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STRATIGRAPHY AND SEDIMENTATION OF THE JURASSICS IN NORTH-EASTERN BALUCHISTAN

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ABSTRACT

Northeastern Baluchistan may be conveniently divided into two major structural zones, a northern imbricated allocthonous zone characterised by extensive thrust faults and a southern autochthonous fold belt which is mainly comprised of simple folds. The Jurassic sediments exposed in these two zones differ structurally as well as lithologically. In the allochthonous zone the imbricate structure has resulted in repetition and thickening of beds as well as cropping out of Triassic and earlier strata. In this zone the Jurassics are mainly comprised of thick to thin bedded limestone inter-bedded with shales.

In the allochthonous zone, such as the Ziarat-Harnai region, an undisturbed thick succession (133 m plus) of Jurassic strata comprising the Mazar Drik Formation, the Chiltan Limestone and the Shirinab Formation is seen in the core of major anticlines. The Mazar Drik Formation is exposed in the Mehrab Tangi, south of Ziarat, but in the Khalifat Range it is missing due to a major Late Jurassic unconformity.

In this paper the stratigraphy, sedimentary structures, and palaeogeography of the Jurassics of the Ziarat area have been described.

INTRODUCTION

The Jurassic sedimentary rocks in northeastern Baluchistan are exposed in a large area extending from Khuzdar in the west, through Kalat, Quetta, Ziarat, to the Sulaiman Range in the east. They largely comprise a thick pile of limestone and shale with subordinate amounts of dolomitic and sandstone beds. Vredenburg (1909), Kazmi (1955), Williams (1959), Hunting Survey Corporation (1961), and Shah (1977) have previously described these rocks in some detail. Vredenburg was the first to divide the Jurassics into three maorj stratigraphic units. Subsequent workers have confirmed the presence of these units and with the passage of time the stratigraphic nomenclature of these units has changed as may be seen from Table 1.

The region in which the Jurassic rocks crop out may be conveniently divided into two major tectonic zones, a northern allocthonous zone and a southern autochthonous zone (Kazmi, 1979; Kazmi and Rana, 1982)).

Intensive imbrication and sporadic emplacement of ophiolites charcterises the alochthonous zone and for this reason a part of it has been referred to as the Bhalla Dhor-Zhob-Kurram ophiolite and schuppen zone on the Tectonic map of Pakistan (Kazmi and Rana, 1982). The allocthonous zone (Fig. 1) contains massive and extensive sheets and slices of Jurassic strata, which dip W, NW or N and have been thrusted over younger sediments of the autochthonous zone. It is, therefore, not easy to find an undisturbed normal sequence of Jurassic sediments in this schuppen zone.

The autochthonous zone, on the other hand, contains a number of large simple anticlinal folds, in the core of which Jurassic rocks are exposed. These strata not only obtain their maximum thickness in the Ziarat area, but are also well-exposed and easily accessible for study. A brief account of the stratigraphy and sedimentation of the Jurassic rocks in this area is given in the following pages, together with an account of the structure and palaeogeography.

DISTRIBUTION AND STRATIGRAPHY

In the Ziarat area, three major Jurassic inliers occur in the Kasa, Pile Aghbarg and Khalifat Ranges. The best section is exposed south of Ziarat in the Khalifat Range along the Dumyara nala where more than 1300 m of Jurassic sediments are exposed. These sediments may be divided into the following lithostratigraphic units :

Chiltan Limestone:

— Massive oolitic limestone member — 500 m

— Oolites and cherty, marly limestone member — 160 m

Shrinab Formation:

— Porcellaneous limestone and shale member — 250 m

— Black limestone, marl and shale member — 500 m

Base not exposed

The Khalifat Range section has not yet yielded any fossils which could help in determination of the ages of the Jurassic succession. However, based on ammonite fossils found in adjacent areas (summarised in Shah, 1977), Early to Middle Jurassic age has been assigned to the rock formation in this region.

LITHOLOGIC DESCRIPTION

Shrinab Formation —Lower Member

This unit is composed of alternate beds of limestones and shales. The limestones are coquinoidal, oolitic, lithographic or of calcilutite type, 1 to 3 m thick, dark grey to black, carbonaceous, full of fossil debris, comprising mainly crinoidal stems, mollusc shells and corals.

