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APPENDIX 1

X-ray diffractograms of the Mae Chedi granites

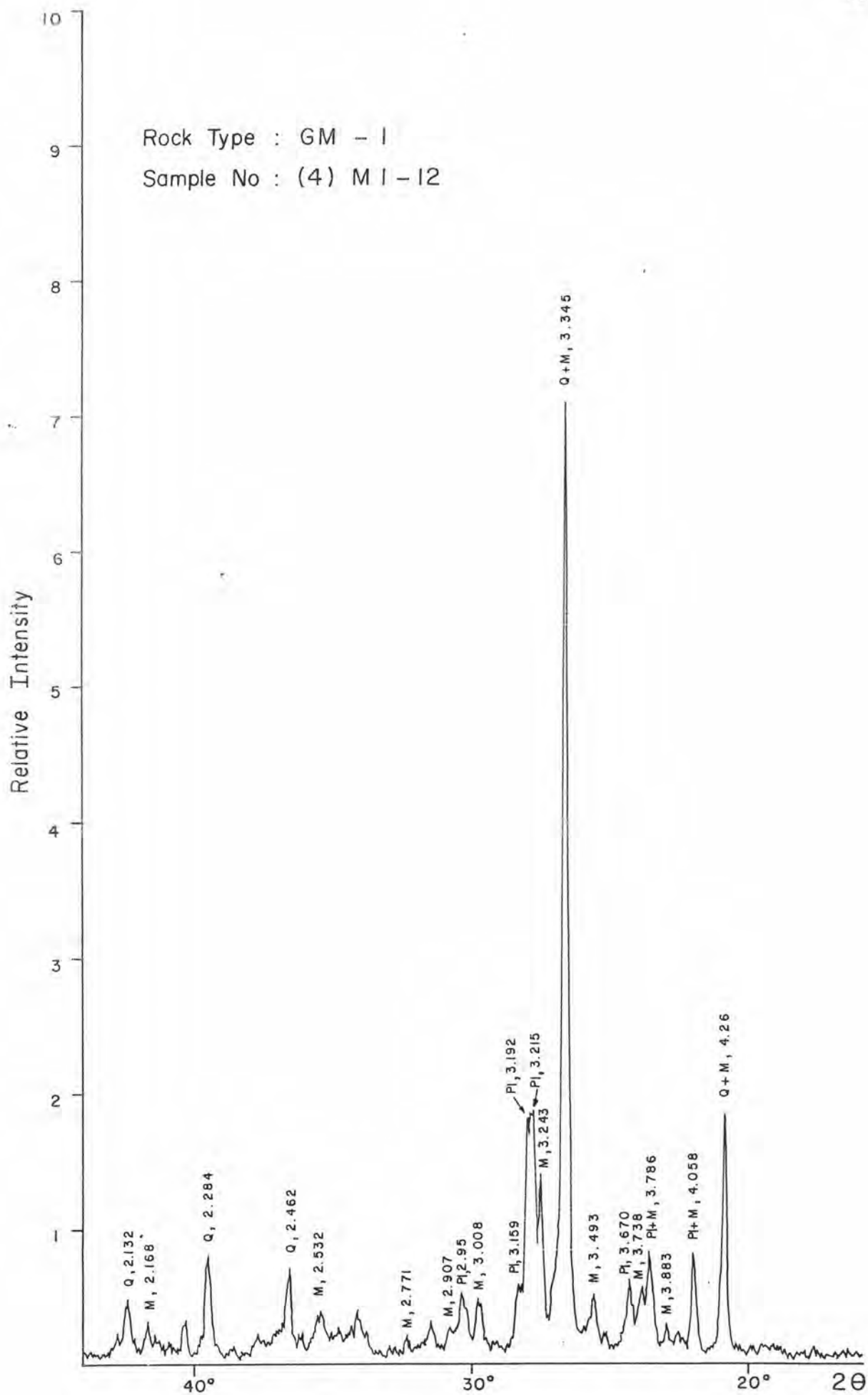
Operation conditions of X-ray diffractometer :

