CHAPTER VI

MINERALOGICAL AND GEOCHEMICAL STUDIES

The mineralogical and geochemical studies of carbonate sequences are equally important as their allochem analyses. A critical appraisal of mineralogical composition, carbonate as well as non-carbonates, as also geochemistry, especially trace elements and isotopes, furnishes vital information on the diagenesis and depositional environments of carbonate sediments. The present chapter deals with a detailed account on mineralogical and geochemical constituents of carbonate sequences of Jhurio and Jumara formations exposed in three domes.

During the present study, precise mineral determinations are carried out by X-ray diffraction analyses besides stained and unstained thin sections study. Where non-carbonate constituents are present in carbonate rocks (as in the case of the study area) they often are best analyzed in acid insoluble residues. Therefore, insoluble residue study has also been carried out. Besides these, trace elements like strontium, manganese, iron, boron, vanadium and magnesium and stable isotopes like O^{18} and C^{13} have also been determined in representative samples of each formations from Jumara, Jhura and Habo domes.

INSOLUBLE RESIDUE STUDIES

Insoluble residue or the non-carbonate content of the carbonate rocks is a valuable indicator regarding the purity of sedimentation and diagenesis. The abundance of terrigenous component depends on the influx from the continents. The influx increases during regressions, periods of orogeny, uplift and high erosion of the provenance and it decreases during transgression. The "absolute" or the "relative" amount as well as composition of the residues can provide meaningful information about the process of sedimentation. In the present study, the author has selected representative samples from different lithofacies identified in study area i.e. Jumara, Jhura and Habo domes. The quantification of insoluble residue is done by following method :

1. A small piece of sample (about 15-20 gms) is crushed to fine powder (200 mesh)
2. A correctly weighed, usually about 20 gms of this powder was placed in a beaker and digested with 1:10 Hcl for 48 hours to remove its carbonate content.

3. The remaining sample was then washed with distilled water and decanted water after giving sufficient time for settling (about 12 hrs in case of argillaceous limestones).

4. The sample was dried at temperature below 100 ^{0}C

5. Once dried, the residue was weighed and its percentage calculated.

The weight percentages of insoluble residues have been tabulated separately for Jhurio and Jumara Formations in all three domes and have been given in **Table VI.1 to 3**. A comparative overview has also been graphically represented in the form of pie diagrams and bar chart (**Fig.VI.1 to 3**).

The above study has revealed that the terrigenous influx in Jhurio Formation is very low whereas disruption by the clastic influx in the carbonate sequence of Jumara Formation reflects frequent changes in shoreline conditions during depositions. The percentage of terrigenous influx is more towards eastern part i.e. in Jhura and Habo dome which is also supported by microfacies analyses. The study in Jhurio Formation has revealed that the average percentage of insoluble residues increases from 18.96% in Jumara dome to 25.2% in Jhura dome and 36.72% in Habo dome. In Jumara Formation the average percentage of insoluble residues is more than that in Jhurio Formation. It is 52.83% in Jumara; 58.86% in Habo and 65.89% in Jhura dome. This is due to existence of more non-carbonate facies in the eastern part of

Table No. VI.1: **INSOLUBLE RESIDUE STUDY OF JUMARA DOME**

SAMPLE NO	SAMPLE WT. BEFORE TREATMENT	SAMPLE WT AFTER TREATMENT	CARBONATE PERCENTAGE	INSOLUBLE RESIDUE PERCENTAGE
JUMARA FORMATION :				
KJ-2	20.752	9.435	54.535	45.465
KJ-3	20.620	10.185	50.606	49.394
KJ-10	20.766	14.101	32.096	67.904
KJ-11	20.340	9.431	53.633	46.367
KJ-12	21.188	9.076	57.164	42.836
KJ-13	22.022	14.312	35.010	64.990
JHURIO FORMATION :				
KJ-16	18.033	2.262	87.456	12.544
KJ-21	20.990	2.322	88.938	11.062
KJ-22	20.051	3.818	80.959	19.041
KJ-23	20.742	4.985	75.967	24.033
KJ-24	22.126	1.538	93.049	6.951
KJ-25	21.551	0.933	95.671	4.329
KJ-26	20.672	9.315	54.939	45.061
KJ-28	21.303	4.896	77.017	22.983
KJ-47	21.025	1.488	92.923	7.077
KJ-48	20.583	3.785	81.611	18.389
KJ-49	20.183	4.962	75.415	24.585
KJ-50	19.844	3.701	81.350	18.650
KJ-53	20.696	8.355	59.630	40.370
KJ-56	20.878	2.152	89.692	10.308

Table VI.2: **INSOLUBLE RESIDUE STUDIES OF JHURA DOME**

SAMPLE NO	SAMPLE WT. BEFORE TREATMENT	SAMPLE WT. AFTER TREATMENT	CARBONATE PERCENTAGE	INSOLUBLE RESIDUE PERCENTAGE
JUMARA FORMATION :				
KJH-53	21.201	20.962	1.127	98.873
KJH-54	20.852	18.275	12.359	87.641
KJH-55	20.392	10.284	49.568	50.432
KJH-57	19.592	11.838	39.577	60.423
KJH-60	20.964	6.621	68.417	31.583
KJH-73	21.539	10.410	51.669	48.331
KJH-74	21.091	15.519	26.419	73.581
KJH-78	21.100	15.142	28.237	71.763
KJH-79	20.169	16.254	19.411	80.589
KJH-80	20.689	11.528	44.280	55.720
JHURIO FORMATION:				
KJH-21	21.739	4.404	79.741	20.259
KJH-35	21.128	3.899	81.546	18.454
KJH-37	22.035	8.888	59.664	40.336
KJH-63	21.356	1.554	92.723	7.277
KJH-65	20.783	3.962	80.936	19.064
KJH-67	21.617	8.808	59.254	40.746
KJH-87	21.005	6.361	69.717	30.283

Table VI.3: **INSOLUBLE RESIDUE STUDY OF HABO DOME**

SAMPLE NO	SAMPLE WT. BEFORE TREATMENT	SAMPLE WT. AFTER TREATMENT	CARBONATE PERCENTAGE	INSOLUBLE RESIDUE PERCENTAGE
JUMARA FORMATION :				
KH-2	20.596	7.424	63.954	36.046
KH-4	20.527	4.068	80.182	19.818
KH-5	20.957	9.505	54.645	45.355
KH-7	20.688	15.175	26.648	73.352
KH-9	20.542	7.875	61.664	38.336
KH-10	20.527	16.333	20.432	79.568
KH-11	20.557	19.939	3.006	96.994
KH-13	20.346	17.981	11.624	88.376
KH-18	20.547	12.144	40.896	59.104
KH-19	20.627	16.223	21.351	78.649
KH-20	20.981	8.243	60.712	39.288
KH-22	21.031	10.808	48.609	51.391
JHURIO FORMATION :				
KH-29	20.478	2.785	86.400	13.600
KH-30	20.898	13.637	34.745	65.255
KH-31	20.815	12.046	42.128	57.872
KH-32	19.347	2.015	89.585	10.415
KH-34	20.393	6.920	66.067	33.933
KH-35	20.403	8.737	57.178	42.822
KH-36	21.124	7.258	65.641	34.359
KH-38	21.069	7.488	64.460	35.540

