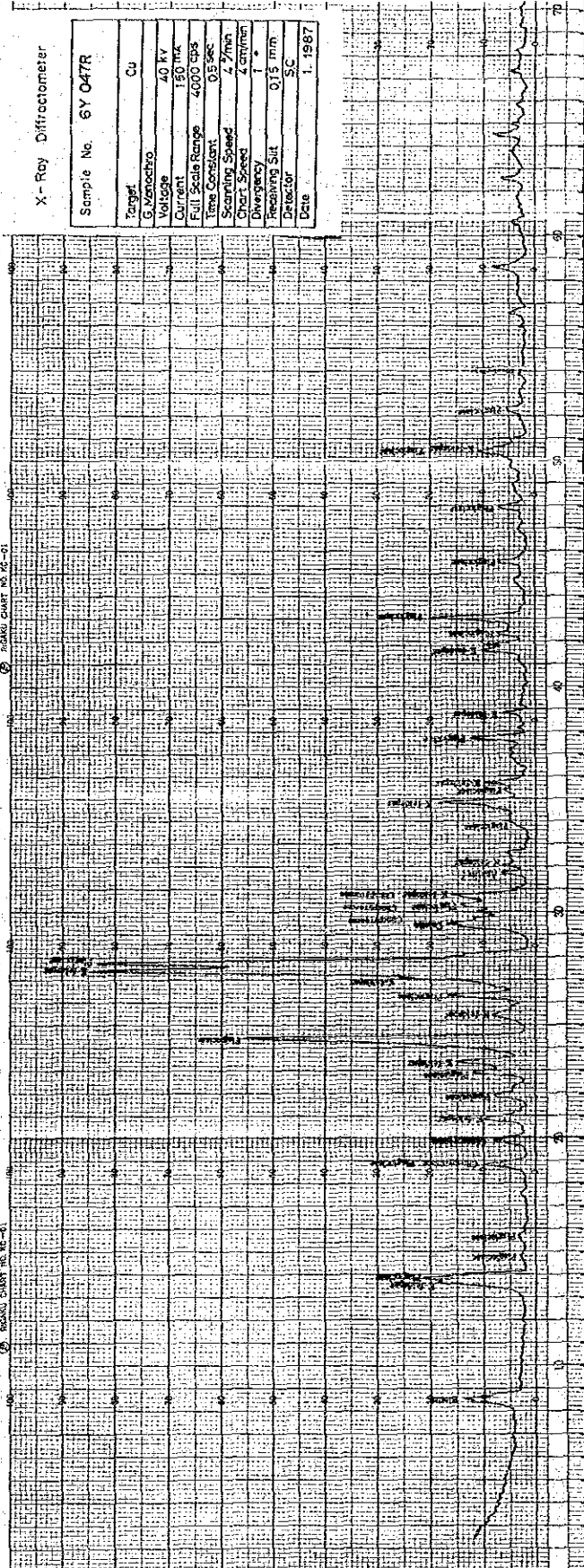


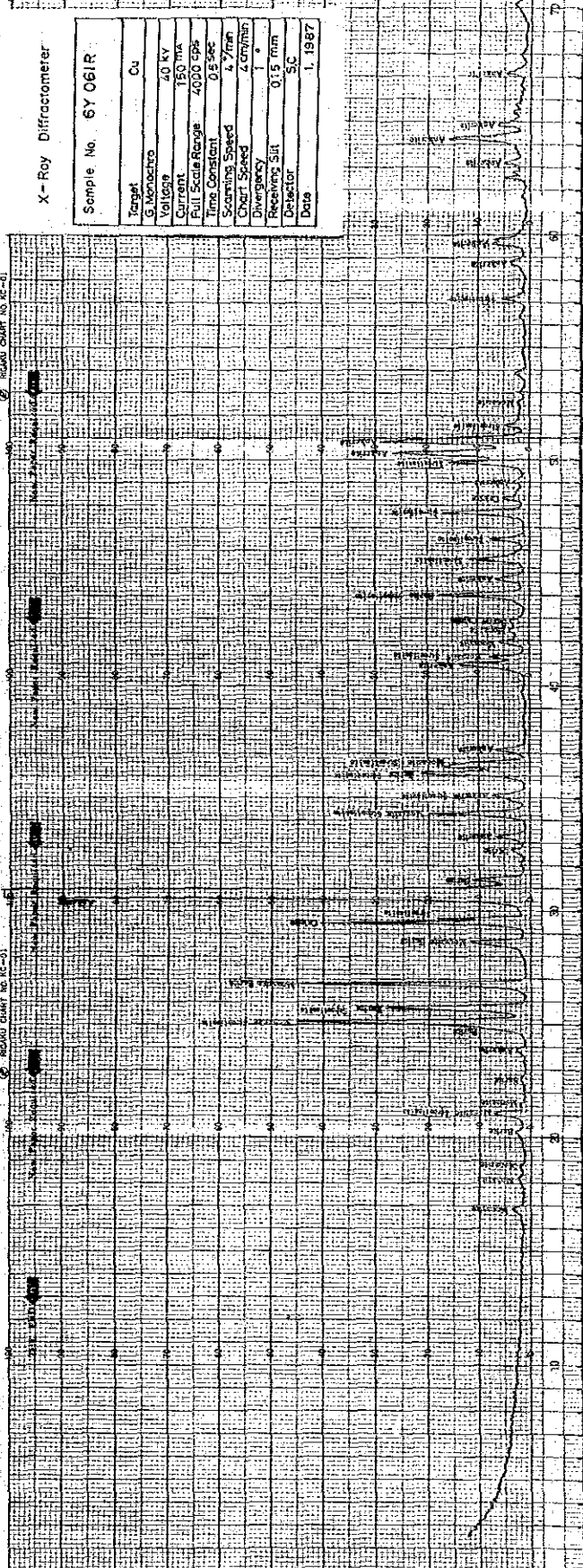
X-Ray Diffractometer

| | |
|------------------|----------|
| Sample No. | 6Y 047R |
| Target | Cu |
| G. Monochro | |
| Voltage | 40 kv |
| Current | 150 ma |
| Full Scale Range | 4000 cps |
| Time Constant | 0.5 sec |
| Scanning Speed | 4.7/min |
| Chart Speed | 4 cm/min |
| Divergency | 1° |
| Receiving Slit | 0.15 mm |
| Detector | SC |
| Date | 1. 1987 |



