ZESZYTY NAUKOWE POLITECHNIKI ŚLĄSKIEJ 1990

Seria: GÓRNICTWO z. 175 Nr kol. 986

Wu XIANTAO

Mining College of Jiaozuo, China

THE ROLE OF TRACE FOSSILS AND THEIR ASSOCIATED SEDIMENTARY STRUCTURES IN DETERMINING MARINE ENVIRONMENTS OF COASTAL CLASTIC DEPOSITS

Summary. Five types of marine coastic clastic deposits have been recognized in Guanshan Formation of Upper Devonian from Lower reach of Yangtze River, China. Though it has long been treated as terristial facies since 1919.

Type A is characterized by pebbles deposited directly on the trough of rippled bed without erosion and therefore is interpreted as rip strand gravels on the back shore environment.

Type B deposits recorded the wave-like pebbles distributing vertically in the section and may suggest a beach cusp-like origin in foreshore area.

Type C deposits contains pure white middle-grained sandstone with escape structures above and herringbone cross-bedding below. Thus it is thought to be intertidal bar.

Type D deposits is composed of conglomerate lag, double clay layers and trace fossils of Arenicolites and w-shape burrows implying a shallow subtidal channel environment.

Finaly type E deposits has lower part of medium to coarsegrained sandstone with pebbles, and middle part of large planar cross-beded and herringbone cross-beded, as well as thin beded fine to medium grained sandstones alternating with sandy clay layers in which trace fossils of Cochlichnus, Gordia and traces of Crustacea have been found. The features of this type probably were of deep subtidal channel.

Introduction

The sedimentary environments of Guanshan Formation, Wutong Group (upper Devonian) in South Jiangsu, China, puzzled the geologists for decades because of lacking identifiable body fossils and other depositional features in the sandy deposits. But both trace fossils and sedimentary structures are abundant after carefully looking into the well displayed section in Kongshan near Nanjing, and Taihushan about 80 km southeast to Hefee, capital of Anhui province.

Wutong Group is a clastic deposit system of 150-200 m in thickness and primaryly was named Wutongshan Mount quartzsandstone by Ding Wenjiang in 1919. Later works show the Group can be divided into two parts. The upper part is called Leigutai Formation and consists of coloured sandstones, silts and shales including plants of Leptophloeum rhombicum, Sublepidodendron mirabile, Archaeopteris sp., and estheritina od Lioestheria lon␣ianensis. The thickness is about 90 m.

The lower part is known as Guanshan Formation which is mainlycomposed of quartz sandstone of 50-80 m thick. No body fossils have been found except Sangninolites sp., but trace fossils and sedimentary structures are abundant. The purpose of this paper is to analyse the sedimentary environments of Guanshan Formation ichnologically and sedimentologically in terms of the field observation in Kongshan of Nanjing and in Taihushan of Anhui. The two well displayed sections are all on the motor way side and thus are ideal places for the studies of Guanshan Formation in lower Yangtze District.

Sedimentary facies

Type A. Trough of rippled sandstone bed filled with pebbles

The boundary between Maoshan Group (lower Devonian) and Wutong Group is usually marked by a 30 cm thick of conglomerate bed which has been treated as basal conglomerate by stratigraphers since 1949. However, carefully studies show that the so called basal conglomerate was actually leid directly on the trough of a rippled sand bed which consist of quartz and feldspar with pink colour. Thus it is quite easy to distinguish from that of white pure quartz sandstones in Guanshan Formation, Wutong Group. This may be the reason that why the former geologists considered there is a disconformity between pink sand and pebble bed.

But the well preserved assymmetric ripple moulded by overlying pebbles can be seen clearly on outcrop. It is interesting that in what way the "basal conglomerate" could be transported and deposited on the ripple trough without eroding and destroying the underlying ripple structures. It seems likely that storm or rips may play an important role to from such unusual deposits in an area beyond the fair weather high tidal level, then the energy could be strong enough to carry the pebbles and other coarse sediments toward backshore where the fluvial sediments of pink sande with assymmetric ripples dominated. After the energy suddenly decreased, pebbles were stranded on the surface of rippled bed just like ships or other tools stranded on the coastal districts.