INSOLUBLE RESIDUE PERCENTAGES OF JHURIO FORMATION

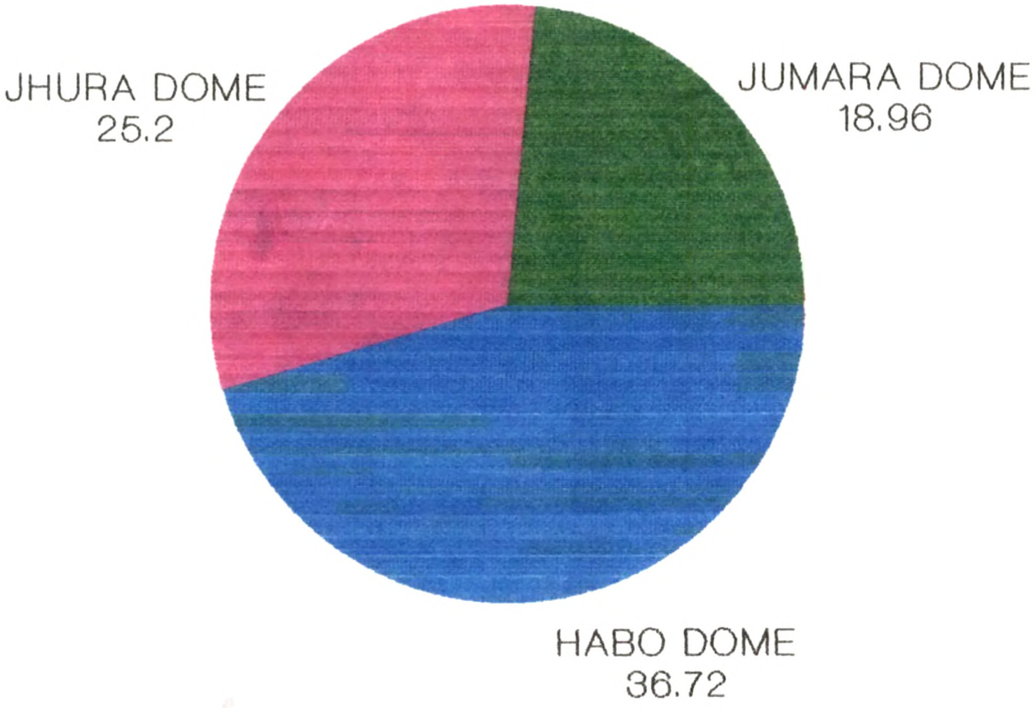


FIG. VI.I

INSOLUBLE RESIDUE PERCENTAGES OF JUMARA FORMATION

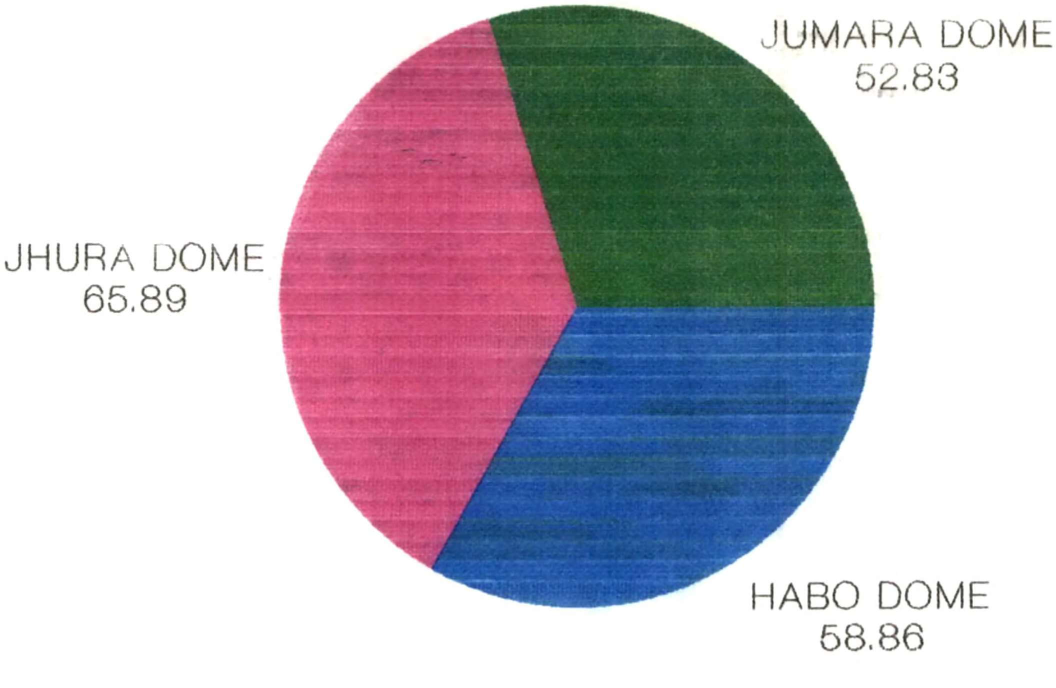


FIG.VI.2

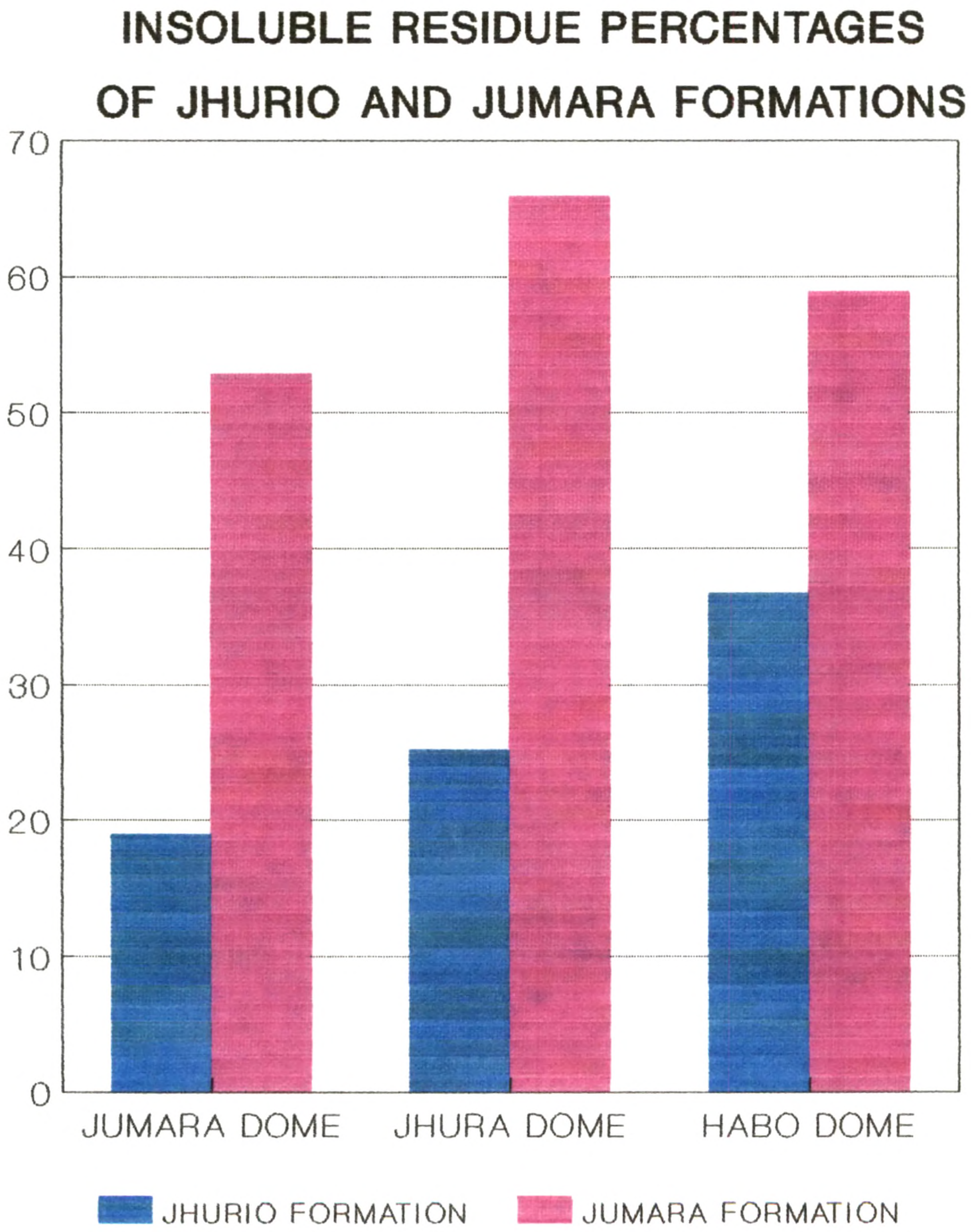

INSOLUBLE RESIDUE PERCENTAGES
OF JHURIO AND JUMARA FORMATIONS
70
60
50
40
30
20
10
0
JUMARA DOME
JHURA DOME
HABO DOME
JHURIO FORMATION
JUMARA FORMATION

