CHAPTER - VI

PETROGRAPHIC STUDIES

GENERAL

Petrographic study has been carried out on representative litho units of different formations i.e Lathi, Jaisalmer, Baisakhi and Bhadasar formations of the Jurassic sediments. In this sequence the Lathi, Baisakhi and Bhadasar formations are predominantly a clastic sequence while the Jaisalmer Formation is mainly a carbonate sequence with thin interbeds of calcareous sandstone. For the sake of convenient and better understanding of microfacies, the clastic as well as carbonate sections have been dealt separately formation wise.

MICROFACIES OF CLASTIC SEDIMENTS

The microfacies were identified on the basis of petrographic characters of clastic sequence of Jurassic sediments, following the scheme of classification adopted by William, Turner and Gilbert, (1953), and later on modified by Dott. (1964). The important microfacies has been discussed formation wise in proceeding paragraphs.

LATHI FORMATION

The Lathi Formation comprises a sequence of conglomerate, coarse grained, poorly sorted, sandstone and siltstone with abundant fossilwood, mostly ferruginised and occasionally silicified. The

lower part of Lathi Formation (Odania Member) is characterised by conglomerate bed, followed by a sequence of white to maroon siltstone, coarse to medium grained, poorly sorted, gritty sandstone which grades upward to siltstone, exhibiting fining upward sequence. In the scarp section of south of Bhojaka and Akal areas the sandstones are light grey to grey in colour, soft, medium to coarse, moderately compacted and occasionally well bedded. Based on the petrographic characters, the following microfacies have been identified within rocks of the Lathi Formation (Table VI.1).

(a) Quartz wacke.

(b) Quartz arenite

(c) Siltstone.

Quartz wacke

This microfacies is composed of fine to medium grained, moderately sorted, subangular to subrounded mainly monocrystalline quartz grains (60-80%;Plate VI.1A) at places showing bimodal population; one characterised by fine grained and other medium to coarse grained, suggesting existence of more than one provenance providing detritus to the area. Feldspars are occasional, at places vary from 2-5% and are basically plagioclase. The rock fragments are in minor amount ranging from 2-5%, composed of mainly chert and traces of chalcedony. Micas are present throughout the section in this microfacies, out of which, muscovite is a common mineral. The infilling material acting as matrix are basically chloritomicaceous clays ranging from 15 to 25%. At places the ferruginous matter has

TABLE : VI.1 : PETROGRAPHIC DETAILS OF CLASTIC SEQUENCE IN LATHI FORMATION,

JAISALMER BASIN, WESTERN RAJASTHAN

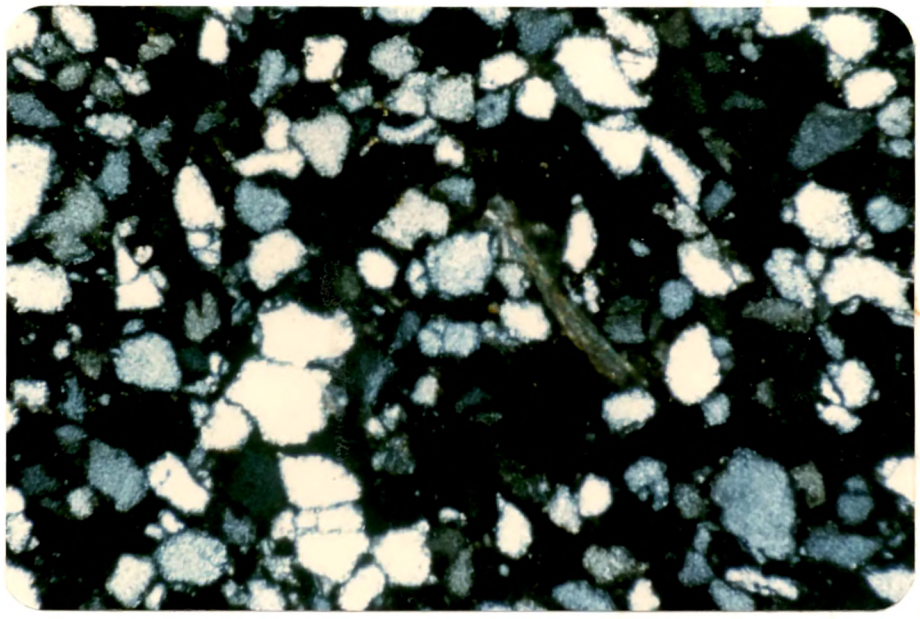
FORMATION	MEMBER	SAMPLE No	GRAIN-TYPE %					MATRIX %	CEMENT %	TEXTURAL CHARACTERISTICS	NAME OF THE ROCK	REMARKS
			Quartz	Feldspar	Mica	Rock Frag.	HEAVY OTHERS Minerals					
		L-1	80	Occ.	P	5	Tour Zir, Rut.	15		Fine to Med grained -Subangular to sub rounded	Quartz wacke	Porosity intergranular, -Chert and chalcedony as rock fragments.
		L-1A	80	Occ	P	5	do	15		-Fine to Med grained subangular to sub rounded	Quartz wacke	-Chert as a rock fragments -chlorito clayey matrix.
	T											
		L-2	80	Occ.	P	5	Tour	15	Calc. cement in patches	-Fine to Med grained subangular to subrounded	Quartz wacke	-Two types of quartz (1) Monocrystalline (2) Poly crystaline
	H							15	-			-Microcline Plagioclase present
L		L-3A	77	5	P	3	Tour Mica Zir,	15		-Fine to Med grained, Med grained dominating subang to sub rounded	Quartz wacke	-Two types of quartz (1) Mono crystalline (2) polycrystalline -chloritic, micacaceus clayey matrix -Bimodal population of quartz -Mod Ø intergranular
A	A											
T												
	I											
H												
I	Y	L-6	90	-	P	P	Magnetite Hematite	10 Chlorito-micaceous clay	-	-Fine grained dominating, grains are sub ang to sub rdd	Quartz arenite	-Alignments of quartz showing effect of pressure
	A	L-7	90	-	P	5	P	5	-	Fine grained dominating	Quartz arenite	-Two type of quartz (1) Monocrystalline (2) Poly crystalline
	T	L-9A	85	-	P	P (chert)	- -	15 Clay matrix	-	-Predominantly fine grained Subang to sub rdd	Quartz wacke	-Two type of quartz (1) Monocrystalline (2) Poly crystalline
		L-11	90	-	P	P	Tour. - Magnetite -	10 Clay matrix, admixed with silt. grade quartz	-	Poorly sorted fine to med grained, at places coarse grained	Quartz arenite	Bimodal population of quartz

FORMATION	MEMBER	SAMPLE No	GRAIN TYPE %						MATRIX %	CEMENT %	TEXTURAL CHARACTERISTICS	NAME OF THE ROCK	REMARKS
			Quartz	Feldspar	Mica	Rock Frag.	Heavy Minerals	Other					
	O												
	D	L-12	50	5	P	5	Tour. maline	20 Bio clasts	20% Ferr. calc. matrix	-	Silt grade to med. quartz	Calc. quartz wacke	-
	A												
	N	L-13	83	-	P	2			15 clayey admixed with ferr. matter		-Mod; sortec, fine to Med. grained, at places coarse grained, -Subang. to sub rdd.	Quartz wacke	Biomodal population of quartz
	I												
	A	L-14	90	-	P	-	Tour		10	Calcareous	-Mod. sorted, predominantly med. grained, subanglar sub. ang. to sub rdd,	Calc. quartz arenite	-Presence of quartz overgrowth -Calcite cement replaced by ferruginous matter -Biomodal Population of quartz grains
L		WL-1	80	5 Plagioclase	P	-	-		15 Ferruginous clayey matrix		-Predominantly fine, sub ang. to sub rdd,	Quartz wacke	-Biomodal Population of quartz
A													
T		WL-2	80	P	p		Tour		20 Ferr. clayey matrix		-Predominently very fine grained grained	Siltstone very fine grained quartz wacke	-Partly dolomitised
H													
I		WL3	80	Occ	Occ	2 Chert, Claystone	-	-	18 Clayey matrix	-	Predominantly silt - grade quartz grain - subang to subrdd	Siltstone	Sharp edged quartz grains present
		WL-4	90	P	P	-	-	-	10 clayey matrix	-	-do-	Siltstone fine grained quartz wacke	Moderately lithified
		WL-5	80	5 (Plag)	2 (Mus)	8 Chert	-	-	5 clay matrix		Predominantly fine grained -Subang to sub rdd	Quartz arenite	Moderately lithified
		TL-1	80	5	fare	Occ chert	Magnetite	-	15 clayey at places calcareous.	-	Predominantly fine grained,	Quartz wacke	Development of sparry calcite in matrix