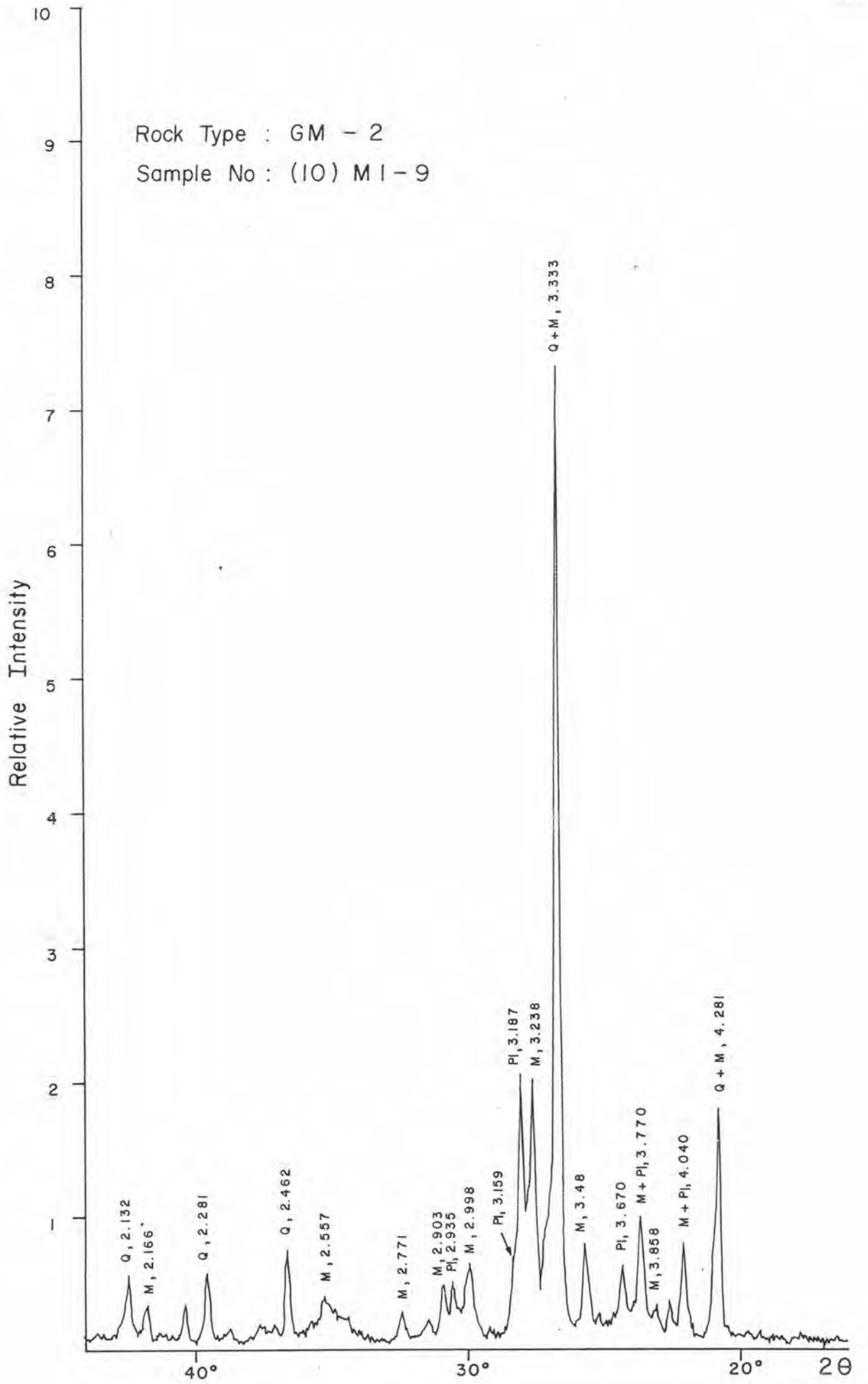
(Philips : Type PW 1130/90)