Type B. Undulated pebbles in the middle and pure quartz sandstone with reverse graded bedding at the top

Few meters above the type A there is a white pure mediumgrained sandstone bed, about 0,66 m thick and an undulate pebbles surronded by medium grained sand can be seen in the vertical section, the wavelength of the undulate pebbles is nearly two meters. The distribution pattern of the pebbles is neither like those of lag deposits nor like channel fills but appers to be simmilar to the modern beach cusped coastal sediments studied by J.R.L. Allen (1982). This suggestion is supported by reverse graded bedding at the top of the bed though the record of their horns and embayments are difficult to judge on the outcrop because characteristics of beach cusp internal structure are still uncertain (Allen, 1982), and Worall (1969) shows that beach cusps can be abundantly preserved only as surface forms. In fact, very few fossil beach cusps have been recorded except one found in the Lyons Sandstone (Permian) of Colorado (Thompson, 1949) and another in the littoral Downton Castle Formation (Silurian of the Welsh Borders, Allen, 1974). Therefore the present example of Devonian age in Kongshan, Nanjing may be helpful in discussing foreshore sedimentary environments.

Type C. Intertidal bar deposits

Three parts constitute this type of deposits. The lower part of this deposits is composed of medium grained quartz sandstone with well rounded pebbles of 4 x 4 mm - 6 x 8 mm in diameter. The dominate compositon of the pebbles is quartz. The middlo and upper part of this deposits consinst of herringbone cross-beded white medium grained quartz sandstone and is characterized by escape structures just preserved above the herringbone cross-bedding (fig. 4). The dip degree of the bedding towards coast ranging from 39 to 15 and that towards the sea is 10-5. The bed is 1.2--1.75 m thick and usually was overlaid by medium grained sandstone with pebbles at top showing reverse grading.

The pebbles of the top sandstone bed are smaller in size and monotous in composition, and mainly distribute at the upper surface of the bed, thus differ from those of the lower sandstone bed.

This deposits type is 2.5--4.5 m in thickness and usually found at the lower part of Guanshan Formation.

It is suggested that type C deposits was formed in intertidalzone as herringbone cross-bedding is well accepted as typical intertidal sedimentary structure (Reineck and Singh, 1980). The reverse graded bedding, according to Reineck at all, may also be found in tidal flat or beach. The most striking features are the escape structures which may be formed by unknown animals or possibly air heave structures. Nevertheless, whichever of the structures is thought to be indicators of intertidal environment.

As to the sedimentary environment of the lower part of this deposits, it can be compared with the precambrian shallow subtidal sand bar of Scotland studied by Klein (1975) and also be parallel with the upper shoreface sand bar of Tertiary from New Jersey (Carter, 1978). They are similar both in texture and sequence in the lower part and all present herringbone cross-bedding at the top. Thus the sedimentary environments of type C deposits may begin with upper shoreface sand bar, then pass into intertidal bar in the middle and ended by beach at the top, but the dominate part is intertidal bar.

Type D. Shallow subtidal channel deposits

This type of deposits consists of three parts. The lower part is composed of pebbles which contain well rounded quartz pebbles and poor rounded pink lithoclasts. The diameter of the lithoclasts is commonly 2 x 2 cm and that of quartz pebbles is smaller, usually 0.2 x 0.3 cm. This part of sediments is 4.6-6 cm in thickness and gradually pass into fine quartz sandstone with few pebbles upwards. This sandstone is about 7.8 cm thick.

The middle part is also fine quartz sandstone but obviously has double clay layers. The layers are very thin, usually less than 0.12 cm and are parallel each other separated by thicker fine sandstone (2-11 mm) and thinner fine sandstone (2-5 mm) respectively.

The upper part is characterized by trace fossils of Arenicolites and w-shape burrows in fine quartz sandstone (fig. 6).

