CHAPTER - VIII

DIAGENESIS

GENERAL

Diagenesis is defined as the changes which occur in the characteristics and composition of the sediments beginning from the movement of deposition and lasting until the resulting material (rocks) are either mould into realm of metamorphism or became exposed to the effects of atmospheric weathering (Larsen & Chillingar, 1985).

In the present chapter, an attempt has been made to analyse quantitative chemical, mineralogical, petrological and textural characteristics of lithofacies of Jurassic sediments and to establish their diagenetic sequences.

DIAGENESIS IN CLASTIC SEDIMENTS

The clastic sequence are dominating in Jurassic sediments in Lathi, basal part of the Jaisalmer, Baisakhi and Bhadasar formations. The predominant microfacies identified in this clastic sequence are quartz wacke, quartz arenite, calcareous quartz wacke, ferruginous quartz wacke and dolomitic quartz wacke with minor occurrence of siltstone.

In the present study an attempt has been made to understand the diagenetic events within the depositional and tectonic frame work of Jaisalmer basin. This area provides an excellent opportunity to examine surface exposures and cores from nearby exploratory fields. Surface sections were measured and studied with special attention to describe environmentaly sensitive sedimentary structures, thin sections of samples from surface and subsurface were examined to discriminate among primary textural attributes, grain packing(Figs VIII.1 & VIII.2) grain overgrowth and pore filling cements, X-rays minerlogy, surface texture studies by SEM and geochemical analysis were carried out to understand authigenic clay and nature of matrix. On the basis of the integrated study, the following four stages of diagenesis have been recognised in the clastic sequence.

(I) Early phase of diagenesis (cementation, lithification, formation of clay rim around grains etc).

(II) Dissolution of feldspar and calcite cement, (replacement of calcite by iron oxide in the later phase of diagenesis).

(III) Pressure solution phenomena (development of quartz overgrowth and microstylolite).

(IV) Neomorphism (recrystallisation of calcite and dolomitisation).

