○ ZaydaからZayda南西部にかけて，基盤深度約１００ｍ以内の地表下浅所に数本の古流路系が把握されており，南側では南流し，北側では北流する。

○ Bou Miaの北方，Bou Mia花崗岩体の東側には，Almagh川の両側に平行する古流路系が抽出されており，一部溜り場的な箇所が認められる。

(g) 調査地付近に知られるウラン鉱徴のうち，P－T赤色砂岩層中の基底であるアルコーズ砂岩に関連する，砂岩型（Sandstone Type）ウラン鉱徴は，上記古流路系と密接な関係を持つと考えられる。

ウランの沈積・濃集する地形的な環境として，古流路の緩傾斜部あるいは蛇行部に着目すれば，次の鉱床賦存の期待される地区が指摘される。

○ Zayda 南方に延長１０Km以上にわたって把握された古流路地形のうち，上流～中流部の約５Kmの範囲，及び下流の終末部

○ Zayda の南南西約５Km付近の，地下浅所に形成されると思われる古流路

○ Bou Miaの北方約６Km付近の，Bou Mia 花崗岩体に隣接する古流路の中心部

(h) Zayda付近には，Zayda鉱山によって稼行されている鉛鉱床が多数ある。これはアルコーズ砂岩中に鉱化した層状砂岩型鉱床であり 上記の砂岩型ウラン鉱徴と，生成環境についての関連性が考えられる。すなわち，鉛鉱床は比較的花崗岩体近辺に賦存しているが，それらが分布する古流路の延長先にはウラン鉱床胚胎の可能性が有り得る。従って，古流路の探査は両鉱種の探査にとって重要な意味を持つと考えられる。

５－２　今後の探査指針

今回の重力探査の結果，本調査の課題である基盤構造の概要と，古地形の上に刻まれた古流路系の推定がなされ，重力探査の適応性が裏付けられた。特に，地下浅所における古流路系が明らかにされ，ウラン・鉛鉱床胚胎の期待される地区が指摘された。

本重力探査の調査結果より，今後の探査指針について，次の諸項が挙げられる。

(a) 基盤上の古流路系を反映する重力異常は，１mgal 以下と非常に小さい異常量で示される。従って，今回の調査においても十分留意したように，高度な測定精度・補正精度が要求される。状況に応じて，測点位置測量も併用することが必要である。

(b) 基盤深度の比較的浅い地区において，重力的応答が顕著であることから，調査地の選定には，地質調査の知見より，基盤深度の深いと考えられる地区は除外すべきである。

(c) 今回の調査計画は，面積約４００Km^2 の範囲に測点数６００点と，１.５点／Km^2 の測点密度で実施された。しかし，地下浅所の小規模な古流路系の把握をも念頭に入れた場合，さらに測点密度の高い調査が望まれる。例えば，基盤深度が約５００ｍまでの地域に４００Km^2 の面積を設定した場合，測点間隔約４００ｍ，測点数９００程度の調査計画が必要と思われ

る。

(d) 本地域の北部には，E－W方向の基盤の背斜軸を頂点として北流する，数本の古流路系が抽出されている。これらを追跡して，鉱床賦存有望地区を選定する為に，北方に拡張した調査を行うべきである。

(e) 今回の鉱床有望地区として指摘された場所周辺に対し，確認の為の試錐調査を実施すべきである。また，今後重力探査が計画された場合，その地区における基盤深度を確認して解析資料とする為の構造試錐を行うことが望ましい。

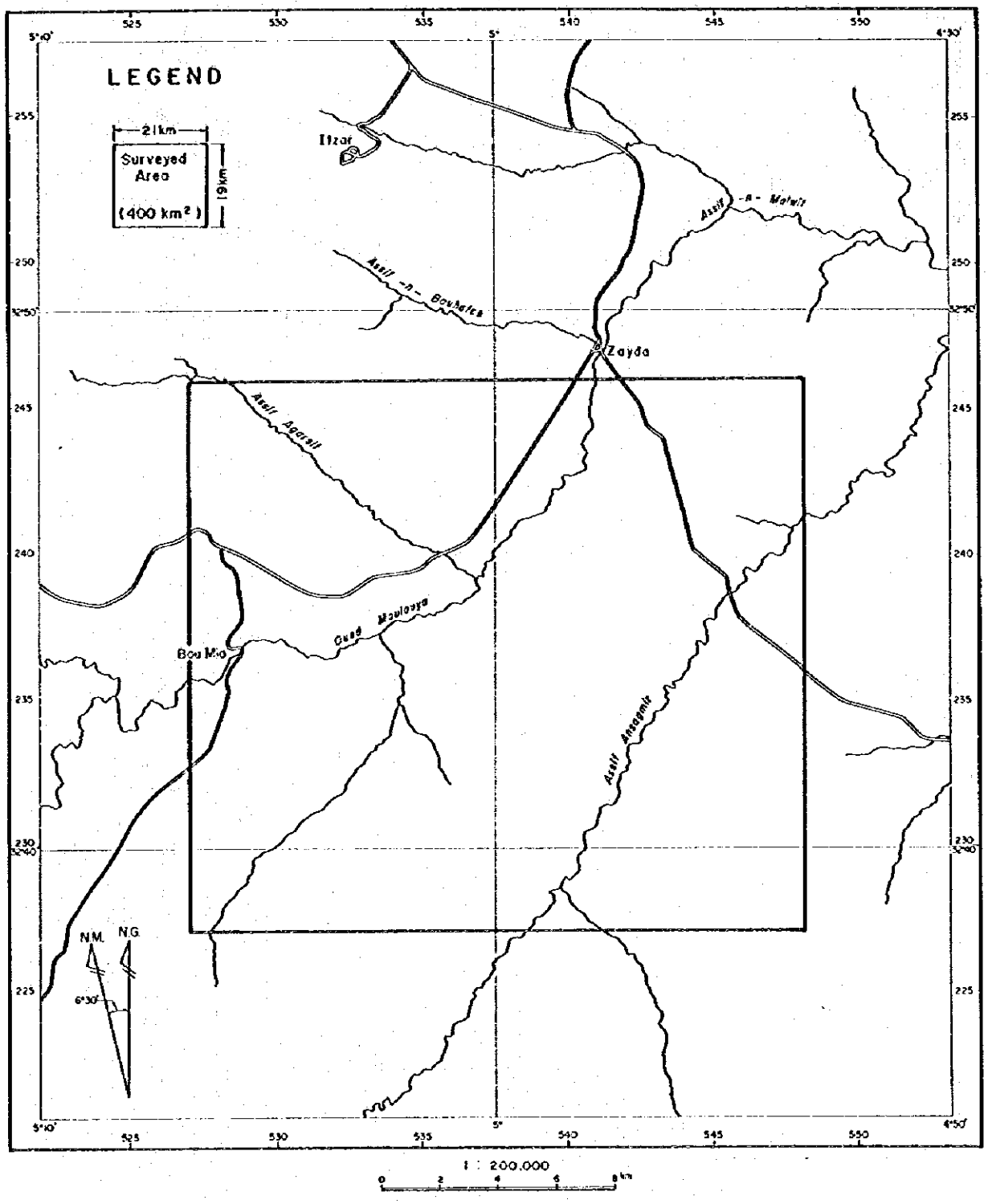
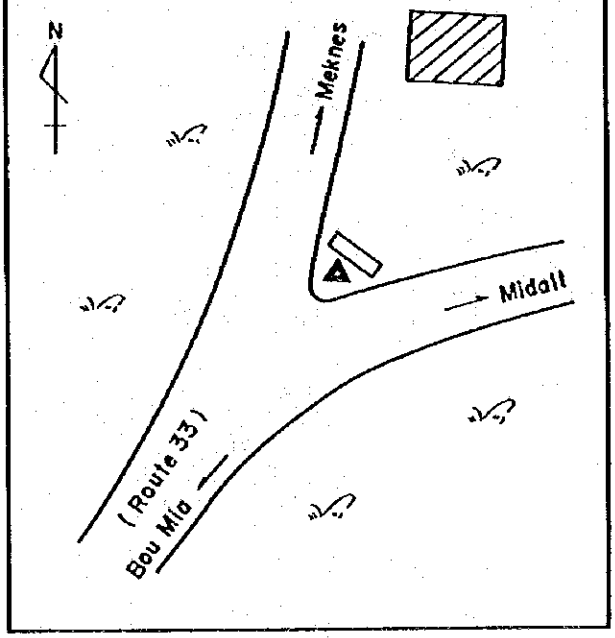
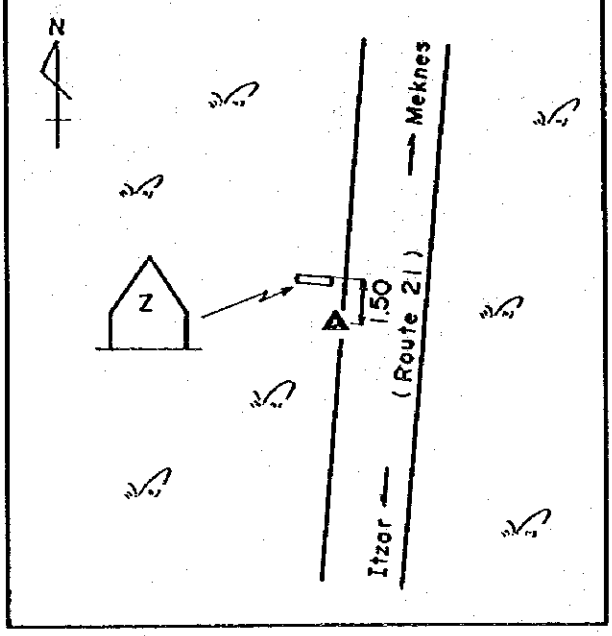


Fig. II-1 Location of Gravity Survey

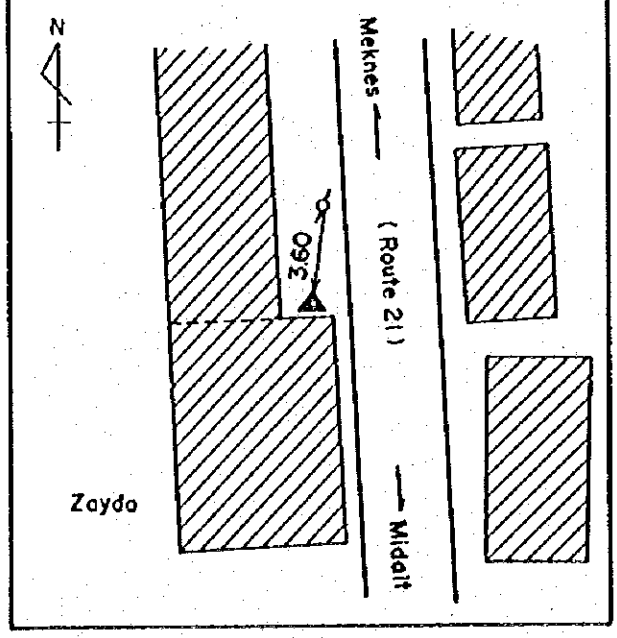
Station No.	B – 7	X = 540 840 m
		Y = 246 990 m
g = 979,154.65 mgal		Z = 1458.78 m (Altitude)



Station No.	B – 8	X = 531 553 m
		Y = 260653 m
g = 979,116.73 mgal		Z = 1801.92 m (Altitude)



Station No.	2000	X = 541 060 m
		Y = 247040 m
g = 979,155.410 mgal		Z = 1455.3 m (Altitude)



Station No.	3000	X = 541 360 m
		Y = 246 410 m
g = 979,152.892 mgal		Z = 1461.5 m (Altitude)

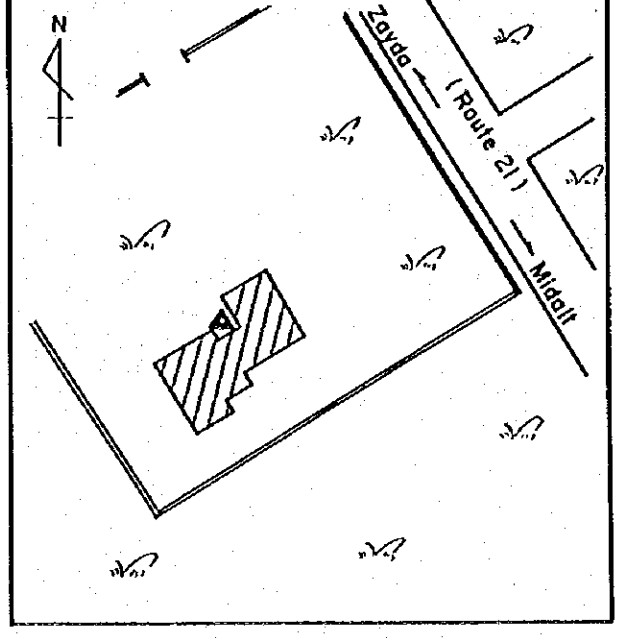
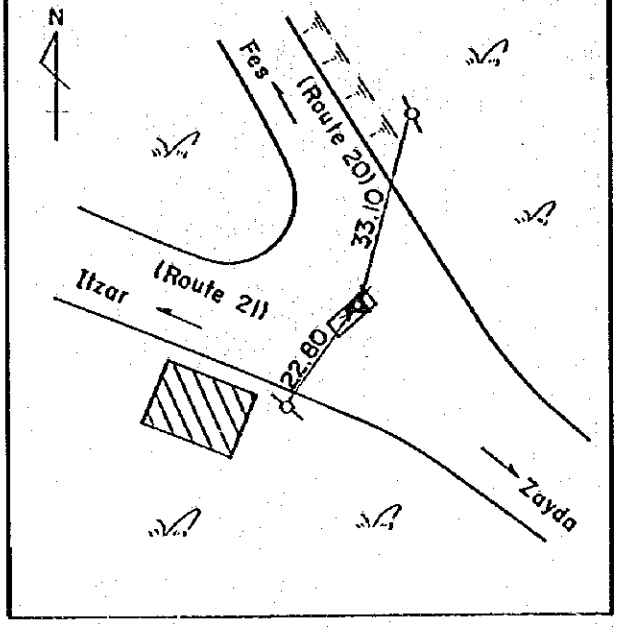
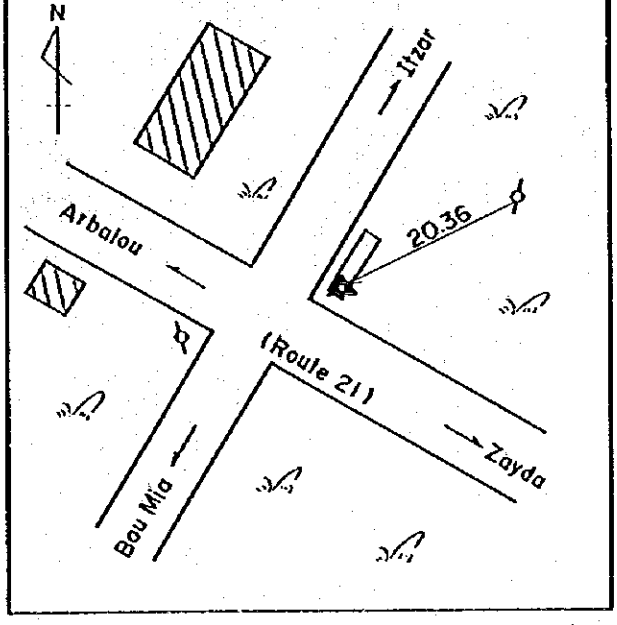


