007	1991	833	115.80	32.60	8.30	85.0	2689	124	1740.0	4936.6
C2805	21.7	26.7	1051	2700	1339	242.50	58.30	9.80	68.0	5634	178	5421.0	6695.9
C2806	26.7	31.7	2224	5091	2431	386.50	89.30	32.60	298.0	6330	274	10134.0	12632.3
C2807	31.7	36.7	998	2527	1264	189.60	48.10	12.40	100.0	6420	178	3907.0	6263.6
C2808	36.7	41.7	1189	2864	1421	230.70	56.90	3.80	103.0	7061	231	3337.0	7199.8
C2809	41.7	46.7	1197	2434	1001	150.70	44.20	20.00	304.0	6790	165	4238.0	6018.8
C2810	46.7	50.2	1422	2718	1096	175.90	55.80	29.50	486.0	8471	629	52071.0	7385.1
	(10 Samples)		1334	2944	1352	214.75	55.00	15.89	252.3	5793	205	7391.3	7347.4

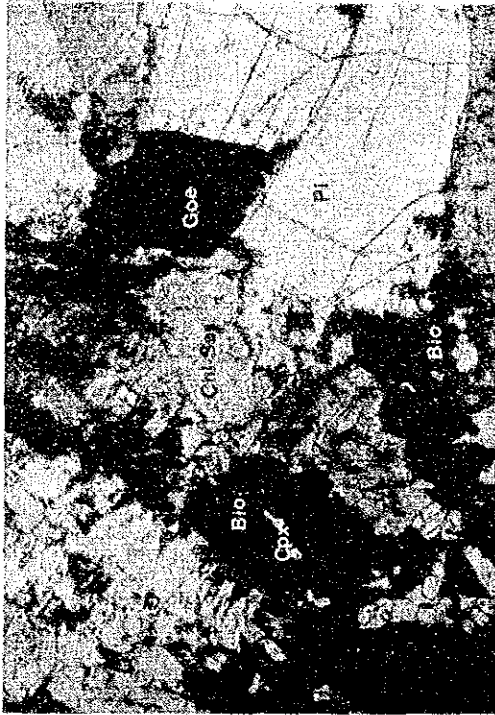
SAMPLE	Depth~ (m)	Depth Thick- (m)	ness(m)	La	Ce	Nd	Sm	Eu	Tb	Nb	Sr	Y	P	REO
C2901	0.4	5.4	5.0	3246	4956	1445	219.10	50.00	16.60	117.0	5041	222	5410.0	12191.5
C2902	5.4	10.4	5.0	3458	5547	1647	231.30	54.60	22.10	125.0	3657	199	2487.0	13398.1
C2903	10.4	15.4	5.0	1600	2707	924	131.80	36.00	3.00	186.0	3321	229	7706.0	6757.2
C2904	15.4	20.4	5.0	1725	3222	1871	207.80	50.00	5.40	22.0	4793	135	2125.0	8055.2
C2905	20.4	25.4	5.0	1392	2548	891	118.80	29.70	2.00	39.0	3557	96	1735.0	6097.1
C2906	25.4	30.4	5.0	2055	3457	1117	174.30	40.90	5.10	46.0	4964	163	4518.0	8420.6
C2907	30.4	35.4	5.0	2410	4406	1678	323.80	75.80	14.70	91.0	3588	180	1736.0	10903.0
C2908	35.4	40.4	5.0	2179	3771	1257	212.30	51.10	14.20	396.0	5051	168	4558.0	9187.6
C2909	40.4	45.4	5.0	1892	3565	1337	238.00	61.10	23.00	120.0	4675	262	13403.0	8862.1
C2910	45.4	50.3	4.9	1962	4111	1765	332.90	82.30	24.50	294.0	5797	255	6898.0	10241.2
(10 Samples)														
C3001	0.0	5.2	5.2	186	480	107	9.30	6.20	13.60	523.0	3607	18	10908.0	988.9
C3002	5.2	10.2	5.0	250	450	177	17.80	11.60	2.80	222.0	4133	112	4822.0	1231.8
C3003	10.2	15.2	5.0	1098	1710	517	64.50	21.50	11.90	521.0	2428	161	6705.0	4308.5
C3004	15.2	20.2	5.0	549	914	314	31.20	16.40	4.80	540.0	2286	141	4778.0	2372.3
C3005	20.2	26.3	6.1	386	678	249	33.80	15.30	16.30	596.0	3124	146	10755.0	1836.8
C3006	26.3	32.3	6.0	321	576	223	47.20	17.90	5.70	446.0	4036	107	9346.0	1561.8
C3007	32.3	38.8	6.5	174	293	111	11.10	7.10	2.40	188.0	3620	57	5029.0	789.6
C3008	38.8	44.0	5.2	437	833	343	64.30	30.60	14.00	449.0	3813	252	9595.0	2381.6
C3009	44.0	50.2	6.2	282	482	192	24.80	12.20	0.05	234.0	2831	78	7156.0	1233.6
(9 Samples)														
C3101	7.0	14.0	7.0	395	691	242	33.18	15.17	7.78	407.4	3330	117	7705.8	1808.5
C3102	14.0	15.5	1.5	199	356	139	36.70	14.10	0.20	300.0	1394	56	2329.0	962.9
C3103	15.5	20.5	5.0	670	1095	357	73.70	19.40	0.10	262.0	1904	93	10133.0	2773.0
C3104	20.5	26.6	6.1	237	404	129	29.80	8.40	0.05	319.0	3104	55	2753.0	1038.7
C3105	26.6	33.0	6.4	198	346	109	31.00	9.40	0.05	282.0	1954	57	2493.0	903.5
C3106	33.0	39.6	6.6	226	429	150	52.50	16.40	0.05	275.0	2501	61	2293.0	1124.2
C3107	39.6	43.1	3.5	209	381	158	45.20	14.70	0.05	257.0	2844	58	2536.0	1040.4
C3108	43.1	47.2	4.1	93	177	84	27.80	7.00	5.70	319.0	3201	23	3476.0	500.5
C3109	47.2	50.2	3.0	308	576	264	114.80	32.70	10.30	294.0	3718	72	2531.0	1650.8
(9 Samples)														
C3201	2.5	7.0	4.5	249	447	171	52.93	16.22	1.67	290.6	2624	60	2981.8	1198.6
C3202	7.0	8.7	1.7	124	212	55	28.30	10.50	12.90	280.0	4297	49	6310.0	592.0
C3203	8.7	13.4	4.7	291	527	171	33.80	8.40	0.05	329.0	5201	50	4544.0	1300.4
C3204	13.4	15.0	1.6	409	744	227	79.30	25.30	13.40	220.0	4463	127	5964.0	1956.1
C3205	15.0	20.1	5.1	305	549	178	24.40	6.80	0.30	261.0	4804	59	2202.0	1350.9
C3206	20.1	26.5	6.4	1329	2272	645	122.20	35.50	5.90	5920.0	6058	190	20038.0	5332.0
C3207	26.5	31.3	5.0	844	1589	457	105.10	35.50	7.50	3398.0	5697	185	9955.0	3880.8
C3208	31.3	36.5	5.0	897	1524	469	52.20	19.00	5.20	1224.0	10163	138	13394.0	3734.3
C3209	36.5	41.0	4.5	953	1697	496	88.60	31.00	5.00	957.0	6695	253	12365.0	4245.9
C3210	41.0	46.0	5.0	46	73	15	24.20	16.40	7.60	654.0	5608	175	5652.0	439.2
C3211	46.0	50.1	4.1	503	1029	403	59.60	26.80	0.05	737.0	13036	159	6323.0	2625.7
(11 Samples)														
				656	1074	325	64.86	22.87	5.96	1616.1	6482	145	9351.9	2753.9