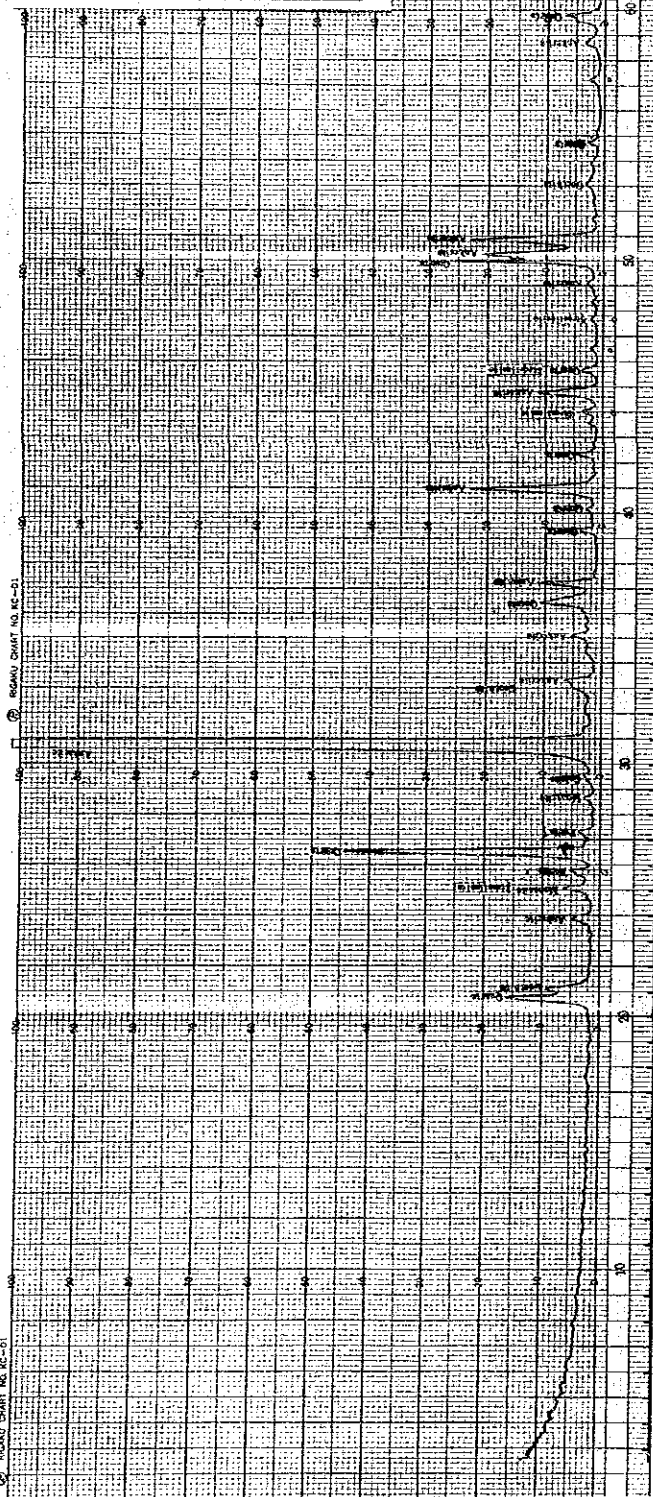
X-Ray Diffractometer

| | |
|------------------|----------|
| Sample No. | 6Y 061R |
| Target | Cu |
| G. Monochro | |
| Voltage | 40 kv |
| Current | 150 ma |
| Full Scale Range | 4000 cps |
| Time Constant | 0.5 sec |
| Scanning Speed | 4.7/min |
| Chart Speed | 4 cm/min |
| Divergency | 1° |
| Receiving Slit | 0.15 mm |
| Detector | SC |
| Date | 1. 1987 |



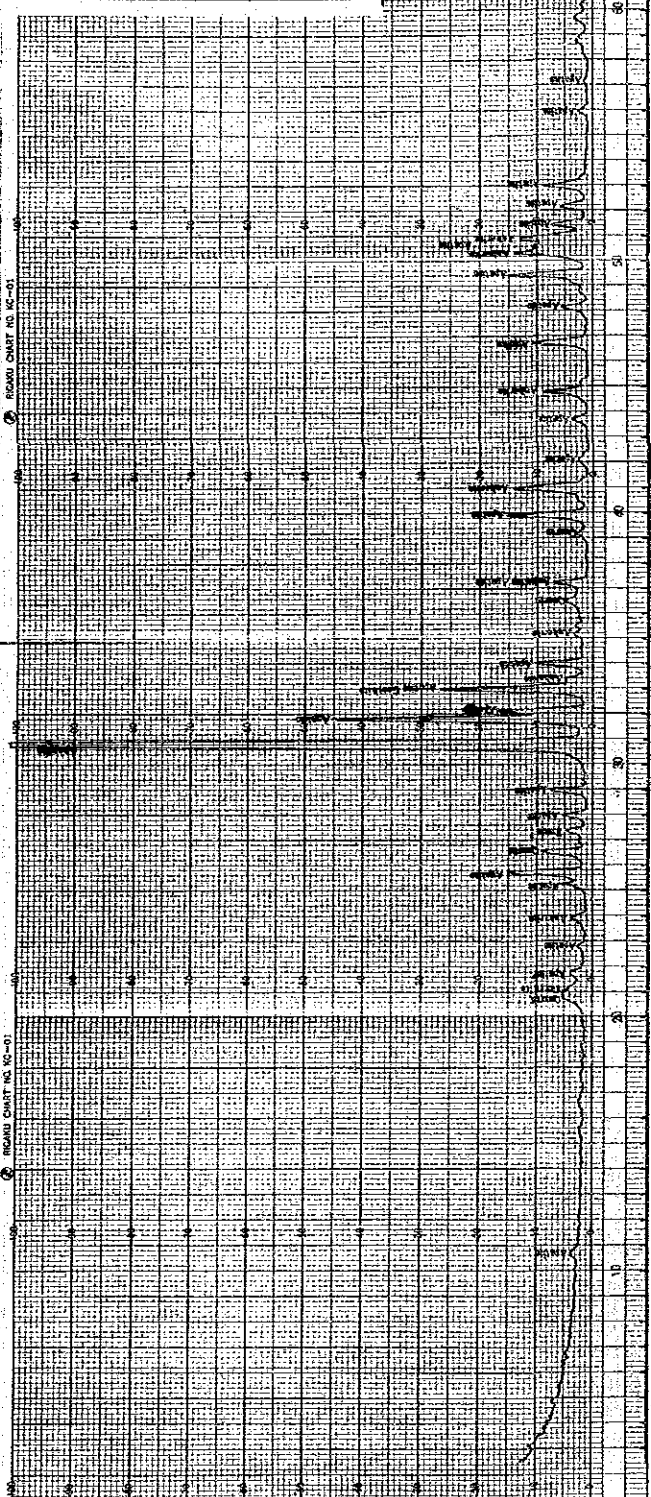
X-Ray Diffractometer

| | |
|------------------|----------|
| Sample No. | 6Y 062R |
| Target | Cu |
| G. Monochro | |
| Voltage | 40 kv |
| Current | 150 ma |
| Full Scale Range | 4000 cps |
| Time Constant | 0.5 sec |
| Scanning Speed | 4 7/min |
| Chart Speed | 4 cm/min |
| Divergency | 1 ° |
| Receiving Slit | 0.15 mm |
| Detector | SC |
| Date | 1. 1987 |



