Geol. Bull. Univ. Peshawar, 1987, Vol. 20, pp. 53–62

SEDIMENTOLOGY OF THE GHAZIJ FORMATION, KACH AREA, BALUCHISTAN

AKHTAR MOHAMMAD KASSI, AMJAD RASHID QURESHI
and DIN MOHAMMAD KAKAR

Geology Department University of Baluchistan, Quetta.

ABSTRACT

Sedimentary structures, palaeocurrents and lithofacies associations of the Ghazij Formation were studied in Kach area of Baluchistan. A variety of sedimentary structures including several types of sole marks, cross-strata, convolute laminae, current ripples, mudcracks, graded beds and other biogenic structures are commonly present. Palaeocurrent directions are mostly from northeast to southwest and some from southeast to northwest suggesting that flow was generally from east to west. Study of lithofacies associations shows that cyclicity, although not very prominant, is present and suggests a general coarsening-upwards trend in the middle part and a marked fining-upwards cycle in the upper part of the formation. These rhythmic and graded sandstone strata in lower shale-dominant part of the formation possess characters of the turbidites. Similarly the uppermost part of the formation is also shale-dominant, suggesting a marine transgression. Most characters support a deltaic origin for succession of the Ghazij Formation.

INTRODUCTION

The Ghazij Formation has been attracting attention of the geologists because of its natural wealth of coal and alabaster. Coal has been mined from the Ghazij Formation in various areas of Baluchistan like Sor Range, Degari, Duki, Mach and Sharigh. The formation comprises dominantly of shales and subordinate sandstones and conglomerates, with alabaster and coal seams. The shales are of pale greenish-grey, brown, reddish-grey, olive grey, maroon and purple colour, calcareous, hard and flaky. Sandstones are dark grey, greenish and brownish-grey, medium to coarse grained, poorly sorted and subangular to subrounded. Conglomerate consists of poorly sorted and well rounded fragments of granules to cobbles range. The formation is 590 m thick at type section in Spintangi. It

conformably overlies Dungan Formation, Laki Formation and Rani Kot Group of Paleocene age in different areas and underlies the Kirther Formation of Upper Eocene. Age of the Ghazij Formation is Early Eocene based on fossil content.

PREVIOUS WORK

The formation was initially mapped by Oldham (1890), Williams (1959), and Hunting Survey Corporation (1961) and was subdivided into the Baska Shales (Alabaster Member) and Marap Conglomerate Members. Megafauna and stratigraphy of the formation has been dealt with in detail (Kazmi, 1962; Iqbal, 1970). Sedimentology has been described by Kazi (1968) and Farshori and Ahmad (1969). Kassi (1986) described the sandstone petrography and provenance of the formation of Kach, Degari, Murree Brewery and Bibi Nani areas and mutually compared and classified them.

The present paper is an attempt to describe the sedimentology of the formation in Kach area with the help of data acquired about sedimentary structures, palaeocurrents and lithofacies associations.

DESCRIPTION

It has been established that the Ghazij Formation is a deposit of deltaic environment (Kazmi, 1962; Fershori and Ahmad, 1969; Iqbal, 1970). Therefore it is desirable to briefly review the characters of the deltaic sequences and compare them with the observed succession of the Ghazij Formation in Kach area (Fig. 1).

a. The delta model

Lyell (1954) defined delta as 'alluvial land formed by a river at its mouth'. Delta and its associated sub-environments both in plane and in section are shown in Fig. 2. It has been established (de Raaf, Reading and Walker, 1965; Bernard, *et al.*, 1970; Kaiser, 1971, 1972) that the deltaic deposits comprise of large-scale coarsening-upwards cycles (up to 100 m thick) stacked one upon the other (Fig. 2). These cycles begin with shales in the lowermost part and end with coarse grained and locally gravelly sandstones and conglomerate in the uppermost part. In some cases the delta is topped with the fluvial deposits (usually fining-upwards cycles) of meandering rivers. The coarsening upwards cycles are interpreted to represent gradual progradation (seaward growth) of deltas into shallow marine water. Progressive shallowing lead to changes in bedding thickness and texture. The whole sequence is terminated presumably because of an upstream avulsion and abandonment of river responsible for the growth of the sequence. Sedimentation is followed by non-deposition and gradual subsidence and resumed when the stream is again diverted to the same region. Therefore the cyclicity may be due to lateral migration of rivers and consequently delta switching and continued subsidence. Ideal cycles are modified by reduction or elimination of pro-delta clays (marine) and/or extention of coarse sequences of alluvial deposits. The variations are related to the timing of delta switching and regional subsidence.

