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A Reconnaissance Microfacies Study of Kawagarh Formation Near Giah, Abbottabad-Nathiagali Road, Hazara, Pakistan

M. Nawaz Chaudhry[1], Tariq Mahmood[1], Riaz Ahmed[2] and Munir Ghazanfar[1]

ABSTRACT

The Kawagarh Formation of Upper Cretaceous age from near Giah, Abbottabad-Nathiagali Road, Hazara, has been studied in detail for internal units, microfacies and diagenetic fabrics. A total of eighteen microfacies and five internal units have been defined.

The eighteen microfacies based on depositional textures cum composition from bottom to top are Wackestone (Biomicrite)- Dolomitic Limestone, Dolomitic Limestone, Wackestone (Biomicrite), Dolospar, Wackestone (Biomicrite)-Dolomitic Limestone, Dolospar, Wackestone (Biomicrite)-Dolomitic Limestone, Calcitic Dolomite, Wackestone (Biomicrite), Wackestone (Biomicrite)-Dolomitic Limestone, Wackestone (Biomicrite), Calcitic Dolomite, Wackestone (Biomicrite), Dolospar, Wackestone (Biomicrite), Sandy Wackestone (Biomicrite), Sandy Dolomitic Limestone and Sandy Dolospar.

A total of five facies units have been established which (internal units) from bottom to top are Mixed Dolomitic Limestone and Dolospar Unit, Biomicrite Unit, Sandy Biomicrite Unit, Sandy Dolomitic Limestone Unit and Sandy Dolospar Unit.

The lower three units contain predominantly Late Cretaceous planktonic foraminifera species of *Globotruncana* and deeper water Algae (*Oligosteginids*) and are considered to have been deposited in deep water low energy environments (outer shelf, close to the edge) while the upper two units which contain rare planktonic foraminifera and are sandy in nature are interpreted to have been deposited in shallower waters (Littoral to inner shelf) with ingress of detrital material.

There is evidence to suggest that the dolomitization in the lower two units took place mainly during the deep burial diagenesis while dolomitization in the upper two units owes its origin to ground water mixing during early diagenesis.

A study of diagenetic fabrics shows that mechanical compaction is unimportant while chemical compaction is wide spread.

[1] Institute of Geology, Punjab University, Lahore.
[2] Hydrocarbon Development Institute of Pakistan, P.O.Box 1308, Islamabad.

INTRODUCTION

The Kawagarh Formation is an important and widespread stratigraphic unit of the so-called Kohat-Potwar and Hazara basin. Being Late Cretaceous in age, it is located at the stratigraphically important Cretaceous-Tertiary boundary. It is overlain by the Hangu Formation which has a part of wholly residual character at many places. Tectonically the uppermost part of Kawagarh Formation marks the period of initial collision between India and Eurasia and any light on its depositional and sedimentary history will have important bearing on the tectonic history of the Indian plate margin. This prompted authors to describe and integrate the petrologic microfacies variation in a measured section of the formation. Two mega-facies of the Kawagarh Formation are known, one is an early facies developed in the southern part of Attock-Hazara Fold and Thrust belt (Ghazanfar et al., 1990) and the other a limestone facies occurring in the north and described below.

The measured section discussed below is located at Giah (Figure 1) and exposed on the Abbottabad-Nathiagali Road towards Abbottabad side of Giah (Lat.34° 6′ 30″, Long. 73° 21′ 26″, Survey of Pakistan Sheet No. 43F/8) about 30 km from Abbottabad. The section was measure 607 ft and 5 inches thick (Figure 2).

Day (in unpublished Attock Oil Company's report) introduced the name Kawagarh marls for the Upper Cretaceous rocks exposed in the Kawagarh hills north of Kala Chitta Range. The name Kawagarh Formation was approved by the Stratigraphic Committee of Pakistan to incorporate Day's "Kawagarh marls" and its facies changes in Kohat and Hazara area. The name thus replaces "Sublithographic limestone" of Davies (1930) in the Samana Range, "Darsamand limestone" of Fatmi and Khan (1966) in Western Kohat, "Dabran limestone" of Khan and Ahmed (1966), "Sattu limestone" of Calkins and Matin (1968) and "Chanali limestone" of Latif (1970) in Hazara area. The type section is located in Kawagarh hills north of the main Kala Chitta Range in Attock District.

The regional stratigraphy of the Hazara area of the Attock Hazara Fold and Thrust belt is summarized in Table 1.

