

PART III CONCLUSION AND RECOMMENDATION

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CHAPTER 1 CONCLUSION

1-1 North & South Ruri Hill Area

Geological and geochemical explorations were conducted in three sectors of the area. The three sectors are situated in the marginal parts of the carbonatite cone-sheets of the Ruri Hills and their geology comprises basement Nyanzian Metabasalt and carbonatitic rocks which have intruded the former.

From the geochemical exploration, it is found that rare earth elements (REE) and Y concentrate in ferrocarbonatites or ferrocarbonatite breccias in these three sectors.

Conclusion on geology and geochemistry of the three sectors is summarized as follows:

1-1-1 North Ruri Hill North Sector

Ferrocarbonatite breccias occur in the central part of the sector in an area of 0.03 km² trending eastwards. The rocks have undergone strong weathering and have their facies change.

Geochemical anomalies of REE and Y are in the zone of ferrocarbonatite breccias and their immediate peripheries.

The ferrocarbonatite breccias in the zone is rich in middle to heavy rare earth elements and poor in light rare earth elements in comparison with other sectors.

However the possibility of a potential mineralization occurring in the sector is thought to be very low from results of both geology and geochemistry.

1-1-2 North Ruri Hill South Sector

A group of small ferrocarbonatite dykes (dyke swarm) is found in the southern part of the sector. The dykes are usually a few to several tens of centimeters wide and a few to several tens of meters long.

Main geochemical anomalies of Y, Th and La + Ce + Nd cover the dyke swarms in an area of 0.06 km².

The ferrocarbonatite in the zone are richer in La and Ce in comparison with the other sectors.

From results of both geology and geochemistry the possibility of potential mineralization here is very little.

1-1-3 South Ruri Hill Sector

The main ferrocarbonatite zone is in the central to northwestern part of the sector in an area of 0.05 km². The zone comprises a group of small ferrocarbonatite dykes and the basement Nyanzian Metabasalt.

A major geochemical anomaly of La + Ce + Nd covers the zone, but no other important anomaly was observed in the sector.

The ferrocarbonatites of the zone are somewhat richer in La and Ce in comparison with other sectors.

From the nature of ferrocarbonatite dykes, the zone is considered to be worthless for further follow up explorations.

1-2 Kuge-Lwala Area

1-2-1 Kuge Sector

There is a group of ferrocarbonatite dykes which forms a body of 600 m long and 60 m wide maximum in the eastern part of the Kuge Hill.

Strong geochemical anomalies of Y, Th, La + Ce + Nd, Eu and Yb are found in a zone covering the body, and the rocks are rich in Nd in comparison with the other sectors.

The large scale of the body and the strong geochemical anomalies suggest an existence of a potential mineralized zone of REE and Y.

1-2-2 Lwala Sector

The geology of the sector comprises basement Nyanzian Metabasalt, carbonatitic rocks and phonolitic rocks.

Ferruginous breccias which widely occur in the northern part of the area and were expected to be a potential target for REE and Y by the Phase I survey, are considered to be thin effusive facies of carbonatites. The rocks comprise breccias of ferrocarbonatite, alvikite and metabasalt, and ferruginous matrix.

Main geochemical anomalies of Y, La + Ce + Nd and Eu are found in the zone of the ferruginous breccias in the northern part of the sector. But the scale are very small.

Chondrite-normalized patterns of the ferruginous breccias show poor contents of REE, particularly in light rare earth elements.

It is considered that the sector is not a target area for Phase III because the contents of REE and the thickness of ferruginous breccias are very low.

1-3 Buru Hill Area

1-3-1 Geology

Buru Hill Area is located in the Kavirondo Rift Valley which is a branch of Kenya Rift Valley, and the geology comprises a concealed carbonatite body which is overlain by brecciated basement rocks of the Mozambiquean System.

The carbonatites are composed mainly of alvikite and partly sövite, ferrocarbonatite and vein rocks. The carbonatites in the area are considered to be shallow facies of an intrusive carbonatite body.

There is a possibility that a blind carbonatitic plug may occur below a brecciated zone of silicified basement rocks in a place which is about 500 m to the south of the Buru Hill.

1-3-2 Mineralization

Primary mineralizations are divided into five types, i.e., carbonatite, ferrocarbonatite, calcareous iron ore veins, manganiferous iron ore veins and siliceous iron ore veins. Brecciated gneisses overlying the carbonatite body have acquired strong mineralization from these primary materials and supergene enrichment.

The main REE mineral of the primary mineralized materials is bastnäsite which is a carbonate mineral with fluorides. The main Nb-bearing mineral is pyrochlore. The whole mineral assemblage in the supergene zone remains uncertain.

1-3-3 Size of the zone and mode of occurrence of the minerals.

The mineralized zone covers almost all of the Buru Hill area in an area of 0.2 km² and continues at least for more than 200 m in depth from the surface of the hill.

With the water table of the area as a boundary, the mineralized zone can be divided into an upper oxidized layer of supergene enrichment and a lower layer of primary mineralization.

Average chemical contents of 50 m depth from the surface in the mineralized zone are estimated as follows ; La + Ce + Nd : 1.93%, Sm + Eu + Tb : 0.036%, Yb + Lu : 0.0037%, Nb : 0.095% and Y : 0.065%.

The large scale and the high chemical contents of the mineralized zone suggest that the area is a potential target area for REE, Y and Nb.

CHAPTER 2 RECOMMENDATION

It is recommended to carry out following works as the 3rd Phase Programme to the Buru Hill and the Kuge-Lwala Areas.

2-1 Buru Hill Area

A programme concentrated mainly in diamond drilling and mineralogical tests is recommended .

The aims of drilling are to know the exact boundary of the mineralized zone and the shape and character of the supergene enrichment and the lower zones, and also to explore a potential blind carbonatite body that might occur at the depth to the south of Buru Hill.

The aims of mineralogical tests are to reserch the whole mineral assemblage in both the supergene enrichment and the lower primary mineralization layers.

2-2 Kuge-Lwala Area

A programme concentrated mainly in diamond drilling and mineralogical test is recommended .

The aims of drilling is to explore the depths of the group of ferrocarbonatite dykes located in the eastern marginal part of the Kuge Hill.

The aims of mineralogical tests are to know the mineral assemblage of rare earth elements of the dykes.

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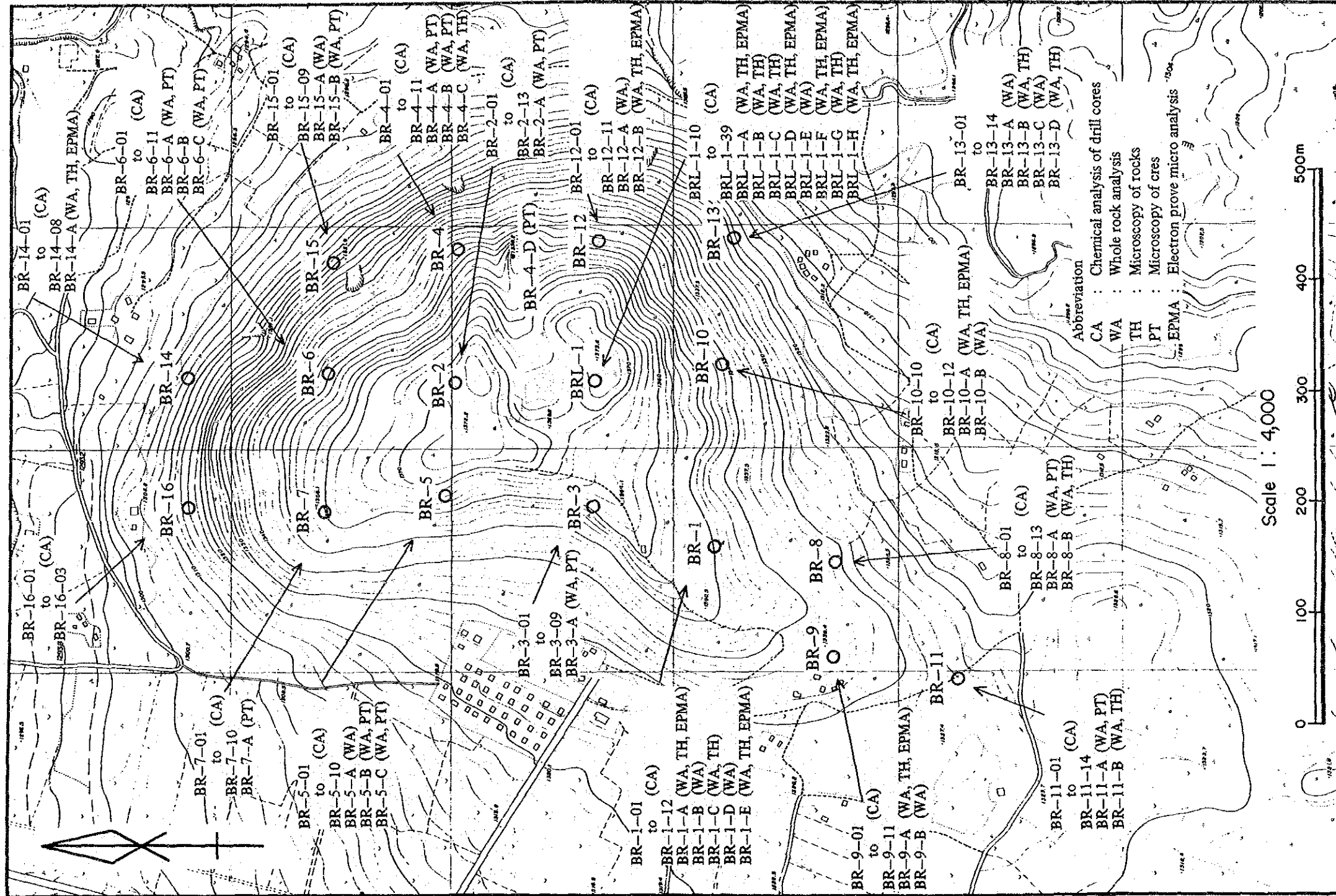
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APPENDIXES