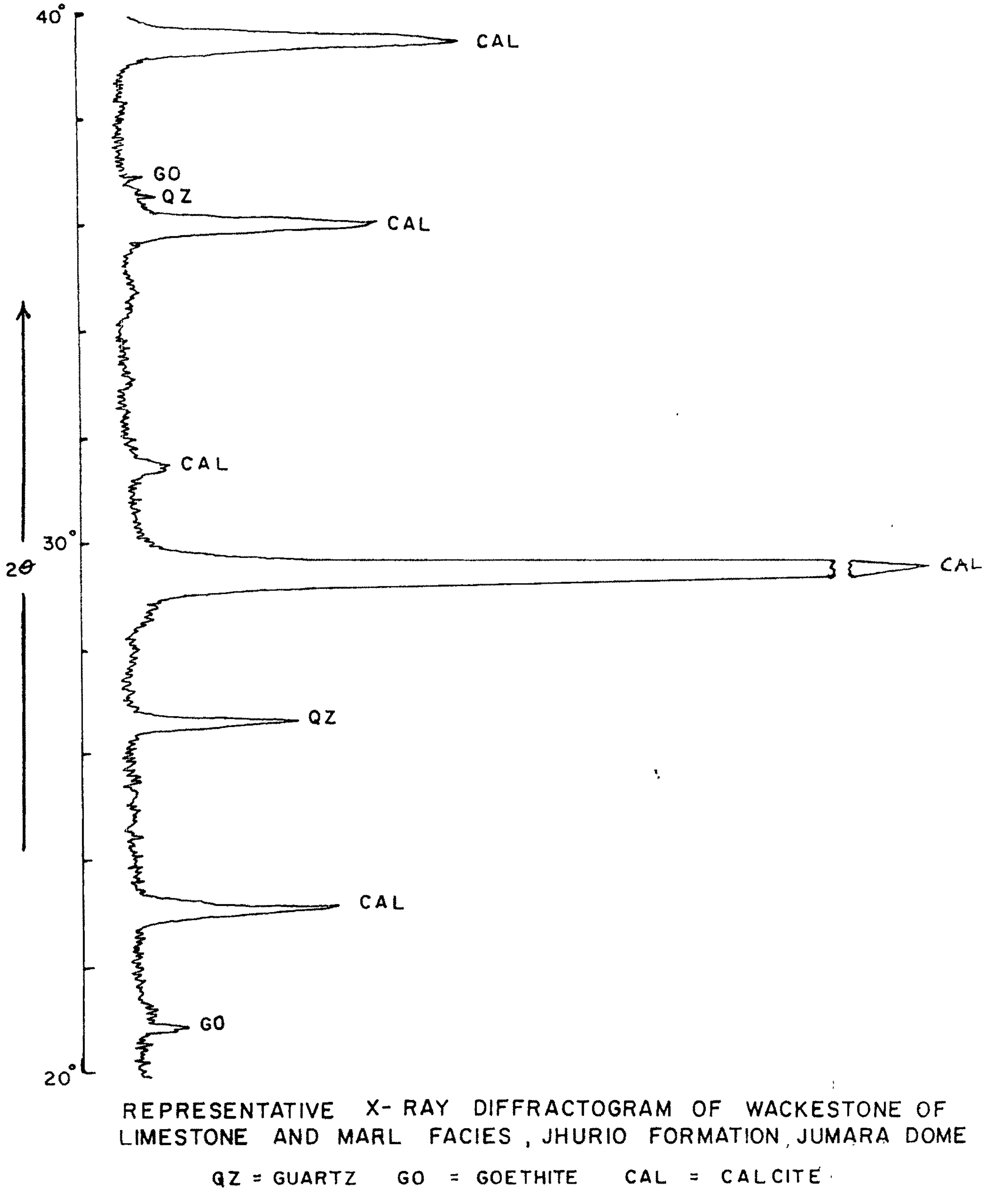
FIG.VI.-3

the Mainland. Besides, the dominance of carbonate percentage within the Jhurio Formation of all the three domes indicate the process of transgression. Whereas, the Jumara Formation is suggestive of both transgressive as well as regressive cycles. This aspect is further dealt with in chapter VII on depositional environment.

X-RAY DIFFRACTION STUDIES

Often, certain minerals are not identifiable under microscope because of their very fine grained nature or lack of crystallinity. In such cases X-ray diffraction becomes an important tool for investigation. These studies are also useful in qualitative as well as quantitative determination of mineralogy of the carbonate rocks.

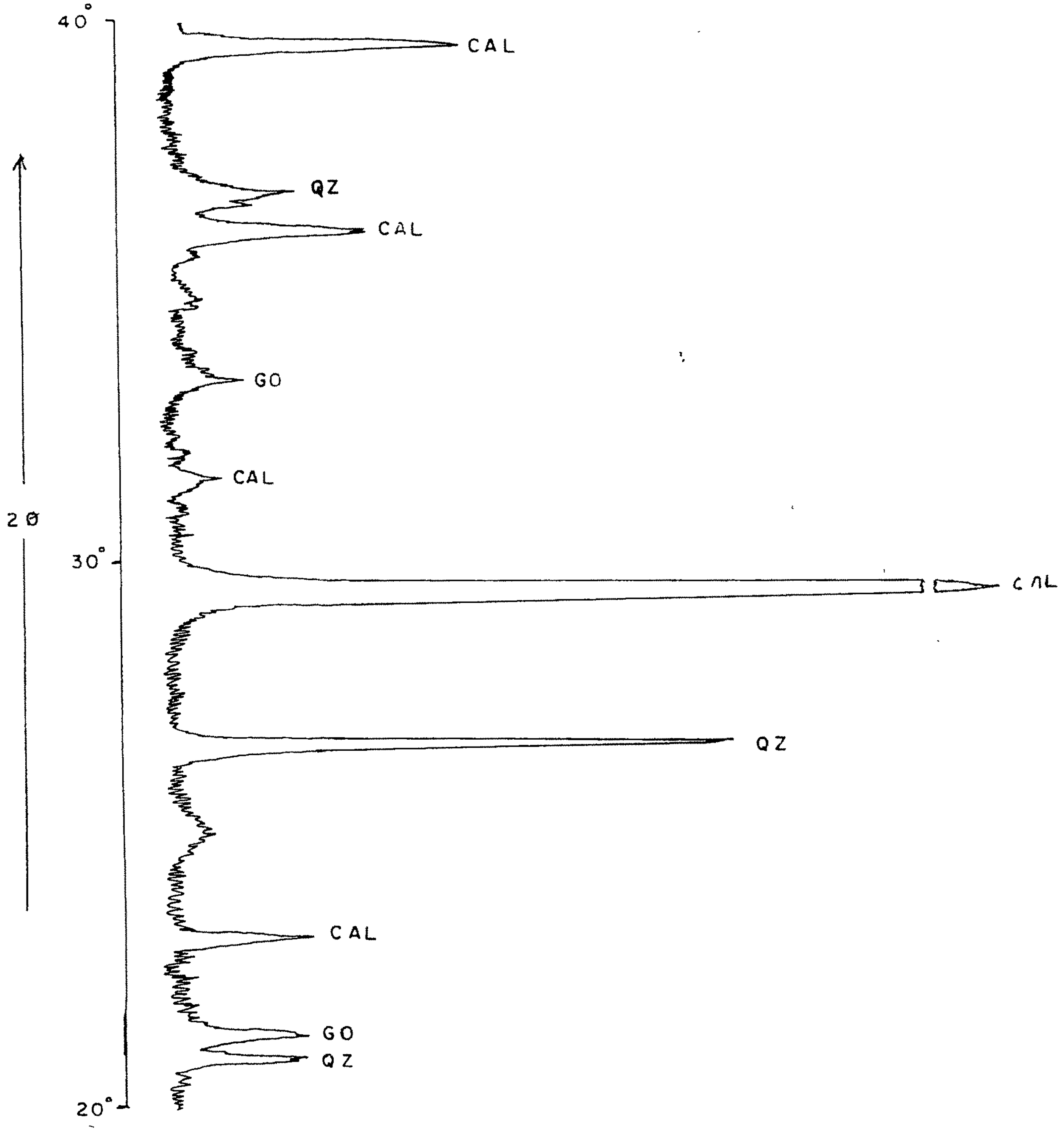
In the present study, the instrument used is Philips PW 1710 Diffractometer with nickel filtered copper radiation (CuαK). The instrument uses an electronically controlled linear recorder with an accelerating potential of 40 KV and current 30 mA and time constant. During the present work, carbonate powder packs are scanned by X-ray diffraction technique between 20° to 40° of 20. However, this range has been expanded as and when needed for identification of additional minerals. Besides, few insoluble residues were also examined for possible clay mineralogy after preparing the oriented sections between 4° to 40° of 20. The characteristic XRD curves of analysed samples are shown in **Fig.VI.4 To 11**.



