Jour. Korean Earth Science Society, v. 26, no. 8, p.809–820, December 2005

Architectural Elements of the Fluvial Deposits of Meander Bends in Midstream of the Yeongsan River, Korea

Gong Soo Chung[1,*], Jin Young Lee[2], Dong Yoon Yang[2] and Ju Yong Kim[2]

[1]Department of Geology and Earth Environmental Sciences, Chungnam National University, Daejeon 305-764, Korea

[2]Geological & Environmental Hazards Division, Korea Institute of Geoscience and Mineral Resources, Daejeon 305-350, Korea

Abstract: The fluvial sequence developed along the channel margin of meander bends in the midstream of the Yeongsan River consists of channel deposits at the bottom and overbank deposits at the top, and shows a fining-upward trend. The fluvial deposits consist of 7 sedimentary facies, and facies association forms 7 architectural elements. The channel deposits formed as channel bar or point bar. The channel bar deposits consisted of architectural element of gravel bedform were formed by channel lag deposits within the channel; whereas, the channel bar deposits consisted of architectural elements of downcurrent-dipping inclined strata sets, cross-stratified and horizontally stratified sets, and horizontally stratified sets were formed by downstream migration of sand wave or downstream transport of sand by traction current in the upper flow regime conditions within the channel. The point bar deposits consist of architectural elements of down current-dipping inclined strata sets, horizontally stratified sets, cross-stratified and horizontally stratified sets, and laterally inclined and horizontally stratified sets. These architectural elements are thought to have been formed by the combined effects of the migration of sand dunes and the formation of horizontal lamination in the upper flow regime plane bed conditions. The overbank deposits consist of the architectural elements of overbank fine and sand sheet and lens. The overbank fines were formed by settling of mud from slackwater during flooding over floodplain whereas the sand sheet and lens were formed by traction of sands introduced episodically from channel to the overbank during flooding.

Keywords: fluvial sequence, architectural elements, meander bends, Yeongsan River

Introduction

The study on modern sequences of fluvial system can provide the information about the ancient fluvial sequence which can be reservoirs of petroleum and groundwater. Fluvial processes are also important in understanding the flooding event. Transportation and deposition of sediments within the channel and floodplain of river form macroform growth increment to macroform (Miall, 1996).

For the study of fluvial strata three dimensional investigations using the architectural elements provide comprehensive picture of the fluvial system evolution and became a standard procedure (Miall, 1996; Jo and Chough, 2001). The three-dimensional arrangement of channel and overbank deposits in a fluvial succession is referred as the architecture of the beds (Nichols, 1999). Previous studies on facies analysis of modern fluvial sequence were conducted by Ethridge et al. (1987), Miall (1996), and Kraus and Gwinn (1997). Architectural analysis of fluvial deposits was reported by Yoshida (2000), Farrell (2001), Jones et al. (2001), Ray and Chakraborty (2002). Flood deposits of river was reported by Benito et al. (2003), and Bridge (2003) provided a comprehensive summary of rivers and floodplains.

Many of the fluvial styles and facies models now used are based on studies of the ancient record (Miall, 1996). Meander bends in midstream of the Yeongsan River (Fig. 1) provide a good opportunity to look at the development pattern of architectural elements of modern meandering river fluvial deposits composed mainly of sand and mud. The purpose of this paper is to document the facies and