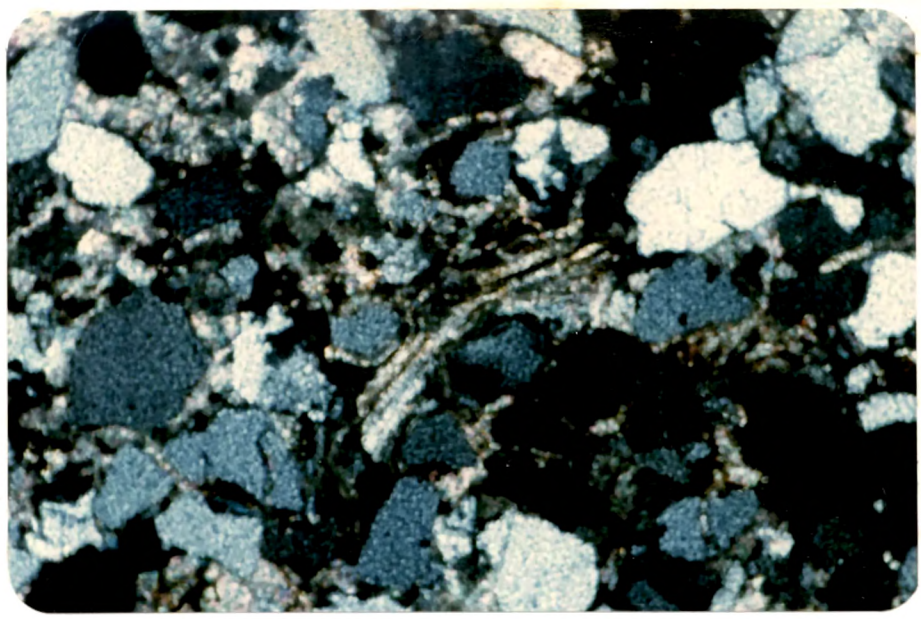
FORMATION	MEMBER	SAMPLE No	GRAIN TYPE %					MATRIX %	CEMENT %	TEXTURAL CHARACTERISTICS	NAME OF THE ROCK	REMARKS
			Quartz	Feldspar	Mica	Rock Frag.	Heavy Minerals Other					
	THAIYAT	TL-2	80	5 (Plag)	-	Occ chert	Tour Zircon - Magnetite	15 Ferruginous clayey	-	Fine to Med grained subangular to surbrdd	Quartz wacke	Moderately Lithified
		AL-1	80	-	P	-	Tour -	20 chloritic clayey matrix	calcareous cement in patches	Fine grd at places fine to med grd.	Fine grained Quartz wacke	-
L		AL2	90	Occ	P	-	Tour	10 chloritic clayey matrix at places patches of ferr, matrix,		Fine to Med grd mod sorted, sub ang to sub rdd.	Quartz arenite	
A		AL-3A	80	Occ	Occ.	P	-	20 calc. clayey	Calcareous in patches	Predominantly fine grained subangular to sub rounded	Quartz wacke	Presence of grain coated by ferr. clay
T		AL4	85	P (Plagioclase)	P	P chert chalcedony.	Garnet	15 Ferruginous clayey		Med to coarse grained	Ferr. Quartz wacke,	Common occurrence of Garnet
	DANIA	AL-5	95	-	P		Tour Magenetite	5 Ferruginous clayey.	Calcite cement in patches	Very fine to fine grained Mod sorted, subang to sub rdd.,	Quartz arenite,	Overgrowth of quartz observed
H		AL-6	90	-	P	chert	Tour Magnetite	10 Ferr. clayey		-do-	Quartz arenite	Quartz overgrowth
I		AL-7	80	-	Rare	Chert	- -	20 Ferruginous clayey matrix	-	Fine to coarse grained Mod. sorted, sub ang. to sub rdd.,	Quartz wacke	-Replacement of ferruginous matrix by carbonate -Sparitisation in matrix
		AL-8	80	Occ	Occ	Occ Chert & quartz	- -	20 clayey		Fine to Med.grained, Mod. sorted, sub ang to sub rdd.	Quartz wacke	Basically two types of quartz 1. quartz with inclusion and 2. quartz without inclusions -Clay coating around quartz grains

FORMATION	MEMBER	SAMPLE No	GRAIN TYPE % Quartz	Feldspar	Mica	Rock Fragments	Heavy Minerals	Other	MATRIX %	CEMENT %	TEXTURAL CHARACTERISTICS	NAME OF THE ROCK	REMARKS
		AL-9	80			Occ chert	-	-	20 ferruginous clay		Fine to Med. grained., Mod. sorted, sub ang to sub rdd.	Quartz wacke	
		AL-10	80	P	Occ	Occ	-	-	20 calc clayey admixed with ferr. matter		Fine to Med. grained Mod.sorted, sub angular to subrounded.	Calc. quartz wacke	-
		AL-11	65	5	Occ	Occ	-	-	25% calc clayey	-	Fine to Med.grained., Mod.sorted, Subrounded.	Calc quartz wacke	-Presence of fractured quariz showing shearing effect.

PLATE-VI.1



A. Photomicrograph of quartz wacke showing moderately sorted fine grained aggregates of quartz, mica flakes set in clayey matrix, tiny crystals of calcite observed within the matrix, Thaiyat Member, Lathi Formation; X55; XN.



B. Photomicrograph of calcareous quartz arenite showing bimodal populations of quartz grains suggesting existence of more than one provenance, Odania Member Lathi Formation; X45; XN.

also been observed within the matrix as isolated patches. This microfacies constitutes more than 70% of the Odania Member - the lower part of Lathi Formation, while in the upper part it ranges from 50-55% and becoming finer.

Quartz arenite

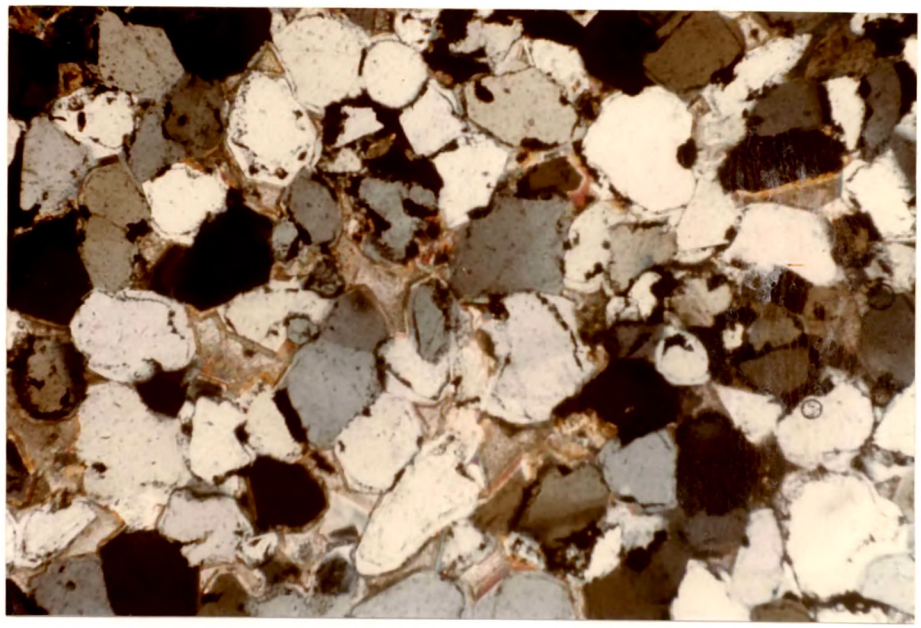
This microfacies is generally fine grained, at places fine to medium grained, composed of predominantly monocrystalline quartz (90-95%), which are subangular to subrounded and moderately sorted (Plate VI. 1B). At places overgrowth of the quartz (Plate VI.2A) have also been observed in the lower part the section. Feldspars are basically plagioclase ranging from 2-5%, rock fragments are generally chert and chalcedony in minor proportion. This facies occurs in approximately subequal proportion (25-30%) in the upper and lower members of this formation and becomes more finer in upper section as compared to lower section.

The infilling materials in this microfacies are ferruginous clays ranging from 2-3%. The intergranular spaces have been occupied by sparry calcite cement (Plate VI. 1B), which has corroded the quartz boundaries in lower part of the section, giving an appearance of more angularity to the grains.

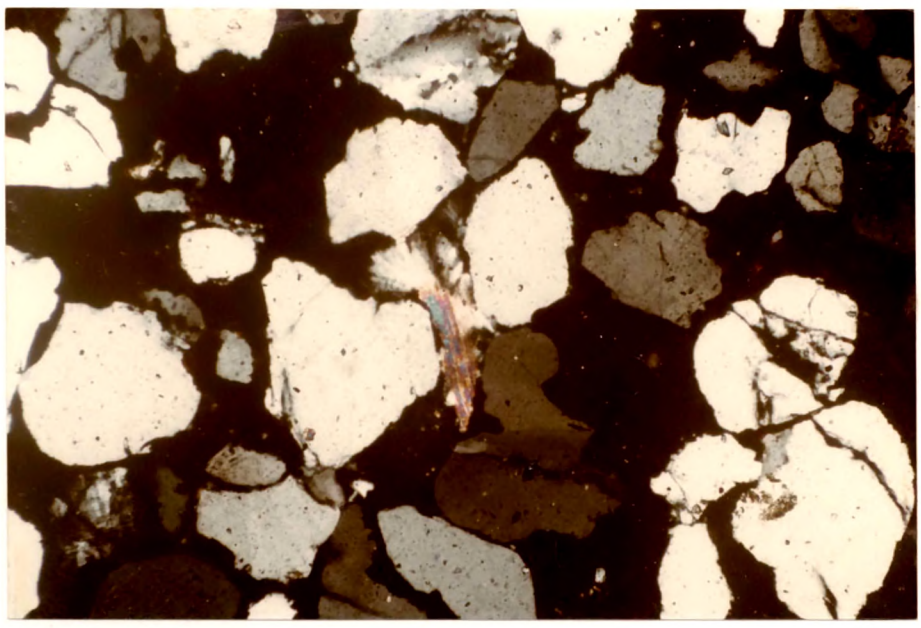
Siltstone

This microfacies is characterised by predominance of very fine

PLATE-VI.2



A. Photomicrograph of calcareous quartz arenite showing quartz overgrowth and sparry calcite cement, Odania Member, Lathi Formation; X45; XN.