Rahmani has recorded double clay-layers in subtidal channel deposits from lower Cretaceous in Alberta, Canada. The same structure is also found by J.R.L. Allen in lower Creteceous sutidal channel facies in southeast England. Besides, the presence of traces especially w-shape burrows show evidence that the trace-maker might lived in often sumerged zone where the air supply might not be good enough for the animal. So they must build more opens for survive. Therefore, it is likely that type D deposits could be formed in shallow subtidal channel environment.

Type E. Deep subtidal channel deposits

The deposits of type E has three parts too. The lower part is made of medium to coarse quartz sandstone with pebbles concentrating on the base and forming lag deposits bed. The diameter of the pebbles is 5 mm. Large scale of planar cross-bedding is developed in this part.

The middle part consists of medium and coarse quartz without pebbles. There are two kinds of large scale of herringbone cross-bedding distributing vertically in the section. The lower one show landward dip 15 and seaward dip 8. The upper one, however, both landward and seaward dips are of 11.

The upper part of this type deposits is characterized by thin bedded medium grained quartz sandstone alternated with thin grey sandy claystone and on the lower surface of the sandstone, abundant trace fossils such as Gordia, Cochlichnus and traces of Crustacea have been found. The fossils are preserved on the lower surface of the sandstone which usually overlying on a thin bedded claystone indicating the tracemarkers had moved about on the clay sediments.

Thus, three obvious features in this type could be summarized as below: (1) has erosional base and conglomerate lag; (2) existance of large scale of planar cross-bedding in middle part of the sequence passing into herribone cross-bedding in middle part and the coset scale of lamina is decreasing upwards accordingly; (3) showing fining upwards in grain size.

These features are evidently parallel to the subbidal channel vertical sequence summarised by G.E. Reinson (1979) and also could compare with the subtidal channel deposits within Tertiary barrier sequence in New Jersey studied by Carter. Thus this type of deposits commence with deep subtidal channel passing into shallow subtidal channel and ended by tidal flat deposits.

Concluding remarks

There are at least five distinctive various type of upwardfining beds in Guanshan Formation, Wutong Group (Upper Devonian) from Kongsnan section, Nanjing and Taihushan section, Anhui, recording repeated tidal or rip activities in Late Devonian times. Generally each type has its own characteristic features in bioturbation and sedimentary structures as well as textures.

It is suggested that deep subtidal channel usually filled with conglomerate lag and upward-fining sands associated with planar cross-bedding and herringbone cross-bedding as well as trace fossils of Gordia, Cochlichnus and Crustacea scratch marks while in shallower subtidal channel fills, the bioturbation patter is replaced by traces of U-shape burrow (Arenicolites) and W-shape burrows, and the specific double clay-layers appear.

In intertidal environment, distinct escape structures associated with herringbone cross-bedding present and in supra tidal area, no traces have been preserved at all except ripple marks and pebble lags.

The sedimentary structures and textures recorded in Kongshan and Taihushan change with wave and current effectdepth.

The bioturbation patters formed in these coastal depositional types indicate that they generally keepp pace with this change Therefore specific traces associated with specific sedimentary structures and textures may provide significant clues to recognize subenvironments of clastic shorelines.

Acknowledgements

I Thank professor A. Seilacher of Tubingen University for fruitful discussions in field excursion. Financial support was supplied by the Chinese Ministry of Petroleum Industry. Mr. Hu Bin, Wang Guanzung and

Zhang Guecheng give me substantial field assistance. Mr. Q.Z. Wang kindly typed the manuscript. All those contributions are gratefuly acknowledged.

REFERENCES

[1] Allen, J.R.L., 1974, Studies in Fluvistile Sedimentation: Implications of Pedogenic Carbonate Units, Lower Old Red Sandstone, Anglo-Welsh outcrop, Geol. J., col. 9, 181-208.

[2] Allen, J.R.L., 1982, Sedimentary Structures, their Character and Physical Basis., volume 2, 453-470, Elsevier Scientific Publishing Company.

[3] Carter C.H., 1978, A Regressive Barrier and Barrier Protected Deposits, Depositional Environment and Geographical Setting of the Late Tertiary Cohansey Sand. Jour. Sed. Petrol., vol. 48, 933-950.