*Corresponding author: gschung@cnu.ac.kr
Tel: 82-42-821-6429
Fax: 82-42-822-8733

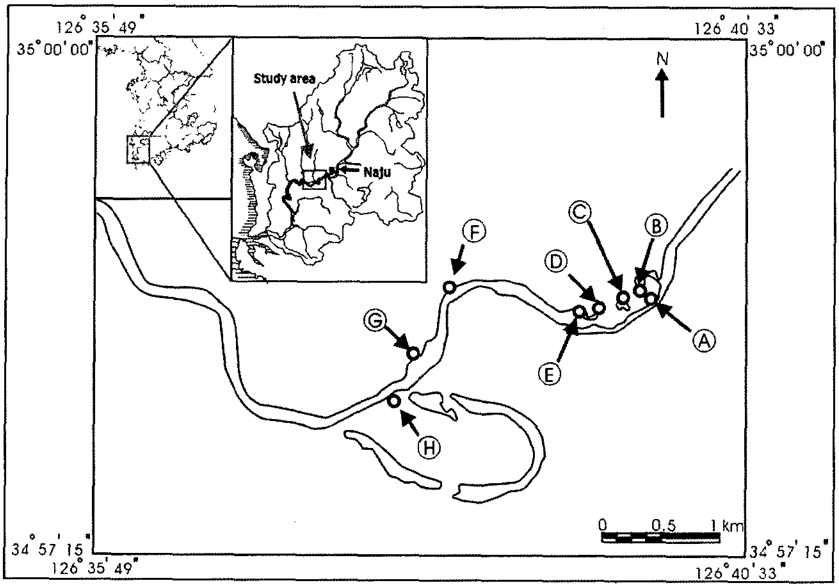


Fig. 1. Map showing the location of the Yeongsan River and meander bends developed in the midstream part. A to H represent localities where stratigraphic sections were measured.

architectural elements of fluvial sequence and to delineate the sedimentary processes to form the architectural elements within the channel and on the overbank of the fluvial deposits along the channel margins of the Yeongsan River.

Methods

For architectural analysis stratigraphic sections were measured at 8 localities along the channel margin (Fig. 1). Fresh sections of fluvial sequences exposed along the channel margin were measured stratigraphically without further excavation. Some sections without fresh surface were excavated with shovel and the longitudinal and transverse sections to the flow direction were measured. Grain size of sediment was measured based on the field scale of sediment which enables to classify at 0.5 phi interval. Color was identified with the rock color chart of the Geological Society of America (1991). Facies were classified based on texture, sedimentary structure, and color. Facies were grouped into architectural elements.

Geologic Setting

The Yeongsan River is located on southwestern part of Korea, which drains mountainous upstream area. The Yeongsan River consists of several tributaries which contribute sediments to the main river. In the midstream area the river flows on the floodplain and meander bends are developed (Fig. 1). Three to five meters thick modern fluvial sequences are exposed along the margin of channel. Stream itself is now a lake near the entrance of the Yeongsan River after construction of embankment across the estuary of the river.

Sedimentary Facies

The sedimentary sequences investigated in the meander bend in midstream of the Yeongsan River consist of 7 facies (Table 1). Theses facies are coded with Miall's classification (1996). They are 1) Matrix-supported gravel facies (Gm or Gh), 2) Planar cross-laminated sand facies (Sp), 3) Ripple cross-laminated sand facies (Sr), 4) Horizontally

Table 1. Description and interpretation of sedimentary facies

Facies	Description	Interpretation
Matrix-supported gravel (Gm or Gh)	Mostly pebble clasts with some coarse-grained sand to granules; mud to sand matrix; poorly sorted clasts and matrices; good lateral continuity; sometimes reversely graded; horizontal orientation of elongate gravels at bedding surface; 6 cm thick; nonerosive but relatively sharp lower boundary.	Deposition from debris flow (Miall, 1996)
Planar cross-laminated sand (Sp)	Very coarse-grained sands with pebbles; stratification in coarse-grained units, lamination in finer-grained units; alternation of either coarser and finer strata or gravelly and sandy strata; several cm to several tens of cm thick.	2-D sandy dunes, linguoid dunes, or bars with slipface (Harms et al., 1982; Collinson and Thompson, 1989; Miall, 1996)
Ripple cross-laminated sand (Sr)	Very fine- to medium-grained sand; set thickness of a few cm; dm thick coset; asymmetric ripples on upper bedding surface; either singular set or coset	Migration of ripples; current ripples (Harms et al., 1982; Collinson and Thompson, 1989)
Horizontally stratified sand (Sh)	Fine- to medium-grained sands and pebble-bearing sands; parallel to low-angle stratified; relatively good lateral continuity; cm to dm thick	Upper plane bed condition (Harms et al., 1982; Best and Bridge, 1992); Bridge and Best (1997)
Massive sand (Sm)	Medium- to coarse-grained sand and pebbly sand; reversely graded; some climbing ripples; a few cm to 11 cm thick; relatively good lateral continuity; sharp lower boundary	Rapid deposition from heavily sediment laden flows during waning floods (Collinson and Thompson, 1989; Todd, 1989)
Horizontally laminated mud (Fl)	Thinly parallel laminated; medium gray; sometimes reddish coated upper boundaries; a few to 2 cm thick; good lateral continuity; some plant roots; relatively sharp upper boundaries; either sharp or gradational lower boundaries.	Deposition from suspension settling and from weak traction currents; later modified by bioturbation (Miall, 1996)
Massive mud (Fm)	Silts to fine-grained sands; massive appearance; several cm thick; plant rootlets; medium dark gray; sharp upper boundaries coated with reddish muds.	Suspension settling from standing water or weak currents; modified by bioturbation (Miall, 1996; Jo and Chough, 2001)