B. Photomicrograph of quartz arenite showing bent mica, strained and fractured quartz suggesting effect of tectonic episode, lower part of Odania Member, Lathi Formation; X45; XN.

grained sands to silt grade quartz (75-80%), subangular to subrounded, moderately sorted with occasional presence of plagioclase feldspar. Tiny muscovite mica flakes are evenly distributed within the ferruginous matrix.

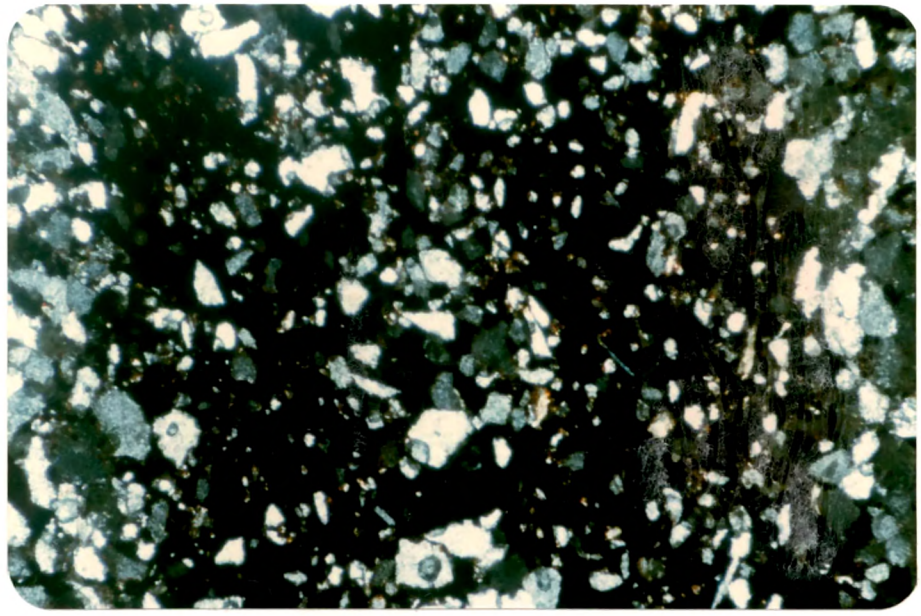
The infilling materials are basically ferruginous clay matter ranging from 15-30%, (Plate VI. 3A). Fine tiny crystals of dolomites have been observed within the matrix. At places replacement of calcite which is occuring in patches, by ferruginous matter, has also been noted. This microfacies has been marked in upper part of the section (Thaiyat Member) as thin interbeds within sandstone section.

JAISALMER FORMATION (CLASTIC SEQUENCE)

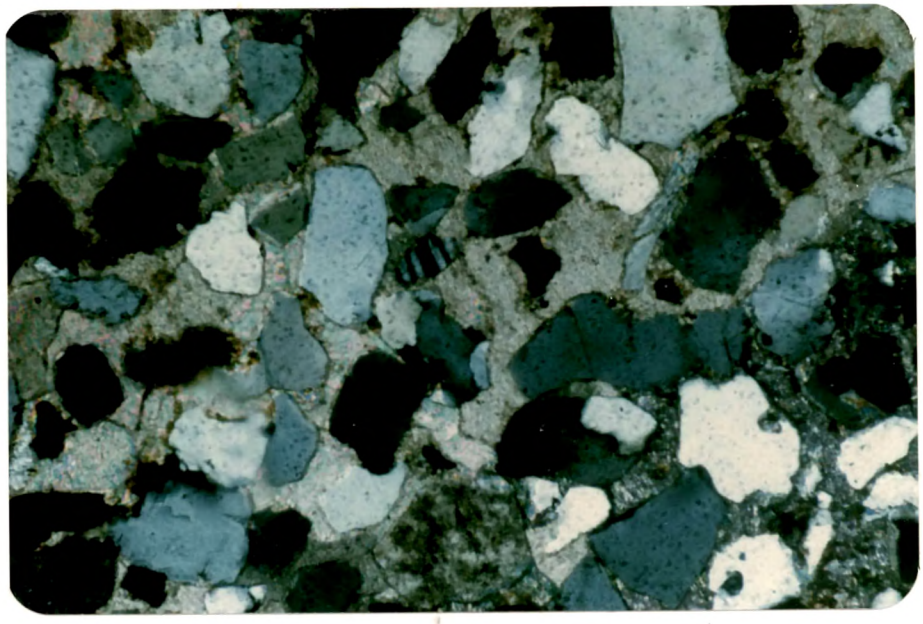
The Jaisalmer Formation is predominantly a carbonate section with intercalation of calcareous sandstones. The petrographic details and microfacies studies of carbonate sections has been dealt separately in a separate subtitle 'microfacies studies of carbonate section of Jaisalmer Formation'. The clastic sections of this formation are basically fine to medium grained, calcareous sandstone, whitish grey to yellowish brown in colour having cross bedded features.

The petrographic details of the clastic sequence show predominantly calcareous quartz arenite (Plate VI.4A) with thin interbeds of calcareous and ferruginous quartz wacke (Plate VI.4B).

The calcareous quartz arenite is characterised by presence of



A. Photomicrograph of argillaceous siltstone microfacies of Odania Member, Lathi Formation showing aggregate of fine to very fine sand grade quartz set in clay matrix, at places influx of ferruginous matter and tiny particles of dolomite within the matrix is also observed; X55; XN.



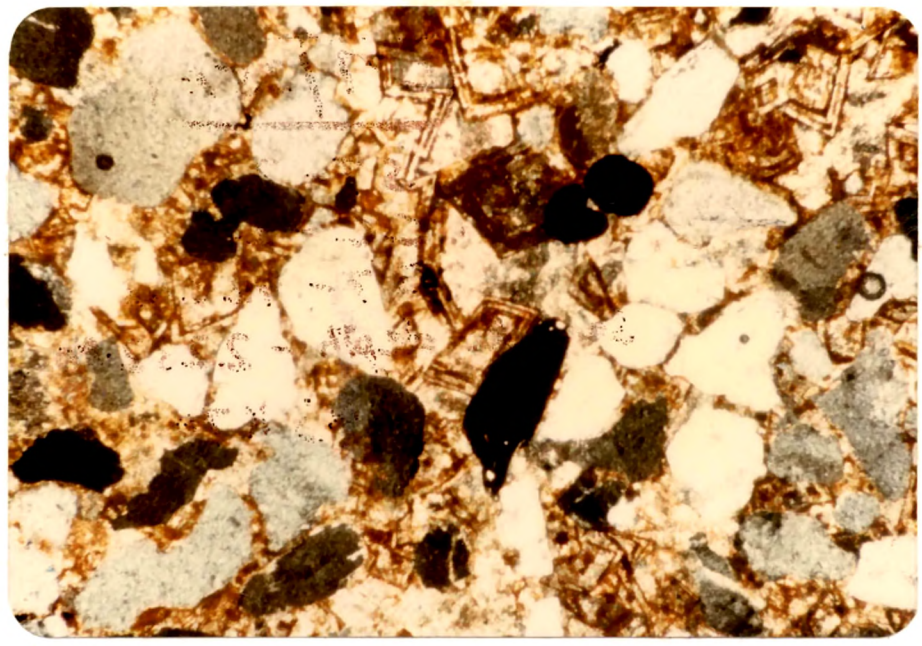
B. Photomicrograph of calcareous quartz arenite showing aggregate of quartz, plagioclase feldspars and chert fragments, Hamira Member, Jaisalmer Formation; X55; XN.

quartz grains, (90-92%), fine to medium grained, subangular to subrounded and moderately sorted along with a few plagioclase feldspars and chert fragments (Plate VI . 3B). Calcite and occasionally dolomite acting as cementing material binds the framework (Plate VI-4A). In some of the sections boundaries of the quartz grains are corroded by the calcite cement and at places calcite spars have been developed as spary cement can change the name of the rock from arenite to wacke.

