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Non Marine Molluscs in the Injana Formation, Kand Anticline, NW of Mosul / Iraq

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ABSTRACT

Monotypic shell beds of molluscan skeletal sand are contained in the non-marine, fluvial sequence of Injana Formation of Upper Miocene age-Kand Anticline, as yet undescribed previously. These carbonate beds are characterised only by abundant pelecypod, oyster with seance and opportunists gastropods and smooth-shelled ostracods. This faunal assemblage is consignable with non-marine low salinity eoryhaline fresh, brackish water. The sudden change in their composition and distribution has been influence by salinity variation. The exclusion of normal marine-stenohaline fauna point to their deposition in non-marine setting including interchannel lake initiated on distal floodplain and/or river dominated bay estuary, or fan delta lake-lagoon.

الرخويات غير البحرية في تكوين انجانة، طية قند المحدبة، شمال غرب الموصل / العراق

الملخص

يحتوي التتابع النهري لتكوين انجانة بعمر المايوسين الأعلى، ضمن طية قند، طبقات من اصداف الرخويات الأحادية النوع بشكل رمال هيكلية لم توصف سابقا وتتميز طبقات الكاربونات هذه فقط بوفرة القواقع وندرة البطنقدميات والاوستراكودا ذات الجدار الناعم، وهذا التجمع الاحيائي يقترن مع مياه غير بحرية، قليلة الملوحة ومتغايرة. ان الانقلاب المفاجئ من نوع الى آخر من الرخويات وتوزيعها قد يتم ارجاعه الى تغاير درجة الملوحة. وعند الاخذ بنظر الاعتبار استثناء او غياب المتحجرات البحرية الاعتيادية فانه يعتبر مؤشر الى ترسيب وتجمع هذه الرواسب الكاربوناتية في مواقع غير بحرية قد تتمثل ببحيرات صغيرة وبرك ما بين القنوات النهرية ضمن الجزء النائي من السهل الفيضي، خلجان واهوار ذات سيطرة نهرية، او رواسب مروحية – دلتاوية تصب في البحيرات.

INTRODUCTION

Upon visiting the northern limb of Kand Anticline (Fig. 1), Al-Dewachi made incisive observation on the reddish, dense and fossiliferous carbonate beds carrying a mudstone – sandstone succession attaining 2.5m. in thickness.

This incomplete section is situated at the middle part of the fluvial sequence of Injana Formation, where the road cut crosses the dipping strata. Although these carbonate beds, about 50 cm. thick, seem patchy in distribution, they extend over a few 100 m. laterally.