## Appendix 3

### Microscopic observations and microphotographs



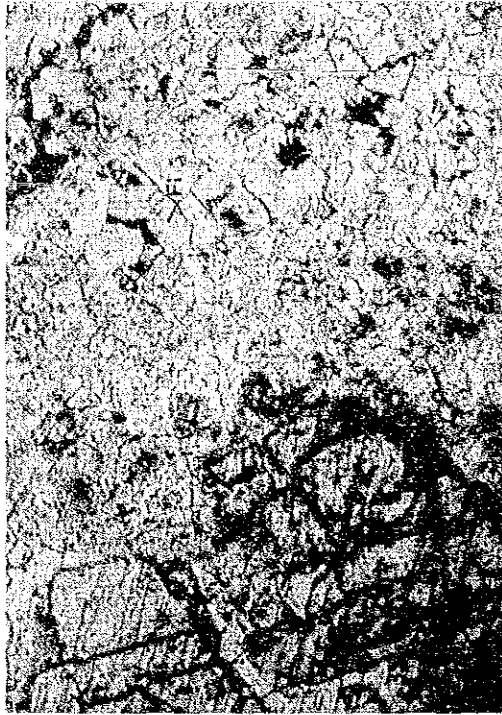
Plain polarized (transmitted light)



Sample No. C0709  
Sector: Chilwa Is.  
Rock name: Syenite  
Observation Note:

The specimen is mainly composed of potassium feldspar and plagioclase. Potassium feldspar occurs as an euhedral or subhedral grain of about 0.15 to 2.5 mm, which is mostly altered to muscovite and chlorite. Plagioclase shows comparatively fresh occurrence. Mafic minerals are mainly presented as biotite (0.05 to 0.9 mm in diameter) and clinopyroxene (less than 0.5 mm in diameter). Small amount of sphene, apatite carbonate minerals and magnetite which is partly altered to goetite are also observed. Clinopyroxene is closely associated with biotite and is partly decomposed into carbonate minerals.

Plain polarized (transmitted light)

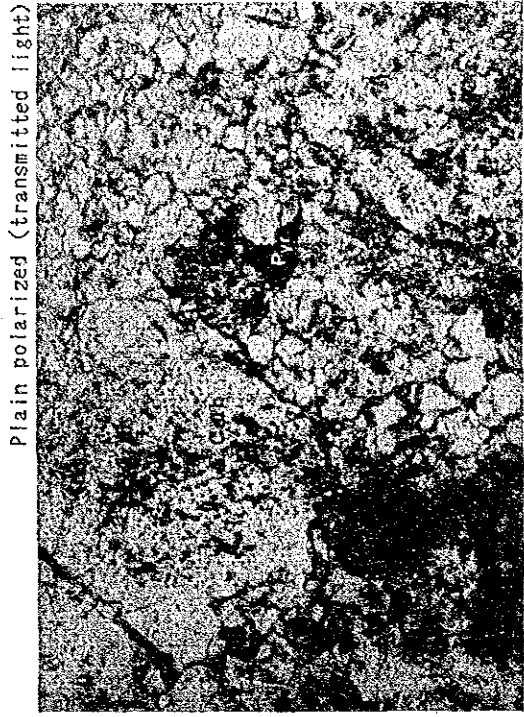


Sample No. C1208  
Sector: Chilwa Is.  
Rock name: Sovite  
Observation Note:

The specimen shows porphyritic texture with euhedral to anhedral carbonate mineral (0.1 mm in diameter) and euhedral to subhedral fluorite (0.5 to 2.0 mm in diameter). Phenocrysts of carbonate minerals (0.5 to 2.0 mm in diameter) are also observed. Anhedral plugged quartz (0.1 to 0.2 mm in diameter) and barite, and anhedral dusty or granular magnetite which is partly altered to goetite are also rarely detected.

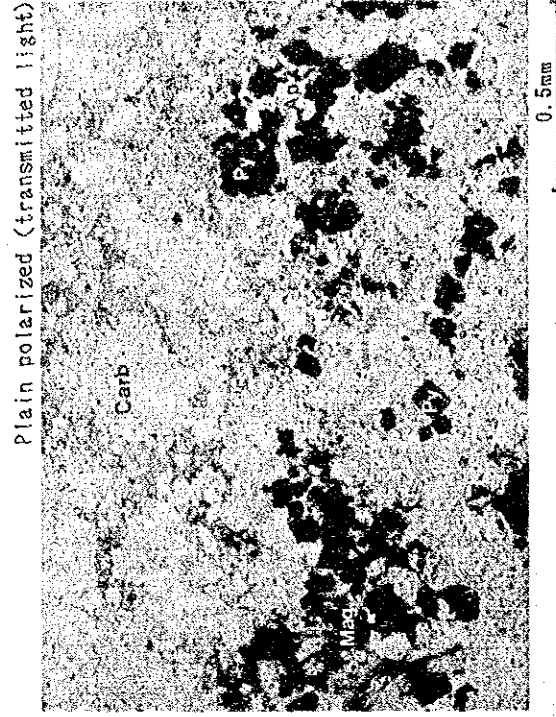
Sample No. C1304  
 Sector: Chilwa Is.  
 Rock name: Ankeritic sovite  
 Observation Note:

The specimen is mainly composed of carbonate mineral which occurs as a porphyritic texture. The porphyritic part consists of grains from 0.35 to 1.75 mm in diameter, and the matrix is formed by grains less than 0.15 mm in diameter. The area proportion between porphyritic and matrix parts are almost same. Dark green subhedral to anhedral pyrochlore (less than 0.2 mm in diameter) and plugged quartz and magnetite are rarely detected.