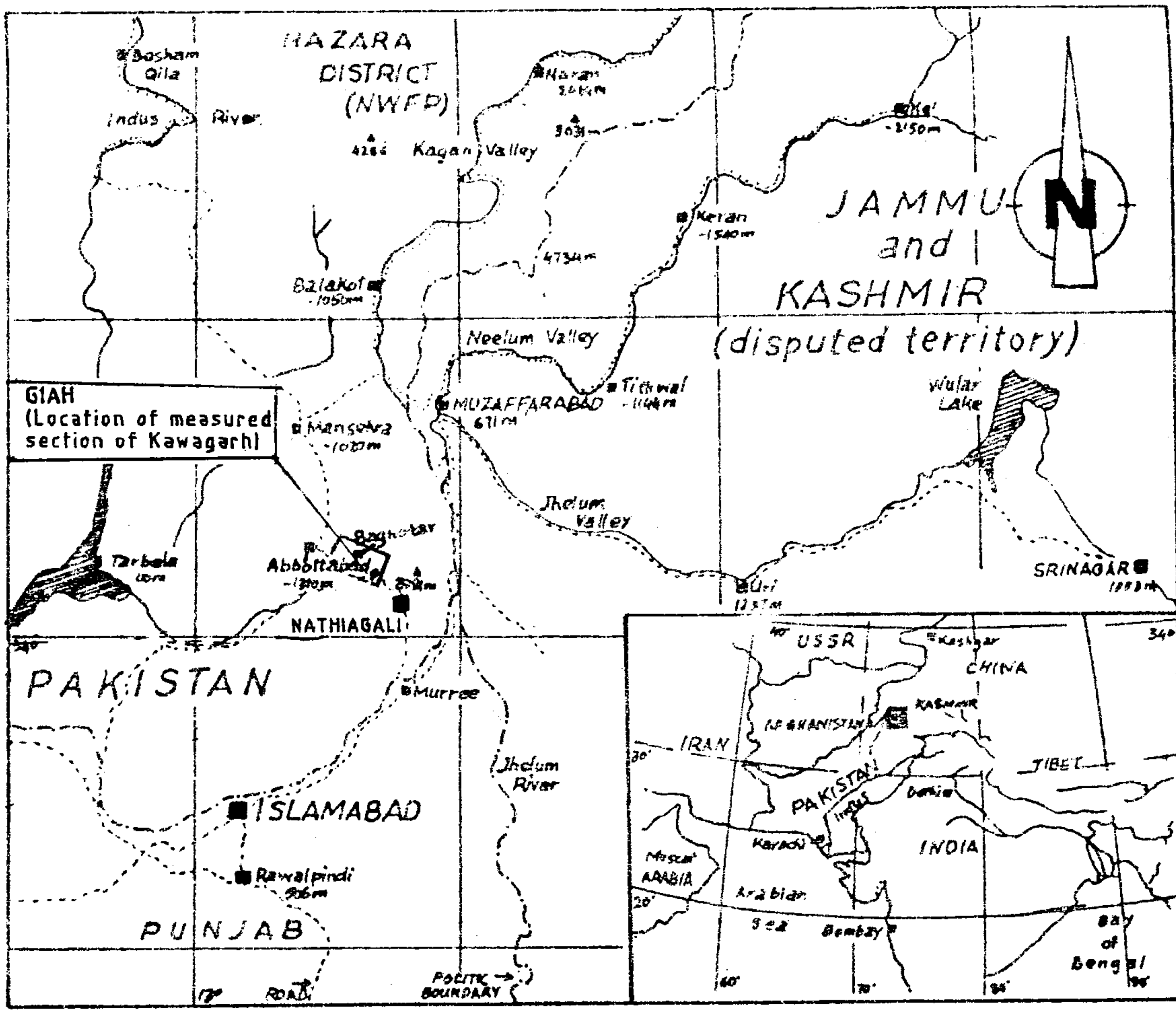


Figure 1— Geographic location of investigated area.

The scheme of classification of carbonates followed in this study is generally after Dunham (1962) and Folk (1962 and 1974).

LITHOLOGIES AND FACIES

The measured section of Kawagarh Formation near Giah starts from the top most part of the Lumshiwal Formation. The Lumshiwal Formation consists mainly of medium to coarse grained glauconitic sandstone. The sandstone is brownish grey on weathered surface and medium grey to brownish grey on fresh surface. Fine limonitic specks are, at places, present even on the fresh surface. The formation is well jointed and fractured. The sandstone is thick bedded, massive and tough. Some greenish grey shaly intercalations are also present near the base. The top of Lumshiwal Formation is brownish to yellow with some black sandy patches that appear to be the product of some reworking of the Lumshiwal Formation which has disconformable contact with the overlying Kawagarh Formation.

The outcrop of the Kawagarh Formation is well exposed near Giah. Its lower part near the top of Lumshiwal sandstone is fine grained, off-white to light grey on fresh surface and whitish grey to dull grey on weathered surface. It is irregularly dolomitised on surface. Overlying there are relatively coarser grained as well as small coarse grained patches in fine grained micritic limestone. This is followed by fine grained limestone, bluish grey on weathered surface to medium grey on fresh surface. Closely developed joints give a brecciated appearance. The beds are generally from 1 to 1.5 ft thick, rarely beds upto 2.5 ft thick are also encountered. It breaks with conchoidal to sub-conchoidal fracture. Overlying this, there is a sequence of relatively coarser grained thick bedded limestone, which is medium to dark grey on fresh surface. Conchoidal fracture is generally absent in it.

Towards the top Kawagarh Formation is relatively coarser grained, arenaceous and somewhat lighter in colour. The bedding of Kawagarh limestone is parallel to the overlying sequence (The Hangu Laterite). At places the