Fig. II-3 Sketches of Gravity Base Stations

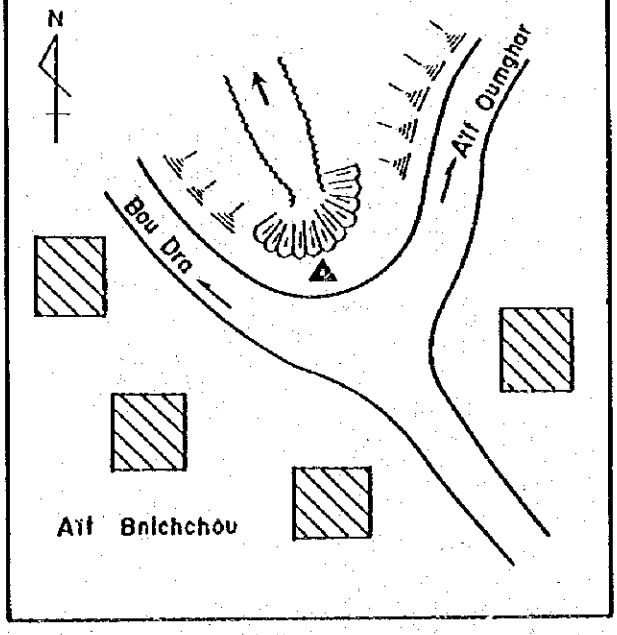
Station No.	2001	X = 540 200 m
		Y = 254 520 m
g = 979,150.300 mgal		Z = 1522.65 m (Altitude)



Station No.	2002	X = 528 130 m
		Y = 240 190 m
g = 979,111.124 mgal		Z = 1608.67 m (Altitude)



Station No.	2003	X = 538 790 m
		Y = 226 830 m
g = 979,112.782 mgal		Z = 1558.13 m (Altitude)



Station No.	2004	X = 549 320 m
		Y = 234 990 m
g = 979,127.233 mgal		Z = 1542.95 m (Altitude)