stratified sand facies (Sh), 5) Massive sand facies (Sm), 6) Horizontally laminated mud facies (Fl), and 7) Massive mud facies (Fm).

Matrix-supported gravel facies (Gm or Gh)

This facies consists of sandy pebbles to pebbles and sometimes it shows reverse grading (Fig. 2a). Sands are coarse- to very coarse-grained sand and pebbles are 1.5 to 2 cm in diameter. The clasts are poorly sorted and are supported by poorly sorted matrix of sand, silt, and mud. This facies shows no imbrication, but shows horizontal orientation of elongate gravels at bedding surface (Fig. 2b). This facies is pale yellowish orange to dark yellowish orange and shows relatively good horizontal continuity. The thickness of this facies is 6 cm. Planar cross-laminated sand or laminated mud bed is distributed beneath this facies. The boundary of this facies is relatively sharp with nonerosional relationship with underlying bed.

Coarse sands to pebbles suggest plastic debris flow or pseudomorphic debris flow (Miall, 1996). Relatively sharp boundaries with underlying sand and mud beds suggest input of matrix-supported gravel by traction.

Planar cross-laminated sand facies (Sp)

This facies consists of fine- to very coarse-grained sands with minor amount of 1 to 2 cm size pebbles. Planar cross-bedding is distributed in this facies (Figs. 2b and h). Sands show good sorting. This facies is grayish orange and shows relatively good horizontal continuity. The thickness of the facies is several cm to more than 10 cm. The upper and lower boundaries are flat with little evidence of scouring. Some upper boundary of this facies shows reddish-coated laminae and lower and upper boundaries of this facies are gradational.

Planar cross bedding suggests migration of dunes presumably in the lower flow regime. This facies is interpreted to have been deposited in point bar or crevasse splay (Bridge, 2003).

Ripple cross-laminated sand facies (Sr)

This facies consists of very fine- to medium-grained sands with ripple cross-lamination (Figs. 2c and g). It shows pale yellowish orange and relatively good horizontal continuity. Ripple height is less than 4 cm. The thickness of this facies is several cm to more than 10 cm. Underlying and overlying this facies there are fine laminated muds. The lower and upper boundaries are gradational.

Ripple cross-laminated sands suggest lower flow regime deposition (Simons et al., 1965). This facies is interpreted to have been deposited in relatively low energy conditions including levee, crevasse splay, and upper point bar (Miall, 1996).

Horizontally laminated sand facies (Sh)

Most of this facies shows 2 to 3 mm thick laminae consisted of fine- to medium-grained sands (Figs. 2d and g). Some laminae consist of coarse- to very coarse-grained sands. It shows grayish orange and relatively good horizontal continuity. The thickness of facies is several cm to more than 10 cm. Underlying and overlying this facies there are horizontal laminated muds (Fl). Facies boundaries are sharp.

This facies is interpreted to have been deposited as plane bed in the upper flow regime (Miall, 1996). Bridge and Best (1997) described formation of planar laminae by migration of low-relief bed waves. This facies is interpreted to have been deposited in the levee and point bar.

Massive sand facies (Sm)

This facies consists of sands to pebbly sands and shows reverse grading (Fig. 2e). Pebble size is 2 to 3 cm in diameter. It shows grayish orange. The thickness of facies is a few cm to 11 cm. It shows relatively good horizontal continuity. Lower and upper boundaries are sharp.

This facies is interpreted to have been deposited as traction carpet (Sohn, 1997) or debris flow. This type of flow might have formed during flood.

Horizontally laminated mud facies (Fl)

This facies consists of finely laminated medium gray muds. The thickness of facies is a few cm to 2 m (Fig. 2f). Some of the upper boundaries of this facies is reddish-coated. Some plant roots are distributed in this facies. The upper boundary of this facies is relatively sharp and lower boundary is either sharp or gradational.