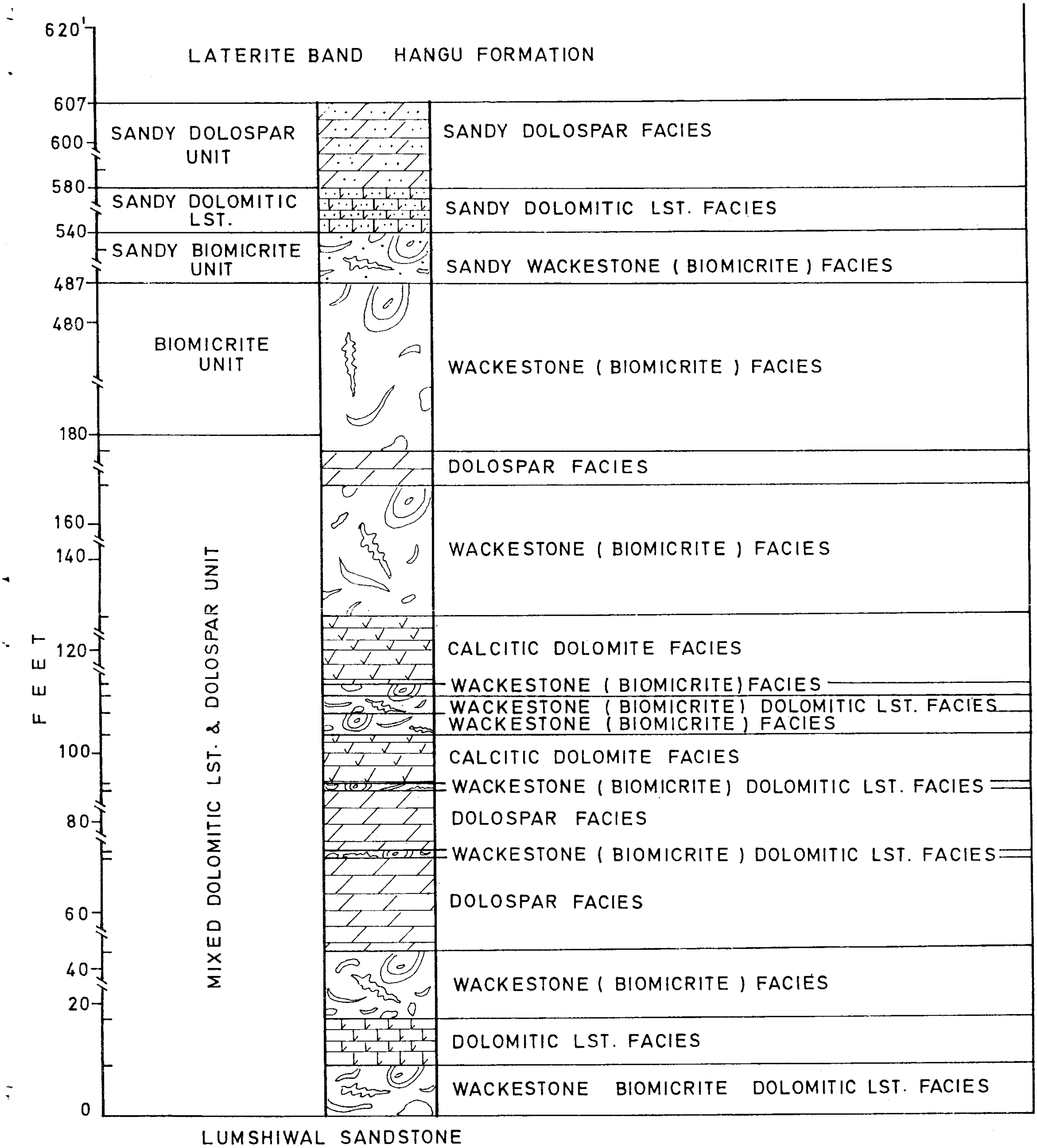


Figure 2— Lithofacies log of Kawagarh Limestone near Giah, Abbottabad-Nathiagali Road.

Table 1. Stratigraphic Table of Hazara Area, AHFTB.

Age	Formation	Lithology
Early Miocene	Murree	Grey and reddish sandstone and shales
Middle Eocene	Kuldana	Maroon to variecoloured shales and marls
Early to Middle Eocene	Chorgali	Thinly bedded limestone and marls
Early Eocene	Margala Hill Limestone	Nodular foraminiferal limestone
Late Paleocene	Patala	Greenish grey/khaki shales with limestone beds
Middle Paleocene	Lockhart Limestone	Nodular foraminiferal limestone
Early Paleocene	Hangu	Sandstone, claystone, laterite
--------- Disconformity ---------		
Late Cretaceous	Kawagarh	Fine grained light grey limestone
Early Cretaceous	Lumshiwal	Grey to brownish coarse sandstone
Late Jurassic to Early Cretaceous	Chichali	Dark grey shales with sandstone beds, medium grained
--------- Disconformity ---------		
Middle Jurassic	Samana Suk	Limestone with dolomitic patches
Early Jurassic	Datta	Sandstone, quartzite, microconglomerates
--------- Disconformity ---------		
Early Cambrian	Hazira/ Galdanian	Calcareous siltstones and shales
Precambrian	Abbottabad	Dolomites with sandstone, shale and boulder bed at base
--------- Unconformity ---------		
Late Precambrian	Hazara	Slates, sandstone and quartzites

laterite is seen to fill 1" - 2" deep cusps of Kawagarh Formation. The top 1" or more of Kawagarh limestone also appears to have been weathered and partially lateritised. The Kawagarh limestone at this locality is thick bedded.

The Laterite Band overlying Kawagarh Formation near Giah is about 20" thick, the lower half comprises laterite and the upper half is a claystone. The laterite part is dark grey with a brownish tinge. It appears to be oolitic and also has smaller grains. A few pisolites are also seen. Its specific gravity is high. The upper half of the laterite band comprises yellowish claystone which is in fact a flint clay. It is weathered and the exposure is not good.

INTERNAL UNITS

The Kawagarh Formation is divided into the following five units from bottom to top (Figure 2).

1. Sandy Dolospar Unit
2. Sandy Dolomitic Limestone Unit
3. Sandy Biomicrite Unit
4. Biomicrite Unit
5. Mixed Dolomitic Limestone and Dolospar Unit

Mixed Dolomitic Limestone and Dolospar Unit.— The main mass is a fine grained but unequigranular rock. It is off- white to light grey on fresh surface and grey to dull grey on weathered surface. It is irregularly dolomitised. It is composed of calcitic micrite, idiotopic dolomite rhombs and planktonic foraminifera.

Dolospar also occurs as interbeds, areas, layers and patches in this unit. Here it is generally subidiotopic to anhedral, unequigranular to subequigranular and even sub-porphyrotopic. The grain size may vary irregularly. This part of the unit is very poor in fossils. It is off-white to pinkish yellowish grey.

Biomicrite Unit .— This is a medium grey fine grained limestone unit. It weathers to a characteristic bluish grey colour. It breaks with a typical conchoidal to subconchoidal fracture. It is composed of micrite with embedded planktonic foraminifera.

Sandy Biomicrite Unit.— This is medium to dark grey with yellow patches and is thick bedded limestone. Its weathered surface is dark rusty grey to dark yellowish grey. It generally lacks conchoidal fracture. The rock is composed of calcitic micrite, bioclasts and detrital quartz grains.

Sandy Dolomitic Limestone Unit.— This is medium to dark grey and somewhat rusty looking unit. It is relatively coarser grained. It is composed mainly of calcitic micrite, dolospar rhombs and detrital quartz.

Sandy Dolospar Unit.— This is off-white to dirty white to dark grey in colour. Dark grey parts occur as patches. Its weathering colours are dirty medium grey to off-white. Its upper surface is irregular.

MICROFACIES TYPES

A total of 18 microfacies types of Kawagarh Formation are established (from bottom to top as shown in Figure 2).

Wackestone (Biomicrite) Dolomitic Limestone Facies

This facies (Plate I-1) is mainly Wackestone, Biomicrite with dolomitic limestone patches and represents the base of the Kawagarh Formation. It is composed of planktonic fossils (about 15%), micrite (54%) and dolospar rhombs (20%). Pore filling calcite is 2% while clay is about 1%. Intergranular porosity is 1% and fracture porosity is 3%. Intragranular porosity occluded by spar is 4%.