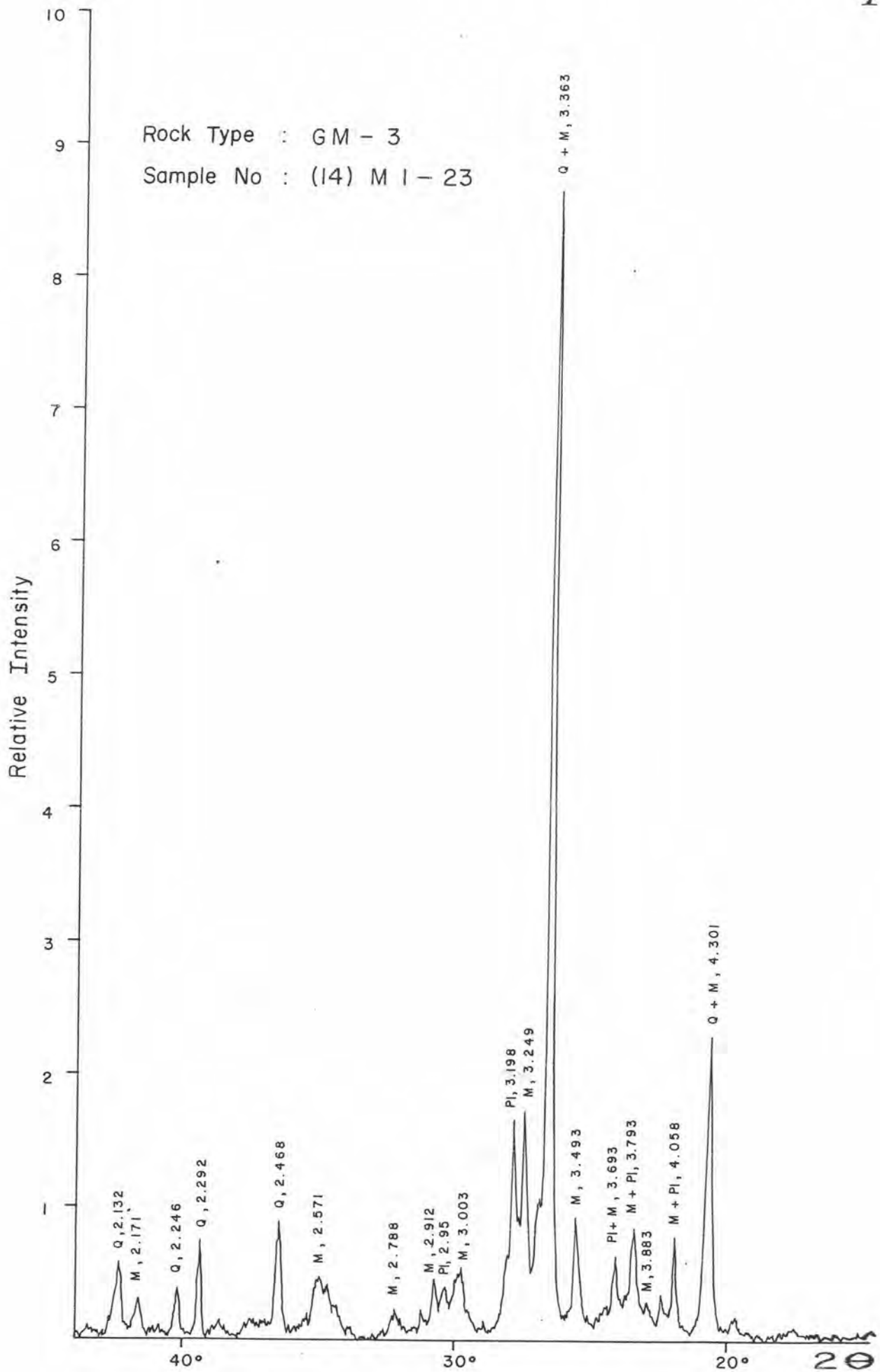
CuK α	radiation		
kV	40	Chartdrive	1 cm/minute
mA	25	Degree 2 θ per minute	2
Range	2 x 10 ³	Lower Level	480
Gain	8	Window	10%
HV	1860	Time Constant	1