REPRESENTATIVE X-RAY DIFFRACTOGRAM OF WACKESTONE OF LIMESTONE AND MARL FACIES, JHURIO FORMATION, JUMARA DOME

QZ = GUARTZ GO = GOETHITE CAL = CALCITE

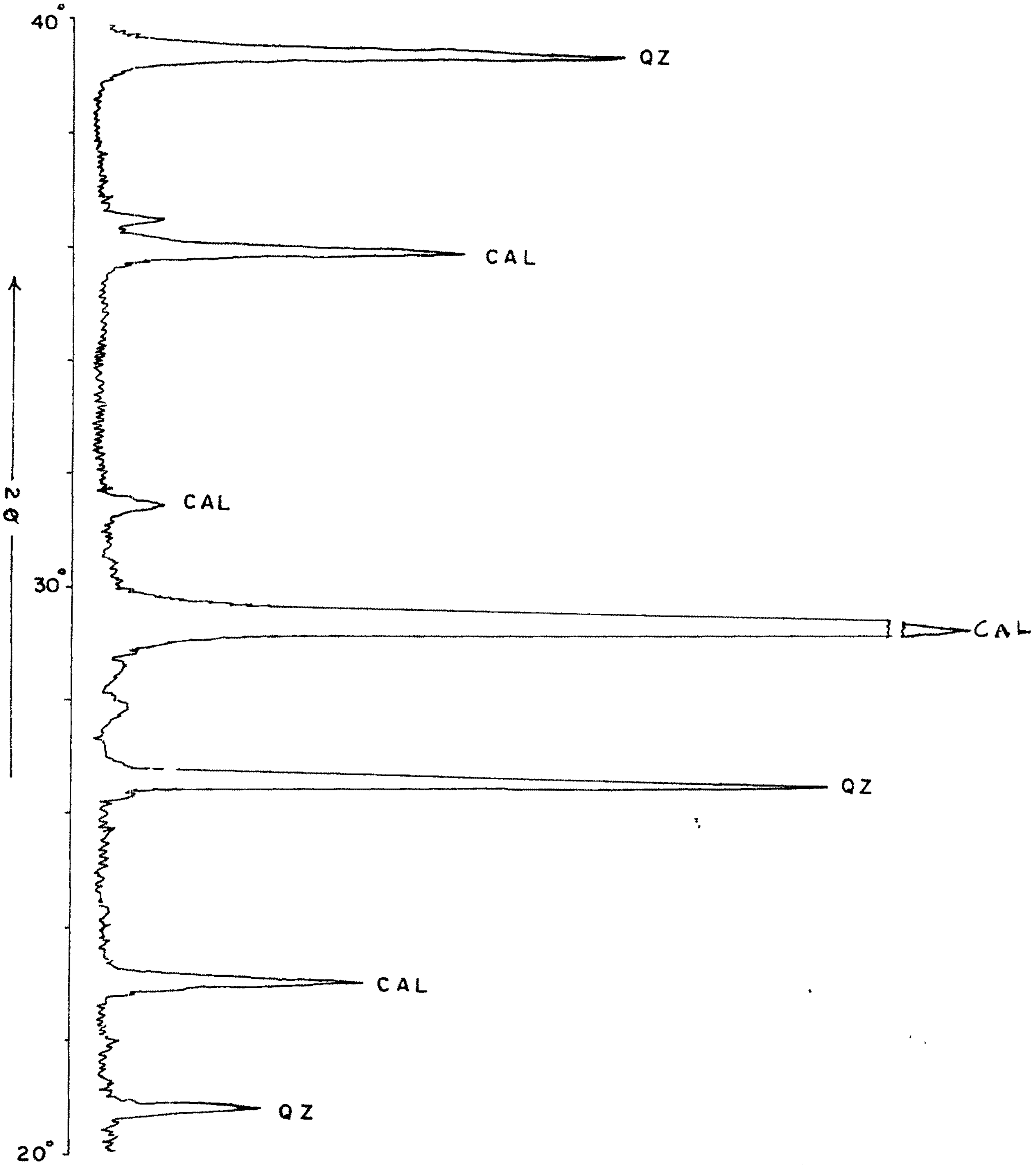
FIG.VI.4



REPRESENTATIVE X-RAY DIFFRACTOGRAM OF OOLITIC LIMESTONE FACIES JUMARA FOMATION, JUMARA DOME

Qz - QUARTZ , GO - GOETHITE , CAL - CALCITE

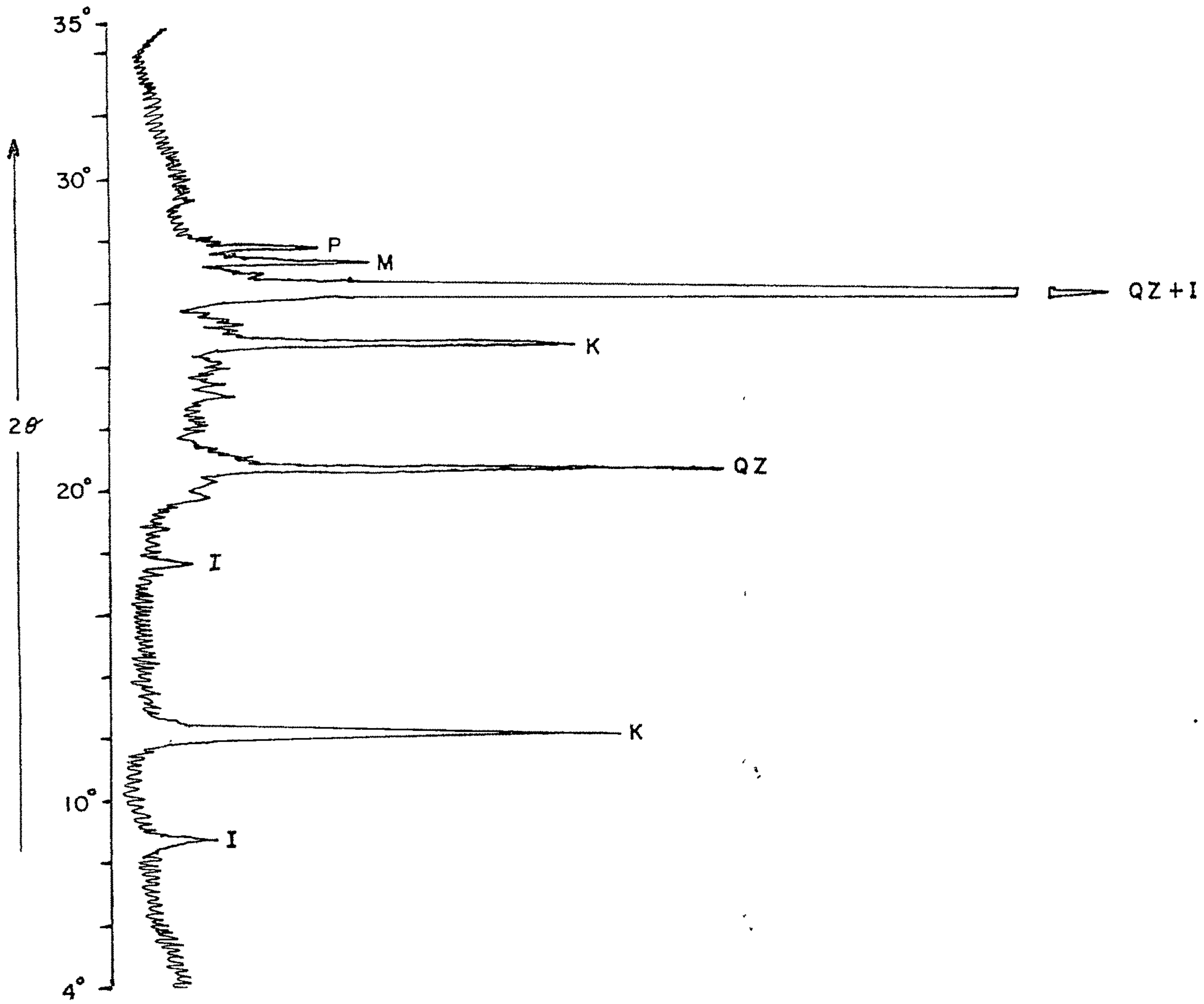
FIG VI 5