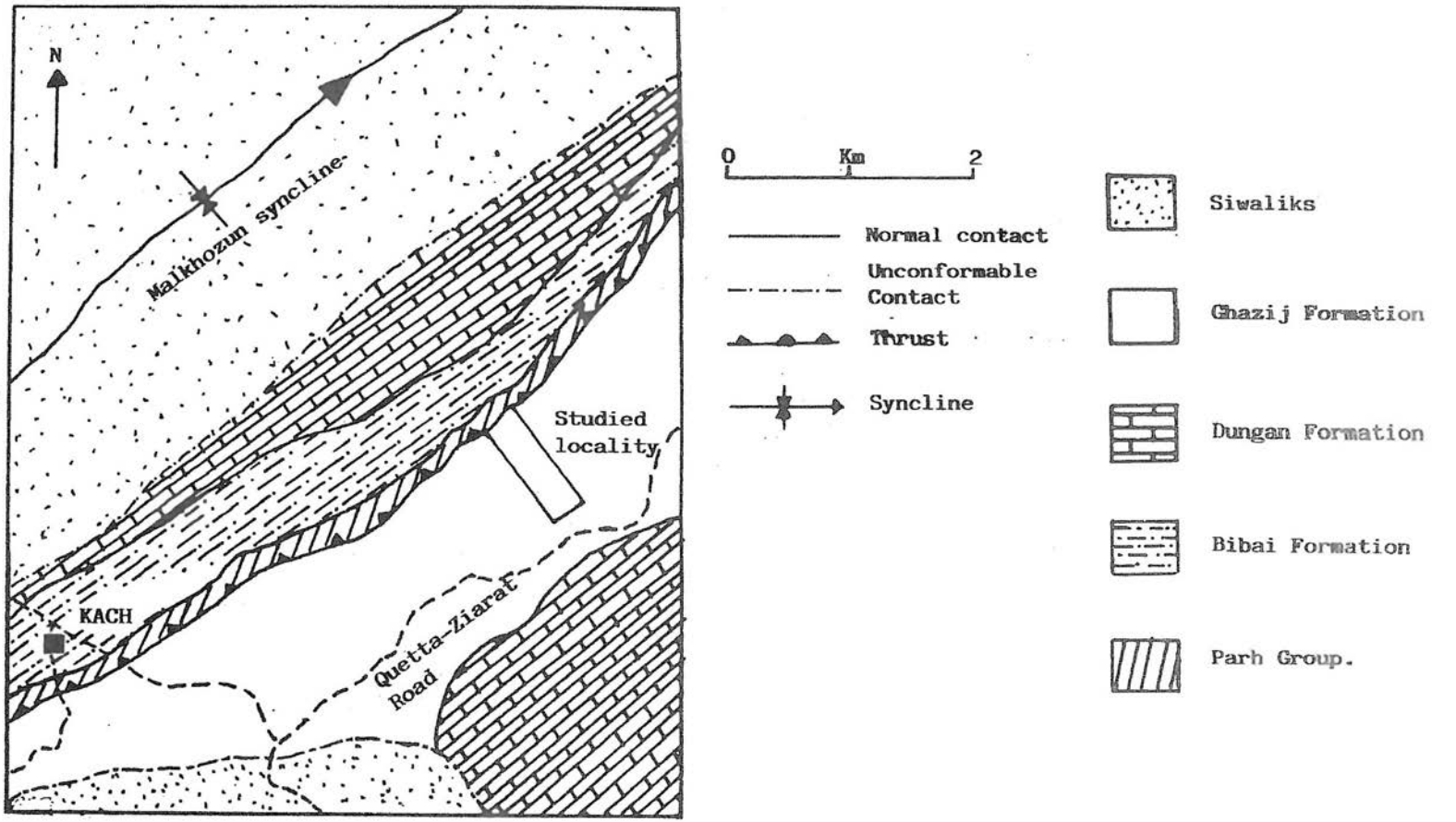

Fig. 1. Geological map of the Kach area.