TABLE 1. STRATIGRAPHY OF THE JURASSICS IN N.E. BALUCHISTAN AS SUMMARISED BY VARIOUS AUTHORS

Vredenburg (Kalat) 1909	Allison (Quetta) Unpublished Report.	Kazmi (Ziarat) 1955	Williams (Eastern Baluchistan) 1959	Huntings Survey Corp. (Baluchistan) 1961	Shah (Baluchistan) 1977	Age
– *"Polyphemus Beds"*. Thin-bedded limestone & shales	Unconformity	Unconformity	Unconformity	Unconformity	Unconformity Mazar Drik Formation	Middle Jurassic
– Massive grey limestone (several hundred m)	Black fine grained lst. with chert (120 m)	*Khalifat Formation* – Massive oolitic limestone (485 m)	*Takhatu limestone* Grey to brown, massive, biohermal, oolitic (0 to 760 m)	– Chiltan limestone	– Chiltan limestone.	
–	Thin-bedded blue limestone & shales. Fossiliferous (55 m)	– Thick-bedded oolitic & marly limestone (150 m)	– *Anjira Formation* Dark grey, thin-bedded (100–365 m)	– Loralai limestone	Zidi Formation / Windar Group: Anjira Member	
	– Dark fine-grained dense limestone with chert. Higher beds oolitic (1930 m)		– *Loralai Formation* Dark grey. Med. to thin-bedded, with thin shale inter beds (465 m)		Loralai Limestone Member.	Early to Middle Jurassic
–*Dark grey, black limestone* interbedded with fossiliferous dark calc. Shales. (Several hundred m)	– Thin-bedded fine grained black limestone with shaly partings (330 m) Thin-bedded black limestone intercalated with with black shales (2210 m)	*Dumyara Formation* – Thin-bedded percellaneous limestone & shale (230 m) – Dark grey limestone marls & shales (455 m) Base not exposed	– *Spingwar Formation* Limestone & shale, dark grey, thin-bedded. (650 to 1820 m)	– Shrinab Formation – Alozai Group	Shrinab Formation – Spingwar Member.	

The limstone is interbedded with marls and shales. The shales are calcareous, compact and splintary. They are rarely fissile and vary from massive mudstone or flaggy shale to thin-bedded shale. Towards base these beds have been differentiated into a fine-grained, thin bedded calcareous upper part, and a more arenaceous, platy to flaggy or porcellaneous lower part, often containing silstones that grade upward into shales.

The above lithologic units tend to form repetitions of the following sequence.

- Oolites, spergenites or coquinoid limestone (this unit is commonly missing probably due to erosion).
- Impure limestones, marls or lithographic limestones.
- Calcareous shales.
- Sandy shales or siltstones.

The Lower Member of the Shrinab Formation in the Khalifat Range may be correlated with the Spingwar Member of this Formation.

Shrinab Formation — Upper Member

This unit conformably overlies the Lower Member and is comprised of dark grey, fine-grained limestones, marls and splintary shales.

The limestones are thin-bedded, hard, porcellanous, and weather to greyish white. They contain a fair amount of detritus and are commonly oolitic. Ooolites are 0.1 to 0.5 mm, often ferruginous or dark grey, ellipsoidal to spherical, showing concentric and radiate setructures. Often, grains of quartz, calcite or fossil debris form nuclei of these oolites, which are set in a hard calcite cement. These microfossil debris is interspersed between oolites.

The shales are siliceous, grey to olive-coloured, and weather into fine mud. In the lower part of the unit they form upto 3 m thick beds, alternating with 3 to 30 m thick zones of limestone. Upwards the shale gradually thin out and form thin partings between limestone beds.

The contact between the Upper and Lower Member of the Shrinab Formation is gradational. The transitory beds are about 30 m thick. The Upper Member is more resistant to weathering and the contact zone between the two members commonly finds expression in geomorphic features such as tributory streams or series of spurs. This Upper Member of the Shrinab may be correlated with the Loralai Limestone Member of this formation, though the lithologic descriptions of the two differ somewhat.

Chiltan Formation — Lower Member

This unit comprises about 160 m of medium to thick bedded (0.3 to 1.5 m), grey oolitic limestone. The oolites are upto 5 mm, irregular and ferruginous. The

limestones are siliceous, porcellanous or marly. Towards the base cherts bands or nodules are present along bedding planes. Shales are conspicuously absent in the formation.

Chiltan Formation — Upper Member

This unit contains nearly 500 m of thick-bedded to massive, cream-coloured to buff or intensely white to light grey oolitic limestone. The entire unit is markedly oolitic, with hardly any non-oolitic bed.

The oolites comprise up to 80% or more of the rock mass and range in size from mere microscopic specs to pisolites 2 cm in diameter. They are largely spherical or ovoid, comprised of limemud or calcite and at places have been altered into ferruginous ooliths. The larger ooliths have a concentric structure with minute detrital material or fossil debris dispersed within them. At places algal structure is also seen. In thin sections, a few microforaminiferal tests, thin septate filaments of algae, sections of crinoidal stems and diatoms are seen. Coccoliths are also common.