This facies is interpreted to have been deposited by settling from suspension or weak traction currents (Miall, 1996). As river water overflows the levee and the water becomes slackwater, settling occurs to form horizontal-laminated mud. This facies is thought to have been deposited on floodplain or abandoned channel.

Massive mud facies (Fm)

This facies consists of medium dark gray massive muds (Fig. 2c). The thickness of this facies is a few mm to several cm. The upper boundary is sharp and coated with reddish muds. Plant rootlets are distributed in this facies.

Massive mud suggests either low energy environment such as slackwater during flooding or bioturbation. The lower boundary conforms the underlying bedforms.

Architectural Elements

The facies in sedimentary sequence in the meander bend of the Yeongsan River are grouped into 7 architectural elements (Table 2; Fig. 2).

Gravel bedforms (GB)

This architectural element consists of set of cross-stratified and horizontally stratified pebbles (Fig. 2b). It is locally imbricated and shows downstream thickening of bed. It is dm thick. It overlies planar

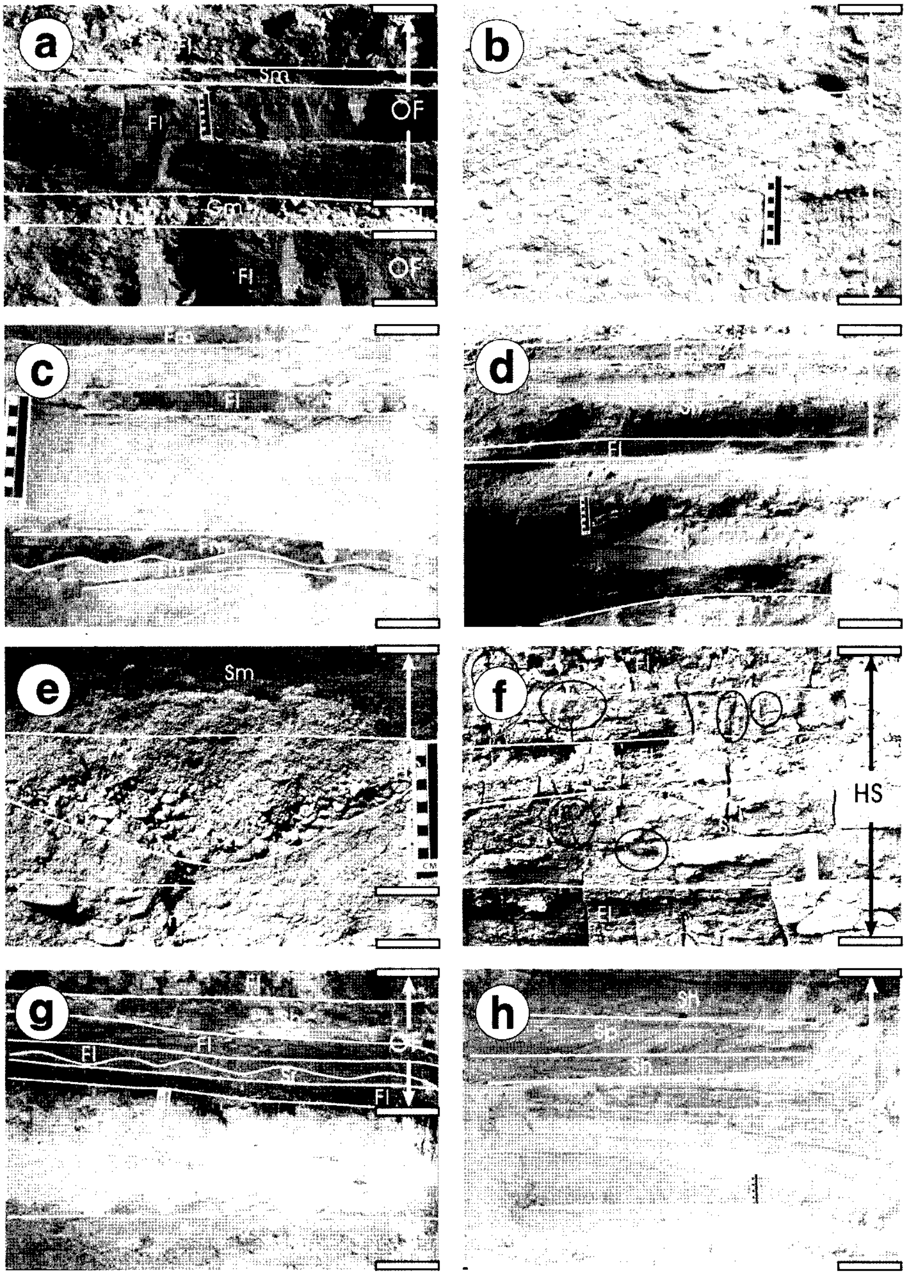


Fig. 2. Field photographs of facies and architectural elements. (a) Overbank fines (OF) intercalated by sand sheet and lens (SSL) at locality B. (b) Gravel bedform (GB) at locality C. (c) Part of cross-stratified and horizontally stratified sets (CHS) at locality C. (d) Horizontally stratified sets (HS) at locality C. (e) Gravel bedform (GB) at the bottom and overlying horizontally stratified sets (HS) at locality D. Channel filling matrix-supported gravel facies (Gm) at the center shows normal grading. (f) Horizontally stratified sets (HS) at locality D. Circles represent bioturbation by plant roots. (g) Downcurrent-dipping inclined strata sets (DIS) at the bottom and overbank fines (OF) at the top at locality G. (h) Downcurrent-dipping inclined strata sets (DIS) at locality G.

stratified sand facies and is overlain by horizontally laminated sand facies. Sometimes it occurs in horizontally laminated muds as reversely graded bed.

This architectural element is thought to be formed by downstream accretion of gravel bar on the channel floor (Miall, 1996). Reversely graded bed in

Table 2. Description and interpretation of architectural elements

Architectural elements	Description	Interpretation