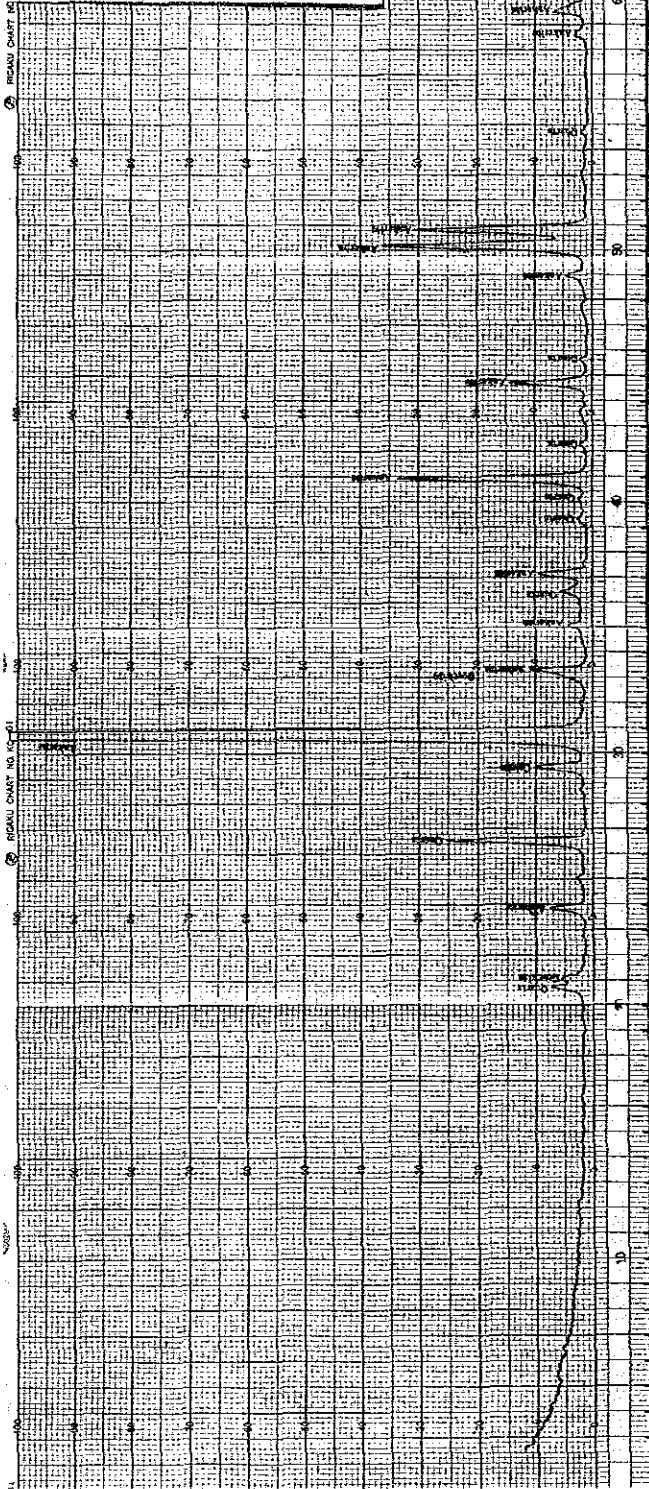
X-Ray Diffractometer

| | |
|------------------|----------|
| Sample No. | 6Y 063R |
| Target | Cu |
| G. Monochro | |
| Voltage | 40 kv |
| Current | 150 ma |
| Full Scale Range | 4000 cps |
| Time Constant | 0.5 sec |
| Scanning Speed | 4 7/min |
| Chart Speed | 4 cm/min |
| Divergency | 1 ° |
| Receiving Slit | 0.15 mm |
| Detector | SC |
| Date | 1. 1987 |



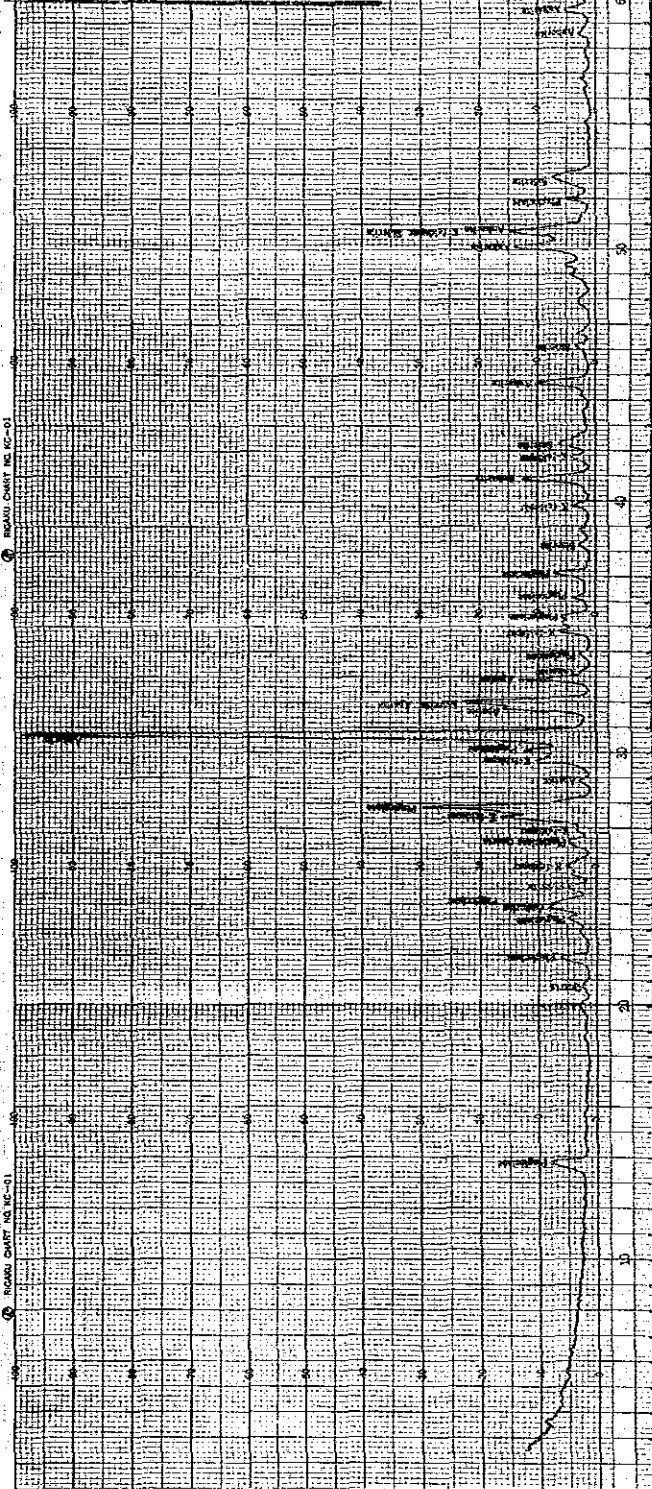
X-Ray Diffractometer

| | |
|------------------|----------|
| Sample No. | 6Y 064R |
| Target | Cu |
| G. Monochro | |
| Voltage | 40 kv |
| Current | 150 ma |
| Full Scale Range | 4000 cps |
| Time Constant | 0.5 sec |
| Scanning Speed | 4 7/min |
| Chart Speed | 4 cm/min |
| Divergency | 1° |
| Receiving Slit | 0.15 mm |
| Detector | SC |
| Date | 1. 1987 |



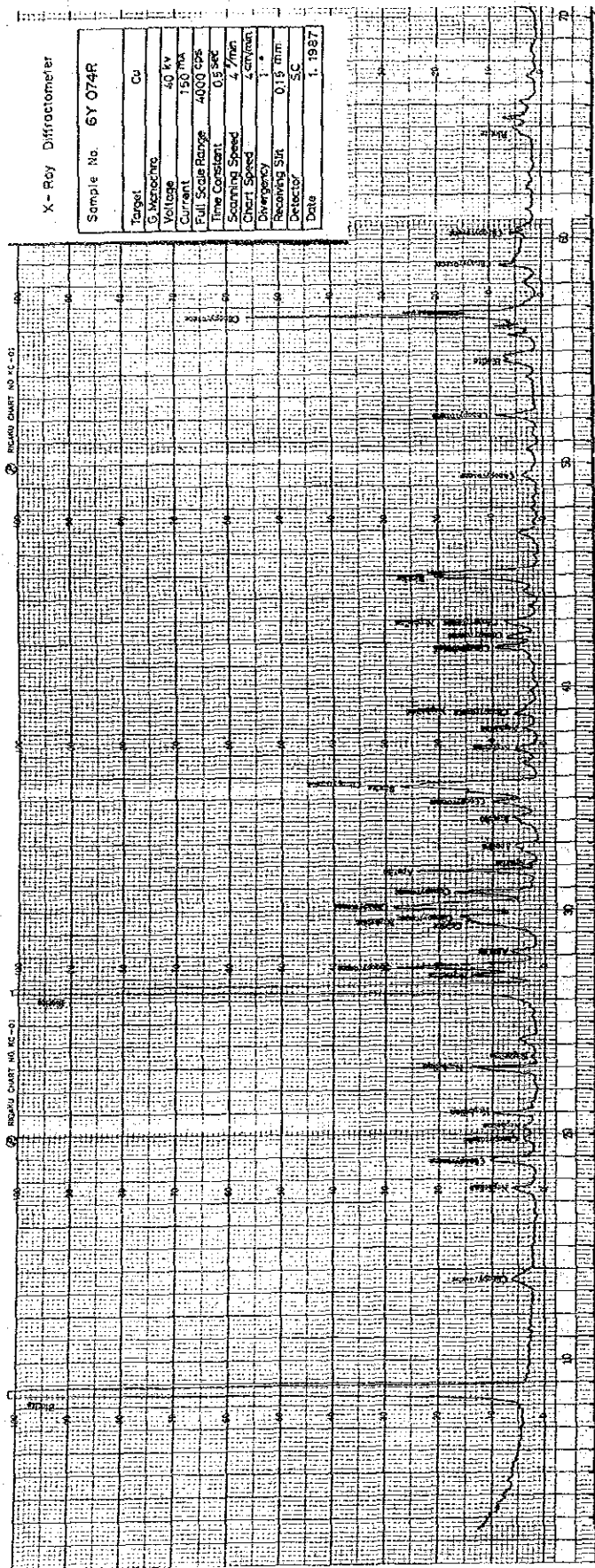
X-Ray Diffractometer

| | |
|------------------|----------|
| Sample No. | 6Y 072R |
| Target | Cu |
| G. Monochro | |
| Voltage | 40 kv |
| Current | 150 ma |
| Full Scale Range | 4000 cps |
| Time Constant | 0.5 sec |
| Scanning Speed | 4 7/min |
| Chart Speed | 4 cm/min |
| Divergency | 1° |
| Receiving Slit | 0.15 mm |
| Detector | SC |
| Date | 1. 1987 |