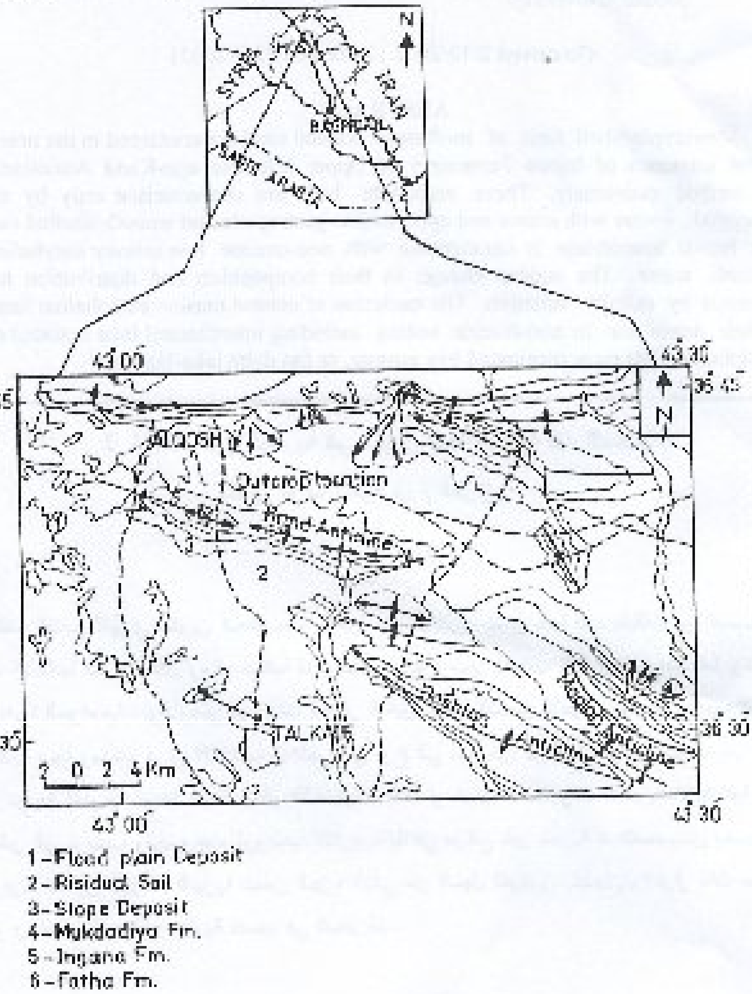

Fig. 1: Location map showing the study area and the surface lithostratigraphy of Kand Anticline.

The non-marine fluvial Injana Formation has been the focus of many sedimentological and paleontological investigation (Sahib et al., 1977, Al-Mubarak, 1978, Al-Banna, 1983, Al-Fattah, 2001) but non has documented such carbonate bed at this level in the sequence a part from Lawa (1995) who just mentioned the only association of oyster, gastropod, and charophytes with scoyenia i.e. ichnofacies in Mosul Qaiyarah area without petrographic examination.

Fluvial lacustrine deposit may include carbonate in their rock record (Friend and Mody-Stuart, 1970, Eggleston et al., 1990, Gierlowski Kordesh, 1990). Many ancient and modern non-marine carbonate can be identified by their stratigraphic setting in exclusively non-marine setting or their fossil content which is confined to pelecypods, gastropods and smooth shelled Ostracods (Parker, 1959, Picard an High, 1972; Hallam, 1981, Freytet, 1984). On the other hand some intraclastic clayey, iron-rich carbonates with dense character are also considered as lacustrine (Freytet, 1984; Eggleston et al., 1990). These non-marine carbonate are generally associated with siliciclastic deposits in lake, river floodplain, bay, esturay and fandelta lagoon setting with fresh-brackish water (Hudson, 1963a, 1963b, Gierlowski-Kordesh; Jo and Chough, 2001).

The present pioneering work records and describes monotypic shell carbonate with non-marine molluscs from fluvial sequence and the emphasis is placed on their depositional environment is the subject of this research.

Surface Stratigraphy And Depositional Setting

Miocene sedimentation on the stable shelf of the Arabian platform is represented by shallow marine, lagoon and fluvial environments (Al-Jumaily, 1978, Al-Mubarak, 1978, Buday, 1980, Mahdi, 1983, Lawa, 1995).

The terminus of the lagoonal setting, representing the northern limit of evaporite basin is between Kand Anticline and Alkosh-Ain sifni Anticlines (Gosling and Bolton, 1959, Shaban et al., 1971), Kand Anticline is located on the Mosul uplift and is aligned with king of two basins; namely Sinjar and Kirkuk (Gosling and Bolton, 1959, Mahdi, 1983).

The surface stratigraphy of Kand Anticline includes the Fat'ha Formation (Middle Miocene) in the core and the Injana Formation occupying the greater part of the limbs. The Fat'ha Formation (135m thick) consists of cyclic repetition of red marl, limestone and anhydrite, interpreted as a sequence of paralic lagoon facies. The Injana Formation (445m thick) is composed of thick bedded reddish-brown sandstone alternating with red mudstone slightly brown marl considered as non-marine fluvial sequence. The fluvial facies are devoid of fossils, except those mentioned by Lawa (1995) as Scoyenia ichnofacies accompanied by oyters, gastropods, ostracods and chara . In contrast the Fat'ha limestones are enriched with benthic foraminifera and aragonitic molluscs preserved as mold (authers own examination). But at the top the molluscs ostrea occur abandantly in two successive horizons of greenish-gray marl with occasional gypsum (Gosling and Bolton, 1959, Shaban et al., 1991, Mahdi, 1983).

Lithologic Units:

The vertical succession of interbed lithologies promotes a tripartite division of the studied profile depicted in figure (2). This three division allow the recognition of three informal sedimentary units.