Gravel Bedforms (GB)	Set of cross-stratified and horizontally stratified pebbles (Gm); locally imbricated; downstream thickening of bed; dm thick	Downstream accretion of gravel bed within channel
Horizontally stratified sets (HS)	Stacked tabular sets of horizontally stratified, fine to very coarse sands (Sh); intercalation of horizontally laminated muds (Fl); individual sets, cm to dm thick; parallel to low-angle inclined strata	Downstream migration of low-relief bedforms within channel or vertical accretion of plane-bedded bedforms on overbank
Downcurrent-dipping inclined strata sets (DIS)	Stacked sets of cross-stratified and horizontally stratified, medium- to very coarse-grained sand with low-angle cross-stratified gravels (Sp, Sh); individual sets dm thick	Downstream accretion of dunes with slipface within channel
Cross-stratified and horizontally stratified sets (CHS)	Stacked sets of cross-stratified, horizontally stratified, and ripple cross-laminated fine to coarse-grained sands (Sp, Sh, Sr); tabular sets; individual sets, dm thick	Vertical accretion and downstream migration of dunes and plane-bedded bedforms within channel
Laterally inclined and horizontally stratified sets (LHS)	Stacked sets of inclined strata perpendicular or oblique to present channel direction and horizontally stratified medium-grained sands (Sp, Sm); pebble-bearing massive sands (Sm); individual sets, dm thick	Lateral accretion and migration of dunes and plane-bedded bedforms
Sand sheet and lens (SSL)	Stacked sets or individual sets of horizontally laminated sands (Sh); cross-tratified sands (Sp); ripple cross-laminated sands (Sr); massive sands (Sm); reversely graded matrix-supported gravels (Gm), Occasional intercalation of horizontally laminated or massive muds (Fl, Fm). Occurrence in association with overbank fines	Vertical accretion of plane-bedded bedform or lateral accretion of dunes or ripples to form crevasse splay or crevasse channel
Overbank fines (OF)	Horizontally laminated mud (Fl); mottled and bioturbated mud by plant roots; good lateral continuity; individual sets, cm to dm thick	Suspension settling from slackwater on overbank

horizontally laminated muds suggests channel fill deposits in the overbank environment.

Horizontally stratified sets (HS)

This architectural element consists of stacked tabular sets of horizontally stratified sand facies intercalated with horizontally laminated mud facies (Fig. 2f) or massive mud facies. Individual sets are cm to dm thick. They are parallel to low-angle inclined strata.