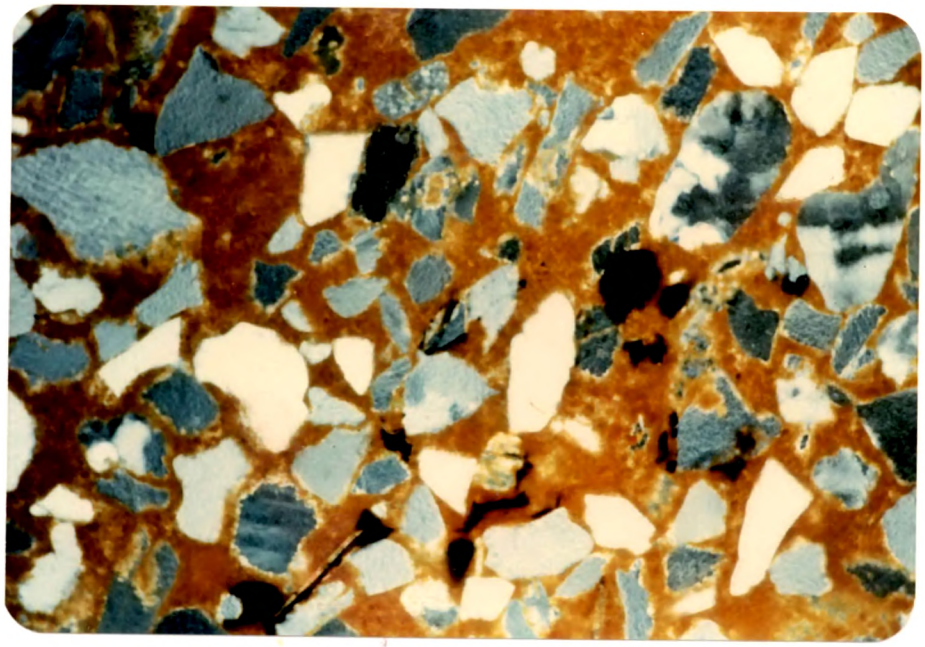
This facies has been marked as thin beds at the base of each member of Jaisalmer Formation in the exposed section. In calcareous quartz arenite facies of Hamira and Joyan members, coarse rhombs of zoned dolomite are observed (Plate VI.4A). This is probably due to subaerial diagenesis of outcrop by meteoric water. Similar microfacies has also been encountered in subsurface section of Jaisalmer Formation in Bhuana and Sumarwali Talai structures.

BAISAKHI FORMATION

The Baisakhi Formation comprises essentially of alternation of fine grained sandstone and gritty shale with occasional claystones. The sandstones are white to grey, occasionally pale yellow and brown, thinly bedded and moderately compacted with occasional encrustations of ferruginous concretions and nodules. At places, clays are variegated with shades of grey, pale yellow and purple colour and are gypseous in nature.



A. Photomicrograph showing subrounded occasionally subangular and rounded quartz bound by ferruginous matrix. Partially quartz grains are cemented by zonned ferron dolomite and calcite, Hamira Member, Jaisalmer Formation; X55; XN.



B. Photomicrograph showing dominantly angular to subangular quartz set in ferruginous clay matrix polycrystalline quartz are also seen, Kuldhar Member, Jaisalmer Formation; X55; XN.

The following microfacies has been identified in the sandy section of this formation, the details are given in Table VI.2.

Quartz wacke

This microfacies is characterised by fine to medium grained, subangular to subrounded quartz (55-80%), feldspar predominantly plagioclase (2-5%), mica occurs occasionally as muscovite alongwith rock fragments (5-10%), the rock fragment composed of mainly chert, argillites and fine grained siltstone. Matrix as infilling material ranging from 15-20%, is basically clayey, admixed with fine silt grade quartz. The quartz grains are predominantly two types (1) monocrystalline (60-80%) and (2) polycrystalline (40-20%). At places bimodal population of the quartz grains has also been observed in the upper part of the formation in Ludharwa and Rupsi members (Plate VI.5A).

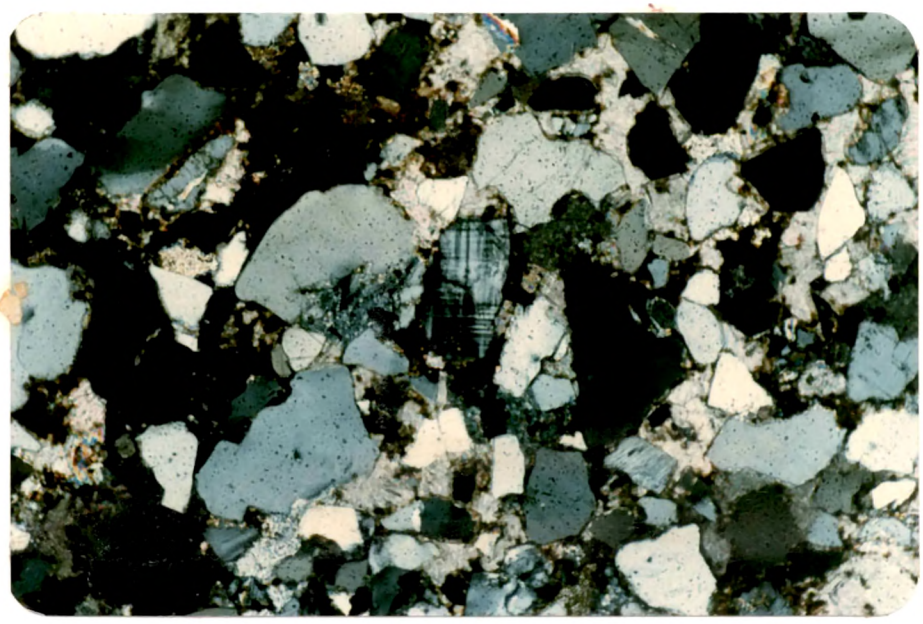
Influx of the ferruginous matter has been observed in the microfacies of Ludharwa and Rupsi members with more dominance of plagioclase feldspars, giving the name of microfacies as ferruginous quartz arenite (Plate VI.5A).

The lower most part of the formation (Baisakhi Member) is characterised by influx of calcareous matter within the clayey matrix along with ferruginised shell fragments giving its nomenclature as calcareous quartz wacke (Plate VI.5B).

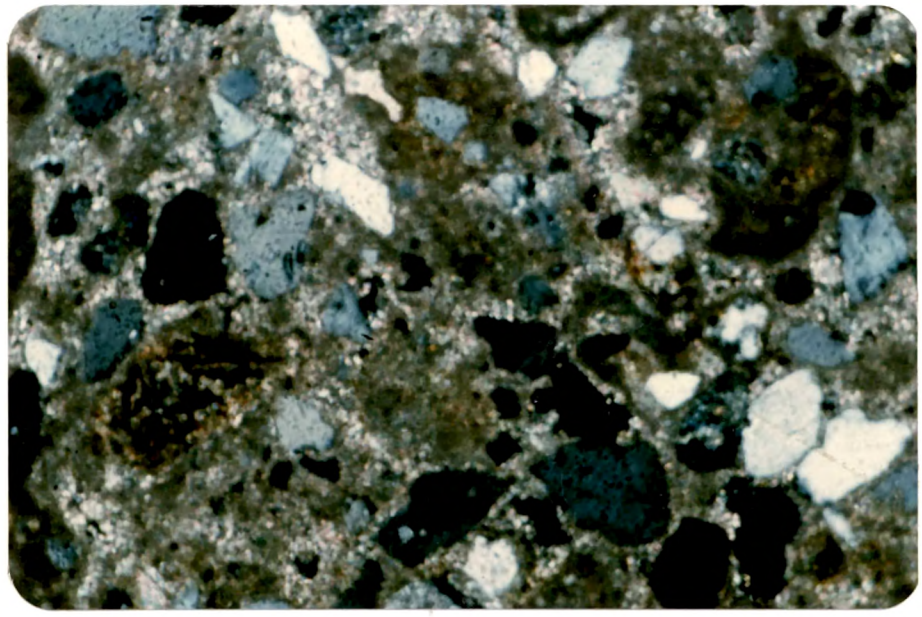
TABLE : VI. 2 PETROGRAPHIC DETAILS OF CLASTIC SEQUENCE IN BAISAKHI FORMATION, JAISALMER BASIN.

FORMATION	MEMBER	SAMPLE NO	GRAIN - TYPES (%) Quartz	Feldspar	Mica	Rock Fragments	Heavy Minerals	Other	MATRIX %	CEMENT %	TEXTURAL CHARACTERISTICS	NAME OF THE ROCK	REMARKS
BAISAKHI	BARU	BR-13	40	5	Occ	Occ	-	30 Echino derm plates	20 Ferr, clayey,	Occ.ferruginous 5	Fine to coarse grd, poorly sorted,	Bioclastic quartz wacke	-Bimodal population of quartz grains
		BR-14	40	5	Occ	Occ	-	20 -do-	30 Ferr.clayey	5% Occ.ferr.	Fine to coarse grd,	-do-	-do- Feldspar plagioclace present
		BR-16	80	5	Occ	Occ		-	15 Ferr.clayey	-do-	Fine to coarse grd, poorly sorted,	Quartz wacke	Bimodal population of quartz
		BR-17	75	5	-	-	-	Iron mineral	20 Ferr.clayey	Occ.Ferr. matter,	Fine to V. coarse grd.,	Quartz wacke	-do-
		BR P-1	80	5	Present	-	Occ.	-	15 Ferruginous clayey	-	-Fine to Med. grd, subangular,	Ferr. Quartz wacke	-Feldspars microcline, and albite present
		BR P-2	80	5	Occ.	-	Occ.	-	15	-	-do-	Quartz wacke	-Ferruginous cement replaced by carbonate cement
		BR P-3	80	5	Occ.	-	Tour. Hematite	-	15	-	-Predominantly finegrd. mod. sorted,	Quartz wacke	-Predominantly two types of quartz(1) monocrystalline (2) poly crystalline
		BRP-4	60	5	Occ.	10			15 Calc.clayey	-	-Fine to med. grd, at places coarse grd., mod. sorted,	Quartz wacke	-Plagioclase present -Rock fragment - chert, quartzite.
	LUDHARWA	BRL-2	80	5 (Plagio., microcline	Occ.				15 Ferr. clayey matrix	-	-Fine to med. grd., at places coarse grd., mod. sorted.	Ferr. Quartz	-
		BRL-3	85	Occ.	Occ.		Tour.		15		Fine to med grd, mod sorted	Quartz wacke	-Microcline present in feldspar
		BRL-4	80	5 Plagio, Microcline	Occ.		Tour.		15 Ferr. clayey		Fine to Med, grd., Mod. sorted	Quartz wacke	Two type of quartz (1) Monocrystalline (2) Poly crystalline
		BRL-5	80	5	Occ.		Tour.		15 Ferr.clayey		-do-	Quartz wacke	-do-