Sample No. C1306  
 Sector: Chilwa Is.  
 Rock name: Apatite Sovite  
 Observation Note:

The specimen consists of two fine grained parts; carbonate-rich and apatite-rich parts. The carbonate-rich part occurs as a granular mosaic texture with 0.05 to 0.5 mm in grain size. The apatite-rich part is very fine (less than 0.15 mm in diameter) and irregularly associates with plugged carbonate minerals. A small amount of barite, quartz, pyrite, magnetite and pyrochlore is also observed, but barite is not detected in the apatite-rich part.



Plain polarized (transmitted light)



Sample No. Cl607  
Sector: Chilwa Is.  
Rock name: Syenite  
Observation Note:

The specimen is mainly composed of medium to coarse grained plagioclase and potassium feldspar, and medium grained clinopyroxene, biotite and magnetite. Plagioclase occurs as an euhedral or subhedral grain and is almost completely decomposed into Sericite (muscovite) + chlorite. Potassium feldspar is subhedral to anhedral and is mostly altered to albite. Clinopyroxene is euhedral to subhedral with light green in color, which is partly altered to carbonate + opaque minerals. Biotite shows anhedral to subhedral and platy shape with light brown or dark brown in color, which is associated with clinopyroxene. Magnetite is generally anhedral and is altered to hematite. Apatite, carbonate and sphene are rarely observed.

Plain polarized (transmitted light)



Sample No. Cl610  
Sector: Chilwa Is.  
Rock name: Nepheline Syenite  
Observation Note:

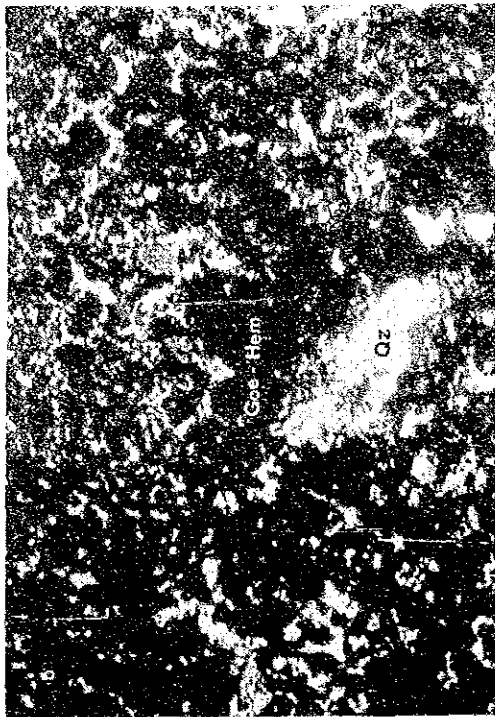
The rock may be originally coarse grained plutonic rock such as nepheline syenite which is composed of feldspar, biotite, clinopyroxene and pyrite. However, feldspar is almost completely altered to sericite and carbonate and only a few plagioclase is remained. Biotite is partly decomposed of plagioclase, carbonate, chlorite, sericite, magnetite and goetite. Clinopyroxene is also partly altered to carbonate, magnetite and goetite.



Sample No. C1901  
Sector: Chilwa Is.  
Rock name: Altered Sideritic Carbonatite  
Observation Note:

The specimen is severely altered. Magnetite is decomposed into goethite and hematite along its grain surface and crack. Siderite is completely altered to goethite and carbonate. Plugged potassium feldspar and quartz are rarely observed.

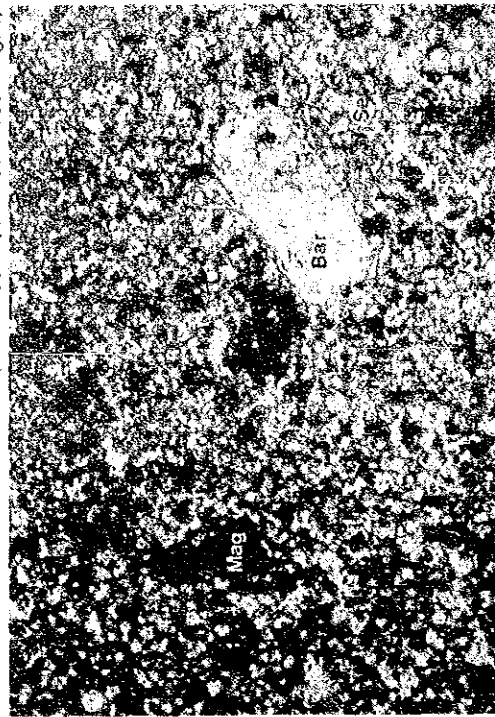
Plain polarized (transmitted light)



Sample No. C2007  
Sector: Chilwa Is.  
Rock name: Phonolite  
Observation Note:

The primary rock had most probably an intergranular texture with feldspar and feldspathoid, but were completely altered to sericite. The specimen consists of euhedral to subhedral feldspar or feldspathoid, subhedral clinopyroxene and anhedral biotite. Phenocrysts of barite (0.6 mm in diameter) and biotite (less than 0.3 mm in diameter) are observed. Magnetite and secondary carbonate are also detected.