REPRESENTATIVE X-RAY DIFFRACTOGRAM OF CHALKY LIMESTONE SUBFACIES JHURIO FORMATION JHURA DOME

QZ = QUARTZ CAL = CALCITE

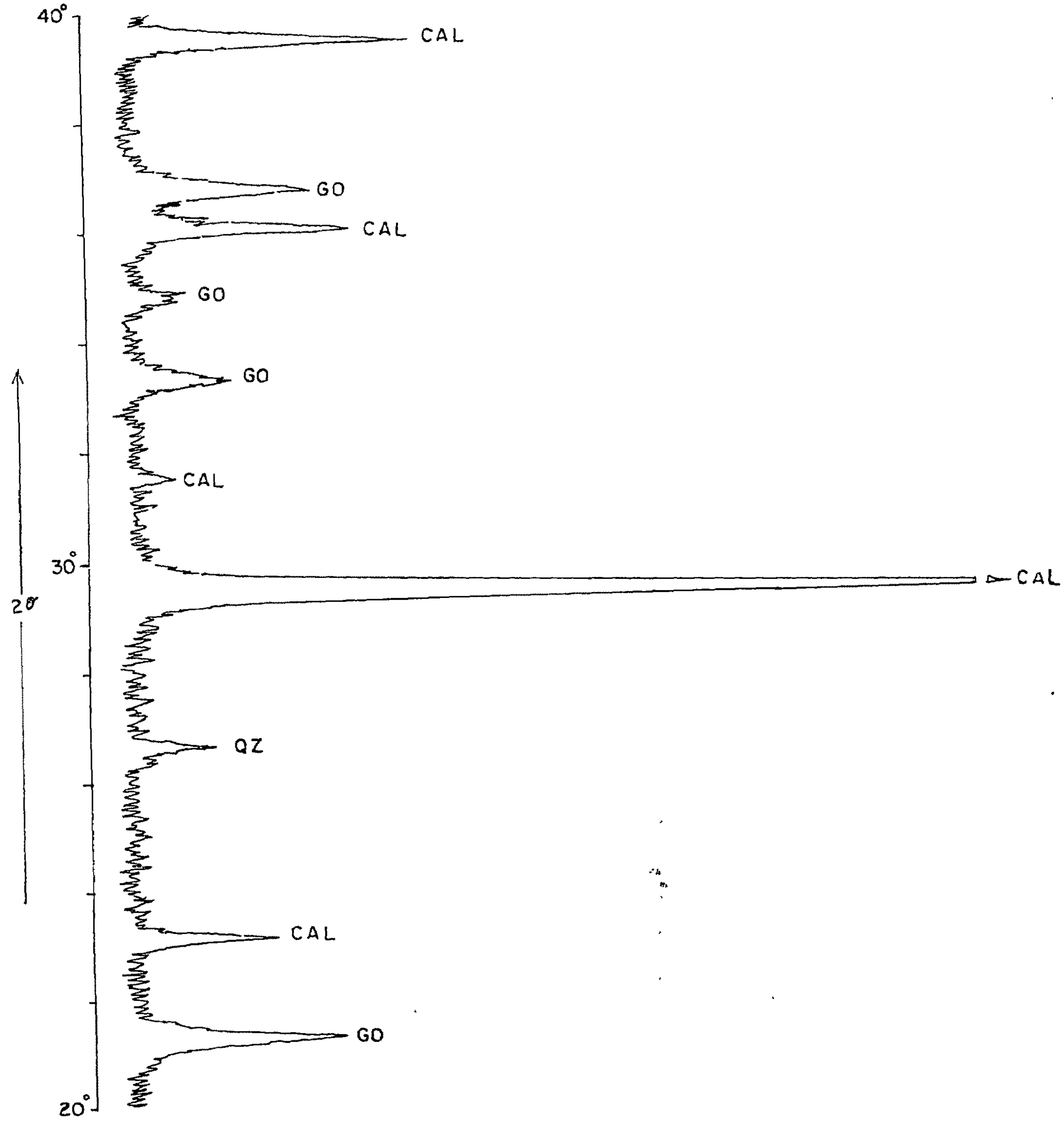
FIG.VI.6



REPRESENTATIVE X-RAY DIFFRACTOGRAM OF CALCAREOUS SANDSTONE FACIES (INSOLIUBLE RESIDUE) JUMARA FORMATION JUMARA DOME

I = ILLITE, K = KAOLINITE, QZ = QUARTZ, QZ + I = QUARTZ + ILLITE
M = MICROCLINE, P = PLAGIOCLASE.