X-Ray Diffractometer

| | |
|------------------|----------|
| Sample No. | 6Y 074R |
| Target | Cu |
| G. Magnifying | |
| Voltage | 40 kv |
| Current | 150 ma |
| Full Scale Range | 4000 cps |
| Time Constant | 0.5 sec |
| Scanning Speed | 1/2°/min |
| Chart Speed | 4 cm/rev |
| Divergency | 1° |
| Receiving Slit | 0.15 mm |
| Detector | SC |
| Date | 1. 1987 |



Appendix 10 Results of Isotopic Age Determination

| Sample No. | Sector | Rock name | Mineral | K (wt.%) | Ar ⁴⁰ (10 ⁻⁸ ccSTP/g) | K-Ar age (Ma) | Air conc. (%) | Remarks |
|------------|-----------|-------------------|------------|---------------|---|------------------------|---------------|--------------------|
| 6M003R | Tundulu | Nepheline syenite | biotite | 7.15 +0.14 | 3927+26 3812+23 | 136.2+2.8 132.4+2.7 | 4.3 4.4 | |
| 6Y026R | Namangale | Phonolite | hornblende | 1.21 +0.02 | 623.9+4.0 654.2+4.8 | 128.2+2.6 134.2+2.8 | 10.6 10.4 | including pyroxene |
| 6Y047R | Mongolwe | Nepheline syenite | hornblende | 1.08 +0.02 | 693.6+5.6 704.6+4.9 | 158.3+3.3 160.7+3.3 | 10.9 10.0 | including pyroxene |
| 6M041R | Chikala | Perthosite | whole rock | 4.15 +0.08 | 3100+20 3147+19 | 182.8+3.7 185.5+3.7 | 3.8 3.7 | |
| 6Y072R | Kapiri | Nephelinite | hornblende | 0.19 +0.01 | 153.0+2.4 166.6+2.2 | 196+10 213+10 | 54.8 49.8 | including pyroxene |
| 6M079R | Mindi | Gabbro | biotite | 7.14 +0.14 | 15887+106 15816+91 | 497.8+9.2 495.8+9.0 | 1.0 1.0 | |
| 6M062R | Nsala | nepheline syenite | hornblende | 1.23 +0.02 | 563.9+5.0 561.0+6.2 | 114.4+2.4 113.8+2.5 | 31.7 31.1 | including pyroxene |

Appendix II Results of EPMA Analysis (Qualitative Analysis)

| No. | Sample No. | Sector | Mineral | Elements | | | | | | | | | | | | | |
|-----|------------|---------------|--------------|----------|---------|---------|---------|---------|---------|---------|--------|--|--|--|--|--|--|
| | | | | Zn | S | | | | | | | | | | | | |
| 1 | 6H010R | Chilwa Island | Sphalerite | Zn ⊙ | S ○ | | | | | | | | | | | | |
| 2 | 6H010R | Chilwa Island | Brucite | Mg ⊙ | Fe ○ | Mn △ | Ca • | O • | | | | | | | | | |
| 3 | 6M004R | Tundulu | Rutile | Ti ⊙ | Nb ○ | Ca △ | Fe • | O • | | | | | | | | | |
| 4 | 6M004R | Tundulu | Zircon | Zr ⊙ | Si ○ | Fe • | O • | | | | | | | | | | |
| 5 | 6M004R | Tundulu | Apatite | P ⊙ | Ca ○ | Sr • | F • | O • | | | | | | | | | |
| 6 | 6M004R | Tundulu | Rutile | Ti ⊙ | Nb ○ | Ca △ | Fe • | O • | | | | | | | | | |
| 7 | 6M044R | Kangankunde | Monazite | P ⊙ | Ce ⊙ | La ○ | Ca ○ | Nd △ | Sr • | O • | | | | | | | |
| 8 | 6M044R | Kangankunde | Strontianite | Sr ⊙ | C ○ | Ca ○ | O • | | | | | | | | | | |
| 9 | 6M045R | Kangankunde | Zircon | Zr ⊙ | Si ○ | O • | | | | | | | | | | | |
| 10 | 6M045R | Kangankunde | Rutile | Ti ⊙ | Nb △ | Ca △ | Fe △ | O • | | | | | | | | | |
| 11 | 6M045R | Kangankunde | Rutile | Ti ⊙ | Nb △ | Ca △ | Fe △ | O • | Si • | | | | | | | | |
| 12 | 6M053R | Kangankunde | Monazite | P ⊙ | Ce ⊙ | La ○ | Ca ○ | O • | Sr • | F • | | | | | | | |
| 13 | 6M053R | Kangankunde | Rutile | Ti ⊙ | Nb △ | O • | | | | | | | | | | | |
| 14 | 6M053R | Kangankunde | Monazite | P ⊙ | Ce ⊙ | La ○ | Ca ○ | O • | Sr • | F • | | | | | | | |
| 15 | 6Y005R | Tundulu | Magnetite | Fe ⊙ | Ti ○ | Mn • | O • | | | | | | | | | | |
| 16 | 6Y005R | Tundulu | Ilmenite | Fe ⊙ | Ti ⊙ | Mn • | O • | | | | | | | | | | |
| 17 | 6Y005R | Tundulu | Biotite | K ⊙ | Al ⊙ | Mg ⊙ | Si ⊙ | Fe ○ | Mn • | Ti • | O • | | | | | | |
| 18 | 6Y005R | Tundulu | Apatite | Ca ⊙ | P ○ | Sr • | O • | | | | | | | | | | |
| 19 | 6Y005R | Tundulu | Carbonate | Ca ⊙ | C ⊙ | Sr △ | Fe • | Mn • | P • | O • | | | | | | | |
| 20 | 6Y034R | Tundulu | Aegirine | Ca ⊙ | Na ⊙ | Si ⊙ | Fe ○ | Mg △ | Al △ | O • | | | | | | | |
| 21 | 6Y034R | Tundulu | Goethite | Fe ⊙ | Ca ○ | Si △ | Mg • | O • | | | | | | | | | |
| 22 | 6Y034R | Tundulu | Pyrite | Fe ⊙ | S ⊙ | | | | | | | | | | | | |
| 23 | 6Y037R | Chilwa Island | Rutile | Ti ⊙ | Nb △ | Fe △ | O • | | | | | | | | | | |
| 24 | 6Y037R | Chilwa Island | Calcite | Ca ⊙ | C ⊙ | O • | | | | | | | | | | | |
| 25 | 6Y037R | Chilwa Island | K-felspar | K ⊙ | Al ⊙ | Si ⊙ | Na • | Fe • | O • | | | | | | | | |

⊙ Abundant

○ Common

△ Little

• Rare

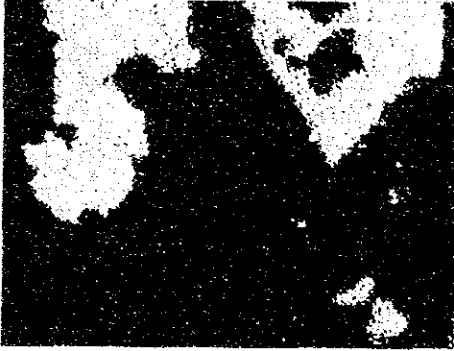
(X-Ray image)

Abbreviations

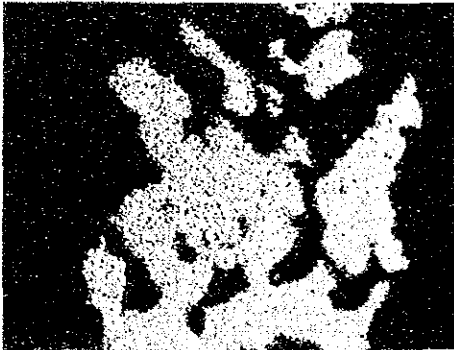
Kf : Alkali feldspar
Rt : Rutile
Fe : Fe-oxide
Ap : Apatite
Zr : Zircon
Qz : Quartz
Mz : Monazite
St : Strontianite
Goe : Goethite
Carb : Carbonate mineral