Plain polarized (transmitted light)



Sample No. C2106

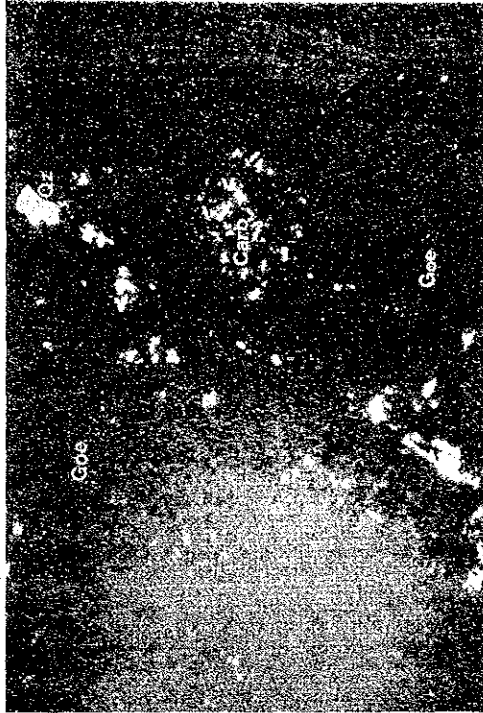
Sector: Chilwa Is.

Rock name: Altered Sideritic Carbonatite

Observation Note:

The specimen consists mainly of euhedral to subhedral magnetite and goetite. The texture shows porphyritic part (1.5 to 7 mm in grain size) and matrix part (less than 0.5 mm in grain size). AnhedraI quartz (less than 0.3 mm), yellowish brown to colorless carbonate and potassium feldspar (less than 0.3 mm) are rarely observed in the matrix part.

Plain polarized (transmitted light)



0.5mm

Sample No. C2208

Sector: Chilwa Is.

Rock name: Ankeritic Sovite

Observation Note:

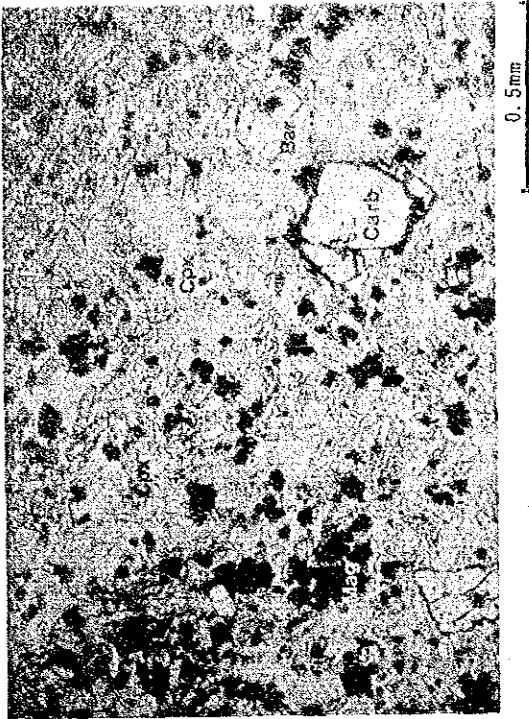
The specimen mainly consists of carbonate and shows porphyritic texture with 0.2 to 1.0 mm porphyritic part and very fine grained matrix. Euhedral to subhedral grains are common in the porphyritic part but anhedraI in the matrix part. Siderite is involved in the matrix carbonate minerals. AnhedraI to euhedral magnetite which is altered to goetite and hematite, and granular to plugged quartz are rarely observed.

Plain polarized (transmitted light)



0.5mm

Plain polarized (transmitted light)



Sample No. C2301  
Sector: Chilwa Is.  
Rock name: Comptonite  
Observation Note:

The specimen shows a panidiomorphic texture and is composed of euhedral clinopyroxene, platy biotite, granular magnetite and plugged sericite. The other porphyritic mineral is also observed, which is completely decomposed into chlorite and carbonate except partly remained barite.

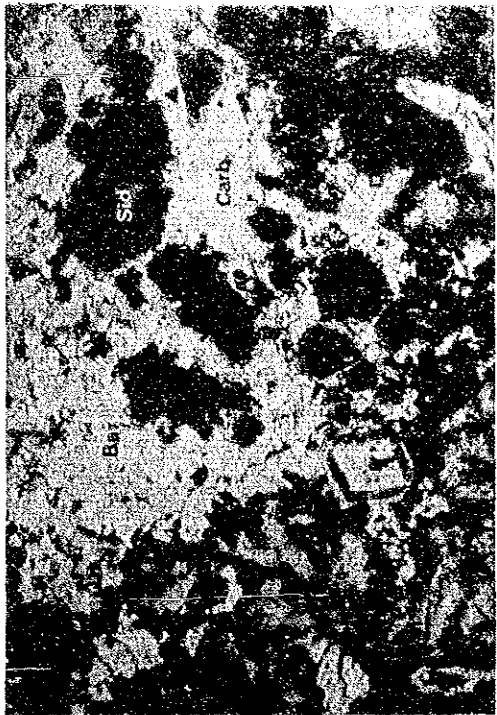
Plain polarized (transmitted light)



Sample No. C2404  
Sector: Chilwa Is.  
Rock name: Lamprophyre  
Observation Note:

The specimen shows a panidiomorphic texture with plagioclase (0.15 mm in diameter), platy biotite (ca.0.05 mm) and hornblende (ca. 0.05 mm). Biotite pseudomorphs displaced to chlorite and carbonate are observed. A small amount of magnetite and pyrite is present.

Plain polarized (transmitted light)



Sample No. C2408  
Sector: Chilwa Is.  
Rock name: Sideritic Carbonatite  
Observation Note:

The specimen shows a porphyritic texture. Phenocrysts consist of euhedral to subhedral light yellowish brown siderite (0.2 to 1.75 mm in diameter) and subordinate colorless carbonate. The groundmass is composed of siderite, barite, fluorite and quartz. Siderite shows a spherulitic texture and fluorite concentrates as a pool (8 mm in diameter). Quartz and barite occur as aggregates (less than 0.6 mm in diameter). Opaque mineral is little observed.

A-25

Plain polarized (transmitted light)



Sample No. C2606  
Sector: Chilwa Is.  
Rock name: Sideritic carbonatite  
Observation Note:

The specimen is severely altered. Magnetite is altered to goethite, and feldspar is decomposed into sericite. Aggregate of goethite and carbonate is also formed, which suggests siderite is the primary mineral. Magnetite, quartz, fluorite and barite are barely remained as the primary mineral.