Apx. 1 Location Map of Tested Samples, Buru Hill Area

Apex 2 Results of Whole Rock Analysis of Carbonatites and Related Rocks

Number	Sample Description Depth (m)	Rock Type	SiO ₂ %	Al ₂ O ₃ %	Fe ₂ O ₃ %	MgO %	CaO %	Na ₂ O %	K ₂ O %	TiO ₂ %	P ₂ O ₅ %	MnO %	BaO %	LOI %	TOTAL %	F %
BR-1-A	9.50	Ferrocarnatite	1.45	0.33	37.78	0.16	21.90	0.17	0.05	0.09	2.88	4.36	0.94	19.03	89.15	0.87
BR-1-B	12.40	Ferrocarnatite	1.82	0.37	31.35	0.19	24.57	0.27	< 0.01	0.23	4.30	3.53	1.02	19.52	87.19	1.55
BR-1-C	20.20	Carbonatite	1.21	0.22	13.14	0.15	37.15	0.21	< 0.01	0.03	2.51	6.14	3.29	23.78	87.85	7.18
BR-1-D	27.50	Siliceous ore	12.06	2.98	28.91	1.02	16.88	0.22	1.91	0.47	1.39	4.79	3.79	17.61	92.04	2.13
BR-1-E	38.20	Carbonatite	1.42	0.31	17.55	0.31	29.97	0.36	< 0.01	0.27	6.55	5.86	5.61	18.94	87.17	4.19
BR-2-A	25.50	Ca-Fe-ore	2.47	0.63	43.60	0.25	14.96	0.14	< 0.01	0.05	0.56	7.20	1.63	12.26	83.79	10.60
BR-3-A	8.50	Ca-Fe-ore	1.61	1.17	41.65	0.25	13.11	0.12	< 0.01	0.23	0.95	6.22	6.58	10.51	82.43	9.20
BR-4-A	10.40	Siliceous ore	25.45	0.41	40.36	0.33	5.71	0.15	< 0.01	0.10	0.47	6.68	2.27	10.60	92.55	4.23
BR-4-B	17.00	Siliceous ore	36.62	0.30	25.45	0.13	14.50	0.27	< 0.01	0.22	0.55	3.83	1.22	11.07	94.18	10.10
BR-4-C	45.20	Carbonatite	3.49	0.21	17.26	0.29	31.90	0.23	< 0.01	0.14	1.68	4.47	6.92	22.89	89.50	4.88
BR-5-A	14.80	Mn-Fe ore	5.16	1.35	49.34	0.41	5.54	0.13	0.06	0.06	0.37	10.01	2.17	14.16	88.77	4.10
BR-5-B	31.90	Siliceous ore	34.58	1.49	39.67	0.38	0.88	0.11	0.44	0.36	0.38	0.42	1.39	9.22	89.33	0.89
BR-5-C	50.30	Siliceous ore	29.40	0.46	28.40	0.14	12.32	0.11	< 0.01	0.11	0.28	4.93	3.65	11.60	91.42	9.16
BR-6-A	10.50	Ca-Fe ore	1.36	0.99	43.82	0.27	11.54	0.13	< 0.01	0.01	0.16	10.06	2.58	11.97	82.91	8.46
BR-6-B	18.90	Mn-Fe ore	4.66	2.06	26.87	0.45	4.68	0.12	0.17	0.04	0.53	11.58	14.09	14.56	79.82	4.51
BR-6-C	30.80	Ca-Fe ore	2.57	0.58	46.98	0.24	16.20	0.17	0.24	0.09	0.14	3.06	3.27	6.17	79.72	11.80
BR-8-A	99.45	Ca-Fe ore	3.68	0.49	42.14	0.40	11.45	0.14	0.02	0.10	0.10	6.21	5.23	13.93	83.90	6.70
BR-8-B	45.70	Carbonatite	3.58	0.48	13.43	0.66	37.52	0.22	0.59	0.14	2.97	4.31	1.01	29.35	94.27	1.08
BR-9-A	29.20	Carbonatite	1.17	0.25	24.68	0.18	34.77	0.23	< 0.01	0.09	5.54	2.28	1.04	22.37	92.62	1.42
BR-9-B	35.20	Ferrocarnatite	2.42	0.49	23.20	0.50	22.98	0.20	< 0.01	1.05	2.49	5.55	8.33	17.92	85.15	2.92
BR-10-A	26.10	Carbonatite	1.09	0.24	14.52	0.28	40.75	0.27	< 0.01	0.08	4.86	6.18	1.59	25.06	94.94	4.11
BR-10-B	49.80	Ferrocarnatite	2.22	0.30	36.64	0.25	14.50	0.19	< 0.01	0.19	2.48	7.91	7.51	15.96	88.17	1.85
BR-11-A	36.50	Mn-Fe ore	1.38	0.33	60.02	0.21	0.71	0.12	< 0.01	0.01	0.09	10.08	7.99	9.48	90.44	0.20
BR-11-B	38.90	Carbonatite	0.89	0.13	10.53	0.30	41.10	0.23	< 0.01	0.02	3.53	4.86	2.43	29.58	93.62	1.92
BR-12-A	48.00	Carbonatite	2.49	0.28	12.62	0.27	35.46	0.14	< 0.01	0.09	0.43	4.42	2.98	29.60	88.80	2.92
BR-12-B	50.30	Ferrocarnatite	2.84	0.45	38.23	0.42	14.01	0.12	< 0.01	0.37	0.19	4.94	7.10	13.31	82.00	4.72
BR-13-A	27.20	Mn-Fe ore	3.94	0.81	54.16	0.21	0.72	0.19	0.12	0.09	0.06	13.75	5.15	13.36	92.57	0.40
BR-13-B	32.80	Mn-Fe ore	1.62	0.37	51.11	0.36	5.01	0.10	< 0.01	0.05	0.05	11.24	9.10	13.00	92.01	0.42
BR-13-C	38.50	Carbonatite	2.79	0.18	14.31	0.19	29.49	0.21	< 0.01	0.69	2.84	5.19	9.72	15.04	80.67	9.84
BR-13-D	50.00	Carbonatite	0.92	0.26	32.34	1.11	19.91	0.19	< 0.01	0.17	0.63	6.71	3.67	29.43	95.42	1.93
BR-14-A	9.30	Carbonatite	4.16	0.22	14.78	0.62	27.55	0.13	< 0.01	0.14	0.10	4.77	10.06	24.42	86.97	2.51
BR-15-A	38.80	Mn-Fe ore	3.94	0.25	61.57	0.29	1.56	0.10	0.01	0.01	0.09	11.70	2.38	12.89	94.80	1.12
BR-15-B	42.80	Mn-Fe ore	3.85	0.27	55.57	0.79	4.51	0.11	< 0.01	0.01	0.04	11.25	1.56	15.13	93.11	1.13
BR-15-C	68.10	Mn-Fe ore	1.83	0.26	58.73	0.20	5.39	0.08	< 0.01	0.01	0.26	12.60	1.32	13.17	93.87	0.32
BR-15-D	74.10	Carbonatite	2.37	0.50	30.13	0.31	18.78	0.17	< 0.01	0.39	2.17	8.40	6.84	14.21	84.29	5.16
BR-15-E	85.40	Carbonatite	1.29	0.24	33.15	1.07	21.37	0.27	0.11	0.33	3.09	3.43	1.38	25.23	90.97	1.64
BR-15-F	113.90	Carbonatite	1.15	0.30	21.54	1.40	34.87	0.32	< 0.01	0.15	6.02	2.91	0.47	27.98	87.13	1.19
BR-15-G	131.30	Carbonatite	1.01	0.23	19.98	1.10	32.21	0.20	< 0.01	0.05	0.12	3.02	1.90	33.25	92.58	3.32
BR-15-H	198.10	Carbonatite	4.11	0.30	9.02	3.13	34.82	0.30	0.22	0.22	3.45	3.63	2.30	25.95	88.06	3.94
BR-15-I	180.00	Nephelinite	41.28	11.41	9.25	3.18	11.00	2.49	2.05	1.28	1.23	0.27	2.75	11.02	97.22	0.34
Average	15	Carbonatite	2.14	0.27	17.78	0.89	32.52	0.23	-	0.19	3.05	4.65	3.84	24.51	89.96	3.69
Value by	6	Ferrocarnatite	1.96	0.37	33.31	0.44	19.64	0.19	-	0.35	2.16	5.50	4.76	19.20	87.85	2.31
rock type	5	Ca-Fe ore	2.34	0.77	43.64	0.28	13.45	0.14	-	0.10	0.19	6.55	3.86	10.96	82.55	9.35
(ore)	5	Siliceous ore	27.62	1.13	32.56	0.40	10.06	0.17	-	0.25	0.61	4.13	2.46	12.02	91.90	5.30
	8	Mn-Fe ore	3.30	0.71	52.17	0.37	3.52	0.12	-	0.04	0.19	11.53	5.47	13.22	90.67	1.52

Apx. 3 Summary of Microscopic Observation -- Polished Thin Sections --

Sample description			Opaque minerals					Transparent minerals							Und	Remarks *
Number	Depth (m)	Ore type	Goe	Hem	Lep	Mag	Qua	Flu	Bas	Cra	Bar	Non	Cal	Und	Remarks *	
BR-2-A	25.50 m	Ca-Fe ore	⊙	△	+			○	+	+						
BR-3-A	8.50	Ca-Fe ore	○	⊙	△	+	+	△	+	+	+		+			
BR-4-A	10.40	Sil-ore	○	○	△	△	○*	△		+					Opal	
BR-4-B	17.00	Sil-ore	⊙	+	+		△*	△	+	+					Opal	
BR-4-D	Drill site	Sil-ore	△	+			⊙*	○	△		△	+			Opal > qua	
BR-5-B	31.90	Sil-ore	△	○		△	+	○	+		△			△		
BR-5-C	50.30	Sil-ore	⊙	+	+		△*	+		+		+			Opal > qua	
BR-6-A	10.50	Ca-Fe ore	⊙	⊙	△			△	+	+	+	+				
BR-6-C	30.80	Ca-Fe ore	○	⊙		○		△	+	+	+					
BR-7-A	Drill site	Sil-ore	⊙	○	+		△	+		+		+				
BR-11-A	38.50	Mn-Fe ore	⊙	⊙	△	△		+	+	△						
BR-15-B	42.80	Mn-Fe ore	⊙	+	+			+				+	△			

⊙ : abundant, ○ : common, △ : poor, + : rare

Abbreviations

Goe ; goethite, Hem ; hematite, Lep ; lepidocrocite, Mag ; magnetite
 Qua ; quartz, Opal ; chalcedonic quartz
 Flu ; fluorite, Bas ; bastnaesite, Cra ; crandallite group mineral
 Bar ; barite
 Non ; smectite (montmorillonite) group mineral, probably nontronite
 Cal ; carbonate mineral, probably calcite, partly siderite or dolomite
 Und ; undetermined mineral

Apx. 4 Summary of Microscopic Observation -- Thin Sections --

Sample description			Opaque minerals							Minerals characteristic in carbonatite							Silicate minerals					Unidentified minerals												
Number	Depth (m)	Rock type	Goe	Hem	Mag	Jac	Cal	Sid	Bar	Apa	Flu	Pyc	Bas	Syn	Mic	Ser	Cpx	Amp	Sph	CD	AM													
BR-1-A	9.50	Ferro-CB	⊙	△			⊙			○	△																							
BR-1-C	20.20	CB	○				⊙ ^{*1}		△		○		+																					
BR-1-E	38.20	CB	○				⊙		○	△	○		△																					
BR-4-C	45.20	CB	⊙				○		△	△	△		+																					
BR-8-B	45.70	CB	○				⊙			△	+																							
BR-9-A	29.20	CB			○		⊙			△	○																+	pyc-like						
BR-10-A	26.10	CB	△	○	○		⊙			△	○		+																					
BR-11-B	38.90	CB	△				⊙			○	△		+																					
BR-12-B	50.30	Ferro-CB	⊙				△			+	+		+															○	Al ₂ O ₃ -P ₂ O ₅ mineral					
BR-13-B	32.80	Mn-Fe Ore	⊙	△	△		○		△	△	△																+	cubic crystal						
BR-13-D	50.00	CB					⊙ ^{*1}		△		△			+																				
BR-14-A	9.30	CB					○			+	△		+															○	Mn-Fe oxide					
BRL-1-A	68.10	Mn-Fe Ore				⊙				+				+															△	cryptocrystalline				
BRL-1-B	74.10	CB			○		⊙		△		△		+															○	ditto					
BRL-1-C	85.40	CB					⊙ ^{*1}				△																	+	ditto					
BRL-1-D	107.30	CB			△		⊙		○	△	△																		△					
BRL-1-F	131.30	CB					⊙		○	△	△																							
BRL-1-H	198.10	CB					△				△																							
BRL-1-G	180.00	Nephelinite								△																			○	○	△	○ ^{*2}	○ ^{*3}	
KUGE-A	(Kuge Hill)	Ferro-CB	⊙				⊙		△		△		+																				△	fibrous

BR-1 to BR-16 and BRL-1 are DDH No. in Buru Hill Area. Kuge Hill is one of sectors of Kuge-Lwala Area.

⊙ : abundant say > 40%, ○ : common say 20 to 40%, △ : poor say 5 to 20%, + : rare say < 5%

Abbreviations

Goe; Goethite, Hem; hematite, Mag; magnetite, Jac; Jacobsite, Cal; calcite, Sid; siderite, Bar; barite
 Apa; apatite, Flu; fluorite, Pyc; pyrochlore, Bas; bastnaesite, Syn; Synchusite, Mic; mica, Ser; serpentine,
 Cpx; clinopyroxene, Amp; amphibole, Sph; sphene, CD; groundmass, AM; alteration minerals

Remarks

*1 : including Fe-rich calcite, *2 : feldspar + nepheline, *3 : tridymite and/or calcedony or zeolite

Apex 5 Summary of EPMA Test-1, Mineral List Identified by Qualitative Analysis

Sample description			Opaque minerals										Minerals characteristic in carbonatite										Others			Unidentified
Number	Depth(m)	Type	Geo	Hem	Mag	Ilm	Sph	Cal	Do-An	Sid	Str	Bar	Apa	Flu	Pyc	Bas	Syn	Par	Hua	Ran	Mic	Qua	Un-1	Un-2		
BR-1-A	9.50	Ferro-CB	△		△			⊙		△		+	○	○	+								+			
BR-1-E	38.20	CB						⊙		○		○	△	○		△					+			-		
BR-9-A	29.20	CB	○		○	△		⊙		○			○	○	+						+					
BR-10-A	26.10	CB	△					⊙		○		△	○	○				△		+			○			
BR-12-B	50.30	Ferro-CB	⊙		+			△			△					△						△				
BR-14-A	9.30	CB	○					⊙				○				△						△	+			
BR-1-A	68.10	Mn-Fe ore	⊙		○			△		△								△								
BR-1-D	107.30	CB	○		○		△	⊙		○		△														
BR-1-F	131.30	CB						⊙		⊙			△		△											
BR-1-H	198.10	CB						⊙		○	△	+	△									△				

⊙: Major, ○: Common, △: Accessory, +: rare

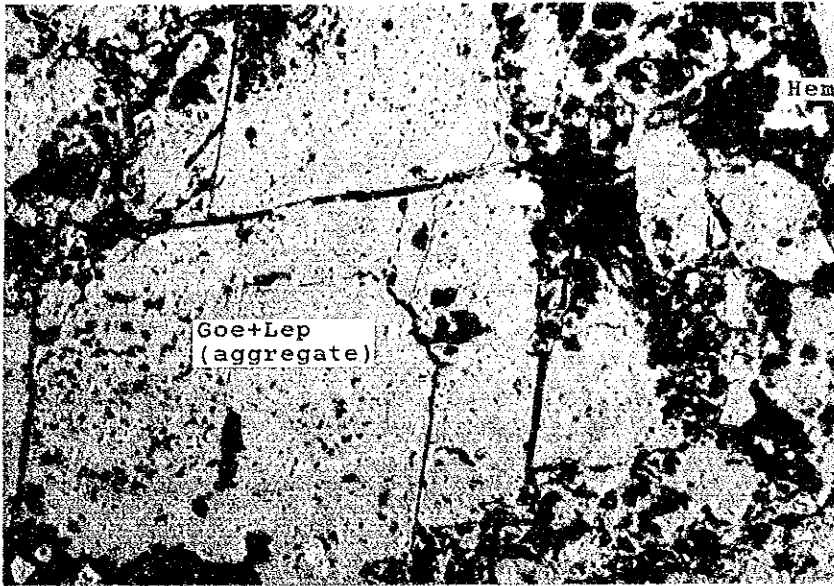
Abbreviations

- Goe; goethite, Hem; hematite, Mag; magnetite, Ilm; ilmenite, Sph; sphalerite
- Cal; calcite, Do-An; dolomite-ankerite mineral, Sid; siderite, Str; strontianite
- Bar; barite, Apa; apatite, Flu; fluorite,
- Pyr; pyrochlore, (Na, Ca, Ce)₂(Nb, Ta, Ti)₂O₆(OH, F)
- Bas; bastnaesite, (Ce, La) (CO₃)F
- Syn; synchysite (Ce, La) Ca (CO₃)₂F
- Par; parisite (Ce, La)₂Ca(CO₃)₃F₂
- Hua; huanghoite BaCe(CO₃)₂F
- Ran; rancieite (Ca, Mn⁺²) Mn₄O₉·3H₂O
- Mic; mica mineral, sericite except BR-14-A (phlogopite)
- Qua; quartz
- Un-1; probably Ba-rich rancieite
- Un-2; hydrous Al₂O₃