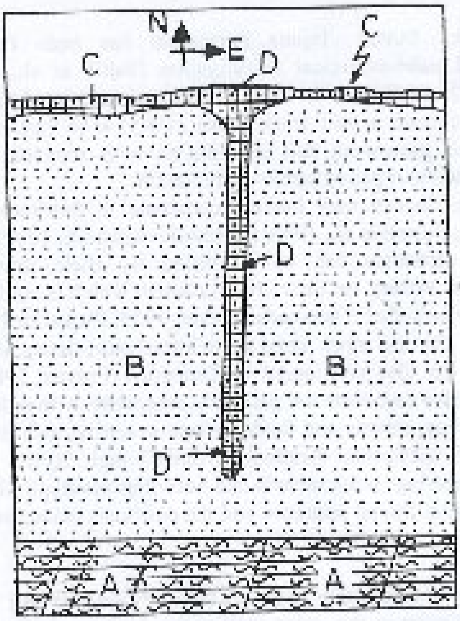

Fig. 2: Sketch of outcrop photo showing the vertical succession of lithologic units described.

Unit A : Red Mudstone

It occurs at the base with indeterminate thickness as constrained by the road-cut, it is highly fractured with massive-slightly laminated appearance; devoid of fauna. Petrographic examination shows a silt-size quartz, feldspar and mud pelloid set in clayey carbonate matrix stained with iron oxide.

Unit B : Brown–Buff sandstone

Fine medium, massive-faintly laminated sandstone; composed of quartz, feldspar, micritic grains and chert spherules embedded in clayey carbonate matrix permeated with iron oxide. Diagenesis renders the sandstone more responsive to dissolution, recrystallization and vugs development. This unit embraces a joint-dike filling (D) of sandy carbonate crossed by stylolites. The indistinct sedimentary structures are constrained by grain size uniformity.

Unit C : Buff – creamy limestone :

This unit comprises variable types of intermixed limestones.

I- Intraclastic limestone in which it is difficult to recognize the allochems and appear as micritic intraclastic with faded out boundaries.

II- Pelecypod limestone: It appears as skeletal, reddish limestone that is impressively dense and with clastic texture imposed by fragmented fossils and their debris. Thin section study reveals a chaotically distributed disarticulated pelecypod

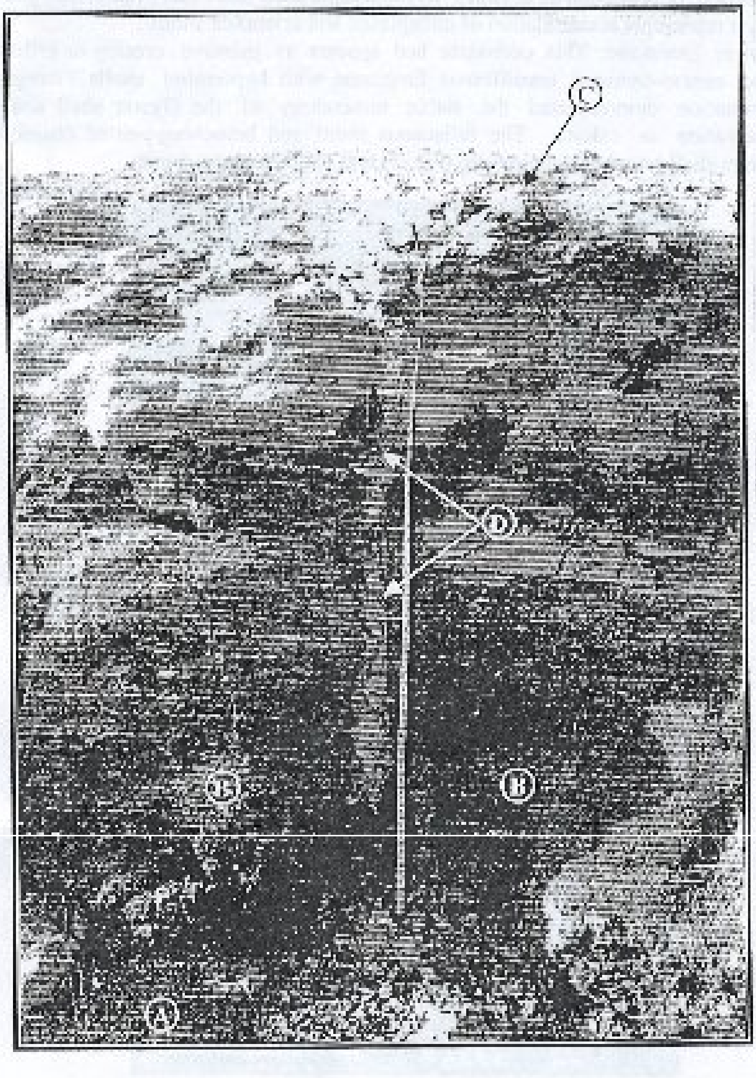

Photo A: showing the vertical succession of litho age units described.

shells with their original calcitic mineralogy and foliated texture preserved (Fig. 3). The shell fragments are set in groundmass of microcrystalline calcite. Other fossils are sparse gastropod (Fig. 4) and thin walled Ostracod (Fig. 5). The limestone contain pelecypod in profusion as to appear as monotopic shell bed. The implication gained is that, it represents accumulation of transported and reworked shells.