FORMATION	MEMBER	SAMPLE NO	GRAIN - TYPE (%)						MATRIX %	CEMENT %	TEXTURAL CHARACTERISTICS	NAME OF THE ROCK	REMARKS
			Quartz	Feldspar	Mica	Rock frag-	Heavy Minerals	Others					
		BB-1	75	5	-		P	Pellets, Bioclast,	20 Clayey		Fine to Med.grd., Mod. sorted.	Quartz wacke	-do-
B A I S A K H I	B A I S A K H I	BB-2	65	5	5		P		25 Clayey	-do-	-do-	Calc. quartz wacke	Dominance calcareous matter,
		BB-5	80	5	-	-			15 Calcareous matrix	-	Fine grd, sub angular to sub rdd.,	Calc quartz wacke	Fine grd., dominance of calc. matter
		BB-6	80	5	-		Tour. Hematite		15 Calcareous	-	Fine grd., sub angular to sub rdd.,	Calc. quartz wacke	Fine grd., dominance of calc. matter
		BB-7	25	10	Present		-	Pellets 30% Bioclasts 20 %	15 Calcareous clayey	-	-Fine grd -Subangular to elongated.	Calc. quartz wacke	Fine grained
		BB-8	75	5	-		Tour. Magnetite		20 Argilaceous clayey admixed with ferr.matter,	At places ferr. matter,	Fine grd.,	Ferr. quartz wacke	-do-



A. Photomicrograph showing fine to medium grained, ill sorted quartz and occasional feldspar in quartz arenite microfacies. The cements are mainly ferruginous. At places calcite cements are also observed. The quartz boundaries are corroded by calcite, Ludharwa Member, Baisakhi Formation; X45; XN.



B. Photomicrograph of calcareous quartz wacke comprising dominantly fine grained quartz set in calcareous clay matrix. Occasional feldspar and ferruginised shell fragments are also observed. The quartz boundaries are generally corroded by calcite, Baisakhi Member, Baisakhi Formation; X45; XN.

The vertical distribtution of average mean grain size in the microfacies of the Baisakhi Formation as a whole, characterised by coarsening upward trend and the maturity of the sand along with better sorting and textural characteristics suggest marine influx during deposition of the sediments.. Basically the two types of quartz grains and their bimodal population suggest more than one type of provenance responsible for supplying the detritus.

BHADASAR FORMATION

The Bhadasar Formation is characterised by ferruginised gritty sandstones interbedded with friable red sandstones, followed by brown argillaceous fine grained sandstones. On the basis of petrographic details, the following microfacies have been identified in the formation. (Table.VI.3).

Quartz wacke

This microfacies is characterised by fine to coarse grained, poorly sorted quartz (70-80%), feldspars (2-5%) predominantly plagioclase, occasional rockfragments, at places varying from 3-5% with ferromagnesian minerals (2-3%), set in ferruginised clayey matrix (Plate VI. 6A). The quartz grains show bimodal populations being polycrystalline and monocrystalline in nature. At places overgrowth in the quartz has also been observed (Plate VI.6B).

In the lower part of the formation, the quartz wackes are

TABLE VI. 3 PETROGRAPHIC DETAILS OF CLASTIC SEQUENCE OF BHADASAR FORMATION OF JURASSIC SEDIMENTS,

JAISALMER BASIN, WESTERN RAJASTHAN

FORM.	MEM.	SAMPLE NO	GRAIN -TYPES (%)						MATRIX %	CEMENT %	TEXTURAL- CHARACTERISTICS	NAME OF THE ROCK	REMARKS
			Quartz	Feldspar	Mica	Rock Fragments	Heavy Minerals	Others					
BHADASAR	MOKAL	MBR-1	90	Occ.	Occ.	-	Present	5%	5% Ferruginous clay	Ferr.	-V.fine to med. grd., sub angular to sub rounded,	Quartz arenite	-Ferruginous matter present
		MBR-2	70	5	Occ.	-	-	5%	20 Calc.clayey	-	-Fine to Med. grained, subangular to sub rounded,	Quartz wacke	-Two type. of quartz (1) Poly crystalline (2) Mono crystalline
		MBR-3	75	5	Occ.	5	-	Occ. iron mineral	10 Ferr.clayey	5. Ferr. cement present,	-Fine to Med. grd, subang to sub rounded,	Quartz arenite	-Ferruginous cement present
		MBR-4	65	5	-	10	Occ	-	15	5 Calc. ferr	-Fine to coarse grd, poorly sorted,	Quartz wacke	-Rock fragments are chert, chalcedony.
	KOLAR	MBR-5	45	5	Occ	10	-	-	35 calc. clayey mixed with ferr.matter	10 Ferr. & calc.	-Fine to coarse grd, subang. to subrounded,	Ferr. Quartz wacke	-Solution phenomenon,
		MBR-5A	88	Occ	Occ	Present 20%	-	-	10 Ferr. clay.	Ferr.	Fine to coarse grd.,	Quartz wacke	-Rock fragments are chert. -Presence of quartz over growth
		MBR-6	80	2	Occ	Occ	3		15 Ferr clayey mixed	Ferr. cement at places calcite & siderite.	-Fine to coarse grd, subangular to subrounded,	Quartz wacke	-
	DUNGAR	MBR-7	60	2	-	-	Occ Fe-Min	18% Oolitic growth	20 Ferr. clayey	Ferr. matter present	-Fine to coarse grd, poorly sorted,	Quartz wacke	-Quartz over growth are present -Ferr.Min around quartz grains
		MBR-8	30	-	-	-	Occ	40% Siderite ooidal grains.	20 Ferr. Clayey	10 Ferr.,	-Fine to coarse grd,	Oolitic quartz wacke	-At places pellets are present
		MBR-10A	90	Occ	Occ	5	Occ	5% Magnetite Hematite etc.	10 Ferr. clayey	-	-Fine to Med. grd, sub angular,	Quartz arenite	-

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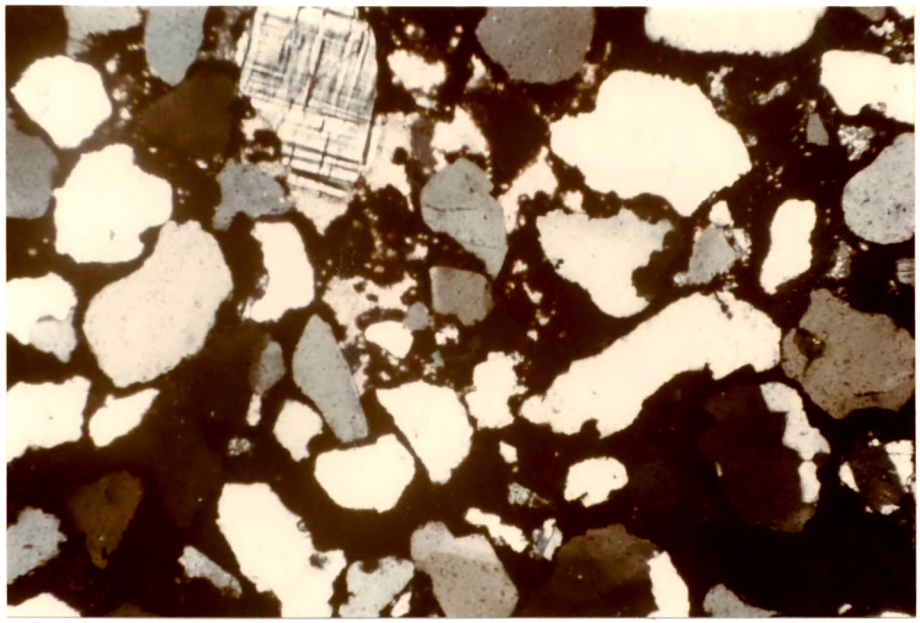
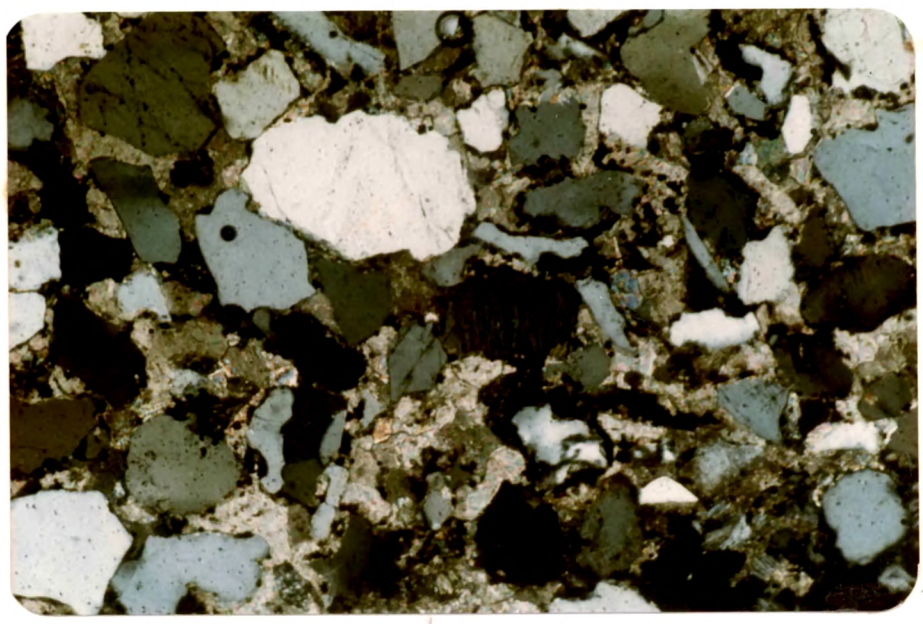
PLATE-VI.6



A. Photomicrograph of quartz wacke comprising fine to medium grained, mainly monocrystalline occasionally polycrystaline quartz and feldspar (microcline) set in ferruginous clay matrix. At places patches of calcite are also seen, Mokal Member, Bhadasar Formation; X45; XN.