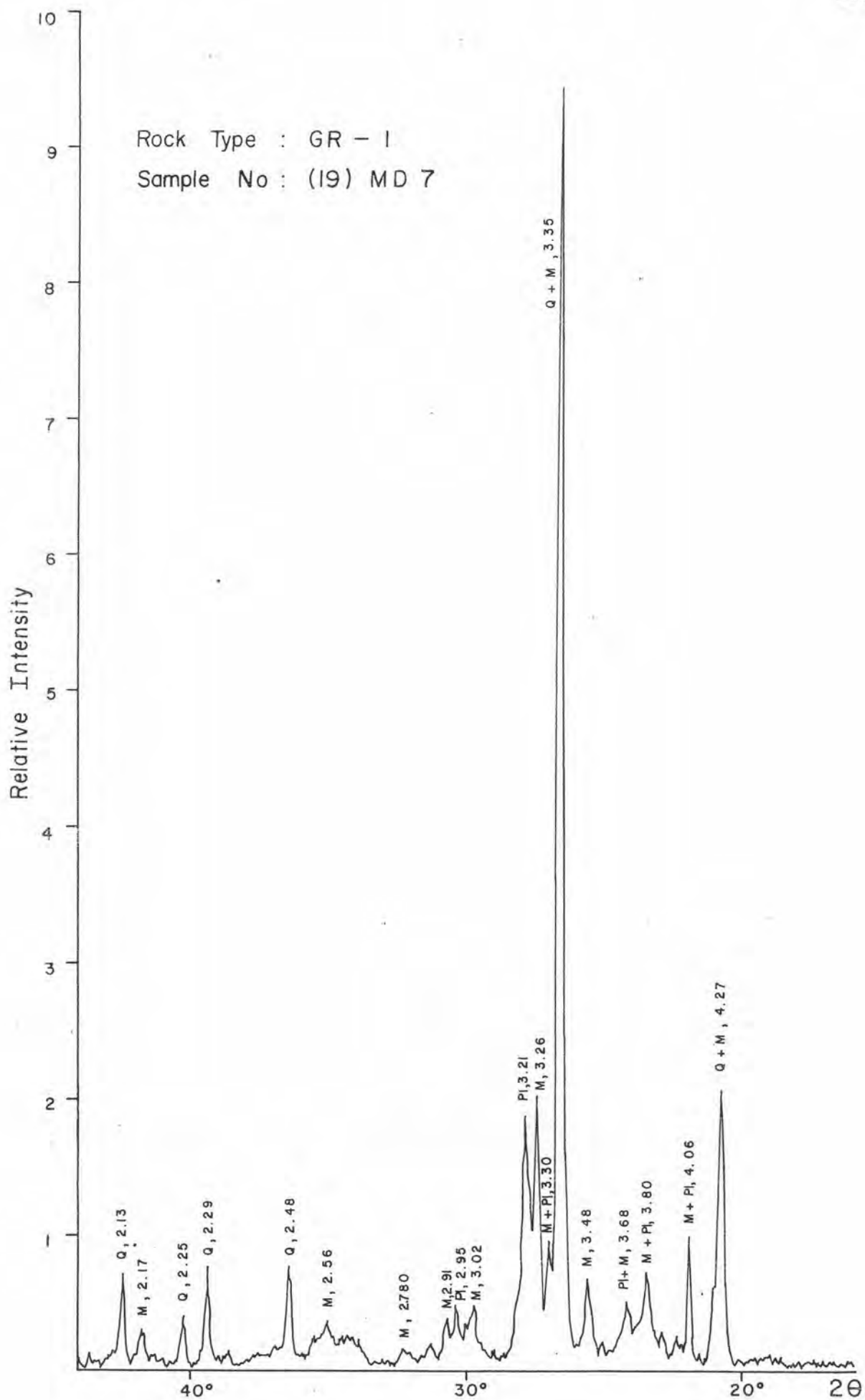
Explanation