III- Oyster limestone: This carbonate bed appears as massive, creamy or yellowish white, coarse textured fossiliferous limestone with hyperrelief shells. Petrographic examination demonstrated the stable mineralogy of the Oyster shell and their preservation as calcite. The foliaceous motif and branching-veined character of discrete shell remains is diagnostic (Fig. 5) and validate their identity.

Fig. 3: Disarticulated pelecypods shell with their calcitic mineralogy unaltered and well preserved wall structure. Monotypic shell bed. Groundmass is clayey-micro crystalline calcite. Bar scale on all photographs is 1 mm.

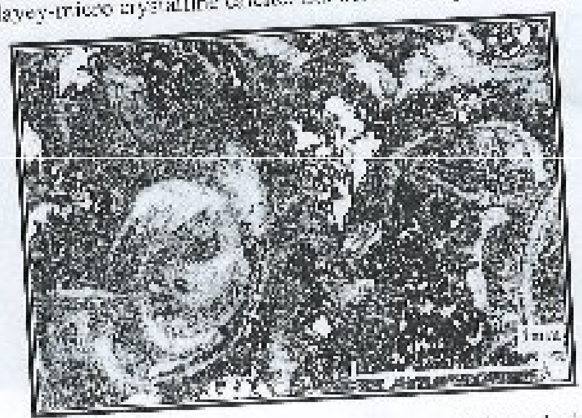

Fig. 4: Gastropod preserved as a cast. The outer margin is marked by a thick calcite layer. Pelecypod fragments are also present. Voids appear as white patches.

Fig. 5: Thin-walled ostracod filled with sparry calcite and associated with pelecypod fragments dark groundmass with empty clear vugs.

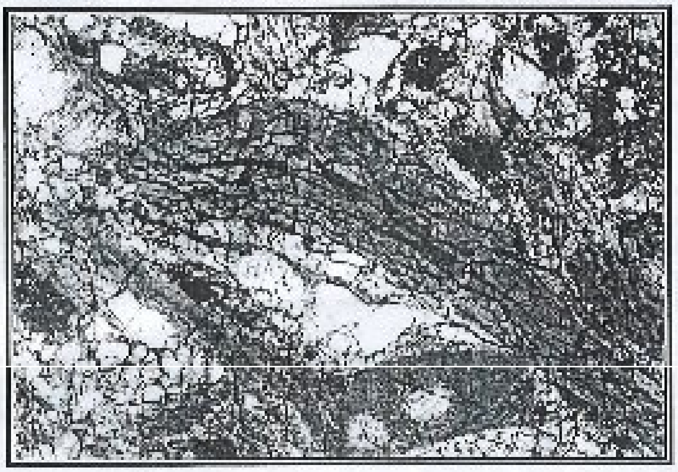

Fig. 6: Neotypic calcite oyster fragment having thick shell with foliated, veined-branching character.

Paleoenvironmental Interpretations

The distinct signature of fresh water fluvial origin of the Injana Formation is imparted by sedimentological attributes of the interbedded mudstone–sandstone which are commonly consignable and devoid of fossil (Sahib et al., 1977; Al-Mubark, 1978, Buday, 1980). The general consensus is that the red mudstone–siltstone and fine sandstone represent alluvial plain–levee, splay deposit while the coarse sandstones are considered as channel–bar deposits (Hallam, 1981, Al-Banna, 1982, Al-Fattah, 2001).

Flood plain deposits may be proximal intermediate and distal with respect to active channel belt (Morendetall, 2002). The association of carbonate–freshwater lakes with distal overbank mudstone has been described from fluvial sequence (Jo and Chough 2001).