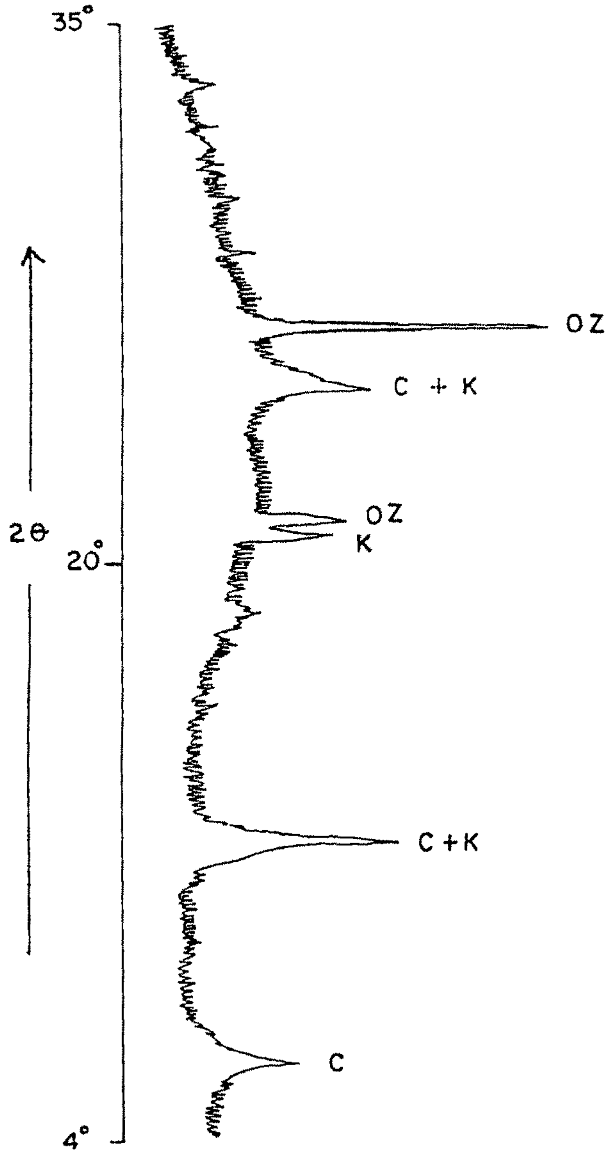
FIG. VI.7



REPRESENTATIVE X-RAY DIFFRACTOGRAM OF LIMESTONE OF GOLDEN OOLITE FACIES, JHURIO FORMATION JHURA DOME

GO = GOETHITE   CA = CALCITE   QZ = QUARTZ

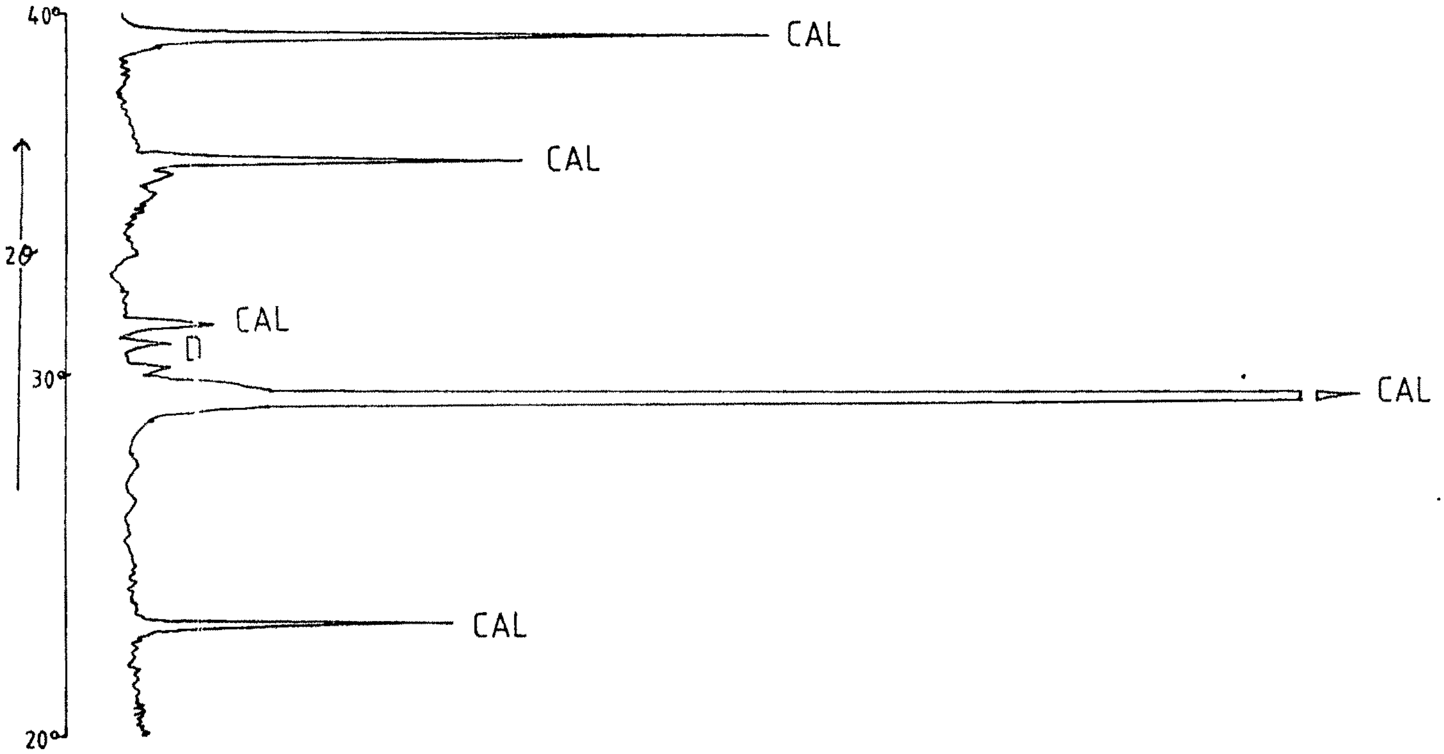
FIG.VI.8



REPRESENTATIVE X-RAY DIFFRACTOGRAM OF OOLITIC LIMESTONE FACIES (INSOLUBLE RESIDUE) JUMARA FORMATION JUMARA DOME

C = CHLORITE OZ = QUARTZ K = KAOLINITE
C+K = CHLORITE + KAOLINITE

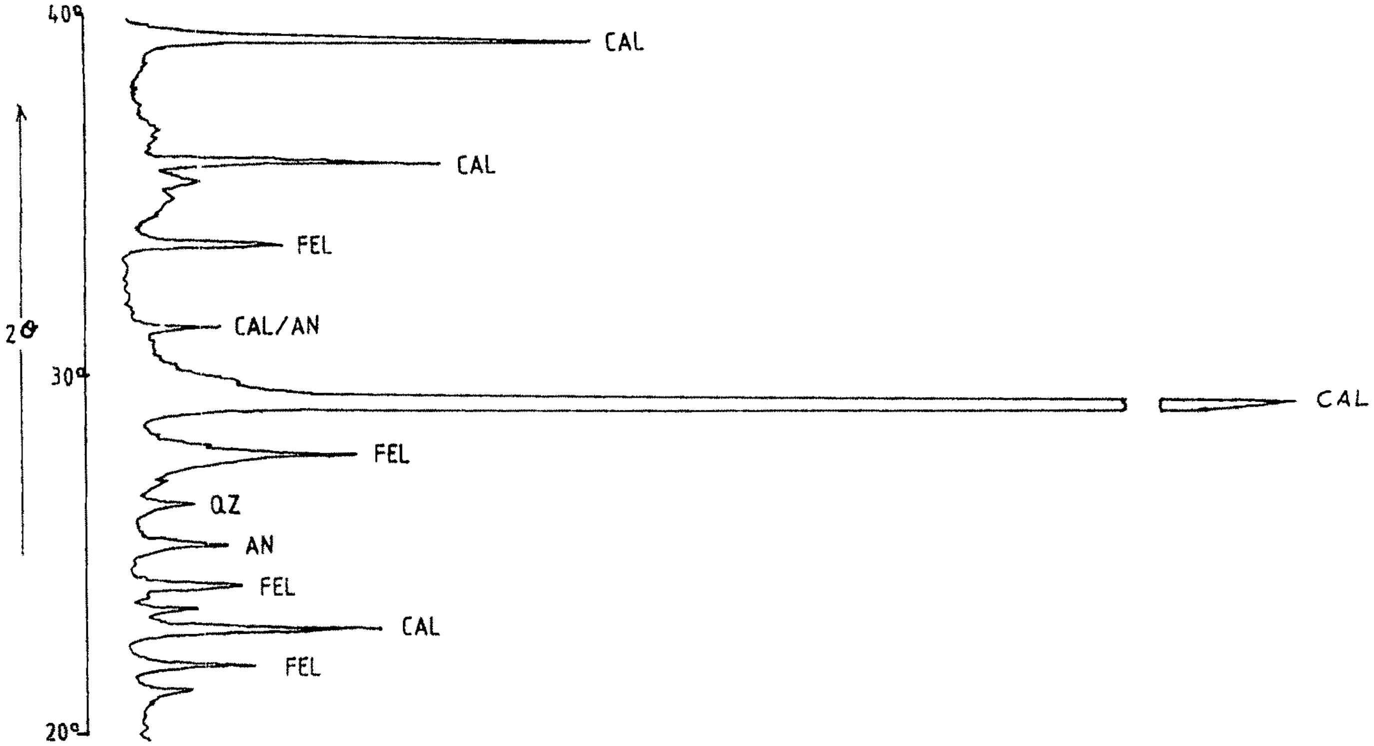
FIG.VI 9



REPRESENTATIVE X-RAY DIFFRACTOGRAM OF LIMESTONE UNDER BEDDED LIMESTONE FACIES (KH-I), JHURIO FORMATION, HABO DOME

CAL = CALCITE D = DOLOMITE

FIG. VI. 10



REPRESENTATIVE X-RAY DIFFRACTOGRAM OF LIMESTONE UNDER BEDDED LIMESTONE FACIES, JHURIO FORMATION, HABO DOME

CAL. = CALCITE FEL = FELSPAR AN = ANHYDRITE

QZ = QUARTZ

FIG. VI 11

The powdered packs of representative samples of selected lithofacies have indicated the presence of mainly calcite and quartz. The presence of hematite and goethite as iron minerals has also been established. Presence of dolomite and anhydrite has been indicated only in the bedded limestone facies (KH-I) under Jhurio formation of Habo dome. The XRD curves of selected samples of insoluble residues have shown the presence of clay minerals like kaolinite, chlorite and illite.

The presence of kaolinite indicates a near coastal shallow sea sedimentation (Bausch,1971). Illite is the most abundant marine clay mineral. An interpretation of illite in carbonates is difficult, because a diagenetic origin cannot be ruled out. Deeper offshore depositional areas often exhibit association of illites and chlorites (Rateev et. al., 1969).

TRACE ELEMENT STUDY

In order to supplement diagenetic observations through microfacies analyses, trace element studies were carried out. They help in determining the diagenetic environment of processes such as cementation. Sr and Mg are of particular interest because metastable carbonate mineral suites from modern shallow marine environments are dominated by aragonite (Sr rich) and magnesian calcite (Mg rich). Stabilization of these shallow marine carbonates to calcite and dolomite involves a major reapportionment of these elements between the new diagenetic carbonates and the diagenetic fluids (Moore, 1989).

The pH-Eh sensitivity of Fe and Mn has been used extensively to infer the environmental conditions under which cements have been precipitated. Besides, trace elements may be useful in determining the original mineralogy of rock components, such as ooids, bioclasts and cements.

During the present study, 15 representative samples of both Jhurio and Jumara Formations from the three domes were analyzed for trace elements. The elements chosen for the study are Strontium (Sr), Manganese (Mn), Iron (Fe), Boron (B), Magnesium (Mg), and Calcium (Ca). Boron has been reported as negligible as the lowest limit of the lamp sensitivity (360 ppm). For analysis, the sample is powdered and passed through 250 mesh size. To 1 gm of sample in a Platinum Crucible, 10 gm of Sodium Carbonate and 0.5 gm of Sodium Peroxide are added as a fusion mixture and is heated in a Muffle furnace to a temperature of 1000°C for 30 minutes. The fused mass is then dissolved in distilled water and acidified with Hcl. The solution is transferred in 500 ml measuring flask and made up with distilled water to the mark. The concentrations of elements are determined by Atomic Absorption Spectrophotometry (Model GBC 906 A) and are reported as parts per million (PPM) in each sample (**Table VI.4**).

Table VI.4 **TRACE ELEMENT ANALYSES**

SAMPLE NO.	AREA	MANGANESE (ppm)	MAGNESIUM (ppm)	IRON (ppm)	STRONTIAN (ppm)	CALCIUM wt%
JUMARA FORMATION						
KJ-2	JUMARA	546.46	4441.57	480.03	329.81	15.50
KJ-10	-DO-	960.06	17236.51	670.13	224.74	11.22
KJ-13	-DO-	424.97	3588.08	1051.22	440.41	7.55
KJH-5	JHURA	1113.57	18506.95	885.14	1608.18	34.38
KH-1	HABO	389.18	4281.93	1598.86	360.75	20.41