Early phase of diagenesis

The quartz wacke and quartz arenite facies of Lathi, Baisakhi and

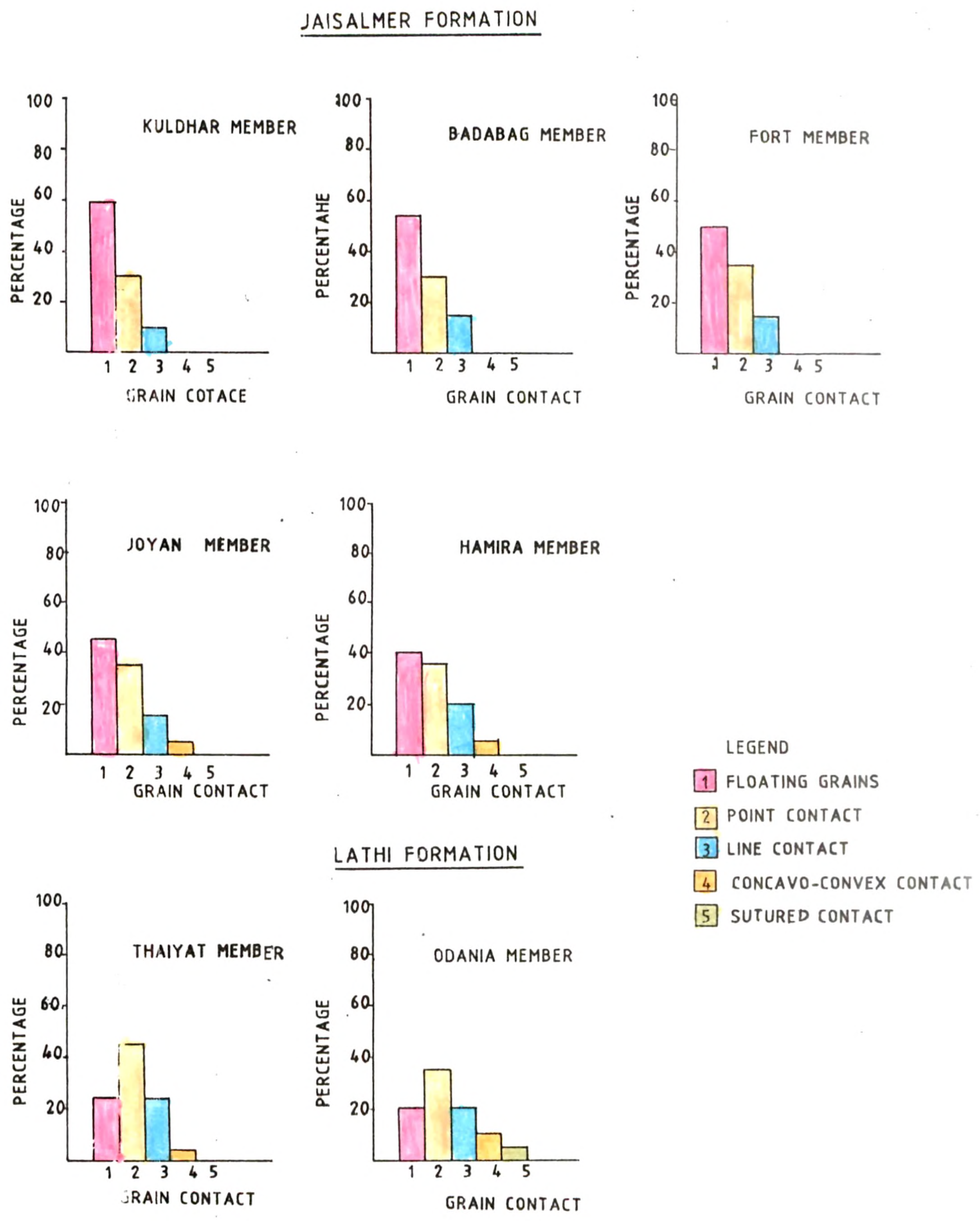


FIG. VIII-1. HISTOGRAM SHOWING TYPES OF GRAIN CONTACT, LATHI & JAISALMER FORMATIONS

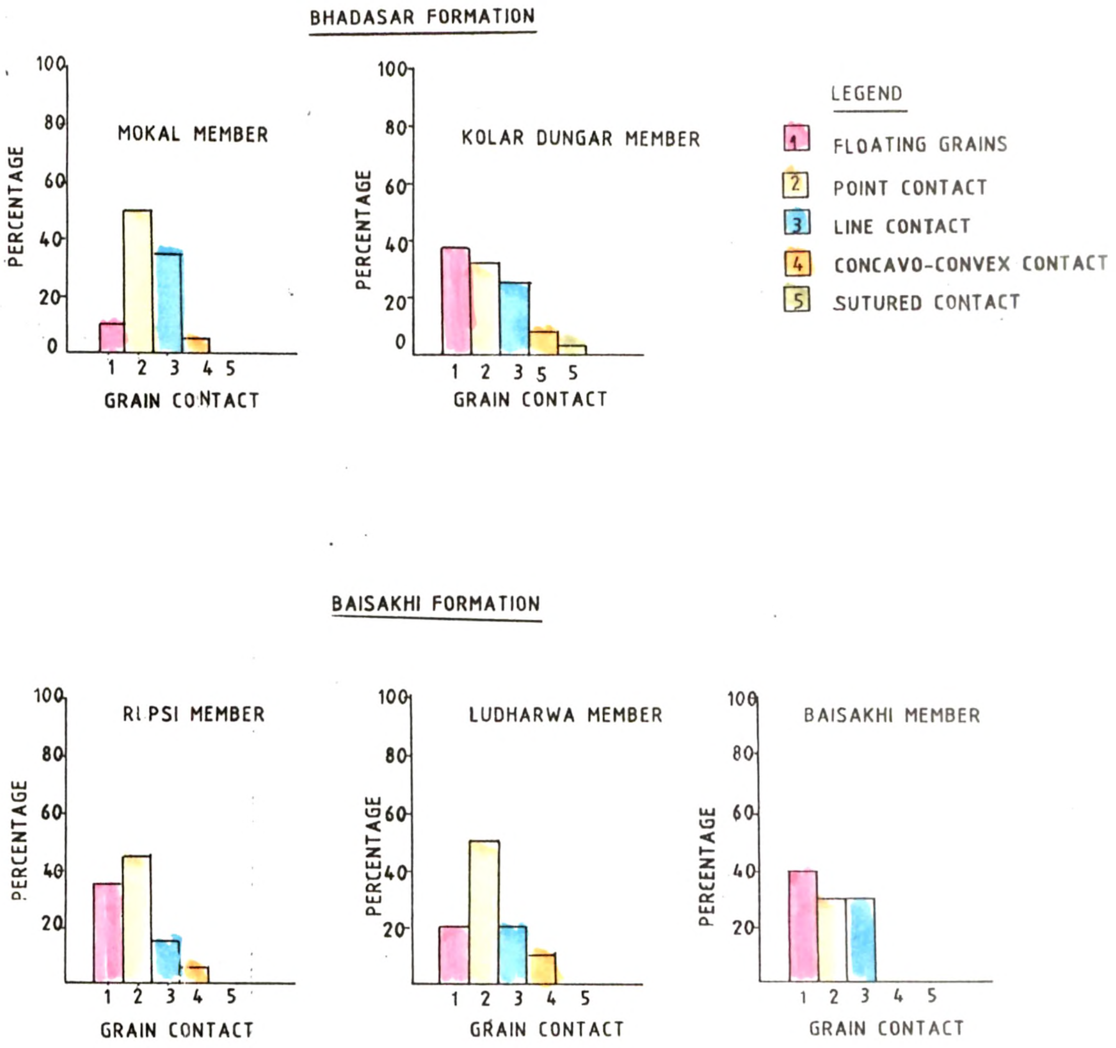


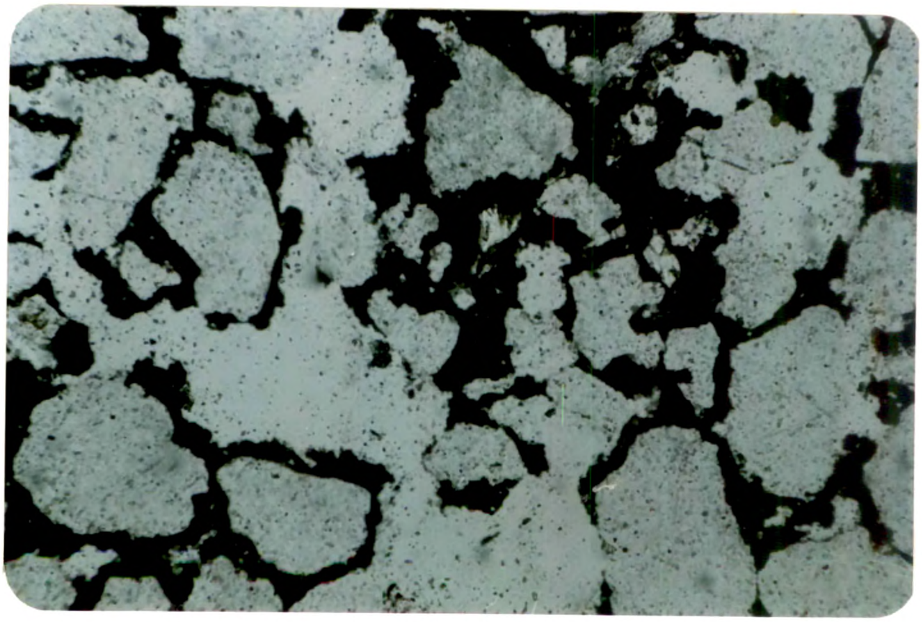
FIG. VIII.2 HISTOGRAM SHOWING TYPES OF GRAIN CONTACT OF BAISAKHI & BHADASAR FORMATIONS

Bhadasar formations show moderate lithification after deposition in fluvial to deltaic environment. Grain packing are characterised by dominance of line contact and point contact (Plate VIII.1A & VIII.1B) with minor occurrence of concavoconvex contact, (Table VIII.1) suggesting moderate lithification during early burial diagenesis.

Carbonate cement, primarily calcite is common in upper part of Lathi, lower part of Jaisalmer and upper part of Baisakhi formations. In many cases this cement may be interpreted as precompaction, inasmuch the detrital sand grains appear to be floating in the calcite. Corroded quartz boundaries by calcite cement and later on complete replacement of calcite by iron oxide (hematite) cement has been observed in upper part of Bhadasar Formation (plate VIII.1A). The lower part of Lathi Formation shows formation of iron rich cement during later stage of diagenesis and replacing calcite cement.

The origin of hematite however has been the subject of considerable debate. The lower part of Lathi Formation are basically fluvial sandstone, mineralogically, they are often feldspathic indicating source area as crystalline granite admixed with metamorphic terrain. The hematite pigments in reddish coloured sandstone of Lathi Formation may be products of the in situ diagenetic alteration of iron bearing grains, or could be due to oxidising condition at time of burial.

The clay rims and clay coats form a rind around detrital quartz grains in the clastic sequence of the Fort Member of Jaisalmer



A. Photomicrograph showing corroded quartz boundaries by calcite cement in the early diagenetic phase, later on complete replacement of calcite by iron oxide (hematite). Hematite cement causes the complete destruction of porosity, Mokal Member, Bhadasar Formation; X50; PP.

B. SEM photomicrograph of lower sandstone facies in Fort Member, showing grain packing, predominantly tangential point and line contacts which create floating appearance in thin section.

TABLE. VIII.1 Showing different grain contacts suggesting lithification in different formations of Jurassic sediments.

FORMATION	MEMBER	SAMPLE No	FLOATING	POINT CONTACT	LINE CONTACT	CONCAVO CONVEX CONTACT	SUTURED CONTACT	MICRO FACIES	TEXTURAL CHARACTERISTICS	REMARKS
BHADASAR	MOKAL	MBR-1	10	60	20	5	5	Quartz arenite	Fine to med, grd;mod. sorted.	
		MBR-2	5	50	40	5	-	Quartz arenite	Fine to coarse grd, poorly sorted	
		MBR-3	10	45	40	5	-	Quartz wacke	Fine to Med. grd; mod, sorted,	Ferruginous clay matrix.
		MBR-4	15	40	40	5	-	Quartz wacke	Fine to coarse grd; mod, sorted	Predominance of plutonic type quartz
		MBR-5	15	40	40	5	-	Calc. quartz wacke	Fine to med, grd; Mod. sorted	Presence of fractured quartz
	KOLAR	MBR-5A	15	45	35	5	-	Quartz arenite	Fine to coarse grd;poorly sorted	Replacement of felspars
		MBR-6	45	25	20	8	2	Ferr. quartz wacke	Fine to V.coarse grd; poorly sorted	
	DUNGAR	MBR-7	50	25	20	5	-	Pelletal quartz wacke	Fine to coarse grd; poorly sorted	Presence of sideritic oolites and pellets (30%)
		MBR-8	10	45	35	5	-	Pelletal quartz wacke	Fine to med, grd; mod. sorted	Ferr. rim around pellets
		MBR-10A	5	35	45	10	5	Ferr. quartz arenite.	Fine to med, grd; mod, sorted	Bimodal population of quartz grains.

FORMATION	MEMBER	SAMPLE No	FLOATING	POINT CONTACT	LINE CONTACT	CONCAVO CONVEX CONTACT	SUTURED CONTACT	MICRO FACIES	TEXTURAL CHARACTERISTICS	REMARKS
		BR-13	35	45	10	5	5	Bioclastic quartz wacke	Fine to Med. grained	
B	R U	BR-14	60	20	10	5	5	Ferr.quartz wacke.	Fine to coarse grd; poorly sorted	
	P	BR-15	55	20	15	5	5	-do-	-do-	
A		BR-16	55	25	10	5	5	-do-	--do-	
	S	BRP-11	60	30	5	5	-	Ferr.quartz wacke	Fine to coarse grd mod. sorted,	Ferr. clayey, mod. lithified
I	I	BRP-2	30	45	20	3	2	Quartz wacke	Fine to coarse grained	Replacement of Fe. by calcite.
		BRP-3	20	50	25	5	-	Quartz wacke	Fine grd., mod to good sorting	
S	L	BRL-1	20	40	35	5	-	Calc. quartz wacke	Fine to med. grd., mod. sorted.	
A	U D H A	BRL-2	10	65	20	5	-	Quartz wacke	Fine to coarse grd., mod. to poorly sorted,	Sparry calcite cement
K	R W A	BRL-3	20	55	20	5	-	Quartz wacke	Fine to coarse grd; mod. sorted	Presence of ferrg. matter in matrix.
		BRL-4	15	40	40	5	-	Quartz wacke	-do-	-do-
H		BRL-5	20	40	35	5		Quartz wacke	Fine to med. grd;	-do-
	B A	BB-1	15	45	35	5		Quartz wacke	-do-	
I	I S A K H I	BB-2	20	45	30	5		Calc.Quartz wacke	-do-	

FORMATION	MEMBER	SAMPLE No	FLOATING	POINT CONTACT	LINE CONTACT	CONCAVO CONVEX CONTACT	SUTURED CONTACT	MICRO FACIES	TEXTURAL CHARACTERISTICS	REMARKS
JAISALMER	BAISAKHI	BB-6	45	45	5	5	-	Calc. Quartz wacke	Fine grd., Mod. sorted,	
		BB-7	40	55	5	-	-	Calc.Quartz wacke	-do-	
		BB-8	40	50	5	5	-	Ferr.Quartz wacke	-do-	
	KULDAR	K-17	60	30	10	-	-	Calc.Quartz wacke	Fine to med.grd; mod. sorted	Effect of dolomitisation
	BADABAG	BG-7A	55	30	15	-	-	Calc.Quartz wacke	-do-	
	FORT	F-2	40	30	10	-	-	Calc.Quartz wacke	Fine to med.grd; mod. sorted	Corroded boundary of quartz by calcite
	JOYAN	TH-27	45	35	15	5	5	Calc.Quartz wacke.	Fine grd; mod. sorted	
	HAMIRA	TH-17	45	40	10	5		Quartz wacke	Fine to med. grd, Mod. sorted	Replacement of dolomite by calcite
		TH-10	60	20	15	5		Calc. quartz wacke	Fine to med. grd.	Presence of dolomite
		TH-8	40	35	20	5		Calc. dolomite	Fine to med. grd;	Dominance of dolomite.
		TH-4	55	20	20	5		Calc.Quartz wacke	Fine to med grd.,	Presence of zonned dolomites
		TH-2	50	30	10	5		Dolomite	Fine grd; Mod. sorted,	Presence of zoned dolomite
		TH-1	15	40	20	5		Calc.Quartz wacke	Fine to Med. grd; mod. sorted	Effect of dolomitisation
LATHI	THAIYAT	L-1	5	50	35	7	3	Quartz wacke	Very fine to med. grd, mod, sorted	

FORMATION	MEMBER	SAMPLE No	FLOATING	POINT CONTACT	LINE CONTACT	CONCAVO CONVEX CONTACT	SUTURED CONTACT	MICRO FACIES	TEXTURAL CHARACTERISTICS	REMARKS
		L-A	-	40	40	10	10	Quartz wacke	Fine grd; mod. sorted,	
	T	L-2	-	40	40	15	5	Quartz wacke	Fine to med. grd; mod. sorted	
L	H A	L-3	-	50	30	5	5	Quartz wacke	Fine to med. grd; mod. sorted	
A	I	L-6	-	30	40	15	15	Quartz arenite	fine grd; mod. sorted	
	Y	L-7	-	40	30	20	10	Quartz arenite	Fine to med.grd; mod. sorted	
T	A	L-9A	15	40	35	10	-	Quartz wacke	Fine to med. grd; mod. sorted	
H	T	L-11	5	50	30	10	5	Quartz arenite	Fine to med, grd; poorly sorted	Two population of quartz (1) monocrystalline (2) Polycrystalline
I		L-12	15	40	35	5	5	Quartz wacke	-do-	
		L-13A	30	40	30	-	-	Quartz wacke	Fine to coarse grd., poorly sorted	Quartz strained, showing undulose extinction
		L-14	-	30	60	10	-	Calc.Quartz arenite	Fine to med grd. mod.sorted	Ferr. clayey matrix
		WL-1	30	40	30	-		Ferr. quartz wacke	Fine grd; subang. to subrounded.	Ferr.clayey matrix