Absorbed electron image
Sample No : 6M004R, 10
Rock Name : Apatite feldspathic rock
Sector : Tundulu



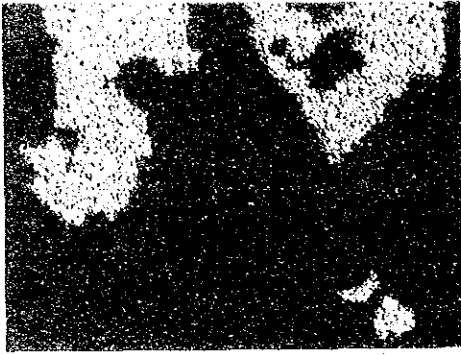
Al X-ray image



Ti X-ray image



P X-ray image

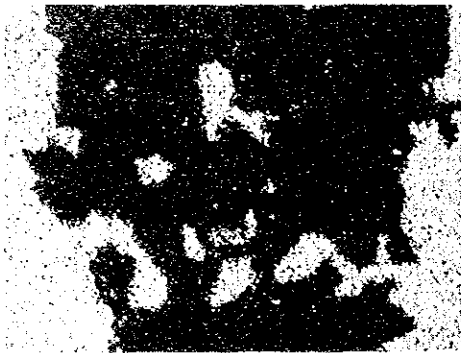


Continuation of 6M004R, 10
Si X-ray image

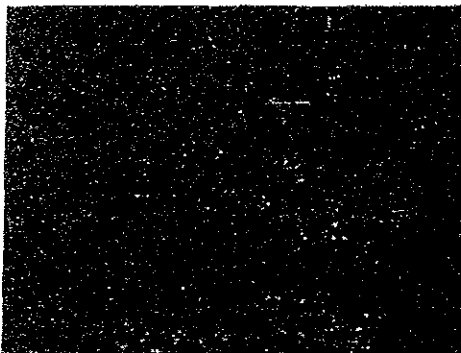


K X-ray image

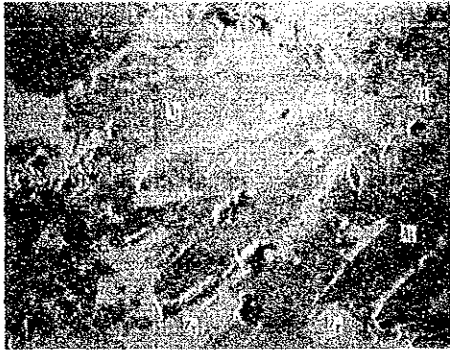
0 0.5mm
└──────────┘



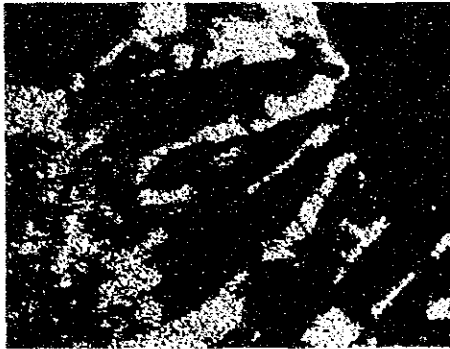
Ca X-ray image



Fe X-ray image



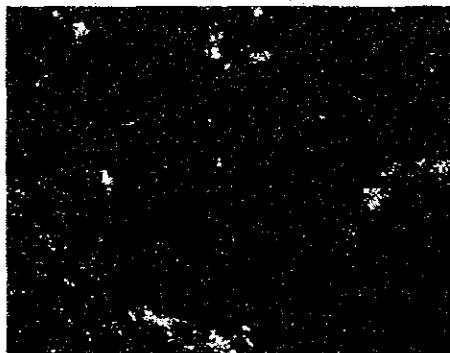
Absorbed electron image
Sample No : 6M004R, 13
Rock Name : Apatite feldspathic rock
Sector : Tundulu



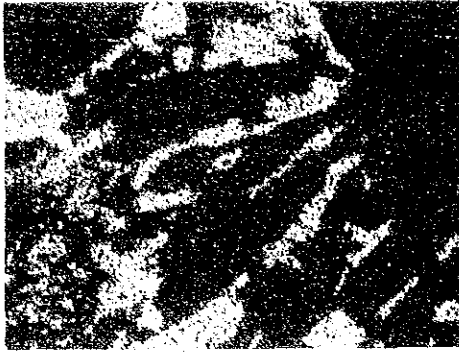
Si X-ray image



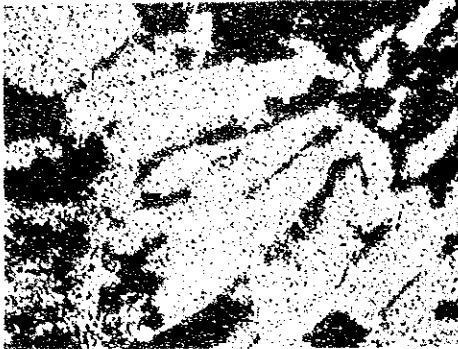
P X-ray image



Fe X-ray image



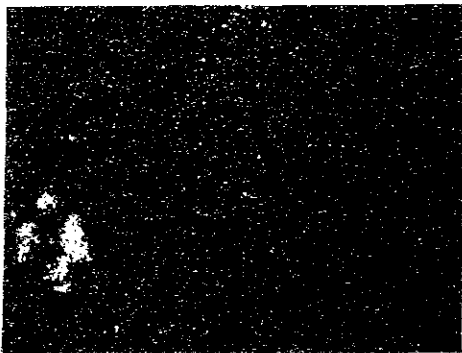
Continuation of 6M004R, 13
Zr X-ray image



Ca X-ray image



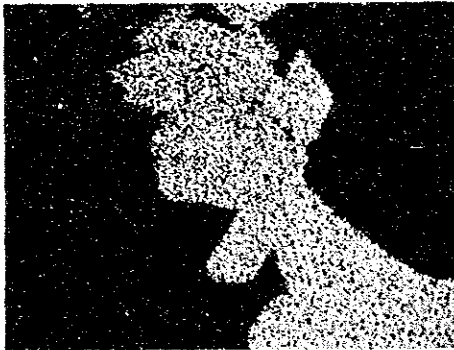
Ti X-ray image



Al X-ray image



Absorbed electron image
Sample No : 6M044R, 19
Rock Name : Monzonite bearing Carbonatite
Sector : Kangankunde



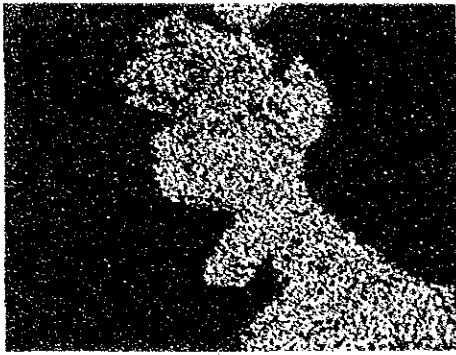
Ce X-ray image



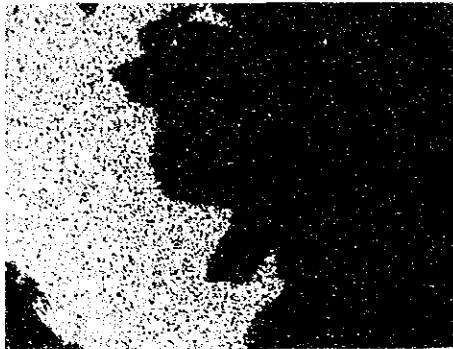
P X-ray image



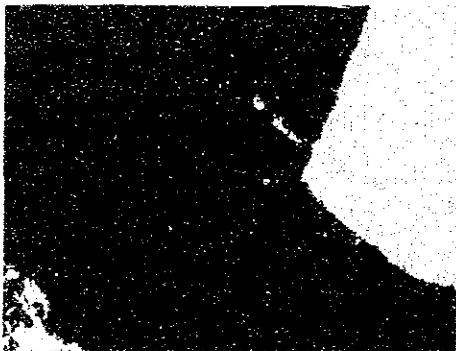
Si X-ray image



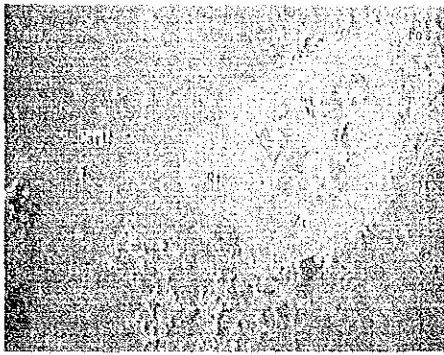
Continuation of 6M044R, 19
La X-ray image