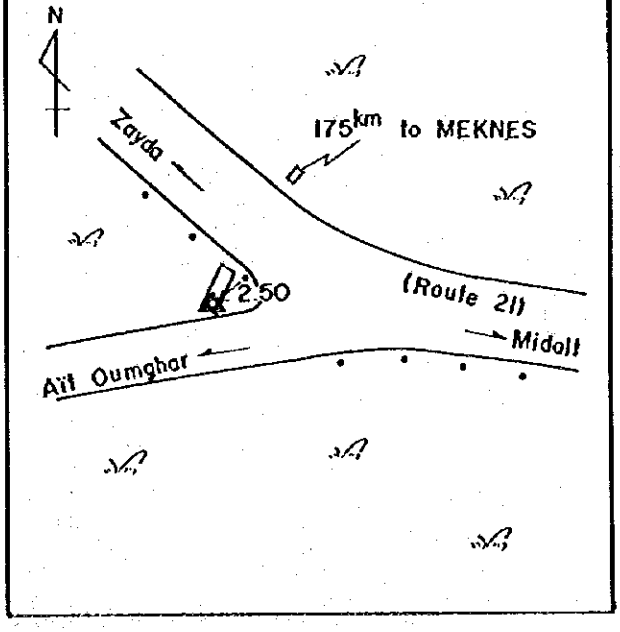


Fig. II-4 Sketches of Sub-Base Stations

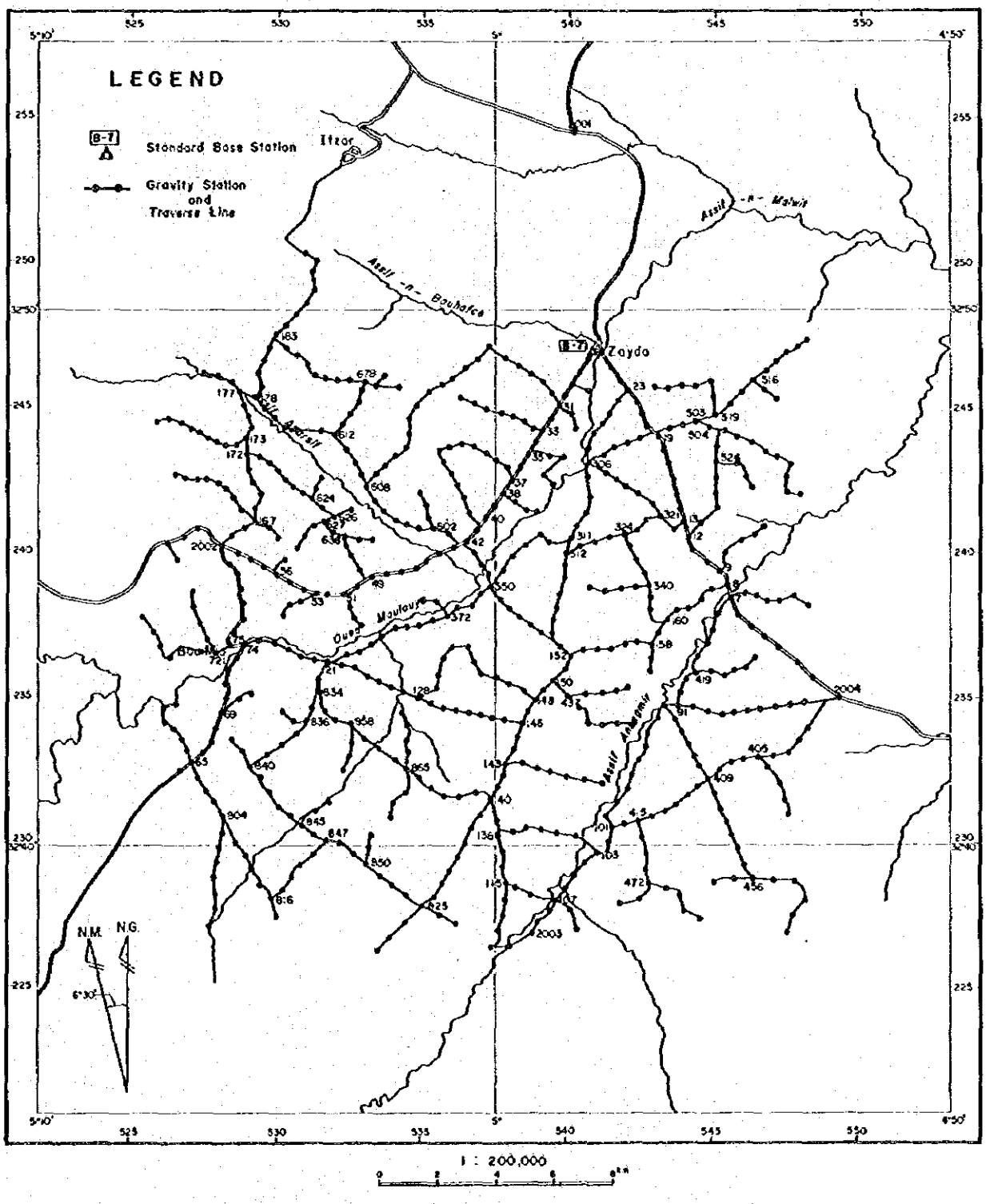


Fig. II-5 Network of Leveling Survey

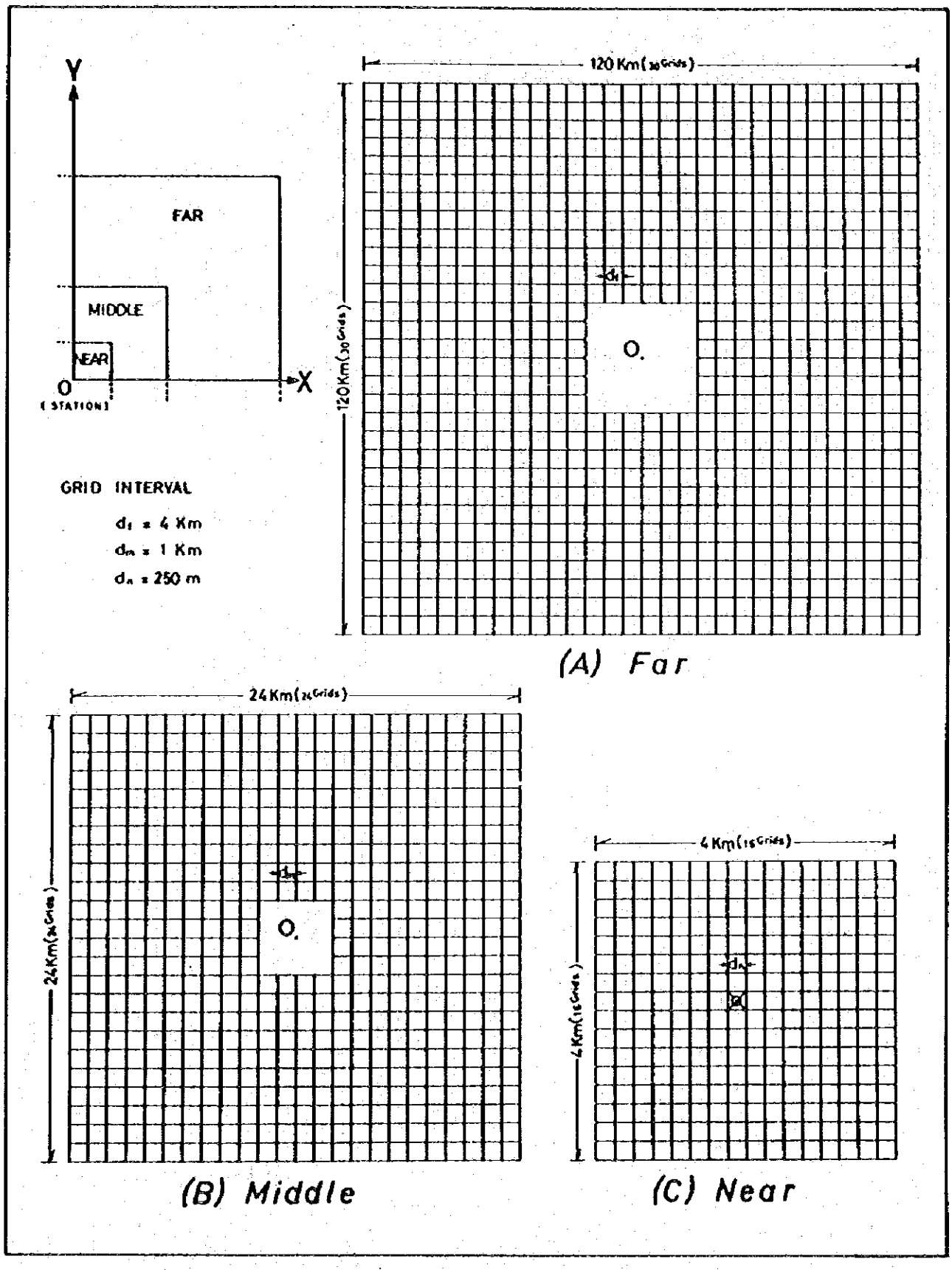


Fig. II-6 Grids of Topographical Correction

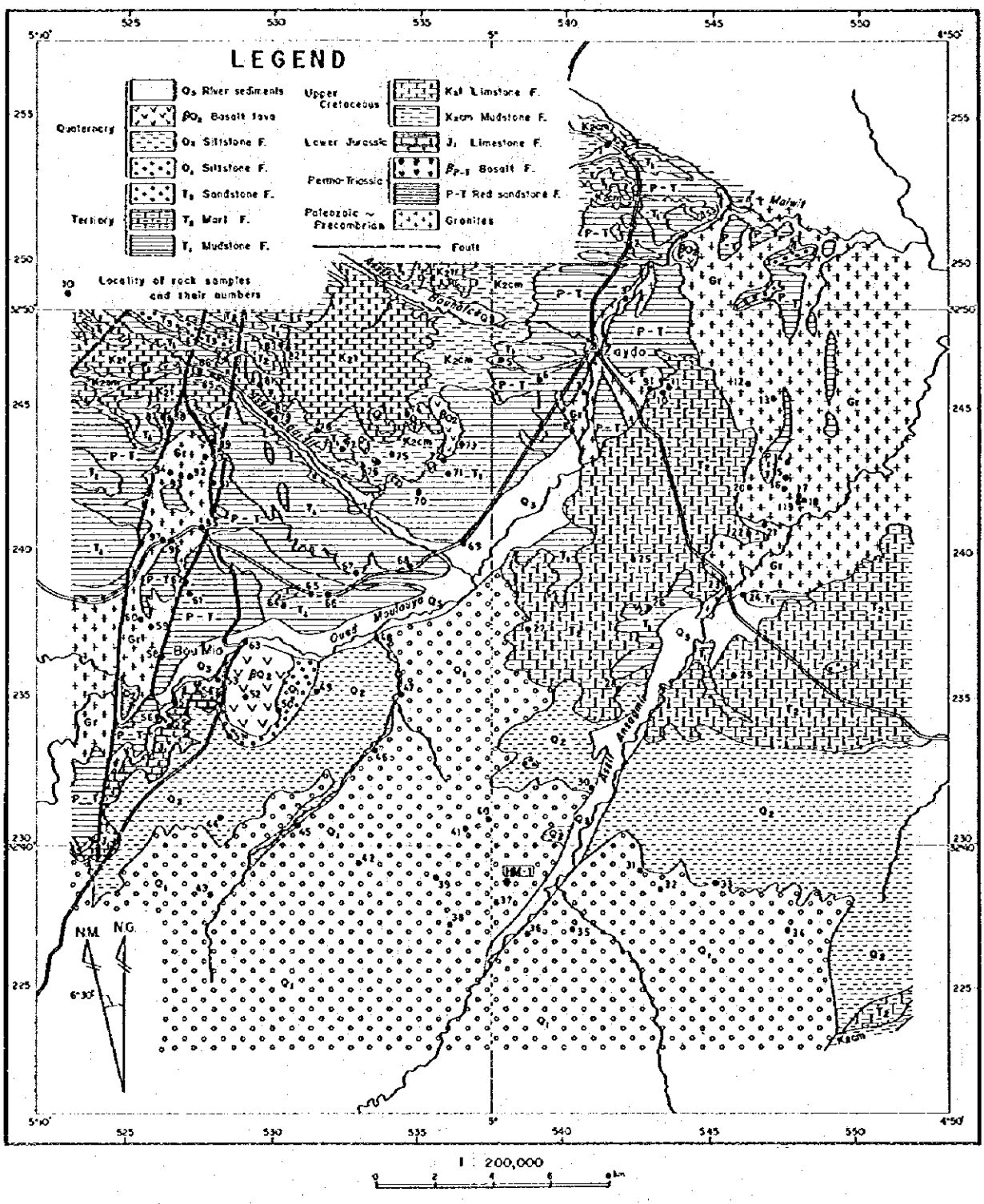


Fig. II-7 Geological Map and Locality of Rock Samples

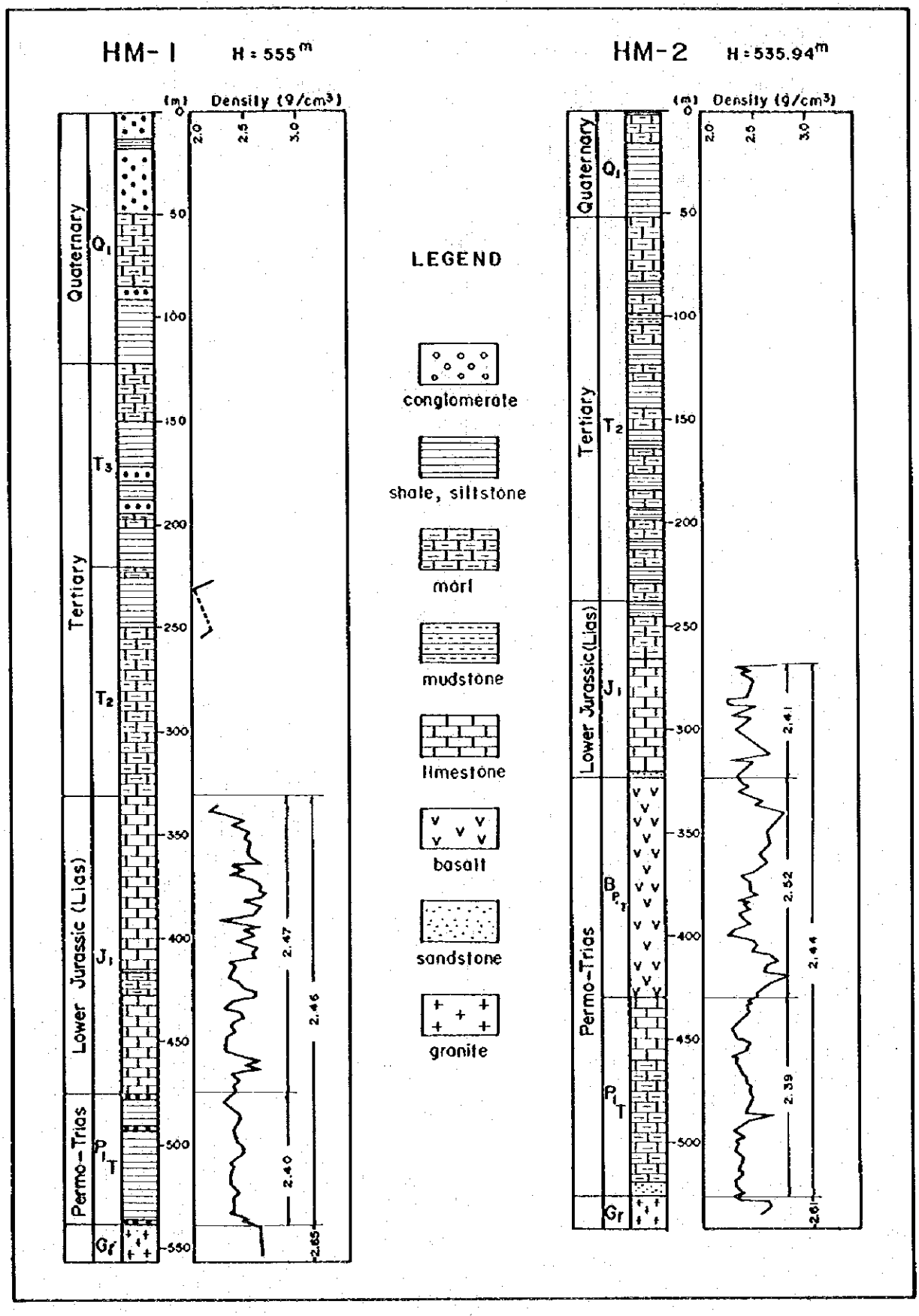


Fig. II-8 Result of Density Measurement of Boring Core

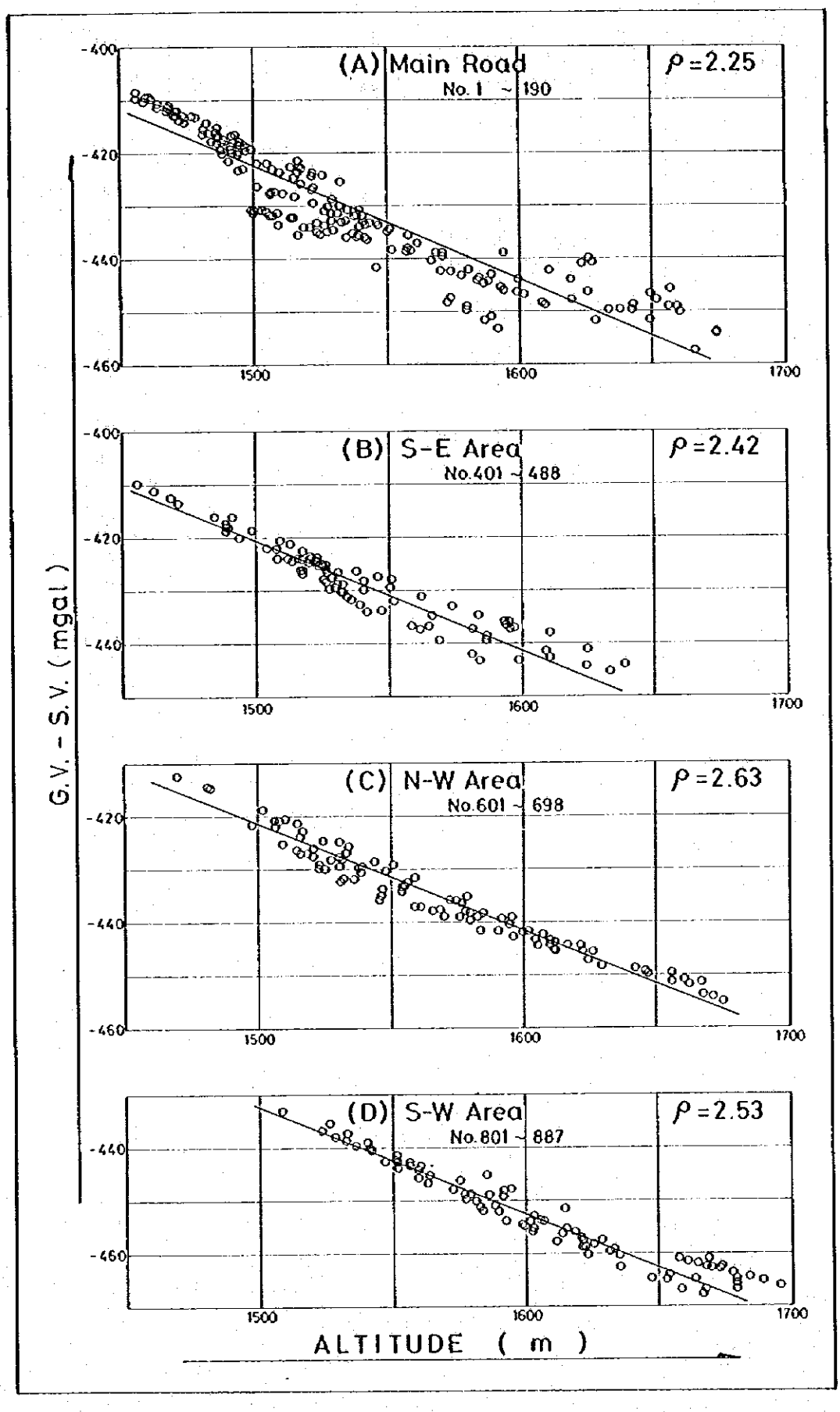


Fig. II-9 Gravimetric Value - Elevation Curve

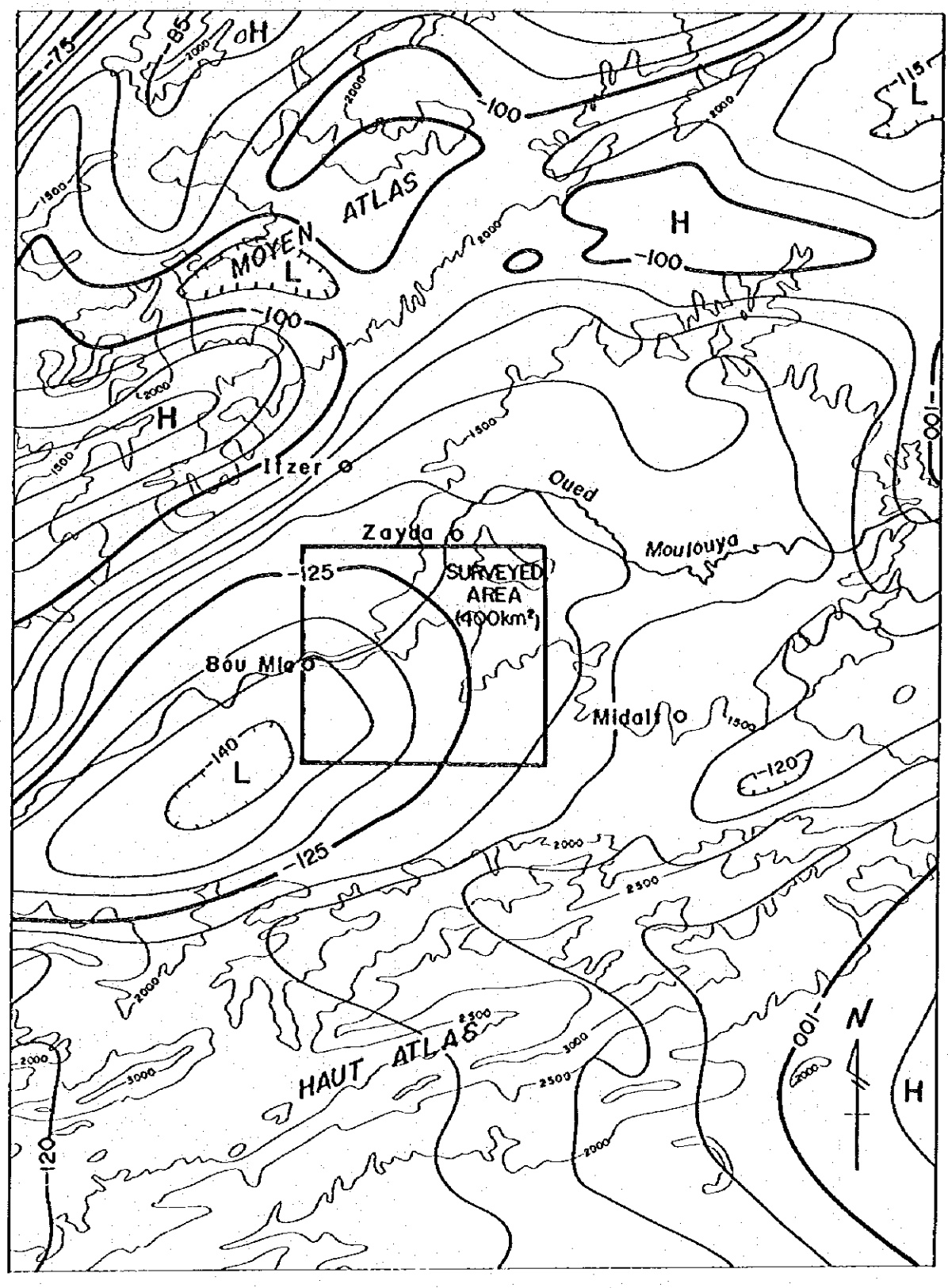


Fig. II-10 Bouguer Anomaly Map on Haute Moulouya Area (ρ = 2.67)