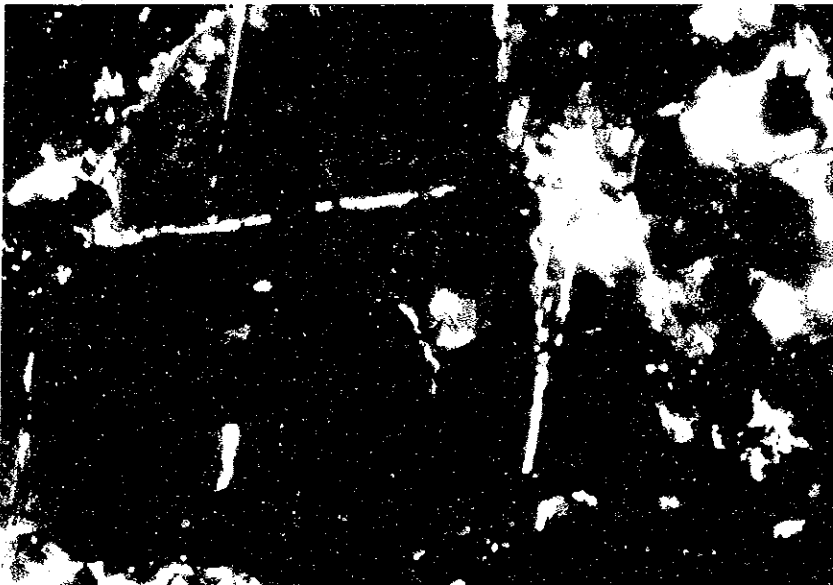
* phlogopite

APX. 6 Summary of EPMA Test-2, Quantitative Analysis of Minerals

Sample Number	Minerals	Results (weight %)				
		Components	1	2	3	Average
BR-1-A	Unknown ; Probably Ba-rich Rancieite	MnO	57.96	52.64	58.08	56.23
		(MnO ₂)	(70.71)	(64.22)	(70.86)	(68.60)
		BaO	13.26	12.00	12.75	12.67
		FeO	2.46	7.78	2.74	4.33
		CaO	2.55	1.86	1.89	2.10
		Total	(88.98)	(85.86)	(88.24)	(87.69)
BR-1-E	Bastn�esite	Ce ₂ O ₃	34.27	33.56	33.60	33.81
		La ₂ O ₃	26.47	25.17	25.07	25.57
		Nd ₂ O ₃	2.71	4.20	2.57	3.16
		SrO	1.69	1.54	1.49	1.57
		CaO	4.19	4.88	4.75	4.61
		Total	69.33	69.35	67.48	68.72
BR-9-A	Pyrochlore	BaO	65.93	66.72	66.80	66.48
		SO ₃	33.40	33.04	33.60	33.35
		CaO	0.50	0.35	0.32	0.39
		FeO	0.31	0.13	0.17	0.20
		SrO	0.43	1.40	1.09	0.97
		Total	100.57	101.64	101.98	101.40
BR-10-A	Parisite	Nb ₂ O ₅	61.96	61.09	60.64	61.23
		Ta ₂ O ₅	8.25	10.06	9.71	9.34
		TiO ₂	5.14	5.00	4.64	4.93
		Fe ₂ O ₃	1.56	1.08	1.81	1.48
		CaO	14.32	13.89	14.00	14.07
		Total	99.47	101.18	99.88	100.18
BR-12-B	Barite	CaO	8.82	8.94	9.05	8.94
		Ce ₂ O ₃	30.07	29.02	29.01	29.37
		La ₂ O ₃	22.30	22.10	22.30	22.23
		Nd ₂ O ₃	2.24	2.35	2.69	2.43
		SrO	1.17	1.26	1.56	1.33
		Total	64.60	63.67	64.61	64.29
BR-14-A	Rancieite	Ce ₂ O ₃	36.05	34.20	34.72	34.99
		La ₂ O ₃	19.33	19.30	19.34	19.32
		Nd ₂ O ₃	8.36	7.45	7.97	7.93
		SrO	1.38	1.49	1.48	1.45
		CaO	2.49	2.28	2.39	2.39
		Total	68.05	65.03	65.90	66.34
BRL-1-A	Synchysite	BaO	67.38	66.16	66.55	66.70
		SO ₃	34.27	34.36	34.21	34.28
		CaO	0.00	0.00	0.00	0.00
		FeO	0.43	0.36	0.39	0.39
		SrO	0.30	0.58	0.42	0.43
		Total	102.38	101.46	101.57	101.80
BRL-1-D	Barite	Ce ₂ O ₃	33.44	32.56	31.94	32.64
		La ₂ O ₃	22.77	22.11	22.04	22.31
		Nd ₂ O ₃	2.84	1.18	3.53	2.52
		SrO	1.07	0.74	1.09	0.96
		CaO	6.77	6.59	7.73	7.03
		Total	66.89	63.18	66.33	65.47
BRL-1-F	Pyrochlore	CaO	14.29	15.08	15.01	14.79
		SrO	1.49	1.34	1.56	1.46
		BaO	1.18	0.23	1.47	0.96
		Ce ₂ O ₃	24.80	24.25	25.42	24.82
		La ₂ O ₃	7.00	4.70	6.70	6.13
		Total	59.29	57.24	60.89	59.14
BRL-1-H	Huanghoite Synchysite	SO ₃	33.56	34.45	32.85	33.62
		BaO	66.82	66.59	66.48	66.63
		CaO	0.42	0.13	0.08	0.21
		FeO	0.36	0.40	0.46	0.41
		SrO	0.48	0.31	0.27	0.35
		Total	101.64	101.88	100.14	101.22
BRL-1-E	Strontianite	Nb ₂ O ₅	61.06	61.34	59.78	60.73
		Ta ₂ O ₅	9.27	9.88	10.23	9.79
		TiO ₂	4.82	4.41	4.56	4.60
		Fe ₂ O ₃	0.77	0.62	0.70	0.70
		CaO	13.98	14.45	13.97	14.13
		Total	98.38	98.00	98.78	98.38
BRL-1-F	Huanghoite Synchysite	SrO	62.16	65.94	66.72	64.94
		CaO	8.09	5.90	4.69	6.23
		Total	70.25	71.84	71.41	71.17
		CaO	4.34	8.35	6.77	6.49
		SrO	4.22	3.06	3.84	3.71
		Total	14.95	8.55	11.93	11.81
BRL-1-H	Huanghoite Synchysite	Ce ₂ O ₃	20.74	21.58	20.80	21.04
		La ₂ O ₃	21.58	22.43	21.03	21.68
		Nd ₂ O ₃	2.02	2.01	1.87	1.97
		Total	67.85	65.98	66.24	66.69
		CaO	67.91	67.30	67.91	67.30
		SO ₃	34.65	34.48	34.88	34.64
SrO	0.17	0.46	0.21	0.28		
FeO	0.51	0.40	0.48	0.46		
Total	102.51	102.14	103.48	102.71		



(in reflecting light, open)



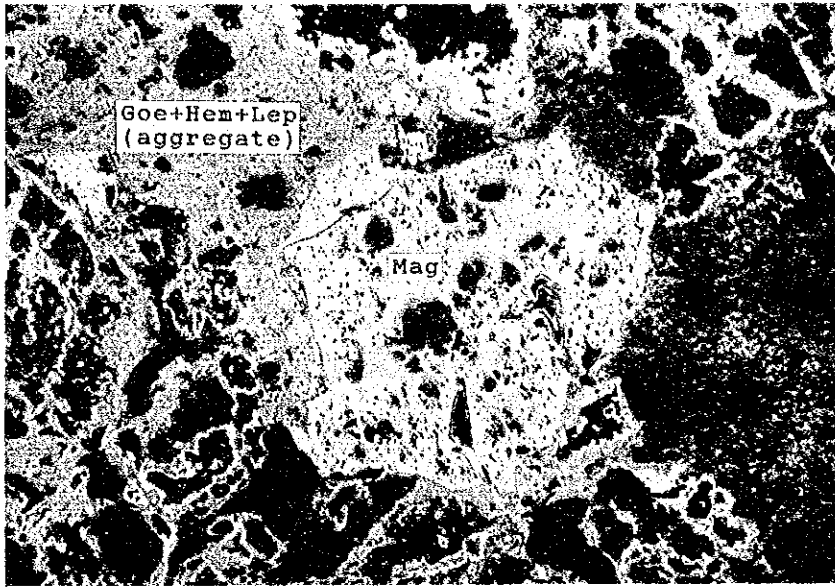
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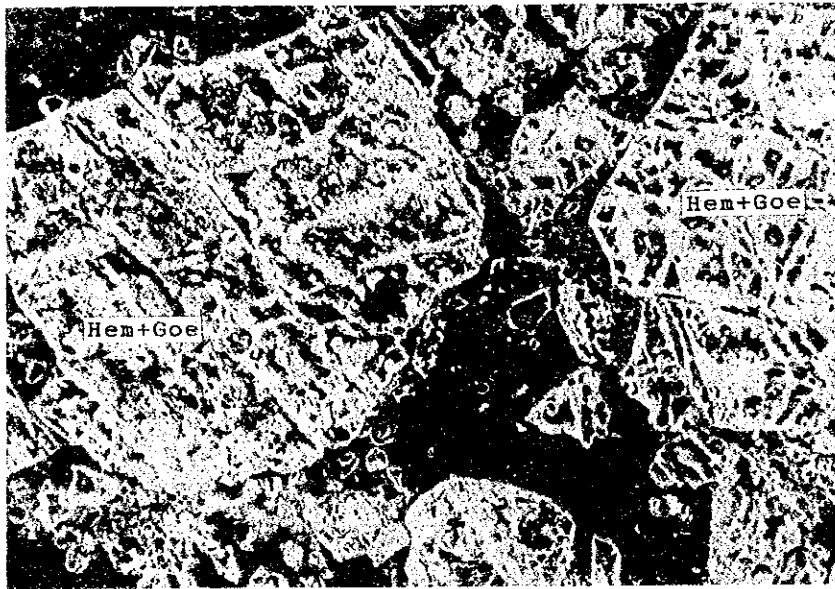
Goe : Goethite
Hem : Hematite
Lep : Lepidocrocite

Boring No. : BR-2
Sample No. : BR-2-A
Depth : 25.50m
Ore name : Calcareous iron ore

Apx. 7 Microphotographs (Under Polished Thin Sections)



(in reflecting light, open)



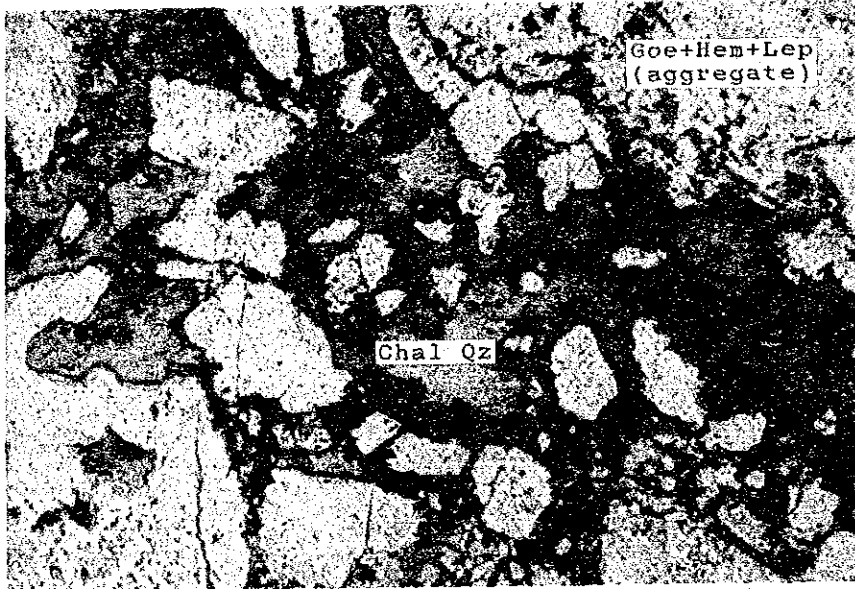
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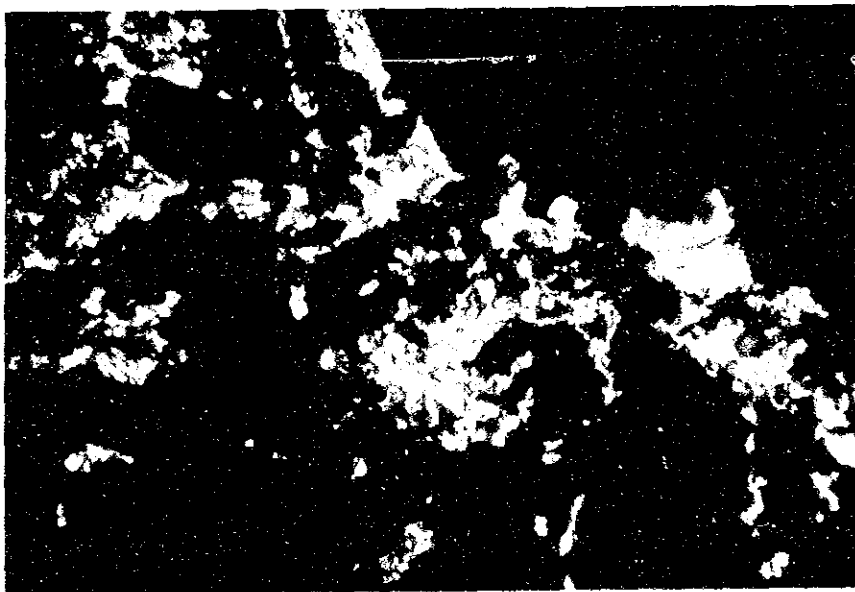
Mag : Magnetite
Goe : Goethite
Hem : Hematite
Lep : Lepidocrocite