B. Photomicrograph of quartz arenite showing aggregates of moderately sorted grains of quartz, feldspars set in admixed matrix of ferruginous clays and calcareous matter. Corroded quartz boundaries, overgrowth of quartz and ferruginous rim around the quartz grains are observed, Kolar Dungar Member, Bhadasar Formation; X55; XN.

poorly sorted, having fine to coarse grained quartz at places very coarse to gritty in nature showing immaturity of the sediments. In the upper part of the formation i.e Mokal Member, this microfacies is composed of fine to medium grained, subangular to subrounded quartz grains with feldspars.

Quartz arenite

This microfacies is characterised by fine to medium grained, subangular to subrounded, moderately sorted grains of quartz (85-90%) with occasional occurrence of feldspar and mica flakes. The infilling materials are basically ferruginous clays admixed with calcareous matter (15-10%) (Plate VI.6B). This microfacies has been observed in upper part of the formation i.e Mokal Member with rare occurrence in the lower part. Quartz overgrowth and ferruginous rim around the quartz grains are common phenomenon suggesting increasing trend of lithification and maturity of the facies from bottom to top in the vertical section of the formation.

Oolitic quartz wacke

This microfacies is characterised by poorly sorted, fine to coarse grained, quartz (30-40%), ferruginous sideritic oolite and pellets (30-40%) set in ferruginous clayey matrix (20-25%). This facies has been observed in Kolar Dungar Member within the sandstone section, suggesting agitating shallow water condition during the deposition of the sediments.

The vertical profile of the microfacies in the formation shows a fining upward trend and moderate to poorly sorted nature of the grains suggesting dominance of continental environment during deposition of the sediments.

MICROFACIES STUDIES OF JAISALMER FORMATION (CARBONATE SECTION)

Petrographic studies have been carried out for representative samples of carbonate section of Jaisalmer Formation, to identify the different predominant microfacies. Various schemes of classification of carbonate sediments by R.L. Folk (1959), M.W. Leighton and C. Pendexter (1962) and R.J. Dunham (1962) were published nearly simultaneously. In the present study, classification of carbonates by Dunham (1962) has been adopted since it is essentially a textural classification and is more valuable for lithified rocks. It is more explicitly descriptive than other schemes and has added the advantage of indicating textural elements from which depositional and diagenetic processes can be deduced.

The limestone consists of mainly three identifiable components grains (both skeletal and non skeletal), mud (micrite) and cement (sparite). The main skeletal particles observed in carbonate section of Jaisalmer Formation are echinoids, pelecypods, gastropods, brachipods, algae, corals, and smaller forams. The non skeletal bodies include pellets, oolites, intraclasts and terrigenous particles which includes mainly quartz. (Table VI.4).

TABLE : VI.4 PETROGRAPHICAL DETAILS OF MICROFACIES IDENTIFIED IN CARBONATE SEQUENCE OF JAISALMER BASIN, WESTERN RAJASTHAN.

FORMATION	MEMBER	SAMPLE DETAILS	NUMMULITES	SMALLER FORAMS	MILIOLITES	FUSULINIDAE	PELECYPODS	GASTROPODS	ECHINODERMS	BRACHIOPODA	CORALS	ALGAE	INT.BIOCLASTS	PELLETS	OOLITES	MICRITE	SPARITE	DOLOMITE	GLAUCONITE	ANHYDRITE	QUARTZ	SHALE	POROSITY	MICROFACIES	REMARKS
J	K	K-1	5				5	5	5	5		10			10	25	10				20		Oomoldic Biomoldic intergranular	Bioclastic-Oolitic packstone	Slightly arenaceous
	U	K-3	5				5	5	5	5		10			10	25	10				20		-do-	Bioclastic-Oolitic packstone	
A	L	K-5	5		15			5	15							50					10		Moderate to poor	Crinoidal wacke-stone	Mainly argillaceous in nature
	D	K-6	5				5	10		10				5	10	55							Poor	Bioclastic pack-stone	At places bioclastic & sparitised.
I	H	K-8	5						20				10		20	40					5		Poor	Oolitic Bio-clastic wackestone	Low energy deposit pelloids, Bioclasts coated with ferrg. clay
S	A	K-9	P											5			70				20			Bio-clastic wacke-stone	Neomorphic development of microspar from micrite.
	R	K-13						5		5					20	65					5		Poor	Oolitic wackestone	
A		K-17																			80			Ferruginous quartz-wacke	20 % Ferr clay matrix
		K-18					5			10			10			75							Poor	wackestone	
		K-18A					P					5		55			40							Pelletal wackestone	
L	B	BG-14	5						5			5		30		55					P		Negligible	Pelletal wackestone	Pellets & algae are micritic
	A	BG-10A						5	5			5			30		50				5		Intergranular Poor	Oolitic grainstone	Ø is effected by sparitisation
M	D	BG-8																			95		good (Inter-granular)	quartz arenite	3 % clay matrix 2 % Feldspar, quartz fine grained
	A	BG-8A					5	5		5							40	5			40			Bioclastic calc. quartz arenite	Acicular rim cement corr-osion of quartz by calcite
E	B	BG-7	5									20		10	5	55					5		Poor	Algal wackestone	
		BG-6	P									10		30			40				20		Intergranular poor,	Pelletal grainstone	Silt grade pellets showing grain supported texture
R	A	BG-3	P						5						40		55	P			P		Poor, Interg-ranular	Oolitic grainstone	Intergranular Ø is occluded by sparitisation
	G	BG-2		5	5	5	5					5		40			25				10		Poor, Inter-granular	Pelletal grainstone	Dolomitisation Bioclasts sparitised

FORMATION MEMBER	SAMPLE DETAILS	NUMMULITES	SMALLER FORAMS	MILIOLITES	FUSILINIDAE	PELECYPODS	GASTROPODS	ECHINODERMS	BRACHIOPODS	CORALS	ALGAE	INT. BIOCLASTS	PELLETS	OOLITES	MICRITE	SPARITE	DOLOMITE	GLAUCONITE	ANHYDRITE	QUARTZ	SHALE	POROSITY	MICROFACIES	REMARKS
JAISALMER FORT JUYAN HAMIRA	F-7					10		5	5		5		10	5		50	10			P		Poor Ø	Bioclastic wackestone	Dolomitisation; Bioclast sparitised
	F-2																			90		Ø mainly intercrystalline	quartz arenite	5 % silica cement 5 %; feldspar (Plagioclase) 2% feldspar (plagioclase)
	TH-17																			98			Quartz arenite (Ferruginous)	
	TH-10					P	P				P						P			90		Negligible	Foss. quartz arenite	Calcareous cement 10 % Ferrd zonned dolomite
	TH-6																			95		Ø is occluded by sparitisation	Calc. quartz arenite	2 % Garnet 3 % Garnet
	TH-5																			95		-do-	Calc.quartz arenite	Feldspar (5 %) plagioclase
	TH-4																			98		Ø is poor occluded by sparitisation	Quartz arenite	Feldspar (2 %) plagiolase Mainly presence of ferron dolomite (zonned) Leached zone

The main microfacies identified are-

- **Mudstone**
- **Pelletal wackestone**
- **Bioclastic wackestone**
- **Pelloidal-bioclastic packstone**
- **Pelletal grainstone**
- **Oolitic grainstone**
- **Oncolite - Oolitic grainstone**

Mudstone

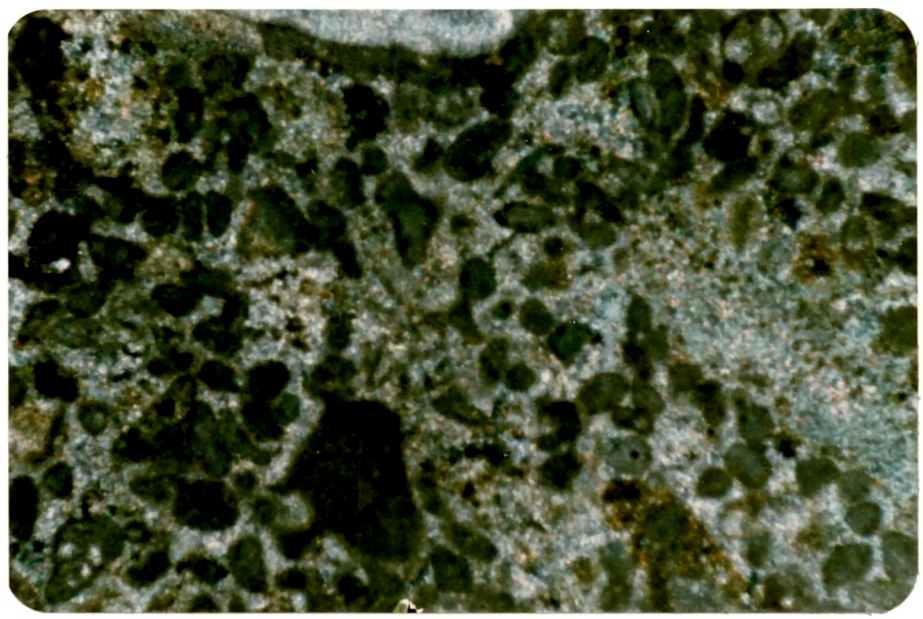
This microfacies is mud supported comprising clay sized lime mud (micrite with less than 10% grains). The grains are generally smaller forams and small skeletal fragments (Plate VI.7A). At places they are recrystallised and selectively dolomitised.