[4] Klein G. dev., 1975, Sandstone Depositional Models for Exploration for Fossil Fuels, Continuing Education Publishing Company, 46-66.

[5] Reineck H.E. and Sing I.B., 1981, Depositional Sedimentary Environments (2nd Edition), Springer-Verlag, 97-121, Thompson W.O., 1949, Bull. Am. Ass. Pet. Geol., 33: 52-72, Worrall G.A., 1969, Geol., 77: 484-487.

Recenzent: Prof. dr hab. inż. Mirosław Chudek

Wpłynęło do Redakcji w czerwcu 1988 r.

ROLA SKAMIELIN ŚLADOWYCH I ZWIĄZANYCH Z NIMI STRUKTUR OSADOWYCH W OKREŚLENIU MORSKICH ŚRODOWISK PRZYBRZEŻNYCH ZŁÓŻ KLASTYCZNYCH

S t r e s z c z e n i e

W formacji Guanshan Górnego Dewonu z dolnego odcinka rzeki Jangcy w Chinach rozróżniono 5 typów osadów morskich przybrzeżnych złóż klastycznych chociaż dawna (1919 r.) traktowano je jako facje lądowe. Osad typu A charakteryzuje się kamykami bezpośrednio w korycie pofałdowanego łożyska bez erozji, a więc interpretowane jest jako żwir plażowy w środowisku nadbrzeżnym. Osad typu B stanowią kamyki o wyostrzonych kształtach rozmieszczone pionowo w przekroju, co może sugerować plażowe pochodzenie w środowisku nadbrzeżnym. Osad typu C zawiera biały średnioziarnisty piaskowiec o teksturze w górnej części klinowej, a w dolnej krzyżowej. Stąd uważa się, że jest to wywołane zmianą facji. Osad typu D składa się z gliny twardoplastycznej i skamielin śladowych arenikolitów ułożonych w kształcie litery "W", co sugeruje środowisko płytkiego kanału. Wreszcie osad typu E, który w dolnej części składa się z średnio lub gruboziarnistego piaskowca z kamykami, w środkowej części z piaskowca

drobno- lub średnioziarnistego poprzecznie przeławiconego gliniastymi warstwami, w których stwierdzono śladowe skamieliny COCHLICHNUS, GORDIA i ślady CRUSTACEA (skorupiaków). Cechy tego typu przypisać należy przypuszczalnie środowisku głębokiego kanału.

РОЛЬ ОСТАТОЧНЫХ ОКАМЕНЕЛОСТЕЙ И СВЯЗАННЫХ С НИМИ ОСАДОЧНЫХ СТРУКТУР В ОПРЕДЕЛЕНИИ МОРСКИХ БЕРЕГОВЫХ СРЕД ОБЛОМОЧНЫХ ОТЛОЖЕНИЙ

Р е з ю м е

В формации Гуаншан Горного Девона в низовьях реки Янцзы в Китае различают 5 типов морских осадков береговых обломочных отложений, хотя издавна 1919 г. они трактовались как континентальные фации.

Осадок типа А характеризуется камешками непосредственно в складчатом русле без эррозии, т.е. интерпретируется как пляжный гравий в береговой среде.

Осадок типа В состоит из камешков острой формы, размещённых вертикально в разрезе, что может подсказывать пляжное происхождение в береговой среде.

Осадок типа С содержит белый среднезернистый песчаник с клинообразной в верхней части текстурой, и крестообразной в нижней части. Поэтому, считают, что это влияние смены фации.

Осадок типа Д состоит из твёрдопластичной глины и остаточных окаменелостей арениколитов, уложенных в форме буквы "U", что подсказывает среда мелкого канала.

И, наконец, осадок типа Е, который в нижней части состоит из средне- или крупнозернистого песчаника с камешками, в средней части из мелко- или среднезернистого песчаника с прослойками глины, в которых найдены остаточные окаменелости COCHLICHNUS, GORDIA и следы CRUSTACEA ракообразных.

Черты этого типа следует предположительно приписать среде глубокого канала.