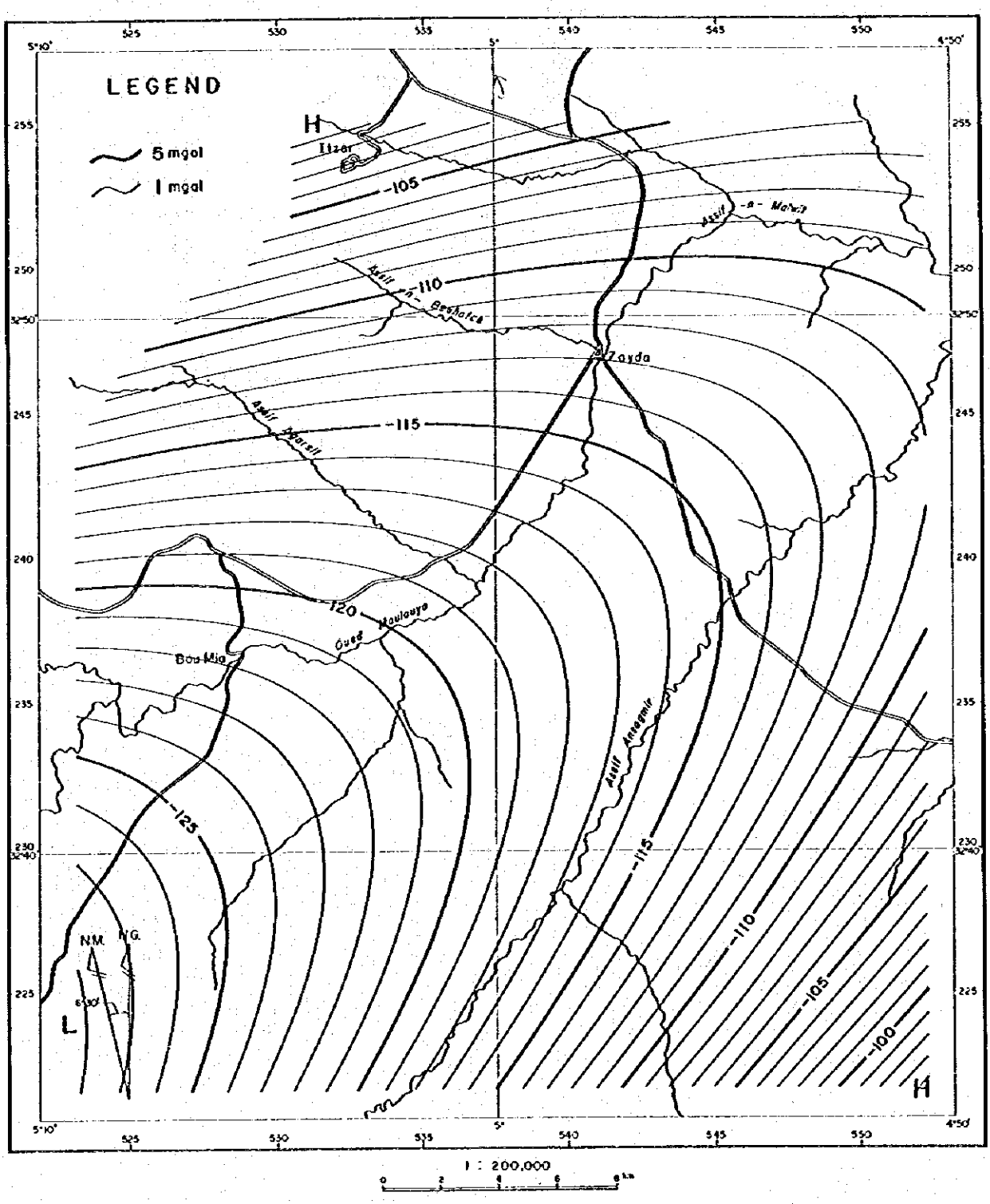


Fig. II-11 Regional Gravity Trend in Polynomial of Second Order

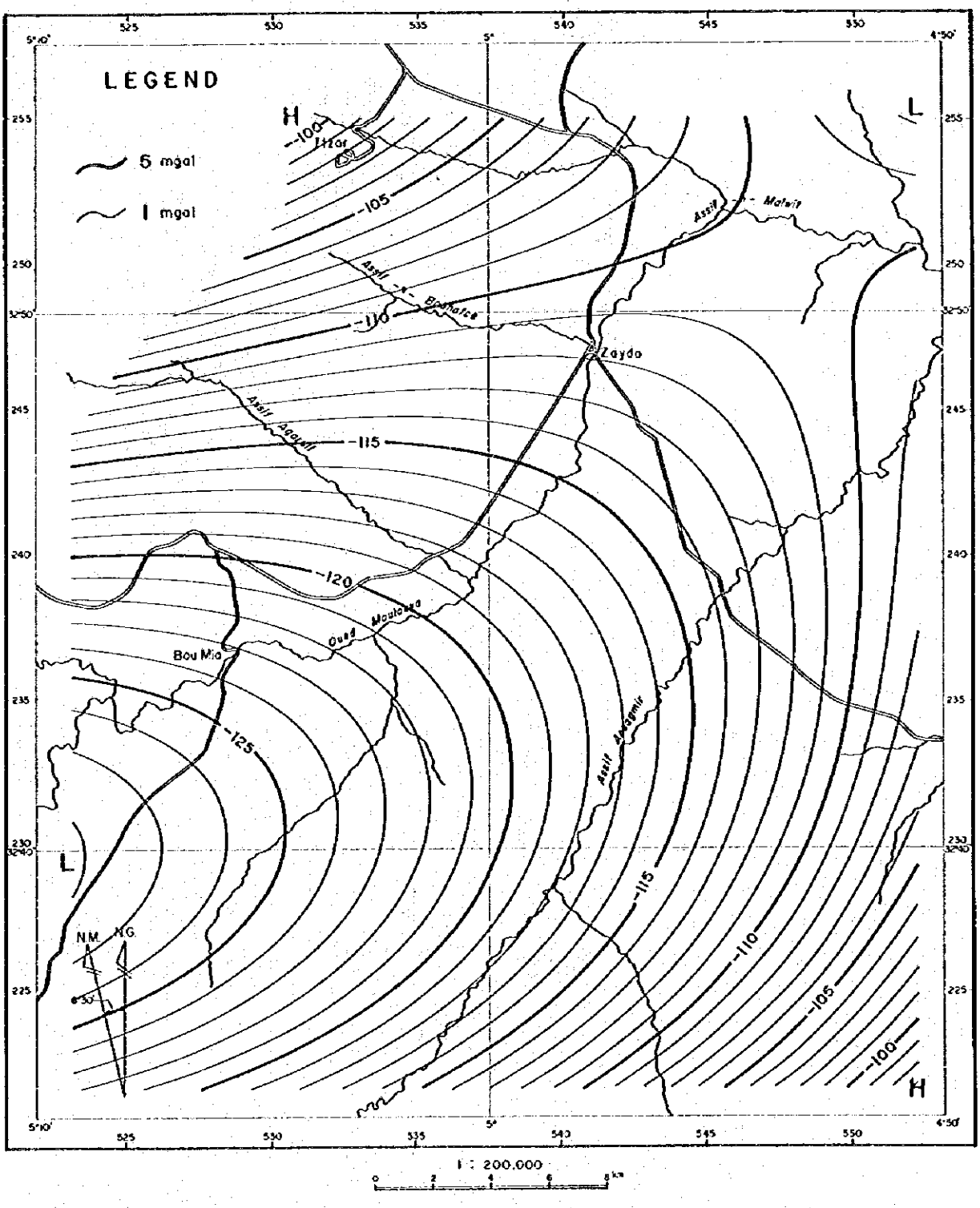


Fig. II - 12 Regional Gravity Trend in Polynomial of Third Order

Table II—2 Cretaceous Molluscan Fossils of the District

Campanian	Early	Pen	Upper	Delawarella danei Placenticeras meeki
Santanian	Late ≀ Middle	Pen	Lower	Inoceramus (Platyceramus) cf. platinus
	Middle ≀ Early	San Vicente	upper	Inoceramus (Cladoceramus) undlatoplicatus Texanites (Texanites) cf. Texanus
	Early	San Vicente	upper	Inoceramus (Platyceramus) ex gr. cycloides
Coniacian	Late ≀ Middle	San Vicente	middle	Inoceramus cf. subquadrates Inoceramus cf. stantoni
	Early	San Vicente	lower	Didymotis sp.
Turonian	Late	Boquillas	upper	Inoceramus aff. perplexus Inoceramus (Mytiloides) aff. latus
	Middle	Boquillas	middle	Inoceramus (Inoceramus) ex gr. lamarrki
	Early	Boquillas	lower	Inoceramus (Mytiloides) labiatus
Cenomanian	Middle Early	Buda		Inoceramus aff. crippsi
	Early	Del Rio		Budaiceras sp.
Albian	Late	Santa Elena		
	Middle	Sue Peaks	upper	Oxytropidoceros (Adkinsites) bravoensis
		Sue Peaks	middl	Hoplites sp.
		Sue Peaks	lower	Cleoniceras sp.
	?	Sue Peaks	upper	Douvilleiceras sp.
	Early	Aurora		Hypacanthoplites sp. Acanthohoplites sp.
Aptian	Late	La Peña		Australiceras sp.

(This list is prepared by the leading fossils collected by the regional and semi-detailed survey.)

Table II—3 Calculation of gravity values at base stations

No. of Gravity Meter & Date	No. of Station	Time	Reading Value	x Factor	Correction of Tidal Gravity (mgal)	Height of Gravity Meter (m)	Correction of Instrument Height (mgal)	Corrected Value (mgal)	Correction of Diural Drift (mgal)	Corrected Value (mgal)	Difference from Standard Base Station (mgal)	Standard Value (mgal)
	B-7	13:52	2701.27	2856.304	0.039	0.29	0.089	2856.432	0.000	2856.432		979,154.650
G-366	2000	13:57	2701.98	2857.055	0.040	0.29	0.089	2857.184	0.005	2857.189	0.757	979,155.407
Sep. 20 1978	B-7	14:03	2701.26	2856.293	0.040	0.29	0.089	2856.422	0.010	2856.432		
	2000	14:08	2701.98	2857.055	0.041	0.29	0.089	2857.185	0.009	2857.194	0.762	979,155.412
	B-7	14:13	2701.26	2856.293	0.041	0.29	0.089	2856.423	0.009	2856.432		
	B-7	11:26	2698.72	2853.612	0.021	0.29	0.089	2853.722	0.000	2853.722		979,154.650
G-366	3000	11:33	2697.06	2851.856	0.025	0.29	0.089	2851.970	-0.004	2851.966	-1.756	979,152.894
Oct. 4 1978	B-7	11:39	2698.72	2853.612	0.028	0.29	0.089	2853.729	-0.007	2853.722		
	3000	11:45	2697.05	2851.845	0.031	0.29	0.089	2851.965	-0.004	2851.961	-1.761	979,152.889
	B-7	11:51	2698.71	2853.601	0.034	0.29	0.089	2853.724	-0.002	2853.722		
G-366	B-7	12:56	2698.55	2853.432	0.000	0.29	0.089	2853.521	0.000	2853.521		979,154.650
Oct. 6 1978	B-8	13:47	2662.78	2815.589	0.011	0.27	0.083	2815.683	0.004	2815.687	-37.834	979,116.816 (979,116.730)
	B-7	14:22	2698.53	2853.411	0.014	0.29	0.089	2853.514	0.007	2853.521		

Table II—4 Densities of rock samples

Sample No.	Density (g/cm³)	Rock Name	Geological Unit
1	2.53	Calcareous Siltstone	K_{2c}
2	2.50	Conglomerate	T_3
3	2.35	Arkose Sandstone	P-T
4	2.56	Aplitic Granite	Ap-Gr
5	2.50	Calcareous Conglomerate	T_1
6	2.55	Fine Grained Limestone	K_{2c}
7	2.57	Medium Grained Granite	Gr
8	2.56	Aplitic Granite	Ap-Gr
9	2.52	Arkose Sandstone	P-T
10	2.54	Fine Grained Sandstone	P-T
11	2.52	" "	P-T
12	2.55	Aplitic Granite	Ap-Gr
13	2.63	Granite	Gr
14	2.53	Fine Grained Sandstone	P-T
15	2.56	Quartz Vein	-
16	2.57	Granite	Gr
17	2.64	Medium Grained Granite	Cnt-Gr
18	2.57	" "	Cnt-Gr
19	2.76	Schist	Sch
20	2.61	Coarse Grained Granite	Gr
21	2.67	Granite	Gr
22	2.63	Aplitic Granite	Ap-Gr
23	2.66	Granite	Cnt-Gr
24	2.64	Medium Grained Granite	Cnt-Gr
25	2.26	Limestone	T_2
26	2.33	"	T_2
27	2.34	Conglomerate	T_2
28	2.44	"	Q_2
29	2.25	Limestone	T_2
30	2.38	Conglomerate	Q_2
31	2.33	Calcareous Mudstone	Q_1
32	2.37	Calcareous Conglomerate	Q_1
33	2.17	Calcareous Siltstone	Q_2
34	2.50	Conglomerate	Q_2
35	2.16	Calcareous Conglomerate	Q_1
36	2.41	Conglomerate	Q_1
37	2.44	"	Q_1
38	2.38	Calcareous Silty Sandstone	Q_1
39	2.39	Limestone	Q_1
40	2.36	Calcareous Conglomerate	Q_1
41	2.34	Limestone	Q_1
42	1.81	Calcareous Siltstone	Q_1
43	2.29	Calcareous Conglomerate	Q_1
44	1.87	Calcareous Siltstone	Q_2
45	2.51	Conglomerate	Q_2
46	2.49	"	Q_1
47	2.26	Medium Grained Sandstone	Q_2
48	2.55	Quartz Vein	-
49	2.56	Conglomerate	Q_2
50	2.80	Basalt	β_{Q_2}
51	2.62	"	β_{Q_2}
52	2.69	"	β_{Q_2}
53	2.40	Calcareous Conglomerate	Q_3
54	2.44	Limestone	J_1
55	2.35	"	J_1
56	2.56	Basalt	β_{P-T}
57	2.40	"	β_{P-T}
58	2.66	Barite Vein	-
59	2.60	Aplite	Ap-Gr
60	2.56	Aplitic Granite	Ap-Gr
61	2.49	Sandstone	P-T
62	2.45	"	P-T
63	2.72	Basalt	β_{Q_2}
64	2.33	Conglomerate	T_2
65	1.98	Calcareous Sandstone	T_1
66	2.66	Limestone	T_2
67	2.16	Calcareous Siltstone	T_1
68	2.40	Calcareous Conglomerate	T_1
69	2.50	" "	Q_3
70	2.45	Basalt	β_{Q_2}
71	2.23	Calcareous Sandstone	T_1
72	2.89	Basalt	β_{Q_2}
73	3.05	"	β_{Q_2}
74	2.56	Silly Limestone	K_{2c}
75	2.54	" "	K_{2c}
76	2.93	Basalt	β_{Q_2}
77	2.43	Calcareous Conglomerate	T_1
78	2.37	Fine Grained Sandstone	T_1
79	2.35	Argilous Limestone	K_{2t}
80	2.41	" "	K_{2t}
81	2.60	Limestone	K_{2t}
82	2.46	"	T_1
83	2.61	"	T_1
84	2.30	Calcareous Siltstone	K_{2t}
85	2.60	Limestone	K_{2c}
86	2.49	"	K_{2t}
87	2.44	"	K_{2c}
88	2.52	"	K_{2c}
89	2.59	Aplitic Granite	Ap-Gr
90	2.47	Arkose Sandstone	P-T
91	2.64	Granite	Gr
92	2.69	"	Gr
93	2.63	Aplitic Granite	Ap-Gr
94	2.59	Granite	Gr
95	2.58	Aplitic Granite	Ap-Gr
96	2.59	Medium Grained Granite	Gr
97	2.56	Aplite	Ap-Gr

LEGEND

Quaternary	Q_3, β_{Q_2}, Q_2, Q_1	Lower Jurassic	J_1
Tertiary	T_2, T_1	Permo-Triassic	β_{P-T}, P-T
Upper Cretaceous	K_{2t}, K_{2c}	Paleozoic ~ Precambrian	Ap-Gr, Gr, Cnt-Gr, Sch

Table II—5 Distribution of rock densities

Geological Age		Geological Unit and Mark		Lithology	Amount	Average of Density		Density (g/cm³) 2.0 2.5 3.0
Cenozoic	Quaternary		Q_3	terrace deposit	2	2.45	2.33	
			Q_2	conglomerate, siltstone, mudstone	7	2.31		
			Q_1	conglomerate, siltstone	13	2.33		
			β_{Q_2}	basalt lava	8		2.78	
	Tertiary		T_2	marl, limestone, siltstone, conglomerate	6	2.36	2.36	
			T_1	light brown siltstone, conglomeratic sandstone	10	2.36		
Mesozoic	Upper Cretaceous	Turonian	K_{2t}	micritic limestone, muddy siltstone, calcareous siltstone, turbidite	5	2.43	2.49	
		Cenomanian	K_{2cm}	limestone, calcareous siltstone, poly-colored siltstone, gypsum bed	7	2.53		
	Lower Jurassic	Lias	J_1	limestone, siltstone, marl, sandstone, conglomerate, turbidite, dolomite	2		2.40	
	Permo-Triassic	Permo-Trias	β_{P-T}	basalt lava, sandstone, conglomerate	2	2.48	2.48	
			P-T	red sandstone, arkose sandstone, siltstone, mudstone	8	2.48		
Proterozoic ~ Paleozoic	Paleozoic ~ Precambrian	Basement Complex	Ap-Gr	aplitic granite	10	2.58	2.60	
			Gr	granite	9	2.62		
			Cnt-Gr	contaminated granite	4	2.63		
Others				quartz vein, barite vein, schist	4	–	–	