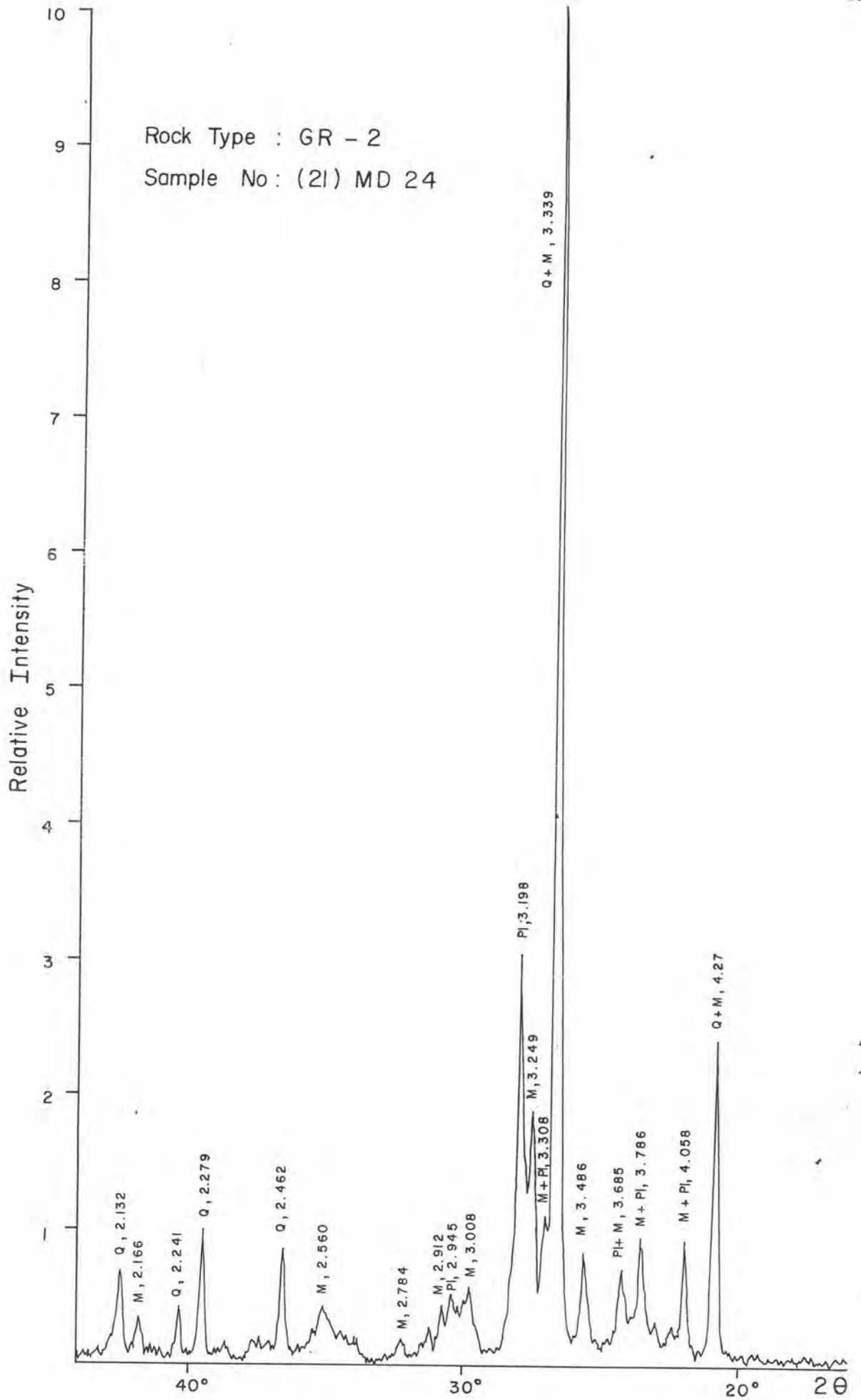
Pl	=	Plagioclase
Q	=	Quartz
M	=	Microcline