Dolomitic Limestone Facies

The dolomitic limestone facies (Plate I-2) is composed mainly of micrite (50%) with zoned dolospar rhombs (46%). The spar veins constitute about 2%, primary intergranular porosity is about 1%, pore filling calcite 0.5% and fracture porosity is 0.5%.

Wackestone (Biomicrite) Facies

The ground mass of this facies (Plate I-3) is micritic (about 73%) with planktonic forams (15%). The spar filling veins are 4%. Intragranular porosity occluded by spar cement is 6%. Fracture porosity is about 1%. Occasional dolomite rhombs (1%) may occur.

Dolospar Facies

This facies (Plate I-4) is mainly composed of anhedral and zoned dolospar (94%) with intergranular pore filling calcite (about 2%), clay (1%). Intergranular porosity is 3%.

Wackestone (Biomicrite) Dolomitic Limestone Facies

The ground mass of this facies (Plate I-5) is mainly micrite (70%) with euhedral dolospar rhombs (12%) and shell fragments (12%). Intragranular porosity (4%) is occluded by calcite (about 2%).

Dolospar Facies

The Dolospar Facies (Plate I-6) is dominantly composed of subidiotopic dolospar (92%) and clays around the rims of dolospar (upto 2%), vein filling calcite is 2% and intergranular porosity is about 4%.

Wackestone (Biomicrite) Dolomitic Limestone Facies

The Wackestone (Biomicrite)-Dolomitic limestone facies (Plate II-1) is mainly composed of micrite (60%) with dolomite patches (upto 15%) and shell fragments (upto 20%). Intergranular porosity is 3% and vein filled by spar is 2%.

Calcitic Dolomite Facies

The calcitic dolomite facies (Plate II-2) is composed of dolospar (70%) and finely crystalline calcite (28%). The dolospar rhombs contain relics of micrite. Intergranular porosity is 2%.

Wackestone (Biomicrite) Facies

This facies (Plate II-3) is composed of predominant micrite (80%), shell fragments (12%), dolospar rhombs (7%) and pore filling calcite (1%).

Wackestone (Biomicrite)-Dolomitic Limestone Facies

This facies (Plate II-4) comprises micrite (55%), dolospar rhombs (30%), shell fragments (10%) and pore filling calcite (2%). Intergranular porosity is 1% and fracture porosity is 1%, clay is about 1.0%.

Wackestone (Biomicrite) Facies

The Wackestone (Biomicrite) Facies (Plate II-5) is composed mainly of calcitic micrite (70%), shell fragments (25%), vein filling spar (1%), clays (0.5%) and pore filling calcite (2%). Intergranular porosity is 0.5% and fracture porosity is 1%.

DESCRIPTION OF PLATES

PLATE I

1. Wackestone (Biomicrite)-Dolomitic Limestone Facies. Magnification 10x10, PPL. a) Zonded dolomite rhomb; b) *Hedbergella sp.*; c) Pore filling calcite.

2. Dolomitic Limestone Facies. Magnification 10x10, PPL. a) Zoned dolomite rhomb.

3. Wackestone (Biomicrite) Facies. Magnification 10x2.5, X- Nicols. a) Calcite occluding fracutre porosity; b) Remaining pore spaces.

4. Dolospar Facies. Magnification 10x6.3, X-Nicols. a) Intergranular porosity.

5. Wackestone (Biomicrite) - Dolomitic Limestone Facies. Magnification 10x2.3, PPL. a) Dolomite rhomb; b) *Helvetoglobotruncana helvetica*; c) Microvein of calcite replacing dolomite and fossils.

6. Dolospar Facies. Magnification 10x6.3, PPL. a) Clay around the rim of dolomite plates.

PLATE II

1. Wackestone (Biomicrite) - Dolomitic Limestone Facies. Magnification 10x6.3, PPL. a) *Helvetoglobotruncana helvetica*.

2. Calcitic Dolomite Facies. Magnifcation 10x6.3, PPL. a) Unzoned dolomitic rhomb; b) Calcitic micrite.

3. Wackestone (Biomicrite) Facies. Magnification 10x2.3, PPL. a) Calcite filling a microfracture; b) Fracture porosity.

4. Wackestone (Biomicrite)-Dolomitic Limestone Facies. Magnification 10x10, PPL.

5. Wackestone (Biomicrite) Facies. Magnification 10x6.3, PPL. a) *Oligosteginids*.

6. Calcitic Dolomite Facies. Magnfication 10x6.3, X-Nicols. a) Dolomite rhomb with micrite core(?); b) Micrite; c) Bioclast.

PLATE III

1. Wackestone (Biomicrite) Facies. Magnification 10x6.3, PPL. a) *Dicarinella concavata*; b) Micrite.

2. Dolospar Facies. Magnification 10x2.5, X-Nicols. Mosaic of anhedral dolomite grains.

3. Wackestone (Biomicrite) Facies. Magnification 10x10. X- Nicols. a) *Marginotruncana pseudolinneiana*; b) Tiny authigenic quartz grains; c) Disseminated caly & carbonaceous matter in vein.

4. Sandy Dolomitic Limestone Facies. Magnification 10x10, PPL. a) Detrital quartz grains; b) Calcite microvein cutting across quartz grains.

5. Sandy Dolomitic Limestone. Magnification 10x10, X-Nicols. a) A patch of micrite; b) Detrital quartz grain; c) A rhomb of dolomite.

6. Sandy Dolospar Facies. Magnification 10x2.3. a) Fracture porosity in sandy dolomite.

PLATE IV

1. Biomicrite (Wackestone) Facies. Magnification 10x6.3, PPL. a) Clay + Carbonaceous matter in a part of a stylolite; b) *Oligosteginids*.