Laterite

In the Khalifat Range, the Jurassics are overlain by a thin bed of laterite (upto 3 m) which occurs in discontinuous patches (Kazmi, 1962). Even where the laterite is missing, the uppermost beds of the Chiltan Limestone show large reddish and pinkish ferruginous patches and contain veins filled with iron oxide.

SEDIMENTARY STRUCTURES

The Lower Member of the Shrinab Formation is characterised by cyclic sedimentation as indicated earlier. The oolitic limestones of the Upper Member of the Chiltan Formation show extensive cross bedding, a feature which has become very clear due to the arrangement of fossil debris and ooliths parallel to the cross laminae. The laminae are fine, closely spaced, and more or less straight. The forsets dip at different angles and in several directions. The Upper Member of the Chiltan Formation also contains extensive stylolite seams.

A conspicuous vertical fault zone containing a large calcite vein may be traced vertically for about 330 m, across the Koshkai scarp. Large blocks of limestone breccia occur in the calcite vein. Upwards the vein contains ferruginous material and near the top it bifurcates into several veins filled with laterite. This fault does not affect the overlying Cretaceous strata and may be therefore Late Jurassic.

CONDITIONS OF DEPOSITION OF THE JURASSIC

During the Early Jurassic a cyclic sedimentation began in an epicontinental part of the Tethys. The deposition was relatively close to shores of the mainland — the Indo-Pakistan plate component of the ancient Gondwanaland. The cyclic

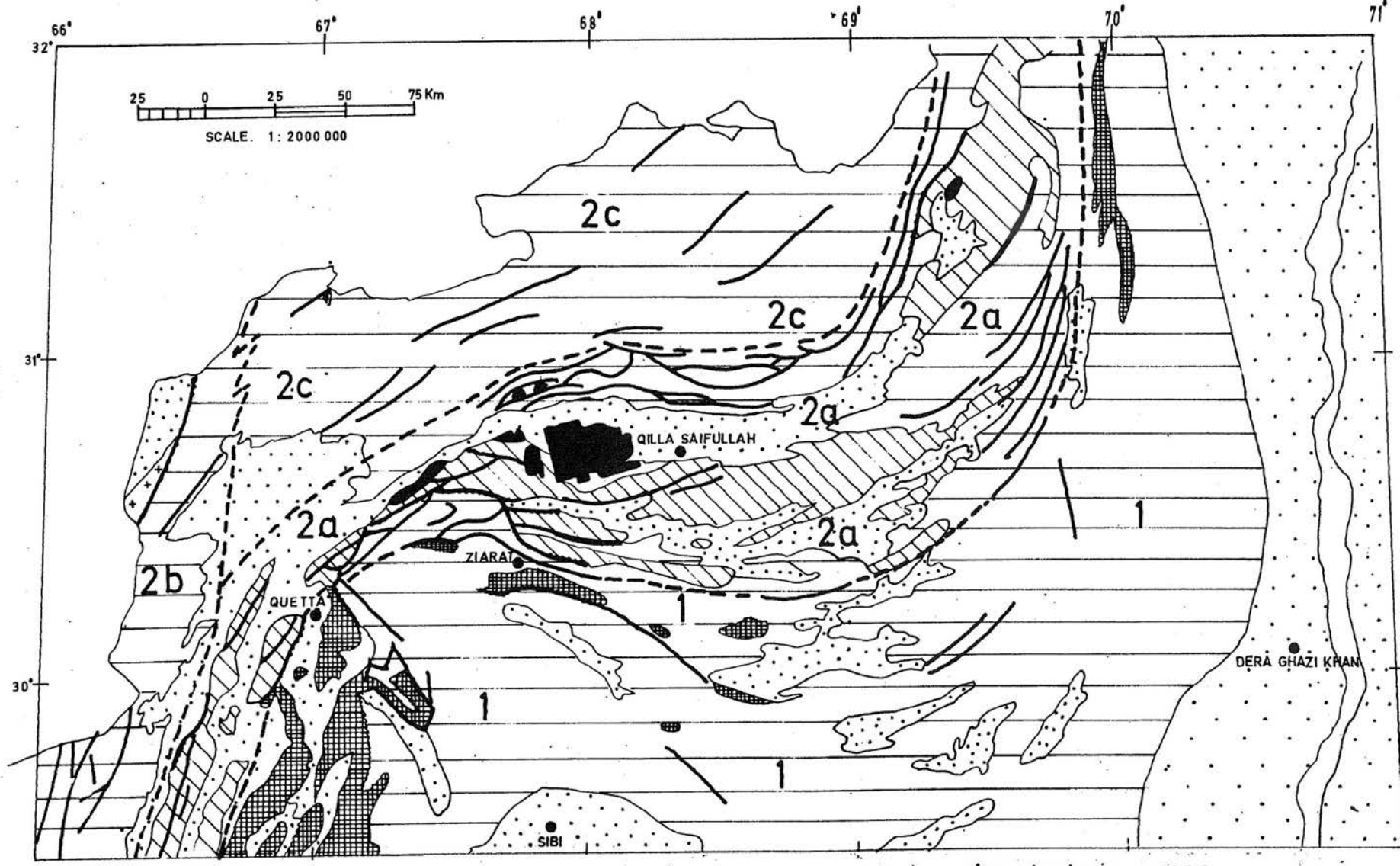

Fig.1. Geological sketch map of N.E. Baluchistan showing Jurassic outcrops and major tectonic zones.