APPENDICES

(Geological Survey)

(Geophysical Survey)

Table I—2 List of Rock Samples

(1)

Sample No.		Location X	Location Y	Location Z	Rock Name	Dating ○ XMA △ X-ray ▲	Chemical Analysis of Rock W.C.	M.C.	U.T.V.	U.T.	Met.	T.S.	P.S.
1	1A02	545.0	251.7	1435	Porphyritic gr					○			
2	1A07	547.2	251.2	1415	Fe-qz vein					○			
3	1A11	540.2	245.8	1470	Aplitic gr	○	○			○		○	
4	1A12	540.7	242.9	1480	Pb-ore						○		○ 13
5	1A14	542.6	248.9	1450	Limonitized sheared gr-porphyry					○			
6	1B04	548.7	248.7	1435	Contaminated gr	○	○			○		○1	
7	1B05	548.7	249.7	1430	Aplitic gr			○		○		○2	
8	1B09	551.5	250.6	1430	Gr-porphyry					○		○	
9	1C02	546.0	238.9	1450	Contaminated gr			○		○			
10	1C12	546.4	242.0	1490	Aplitic gr			○		○			
11	1D01	551.6	252.1	1400	Arkose ss						○		
12	1D05	546.1	251.9	1380	Arkose ss				○				
13	1D10	549.6	250.8	1430	Gr-porphyry					○			
14	1D13	548.2	251.3	1400	Gr-porphyry	△				○			○
15	1D14	551.4	251.3	1390	Arkose ss				○				
16	1D15	551.3	251.1	1410	Arkose ss	△			○			○ 3	○ 17
17	1D16	550.0	251.3	1410	Gr-porphyry					○			
18	1D18	542.8	251.3	1450	Red siltstone				○				
19	1D19	543.4	250.4	1430	Galena-arkose ss						○		
20	1D20	548.0	251.5	1400	Porphyritic gr			○		○		○4	

W.C.: Whole Composition
M.C.: Main Composition
U.T.V.: analysis for Uranium, Thorium, Vanadium
U.T.: analysis for Uranium, Thorium
Met.: Metal Composition (Pb, Cu, Ba, Au, Ag)
T.S.: Thin Section
P.S.: Polished Section
gr: granite
ss: sandstone
Qz: quartz
○ 13: Number of Photomicrograph

Sample No.		Location			Rock Name	Dating ○ XMA △ X-ray ▲	Chemical Analysis of Rock					T.S.	P.S.
		X	Y	Z			W.C.	M.C.	U.T.V.	U.T.	Met.		
21	1E01	554.3	244.1	1500	Pb-ore						○		
22	1E07	551.2	240.9	1500	do						○		○14
23	1E08	554.4	241.6	1460	do						○		
24	1E09	554.4	241.6	1460	do						○		
25	1E10	553.5	241.4	1495	do						○		
26	1E11	552.2	241.0	1500	do						○		○
27	1E12	552.2	241.0	1500	do						○		
28	1E14	553.8	247.0	1430	do						○		
29	1P05	558.7	244.0	1300	Pb-fluorite vein						○		
30	1F11	556.1	244.0	1390	Calcareous siltstone				○				
31	1F12	556.1	244.0	1390	Muddy siltstone				○				
32	1F13	556.1	244.0	1390	do				○				
33	1F14	556.0	242.7	1400	Barite vein						○		
34	1G12	555.2	249.0	1465	Fe-qz vein					○			
35	1G15	554.3	250.0	1450	Fe-qz vein					○			
36	1G19	557.6	251.6	1430	Fe-qz vein					○			
37	1J18	565.3	251.0	1405	Granite			○		○			
38	1K08	571.5	253.7	1320	Fe-qz vein	△				○			○
39	1K09	571.4	253.5	1320	Granodiorite			○		○		○ 5	
40	1K22	571.8	253.1	1340	Microgranodiorite					○		○ 6	
41	1K31	567.4	255.4	1345	Pb-ore						○		○15
42	1K32	569.8	255.3	1330	do						○		
43	2A04	524.9	235.4	1550	Aplitic gr			○		○		○	
44	2A07	527.9	243.5	1600	Arkose ss						○		
45	2A08	527.9	243.5	1600	do						○		

Sample No.		Location X	Location Y	Location Z	Rock Name	Dating ○ XMA △ X-ray ▲	Chemical Analysis of Rock W.C.	M.C.	U.T.V.	U.T.	Met.	T.S.	P.S.
46	2A09	527.9	243.5	1600	Arkose ss						○		
47	2A10	527.9	243.5	1600	do						○		
48	2A11	527.9	243.5	1600	do						○		
49	2A12	527.9	243.5	1600	do						○		
50	2A13	527.9	243.5	1600	Aplitic gr(carapace)	△			○			○ 7	○ 18
51	2A24	525.3	241.7	1660	Arkose ss						○		
52	2A25	525.3	241.7	1660	do						○		
53	2B06	521.5	231.3	1675	Pb-Ba ore						○		
54	2B07	521.3	231.2	1780	do						○		
55	2B20	520.7	236.6	1675	Arkose ss						○		
56	2B21	521.3	235.5	1685	do						○		
57	2B23	521.6	234.7	1700	do			○					
58	2B24	521.7	234.6	1700	Aplitic gr			○		○			
59	2B25	520.4	234.8	1650	do						○		
60	2B26	520.0	232.9	1620	Arkose ss						○		
61	2B28	520.6	233.6	1680	Aplite		○			○		○ 8	
62	2B29	523.3	234.3	1600	Porphyritic gr	○	○			○		○	
63	2B30	525.6	235.5	1560	Gr-porphyry		○			○		○ 9	
64	2B31	525.6	235.5	1560	do			○		○		○	
65	3R05	516.3	255.0	1780	Arkose ss					○			
66	3R06	516.3	255.0	1780	do					○			
67	3R08	516.3	255.0	1780	do					○			
68	3R09	516.3	255.0	1780	do					○			
69	3R11	517.5	253.7	1980	do					○			
70	3R12	517.5	253.7	1980	do					○			

Sample No.		Location			Rock Name	Dating ○ XMA △ X-ray ▲	Chemical Analysis of Rock					T.S.	P.S.
		X	Y	Z			W.C.	M.C.	U.T.V.	U.T.	Met.		
71	3R13	517.5	253.7	1980	Arkose ss					○			
72	3R14	517.5	253.7	1980	do					○			
73	3R15	517.5	253.7	1980	do					○			
74	4I04	562.7	238.6	1440	Pb-ore						○		○
75	4I05	562.7	238.6	1440	do						○		○
76	4I06	562.7	238.5	1450	do						○		
77	4J14	570.6	240.6	1385	do						○		○16
78	4J15	570.6	240.6	1385	do						○		○
79	4J16	570.6	240.6	1385	do						○		
80	4J17	569.9	240.2	1400	do						○		
81	M001	539.7	244.7	1510	Mineralized arkose ss							○10	○
82	M002	548.2	251.4	1410	Granite							○11	
83	M003	517.6	241.3	1650	do							○	
84	M004	517.6	241.3	1650	Arkose ss							○	
85	M005	517.6	241.3	1650	Fine-grained ss							○12	
86	M006	547.7	251.5	1400	Granite							○	
87	M007	547.8	251.5	1400	Contaminated gr							○	
88	M008	517.6	241.3	1650	Decolorized siltstone	▲							
89	M009	517.6	241.3	1650	Red siltstone	▲							

Table I—3 Chemical Analysis of Granitic Rocks

Sample No / Rock Name / Chemical Composition	1 (1A11) Aplitic granite wt (%)	2 (1B04) Contaminated granite wt (%)	3 (2B28) Aplite wt (%)	4 (2B29) Porphyritic granite wt (%)	5 (2B30) Granite porphyry wt (%)
SiO_2	77.88	73.97	77.60	71.85	78.22
TiO_2	0.093	0.34	0.057	0.39	0.26
Al_2O_3	12.48	13.87	12.81	14.92	12.59
Fe_2O_3	0.56	0.80	0.87	0.92	1.09
FeO	0.43	0.94	0.20	1.64	0.37
MnO	0.026	0.032	0.005	0.087	0.004
MgO	0.10	0.17	0.10	0.64	0.07
CaO	0.45	1.19	0.31	1.30	0.13
Na_2O	2.13	1.91	2.26	2.75	0.89
K_2O	4.54	4.44	4.43	3.79	5.18
P_2O_5	0.01	0.11	0.02	0.13	0.079
H_2O+	0.13	0.51	0.14	0.53	0.06
H_2O-	0.33	0.76	0.31	0.45	0.40
Total	99.159	99.042	99.112	99.397	99.343

Sample No / Rock Name / Chemical Composition	6 (1B05) Aplitic granite wt (%)	7 (1C02) Contaminated granite wt (%)	8 (1C12) Aplitic granite wt (%)	9 (1D20) Porphyritic granite wt (%)	10 (1J18) Granite wt (%)
SiO_2	75.87	64.88	75.64	71.54	72.01
Al_2O_3	11.78	14.82	12.36	12.53	14.20
CaO	0.68	1.85	0.56	1.04	1.31
Na_2O	3.82	3.23	2.79	2.66	3.57
K_2O	3.45	4.10	4.41	4.62	3.40
Total	95.60	88.88	95.76	92.39	94.49

Sample No / Rock Name / Chemical Composition	11 (1K09) Granodiorite wt (%)	12 (2A04) Aplitic granite wt (%)	13 (2B23) Arkose sandstone wt (%)	14 (2B24) Aplitic granite wt (%)	15 (2B31) Granite porphyry wt (%)
SiO_2	54.96	77.22	75.34	75.30	75.89
Al_2O_3	15.67	11.29	12.63	12.63	12.10
CaO	5.05	0.46	0.40	0.43	0.15
Na_2O	2.26	3.07	3.10	3.31	1.59
K_2O	3.33	4.55	4.50	4.14	4.79
Total	81.27	96.59	95.97	95.81	94.52

Table I—4 C.I.P.W. Norm Calculation

Sample No / Rock Name / Normative Minerals	1. (1A11) Aplitic granite		2. (1B04) Contaminated granite		3. (2B28) Aplite		4. (2B29) Porphyritic granite		5. (2B30) Granite porphyry	
	wt.(%)	mol.(%)	wt.(%)	mol.(%)	wt.(%)	mol.(%)	wt.(%)	mol.(%)	wt.(%)	mol.(%)
Q	47.54	85.60	44.11	82.28	47.38	85.27	37.77	76.77	53.67	86.67
C	3.31	3.51	4.11	4.52	3.83	4.06	4.31	5.16	5.54	5.27
Or	27.18	5.28	26.83	5.40	26.53	5.15	22.76	4.99	30.96	5.40
Ab	18.26	3.77	16.53	3.53	19.38	4.00	23.64	5.51	7.62	1.41
An	2.20	0.85	5.30	2.14	1.43	0.55	5.69	2.50	0.12	0.04
Salic total	98.49	99.02	96.89	97.88	98.55	99.03	94.16	94.93	97.90	98.79
En-Hy	0.25	0.27	0.43	0.48	0.25	0.27	1.62	1.97	0.18	0.17
Fs-Hy	0.24	0.19	0.57	0.49	-	-	1.80	1.67	-	-
Mt	0.82	0.38	1.19	0.57	0.51	0.24	1.36	0.71	0.44	0.19
Hm	-	-	-	-	0.53	0.36	-	-	0.80	0.48
Il	0.17	0.12	0.66	0.49	0.12	0.08	0.75	0.61	0.50	0.32
Ap	0.02	0.01	0.26	0.09	0.05	0.02	0.31	0.11	0.19	0.06
Femic total	1.51	0.98	3.11	2.12	1.45	0.97	5.84	5.07	2.10	1.21
Q+Or+Ab+An	95.18		92.77		94.72		89.86		92.37	
Q	49.95		47.55		50.02		42.03		58.10	
Or+Ab	47.74		46.74		48.47		51.64		41.77	
An	2.31		5.71		1.51		6.33		0.13	

Table I—5 K-Ar Age Determination of Granitic Rocks

Sample No.	Rock Name	Location	Mineral	$Ar^{40}R/K^{40}$	Age (m.y.)	Argon Analysis			Potassium Analysis		
						$Ar^{40}R$, ppm	$Ar^{40}R$/Total Ar^{40}	Ave. Ar^{40}, ppm	K, %	Ave. K, %	K^{40}, ppm
1A11	Aplitic granite	Zayda	Biotite	0.01904	300 ± 11	0.1625 0.1620	0.853 0.891	0.1623	7.135 6.837	6.986	8.522
1B04	Contaminated granite	Tighbouba-n-Ouzour	Biotite	0.01954	307 ± 11	0.1402 0.1447	0.929 0.887	0.1425	5.794 6.159	5.976	7.291
2B29	Porphyritic granite	Bou Mia	Biotite	0.01943	306 ± 11	0.1552 0.1595	0.942 0.821	0.1574	6.618 6.656	6.637	8.097

Constants Used

$\lambda\beta = 4.72 \times 10^{-10}$ /year

$\lambda e = 0.585 \times 10^{-10}$ /year

$K^{40}/K = 1.22 \times 10^{-4}$ g./g.

$$\text{Age} = \frac{1}{\lambda e + \lambda\beta} \ln\left\{\frac{\lambda\beta + \lambda e}{\lambda e} \times \frac{Ar^{40}R}{K^{40}} + 1\right\}$$

Note: $Ar^{40}R$ refers to radiogenic Ar^{40}.

m.y. refers to millions of years.