Boring No. : BR-4
Sample No. : BR-4-A
Depth : 10.40m
Ore name : Siliceous ore

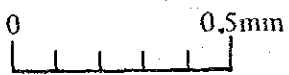
Apx. 7 Microphotographs (Under Polished Thin Sections)



(in reflecting light, open)



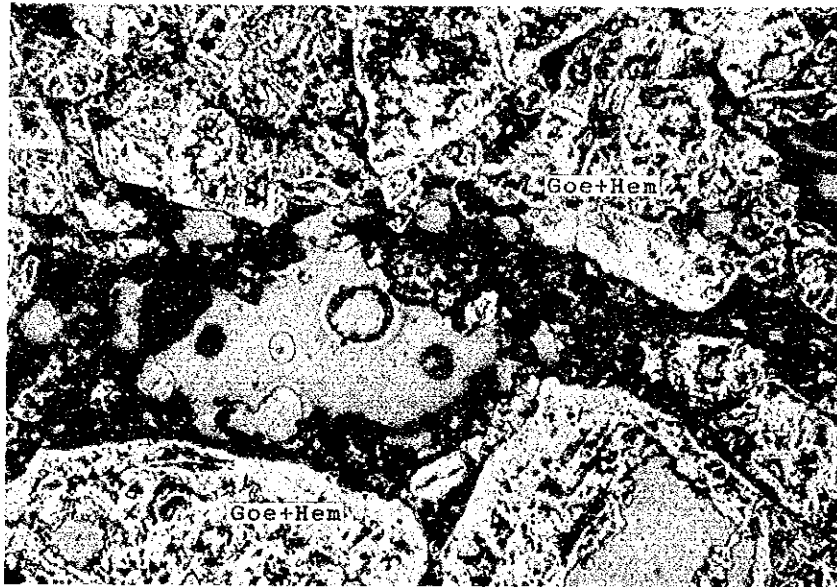
(under crossed polars)



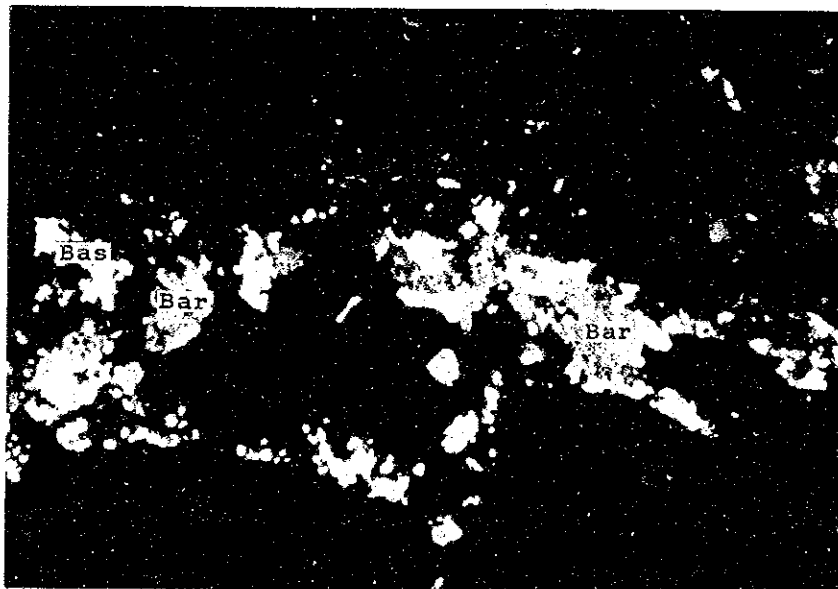
Goe : Goethite
Hem : Hematite
Lep : Lepidocrocite
Chal Qz : Chalcedonic Quartz

Boring No. : BR-5
Sample No. : BR-5-C
Depth : 50.30m
Ore name : Siliceous ore

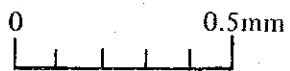
Apx. 7 Microphotographs (Under Polished Thin Sections)



(in reflecting light, open)



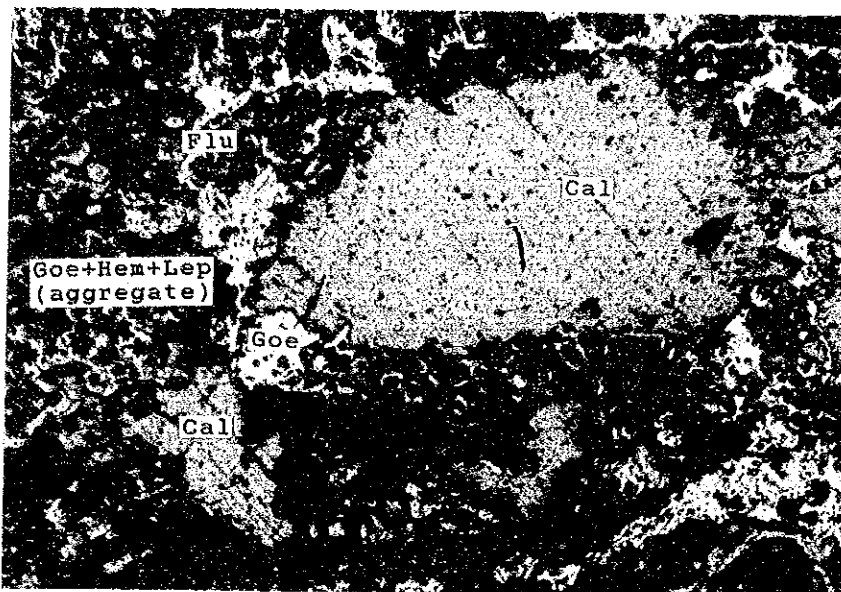
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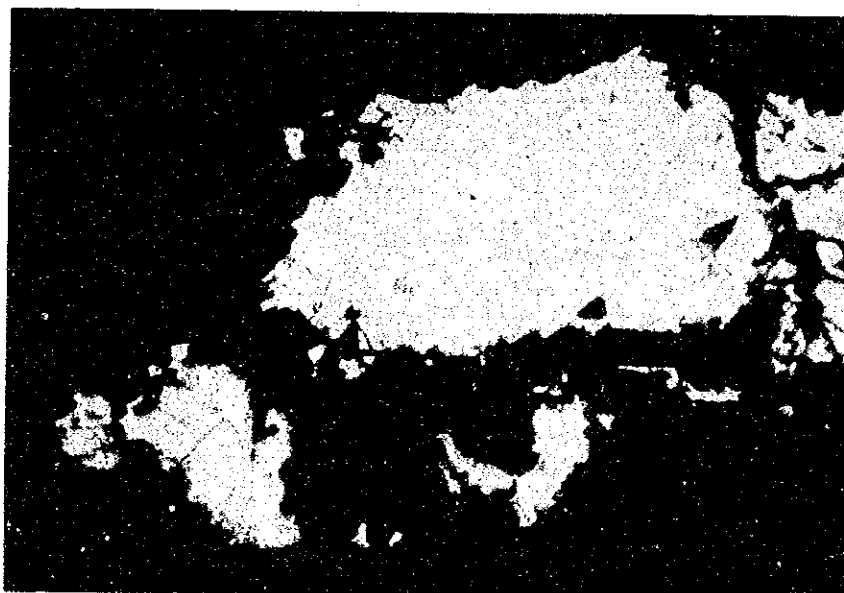
Goe : Goethite
 Hem : Hematite
 Bas : Bastnaesite
 Bar : Barite

Boring No. : BR-6
 Sample No. : BR-6-A
 Depth : 10.50m
 Ore name : Calcareous iron ore

Apx. 7 Microphotographs (Under Polished Thin Sections)



(in reflecting light, open)



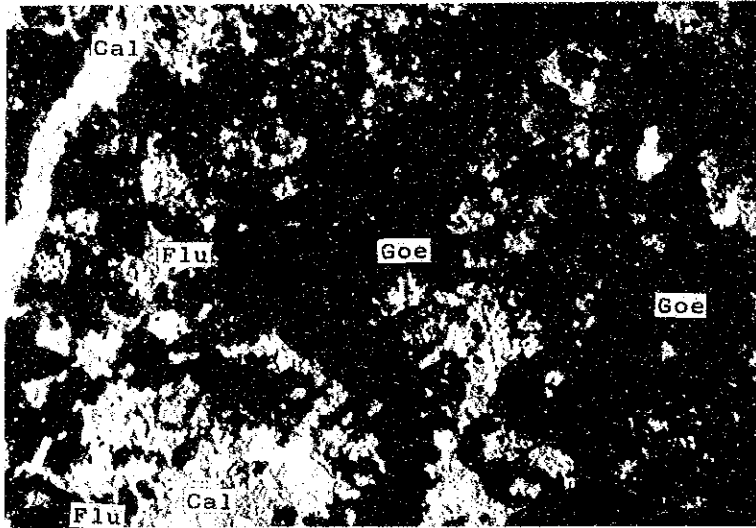
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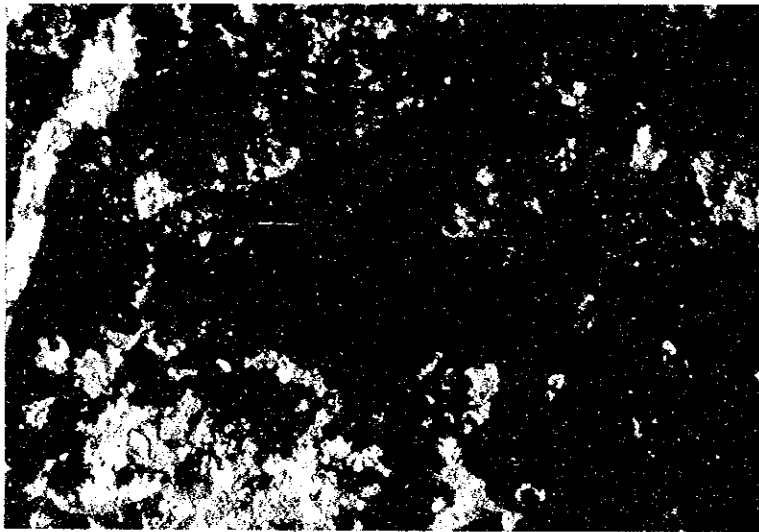
Cal : Calcite
 Flu : Fluorite
 Goe : Goethite
 Hem : Hematite
 Lep : Lepidocrocite

Boring No. : BR-15
 Sample No. : BR-15-B
 Depth : 42.80m
 Ore name : Manganiferous iron ore

Apx. 7 Microphotographs (Under Polished Thin Sections)



(in plane-polarized light)



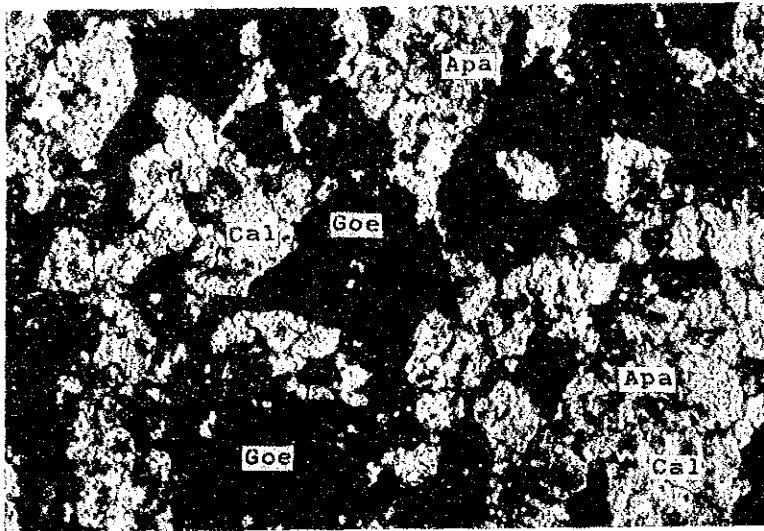
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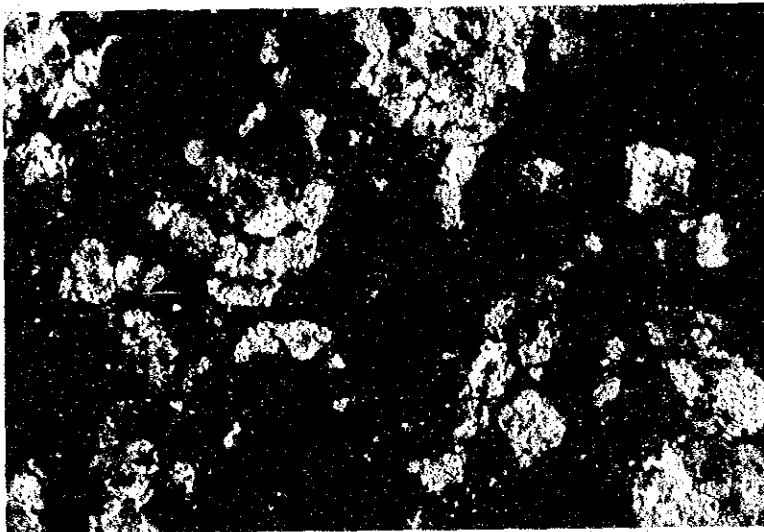
Cal : Calcite
Goe: Goethite
Flu : Fluorite