KH-17	-DO-	415.08	3231.99	896.42	474.52	22.03
KH-23	-DO-	923.14	6368.08	2324.47	845.88	23.83
JHURIO FORMATION						
KJ-21	JUMARA	331.34	7018.92	1035.19	1655.23	25.39
KJ-25	-DO-	983.63	5294.52	417.16	1638.10	25.59
KJH-17	JHURA	280.31	6359.66	5723.60	2210.84	31.32
KJH-19	-DO-	650.87	5207.01	551.81	837.82	28.83
KJH-28	-DO-	365.71	4572.38	3243.81	1728.57	32.14
KJH-36	-DO-	650.86	5149.63	4131.36	751.75	14.93
KH-31	HABO	306.20	12354.88	2032.71	1765.41	25.44
KH-34	-DO-	628.16	3766.08	318.84	1118.10	26.10

From the table, it can be seen that the concentration of manganese in the Jhurio Formation varies from 280.31 ppm to 983.63 ppm with mean of 524.63 ppm; whereas in the Jumara Formation it varies from 389.18 ppm to 1113.57 ppm with mean value of 681.78 ppm. The concentration of iron in Jhurio Formation varies from 318.84 ppm to 5723.60 ppm with average value of 2181.81 ppm; whereas in the Jumara Formation it varies from 480.03 ppm to 2324.47 ppm with average of 1129.47 ppm. The value of Fe/Mn ratio indicates a marine environment and the overall increase in the value of Fe and Mn indicates late stages of diagenetic effects.

The concentration of magnesium and strontium in Jhurio Formation varies from 3766.08 ppm to 12354.88 ppm with mean of 6215.38 ppm and from 751.75 ppm to 2210.84 ppm with mean of 1463 ppm respectively. In Jumara Formation, the value of Mg and Sr varies from 3231.99 ppm to 18506.95 ppm with mean of 8236.44 ppm and 224.74 ppm to 1608.18 ppm with mean of 612 ppm respectively. The overall decrease in concentration of Mg and Sr may be due to the diagenetic alterations. The concentration of calcium has been tabulated in weight percentages. In Jhurio Formation, it varies from 14.93 % to 32.14 % with mean of 26.21 %; whereas, in the Jumara Formation it varies from 7.55 % to 34.38 % with mean value of 19.27 %. This may be due to the later stages of diagenesis within Jumara Formation.

STABLE ISOTOPE STUDY

Isotopes are defined as atoms whose nucleii contain the same number of protons but different number of neutrons. Isotopes can be divided into stable and unstable (radioactive) species. The number of stable isotopes is about 300; whilst over 1200 unstable ones have been discovered so far. Radioactive decay is one of the processes that produces isotope abundance variations. The second process is that of isotopic fractionation caused by small chemical and physical differences between the isotope of an element. Only the later process is used in the present study.

The isotopic composition of a solid precipitated from solution is dependent upon the isotopic composition of the precipitating medium. In the $CaCO_3$-CO_2-H_2O system, the stable isotopes of oxygen and carbon O^{16}, O^{18}, C^{12} and C^{13} are incorporated into the carbonates. The distribution of stable isotopes within a carbonate sequence provides an information about the nature of the medium from which they are precipitated (Flugel, 1982). It is established fact that the $^{18}O/^{16}O$ ratio of ocean water is fairly uniform through geologic time. Ocean water is enriched in ^{18}O relative to fresh water caused by greater volatility of H_2 ^{16}O (Lloyd, 1966; Weber,1967). As a result, fresh water has about 7 to 30 per thousand lower $^{18}O/^{16}O$ ratio than ocean water. The calcium carbonate precipitating from the fresh water is therefore depleted in ^{18}O in comparison to that precipitated from marine water. The enrichment of ^{13}C in the bicarbonate ions of the ocean and of ^{12}C in atmospheric carbon dioxide and continental water are attributed to the isotopic fractionation during the process of photosynthesis and organic decay. This process of isotopic fractionation of carbon and oxygen in nature forms (i) the basis for using stable isotopic enrichments of limestones and fossil shells as indicators of paleoenvironments and (ii) a tool to differentiate between marine and fresh water environments of deposition of carbonates.