FORMATION	MEMBER	SAMPLE No	FLOATING	POINT CONTACT	LINE CONTACT	CONCAVO CONVEX CONTACT	SUTURED CONTACT	MICRO FACIES	TEXTURAL CHARACTERISTICS	REMARKS
LATHI	THAIYAT	WL-2	40	30	30	-	-	Siltstone	Very fine grd. silt grade.	
		WL-3	25	45	25	5	-	Siltstone	Very fine grd. to silt grade.	Sharp edge of quartz
		WL-4	-	50	40	5	5	Siltstone	Very fine to silt grade. mod. sorted,	-do-
		WL-5	5	45	35	10	5	Ferr.Quartz arenite	Fine grd. mod sorted	Ferr. clayey matrix.
		TL-1	40	20	30	5	5	Calc. quartz wacke	Fine grd, mod. sorted	
		TL-2	5	45	40	5	5	Quartz wacke	-do-	Mod. lithified
	ODANIA	AL-1	-	70	25	5	-	Fine grd; quartz wacke	Fine to med grd; mod sorted	
		AL-2	5	40	50	3	2	Fine. grd; quartz arenite	Fine to med. grd, mod sorted	Mod. lithified more elongated grains.
		AL-3	-	60	35	5	-	Quartz arenite	Fine to med. grd;	Mod. lithified
		AL-4	-	50	40	5	5	Ferr. quartz wacke	Fine to med. grd; mod. sorted	Presence of fractured quartz

FORMATION	MEMBER	SAMPLE No.	FLOATING	POINT CONTACT	LINE CONTACT	CONCAVO CONVEX CONTACT	SUTURED CONTACT	MICRO FACIES	TEXTURAL CHARACTERISTICS	REMARKS
L	O	AL-5	-	50	45	5	-	Quartz arenite	Fine to med, grd; mod. sorted	
A	D	AL-6	-	45	40	10	5	Quartz arenite	Fine to med. grd, mod, sorted	Mod. lithified,
T	A	AL-7	40	35	15	5	5	Quartz wacke	Med. to coarse grd; mod. sorted	Mod. lithified sparry calcite, ferr. clayey matrix.
H	N									
	I									
I	A	AL-8	25	40	20	10	5	Quartz wacke	Fine to med. grd;	clay coating along grain boundary
		AL-9	10	45	35	5	5	Calc. quartz arenite	-do-	-do-

Formation (plate. VIII.2A). They form primarily by authigenesis of the clay mineral. The authigenic clay rim consisting of chlorite surrounds detrital grains.

Dissolution of Feldspar and Calcite cement

At greater depth of burial a variety of alteration and replacement reaction complicates both the fabric and mineralogy of the sandstones. Dissolution of the feldspar both orthoclase and plagioclase and selective replacement of calcite by iron oxide have been observed in Kolar Dungar Member of Bhadasar Formation (plate. VIII.2B).

Pressure solution phenomena

Later phase of diagenesis is marked by overgrowth of quartz in Thaiyat Member of Lathi Formation (plate. VIII.3A) and microstylolite showing pressure solution phenomenon in upper part of Jaisalmer Formation in subsurface section of Sumarwali Talai structure (Plate. VIII.3B). These diagenetic features may be developed due to local tectonic episode causing high pressure which is also supported by development of microfactures in oncolite-oolitic grainstone facies of Jaisalmer Formation (Plate. VIII.3B).

In the last phase of diagenesis, the crystallisation of iron rich zoned dolomite (Plate-VIII.4A) and ankerite was observed in the lower part of clastic section (i.e. in Hamira and Joyan members) of Jaisalmer Formation. The amount of this late cement is an important variable that controls the reservoir quality in the clastic sequence of Jaisalmer Formation.

Solutions which precipitate carbonate cement are commonly highly corrosive to the framework of quartz and at places felspar which are susceptible to such alteration (Plate. VIII.2B).

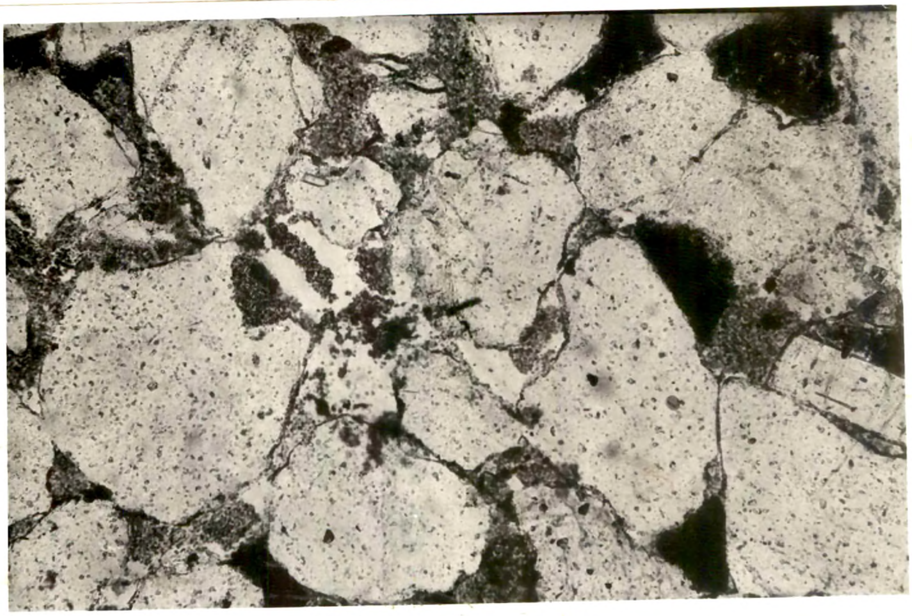
Neomorphism

The neomorphic development of the macrocrystalline calcite within the microcrystalline matrix have been observed in calcareous quartz wacke and oolitic wackestone facies of Kuldhar Member of Jaisalmer Formation (Plate. VIII.5A). The selective dolomitisation has been observed as scattered well developed rhombs of dolomite in rare association with anhydrite (Plate. VIII.5B), in carbonate facies in Vikran Nai Structure as well as in clastic sequence in basal part of Hamira Member.

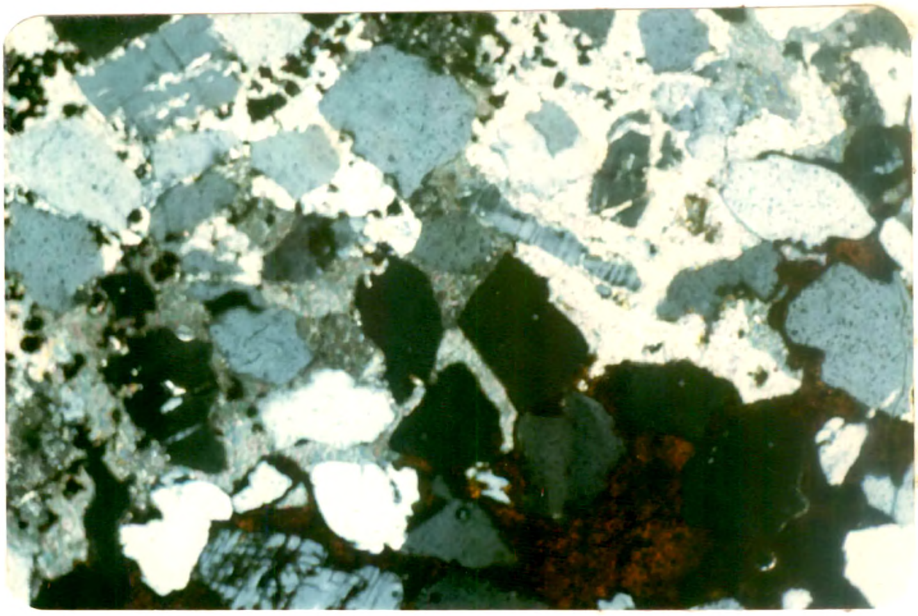
DIAGENESIS OF CARBONATE SEDIMENTS IN JAISALMER FORMATION

The Jaisalmer Formation is characterised by the predominance of carbonate facies with thin interbeds of calcareous sandstone. Basically eight microfacies have been identified. They are mudstone, pelletal wackestone, bioclastic wackestone, pelloidal