2. Calcitic Dolomite. Magnification 10x6.3, X-Nicols. a) Porosity developed due to dolomitisation.

3. Biomicrite (Wackestone) Facies. Magnification 10x6.3, PPL. a) *Heterohelix sp.*; b) *Oligosteginids*.

4. Biomicrite (Wackestone) Facies. Magnification 10x6.3, PPL. a) *Globotruncana sp.*

PLATE I

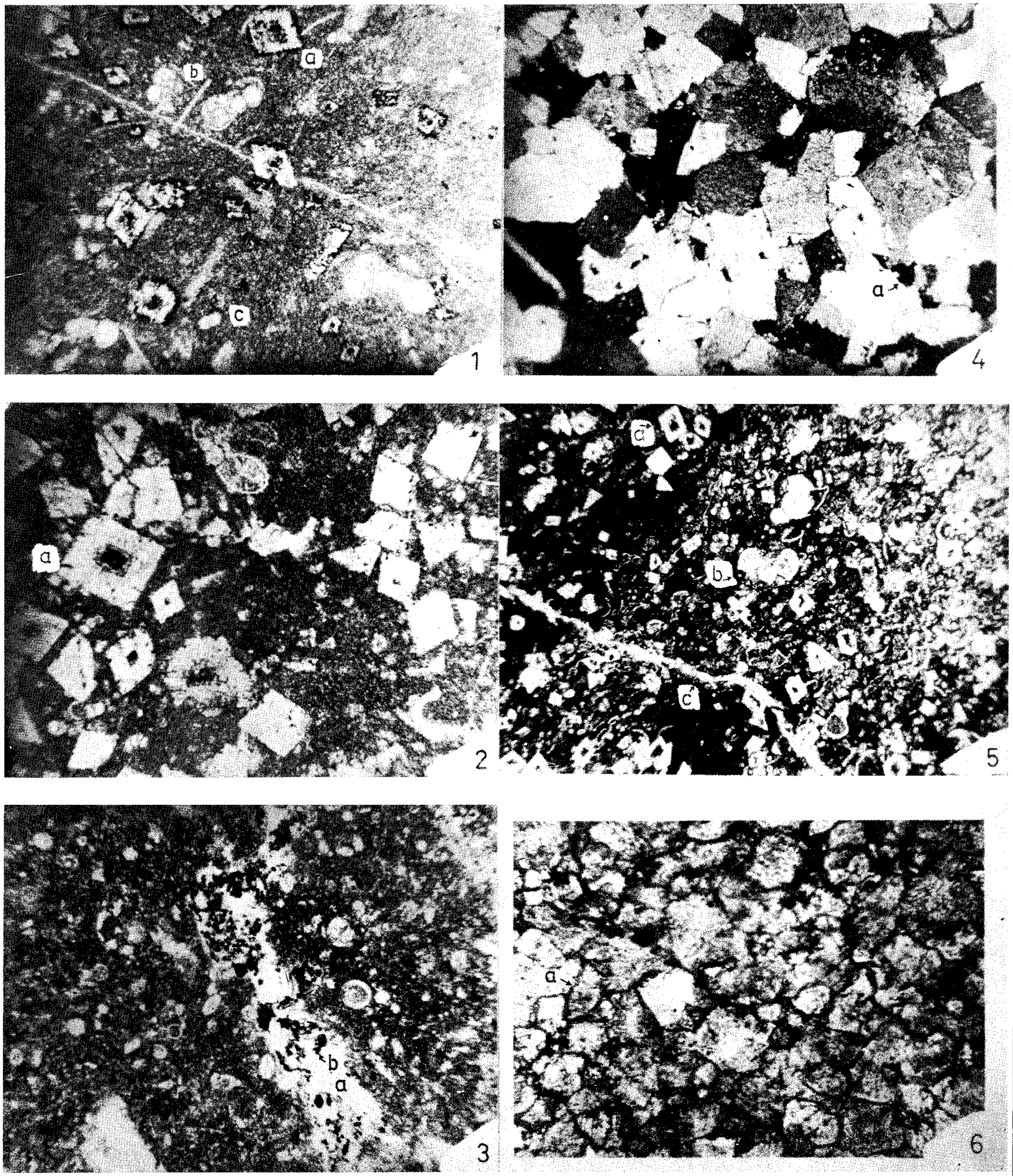


PLATE II

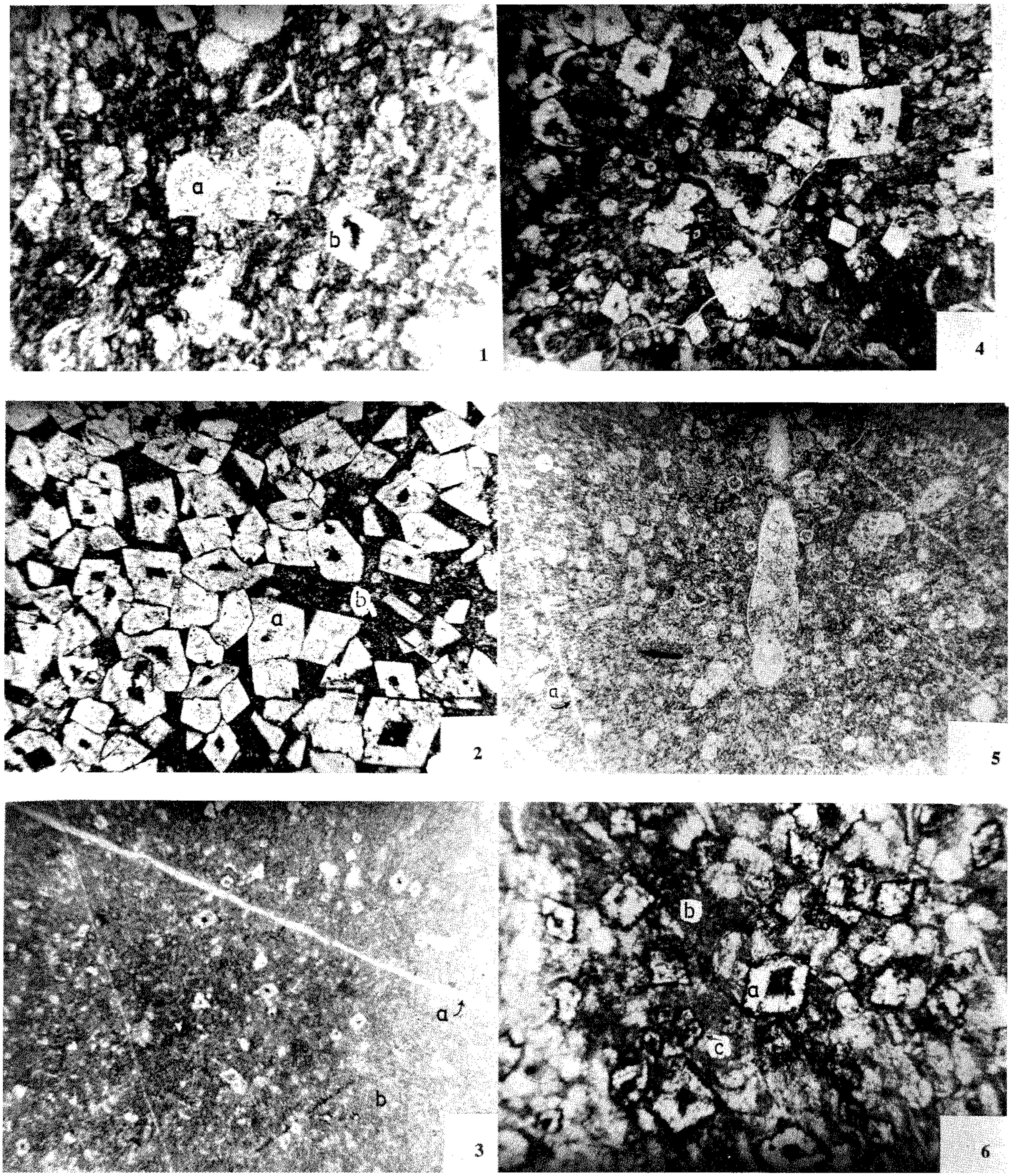


PLATE III

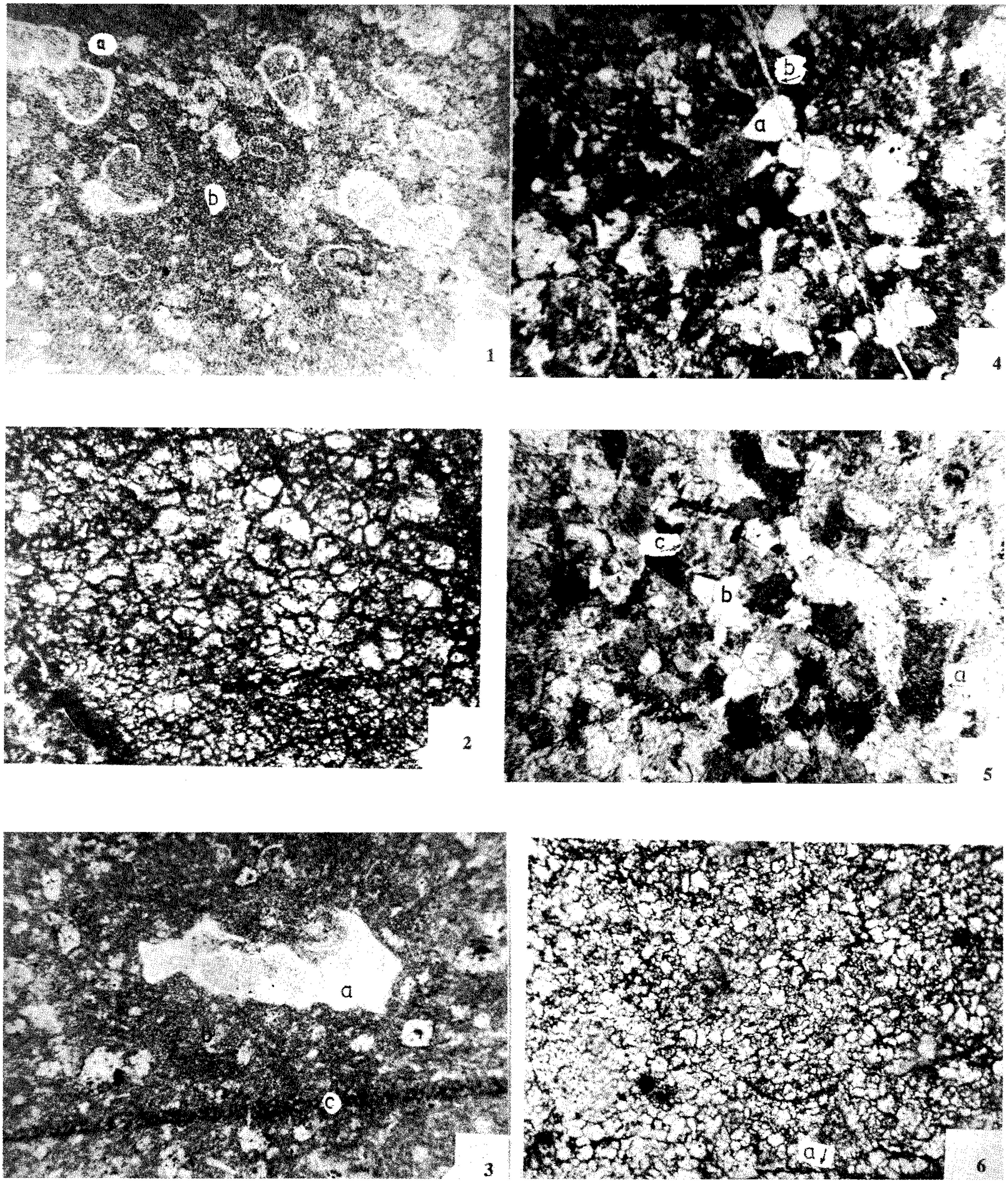
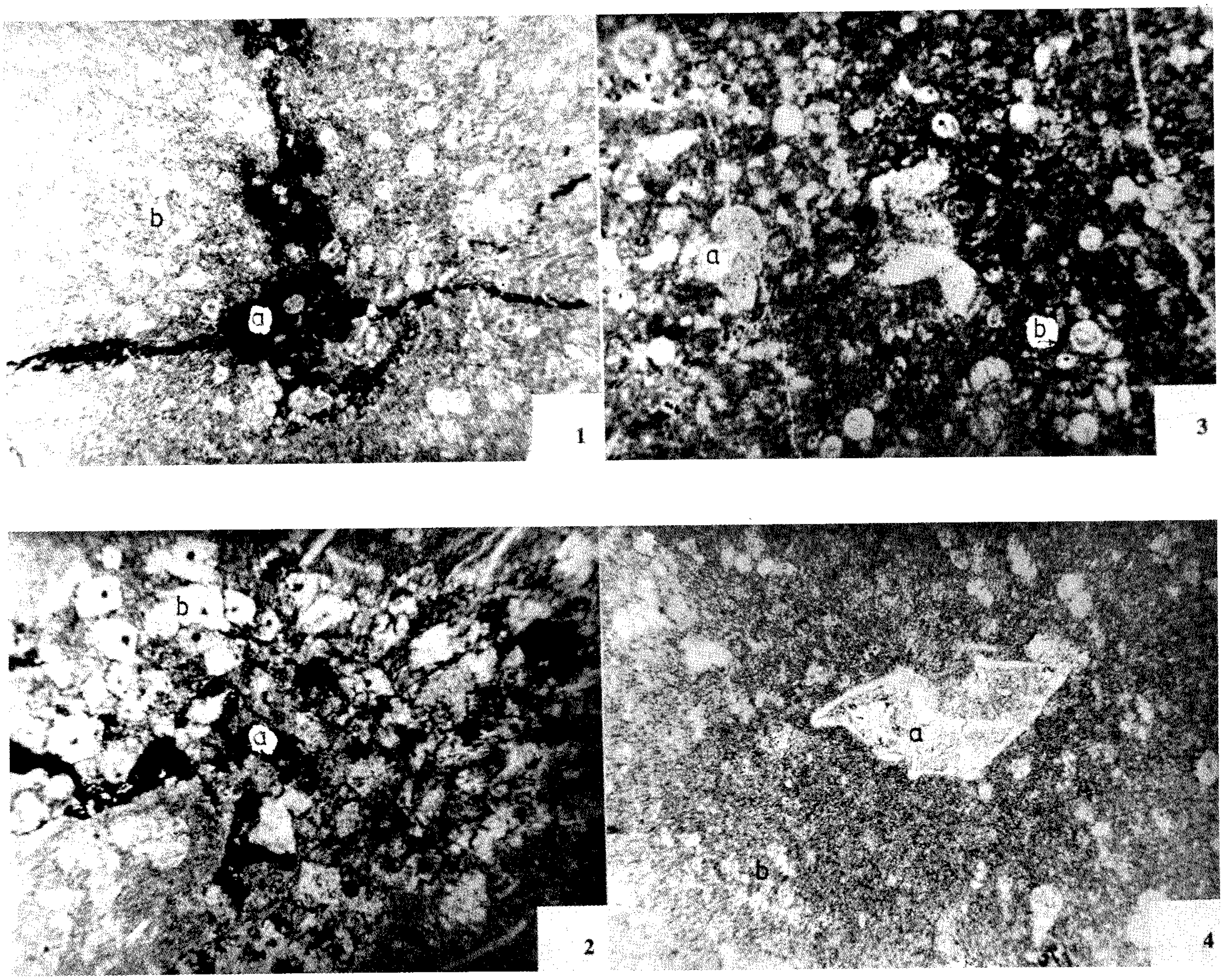