The mudstone microfacies has been observed in upper part of Hamira Member and lower part of Badabag Member of Jaisalmer Formation in exposed section. In the subsurface section this microfacies has been observed in the upper part of Bhuana, Vikran Nai, Bakhari Tibba, and Sadewala structures and also in the lower part of Bhuana and Sumarwali Talai structures.

Pelletal wackestone

This is also a mud-supported microfacies but it contains more than

A. Photomicrograph of mudstone microfacies comprising micrite and scattered small skeletal shell fragments, Jaisalmer Formation, Vikran Nai Structure; X55; XN.



B. Photomicrograph showing mud supported microfacies of pelletal wackestone comprising of fine grained micritic pellets along with smaller forams. At places micritic matrix shows sparitisation, Kuldhar Member, Jaisalmer Formation; X55; XN.

10% grains. As the name of the microfacies implies, it contains fine to very fine grained micritic pellets. In some samples, smaller forams are also observed along with pellets (Plate VI.7B). The pellets are set in micritic matrix which at places shows sparitisation.

This facies has been observed in Fort, Badabag and Kuldhar members as thin interbeds in the exposed section while in subsurface section, it predominates in upper and middle parts of Sadewala Structure.

Bioclastic wackestone

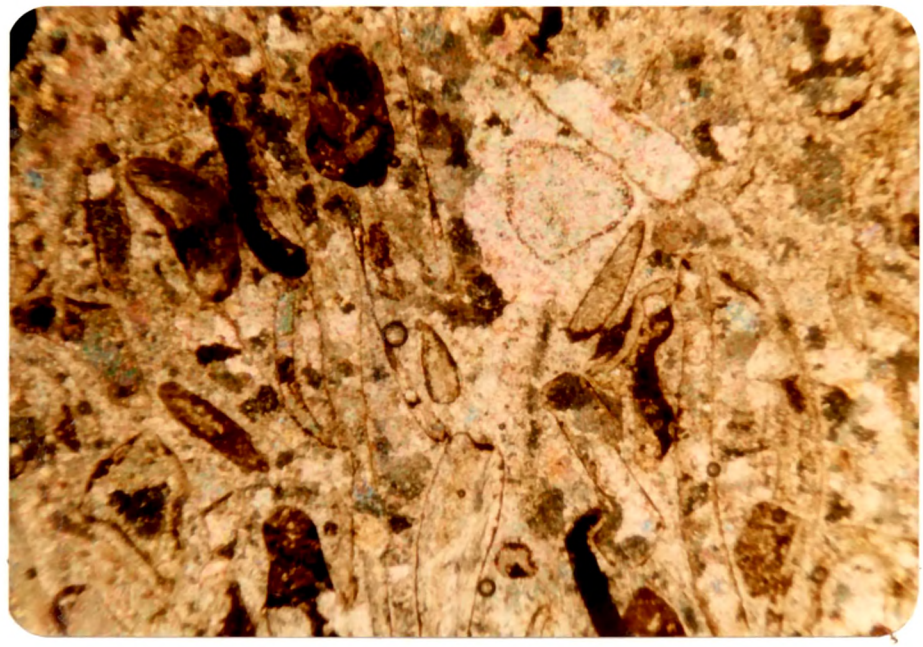
A mud supported microfacies, in which the grains are 20-30%, chiefly algal fragments with crinoids and smaller forams. The matrix is micrite and microsparite, which at times show selective dolomitisation (Plate VI.8A).

This microfacies has been observed as thin beds in Kuldhar and Badabag members of upper part of Jaisalmer Formation in exposed section while in subsurface section it occurs in the middle part of Bhuana and Sadewala structures. Rare occurrence of anhydrite and crystalline dolomite have been also noticed at depth 2033m in subsurface section in Vikran Nai Structure.

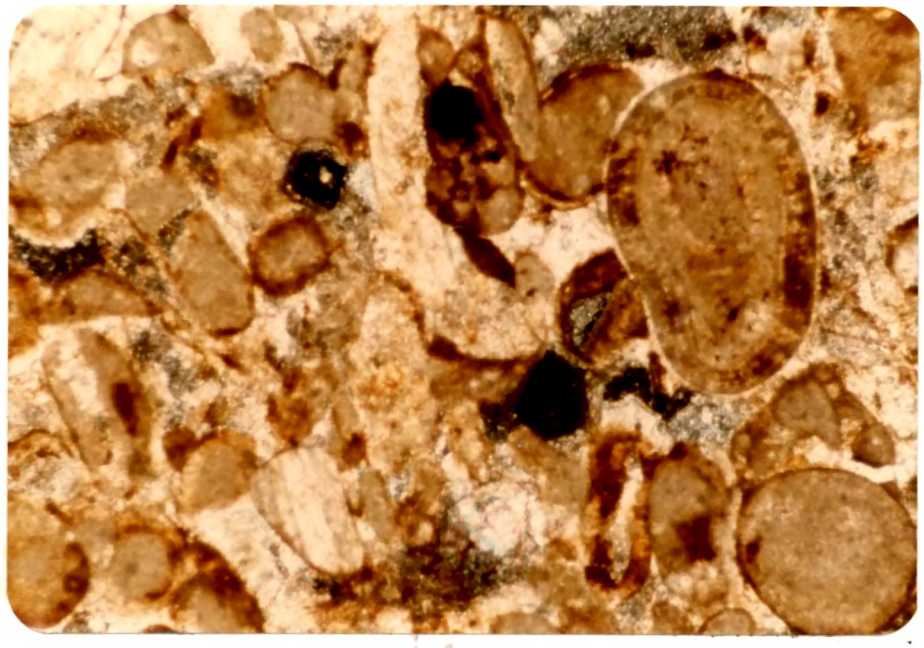
Pelloidal-bioclastic packstone

This microfacies is grain supported. The grains (50-60%) consist of

PLATE-VI.8



A. Photomicrograph showing mud-supported, bioclastic wackestone microfacies. The bioclasts are generally algal fragments and crinoids. The matrix is microspar at places showing selective dolomitisation, Badabag Member, Jaisalmer Formation; X25; XN.



B. Photomicrograph showing grain supported pelloidal bioclastic packstone microfacies. The bioclasts are completely sparitised, Fort Member, Jaisalmer Formation; X65; XN.

medium to coarse sand grade pelloids, bioclasts, predominantly echinoidal plates with occasional oncolites and smaller forams. At places gastropods with glauconite filled chambers are also observed.

This microfacies has been noticed in upper part of Kuldhar Member in the exposed section, while in middle to lower part of Sadewala Structure in subsurface section.

Pelletal grainstone

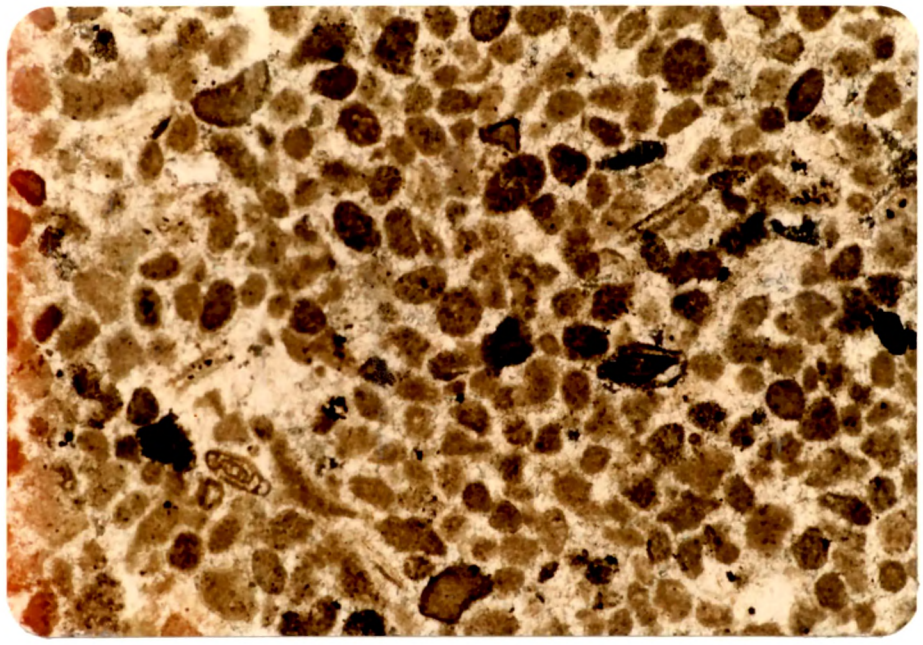
This microfacies is grain supported, chiefly composed of medium to coarse sand sized pelloidal grains. The intergranular spaces are generally filled with macrocrystalline calcite (Plate VI.9A).