Boring No. : BR-1
Sample No.: BR-1-E
Depth : 38.20m
Rock name : Carbonatite

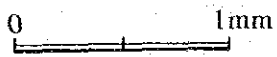
Apx. 8 Microphotographs (Under Thin Sections)



(in plane-polarized light)



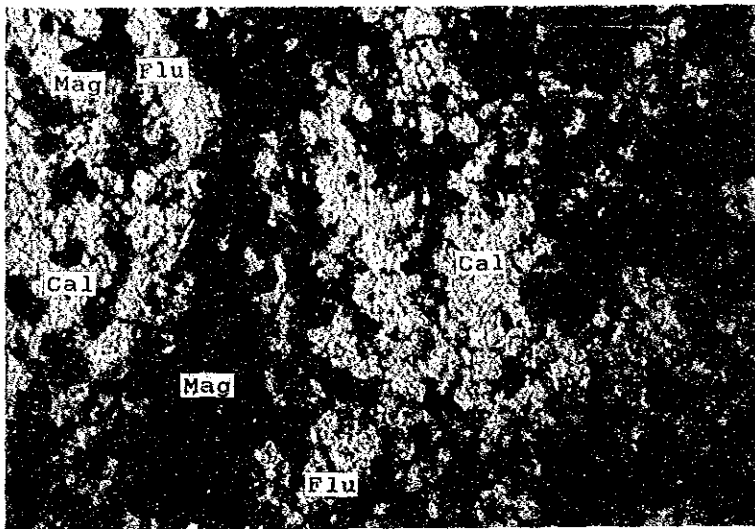
(under crossed polars)



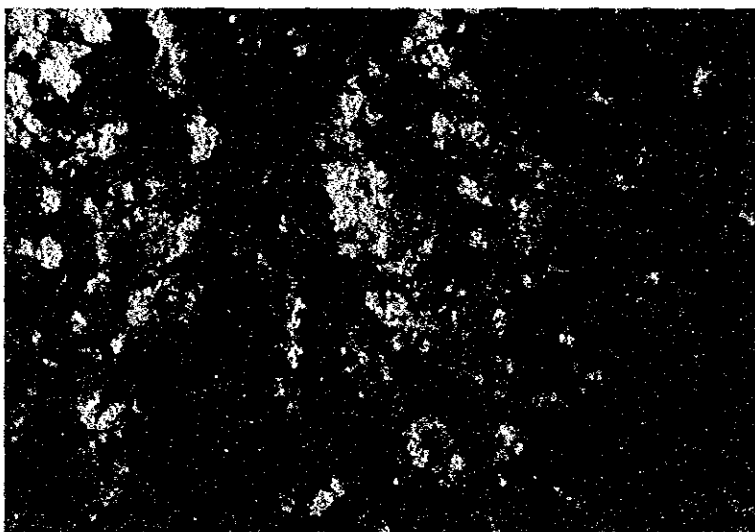
Cal : Calcite
Goe: Goethite
Apa: Apatite

Boring No. : BR-11
Sample No. : BR-11-B
Depth : 38.90m
Rock name : Carbonatite

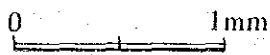
Apx. 8 Microphotographs (Under Thin Sections)



(in plane-polarized light)



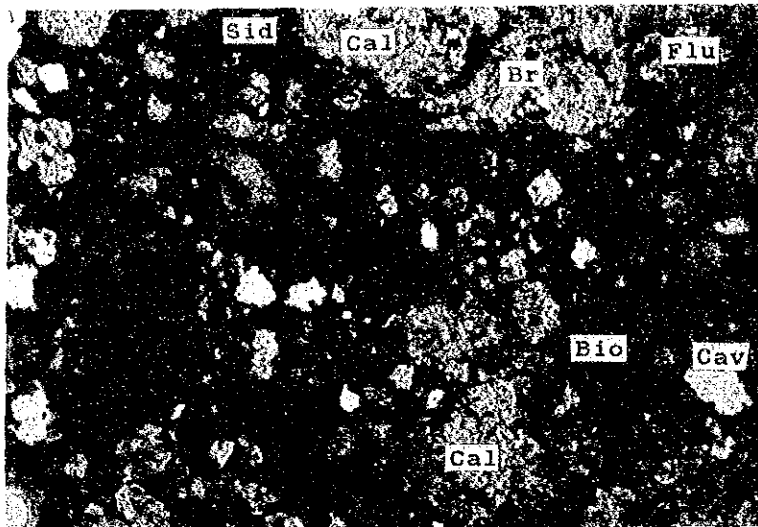
(under crossed polars)



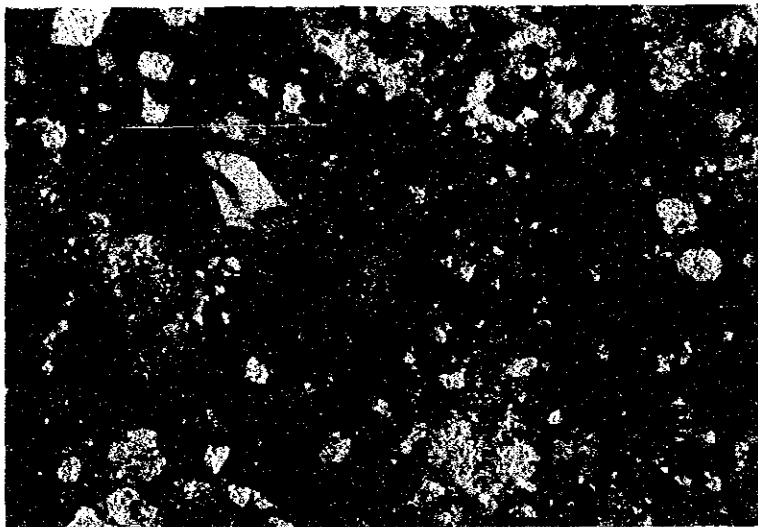
Cal : Calcite
Mag: Magnetite
Flu: Fluorite

Boring No. : BRL-1
Sample No.: BRL-1-C
Depth : 85.40m
Rock name : Banded carbonatite

Apx. 8 Microphotographs (Under Thin Sections)



(in plane-polarized light)



(under crossed polars)

0 ————— 1mm

Br : Breccia of carbonatite
 Cal : Calcite
 Sid : Siderite
 Flu : Fluorite
 Bio : Biotite
 Cav : Cavity

Boring No. : BRL-1
 Sample No. : BRL-1-F
 Depth : 131.30m
 Rock name: Brecciated carbonatite

Apx. 8 Microphotographs (Under Thin Sections)

Apx. 9 Microscopic Observation of Ores under Polished Thin Sections

BR - 2 - A: goethite - fluorite rock

Aggregates of goethite (ca. 0.1mm in size) and hematite with a less amount of lepidocrocite (ca. 0.1mm in size) are predominant. Hematite occurs as irregular masses up to 5 mm in diameter enclosed with goethite-lepidocrocite aggregates. Lepidocrocite, lighter and whiter than goethite and more greenish than hematite, usually occurs as thin plates or tabular crystals in goethite masses.

BR - 3 - A: hematite - goethite rock

Hematite composed of an aggregate of irregular shape with goethite and lepidocrocite, sometimes occurs as acicular crystals up to 0.2mm in length in goethite-rich portion of the aggregate. Hematite-goethite-lepidocrocite aggregate occasionally contains magnetite in irregular shape up to 0.2mm as a remainder after incomplete replacement. This means that hematite replaced magnetite ("martitization") and, goethite and lepidocrocite replaced hematite ("limonitization") probably as a result of weathering.

Fluorite (<2mm X 2mm), bastnaesite (<1mm), crandallite group mineral (<0.1mm), barite (0.2mm X 0.1mm, subhedral) and carbonate mineral, probably calcite (0.2mm, euhedral - subhedral) occupy irregular interspaces. Some grains of fluorite show purple color.

BR - 4 - A: goethite - hematite - chalcedonic quartz rock

Aggregates composed of fine grains of goethite, hematite and less lepidocrocite form a dendritic texture or framboid-like texture, and sometimes occur as a replacement texture of originally short prismatic crystals, maybe magnetite, ranging from 0.1mm to 2mm in size. Hematite often occurs as veinlets 0.02mm - 0.1mm in width. Magnetite grains in irregular shape up to 0.2mm X 0.2mm were incompletely replaced by small grains of hematite. Most of quartz is chalcedonic and associated with smectite (montmorillonite) group mineral, probably nontronite and crandallite group mineral (<0.04mm X 0.1mm, euhedral). Nontronite occurs as microscopic aggregates of finely fibrous or bladed flakes in greenish to brownish color. Fluorite forms an aggregate of many grains up to 0.1mm.

Apx. 9 Microscopic Observation of Ores under Polished Thin Sections

BR - 4 - B: goethite rock

Opaque minerals form aggregates of fine grains of goethite (<0.1mm) and less amounts of hematite and lepidocrocite. Brecciated massive hematite (<0.2mm X 0.2mm) is commonly observed. Aggregates of bastnaesite (<0.05mm, aggregates of acicular crystals), crandallite group mineral (<0.2mm, subhedral - anhedral), nontronite (dusty aggregates), fluorite and chalcedonic quartz occur in irregular interspaces or veinlets.

BR - 4 - D: chalcedonic quartz - fluorite rock

This is composed of chalcedonic quartz (0.05mm - 0.1mm), bastnaesite (<0.05mm), barite (<0.05mm X 0.1mm, subhedral), fluorite, goethite and hematite. Veinlets of chalcedonic quartz up to 0.5mm in width are commonly observed. Hematite and goethite occasionally occur as pseudomorphs of magnetite grains up to 2mm X 2mm.

BR - 5 - B: hematite - fluorite rock

Some aggregates of hematite and goethite occur as pseudomorphs (0.04mm X 0.04mm - 1mm X 1mm) of magnetite. Magnetite is often observed as relict masses in the aggregates. Dendritic texture with quartz are also common in hematite and goethite. Fluorite (<2mm X 2mm), barite (<0.2mm, anhedral), quartz (ca. 0.1mm, anhedral), bastnaesite (ca. 0.05mm, aggregates) and an undetermined mineral occur as an interstitial minerals among the opaque iron minerals.

The undetermined mineral is optically similar to biotite, however, its optical orientation is often perpendicular to that of biotite.

BR - 5 - C: goethite rock

Goethite and small amounts of hematite and lepidocrocite form aggregates up to 1mm X 1.5mm. In the matrix of the aggregates occur chalcedonic quartz, brownish aggregates of minute crystals of nontronite, purple fluorite up to 0.1mm and anhedral crystals of crandallite group mineral up to 0.1mm X 0.04mm. Chalcedonic quartz commonly occurs as veinlets 0.4mm - 1.5mm wide.

Apx. 9 Microscopic Observation of Ores under Polished Thin Sections

BR - 6 - A: goethite - hematite rock

Forms of aggregates composed of goethite, hematite and lepidocrocite suggest that they occurred as pseudomorphs of magnetite. They are also observed as a dendritic texture.

Fluorite (<0.2mm X 0.2mm in most cases, but rarely <3mm X 1mm, anhedral), brownish bastnaesite (0.05mm), crandallite group mineral (0.05mm - 0.2mm), barite (<0.3mm X 0.2mm, subhedral) with cleavage and greenish to brownish nontronite (<0.8mm X 0.4mm) occur in the matrix of the opaque iron minerals. Bastnaesite occasionally includes barite grains, and occurs as a network in the opaque minerals.

BR - 6 - C: hematite - goethite - magnetite rock

Anhedral minute grains of hematite (<1.2mm X 0.5mm), goethite, magnetite (<0.05mm, partly subhedral) are usually observed as aggregates. In the matrix of the aggregates occur partly purple-colored fluorite, crandallite group mineral (<0.2mm X 0.2mm, anhedral), brownish bastnaesite, barite (<0.5mm X 0.3mm, anhedral).

BR - 7 - A: goethite - hematite rock

This is composed of aggregates of goethite, hematite and lepidocrocite up to 0.6mm X 0.4mm and the matrix of chalcedonic quartz, fluorite, nontronite and crandallite group mineral.

BR - 11 - A: goethite - hematite rock

Goethite, hematite and lepidocrocite generally occur as an aggregate. Magnetite occasionally occurs as a relict up to 0.05mm in hematite. Fluorite (<0.03mm), crandallite group mineral (<0.4mm) and bastnaesite (<0.02mm) are observed in the matrix. Bastnaesite usually occurs near the boundary between fluorite and crandallite group mineral.

BR - 15 - B: goethite rock

Aggregates of goethite, hematite and lepidocrocite up to 1mm X 1mm seem to be oxidation products of euhedral to subhedral grains of magnetite. Interstitial fluorite, nontronite and carbonate mineral (<2mm X 1mm, probably calcite, partly siderite?) also occur.

Apx. 10 Microscopic Observation of Rocks under Thin Sections

BR - 1 - C: carbonatite

This is an altered fine grained carbonatite, containing Fe-rich calcite sets in a calcite matrix, fluorite as massive aggregates or inclusions in opaque phases and baryte as thin veinlets associated with fine grained calcite. XRD indicates that the opaque mineral is goethite.

X-ray determinations; calcite, fluorite, goethite, bastnaesite(?)