The analytical procedure adopted in the present study is as follows:
About 3 mg of sample is reacted in vacuum with 100 % H_3PO_4 at a constant temperature of 50°C in an online extraction system. The CO_2 gas evolved is cleaned of water vapour by passing it through an alcohol liquid nitrogen slurry maintained at -90°C. The pure CO_2 gas is then allowed into a **VG Micromass 903 mass spectrometer** and the 45/44 and 46/44 isotope ratios are measured relative to an internal standard, which has been calibrated relative to an International Standard (PDB). Craig corrections were made for isobaric interferences and the $\delta^{13}C$ and $\delta^{18}O$ were determined. The results are precise to +0.1 o/oo.

The carbon isotopic ratios are expressed as delta ^{13}C in parts per thousand difference from the standard.

delta ^{13} C = 1000 (R sample - R standard) / R standard

Where R = Delta ^{13} C / Delta ^{12} C

Delta ^{18}O is defined similarly in terms of ^{18}O/^{16}O ratios. The standard used is belemnite from the Pee Dee Formation, South Carolina, USA. The data thus obtained for about sixty representative samples of Jhurio and Jumara Formations of Jumara, Jhura and Habo domes respectively are given in **tables VI.5, 6 and 7.**

From the tables it can be seen that the value of δ^{13} C in the Jhurio and Jumara Formation of Jumara dome varies from -0.59 to 2.11 with an average of 0.79 and -17.3 to 1.99 with an average of -3.10 respectively. The value of δ^{18} O in the Jhurio and Jumara Formation of Jumara dome varies from -5.68 to -3.5 with an average of -4.36 and -8.06 to -1.84 with an average of -4.64 respectively. Similarly, the value of δ^{13} C in the Jhurio and Jumara Formation of Jhura dome varies from -2.01 to 1.46 with an average of 0.21 and -2.44 to -0.1 with an average of -1.58 respectively. The value of δ^{18} O in the Jhurio and Jumara Formation of Jhura dome varies from -8.2 to -1.9 with an average of -5.17 and -6.9 to -2.65 with an average of -5.61 respectively.

The value of δ^{13} C in the Jhurio and Jumara Formation of Habo dome varies from -0.71 to 1.62 with an average of 0.52 and -5.01 to 1.62 with an average of -1.16

Table VI.5: **THE STABLE ISOTOPE VALUES OF $\delta^{13}C$ AND $\delta^{18}O$ IN JUMARA AND JHURIO FORMATION, JUMARA DOME**

SR.NO.	SAMPLE NO.	FORMATION	$\delta^{13}C$	$\delta^{18}O$
1	KJ-1	**JUMARA**	1.13	- 3.79
2	KJ-2	-DO-	- 4.7	- 4.4
3	KJ-10	-DO-	1.99	- 2.43
4	KJ-11	-DO-	0.19	- 6.76
5	KJ-12	-DO-	- 6.69	- 5.67
6	KJ-13	-DO-	- 5.32	- 8.06
7	KJ-33	-DO-	- 5.04	- 1.84
8	KJ-35	-DO-	- 9.7	- 4.1
9	KJ-37	-DO-	- 17.3	- 3.3
10	KJ-39	-DO-	- 2.9	- 6.1
11	KJ-21	**JHURIO**	2.11	- 3.5
12	KJ-23	-DO-	1.0	- 4.41
13	KJ-24A	-DO-	0.73	- 3.95
14	KJ-24B	-DO-	- 0.59	- 5.39
15	KJ-24C	-DO-	0.17	- 5.68
16	KJ-25	-DO-	0.83	- 3.62
17	KJ-28	-DO-	0.5	- 4.7
18	KJ-48	-DO-	1.58	- 3.67

Table VI.6: **THE STABLE ISOTOPE VALUES OF $\delta^{13}C$ AND $\delta^{18}O$ IN JUMARA AND JHURIO FORMATION, JHURA DOME**

SR.NO.	SAMPLE NO.	FORMATION	$\delta^{13}C$	$\delta^{18}O$
1	KJH-5	**JUMARA**	- 2.08	- 5.11
2	KJH-53	-DO-	- 0.1	- 6.7
3	KJH-54	-DO-	- 2.3	- 6.9
4	KJH-55	-DO-	- 0.9	- 5.5
5	KJH-57	-DO-	- 2.1	- 6.1
6	KJH-73	-DO-	- 1.15	- 5.84
7	KJH-74	-DO-	- 1.56	- 6.07
8	KJH-78	-DO-	- 2.44	- 2.65
9	KJH-17	**JHURIO**	- 0.76	- 5.35
10	KJH-18	-DO-	1.46	- 4.0
11	KJH-19	-DO-	0.81	- 4.09
12	KJH-20	-DO-	0.3	- 4.61
13	KJH-21	-DO-	1.38	- 5.74
14	KJH-23	-DO-	- 0.24	- 4.73
15	KJH-28	-DO-	0.56	- 6.16
16	KJH-30	-DO-	- 0.3	- 7.3
17	KJH-35	-DO-	1.4	- 3.7
18	KJH-36	-DO-	- 1.3	- 7.5
19	KJH-37	-DO-	- 1.45	- 8.2
20	KJH-63	-DO-	- 0.5	- 4.6
21	KJH-65	-DO-	- 0.2	- 5.3

SR.NO.	SAMPLE NO.	FORMATION	$\delta^{13}C$	$\delta^{18}O$
22	KJH-83	-DO-	1.1	- 4.4
23	KJH-84	-DO-	1.9	- 1.9
24	KJH-85	-DO-	1.4	- 3.9
25	KJH-87	-DO-	- 2.01	- 6.51

Table VI.7: **THE STABLE ISOTOPE VALUES OF $\delta^{13}C$ AND $\delta^{18}O$ IN JUMARA AND JHURIO FORMATION, HABO DOME**

SR.NO.	SAMPLE NO.	FORMATION	$\delta^{13}C$	$\delta^{18}O$
1	KH-1	**JUMARA**	0.81	- 1.97
2	KH-4	-DO-	- 0.95	- 3.38
3	KH-5	-DO-	- 1.75	- 4.70
4	KH-7	-DO-	- 0.60	- 8.17
5	KH-9	-DO-	- 1.60	- 8.62
6	KH-10	-DO-	- 4.81	- 7.78
7	KH-11	-DO-	- 5.01	- 6.54
8	KH-13	-DO-	- 1.65	- 3.11
9	KH-18	-DO-	- 1.14	- 6.87
10	KH-19	-DO-	- 0.45	- 7.35
11	KH-20	-DO-	1.62	- 5.42
12	KH-22	-DO-	0.23	- 5.38
13	KH-23	-DO-	- 1.3	- 6.3
14	KH-24	-DO-	0.4	- 8.4
15	KH-32	**JHURIO**	0.68	- 7.27
16	KH-34	-DO-	1.12	- 7.54
17	KH-35	-DO-	- 0.71	- 9.01
18	KH-36	-DO-	1.62	- 4.72
19	KH-38	-DO-	- 0.12	- 11.01

respectively. The value of δ^{18} O in the Jhurio and Jumara Formation of Habo dome varies from -11.01 to -4.72 with an average of -7.91 and -8.62 to -1.97 with an average of -6.0 respectively.

The foregoing account on mineralogical and geochemical studies alongwith a detailed petrography has greatly aided in the interpretation of diagenesis and depositional environment of the carbonate sequences of the study area and forms the subject matter of the subsequent chapter.