Plain polarized (transmitted light)



Sample No. C2609  
 Sector: Chilwa Is.  
 Rock name: Sideritic carbonate  
 Observation Note:  
 The specimen is mainly composed of magnetite, fluorite, quartz, potassium feldspar and carbonate. Magnetite is mostly altered to hematite and goethite. Aggregate of carbonate and goethite (0.2 mm in diameter) which is originated from siderite is observed. Fluorite is euhedral to anhedral and less than 0.7 mm in diameter. Pyrochlore is rarely detected. Anhedral quartz and potassium feldspar occur as a vein or pool (less than 1.25 mm in diameter). Primary carbonate mineral is also observed as an anhedral grain of ca. 0.3 mm in diameter.

Plain polarized (transmitted light)



Sample No. C2810  
 Sector: Chilwa Is.  
 Rock name: Ankeritic Sovite  
 Observation Note:  
 The specimen shows a mosaic texture of colorless carbonate (0.1 to 0.25 mm in diameter). The other rock forming minerals are potassium feldspar, quartz, barite, fluobrite and opaque mineral. Potassium feldspar generally forms an aggregate of fine grains including magnetite and carbonate. Opaque mineral involves euhedral to subhedral pyrite (0.07 to 0.7 mm in diameter) and magnetite (0.05 to 0.1 mm in diameter). A very few muscovite is also observed as the secondary mineral.

Plain polarized (transmitted light)



0.5mm

Sample No. C2904  
 Sector: Chilwa Is.  
 Rock name: Ankeritic Sovite  
 Observation Note:  
 The specimen is mostly composed of anhedronal granular carbonate (0.1 to 0.7 mm in diameter). Anhedronal granular quartz is subordinately present and forms an aggregate (0.2 to 0.7 mm in diameter). Subhedronal to anhedronal pyrite and magnetite which is severely altered to goetite are rarely observed.

Plain polarized (transmitted light)



0.5mm

Sample No. C2907  
 Sector: Chilwa Is.  
 Rock name: Altered Sideritic Carbonatite  
 Observation Note:  
 The specimen is altered severely. Magnetite is probably decomposed into goetite, and siderite into carbonate and goetite. No siderite is observed. Two types of carbonate minerals; colorless and brown grain, are present, which are both less than 0.2 mm in diameter.

Sample No. C3003  
Sector: Chilwa Is.  
Rock name: Sovite  
Observation Note:

The specimen is mainly composed of carbonate (0.05 to 0.7 mm in diameter) with a mosaic texture. Barite, quartz and pyrite are subordinately present. Quartz is less than 0.2 mm in diameter and is accompanied with pyrite which is mostly altered to goetite.

Plain polarized (transmitted light)

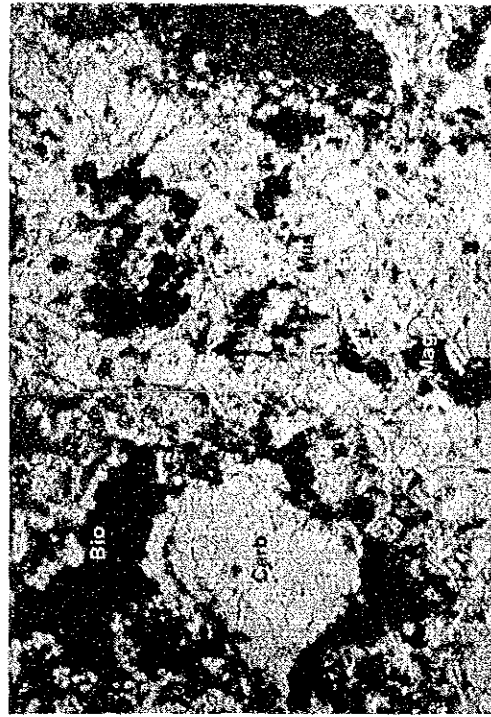


0.5mm

Sample No. C3009  
Sector: Chilwa Is.  
Rock name: Contamination of Alkali rock & Carbonatite  
Observation Note:

The specimen is composed of carbonate, muscovite, biotite and magnetite. Carbonate is anhedral grain with less than 0.5 mm in diameter. Biotite shows a porphyritic occurrence and is altered to aggregate of recrystallized fine biotite. Magnetite partly shows a porphyritic texture and is decomposed into hematite, goetite, carbonate. Apatite and titan mineral are also observed a little.

Plain polarized (transmitted light)



0.5mm

Plain polarized (transmitted light)



Sample No. C3109  
Sector: Chilwa Is.  
Rock name: Syenite  
Observation Note:

The specimen is probably originated from a felspathic syenite (or trachyte), but the feldspar is mostly altered to sericite including kaolinite. The mafic minerals are also altered to carbonate and goethite except a small amount of biotite, magnetite and apatite. Carbonate vein is observed.

Plain polarized (transmitted light)



Sample No. C3210  
Sector: Chilwa Is.  
Rock name: Sovite  
Observation Note:

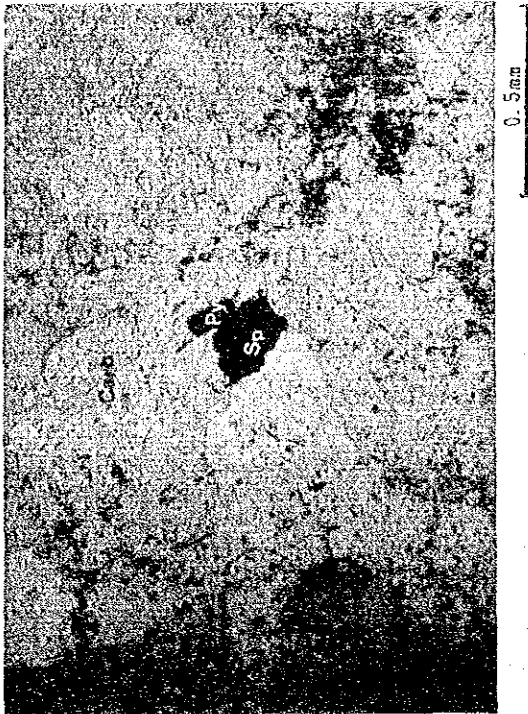
The specimen is composed of carbonate with a mosaic texture (0.07 to 0.25 mm in diameter). Opaque mineral is partly distributed. It is euhedral to subhedral magnetite (0.3 mm in diameter) and pyrite (0.6 mm in diameter). Muscovite and pyrochlore are the other rock forming minerals.