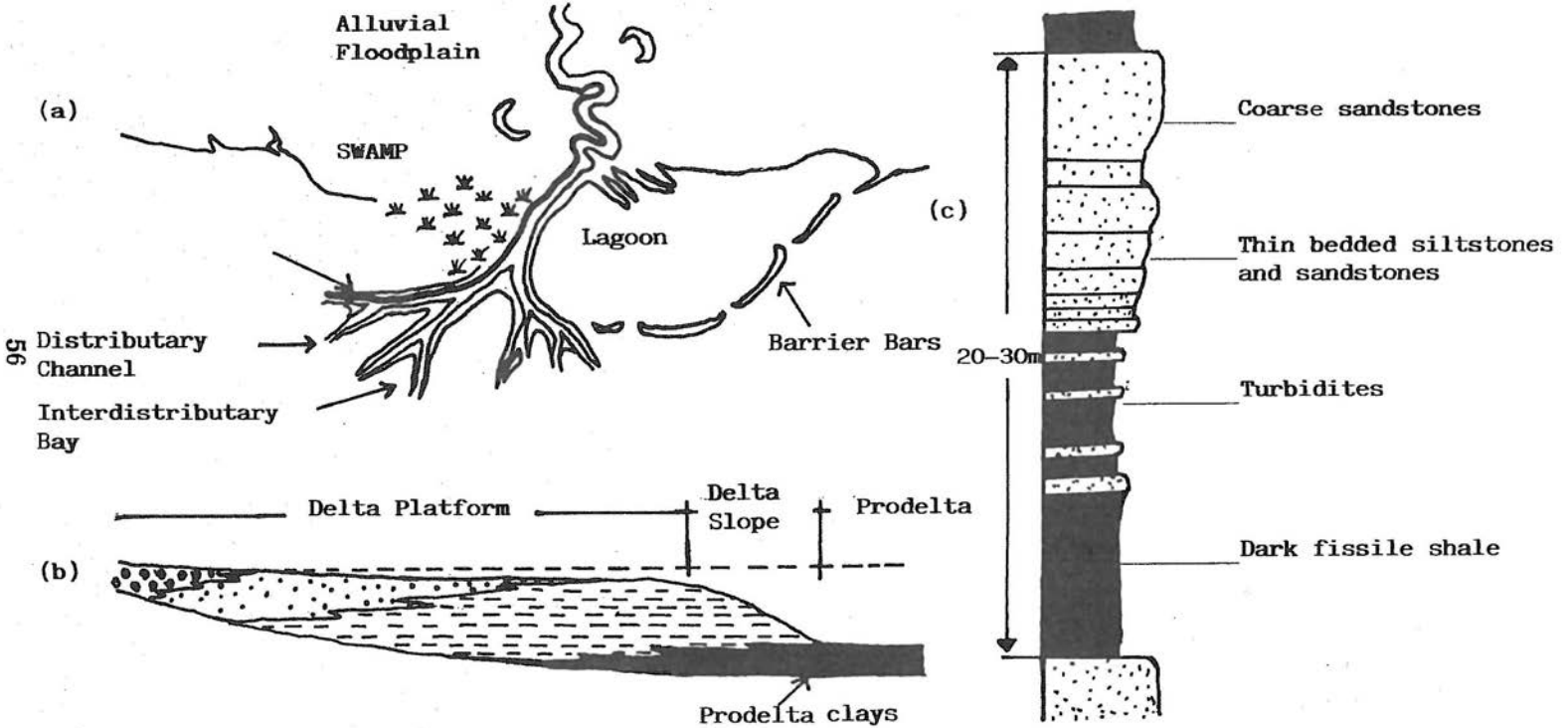

Fig. 2. a) Geomorphology of a recent delta and associated environments.
b) Longitudinal section of a delta showing sea-ward propagation. (After Seruton, 1960).
c) An idealised coarsening-upwards cycle of a delta.

b. Characters of the succession in Kach area

(i) Sedimentary structures

Various type of sedimentary structures are present in succesion of the Ghazij Formation. Among these sole markings (Fig. 3, 4), flute marks, groove marks, longitudinal ridge marks, trace fossils and other irregular marks may be found. Other sedimentary structures include current ripples, cross-strata, graded beds, convolute laminae and mud cracks. Lenticular morphology of the beds which is typical of the channels is also seen. In succession of the Ghazij Formation sedimentary structures are very clearly exposed and may easily be used as a "way-up" criteria which has successfully been used for the understanding of tectonic structutures, especially in the incompetent successions like that of the Ghazij Formation which is highly succeptible to tectonic forces.