Table I—6 Microscopic Observations

(1)

Sample No.	Location	Formation	Rock Name	Microscopic Observation	Remark
1A11	Zayda	Basement Granites	Aplitic Granite	This is granular in texture and mainly composed of quartz, plagioclase, orthoclase and biotite. Anhedral quartz shows weak wavy extinction and up to 2.0 mm in size. Anhedral plagioclase (oligoclase) shows albite twinning and weak zonal structure, core part of which is suffered of weak sericitization. Plagioclase is about 1.0 mm in length. Anhedral orthoclase shows Carlsbad twinning and perthite structure, up to 2.0 mm in length. In part, orthoclase shows mirmekite texture with quartz and plagioclase. Subhedral biotite is light to dark brown and about 1.0 mm in length. Some parts are affected by chloritization and iron-oxidization. Other accessary minerals are fine grained zircon, apatite and opaque minerals.	
1B04	Tighbouba-n-Ouzour	Basement Granites	Contaminated Granite	The rock shows granular texture and is mainly composed of quartz, plagioclase, orthoclase and biotite. Quartz is anhedral in form and up to 4.0 mm in size. It shows wavy extinction. Plagioclase shows subhedral and albite twinning, up to 3.0 mm in length. Plagioclase is more calcic than the above menthoned sample and shows zonal structure, core part of which is affected by sericitization. Anhedral orthoclase shows carlsbad twinning and perthite structure. Some orthoclases have included of small grained(up to 0.5 mm) plagioclase, quartz and biotite crystals. This means orthoclase is final crystallized mineral. Biotite is above 1.0 mm is size and light - dark brown in colour. Other accessary minerals are zircon, apatite and opaque minerals.	Photomicrograph No. 1
1B05	Tighbouba-n-Ouzour	Basement Granites	Aplitic Granite	This texture, constituent minerals and their occurence are the same as the above mentioned rock No. 1A11	Photomicrograph No. 2

Sample No.	Location	Formation	Rock Name	Microscopic Observation	Remark
1B09	South of Paneau-1	Basement Granites	Granite Porphyry	This shows porphyritic texture by crushing. So, phenocryst is granite fragment and matrix is made of crushed granitic materials. Quartz of the fragment shows strong wavy and partial extinction. Orthoclase shows carlsbad twinning and weak perthite structure. Plagioclase shows albite twinning which is broken by crushing, those minerals of the fragment are anhedral in form and about 0.5 - 1.0 mm in size. Matrix is composed of fine grained (0.01 - 0.5 mm) anhedral quartz and feldspars. Whole parts of the matrix is affected by iron-oxidization.	
1D15	Paneau-1	P-T Red Sandstone	Arkose Sandstone	The rock shows clastic texture and composed of quartz, orthoclase, plagioclase and granite fragment. All of the fragments are rounded and about 1.0 - 2.0 mm in size. Quartz shows wavy extinction. Orthoclase shows carlsbad twinning and perthite structure. Plagioclase shows albite twinning. Granite fragment is made of quartz, orthoclase and a few amount of plagioclase. Matrix has been recrystallized and composed of fluorite, hematitie, very fine felsic minerals and opaque minerals. Fluorite is anhedral in form and colourless to blue in colour. The fluoritization has occured in feldspars fragment. Barite shows euhedral and is aggregated in lathlike form. The other matrix minerals is anhedral and occurs like sementation of the fragments.	Photomicrograph No. 3, No. 17 7,000 c/s
1D20	Assaka-n-Tabhirt	Basement Granites	Porphyritic Granite	This is granular in texture and mainly composed of orthoclase, quartz, plagioclase and biotite. Orthoclase is very large crystal, more than 20 mm in length. It shows Carlsbad twinning and perthite structure. The parts of albite composition in perthite shows albite twinning. Anhedral quartz shows wavy extinction and up to 2.0 mm in size. Subhedral phagioclase (oligoclase) shows albite twinning and zonal structure (up to 4.0 mm in length). Biotite is subhedral in form and light to dark in colour (up to 2.0 mm in length). Other accessary minerals are apatite, zircon and opaque minerals.	Photomicrograph No. 4

Sample No.	Location	Formation	Rock Name	Microscopic Observation	Remark
1K09	Sidi Ayyad	Basement Granites	Granodiorite	This is granular in texture and mainly composed of plagioclase, quartz, microcline, biotite and hornblende. Plagioclase is euhedral to subhedral in form and up to 2.0 mm in length. It shows albite twinning and zonal structure and is affected by sericitization. Quartz is anhedral in form and up to 0.5 mm in size. Microcline shows microcline-structure and anhedral form (up to 0.3 mm in size). Biotite is subhedral to anhedral in form and light to dark brown in colour (about 1.0 mm in length). Hornblende is subhedral to euhedral in form and colourless to green in colour (about 1.5 mm in length). The mafic minerals are partly affected by chloritization. Other accessary minerals are sphene, zircon, epidote, apatite and opaque minerals.	Photomicrograph No. 5
1K22	Sidi Ayyad	Basement Granites	Microgranodiorite	This is granular in texture and mainly composed of quartz, plagioclase, orthoclase and mafic minerals. This is affected by strong chloritization, sericitization and iron oxidization, and intruded by many quartz, sericite and copper veins. Quartz shows anhedral form and about 0.2 mm in size. Feldspars are suffered sericitization and iron-oxidization, so they show slightly albite and carlsbad twinning. They are subhedral to anhedral in form and up to 0.5 mm in length. Mafic minerals are perfectly altered to chlorite, which shows aggregated form accompained by opaque minerals. Vein is about 0.2 mm in width and composed of quartz, sericite malachite, cuprite and opaque minerals. Apatite occurs in needle-shaped and granular-shaped.	Photomicrograph No. 6
2A04	Bou Mia	Basement Granites	Aplitic Granite	This is granular in texture and mainly composed of quartz, orthoclase, plagioclase and biotite. Quartz shows anhedral form (up to 2.0 mm in size) and wavy extinction. Anhedral orthoclase shows carlsbad twinning and perthite structure, albite part of which has albite twinning. Orthoclase is up to 4.0 mm in length, and shows mirmekitic texture in its margin. Plagioclase is anhedral in form and about 1.0 mm in length. It shows albite twinning and weak zonal structure. Biotite is subhedral in form and redish brown to light brown in colour. It has pleochroic halo by zircon. Other accessary minerals are muscovite, apatite and opaque minerals.	

Sample No.	Location	Formation	Rock Name	Microscopic Observation	Remark
2A13	Aït Sâid	Basement Granites	Aplitic Granite (Carapace)	The rock shows granular texture with quartz-ferruginous veins. Main constituent minerals are quartz, orthoclase, plagioclase and two micas. Quartz is anhedral in form and up to 2.0 mm in size. Orthoclase is anhedral and up to 4.0 mm in size. It shows Carlsbad twinning, in part. Most quartz and orthoclase have coexisted and show graphic texture. Plagioclase shows albite twinning and subhedral to anhedral form. It is up to 2.0 mm in length and shows graphic texture with quartz in parts. These minerals are penetrated and crashed by quartz ferrugious veins. The vein is made of very fine grained (0.01 mm) quartz, iron oxidized and a few amount of carbonate. Other constituent minerals are brownish biotite, muscovite and opaque minerals.	Photomicrograph No. 7
2B28	Tamarout	Basement Granites	Aplite	This is glanular in texture and mainly composed of quartz, orthoclase and plagioclase. Anhedral quartz is up to 0.5 mm in size. Orthoclase shows Carlsbad twinning and perthite structure. Some orthoclases are very large crystal (up to 4.0 mm) and subhedral in form. But, most orthoclases are anhedral and about 0.5 mm in length. Plagioclase shows anhedral form and albite twinning (up to 0.3 mm in length). A few amount of biotite occurs in subhedral form and light - dark brown in colour. Other accessary minerals are apatite, zircon and opaque minerals.	Photomicrograph No. 8
2B29	Bou Mia	Basement Granites	Porphyritic Granite	This is granular in texture and composed of quartz, orthoclase, plagioclase and biotite. Anhedral quartz is up to 8.0 mm in size. Anhedral orthoclase shows carlsbad twinning and perthite structure, albite part of which shows albite twinning. It is up to 10.0 mm in length. Anhedral plagioclase shows albite twinning and weak zonal structure, core of which is suffured of sericitization. Biotite is up to 2.0 mm in length and light to dark brown in colour. This is accompained by zircon, apatite and opaque minerals. Zircon shows pleochroic halo. Sphene and muscovite occurs in parts.	

Sample No.	Location	Formation	Rock Name	Microscopic Observation	Remark
2B30	Bou Mia	Basement Granites	Granite Porphyry	The rock shows porpbyritic texture. Phenocrysts are composed of quartz, orthoclase and plagioclase. Graundmass is made of the same mineral assemblage, and affected by sericitization and iron-oxidization. Phenocryst quartz is euhedral to subhedral in form (up to 6.0 mm) and shows corroded form. Orthoclase shows euhedral to subhedral and Carlsbad twinning. It is up to 4.0 mm in length. Plagioclase is also euhedral to subhedral and up to 4.0 mm in length. It shows albite twinning and is affected by sericitization. Mafic minerals are perfectly replaced by albite and accompained by sphene and opaque minerals. Groundmass is compossed of felsic minerals and secondary sericite. Felsic minerals are up to 0.2 mm and show micrographic texture.	Photomicrograph No. 9
2B31	Bou Mia	Basement Granites	Granite Porphyry	The rock shows porphyritic texture. Phenocrystic minerals are quartz, orthoclase, a few amount of plagioclase and muscovite. Groundmass is composed of felsic minerals and sericite. Phenocrystic quartz shows subhedral and corroded form (up to 1.5 mm). Orthoclase is subhedral in form and up to 1.5 mm in length. It shows carlsbad twinning. Plagioclase shows albite twinning and subhedral form (up to 1.5 mm). Muscovite is up to 1.0 mm in length. In this rock, there is two type groundmass. One is very fine grained (up to 0.03 mm) felsic minerals and layered sericite. The other is fine -grained (up to 0.2 mm) felsic minerals and dispersed acicular sericite. The latter is nearly same as the above mentioned rock No. 2B30. The boundary of them is sharp. Other accessary minerals are apatite and opaque minerals.	

Sample No.	Location	Formation	Rock Name	Microscopic Observation	Remark
M-001	Zayda Mine No. 54 pit	P-T Red Sandstone	Mineralized Arkose Sandstone	Constituent minerals are quartz, orthoclase, plagioclase, biotite, barite, opaque minerals and clay minerals. Anhedral quartz, up to 4.0 mm, shows wavy extinction. Orthoclase shows carlsbad twinning and perthite structure, up to 4.0 mm in length. Plagioclase which may be oligoclase, shows albite twinning, 0.1 mm - 1.0 mm. Subhedral biotite is dark-brown in colour. Euhedral barite is aggregated in lathlike form and shows plumose pattern. The barite, opaque minerals and clay minerals occur like cementation between the original crystals.	Photomicrograph No. 10
M-002	Aśsaka	Basement Granites	Biotite Granite	Constituent minerals are quartz, orthoclase plagioclase, biotite, perthite and opaque minerals. They show granular texture. Anhedral quartz is up to 3.0 mm in length and in places shows graphic texture with orthoclase. Orthoclase shows perthite structure and carlsbad twinning. Plagioclase shows albite twinning and zonal structure. It may be andesine - oligoclase. Subhedral biotite is light brown to brown in colour and up to 2.0 mm in length.	Photomicrograph No. 11
M-003	Boring Core No. 6-12	Basement Granites	Muscovite Granite	It shows granular texture. Anhedral quartz, in places, shows graphic texture with feldspars. Orthoclase shows perthite structure and Carlsbad twinning, up to 0.5 mm in length. Plagioclase (oligoclase) shows albite twinning, and in place, shows intergraphic texture with orthoclase. Subhedral muscovite is up to 0.5 mm in legth, and someplaces is altered to chlorite.	
M-004	Boring Core No. 6-12 36.8 m ~ 37.1 m	P-T Red Sandstone	Hematite bearing Arkose Sandstone	Constituent minerals are fine-grained quartz, orthoclase, muscovite and hematite. Aggregated fine hematite occurs in vein, along which secondary quartz occurs.	
M-005	Boring Core No. 6-12 8 m ~ 15 m	P-T Red Sandstone	Fine-grained Sandstone	Anhedral fine-grained crystals of quartz, orthoclase, plagioclase and muscovite, up to 0.5 mm, are cemented by glass and hematite (limonite). In parts, carbonates occur with hematite.	Photomicrograph No. 12

Sample No.	Location	Formation	Rock Name	Microscopic Observation	Remark
M-006	Aśsaka	Basement Granites	Two Mica Granite	Texture is granular. Quartz is 0.1 - 1.0 mm in length. Orthoclase shows Carlsbad twinning and perthite structure, and has graphic quartz. Plagioclase show albite twinning. Muscovite is colourless and up to 1.0 mm. Biotite is light - dark brown and accompanied by opaque minerals.	
M-007	Aśsaka	Basement Granites	Contaminated Granite	It has xenolith of granite and phenocrysts of quartz and feldspars. Matrix is consisted of fine-grained quartz, feldspars, muscovite and glass. The glass is mostly altered to limonite.	
1A12	Zayda Mine No. 54 pit	P-T Red Sandstone	Pb-ore	Ore minerals and their occurrences are the same as the sample No. M001	Photomicrograph No. 13
1E07	Bou Tsakourt	Basement Granite	Pb-ore	Ore minerals are almost galena and cerrucite. They occure between gangue minerals. Galena is up to 1 m/m in size and its crystal margin is carbonitized and replaced by cerrucite with warmeaten form.	Photomicrograph No. 14
1K31	Sidi Ayyad	Basement Granite	Pb-ore (Marabout vein)	Ore minerals are galena, cerrucite and chalcopyrite. Galena is up to 2 m/m in size and occures with quartz and fluorite. Cerrucite occures in the marginal parts of galena crystals, replacing galena with carbonitization. Chalcopyrite is about 0.03 m/m in size and occuring within galena.	Photomicrograph No. 15
4I05	Anc Mine	J. Limestone	Pb-ore	This sample is composed of chalcopyrite, Cu-Fe secondary mineral and gangue minerals. Chalcopyrite is up to 1 m/m in size and occures with gangue minerals, oxidized and replaced by Cu-Fe secondary mineral with worm-eaten form, along the margins and the cleavages of galena crystals.	

Sample No.	Location	Formation	Rock Name	Microscopic Observation	Remark
4J14	Mibladane	J_1 Limestone	Pb-ore	Ore minerals are composed of galena and cerrucite. Gangue minerals are quartz and dolomite. Galena is carbonitized and replaced by irregular cerrucite and euhedral dolomite, along the margins of galena crystals.	Photomicrograph No. 16
M001	Zayda Mine No. 54 pit	P-T Red Sandstone	Mineralized Arkose, Sandstone	Ore minerals are mostly galena and a little of sphalerite. They occure between gangue minerals. Galena is anhedral and up to 1.0 mm in size. Fine grained and dotted sphalerite occurs in galena crystals.	