Sample No. C3211  
Sector: Chilwa Is.  
Rock name: Sovite  
Observation Note:

The specimen is mainly composed of anhedral granular carbonate (0.1 to 0.3 mm in diameter) with a mosaic texture. Apatite is partly concentrated and forms plugged aggregates. Zoned pyrochlore (0.1 mm in diameter), sphalerite and pyrite is rarely observed.

Plain polarized (transmitted light)



Sample No. S1404  
Sector: Songwe  
Rock name: Carbonized Agglomerate  
Observation Note:

The specimen is mainly composed of carbonate, potassium feldspar and opaque mineral. Carbonate is anhedral granular (less than 0.3 mm in diameter) and potassium feldspar is euhedral to anhedral porphyritic (less than 1.1 mm in diameter). Opaque mineral is primarily magnetite but is altered to goetite. Dusty opaque is distributed in the matrix.

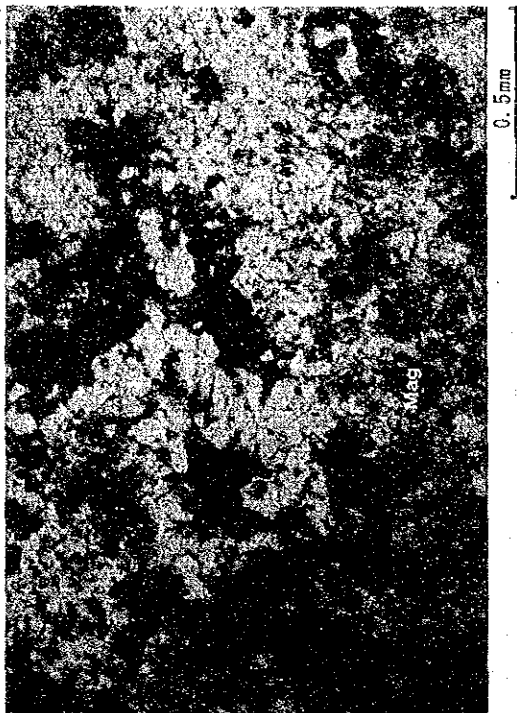
Plain polarized (transmitted light)



Sample No. S1510  
Sector: Chilwa Is.  
Rock name: Sovite  
Observation Note:

The specimen is mainly composed of anhedral granular carbonate (0.05 to 0.45 mm in diameter) with a mosaic texture. Anhedral to euhedral magnetite and hematite are observed. Potassium feldspar altered to albite and light brown carbonate are also observed.

Plain polarized (transmitted light)



Sample No. S1604  
Sector: Songwe  
Rock name: Iron Oxide Ore  
Observation Note:

The specimen is mainly composed of euhedral to subhedral magnetite and hematite (less than 0.1 mm in diameter). Magnetite and hematite form roughly banded texture. Carbonate shows intergranular occurrence and the size is less than 0.2 mm in diameter. Barite is also rarely observed. These subordinate minerals are usually distributed in the part where magnetite and hematite is poor, and form aggregates with coarse grained carbonate.

Plain polarized (transmitted light)



Sample No. S1907

Sector: Songwe

Rock name: Altered nepheline syenite

Observation Note:

The specimen had probably trachytic texture with phenocrysts of feldspar in the primary form, but feldspar and feldspathoid were almost completely altered to albite. The groundmass is decomposed into sericite, chlorite, hematite, goetite, carbonate and partly biotite without potassium feldspar. A small amount of fluorite is also observed.

Plain polarized (transmitted light)



0.5mm

Sample No. T2501

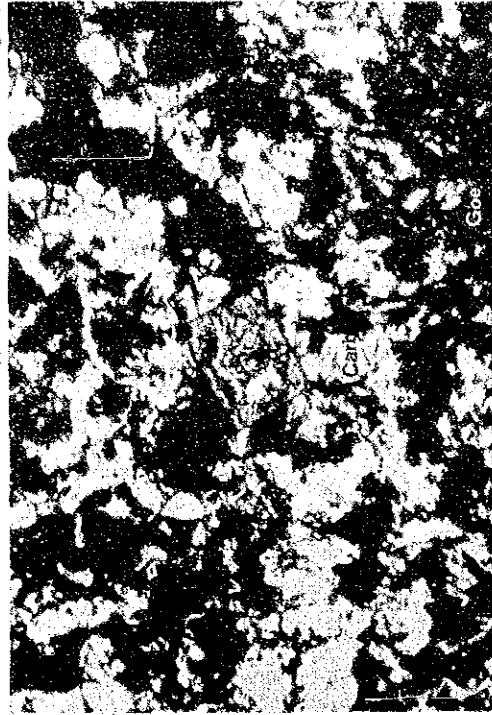
Sector: Tundulu

Rock name: Apatite Rock

Observation Note:

The specimen is mainly composed of apatite, quartz, carbonate and opaque mineral. Apatite is very rich and is euhedral (0.07 to 0.15 mm in diameter). Quartz is anhedral and the size is less than 0.6 mm in diameter. Opaque mineral is euhedral or subhedral (less than 2.5 mm in diameter), and is mostly altered to goetite and carbonate.

Plain polarized (transmitted light)



0.5mm

Sample No. T2606  
Sector: Tundulu  
Rock name: Altered Sideritic Carbonate  
Observation Note:

The specimen is severely altered, which is composed of medium to coarse grained euhedral to subhedral carbonate. Granular quartz and carbonate less than 0.35 mm in diameter are occurred like a vein. Opaque mineral mostly consists of goetite and hematite. Siderite is altered to opaque and carbonate. Euhedral pyrochlore (less than 0.25 mm in diameter) is present in opaque minerals. Apatite and barite are also observed a little.



Sample No. T2607  
Sector: Tundulu  
Rock name: Apatite Rock  
Observation Note:

The specimen is mainly composed of apatite, carbonate, quartz, potassium feldspar and opaque mineral. Opaque mineral is euhedral and is less than 2.5 mm in diameter. It is mostly altered to hematite, goetite and carbonate. Euhedral pyrochlore is rarely observed (less than 0.25 mm). Euhedral apatite is also observed (less than 0.4 mm). Quartz is plugged anhedral crystal with wavy extinction. Potassium feldspar is subhedral to anhedral and is less than 1.2 mm in diameter.