PLATE IV



Calcitic Dolomitic Facies

This facies (Plate II-6) is composed mainly of euhedral dolospar rhombs (54%) with patches of calcitic micrite (40%) and highly fragmented shells (4%). The spar filling vein matter is 2%.

Wackestone (Biomicrite) Facies

The ground mass of this facies (Plate III-1) is calcitic micrite (70%) with shell fragments (25%). The spar filling vein matter is 2%, clays and haematite are 1%. Fracture porosity is 2%.

Dolospar Facies

This facies (Plate III-2) is dominantly composed of anhedral dolospar (92%). Spar filling vein constitutes 3% and amount of clay is 1%. The intergranular porosity is about 4%.

Wackestone (Biomicrite) Facies

The ground mass in the Wackestone (Biomicrite) facies (Plate III-3) is the calcitic micrite, that ranges from 75-82%. Planktonic fossil fragments range between 10-16%. The dolospar rhombs showing zoning may rarely occur. The other components include spar filling veins 1-4%, clay and carbonaceous matter upto 1%. Authigenic quartz is 2%. The quartz grains are subrounded and range from 0.07 to 0.42 mm.

Sandy Wackestone (Biomicrite) Facies

Detrital quartz varies from 8-10% (Plate III-4), the quartz grains are subrounded to subangular and range in size upto 0.07 to 0.17 mm. The ground mass is calcitic micrite that ranges from 66-74%. The shell fragments range from 10-11% and bioclasts (non-planktonic) arcuate in shape upto 2%. Clays range between 0.5-1%. Pore filling calcite is upto 2%, spar filling vein matter is 1-2% and intergranular porosity is about 2%.

Sandy Dolomitic (Biomicrite) Facies

The main component in this facies (Plate III-5) is the calcitic micrite which occurs as ground mass and varies between 50-58%. Detrital quartz grains that range in size from 0.15 to 0.2 mm are present (10-20%). The rhombs of dolospar are 25-30% and pore filling calcite is 1-2%. This facies is almost devoid of any fossils.

Sandy Dolospar Facies

The main component of this facies (Plate III-6) is the anhedral dolospar that ranges between 84-86%. Detrital quartz ranging in size from 0.14 to 0.15 mm is 10%, clays 3% and haematite 0.5 to 1%. This facies is also devoid of any fossils.

DIAGENETIC FABRICS

The term diagenetic fabric used here includes compaction, cementation and dissolution to complete replacement (Scoffin, 1987; Wilson 1975). Diagenetic fabrics also reflect on the depositional environment (Tucker, 1988; Schneidermann and Harris, 1985). Various elements of diagenetic fabrics are outlined below.

Compaction

There is not much evidence of mechanical compaction. Petrographic studies show that the fossil shells are not broken down. Similarly the grain to grain contacts also do not indicate significant mechanical compaction. The fracture porosity observed in some cases can be related mainly to post consolidation tectonic stresses.

It appears that cementation had already progressed substantially before the operation of chemical compaction. The presence of low to medium amplitude stylolites indicates pressure solutioning along particular surfaces within cemented sediments. The insoluble residues deposited along stylolites consist of clay and carbonaceous matter (Plate IV-1, 2). Iron oxides occur only in trace to accessory amount along most of these stylolites. Since in Giah section there are no shale or marl intercalations with Kawagarh Formation, therefore it may be inferred that clay rich stylolite seams are of secondary origin.