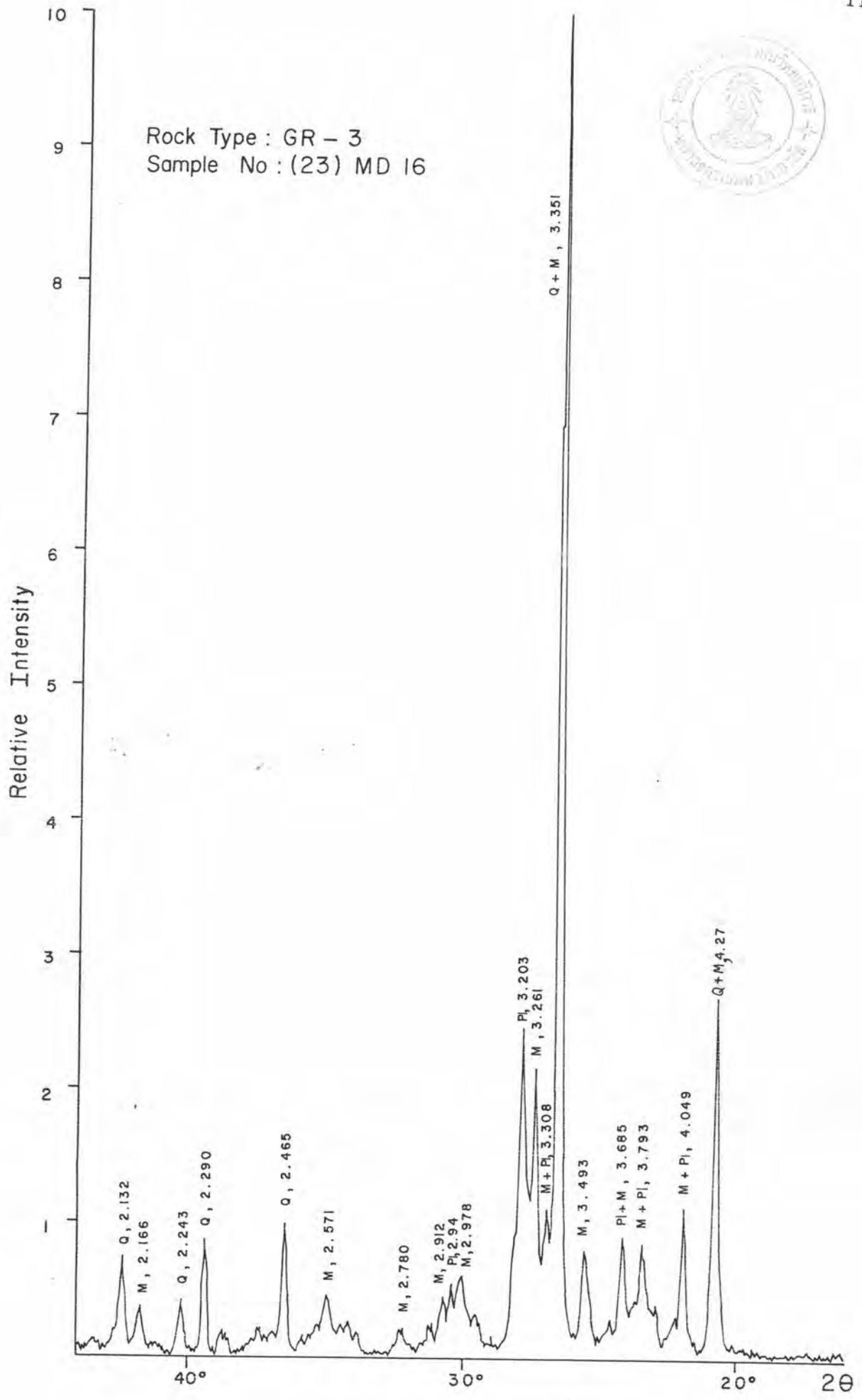








Rock Type : GR - 3
Sample No : (23) MD 16



APPENDIX 2

Staining rock slabs and thin sections techniques

Staining rock slabs

1. Immerse the smooth face of a dry slab (about 10 by 10 cm) in warm conc. 48 % HF acid for 30 seconds.
2. Rinse the entire slab sufficiently in tap-water to remove the excess HF and then dry it in an oven at 90° C for 15 minutes or longer to eliminate all HF.
3. Immerse the etched face of the slab in sodium cobaltinitrite solution (60 %) for 1 minute.
4. Rinse the slab thoroughly in running tap-water to remove excess sodium cobaltinitrite and allowed it to dry. At this point the K-feldspar is stained with bright yellow, while the plagioclase is become chalky white to yellowish white color, but quartz is unaffected.

Staining thin sections

1. Etch an uncovered thin section for 30 seconds in warm HF (48 %) acid vapor and allowed it to dry.
2. Immerse the section, face up, in sodium cobaltinitrite solution (60 %) for 30 seconds.
3. Rinse the section gently but thoroughly in tap-water to remove excess cobaltinitrite, and dry it with compressed air. K-feldspar is stained with bright yellow.
4. Immerse the section in barium chloride solution (5 %) for 15 seconds.

5. Dip the section once or twice in water, and dry it gently with compressed air.

6. Immerse the section in amaranth solution (1.42 %) for 30 seconds.

7. Sweep away excess amaranth with compressed air.

8. Dry the thin section and put a slice of cover glass on it.

APPENDIX 3

Analytical techniques

Determination of major element-oxides

Methods and techniques of chemical analyses of rocks for major element-oxides (Table 1.1), excluding H_2O^+ , employ the two-solution procedure of Shapiro (1975). Rock standards, RGM-1, G - 2, AGV-1, GSP-1, BHVO-1, and PCC-1, provided by the U.S.G.S. were used to make calibration curves.

The combined water (H_2O^+) of the rock samples were determined by a modified Penfield Method. The procedure of the analytical technique is as follows :

1. Place 3 g of sodium tungstate flux and 1.000 g of the sample in a porcelain crucible, and mix them thoroughly with a glass rod. Using a long-stemmed funnel, completely transfer this mixture into the bulb of a dried Penfield tube. Close the tube with a capillary stopper.
2. Horizontally insert the bulb of the Penfield tube, with a strip of damp cloth spirally wrapped around the middle sector, into the open flame from a bunzen burner. Slowly rotate the tube while heating the bulb at red-heated for 30 minutes. Keep the cloth wet throughout the heating period.
3. Heat the juncture of the tube until it softens. Pull off the bulb with iron tongs, and heat the sealed end of the tube for a few seconds to round of the sharp tip.

4. Let the tube cool, unwrap the damp cloth, and blot the water from the outside of the tube with a towel. Remove the stopper and weight the tube (tube weight plus weight of combined water).

5. Dry the tube in an oven at 110° C for 1 hour. Let the tube cool and weight it (tube weight).

6. Combined water in the sample equals to the loss in weight of the tube during drying.

Determination of S by Gravimetry

1. 0.500 g of each sample is fused with approximately 5 g of sodium peroxide in an iron crucible.

2. Dissolve the fused mass in 150 ml distilled water. Leave the solution over night.

3. Filter the solution with filter paper No. 42. Wash the precipitate with sodium carbonate solution (5 %).

4. Evaporate the filtrate to 100 ml and acidify with HCl. Evaporate to dryness on water bath. Add 5 ml 5 % HCl and evaporate to dryness again. Dissolve the residue with 100 ml 5 % HCl.