(ii) Palaeocurrent directions

Palaeocurrent directions based on various types of sedimentary structures, especially sole marks, are shown in Figure 5. It may be seen that palaeocurrents flow mostly from northeast to southwest and some from southeast to northwest, suggesting a general westward flow direction of the delta. High dispersal of the palaeocurrent directions (Fig. 5) may be due to its deltaic origin, although current directions may also have been disturbed by folding and faulting.

(iii) Lithofacies associations

Lithofacies were measured perpendicular to the strike in a stream section covering a cross-strike thickness of nearly 200 m (Fig. 6). It may be observed that sequences are cyclic. The individual cycles do not show any trend, however, the whole sequence shows a general coarsening-upwards trend in the middle part and a very clear fining-upwards cycle near the top of the succession. It may be seen that the coarsening-upwards trend is not very clearly defined. It is suggested that the order of the sequences may have been obscured by folding and faulting which are commonly present in the adjacent rocks. In the Ghazij succession, however, a few very small-scaled (wavelength = a few m), southward-verging asymmetrical folds were seen and adjustments made accordingly. It is very difficult to observe faults, especially when they occur in the incompetent shaley strata, therefore only a few faults could be observed. It is proposed that although stratigraphic sequence of the Ghazij Formation in typically disturbed areas like Kach provides useful information about the sedimentary structures and palaeocurrent directions, the usefulness and reliability of the lithofacies associations is doubtful. The lowermost part of the succession was not measured due to poor exposure. The lower part of the measured sequence (Fig. 6) is dominated by shales with occasional thin, rhythmic and graded beds of sandstone which have spectacular sole marks (Fig. 3, 4). These characters are comparable with the sequences interpreted to have been deposited by turbidity currents in deeper marine conditions (Bouma, 1962; Walker, 1967).

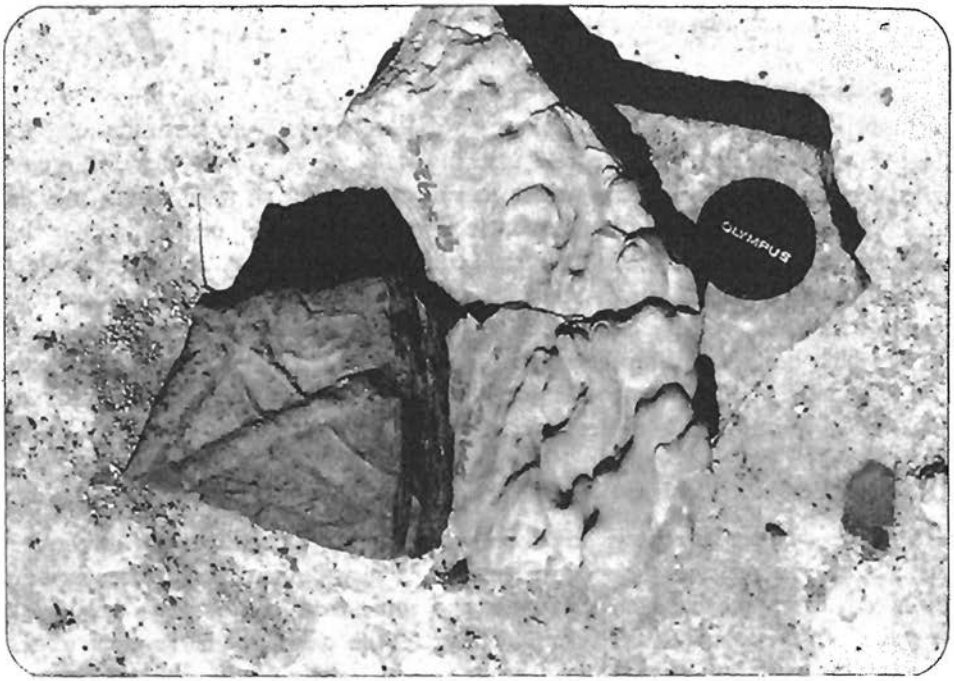

Fig. 3. Flute marks and other marks of trace fossils.