Quaternary deposits

Cretaceous to late tertiary sedimentary rocks.

Felsic intrusive rocks.

Ophiolites.

Jurassic sedimentary rocks.

Jurassic to Triassic undifferentiated.

EXPLANATION

[1] Autochthonous zone comprising Kirthar-Khalifat-Suleiman fold belt.

[2] Allochthonous zone. Comprising following subzones.

[2a] Bhalla Dhor-Zhob-Kurram Ophiolite belt and Schuppen zone

[2b] Choman fault zone.

[2c] Kakar Khurasan flysch bosin.

Major Faults.

sedimentation comprised of repeated phases of transgression characterised by deposition of sandy shales and siltones, followed by deposition of calcareous and carbonaneous shales, marls and impure limestones in the inundation phases. Each cycle culminated with the deposition of oolites, spergenites and coquinoid limestones in the regression phases. This feature indicates considerable crustal instability during Early Jurassic. Indeed it was the period, when consequent to its detachment from the mother Gondwanaland, the Indo-Pakistan plate started on its northward collision course with the Eurasian mainland.

A thick succession of strongly current-bedded massive oolitic limestone during the Middle Jurassic suggests shallowing of the Tethys and deposition under conditions of greater disturbance and agitation and probably a warmer climate.

Complete absence of post-Collovian Jurassic sediments in northeastern Baluchistan, alongwith a major unconformity, at places marked with cappings of laterite (Kazmi 1955, 1961, 1962, 1979) at others with an angular unconformity with overlying Early Cretaceous sediments (Williams, 1959), point towards emergence of extensive tracts of land. This land may have formed part of the frontal promonotory of the Indo-Pakistan plate or it may have comprised a large island or a series of islands. This emergence was caused by the initiation of the over-riding of the Indo-Pakistan plate on the oceanic crust of the Tethys as this plate started drifting northwards.

As evident in the Ziarat area some of the gravity faults were formed during Late Jurassic. Gradual squeezing of the Tethyan ocanic crust gave rise to a series of pre-orogenic earth movements which continued intermittently through the Mesozoic till collision of the major plates culminating in the Himalayan Orogeny (Kazmi and Rana 1982).

DISCUSSION

Most of the stratigraphic studies in Baluchistan uptil now have ignored its unique structural and geodynamical framework. Baluchistan may be conveniently divided into a number of structural zones (Kazmi *et al.,* 1982), each of which differs in geomorphology, structural style and stratigraphy. It is therefore not surprising that the stratigraphic units, when traced from one structural zone to the other, exhibit subtle and some times major changes in lithology or faunal assemblages.

In the case of the Jurassics, most of the type localities of various formations such as the Shrinab, Spingwar, Chiltan, Angira, Mazar Drik belong to different tectonic zones. Some of these, such as the Shrinab and Spingwar, are from the allochthonous zones.

The Jurassic succession in the autochthonous zone (e.g. Ziarat) is less disturbed and more coherent, though the basal part is not exposed. In the allochthonous zone the Jurassic succession is greatly disturbed and is comprised of a large number

of slices or thrust sheets. This imbricate structure has mislead some workers to overestimate the thickness of the Jurassics. However, in the allochthoonous zones overturning and thrusting has also exposed the Triassic and Permian sediments which cannot be seen anywhere in the autochthonous zone.

The tectonic history of these two major zones also differs appreciably. Whereas the autochthonous zone was initially upwarped during the Late Jurassic, it was deformed during the main Himalayan Orogeny (Oligo-Miocene). The allochthonous zone, probably, was first affected by gravity faulting (rifting?) during the Late Jurassic, followed by gravity sliding, obduction of ophiotitic masses and deformation (Paleocene), followed by thrusting and imbrication during the main Himalayan Orogeny.

It is also likely that the Jurassic thrust blocks in the allochthonous zones have travelled considerably and it is therefore not necessary that the Mesozoic formations of the allochthonous zone would be found in the exploratory holes dirlled in the autochthonous zones.

The author therefore proposes that the terms Chiltan and Shrinab Formations be replaced with Khalifat and Dumyara Formations for the Early to Middle Jurassic squence in the allochthonous zone and the Khalifat Range be accepted as the type locality for these formations.

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