BR - 1 - E: ferrocarbonatite

This is a fine to medium grained ferrocarbonatite, containing fluorite, barite, opaque minerals, apatite and bastnaesite. Fine grained bastnaesite occurs as small inclusions in the opaque mineral phases. Fluorite, baryte and apatite occur as aggregates. The opaque mineral is goethite.

X-ray determinations; calcite, bastnaesite, fluorite, F-apatite, baryte, goethite.

BR - 4 - C: carbonatite

This is a medium grained carbonatite, containing a large amounts of goethite associated with fluorite, calcite and baryte. Baryte and fluorite occur as inclusions in the opaque minerals. A rare mica and a cryptocrystalline aggregate of apatite are also present.

X-ray determinations; calcite, fluorite, goethite, bastnaesite(?)

BR - 8 - B: carbonatite

This is a fine grained altered carbonatite with goethite veinlets in a calcite matrix. Apatite occurs as a cryptocrystalline aggregate. Fluorite and a rare mica are also present.

X-ray determinations; calcite, goethite, apatite, fluorite.

BR - 9 - A: ferrocarbonatite

This is a very fine grained opaque rich ferrocarbonatite in which opaque minerals of hematite and magnetite occur as veinlets along the grain boundaries of calcite. Also fine grained fluorite and an unidentified mineral occur in the calcite matrix. The unidentified mineral is cubic (isotropic) and shows a relatively high reflective

Apx. 10 Microscopic Observation of Rocks under Thin Sections

index and it is probably pyrochrore. Apatite crystal aggregates are present adjacent to the opaque minerals.

X-ray determinations; calcite, hematite, magnetite, fluorite, apatite.

BR - 10 - A: ferrocarnatite

This is a fine grained ferrocarnatite, containing euhedral grains of fluorite (up to 0.5mm diameter) occurring in a slightly altered (oxidized) calcite matrix, opaque minerals (hematite, magnetite) which are partly altered to goethite, a brown fine grained aggregate of probably apatite and a minor baryte content. Bastnaesite is not optically identified here.

X-ray determinations; calcite, fluorite, goethite, apatite, bastnaesite, hematite, magnetite.

BR - 11 - B: carbonatite

This is a fine to medium grained carbonatite with opaque minerals which are almost entirely replaced by goethite, brown cryptocrystalline materials (a mixture of apatite and unknown substance) together with the opaque minerals, rounded grains of fluorite in a calcite matrix, a rare mica and baryte. Bastnaesite could not be identified optically, although its presence is suggested by the X-ray diffraction method.

X-ray determinations; calcite, apatite, fluorite, goethite, baryte, mica, bastnaesite.

BR - 12 - B: iron-rich carbonatite

This rock is composed dominantly of iron-oxide (now goethite) and a small amount of calcite, apatite, fluorite, bastnaesite (?) and an unidentified Al-P-mineral. Bastnaesite is present within the opaque minerals as small grains. The unidentified Al-P-mineral is brown in colour under plane polarized light, isotropic and with a higher refractive index than that of calcite. This mineral is present as a euhedral tabular crystal (seems to be a pseudomorph after an unknown pre-existing mineral) or massive aggregates associated with the opaque minerals. EPMA analysis (major elements) indicates that this mineral contains Al_2O_3 and P_2O_5 but no Si or Ti also Ca, Mn, Fe, Na, K, Mg were

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detected, suggesting that this may be a REE bearing Al_2O_3 - P_2O_5 mineral such as florencite. The XRD analysis, however, does not suggest any presence of such a REE-bearing mineral, but indicates the presence of goethite, fluorite, hematite, calcite, and possibly bastnaesite (The unidentified phase is metamict). Fluorite occurs as a grain aggregate in the opaque mineral rich areas. Compared with the other samples, this sample contains a relatively small amount of calcite.

X-ray determinations; calcite, opaque minerals fluorite, apatite, Al-P-unidentified phase.

BR - 13 - B: brecciated ferrocarbonatite

This is a brecciated ferrocarbonatite containing opaque minerals in a calcite matrix. Late stage calcite-baryte veins are evident. Baryte also occurs as inclusions in the opaque minerals. The opaque minerals are hematite, magnetite and goethite. A small amount of an unidentified mineral, brown in colour, euhedral cubic crystal, is also present in the calcite matrix.

X-ray determinations; calcite, baryte, goethite, hematite, magnetite, apatite (?).

BR - 13 - D: brecciated carbonatite

This rock consists of calcite, iron-rich calcite and siderite set in a carbonate matrix. Late stage baryte veinlets are also present. XRD suggests a presence of synchysite which could not be identified under optical observation.

X-ray determinations; calcite, siderite, baryte, synchysite.

BR - 14 - A: brecciated ferrocarbonatite

This rock is composed of calcite, fluorite, baryte, opaque minerals and possibly bastnaesite. A brown isotropic crystal aggregate (unidentified) occurs as a dominant phase. EPMA analysis indicates a presence of a Mn-Fe oxide mineral.

X-ray determinations; calcite, fluorite, bastnaesite, baryte.

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BRL - 1 - A: ferrocarbonatite

This rock is extremely altered, consisting dominantly of opaque mineral (hematite) and calcite together with synchysite and baryte. A brown cryptocrystalline mineral aggregate (unidentified) is present as a major constituent phase.

X-ray determinations; calcite, hematite, synchysite.

BRL - 1 - B: ferrocarbonatite

This rock is fine grained, consisting dominantly of hematite and calcite together with a small amount of baryte, fluorite and an unidentified isotropic crystal aggregate.

X-ray determinations; calcite, fluorite, baryte, hematite, bastnaesite.

BRL - 1 - C: carbonatite

This rock is medium grained and composed of calcite, iron-rich calcite, fluorite, hematite and magnetite. A small amount of an unidentified mineral in tiny cubic brown crystals is present in a calcite matrix.

X-ray determinations; calcite, fluorite, magnetite, hematite.

BRL - 1 - D: carbonatite

This is fine to medium grained carbonatite, consisting dominantly of calcite and siderite together with a small amount of hematite and magnetite, and a small amount of a rare mica, baryte, serpentine and pyrochlore. The pyrochlore is cubic reddish brown with euhedral crystals set in a calcite matrix.

X-ray determinations; calcite, siderite, hematite, pyrochlore (?).

BRL - 1 - F: brecciated carbonatite

This is a brecciated carbonatite with a fine dark carbonatitic matrix (siderite-rich). An opaque mineral is present or an accessory. A large (up to 3mm in diameter) carbonatite breccia (aggregate of fine euhedral grain of calcite) is present. Accessory phases are mica, baryte, fluorite and pyrochlore like phase, all of them are present in a fine grained siderite-rich matrix.

X-ray determinations; calcite, siderite, fluorite.

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BRL - 1 - H: carbonatitic breccia

This is extremely altered fine grained carbonatitic breccia with a Mn-Fe rich calcite matrix and a small amount of an opaque mineral. XRD indicate a presence of jacobsite. Accessory phases are fluorite and synchysite. The latter is only identified by XRD.

X-ray determinations; calcite, jacobsite, fluorite, synchysite.

BRL - 1 - I: melanephelinite or nephelinite

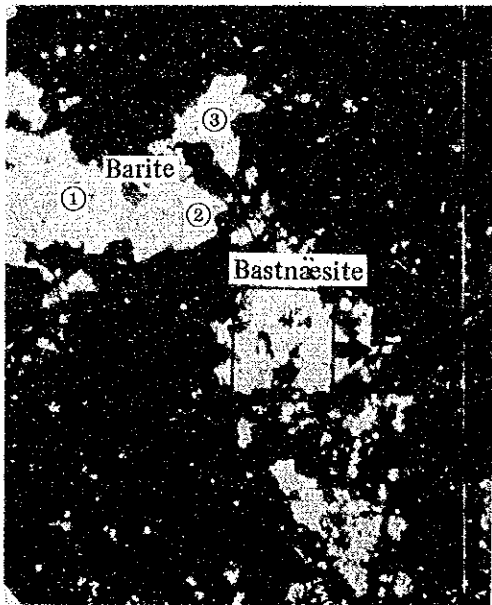
This is extremely altered basic to intermediate volcanic rock, possibly melanephelinite or nephelinite. Phenocryst minerals are euhedral prismatic clinopyroxene (ferro aegirine augite), hornblende, apatite, sphene, and possibly feldspar(?) and nepheline set in a altered groundmass. The groundmass consists of extremely fine grained chalcedony (?), chlorite and possibly zeolite. An opaque mineral is rare. Feldspar(?) and nepheline are entirely replaced by trydimite (?) and/or chalcedony (or zeolite).

KUGE - A: ferrocarbonatite

This is opaque mineral rich fine grained ferrocarbonatite, which is extremely altered, consisting of calcite, baryte, goethite, bastnaesite (?) and mica. A late stage of carbonate veinlets is present. Reddish brown fibrous serpentine-like phase occurs as a fibrous radiated crystal aggregate (up to 50 μm in diameter). EPMA indicates that carbonate minerals are calcite, Fe-rich calcite, and Fe-Mn-rich calcite. An opaque mineral is now entirely composed of goethite.

X-ray determinations; calcite, baryte, goethite, bastnaesite.

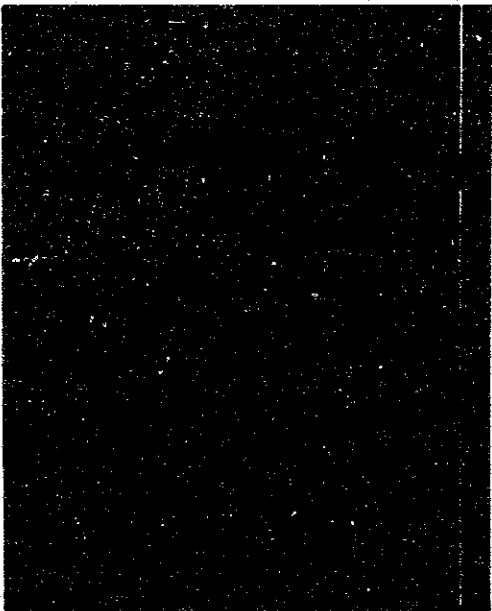
200 X



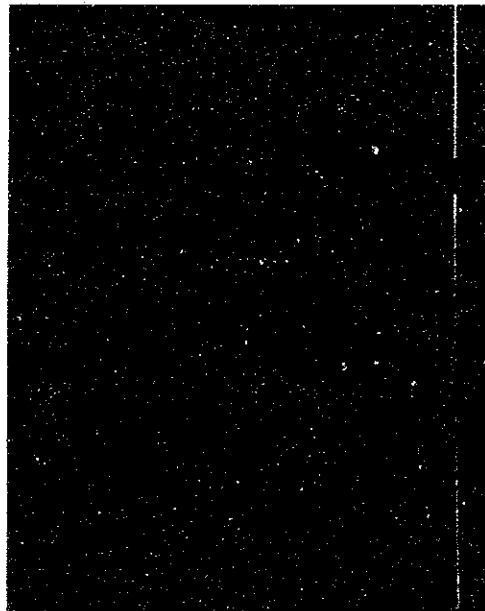
1000 X



300X
Ba-L α



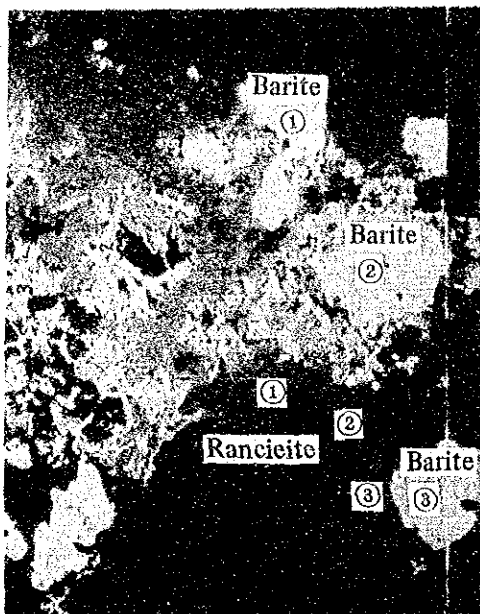
300X
La-L α partly Ba-L α



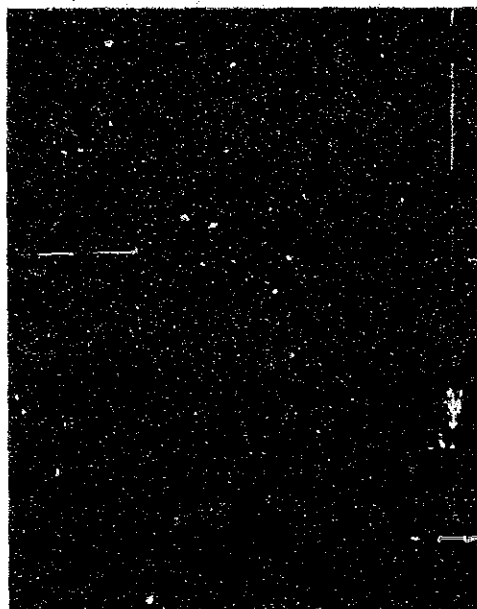
Sample No ; BR-12-B
Depth ; 50.30m
Rock type ; Ferro carbonatite
Mineral name ; Barite, Bastnaesite

Apx. 11 X-ray Images of Minerals (EPMA Test)