Transitional environments with deltaic–tidal flat attributes are non-familiar, but have been recorded from the lower part of the fluvial sequence of Injana clastic overlying the Fat'ha Formation (Al-Nagib and Agwar, 1993, Al-Fattah, 2001). This may lead to occasional ambiguity due to the absence of diagnostic features. However the succession concerned with presently is described from the middle upper part of the Injana sequence, thus highlighting its non-marine character, Nonetheless, the carbonate are expected to contain tangible evidence for lessening problems about their identity. The high density, clayey micritic intraclastic unit A is similar to many fresh–water limestone presumed to be of lacustrine origin (Picard and High, Egglestone et al., 1990). This permits to view the vertically juxtaposed endemic carbonate units (B and C) as prioritized non marine bearing molluscs: represented by the faunal assemblage comprising indeterminated pelecypod, oyster with rare gastropod and ostracod microfauna (Hallam, 1981) Reaffirming and indirect lines of evidence come from other areas where the Injana formation has been allocated to Scoyenia ichnofacies with oyster, gastropod and ostracod advocating its fresh–water character (Lawa, 1995). In this context the criteria diagnostic of brackish water fauna integrate the contemporaneity of reduction in number of species and great abundance of euryhaline fauna (mainly pelecypods with some gastropods and ostracods) and the absence of normal marine (stenohaline) fauna (Hudson, 1963 a, 1963b). These combined data qualify the Injana carbonate bearing molluscs as brackish water limestone, constrained by their monotypic shell identity and absence of stenohaline faunas: implying low salinity. In the Great Estuarine Group and Great Oolite Series, the molluscs unio-viviparus neomiodon and valvata without charophytes are considered as indication of freshwater (Hudson, 1963b, Palmer, 1979, Hallam, 1981, Andrew and Walton, 1990) where as the unio-gastropods limnea, planorbis and physa, inhabit lacustrine lakes or fresh–brackish water (Freytet, 1984) and preserve their calcite shell structures whereas their marine counterpart are commonly preserved as biomold (Bathurst, 1975).

These beds exhibit a remarkable compositional variation in fauna, and even at scale of centimeter-thick laminae, which contain reworked fragmented shells. The effect of adversed salinity is considered to be of paramount importance in influencing the variable distribution of macrofauna and particularly the molluscs, where the fauna of low salinity –water assumes monotopic shell character (Parker, 1959, Palmer, 1979). A faithful imitation is portrayed by the sudden change from intraclastic bed to pelecypod and then oyster monotypic shell beds in the Injana Formation. Indeed this postulated assumption of faunal change with salinity mimics modern river influenced bay where low salinity–freshwater assemblage harbour pelecypods which are replaced by low–salinity brackish water oyster in the Texas Bay; caused by salinity variation (Parker, 1959). Consequently, the most favorable site for the establishment of fresh water conditions are fluvial interchannel pond-lakes, lagoons, bays and estuarine settings which are more responsive to freshwater influx and salinity fluctuation. The opportunity of initiating freshwater conditions is enhanced under wet climate, leading to synchroneity between high runoff and little evaporation.

Taking into consideration all the above mentioned attributes of the Injana analog, a non-marine lake on distal floodplain within fluvially dominated bay, eustuary or lagoon seems more plausible alternative to accommodate the freshwater fluvial clastic and intecalated carbonate beds. Indeed, at the terminal stage of Fat'ha Formation accumulation, vast areas of lagoonal setting where flushed by freshwater, perhaps induced by regression or climatic change. With progressive withdrawal of the lagoon and concomitant progradation of the fluvial system fresh water environment of the Injana Formation dominated the scene. Alternatively, it represents lake-lagoon establishment at the distal part after fluvial flooding.

The corellatibility of these non-marine carbonate and those mentioned elswhere by Lawa (1995) is worthwhile any may render the molluscs as extant species, thus marking a boundary event or disturbance regime in alluvial sequence stratigraphy. Analogous fresh-brackish water molluscs have been used in correllating shallow–short lived Miocene lakes from western Anatolia, Turkey, in order to infer their ages, based on faunal variability, and style level changes due to river influence (Yesilyurt and Taner, 2002).

In conclusion, the intercalated monotypic molluscan beds and redmudstone–sandstone with the in fluvial sequence of Injana Formation are considered as fresh-brackish water non-marine candidates. The abrupt faunal variation in tandem with salinity change can explain the difference in bed composition encountered in the carbonate intercalated in the fluvial sequence of Injana Formation.

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