Table I—7 Observations of X-ray Microanalysis

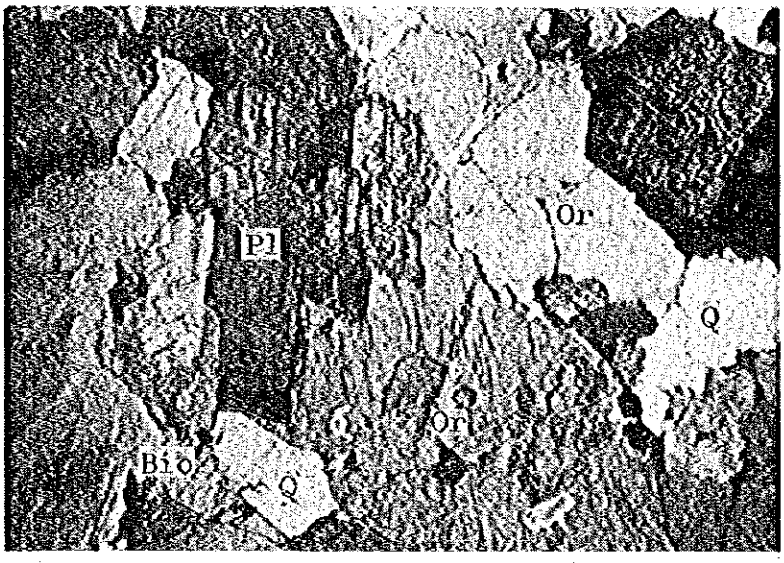
Sample No.	Location	Formation	Rock Name	Observation	Remark
1D13	Assaka-n-Tabhirt	Basement Granites	Granite Porphyry	Two uranium minerals are detected in this sample. One is becquerelite $CaO.6UO_3.11H_2O$ recognized in U and Ca X-ray reflective images. The other is carnotite $K_2(VO_2)_3(V_2O_8).3H_2O$ recognized in U and V X-ray reflective images. It is found in U, V and Fe X-ray reflective images that carnotite is occuring with fervanite $2Fe_2O_3.2V_2O_5.5H_2O$. Gangue minerals are silicate and iron oxide minerals.	U:0,139% 1,000c/s
1D15	Paneau-1	P-T Red Sandstone	Arkose Sandstone	No uranium mineral is detected in this sample. There is found the following minerals cementing between fragments consisting of arkose sandstone. Barite ; in Ba and S X-ray reflective images. Fluorite: in Ca X-ray reflective image Hematite: Showing strong reflection in Fe X-ray reflective image.	U:0,061% 7,000c/s
1K08	Sidi Ayyad		Fe-quartz Vein	Carnotite, composed of U, V and K, is detected in this sample. It is evident in Fe, V, Si and Ca X-ray reflective images that carnotite is occured within the margin of altered fervanite crystal. Gangue minerals are K-Al silicate and Fe-Al silicate.	U:0.188% 2,000c/s
2A13	Aït Sáid	Basement Granite	Aplitic Granite (carapace)	Carnotite is found in U, V and K X-ray reflective images. It is presumed in this sample that there is tyuyamunite $Ca(VO_2)_2(V_2O_8).5H_2O$ replaced K, in carnotite, to Ca. Gangue mineral is ferrouginous quartz consisted of silica and iron oxide.	U:0,072% 1.600c/s

Table I—8 Photomicrographs

Abbreviation

Ba	:	Barite
Bio	:	Biotite
Car	:	Carnotite
Ccp	:	Chalcopyrite
Ce	:	Cerusite
Chl	:	Chlorite
Dol	:	Dolomite
Fe	:	Fe-oxide
Fl	:	Fluorite
G	:	Gangue mineral
Gn	:	Galena
Gr	:	Groundmass
Hb	:	Hornblende
Ht	:	Hematite
Opq	:	Opaque mineral
Or	:	Orthoclase
Pl	:	Plagioclase
Q	:	Quartz
Sp	:	Sphalerite
V	:	Vein

1



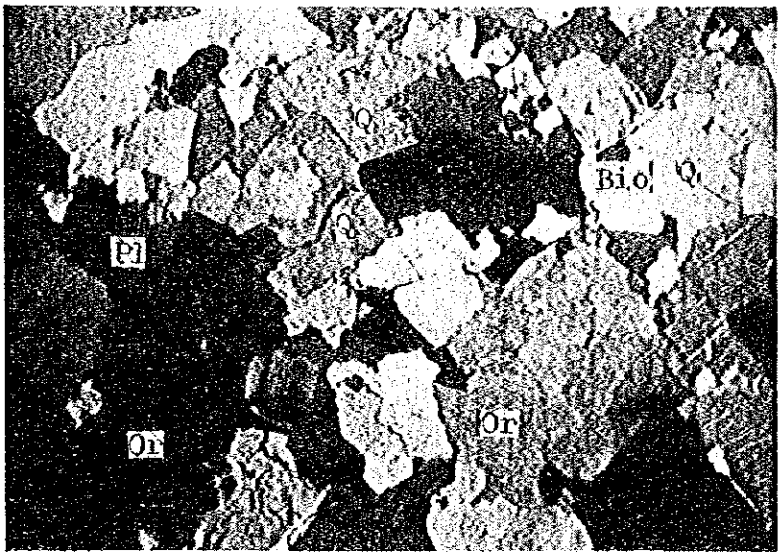
Sample No. 1B04

1mm

Crossed nicols

Rock name: Contaminated granite

2



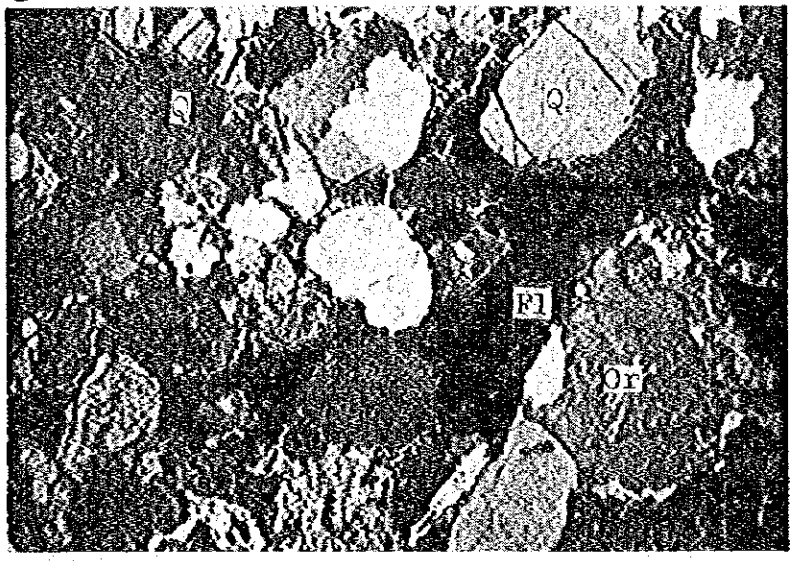
Sample No. 1B05

1mm

Crossed nicols

Rock name: Aplitic granite

3



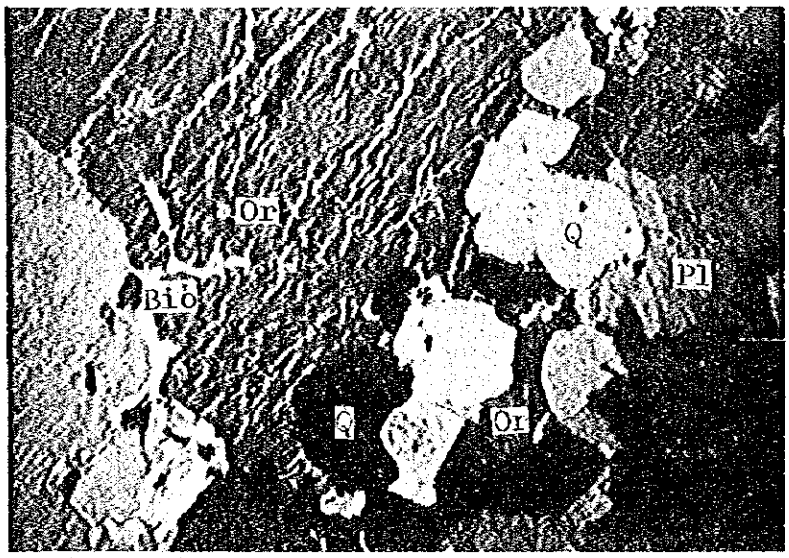
Sample No. 1D15

1mm

Crossed nicols

Rock name: Arkose sandstone

4



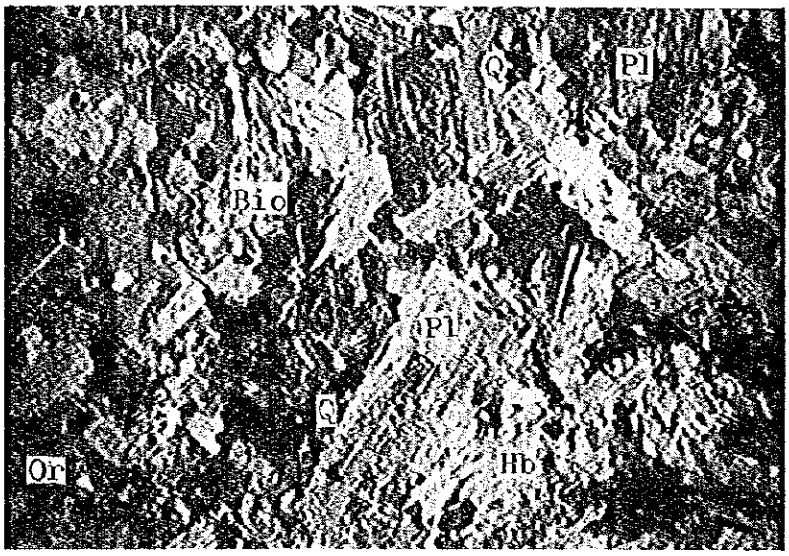
Sample No. 1D20

2 mm

Crossed nicols

Rock name: Porphyritic granite

5



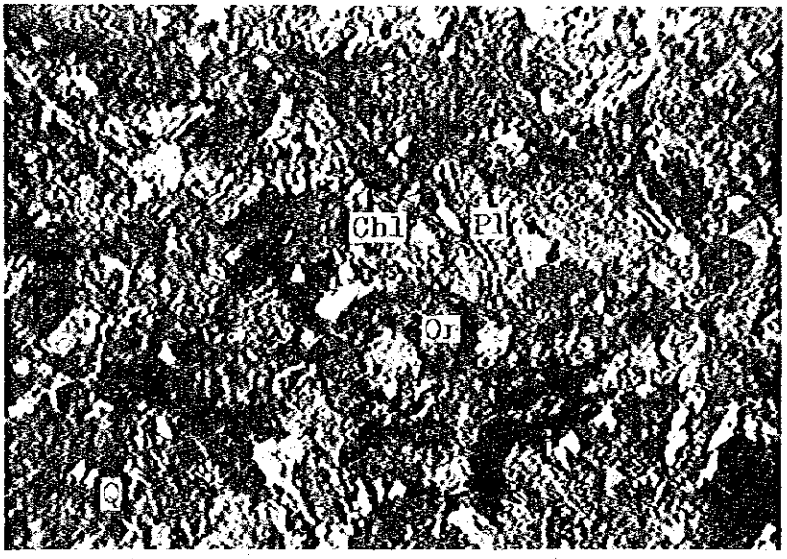
Sample No. 1K09

1 mm

Crossed nicols

Rock name: Granodiorite

6



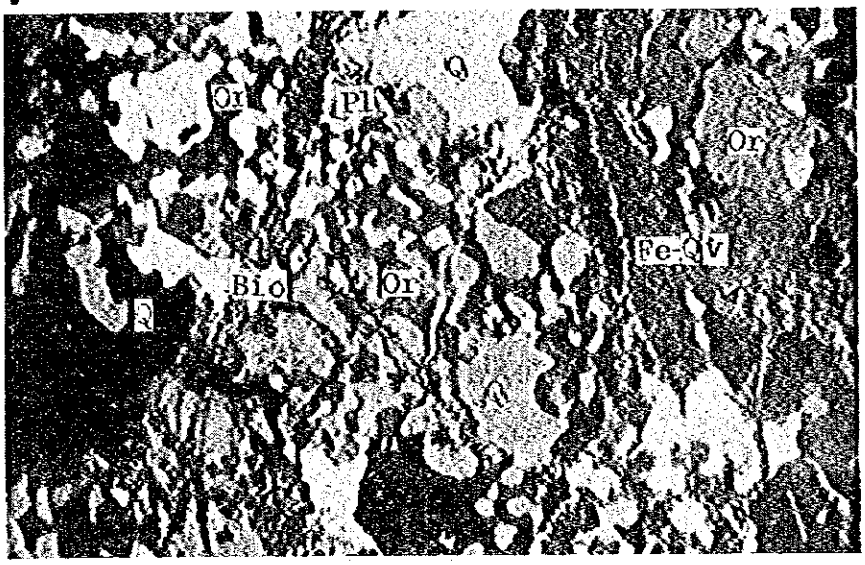
Sample No. 1K22

0.4 mm

Crossed nicols

Rock name: Microgranodiorite

7



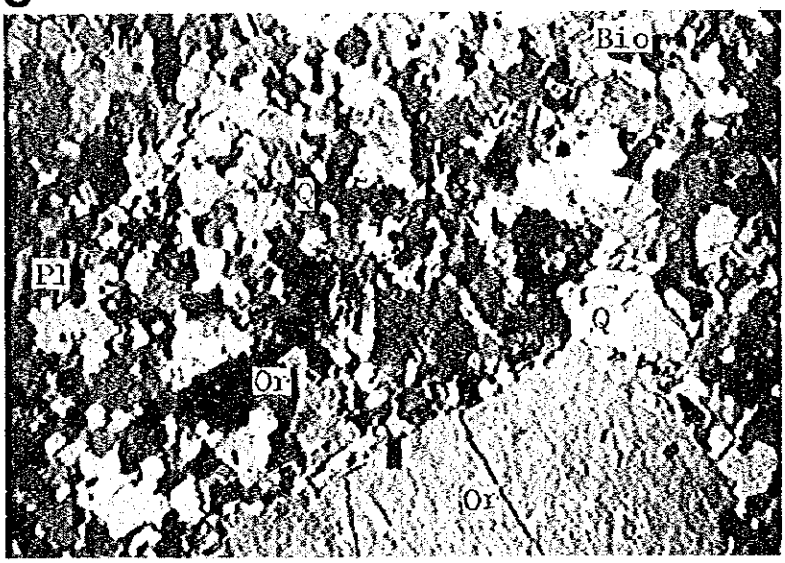
Sample No. 2A13

2 mm

Crossed nicols

Rock name: Aplitic granite
(with graphic texture)
(carapace)