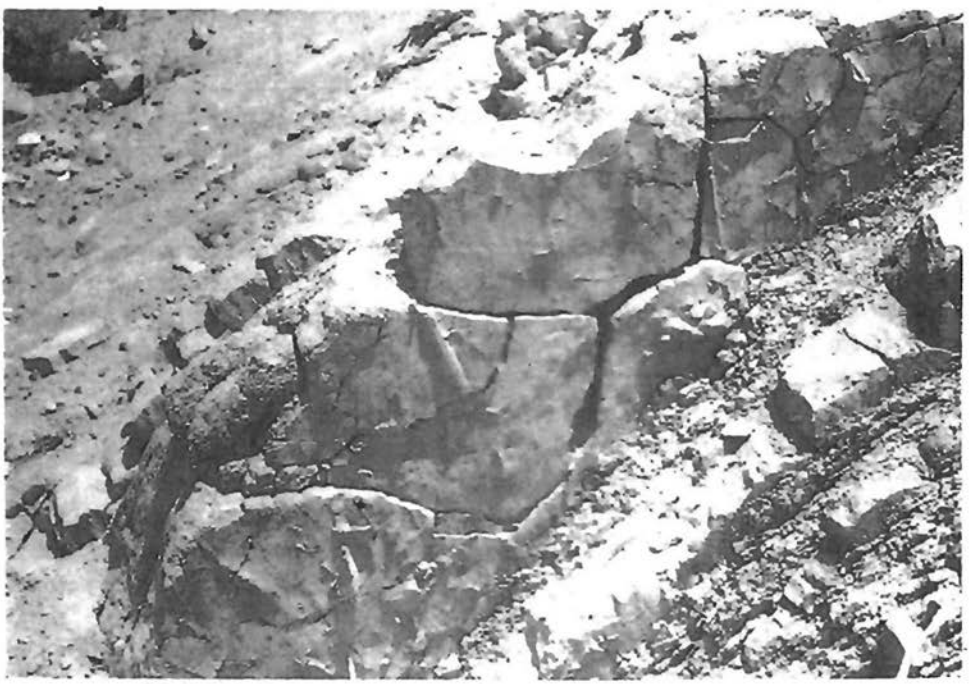

Fig. 4. Other irregular types of sole marks.

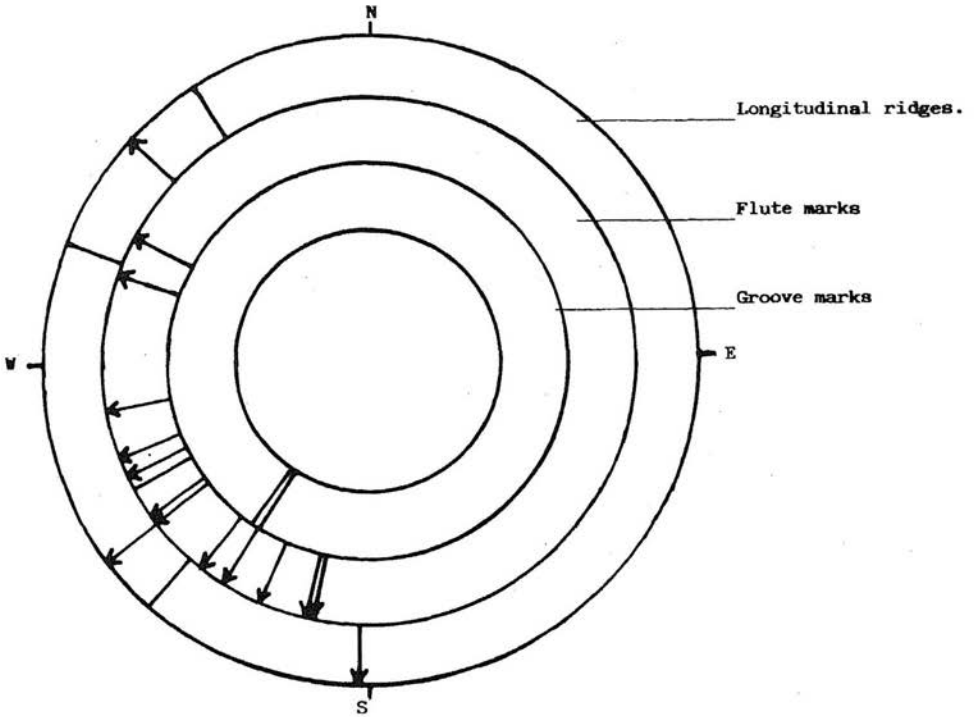

Fig. 5. Palaeocurrent directions based on sole marks (n=22).