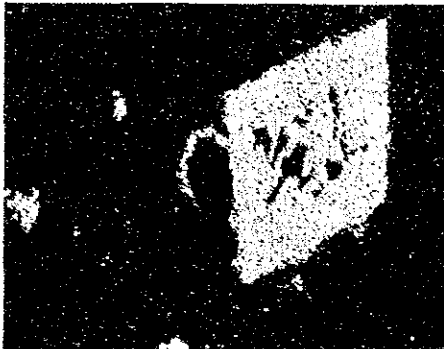
Sr X-ray image



Fe X-ray image



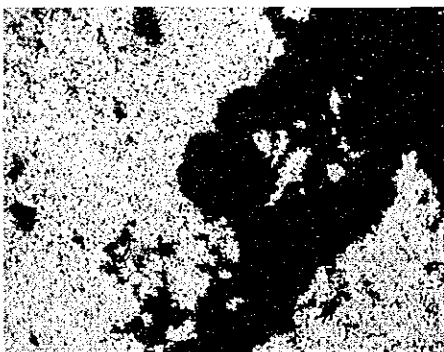
Absorbed electron image
Sample No : 6M045R, 22
Rock Name : Carbonatized feldspathic rock
Sector : Kangankunde



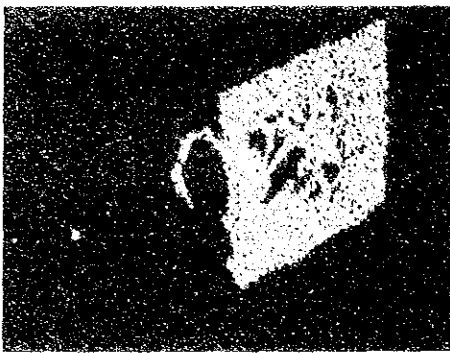
Si X-ray image



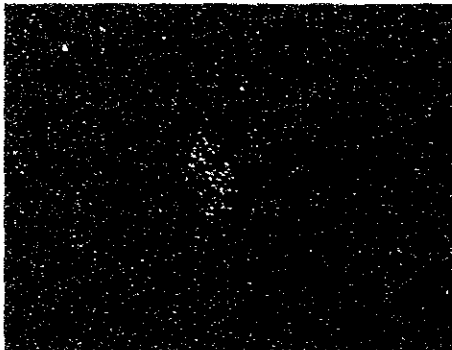
Ti X-ray image



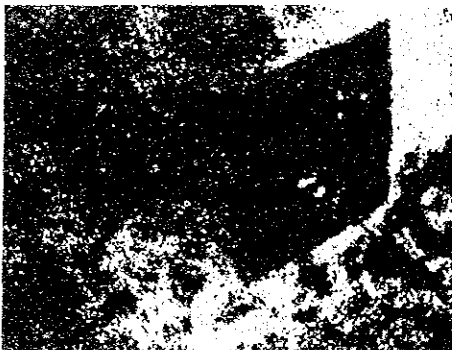
Ca X-ray image



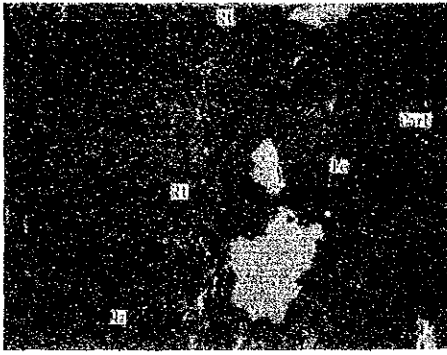
Continuation of 6M045R, 22
Zr X-ray image



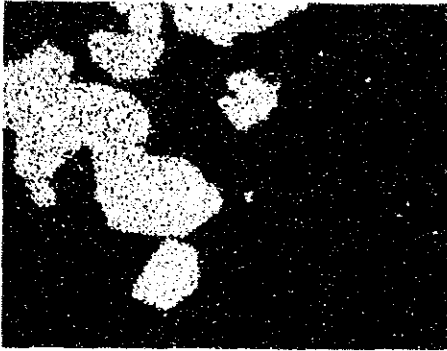
Nb X-ray image



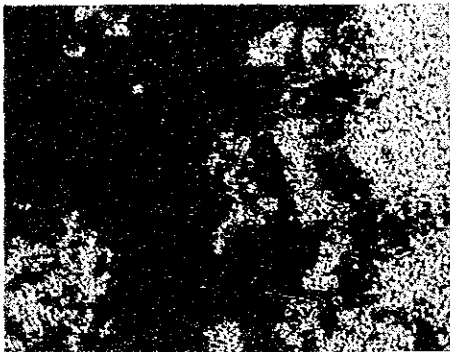
Fe X-ray image



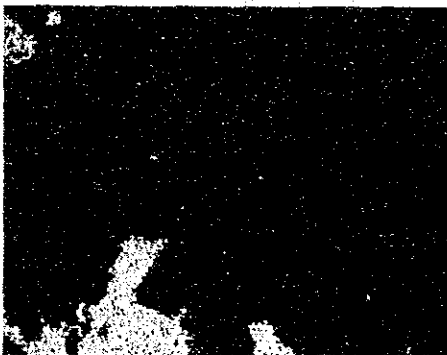
Absorbed electron image
Sample No : 6M045R, 24
Rock Name : Carbonatized feldspathic rock
Sector : Kangankunde



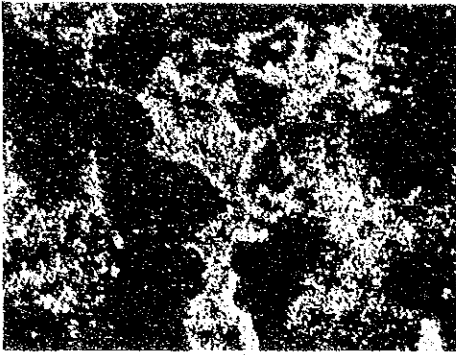
Ti X-ray image



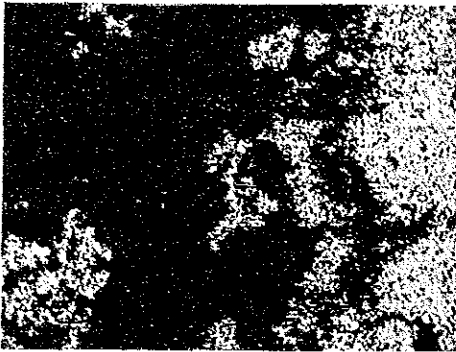
Ca X-ray image



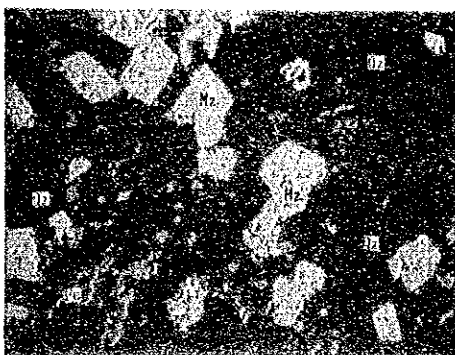
Si X-ray image



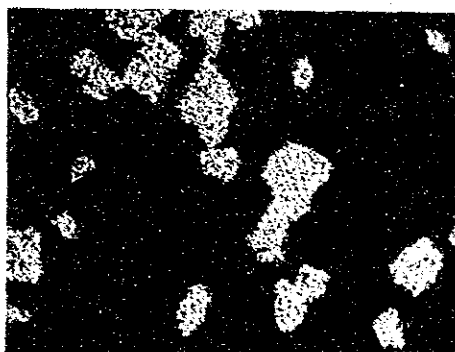
Continuation of 6M045R, 24
Fe X-ray image