There appear to be two distinct periods of stylolitisation with respect to dolomitisation. One period predates dolomitisation and the second period postdates dolomitisation. In the former case dolomitisation (wherever it occurs) is superposed on stylolites whereas in the latter case the stylolites intersect dolomitised areas. Moreover, it may be kept in mind that dolomitisation is confined to the basal and the top part of Kawagarh Formation.

Cementation

The cement in the Biomicrite is mainly micrite. However some cementation may be attributed to microspar also. Spar has played very little role. However in the upper quartz-bearing and dolomitised part, spar has also played some role in cementation. As a whole calcitic spar is confined mainly to microveins.

The grain to grain pressure solution cementation is only of minor importance subsequent to the main cementation event (Wanless, 1979 and 1983).

Replacement

The main replacement in these rocks, specially the lower and upper parts is in the replacement of calcitic matter by dolospar. The replacement is variable and may range from incipient to complete. Where dolomite is subordinate to calcite the former tends to be idiotopic and even poikilotopic. Dolomite rhombs may show zoning indicating more than one episodes of replacement. A granoblastic texture tends to develop where replacement is extensive.

Dolomitisation

Dolomitisation affects mainly the lower and upper parts of Kawagarh Formation. The middle part is a fairly pure biomicrite. In the lower part, which overlies Lumshiwal Formation, the dolomite crystals replace the biomicrite containing planktonic foraminifera. The Lumshiwal Formation (mainly sandstone) which itself overlies Chichali Formation (mainly shales) also contains dolomitic cement. It is most probable that the dolomitising solutions were derived from Chichali Formation and moved through Lumshiwal Formation (sandstone) depositing some dolomite and affected the lower parts of Kawagarh Formation.

The upper dolomitised and arenaceous parts of Kawagarh Formation appear to have been dolomitised under shallow conditions by mixing with ground water at the basal perimeter of fresh water lens. These waters must have been undersaturated with respect to calcite but supersaturated relative to dolomite (Scoffin, 1987).

AGE AND ENVIRONMENTS OF DEPOSITION

Age

The age of the Kawagarh Formation in the discussed section seems to range from Turonian to Campanian as indicated by the occurrence of various zonal species of *Globotruncana*. A range chart done by HDIP for the authors and based on thin section identification only also supports this age (Figure 3).

Environment of Deposition

Following the deposition of Lumshiwal Formation, there was a brief period of regression. This is marked by a slight disconformity. It was followed by a rapid transgression and quick deepening of the sea and consequent deposition of micrite and planktonic foraminifera. The lower most unit is mixed dolomitic limestone and dolospar. The dolomite is idiomorphic, sometimes zoned and encloses ground mass micrite relics. Dolomitisation, therefore is clearly secondary and replacive.

The dolomitic limestone is composed of micrite and rhombs of idiotopic and zoned dolomite. The dolomite may contain relics of enclosing micrite. The dolomite has developed either as suspending crystals (Flugel, 1982) or as later replacement. This unit contains planktonic foraminifera.

This unit is followed by a thick biomicrite unit which is generally a grey limestone. It contains planktonic Foraminifera (mainly *Globotruncana*) and deeper water Algae (*Oligosteginids*) and clearly represents a deeper water facies, probably near the edge of the outer shelf (Plate IV-1, 3, 4) as Oligosteginids have been reported to occur in Cretaceous deposited close to the outer shelf limit in Middle East.

The next unit represents the progressive onset of reduction in sea level. It is accompanied by the ingress of detrital quartz grains as well as deposition of bioclasts. But presence of planktonic foraminifera indicates that the deposition was still taking place at the distal part of the shelf.

The next higher unit is a sandy dolomicrite. This unit contains detrital quartz and lacks planktonic foraminifera. This is clearly a shallow water facies. It may have been deposited on the shelf in relatively low energy environment. This may be inferred from the general absence of spar cements and presence of micrite.

The top most unit of Kawagarh Formation is a sandy dolospar unit. This unit is characterised by the presence of detrital quartz and extensive dolomitisation. It clearly is a shallow water facies. The top of this unit underlies Hangu Formation of continental derivation. This lateritic unit has been derived by chemical weathering of Kawagarh Formation and marks a widespread regression.

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We wish to thank Mr. Jamil Afzal of the Hydrocarbon Development Institute of Pakistan (HDIP) for his

Planktonic Foraminiferal Distribution Chart of Kawagarh Formation Giah, Abottabad, Nathiagali area District Hazara

Period	Stage	Planktonic Foraminiferal Zones	Sample no.	Planktonic Foraminifers															S.benthics		Algae
			SPECIES	*Dicarinella canaliculata*	*Heterohelix ? reussi*	*Helvetoglobotruncana helvetica*	*Marginotruncana renzi*	*M. sigali*	*M. schneegansi*	*M. pseudolinneiana*	*M. coronata*	*Dicarinella primitiva*	*D. concavata*	*Rosita fornicata*	*Globotruncanita elevata*	*Globotruncana bulloides*	*Heterohelix ? globosa*	*Textularid*		*Oligosteginids*
LATE CRETACEOUS	Campanian	*G. elevata*	Kw26												●					
			25												●					
	? ?	? ? ?	24												●					
	Santonian	*D. asymetrica* to *D. concavata*	23												●					
			22																	
			21													●		●		
			20													●		●		
			19													●				●
			18													●	●			●
			17														●			●
			16													●	●			●
			15							●	●			●				●		●
			14																	
			13							●	●									
			12							●	●									●
	? ?		11																	●
	Coniacian		10	●									●							
			9	●					●				●	●						
			8	●					●				●							●
			7						●											●
			6						●				●							
		D. primitiva	5	●					●											
			4																	
			3						●			●								●
	Turonian	*M. sigali*	2		●		●	●										●		●
		H. helvetica	Kw 1		●	●														

Figure 3— Planktonic foraminiferal distribution chart of Kawagarh Formation in the study area.

comments on the age of the Kawagarh Formation in the study area and for his help in preparation of a range chart for this paper. We are also grateful to Director General of HDIP for providing access to HDIP's laboratory facilities.

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