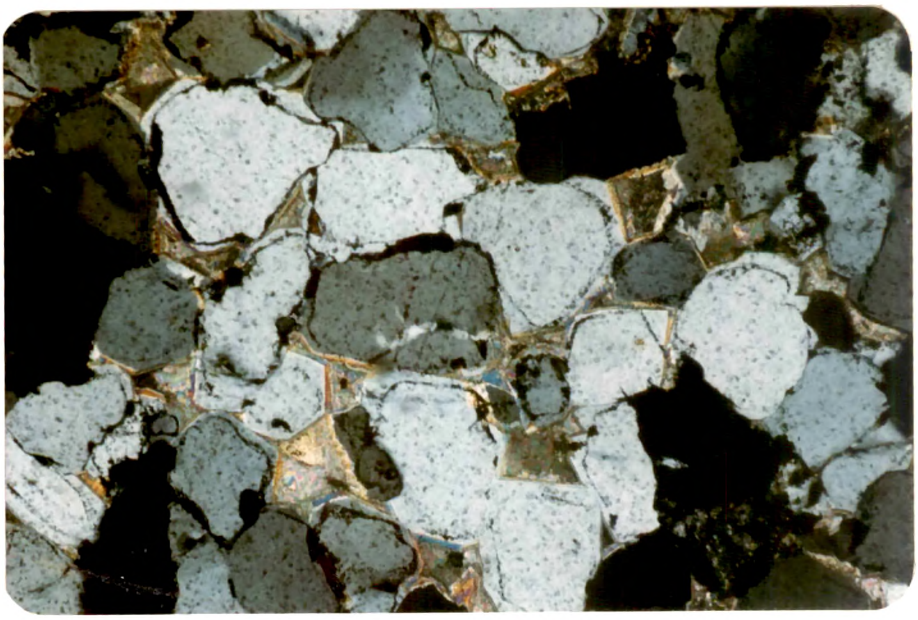
PLATE-VIII.2



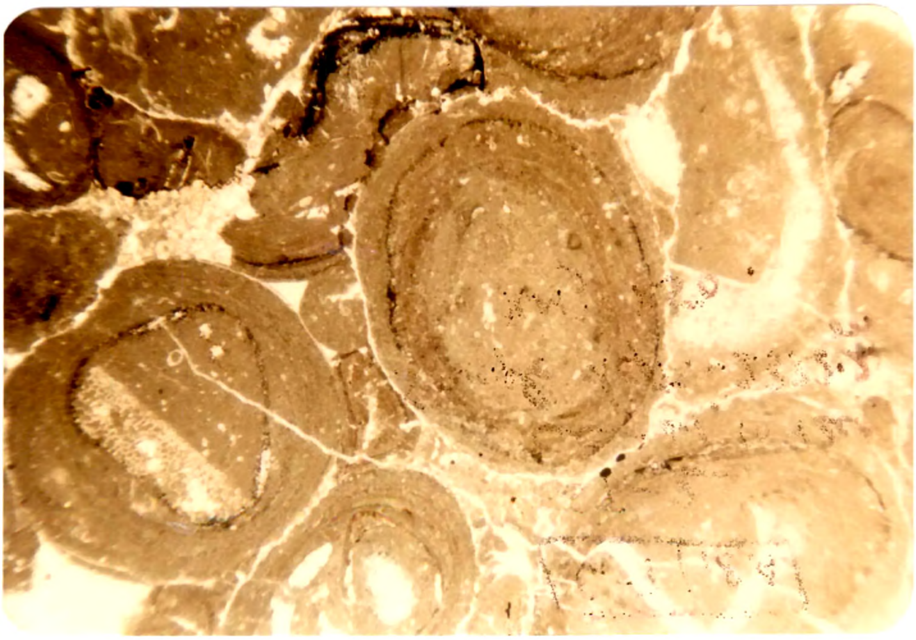
A. Photomicrograph showing clay rims around the detrital quartz grains in the sandstone Section, lower part of fort Member, Jaisalmer Formation. X50, PP.



b. Photomicrography showing Replacement of felspar by Calcite and selective replacement of Calcite by iron oxide; Kalar Dunga, Member, Bhadasar Formation X.50 : XN.



A. Photomicrograph showing quartz overgrowth formed as the first generation of cement and followed by calcite which generally filled the pore spaces, Thaiyat Member, Lathi Formation; X50 ; XN.



B. Photomicrograph showing microstylolite and fracture porosity in Oncolite-Oolite grainstone facies of subsurface section in Upper part of Jaisalmer Formation, Sumarwali Talai Structure; X20 ; PP.

bioclastic wackestone, pelletal grainstone, oolitic grainstone, oncolite oolitic grainstone and calcareous quartz arenite. The details of these microfacies have been mentioned in the previous chapter (chapter VI) while dealing with the petrographic study.

To understand the diagenetic processes in the carbonate section, the basic petrographic study by polarising microscope has been utilised in the present study for distinguishing the matrix, cement and recrystallised spar and other diagenetic fabrics, along with X-ray mineralogy, SEM and chemical analysis. Different bioclasts, pellets, ooids were identified and the relation between matrix, cement and grain fabric has been established by petrographic techniques.

After integrating the different analytical data based on petrographic, staining, X-ray mineralogy, SEM and chemical analyses. (Table VIII.1), three stages of diagenesis have been recognised in the carbonate section of Jaisalmer Formation.

(1) Early burial diagenesis (microcrystallization, submarine cementation.)

(2) Unconformity related diagenesis (extensive leaching fresh water cementation) and

(3) Deep burial diagenesis (stylolitization, fracturing, burial cementation, neomorphism and dolomitization).

Early burial Diagenesis

This includes both synsedimentary processes and early post depositional cementation of the sediments.

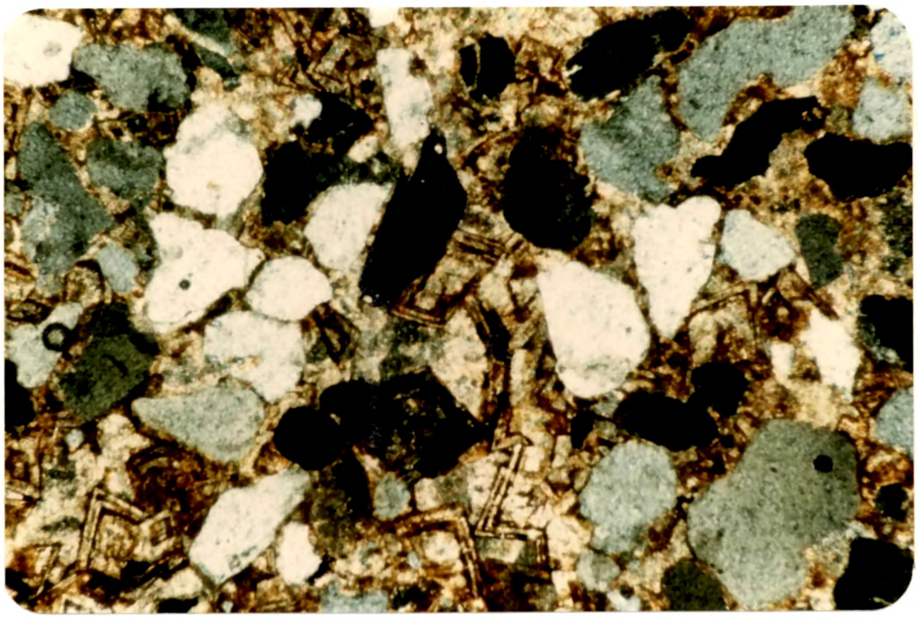
Synsedimentary diagenetic effects are abundant in the lower part of Jaisalmer Formation of Hamira and Joyan members which comprise mudstone and bioclastic wackestone. Micritization of grains through action of endolithic algae and fungi etc, are prominent in proximal and lagoonal facies which comprise predominantly mudstone (Plate. VIII.4B), in the basinal and lower slope facies. Cementation occurred in Hamira, Joyan and Fort members of Jaisalmer Formation, in which cross bedded herring bone features (Plate. VIII.6A) and original bedding are preserved and burrows are protected from compaction.

Unconformity related Diagenesis

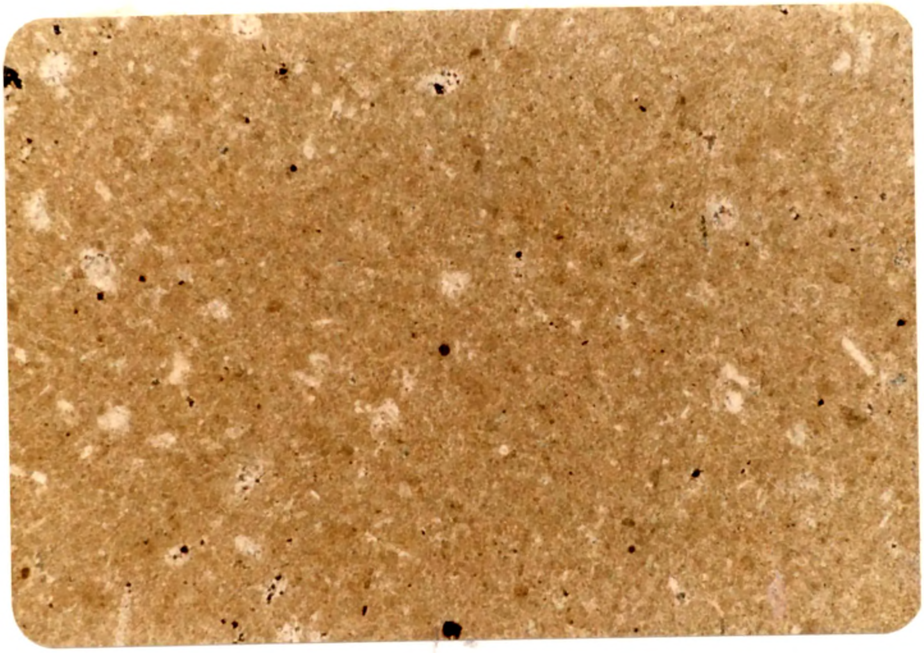
Fresh water invasion during exposure at the upper part of the Jaisalmer Formation in which post Jaisalmer/Baisakhi unconformity resulted in extensive dissolution, minor internal sedimentation, local calcite cementation and formation of gypsiferous claybands and oolitic shale.

Dissolution was particularly pronounced beneath the unconformity in Kuldhar Member in grainstone and oolitic packstone (Fig. VIII.6B), although its precise effects are variable in character

PLATE-VIII.4



A. Calcareous quartz arenite showing crystalline replacement dolomite with considerable iron zoning. Dolomite probably formed in late stage of diagenesis, Joyan Member, Jaisalmer Formation, X55 ; XN.