DISCUSSION

According to the delta model the sequences of a prograding delta show coarsening-upwards cycles. Other characters include occurrence of occasional turbidites and thin shelled pelecypods in shaley units, bioturbation and associated deposits of swamps and meandering rivers. In sequences of the Ghazij Formation of Kach area the coarsening-upward cycles are not very clear. These cycles may undoubtfully have been disturbed by folding and faulting. Figure 6, showing the lithofacies associations suggests that the sequence is divisible into following three zones:

1. A lower, shale dominant zone with occasional turbidites.
2. An upper zone with higher proportion of sandstone and conglomerate, although shales dominate.
3. Higher shale dominant zone.

It is proposed that the lowermost shale dominant zone represents the prodelta (marine) clay deposit and the zone with high proportion of sandstones and conglomerates represents deposits of delta slope and platform. The upper-

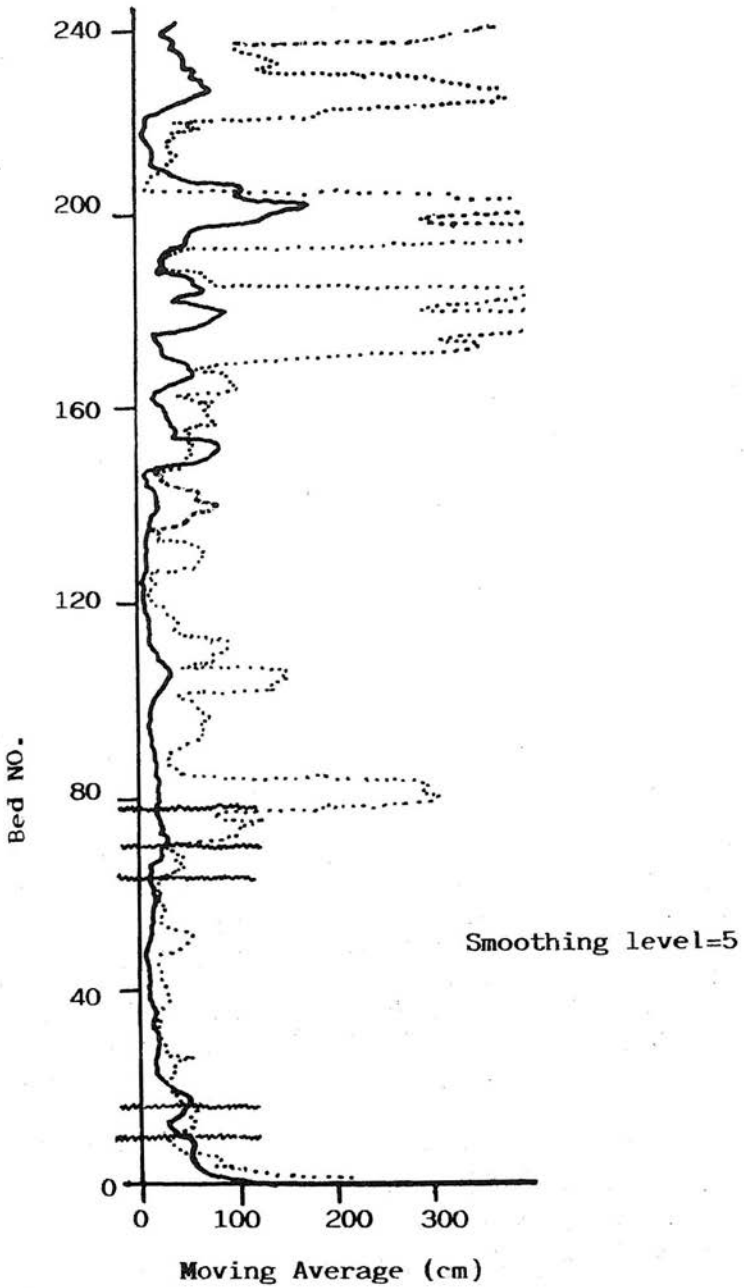

Fig. 6. Thickness variation diagram of shale and sandstone/conglomerate horizons of the succession of Ghazij Formation. Solid lines represent sandstone/conglomerate and dotted lines represent shales.