5. Filter the solution with filter paper No. 42. Wash the precipitate with 5 % HCl. Add 50 ml BaCl₂ solution (10 %) in filtrate and leave the solution over night.

6. Filter the solution with filter paper No. 42. Wash the precipitate with hot water until the filtrate is free from chloride ion (Cl⁻).

7. Ignite the precipitate at 900-1050° C to constant weight (approximately 1/2 hour). Calculate the percent total S by using the relationship :

$$\text{BaSO}_4 = 233.4, \quad \text{S} = 32.06$$

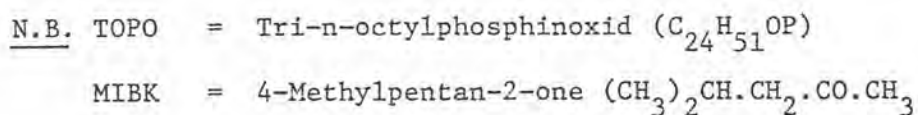
$$\% \text{ S} = \frac{\text{weight of BaSO}_4 \times 32.06 \times 100}{233.4 \times \text{weight of sample}}$$

Determination of Sn by Atomic Absorption Spectrometry

1. 1.000 g of each rock sample was weighed accurately into fusion tube, 5 g of dry ammonium iodide powder was added and the content mix thoroughly. A condenser was attached to it and the tube was dried overnight at 105° C in an electric oven and heated for another 15 minutes at 500° C.

2. After cooling, 15 ml of dilute hydrochloric acid (10 %) and 10 ml of ascorbic acid solution (10 %) were added. The mixture was then heated in boiling water bath for 15 minutes and mixed well while hot and allowed to cool.

3. TOPO - MIBK mixture solution (4 % TOPO in MIBK) was added to each sample and was shaken vigorously to extract tin as complex into the organic layer. The solution was allowed to stand until two layers were formed. The top organic layer was then aspirated into nitrous oxide-acetylene flame of the atomic absorption spectrophotometer. Tin content of the sample was determined from calibration curve, prepared a series (2, 4, 6, 8, 10 ppm) of standard diluted from 1000 ppm Sn standard solution (BDH).



Determination of W by Spectrophotometry

1. 1.000 g of sample was weighed into 100 ml beaker and digested with 5 ml of $HClO_4/HCl$ mixture (1:3). After the reaction has subsided, basified with 5 % NaOH and warmed on a hot plate for 1 hour.
2. The solution was then filtered through filter paper No. 41 and residue was washed with hot 0.2 % NaOH.
3. The filtrate was adjusted to pH between 0.5-1.5 with the $HClO_4 - HCl$ acid mixture by using a pH-meter.
4. 1 ml of 30 % KI solution was added to the filtrate which was then heated on the hot plate, 10 ml of dithiol solution (0.25 %) was added and the solution was stirred thoroughly. The solution was kept on the hot plate for 30 minutes, allowed to cool and transferred to a 100 ml separatory funnel and extracted with 10 ml chloroform.
5. The organic phase was collected and the absorbance was measured at 635 nm.
6. Tungsten concentration was determined from calibration curve prepared by extracting 0.5, 1, 2, 3, 4, 5, and 10 ppm of standard solution of tungsten (1000 ppm W solution (Merch)) with 10 ml each of chloroform and absorbances were measured at 635 nm using chloroform as blank.

Determination of Li, Cu, Pb, Zn, and Ni by Atomic Absorption Spectrometry

1. 1.000 g of sample was transferred into a platinum dish, wetted with 1 ml of distilled water and 10 ml of 50 % HNO_3 and 10 ml HF (48 %) were added. The solution was evaporated to dryness on a steam bath.

2. Another 10 ml of 50 % HNO_3 and 10 ml HF (48 %) were added to the residue and the solution was evaporated to dryness.

3. The procedure was repeated with 20 ml 50 % HNO_3 . After the salts appear to be dry, it was heated for the additional 15 minutes.

4. The salts was then heated to dissolve in 4 ml of 50 % HNO_3 and 10 ml of distilled water.

5. The content was then transferred into 100 ml volumetric flask. Wash the inside of the dish three times with distilled water and add to the flask. Dilute the filtrate to the mark with distilled water and mix well. The trace elements of the sample were determined from calibration curves, prepared a series (0.5, 1, 2, 3, 4, 5, 10 ppm) of standard diluted from 1000 ppm of the trace elements standard solutions (BDH).