B. Photomicrograph showing neomorphic development of calcite in micritic mass of mudstone facies of sub-surface section of Jaisalmer Formation, Vikran Nai Structure; X55, XN.

depending upon lithofacies. Grain leaching and effect of solution activity for creating oomoldic, (Plate. VIII.6B), biomoldic and fracture porosity, (Plate. VIII.3B) were more pronounced in grainstone, pelloidal bioclastic packstone, oolitic grainstone (Plate. VIII.7A) of upper part of Jaisalmer Formation. Internal sedimentation immediately beneath the unconformity in which solution vugs, finer silt moulding, and primary pores may be partially infilled with overlying sediment, (Dunham, 1969). This is best developed in the lagoonal facies in mudstone and wackestone of upper part of Jaisalmer Formation.

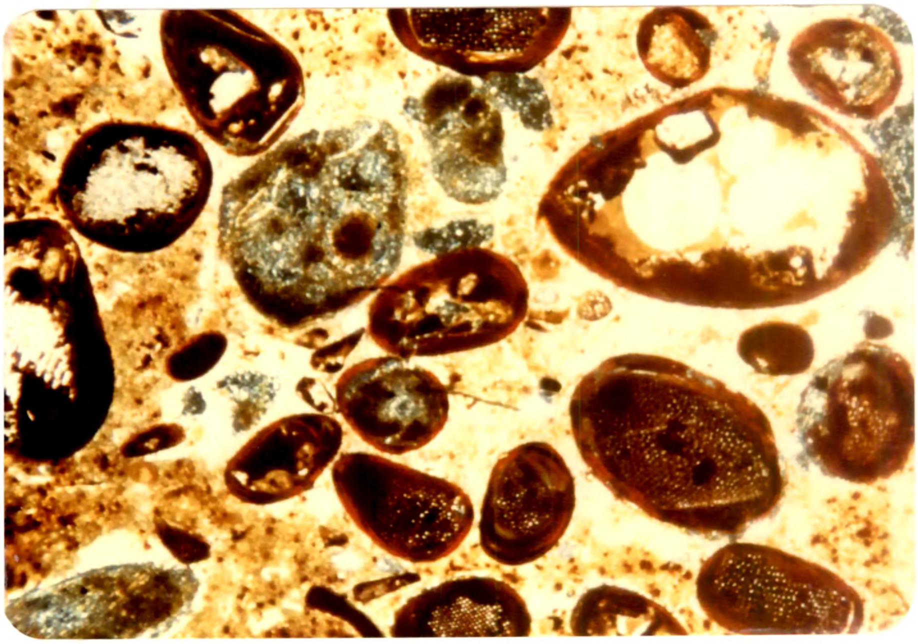
Calcite cementation was locally important during diagenesis. Two Fabrics are distinguished-fine fringing (Plate. VIII.6B) and overgrowth, each being characteristic of different lithofacies. In the upper part of Jaisalmer Formation in calcareous quartz arenite and bioclastic pelletal grainstone, the cement consists of fine($<20\mu$) rhombic to polyhedral, non ferroan calcite, partly occluding and forming lining with pores.

Deep burial Diagenesis

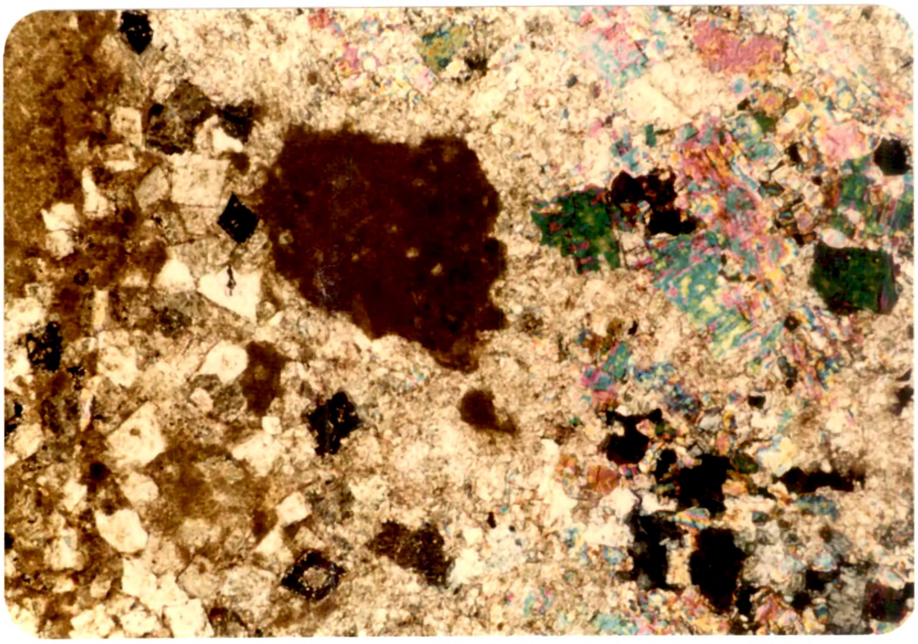
The carbonate section of Jaisalmer Formation was progressively buried to the present depth. Burial resulted in a variety of diagenetic processes, most important of which were-

- Compaction, expressed principally as stylolitization but also as fracturing

PLATE-VIII.5



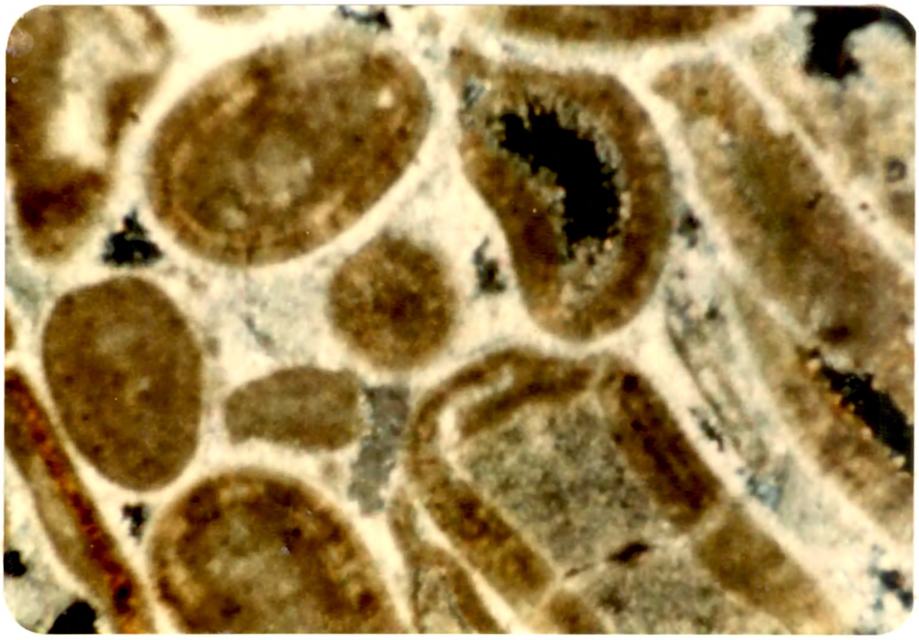
A. Photomicrograph showing neomorphic development of calcite from ferruginous micrite matrix in oolitic wackestone facies, Jaisalmer Formation, Kuldhar Member; X25 ; XN.



B. Photomicrograph showing selective dolomitisation resulting in scattered well developed rhombs of dolomite in rare association with anhydrite, middle part of Vikran Nai Structure; Jaisalmer Formation; X55 ; XN.

PLATE-VIII.6

A. Herring bone cross bedded structure observed in sandy oolitic limestone of Fort Member, Jaisalmer Formation.



B. Photomicrograph showing fine fringing fibrous calcite, oomoldic and dissolution porosity in oolitic grainstone facies of upper part of Jaisalmer Formation (1855m), Bhuana Structure; X85 ; XN.

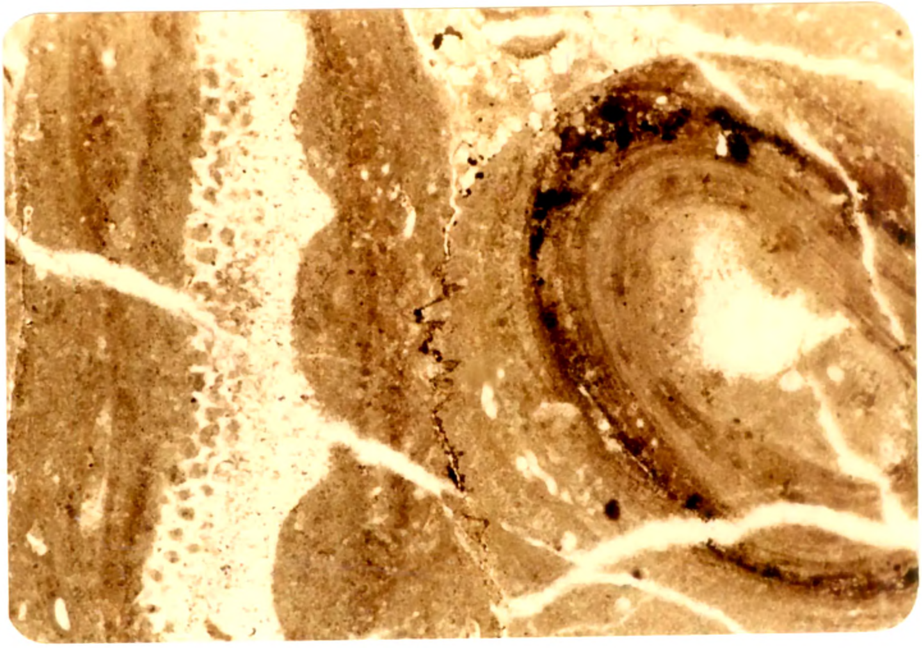
- Calcite cementation as sparitization and blocky calcite
- Dolomitization
- Cementation by ferruginous matter.

The distribution and character of stylolites in the Hamira, Joyan and Fort members of Jaisalmer Formation are strongly related to grain size and therefore to lithofacies. Microstylolites are developed throughout the basinal and lower to mid slope deposits in the lower member of the Jaisalmer Formation (Plate. VIII.7B). At places, microstylolitization contributes to nodular character of the sediments and their early cementation at lower bedded fabric. At places, microstylolites have developed along bedding planes and at junction of grains (Plate. VIII.3B). The lithofacies of Kuldhar and Badabag members of upper part of Jaisalmer Formation also show stylolitic structure, though compaction here is relatively minor being expressed by fractured microspar envelopes and locally by cracks interpenetration.