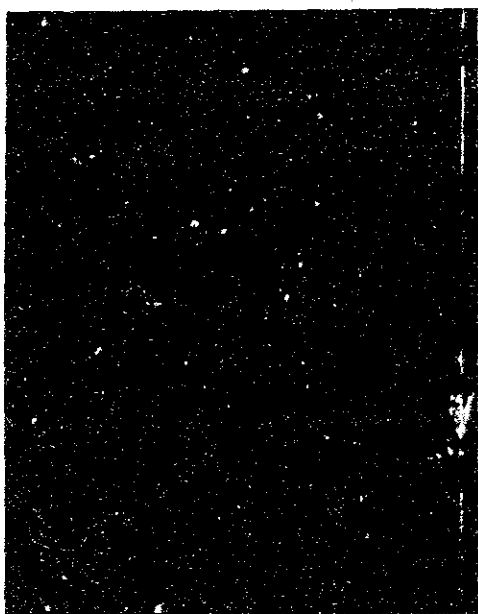
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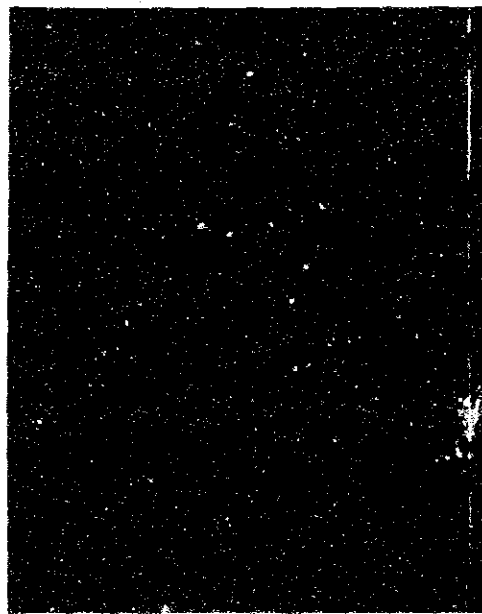
Mn--K α



Ba--L α



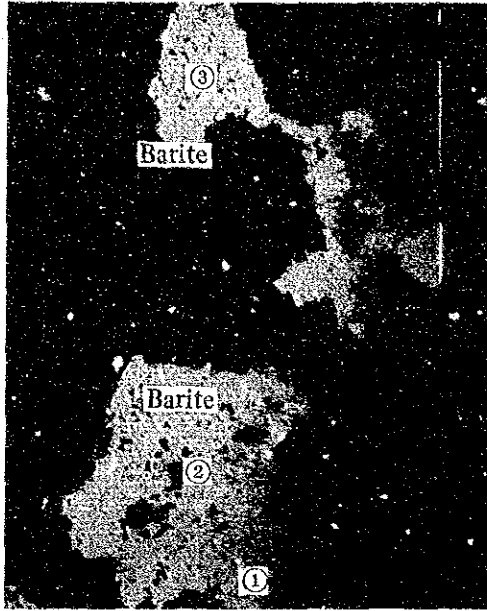
La--L α Partly Ba--L α



Sample No ; BR-14-A
Depth ; 9.30m
Rock type ; Carbonatite
Mineral name ; Rancieite, Barite

Apx. 11 X-ray Images of Minerals (EPMA Test)

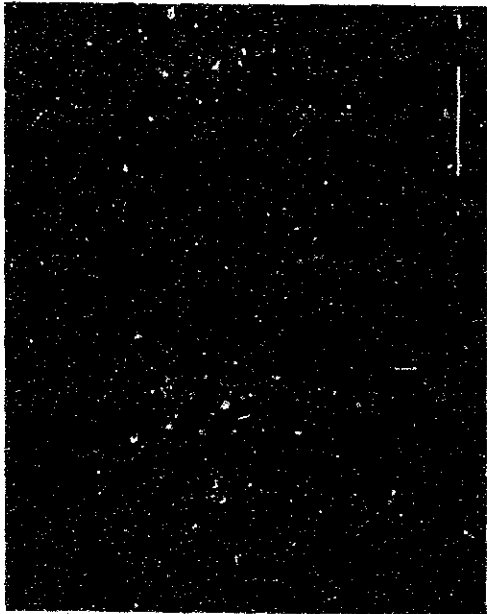
200 X



S-K α



Ba-L α



Sample No ; BRL-1-D

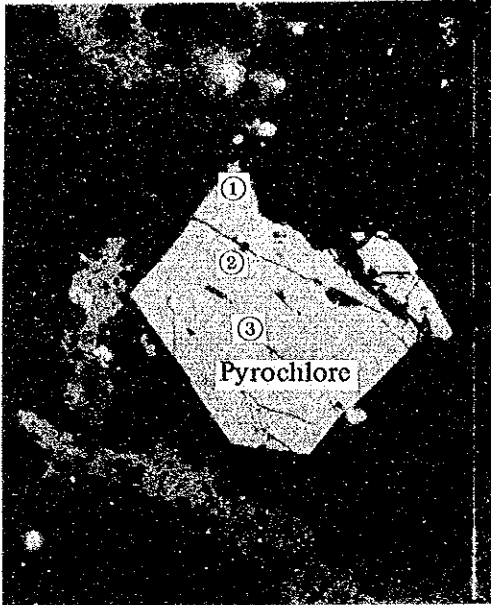
Depth ; 107.30m

Rock type ; Carbonatite

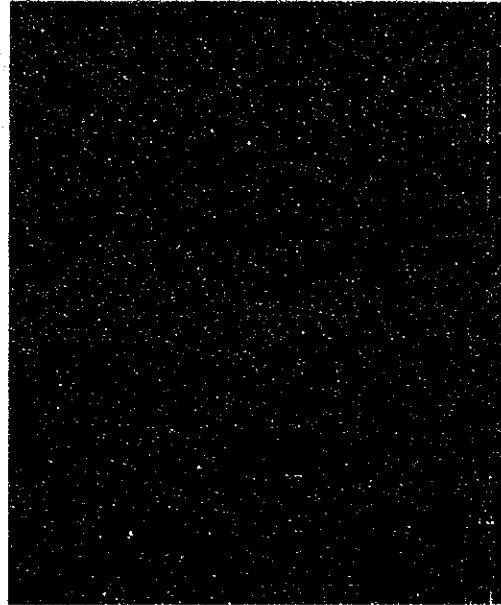
Mineral name ; Barite

Apx. 11 X-ray Images of Minerals (EPMA Test)

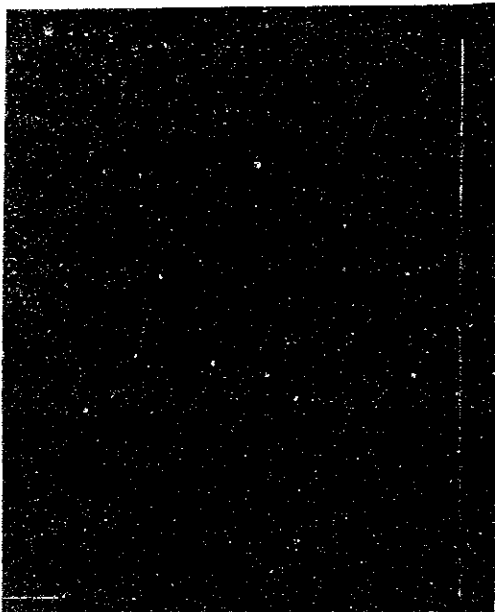
500 X



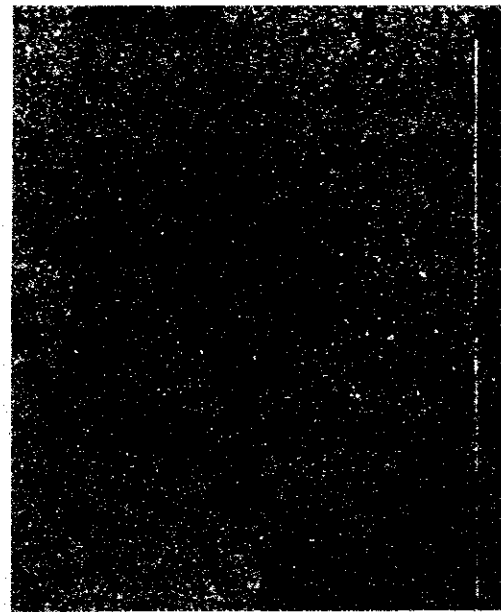
Nd-L α



P-K α



Ca-K α



Sample No ; BRL-1-F

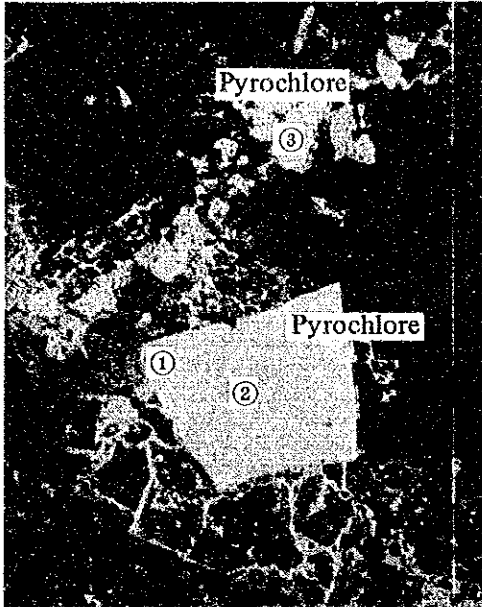
Depth ; 131.30m

Rock type ; Carbonatite

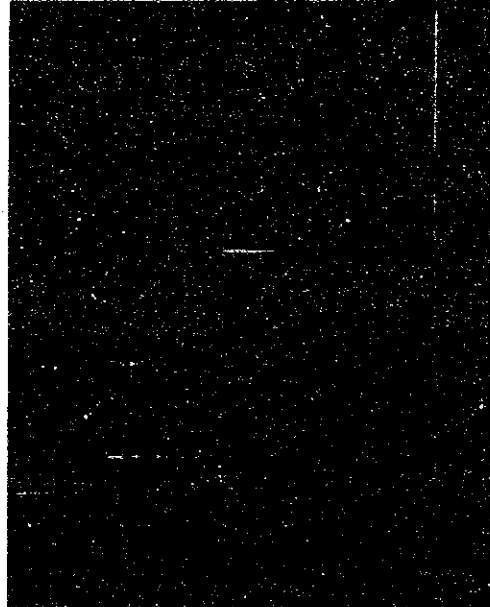
Mineral name ; Pyrochlore

Apx. 11 X-ray Images of Minerals (EPMA Test)

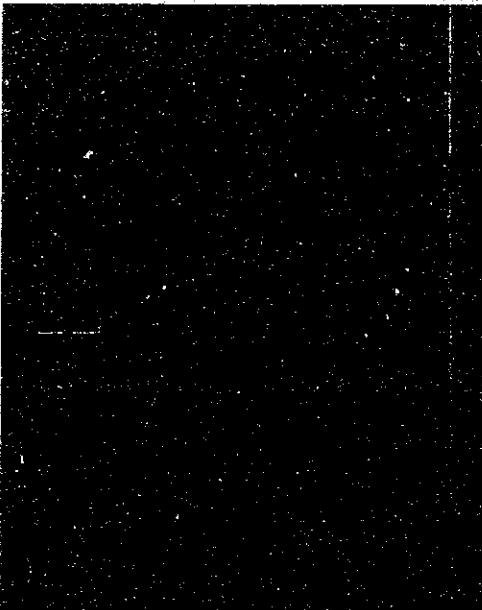
350 X



Nb-L α



Ca-K α



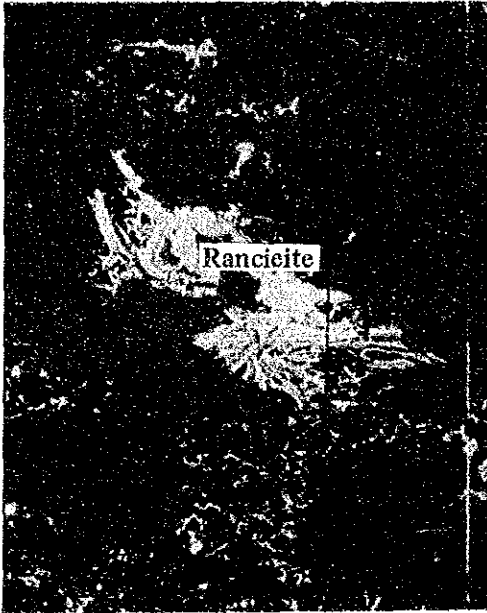
Na-K α



Sample No ; BR-9-A
Depth ; 29.20m
Rock type ; Carbonatite
Mineral name ; Pyrochlore

Apx. 11 X-ray Images of Minerals (EPMA Test)