Plain polarized (transmitted light)



Sample No. T2611  
Sector: Tundulu  
Rock name: Biotite rich carbonatite  
Observation Note:

The specimen is mainly composed of biotite, potassium feldspar, carbonate and opaque mineral. Biotite showing euhedral to subhedral shape is very abundant and the grain size is less than 1.4 mm in diameter. Carbonate is anhedral (less than 1.7 mm in diameter) and sometimes displaces opaque mineral. Potassium feldspar is a subhedral to anhedral crystal of less than 1.75 mm in grain size, and is mostly altered to chlorite + sericite. Opaque mineral is almost decomposed into goethite, hematite and carbonate but a small amount of magnetite is remained. Olivine and quartz are rarely observed.

Plain polarized (transmitted light)



Sample No. 8Y033  
Sector: Chilwa Is.  
Rock name: Altered Trachyte  
Observation Note:

The specimen may originally show a porphyritic texture, but the alteration is very severe and the whole rock is altered to sericite, goethite and hematite. Pseudomorph of feldspar composed of carbonate and sericite is observed (less than 0.6 mm in diameter).

Plain polarized (transmitted light)



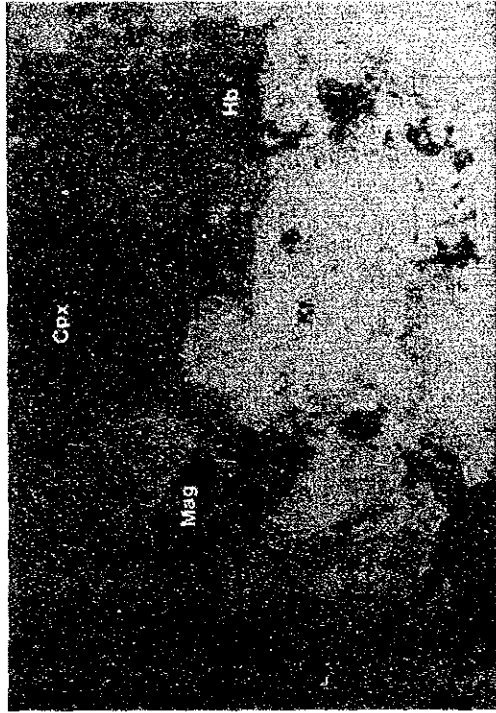
0.5mm

Sample No. 8Y042  
Sector: Chilwa Is.  
Rock name: Syenite  
Observation Note:

The specimen is mainly composed of coarse grained potassium feldspar and fine to medium grained clinopyroxene, plagioclase and quartz. Clinopyroxene is an euhedral to subhedral crystal (less than 0.7 mm in diameter) and shows green in color. Most of the crystal forms aggregates, 0.1 mm in diameter. Potassium feldspar is euhedral to subhedral (less than 3.0 mm in diameter) and is decomposed into albite and a small amount of sericite. Plagioclase shows anhedral to subhedral and occurs albite twin of less than 0.5 mm in grain size. Quartz is anhedral and distributed along the margin of clinopyroxene. Apatite, pyrite, magnetite and carbonate are also observed.

A-35

Plain polarized (transmitted light)

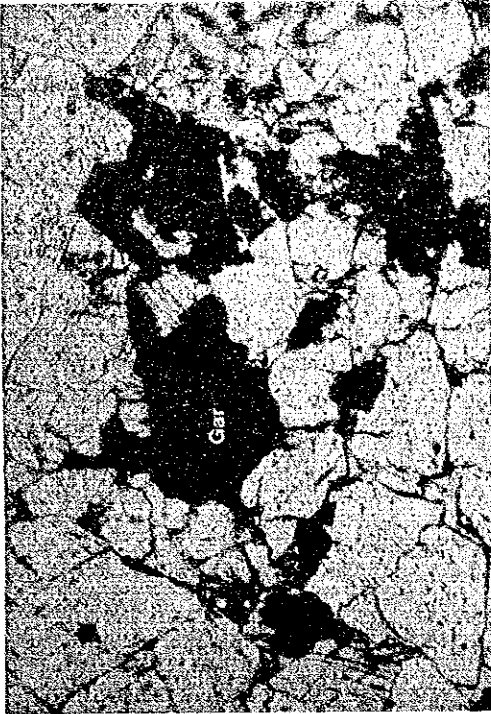


0.5mm

Sample No. 8Y043  
Sector: Chilwa Is.  
Rock name: Finitized gneiss  
Observation Note:

The specimen is mainly composed of medium grained potassium feldspar, plagioclase and quartz, and fine to medium grained clinopyroxene, hornblende and biotite. Potassium feldspar is subhedral to anhedral and plagioclase occurs albite twin. Both are altered to albite associated with sericite. Quartz is anhedral and is less than 1.5 mm in diameter. Clinopyroxene, hornblende and biotite are anhedral to subhedral (less than 1.7 mm), and in particular clinopyroxene and biotite are partly form aggregates, respectively. Apatite, titan mineral and magnetite are subordinately present.

Plain polarized (transmitted light)



Sample No. 8Y057  
Sector: Chilwa Is.  
Rock name: Sovite  
Observation Note:

The specimen consists of anhedronal granular carbonate with mosaic texture, which is 0.2 to 0.5 mm (max 3.5 mm) in grain size. Anhedronal granular quartz which forms aggregates and dark brown subhedronal granular garnet are subordinately present. Pseudomorphs composed of goetite are observed, which are probably derived from hornblende or pyroxene.

Plain polarized (transmitted light)



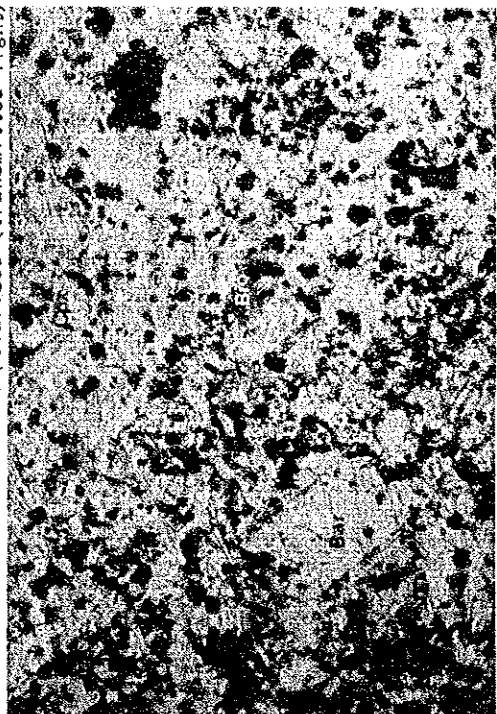
Sample No. 8Y058  
Sector: Chilwa Is.  
Rock name: Sovite  
Observation Note:

The specimen is mainly composed of anhedronal granular carbonate with mosaic texture. Mafic mineral derived from biotite or pyroxene is observed and is completely altered to goetite + quartz + carbonate. Pyrochlore, apatite, quartz, pyrite and magnetite are subordinately present. Occurrence of pyrochlore is closely concerned to apatite and magnetite.