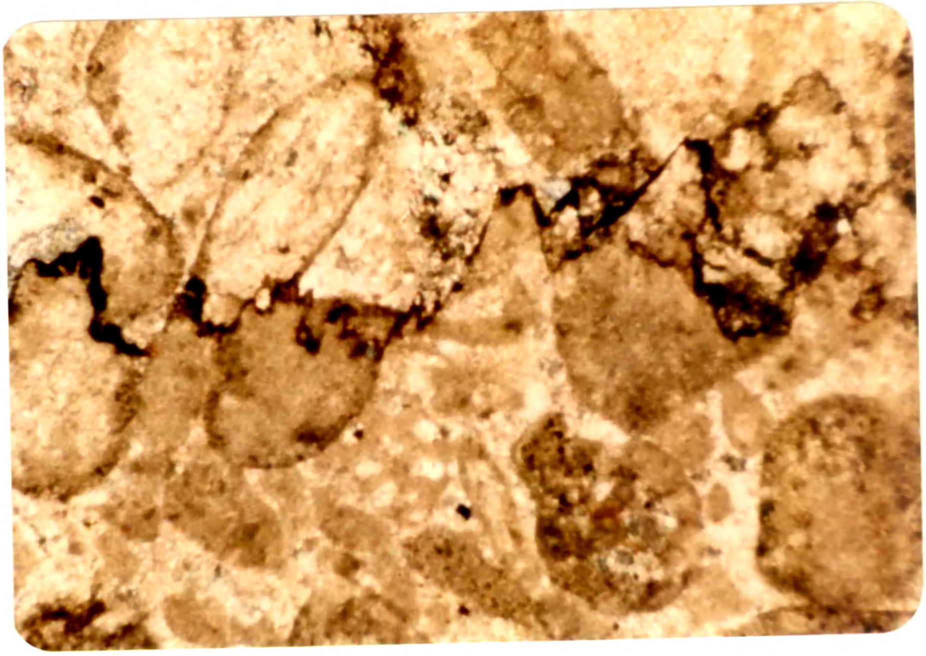
Microscopic fracturing have been observed in carbonate sediments of Jaisalmer Formation. Small fractures upto 1 cm long developed normal to stylolites (Nelson. 1981) are characteristic of lower slope of the lagoonal facies in upper section of Jaisalmer Formation in Sumarwali-Talai Structure. At places fractures are commonly filled with calcite cement.

Non-ferroan, equant, blocky calcite form an extensive pore

PLATE-VIII.7



A. Photomicrograph showing microstylolites junction and development of fracture porosity in Oncolite-Oolite grainstone microfacies at the top of Jaisalmer Formation in Sumarwali Talai Structure; X50; PP.



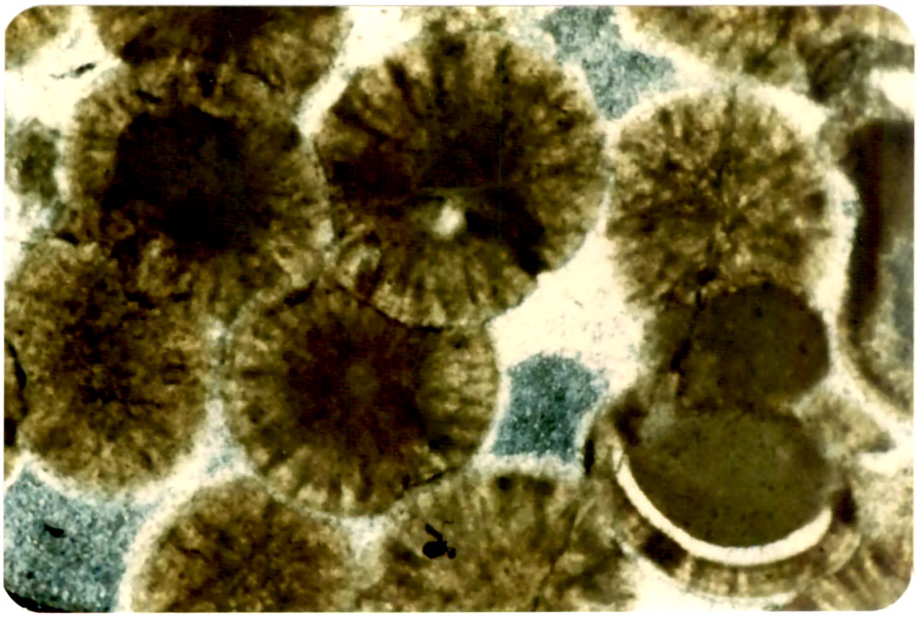
B. Photomicrograph showing microstylolites developed at the junction of the grains in pelloidal-wackestone facies indicative of deep burial diagenesis, Lower part of Jaisalmer Formation, Bhuana structure; X70; XN.

occluding cement in oolitic grainstone facies in basinal part in Sadewala Structure (Plate. VIII.8A) and Kuldhar and Badabag members in exposed section, dip down from unconformity surface and also in marginal part of the basin in upper section of Jaisalmer Formation in Vikran Nai Structure (Plate. VIII.8B). It thus displays an antithetic relationship with freshwater. Fine fringing fibrous calcite cement developed around the oolitic grain have been also observed in upper part of Jaisalmer Formation in Bhuana Structure (Plate. VIII.6B).

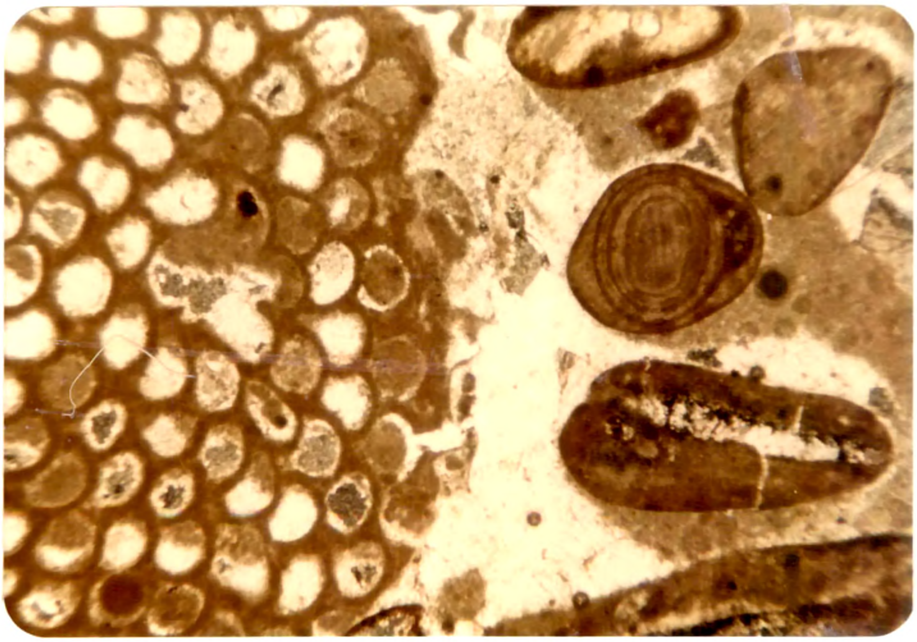
Syntaxial overgrowth rim on echinoderm plates are common in deep burial diagenesis as observed in oolitic bioclastic grainstone facies in middle part of Jaisalmer Formation in Vikram Nai Structure (Plate. VIII.9A).

Calcite neomorphism proceeded during the period of burial diagenesis in ferruginous micritic matrix. Neomorphic crystal enlargement (Plate. VIII.5A) have been observed in most of the lithofacies of Jaisalmer Formation.

Selective dolomitisation and presence of well developed dolomite are represented as accessory diagenetic phases. This occurs as replacive, non-ferroan rhombs 100 to 500 μ, sparsely scattered throughout the basinal and lower scarp sediments in Hamira and Joyan members as well as marginal part of basin in Vikran Nai Structure (Plate. VIII.5B).



A. Photomicrograph showing equant blocky calcite acting as pore occluding cement in oolitic grainstone facies of Sadewala Structure; Jaisalmer Formation; X70; XN.



B. Photomicrograph showing development of blocky calcite occluding the intergranular spaces in coralline-oolitic grainstone facies, middle part of Jaisalmer Formation, Vikran Nai Structure; X60; XN.

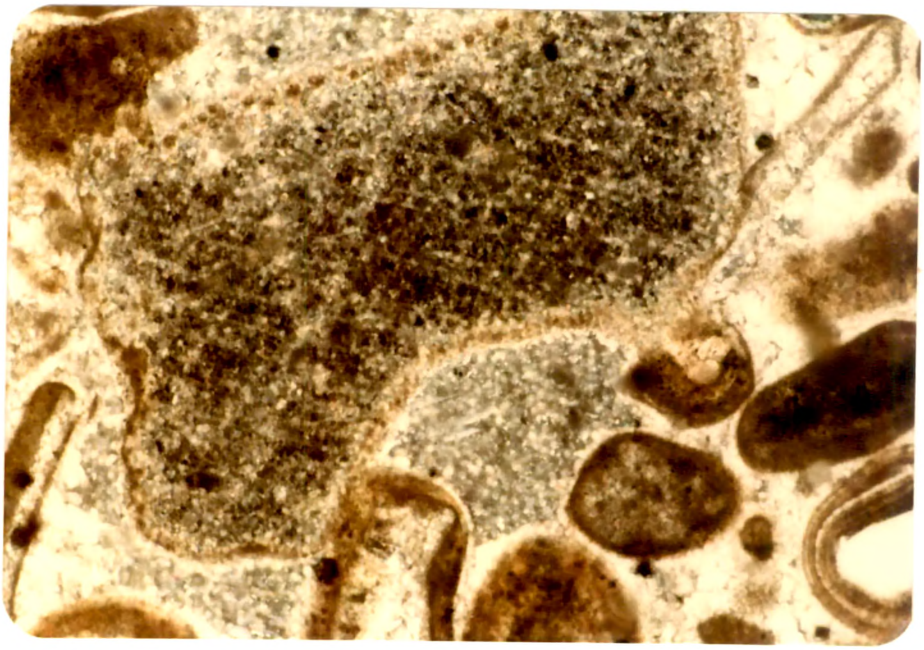
DIAGENETIC EFFECTS ON PORE GEOMETRY

Reservoir petrographic studies added with SEM, XRD and XRF of Jurassic sediments of Jaisalmer Basin has been carried out. Diagenesis has been studied and dealt in separate subtitle in the preceeding chapter. The diagenetic studies have played important role in identifying the changes of porosity type, like precipitation of authigenic clay minerals in pores and pore-throats increase the surface area, creates microporosity, decrease effective intergranular microporosity. However, instances have been observed where porosity type partly or completely occluded by precipitation of mineral cement. Diagenetic processes have also created void space through dissolution of soluble component of the rock. The following main four types of porosity has been observed in the Jurassic sediments.