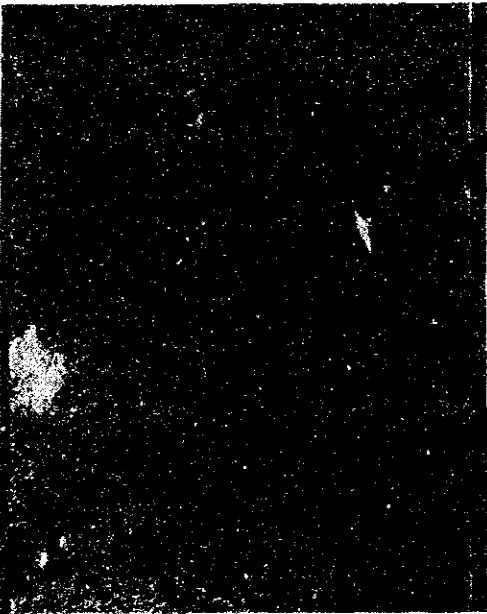
1000 X



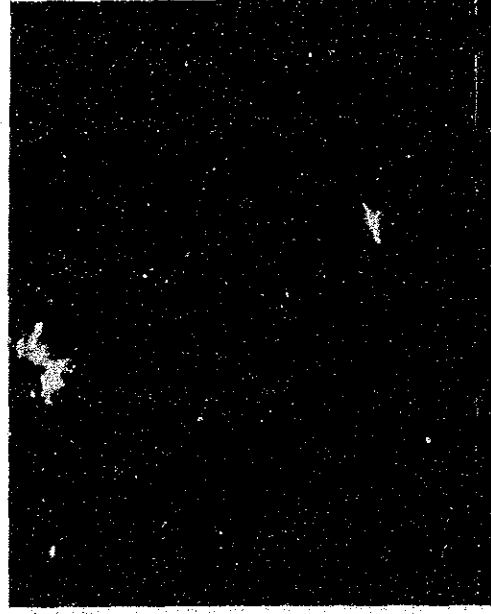
Mn-K α 2000X



Ca-K α 2000X



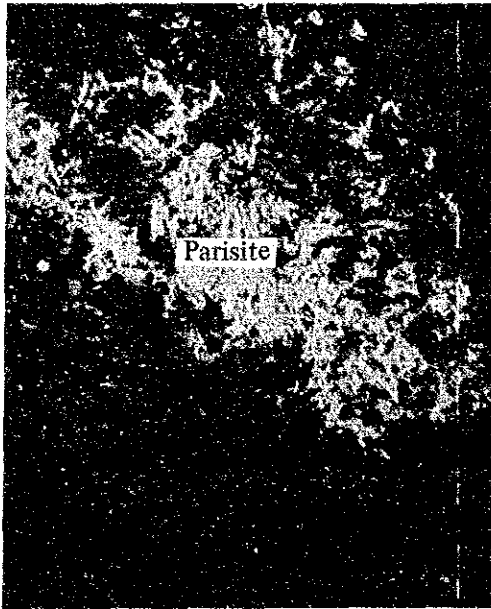
Ba-L α 2000X



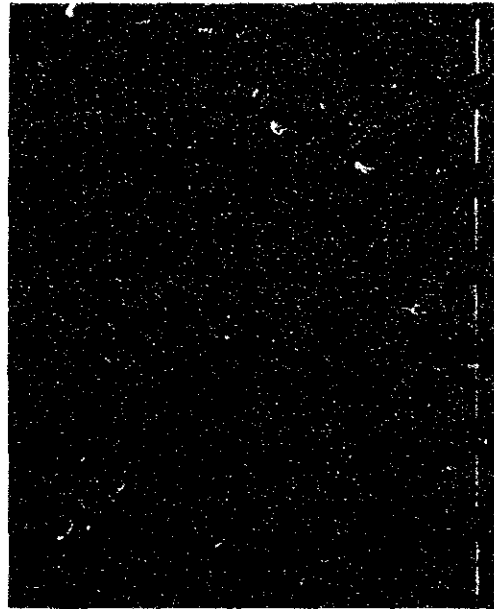
Sample No ; BR-1-A
Depth ; 9.50m
Rock type ; Ferrocarbonatite
Mineral name ; Ba-rich rancieite

Apx. 11 X-ray Images of Minerals (EPMA Test)

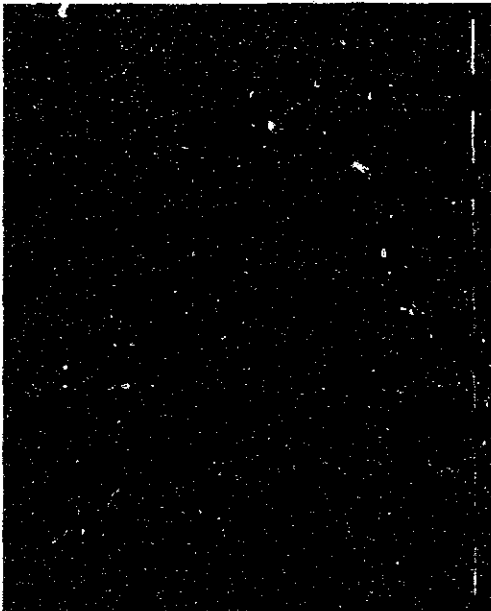
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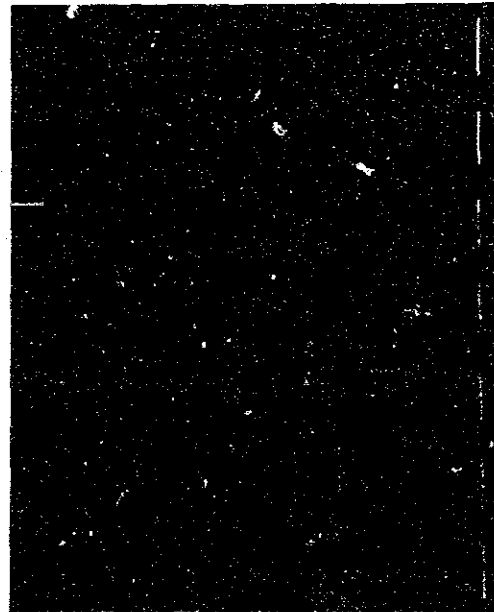
La-L α



Ce-L α



Ca-K α



Sample No ; BR-10-A

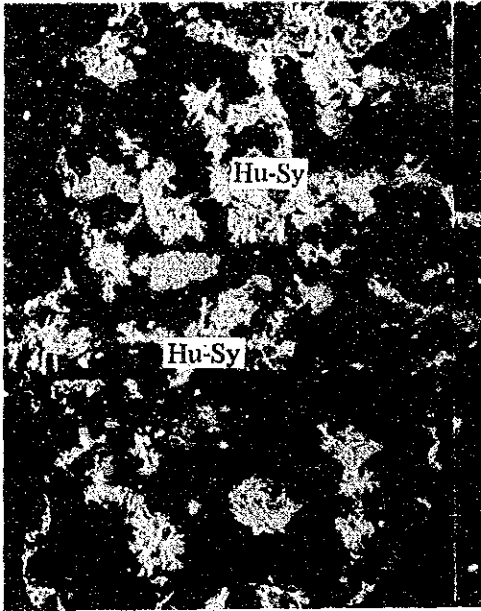
Depth ; 26.10m

Rock type ; carbonatite

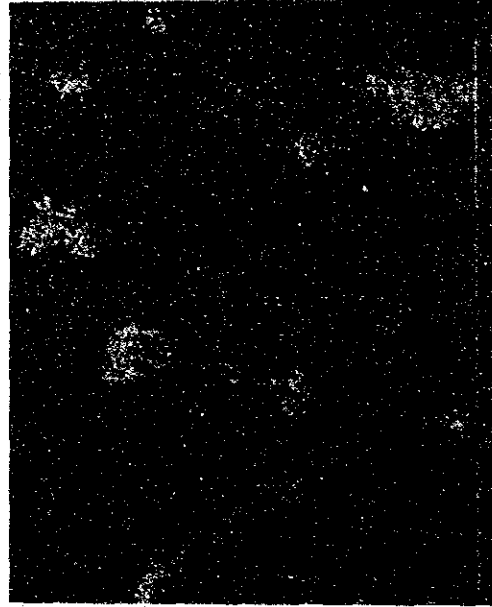
Mineral name ; Parasite

Apx. 11 X-ray Images of Minerals (EPMA Test)

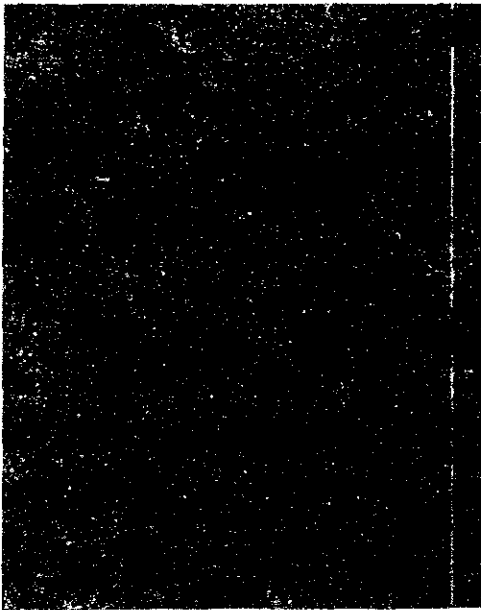
350 X



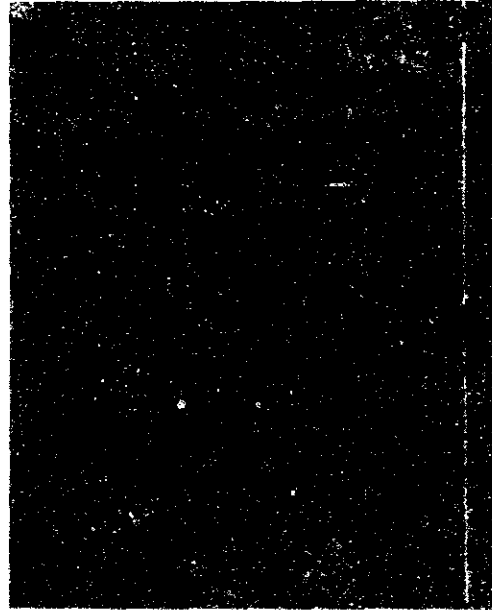
Sr-L α 400X



Ba-L α + Ce-L α + La-L α 400X



Ka-K α 400X



Sample No ; BRL-1-H

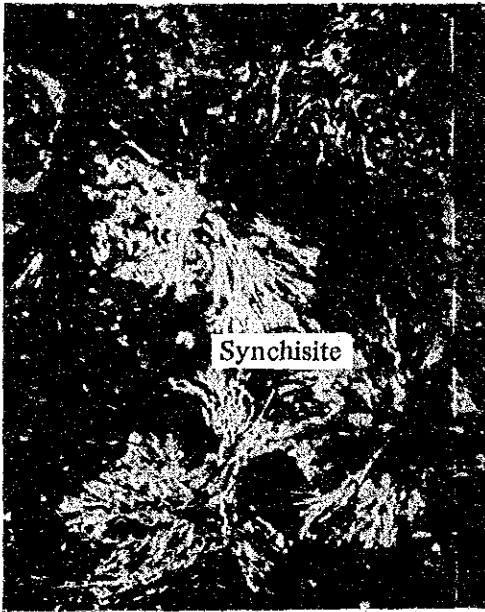
Depth ; 198.10m

Rock type ; Carbonatite

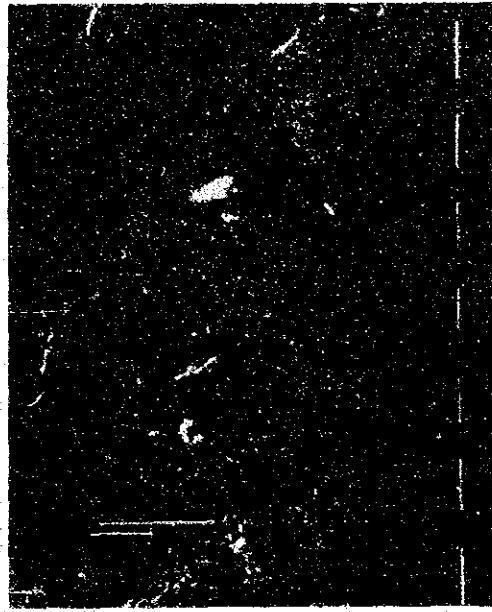
Mineral name ; Huanghoite-Synchysite (Hu-Sy)

Apx. 11 X-ray Images of Minerals (EPMA Test)

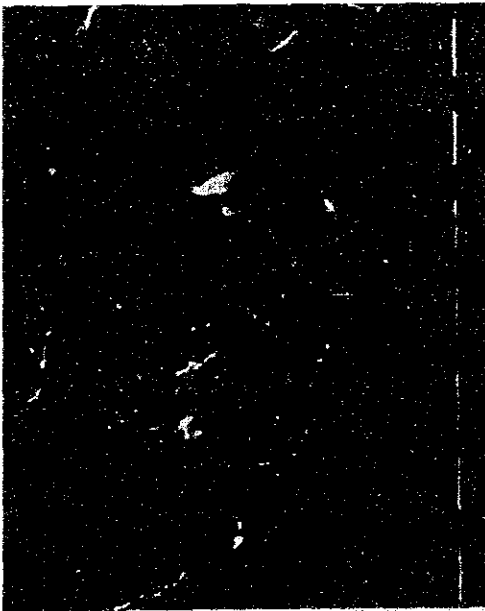
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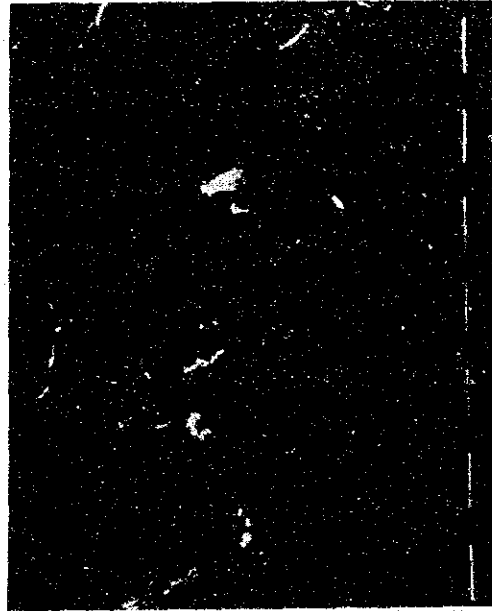
Ca-K α



Mn-K α



Ce-L α partly Ba-L β



Sample No. ; BRL-1-A
Depth ; 68.10m
Rock type ; Mn-Fe ore
Mineral name ; Synchisite

Apx. 11 X-ray Images of Minerals (EPMA Test)