Mg X-ray image



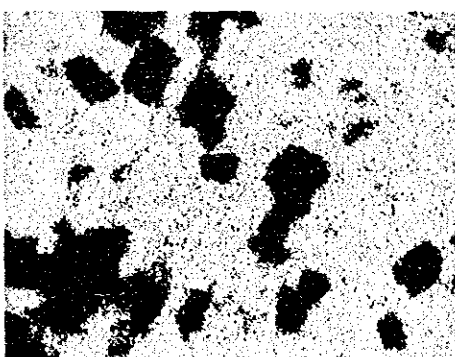
Absorbed electron image
Sample No : 6M053R, 27
Rock Name : Quatrz druse rock
Sector : Kangankunde



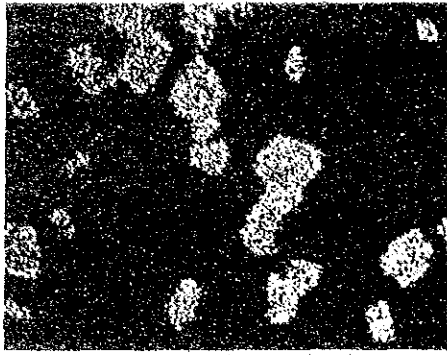
Ce X-ray image



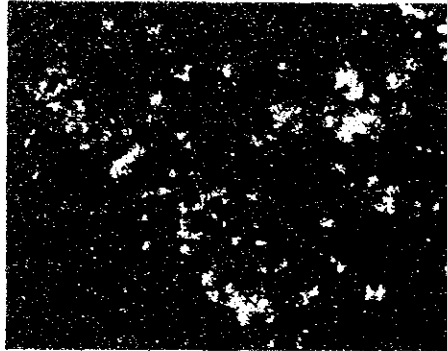
P X-ray image



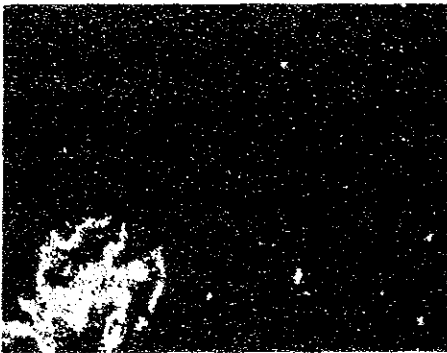
Si X-ray image



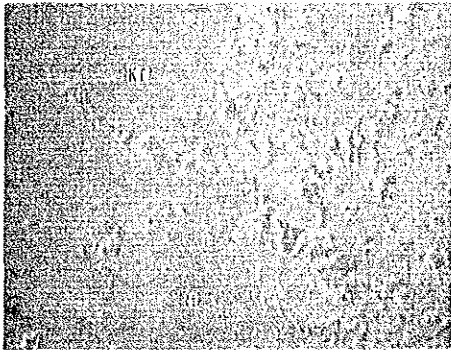
Continuation of 6M053R, 27
La X-ray image



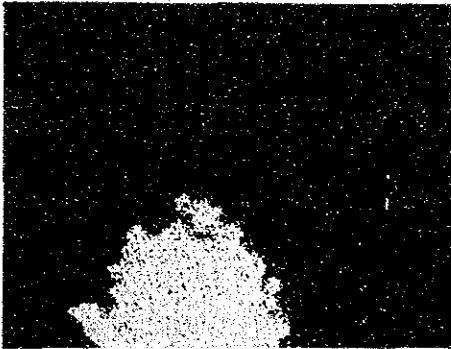
Ca X-ray image



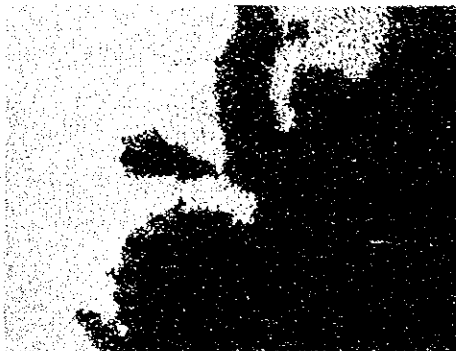
Fe X-ray image



Absorbed electron image
Sample No : 6Y037R, 8
Rock Name : Ankeritic-Carbonatite
Sector : Chilwa Island