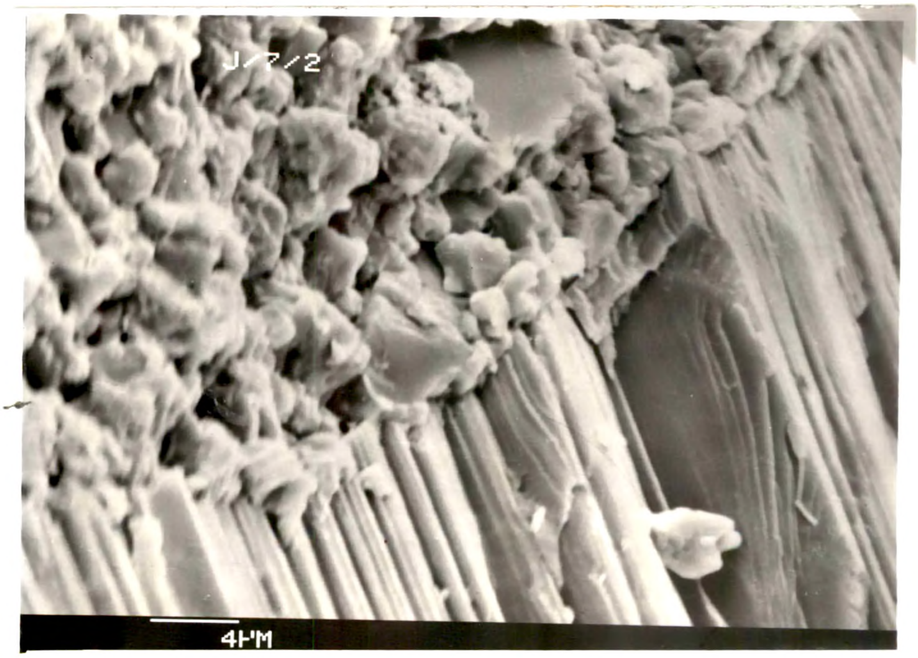
1. Intergranular Porosity

Intergranular porosity have been observed in quartz wacke and quartz arenite of Odania Member of Lathi Formation and Kolar Dungar and Mokal members of Bhadasar Formation (Plate. VIII.1A). It has also been observed in packstone and grainstone facies of Fort, Badabag (Plate. VIII.9B) and Kuldhar members of Jaisalmer Formation and in oolitic grainstone facies of subsurface section in basinal part in Sadewala structure (Plate. VIII.8A), where at places the pore spaces between the grains have been occupied by spar cement, overgrowth of quartz and infilling of Kaolinite clay

PLATE-VIII.9



A. Photomicrograph showing syntaxial overgrowth rim cement on echinoderm plate in oolitic grainstone microfacies observed in the upper part of Jaisalmer Formation, Vikran Nai Structure; X75; XN.



B. SEM photomicrograph showing intergranular porosity in Pelletal grainstone facies (Left corner of Photograph). In the lower part, note calcite spar.

(Plate. VIII.10A).

Intergranular porosity in quartz arenite facies has been destroyed by the presence of calcite and dolomite cement in the basal part of the subsurface section of Sumarwali Talai Struciure (Plate. VIII.10B).

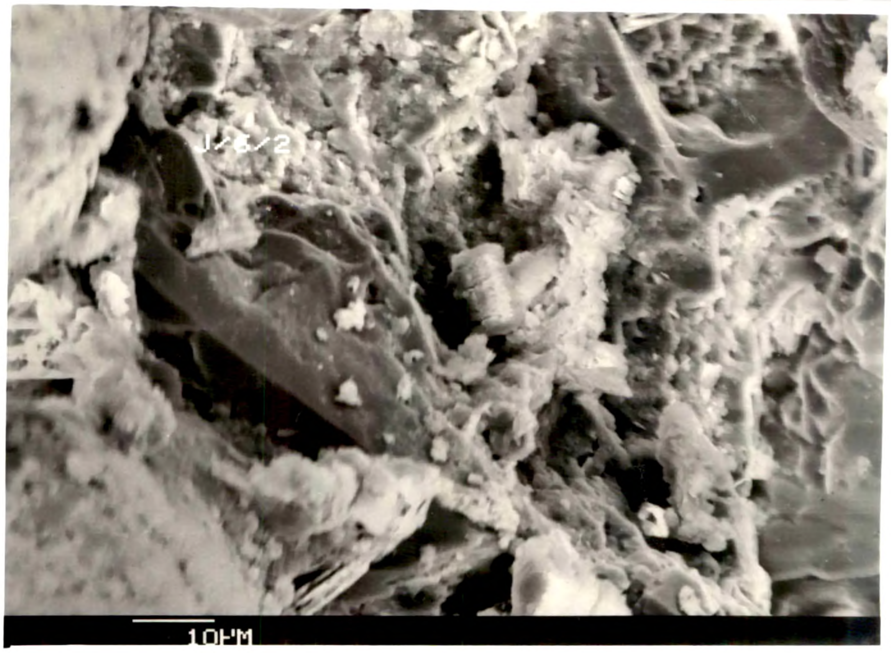
2. Microporosity

Microporosity has been observed in quartz wacke facies of Bhadasar Formation due to dissolution of matrix (Plate. VIII.11A). However, due to influx of ferruginous matter the micropores have been refilled and thus occluded the porosity.

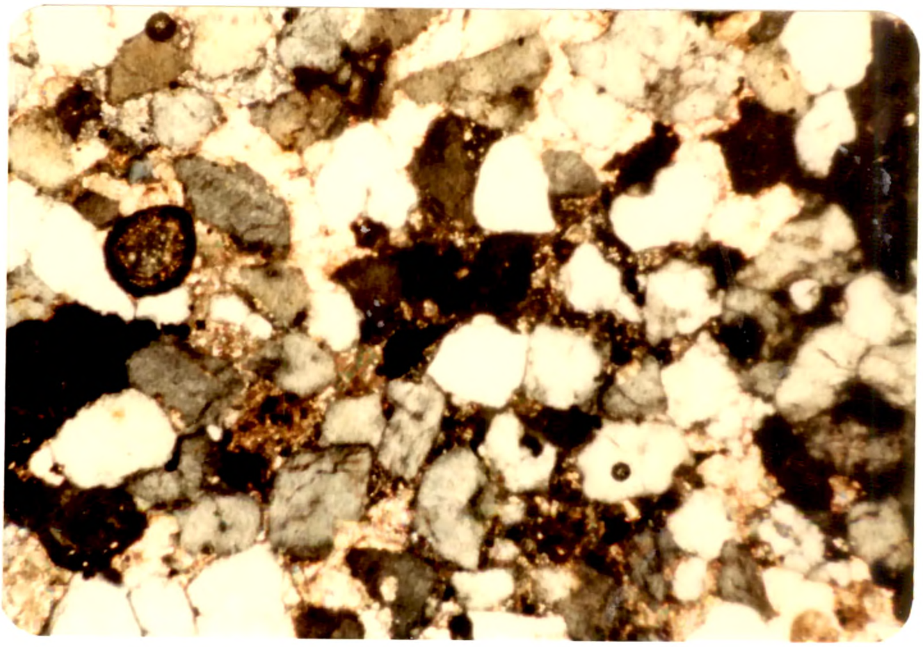
3. Dissolution Porosity

Dissolution pores results from removal of carbonate, feldspar, sulfates, or other soluble materials (Schmidt. et. al; 1977, Stanton and MC Bride, 1976). Porosity created by dissolution of carbonate particles has been noted in oolitic grainstone facies (Plate. VIII.6B). The dissolution of feldspar has been observed on peripheral part of grains in calcareous quartz arenite facies of Kuldhar and Fort members of Jaisalmer Formation. Variable dissolution effect in sandstone facies of basal part of Badabag Member (Plate. VIII.11B) has been recorded.