8



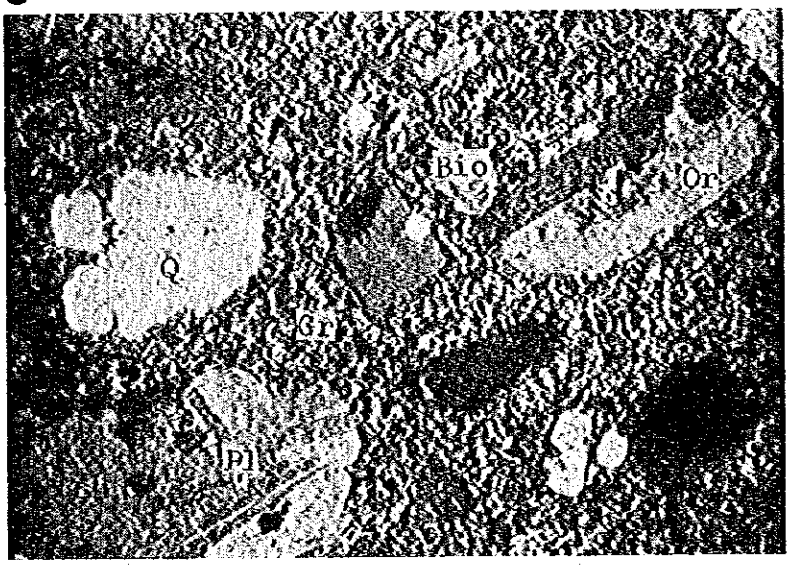
Sample No. 2B28

1 mm

Crossed nicols

Rock name: Aplite

9



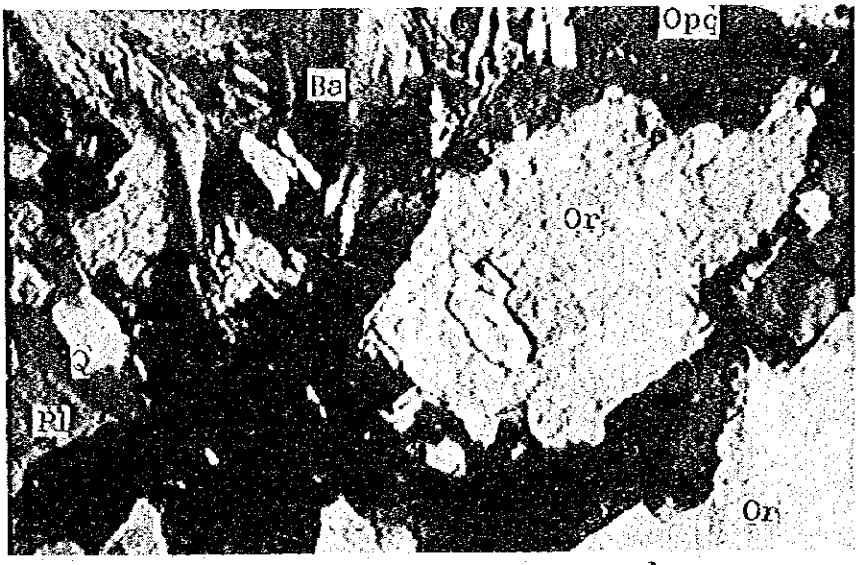
Sample No. 2B30

1 mm

Crossed nicols

Rock name: Granite porphyry

10



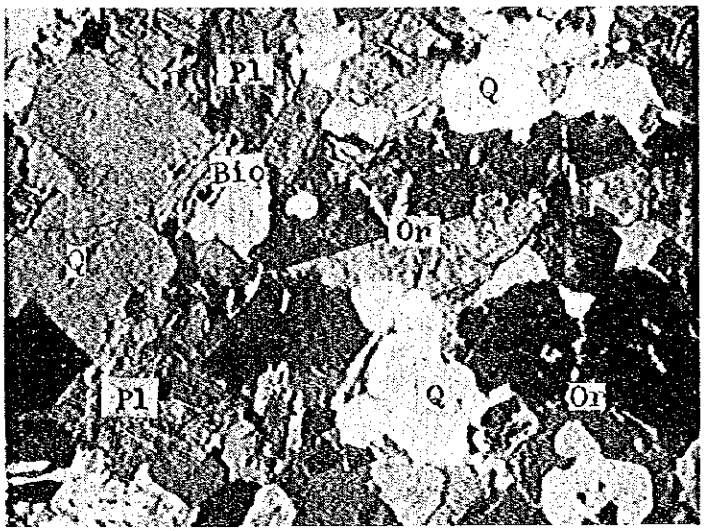
Sample No. M001

1 mm

Crossed nicols

Rock name: Mineralized arkose sandstone

11



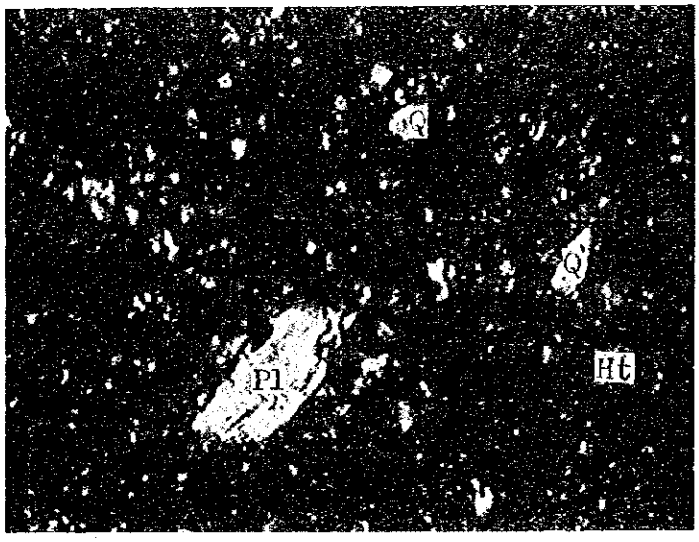
Sample No. M002

2 mm

Crossed nicols

Rock name: Biotite granite

12



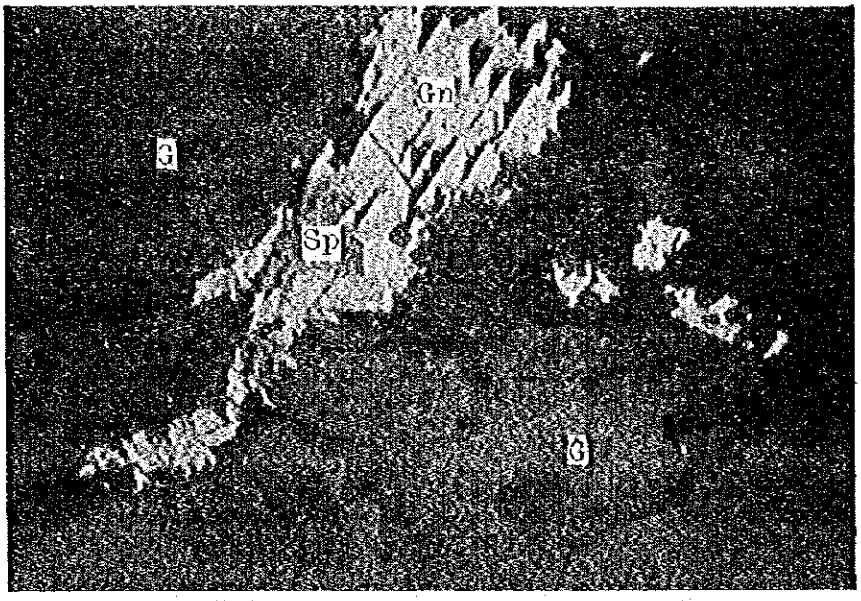
Sample No. M005

1 mm

Crossed nicols

Rock name: Fine-grained sandstone

13



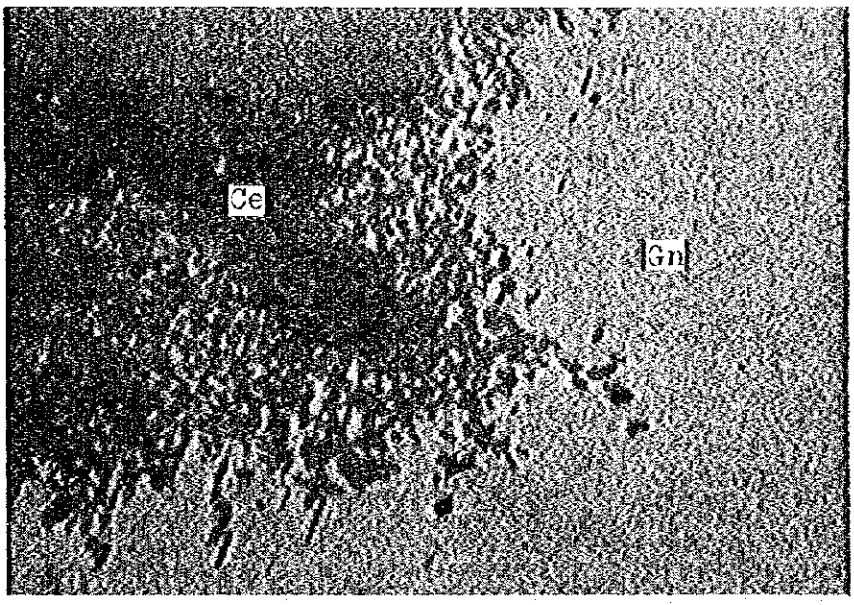
Sample No. 1A12

0.2 mm

Crossed nicols

Rock name: Pb-ore (Zayda pit No.54)

14



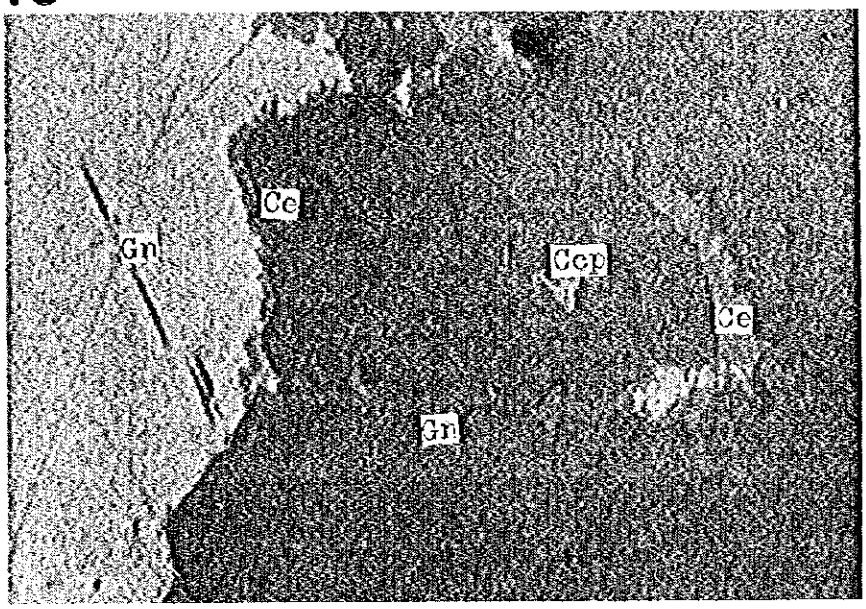
Sample No. 1E07

0.2 mm

Crossed nicols

Rock name: Pb-ore (Bou Tsakourt)

15



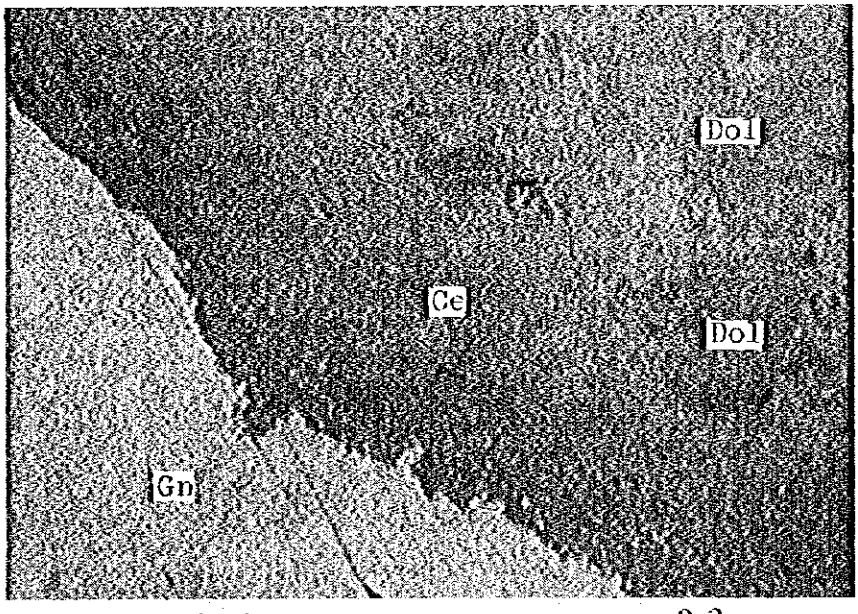
Sample No. 1K31

0.2 mm

Crossed nicols

Rock name: Pb-ore (Sidi Ayyad)

16



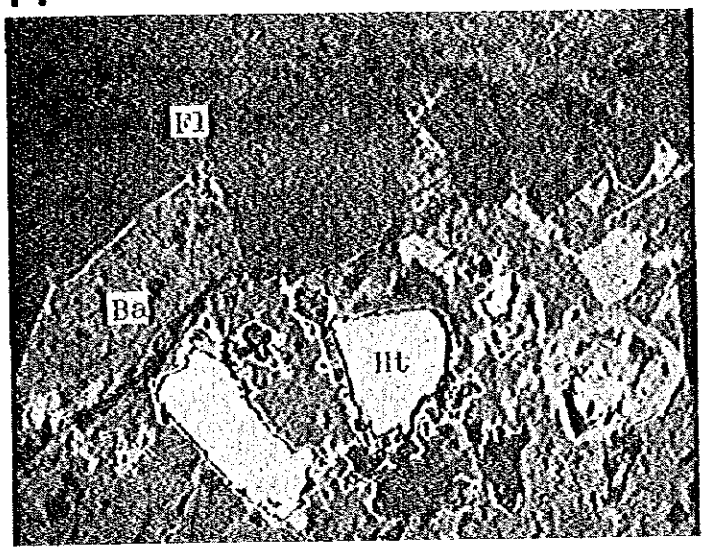
Sample No. 4J14

0.2 mm

Crossed nicols

Rock name: Pb-ore (Mibladane "L" pit)

17



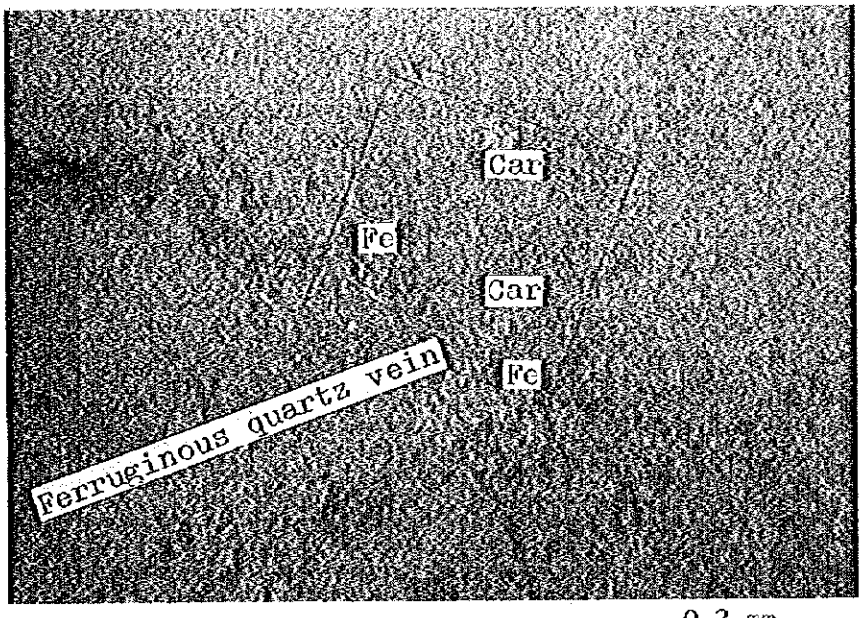
Sample No. 1D15

0.2 mm

Crossed nicols

Rock name: Arkose sandstone

18



Sample No. 2A13

0.2 mm

Crossed nicols

Rock name: Aplitic granite
(carapace)