This microfacies has been observed in upper part of Kuldhar Member of Jaisalmer Formation in exposed section. In the subsurface section it is well developed in upper part of Sadewala and Vikran Nai Structures.

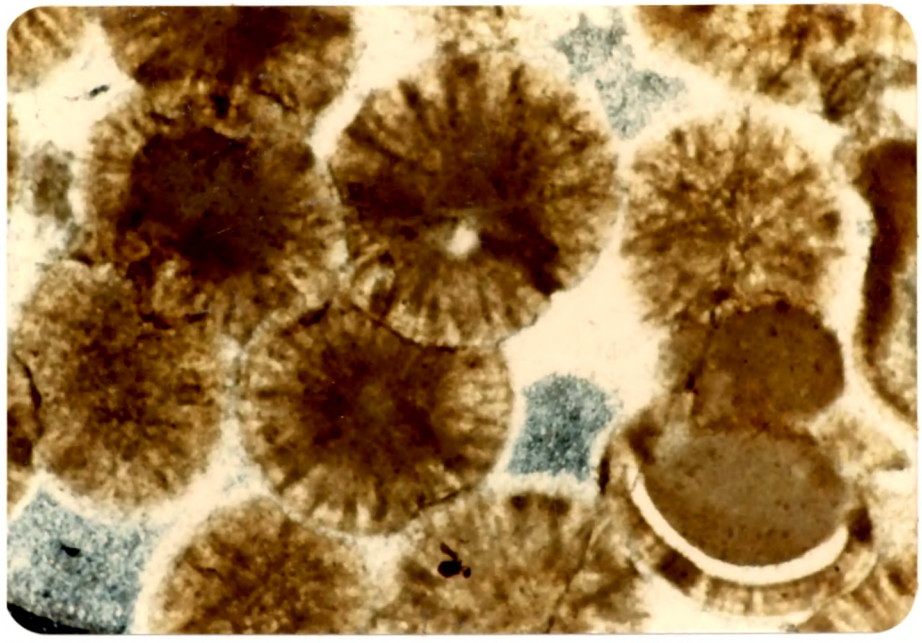
Oolitic grainstone

This is grain supported microfacies characterised by 80-90%, fine to medium sand grade oolites which are spheroidal to ellipsoidal in shape. The nucleii of oolites are mainly quartz and at places fossil fragments. The oolite grains show concentric as well as radial structures (Plate VI.9B). Intergranular spaces are generally filled

PLATE-VI.9



A. Photomicrograph showing grain supported pelletal grainstone microfacies. The pelletes are well sorted, very fine grained and micritic in nature. Occasional milliolids are also observed alongwith pellets. The interspaces are occupied by calcite, Jaisalmer Formation, Vikran Nai structure; X55; XN.



B. Photomicrograph showing grain supported Oolitic grainstone microfacies composed of spheroidal to ellipsoidal shape of oolites showing concentric as well as radial structures, Jaisalmer Formation, Sadewala structure; X55; XN.

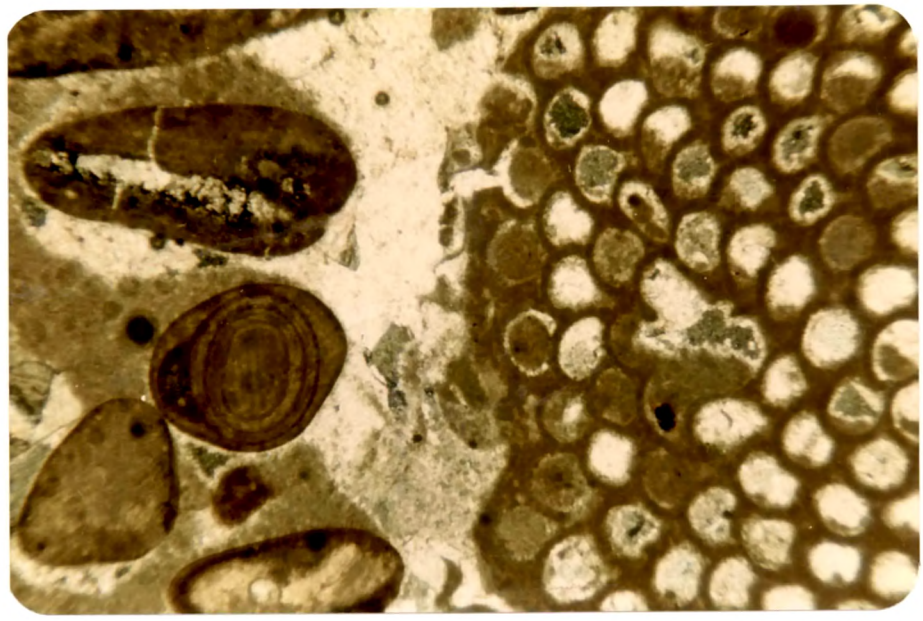
with sparry calcite cement. At places due to dissolution of oolitic layers at their core as well as peripheral part, oomoldic porosity has been developed, which at places, later on filled by sparry calcite.

In the exposed section, the upper part of Kuldhar Member is characterised by occurrence of oolitic grainstone, oolitic bioclastic packstone with interbeds of oolitic wackestone microfacies. Thin intercalation of oolitic grainstone facies has also been observed in Fort and Badabag members. In the subsurface section this facies has been noticed mainly in the upper part, occcasionally in middle part of section in Bhuana, Vikran Nai, Bhakhari Tibba and Sadewala structures. In the subsurface section in Vikran Nai structure around 1725m depth, thin beds of coralline-oolitic grainstone facies has been observed (plate VI.10A).

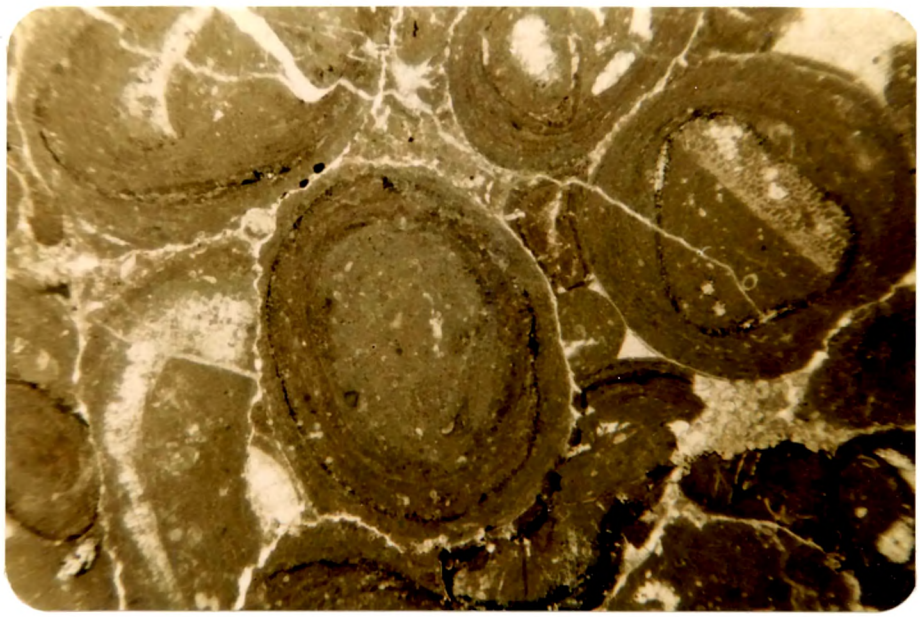
Oncolite-oolitic grainstone

This is grain supported, predominantly oolitic grainstone facies but contains some oncolites (Plate VI.10B) along with oolites. Oolites are commonly ferruginised in nature. Oncolites are algal grains composed of non calcareous green or blue green algal coating on nucleus (Bechar and Moore, 1979).

This microfacies has been observed at top of Jaisalmer Formation encountered in subsurface section in Sumarwali Talai Structure.



A. Photomicrograph of coralline-oolitic grainstone microfacies observed in upper part of Jaisalmer Formation in Vikran Nai structure; X55; XN.



B. Photomicrograph showing grain supported Oncolite-oolitic grainstone microfacies comprising algal coated oncolite grains. The nucleii of the grains are micrite and fossil fragments. At places microstylolite junction has been noticed along the grains boundaries. Fracture and solution porosity has also been observed in this microfacies. Jaisalmer Formation, Sumarwali Talai Structure; X20; PP.

In general the microfacies identified in carbonate sequence in Jaisalmer Formation are more or less similar in both exposed section as well as in subsurface section encountered in different structures from SSE to NNE. However in carbonate section the microfacies are more arenaceous in outcropping area than in subsurface section. These microfacies are thickening from Mari Jaisalmer Arch area to basinal side in Bakhari, Tibba and Sadewala structures (Fig. IV.4). The proportion of clastic supply in outcrop section is more pronounced than its counterpart in subsurface section.

On the basis of variation in microfacies and occurrence of their different constituents, prevailing energy conditions have been identified, and in general five sedimentary cycles (I-V) has been established in Jaisalmer Formation. In general mudstone and wackestone facies were deposited in low energy condition, while packstone and grainstone facies in moderate to high energy condition. The sandstone which is basically calcareous quartz wacke and quartz arenite represent moderate to high energy condition in near shore environments.