PLATE-VIII.10

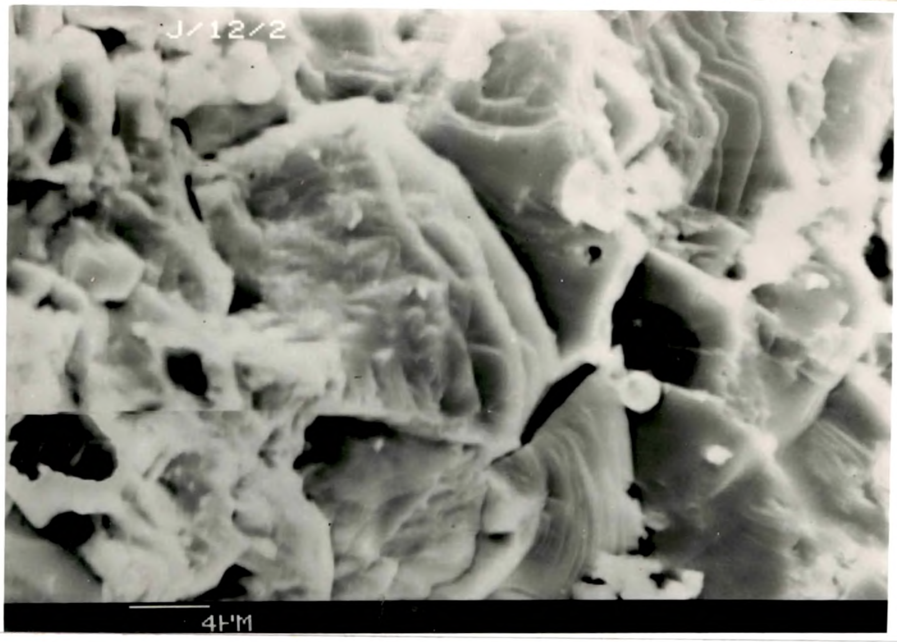


A. SEM photomicrograph showing infilling of intergranular spaces by Kaolinite clay, Lathi Formation.



B. Photomicrograph of calcareous quartz arenite showing well sorted quartz grains, chert and rare oolite with calcite cement, and selective dolomitisation, basal part of Jaisalmer Formation, Sumarwali Talai Structure; X70; XN.

A. SEM photomicrograph showing microporosity developed due to dissolution phenomenon.

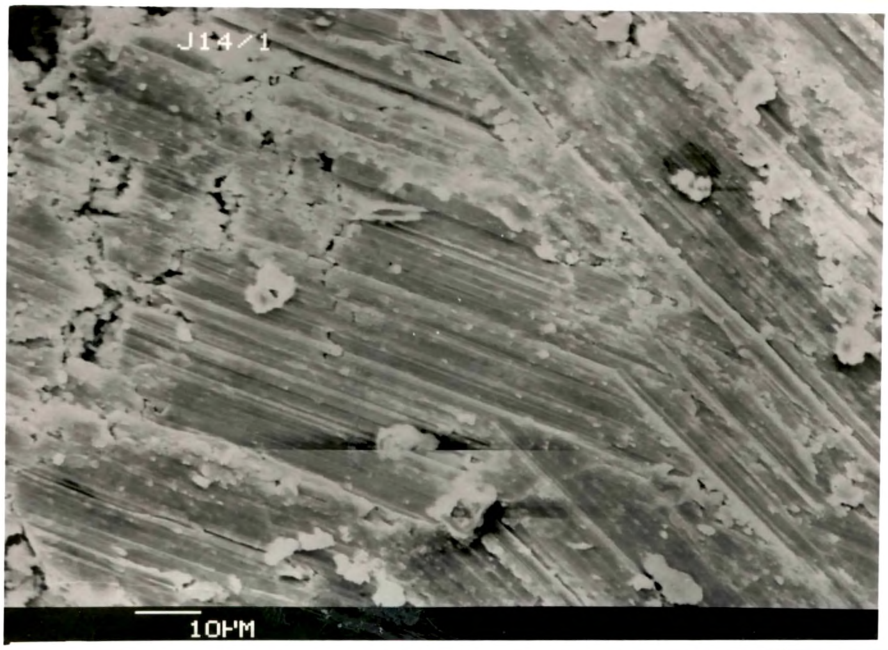


B. SEM photomicrograph of variable dissolution texture in Lower sandstone facies in Badabag Member.

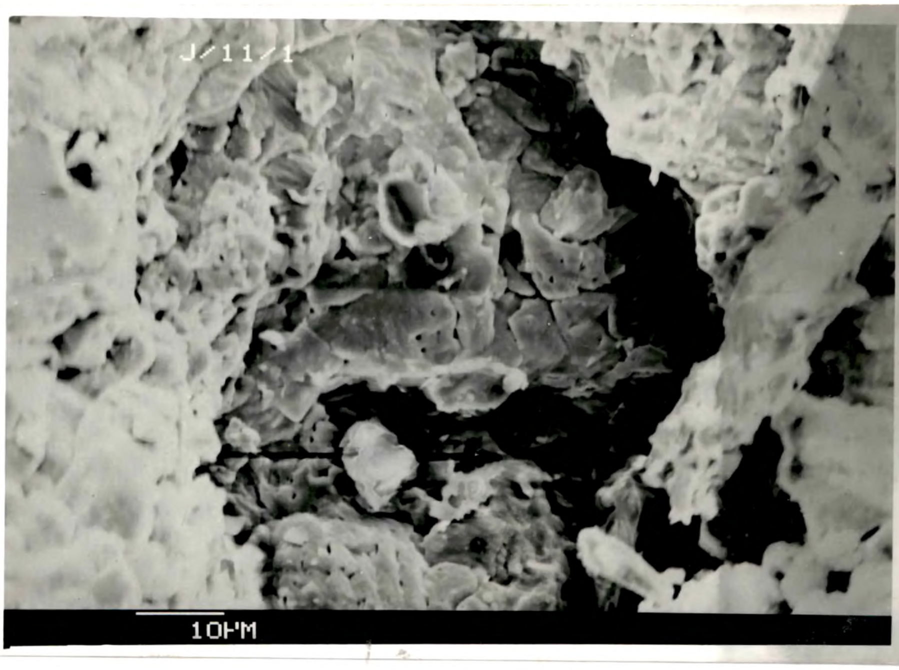
4. Fracture Porosity

Microscopic fracture porosity has been observed in upper part of carbonate section of Jaisalmer Formation in oncolite-oolitic grainstone microfacies in subsurface section of Sumarwali Talai Structure (Plate. VIII. 7A).

As such four basic types of porosity i.e intergranular, micro, dissolution and fracture porosities have been observed in clastic and carbonate section of Jurassic sediments. All the sandstone of clastic sequence in the present study initially have intergranular porosity which later on due to recrystallisation of spars and dolomitisation are often deteriorated (Plate. VIII.12B). Dissolution porosity resulting from leaching of carbonate, feldspar, bioclasts, ooids and pelloids of different microfacies of Jaisalmer Formation have been largely affected by sparitisation. Microporosity observed in clayey matrix in clastic sequence have been affected by influx of ferruginous matter, at places, the ferruginous matrix is replaced by calcite which is evidenced by remnants of iron-oxides (hematite) in matrix, which also occluded the microporosity in general (Plate. VIII.13A). Quartz overgrowth and development of clay rim around the grains (Plate. VIII.13B), have also affected the pore geometry of clastic sequence.



A. SEM photomicrograph showing microstylolite in the calcite spar, developed due to dissolution.



B. SEM photomicrograph showing calcite occluding the intergranular spaces in quartz arenite microfacies, though minor amount of porosity in visible in this section.

Morgan and Gordon (1970) appear to have first discussed the importance of feldspar dissolution on reservoir rock performance. Feldspars commonly affected by dissolution are mainly orthoclase and plagioclase in microfacies of present study.

Dissolution has created microstylolite in calcite spar in Kuldhar Member of Jaisalmer Formation (Plate. VIII.12A).

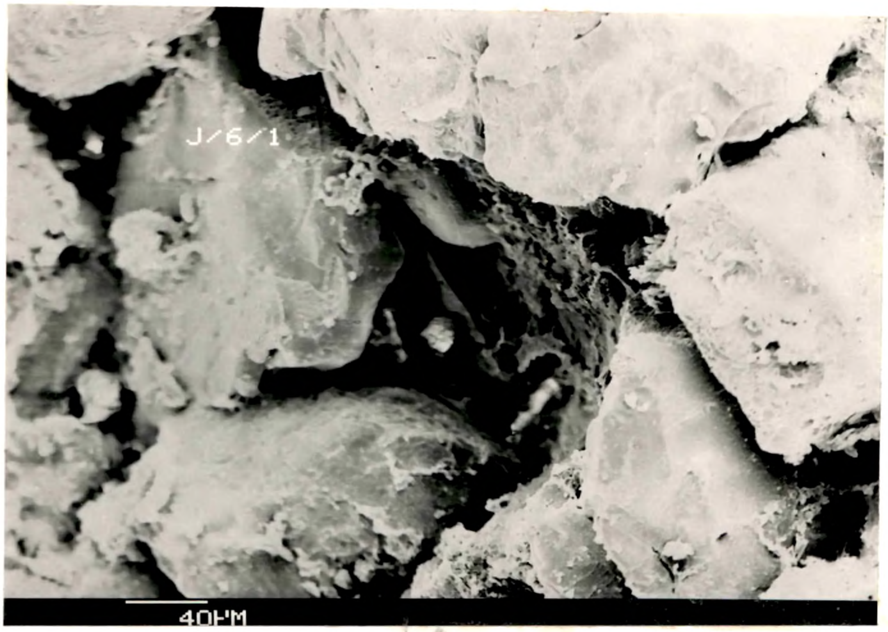
Isolated dissolution porosity have been observed in which carbonbate cement has been removed in mudstone and pelletal wackestone facies of Kuldhar Member (Plate. VIII.6B).

Oomoldic and pelmoldic porosity has been observed in ooids and pelloids of oolitic bioclastic packstone and pelletal wackestone microfacies of Kuldhar Member of Jaisalmer Formation in exposed as well as in subsurface section (Plate. VIII.6B). The pores developed due to dissolution have been filled up by sparitisation and as such occluded the pore geometry in pelletal wackestone facies of upper part of Jaisalmer Formation in Sadewala Structure

Biomoldic porosity has been observed due to dissolution of core as well as peripheral part of echinoderm plates and molluscan shells in grainstone and packstone facies of Jaisalmer Formation.

PLATE-VIII.13

A. Photomicrograph showing ferruginous cement replaced by calcite as evidenced by presence of remnant iron oxide, Thaiyat Member, Lathi Formation; X50; XN.



B. SEM photomicrograph showing textural relationships, clay coating on quartz grains and lining pores, Sandstone facies of upper Lathi Formation.