most shale dominant part again shows prodelta deposits that suggest transgression of the sea. Apart from this broad picture, characters like the occurrance of coal seams, cross-bedded and rippled coarse sandstones and conglomerates, and mud-cracks represent characteristics of associated swamps and meandering river deposits. It may be said that although lithofacies associations of the Ghazij Formation do not exactly correspond to those of the ideal coarsening-upwards cycles of the deltaic deposits, other associated characters are comparable with them.

CONCLUSIONS

a) Sedimentary structures and lithofacies associations of the Ghazij Formation support a deltaic origin of the succession.

b) The uppermost shale-dominant part of the succession indicate that deposits of the prograding delta were succeeded by marine clays, suggesting a marine transgression.

c) High variance of the current directions support its deltaic origin, although disturbance may also have been caused by folding and faulting. Paleocurrent directions show a general westward flow of the delta.

REFERENCES

Bernard, H.A., Major, C.F., Parrott, B.S. & LeBlance, R.J. Sr. 1970. Recent sediments of southern Texers. Bur. Econ. Geol. Univ. Texas. Guid book II.

Bouma, A.H. 1962. Sedimentology of some flysch deposits. Elsevier, Amsterdam.

Farshori, M.Z. & Ahmad, M.R. 1969. Sedimentation in Ghazij Basin. Symp. Petrol. Inst. Pakistan. Jan, 1969.

Hunting Survey Corporation. 1961. Reconnaissance geology of part of West Pakistan. Toronto, Canada.

Iqbal, M.W.A. 1970. Mega Fauna from the Ghazij Formation (Lower Eocene) in Quetta-Sharigh area, West Pakistan. Mem. Geol. Surv. Pakistan. Palaeontologica Pakistanica vol. 5.

Kaiser, W.R. 1971. Cyclic sedimentation in the Middle Devonian of the south central Pennsylvania. Geol. Soc. Amer. Abstr. with Prog. 1971. Mtgs., 3 (7) 616—17.

———1972. Delta cycles in the Middle Devonian of central Pennsylvania: Ph.D. Thesis, John Hopkins Univ., Baltimore.

Kassi, A.M. 1986. Sandstone petrography of the Ghazij Formation of Dagari, Kach, Murree Brevery and Bibi Nani areas, North-East Baluchistan. Geol. Bull. Univ. Peshawar 19, 77—82.

Kazi, A. 1968. Sedimentology of the Ghazij Formation, Harnai, Baluchistan. Geol. Mag. 105, 35—45.

Kazmi, A.H. 1962. Stratigraphy of Ghazij Shales. Geologist, Geol. Soc. Univ. Karachi. 1 (1).

Lyell, Sir Charles. 1854. Principles of Geology. 9th Edu. Appleton & Coy, New York.

Oldham, R.D. 1890. Report on the geology and economic resources of the country adjoining the Sind-Pishin railway between Sharigh and Spintangi and of the country between it and Khattan. India Geol. Surv. Recs., 23 (3), 93—109.

de Raaf, J.F.M., Reading, H.G. & Walker, R.C. 1965. Cyclic sedimentation in the Lower Westphalian of North Devon, England. Sedimentology, 4, 1—52.

Scruton, P.C. 1960. Delta building and the deltaic sequence. In: (Shephard, F.P., Phleger, F.B., Andel, T.H. Van eds.). Recent sediments, northwest Gulf of Mexico, p. 82—102. Tulsa, Oklahoma: Am. Assoc. Petroleum Geologists.

Walker, R.G. 1967. Turbidite sedimentary structures and their relationship to proximal and distal depositional environments. J. Sed. Pet., 37 25—43.

Williams, M.D. 1959. Stratigraphy of the Lower Indus Basin, West Pakistan. World Petroleum-Congr. 5th New York. Proc. Sec. 1, paper 19, 377—390.