Ti X-ray image



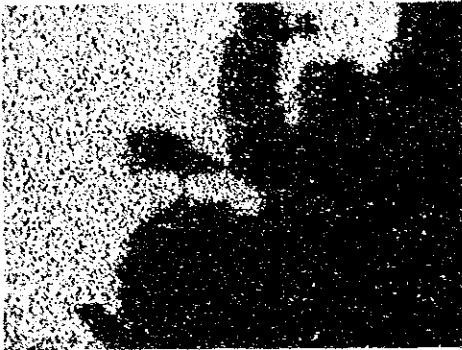
K X-ray image



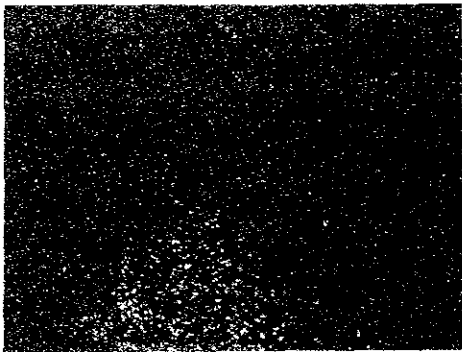
Al X-ray image



Continuation of 6Y037R, 8
Fe X-ray image



Si X-ray image

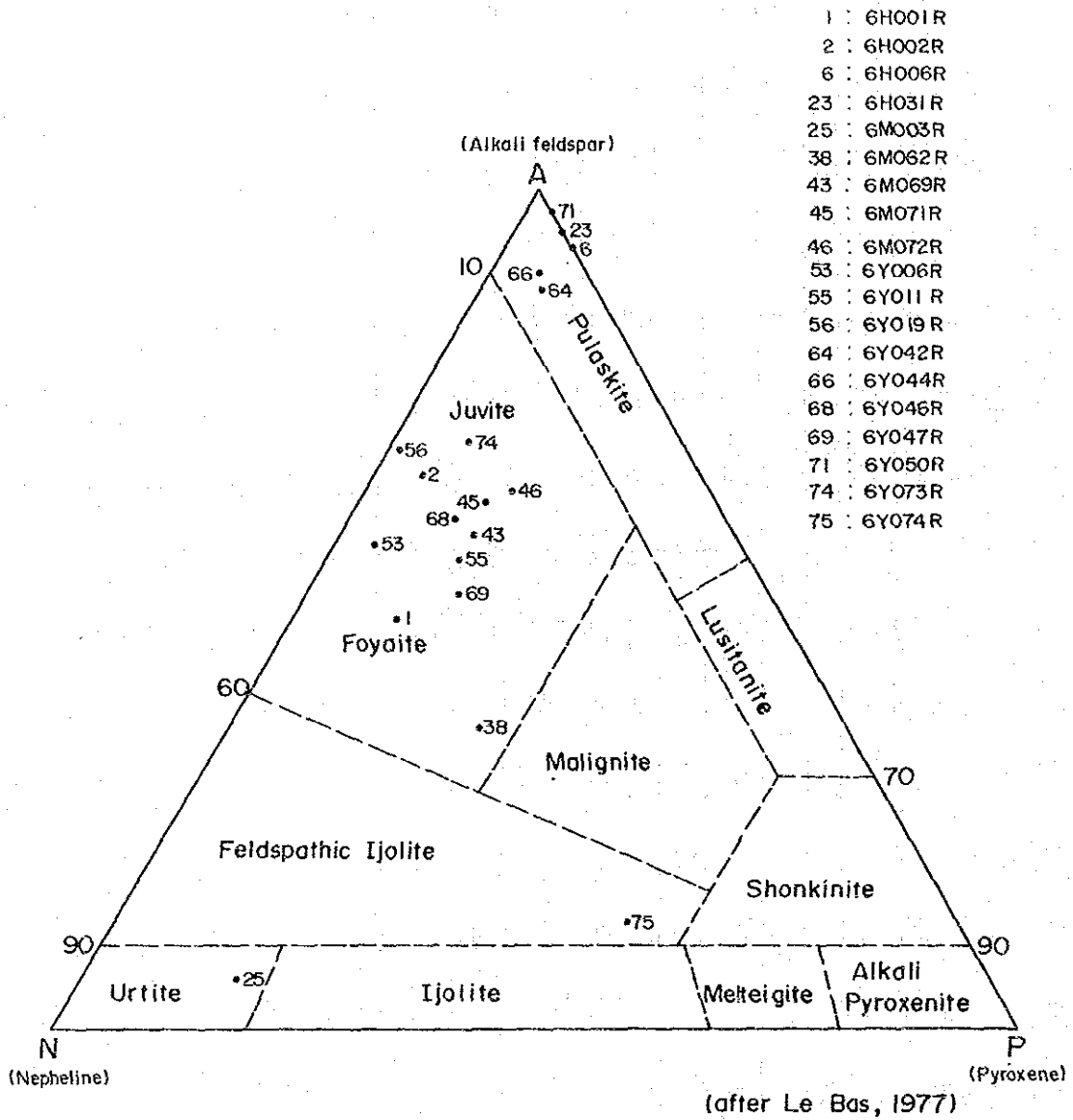


Nb X-ray image

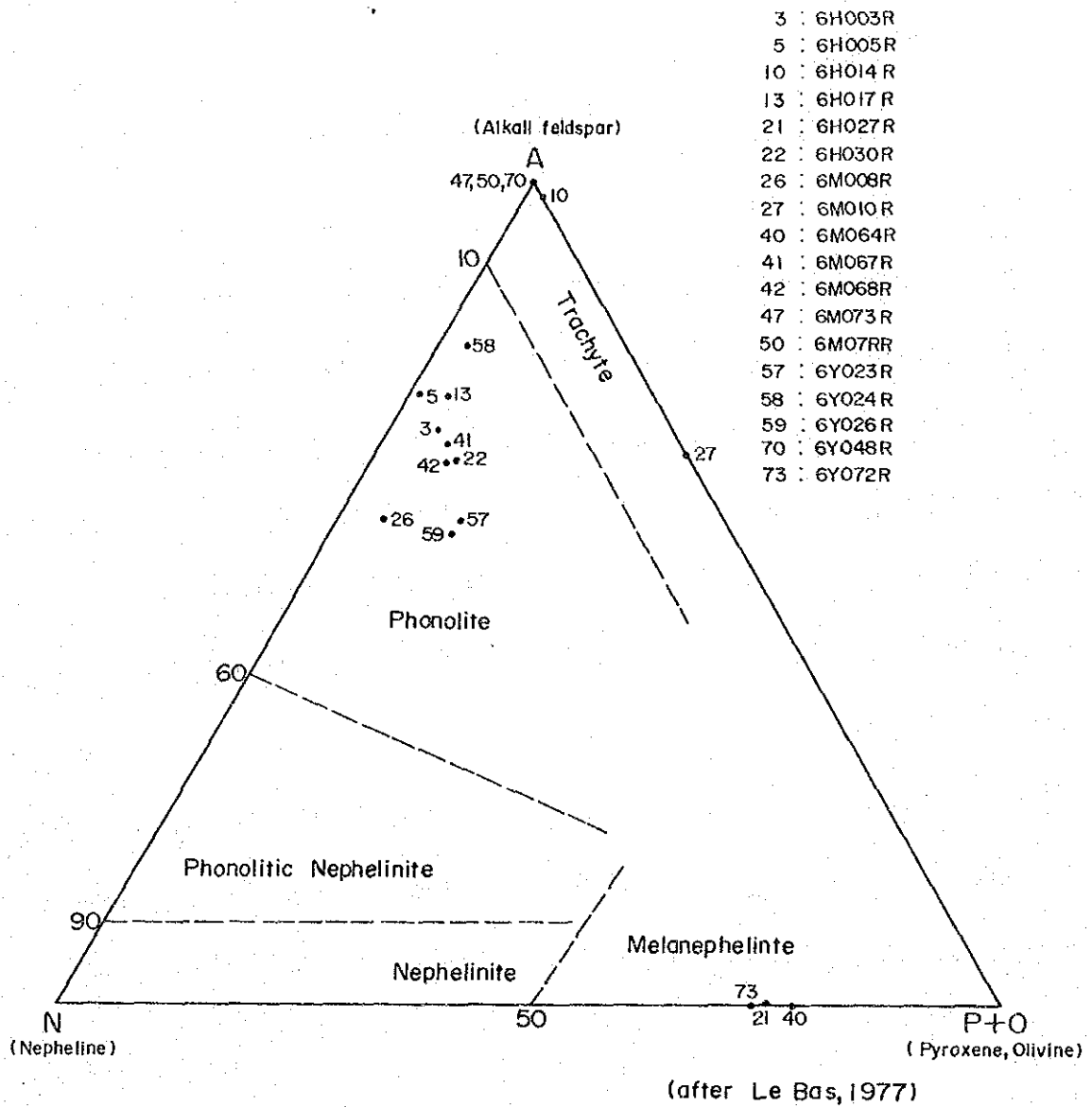
(Quantitative Analysis)

| No. | Sample No. | Sector | Mineral | Elements and Components | | | | | | | | | | | | | | | | Total |
|-----|------------|---------------|------------|-------------------------|------------------|--------------------------------|--------|-------|--------|--------|-------------------|------------------|-------------------------------|--------------------------------|--------------------------------|-------|---|---------|--------|-------|
| | | | | Zn | Fe | Cu | Mn | Ag | Cd | Sb | As | S | K ₂ O | P ₂ O ₅ | Nb ₂ O ₅ | F | O | | | |
| 1 | 6H010R | Chilwa Island | Sphalerite | 63.22 | 4.00 | 0.00 | 0.06 | 0.00 | 0.01 | 0.00 | 32.91 | | | | | | | | 100.19 | |
| | | | | SiO ₂ | TiO ₂ | Al ₂ O ₃ | FeO | MnO | SrO | CaO | Na ₂ O | K ₂ O | P ₂ O ₅ | Nb ₂ O ₅ | F | O | | | Total | |
| 2 | 6M004R | Tundulu | Apatite | 0.205 | 0.020 | 0.020 | 0.041 | 0.039 | 1.568 | 53.861 | 0.164 | 0.004 | 42.033 | 0.000 | 2.539 | 0.000 | | 100.523 | | |
| 3 | 6M004R | Tundulu | Rutile | 0.086 | 85.789 | 0.011 | 3.896 | 0.017 | 0.046 | 0.278 | 0.006 | 0.009 | 0.023 | 9.988 | | | | 100.196 | | |
| 4 | 6M053R | Kangankunde | Rutile | 0.017 | 95.689 | 0.007 | 0.152 | 0.039 | 0.022 | 0.093 | 0.042 | 0.016 | 0.013 | 3.622 | | | | 99.754 | | |
| 5 | 6Y005R | Tundulu | Biotite | 35.873 | 4.029 | 11.995 | 24.014 | 0.405 | 10.231 | 0.154 | 0.082 | 9.259 | 0.000 | 0.154 | 1.267 | 2.287 | | 100.900 | | |
| 6 | 6Y034R | Tundulu | Aegirine | 54.431 | 0.682 | 0.429 | 27.723 | 0.096 | 2.588 | 0.039 | 4.254 | 11.706 | 0.019 | | | | | 98.968 | | |
| 7 | 6Y037R | Chilwa Island | K-feldspar | 63.401 | 0.037 | 18.302 | 0.480 | 0.014 | 0.028 | 0.000 | 0.306 | 16.894 | | | | | | 99.495 | | |

(Weight %)



Appendix 12 Model Variation of Plutonic Rocks in Alkali Rock Series



Appendix 13 Model Variation of Volcanic Rocks in Alkali Rock Series

11111