Determination of F by Ion selective electrodes

1. 40 mg of rock sample was fused with 8 pellets of NaOH in zirconium crucible at a red heat for 3 minutes and allowed to cool.
2. The 10 ml of distilled water was then added and the solution was heated for half an hour on a steam bath.
3. The content of the crucible was emptied into a 100 ml plastic volumetric flask. The crucible was washed with 3 ml 50 % HNO_3 and distilled water. The washings and 25 ml of ammonium citrate solution (25 %) were added to the flask and the solution was made up to the mark with distilled water. The content of the flask was shaken to mix thoroughly.
4. A blank solution was prepared using the same procedure but the sample was omitted.
5. 0.08, 0.10, 0.25, 0.50 ppm fluoride standards were prepared from 10 ppm fluoride standard solution and contained all reagents as the blank solution.
6. 25 ml of each sample, standard and the blank solution (from each 100-ml flask) was pipeted into 50-ml plastic beakers. Into each, 25 ml of TISAB solution was added while stirring with magnetic bar, after the end of 5 minutes, the potential of the solution was measured using fluoride combination electrode.
7. The potential (in mV) of the standards was plotted against mass concentration of fluorine (ppm) on semi-logarithmic (three-cycle) graph paper. The fluoride content of sample can then be

calculated using the calibration graph.

N.B. TISAB solution: Approximately 500 ml of distilled water was placed in a 1-liter beaker. 57 ml glacial acetic acid and 58 g NaCl were added and stirred until dissolve. The beaker was colled in a water bath. A calibrated pH electrode was immersed into the solution, and 5 M NaOH was added slowly until pH was between 5.0 and 5.5. The solution was allowed to cool to room temperature and was poured into a 1-liter flask and diluted to the mark with distilled water.

Standard fluoride solution, 10 ppm, prepared from 1000 ppm Orion fluoride activity standard 940907 diluted with distilled water.

An Orion 701-A digital pH/mV meter with fluoride combination electrode were used for all determinations. All measurements were made on solutions stirred with polyethylene-coated magnetic sterring bars.

Determination of Rb, Sr, Zn, Ba, La, and Ce by X-ray fluorescence

The measurement are performed by an energy dispersive X-ray fluorescence system using radioisotope excitation. For the determination of Rb, Sr, and Zr, the 10 m Ci ^{109}Cd annular source was used to provide exicitation radiation, and the 10 m Ci ^{241}Am annular source was used to determine Ba, La, and Ce.

About 20 g of a homogeneous powder of each granite sample and granite standard (U.S.G.S., G - 2) was weighed and put into a 4.5 cm diameter sample containers. The X-ray fluorescence intensity of

sample and standard were measured by using Si(Li)-detector (ORTEC 7000 series) and a multichannel analyser (1024 channels Nuclear Data System 2200) for 2000 seconds.

Determination of U by Neutron activation analysis

1. About 50 mg of a homogeneous powder of each sample and granite standard (22 ppm U) was weighed and put into a clean small polyethylene vial of 1 ml volume.
2. The vials were heat sealed and then encapsulated in a large polyethylene vial.
3. Samples and standard were irradiated together at a suitable epithermal neutron flux for 20 minutes in a cadmium-covered tube facility of a reactor (TRR-1/M1).
4. After a decay of 10 minutes the samples and standard were counted at a reasonable deadtime for 200 seconds each on a low energy photon detector (LEPD) system.

N.B. The LEPD system consists of a hyperpure germanium (HPGe) detector (ORTEC model 1113-25360) with a multichannel pulse height analyser (1024 channel CANBERRA 8100/E). The 74.67 keV photopeak of U-239 is measured.



BIOGRAPHY

Mr. Rak Hansawek was born in Bangkok, Thailand, on September 25, 1947. He graduated with a B.Sc. in Geology from Chulalongkorn University, Bangkok, in 1972. Then he worked in the Economic Geology Division, Department of Mineral Resources and was firstly assigned to carry out drill-hole loggings as well as prospecting of fluorite at Ban Pang, Li district, Lamphun province, in 1973. Subsequently, he was assigned to work on exploration of radioactive minerals at Kao Hin Son, Phanom Sarakham, Chachoengsao, in 1974 and oil shale exploration at Ban Huai Kaloke, Mae Sot, Tak, in 1975. Both were reported in Thai. From 1976 to 1979, he served as a geologist for Tin Exploration Project and did geochemical prospecting and geologic mapping of tin deposits in the vicinity of Khun Yuam-Mae Sariang batholith, Mae Hong Son and Chiang Mai provinces. In addition, he attended the Symposium on Geology of Tin Deposits and also participated in the Tin Training Course held in Kuala Lumpur, Malaysia, in 1978. At present, he has worked as a geologist in the Tin Exploration Program of Economic Geology Division, Department of Mineral Resources, Bangkok.