Sample No. 8Y061  
Sector: Chilwa Is.  
Rock name: Comptonite  
Observation Note:

The specimen shows a panidiomorphic texture and is mainly composed of clinopyroxene, biotite, magnetite, pyrite and sericite aggregate. Porphyritic mineral which is mostly barite is also observed and is partly altered to chlorite and carbonate. Apatite is partly concentrated.

Plain polarized (transmitted light)



0.5mm

Sample No. 8Y127  
Sector: Chilwa Is.  
Rock name: Syenite  
Observation Note:

The specimen is mainly composed of plagioclase, potassium feldspar and clinopyroxene. Plagioclase and potassium feldspar occur a graphic intergrowth. Plagioclase is euhedral and is 3.5 mm in maximum length. Clinopyroxene shows yellowish green to green in color and is euhedral to subhedral (less than 2.0 mm). Magnetite, sphalerite are subordinately present. Secondary sericite and carbonate are also occupied.

Plain polarized (transmitted light)



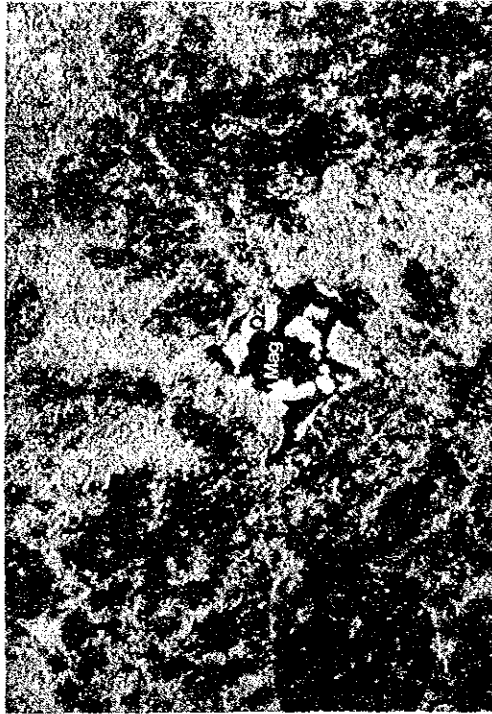
0.5mm



Sample No. 8Y145  
Sector: Chilwa Is.  
Rock name: Alkali syenite  
Observation Note:

The specimen is mostly composed of medium to coarse grained subhedral potassium feldspar which is decomposed into albite. Quartz and magnetite are subordinately present, which are usually associated with together. Magnetite is partly altered to goetite

Plain polarized (transmitted light)



Sample No. 8Y147  
Sector: Chilwa Is.  
Rock name: Sovite  
Observation Note:

The specimen is mainly composed of anhedral granular carbonate with a mosaic texture. Euhedral to subhedral granular light brown garnet is present and is partly altered to carbonate + epidote + opaque mineral. Clinopyroxene, apatite, magnetite, pyrite and biotite are also observed a little. Clinopyroxene is partly altered to epidote and magnetite is partly decomposed into hematite.

Plain polarized (transmitted light)



## Appendix 4

### X-ray diffractive analysis and charts

Result of X-ray Diffraction Analysis

No.	Sample No.	Sector	Locality	Rock Name	Calcite	Dolomite	Ankerite	Kutnahorite	Siderite	Basmaesite	Calciansite	Strontianite	Synchysite	Quartz	Plagioclase	K-feldspar	Chlorite	Sericite	Pyrite	Magnetite	Hematite	Goethite	Pyrochlore	Berillite	Barite	Apatite	Microsilite	Hallite (?)
1	C1304	Chilwa Island	JMC-13 17.9m	Ankeritic sovite		2	4																					
2	C2106	Chilwa Island	JMC-21 28.6m	Altered sideritic carb.	2																	2						
3	C2208	Chilwa Island	JMC-22 33.8m	Ankeritic sovite	4		4				1																	
4	C2408	Chilwa Island	JMC-24 35.6m	Sideritic carbonatite			1	4																				
5	C2810	Chilwa Island	JMC-28 48.2m	Ankeritic carbonatite	4																							
6	C2904	Chilwa Island	JMC-29 17.3m	Ankeritic sovite	4																							
7	C3003	Chilwa Island	JMC-30 12.7m	Sovite	4	1																						
8	S1604	Songwe	JMS-16 14.6m	Iron oxide ore	3	1																						
9	T2501	Tundulu	JMT-25 3.2m	Apatite rock	2		2																					
10	8Y057	Chilwa Island	Surface	Sovite	4				1																			
11	8Y155	Chilwa Island	Surface	Carbonatite	1																							
12	8Y009	Chilwa Island	Surface	Ankeritic sovite	4																							
13	8Y026	Chilwa Island	Surface	Ankeritic sovite	1	4																						
14	8Y038	Chilwa Island	Surface	Sovite	4	1																						
15	8Y058	Chilwa Island	Surface	Sovite	4		2																					
16	8Y068	Chilwa Island	Surface	Sideritic carbonate																								
17	8Y124	Chilwa Island	Surface	Sideritic carbonate																								
18	8Y153	Tundulu	Surface	Apatite rock																								
19	8Y154	Tundulu	Surface	Apatite rock																								
20	JMT 7	Tundulu	JMT- 7 19.3m	Carbonatite	2		3																					
21	JMT 22	Tundulu	JMT-22 41.6m	Sideritic carbonate			4																					
22	JMT 26	Tundulu	JMT-26 25.0m	Sideritic carbonate	3		3																					

1: Rare, 2: Poor, 3: Common 4: Abundant