This architectural element is interpreted to be formed by vertical accretion and lateral migration of levee deposits as well as settling from slackwater (Jo and Chough, 2001). As channel overflows the levee, sand on the levee moves toward flood plain forming horizontally stratified sands. The horizontal stratification represents bed load transportation of fine sands in upper flow regime. Horizontally laminated or massive mud facies is thought to have been formed by settling of suspended muds during slackwater.

Downcurrent-dipping inclined strata sets (DIS)

This architectural element consists of cross-stratified and horizontally stratified medium- to very coarse-grained sand with low-angle cross-stratified gravel strata (Fig. 2g). Individual sets are a few tens of cm to 1 m thick.

This architectural element is thought to have been formed by downstream accretion of dunes with slip face (Jo and Chough, 2001). Downstream migration of dunes with slip face on the channel floor produces cross-stratified set in the lower flow regime. With increase of flow velocity dune sand is thought to be transformed into plane bed as lower flow regime changes to upper flow regime.

Cross-stratified and horizontally stratified sets (CHS)

This architectural element consists of stacked sets of cross-stratified and horizontally stratified sands (Fig. 2c). Ripple cross-laminated fine- to coarse-grained sands are also found. Thin bed of massive muds is intercalated with horizontally sands or cross-stratified sands. Graded sand beds are found. Individual set is dm to one m thick.

This architectural element is interpreted to have been formed by vertical accretion and downstream migration of dunes and plane bedded bedforms within channel (Miall, 1996). Intercalation of sand beds and mud laminae suggests that sands may have been deposited by traction and muds may have settled from slow flowing water.

Laterally inclined and horizontally stratified sets (LHS)

This architectural element consists of stacked sets of inclined strata perpendicular to present channel direction and horizontally stratified medium-grained sand. It also contains pebble-bearing massive sand bed. Individual sets are dm thick.

This architectural element is thought to have been formed by combination of lateral migration of sand dune on point bar and formation of plane bed in the upper flow regime (Miall, 1996; Jo and Chough, 2001). Lateral migration of sand dune might have occurred during the early phase of flood event and followed by sheet flow during the maximum strength of flow during flood event.

Sand sheet and lens (SSL)

This architectural element consists of stacked sets or individual set of horizontally laminated sands, cross-stratified sands, ripple cross-laminated sands, massive sands, and reversely graded matrix-supported gravels (Fig. 2a). Horizontally laminated or massive muds are occasionally intercalated. This architectural element occurs in association with overbank fines.

This architectural element is interpreted to have been formed as crevasse splay or channel (Eberth and Miall, 1991). Breaching of levee during high stage of water level in channel resulted in formation of crevasse splay and transport of sediment by traction produced horizontally laminated, cross-stratified, and ripple cross-stratified sands. Reversely graded gravels may represent crevasse channel deposit. Intercalation of horizontally laminated muds suggests multiple episodes of overflowing of levee to form crevasse splay. The thickness of this architectural element seems to be related to the distance from the levee; relatively thick sand sheet (dm thick) must have been deposited close to the levee whereas thin sand sheet (less than 10 cm thick) distant from the levee.

Overbank Fines (OF)

This architectural element consists of horizontally laminated muds, mottled and bioturbated muds by plant roots, and purple muds. This facies shows good lateral continuity. Individual set is cm to dm thick.

This architectural element is interpreted to be deposit of suspension settling from slackwater (Jones et al., 2001). During the slack phase of flood, muds were settled from turbid water. Mottled muds were bioturbated by plant root. Purple muds were formed by oxidation of surface muds during subaerial exposure on the overbank environment.

Discussion

The stratigraphic sequence measured along the channel margin of the meander bends in midstream part of the Yeongsan River consists of 7 sedimentary facies and 7 architectural elements (Fig. 3). The stratigraphic sections measured at 8 localities show distribution of facies and these facies are grouped into architectural elements. The architectural elements are thought to have been formed either within the channel or on the overbank. The stratigraphic sequence of fluvial deposits in the Yeongsan River is 2 to 3.2 m thick above river water level and it consists of overbank deposits at the top and channel deposits at the bottom, with forming an overall fining-upward sequence (Fig. 4).

The channel deposits are formed either as channel bar or as point bar (Bridge, 2003). The cannel bar deposits of the Yeongsan river include gravel bedforms, downcurrent-dipping inclined strata sets,

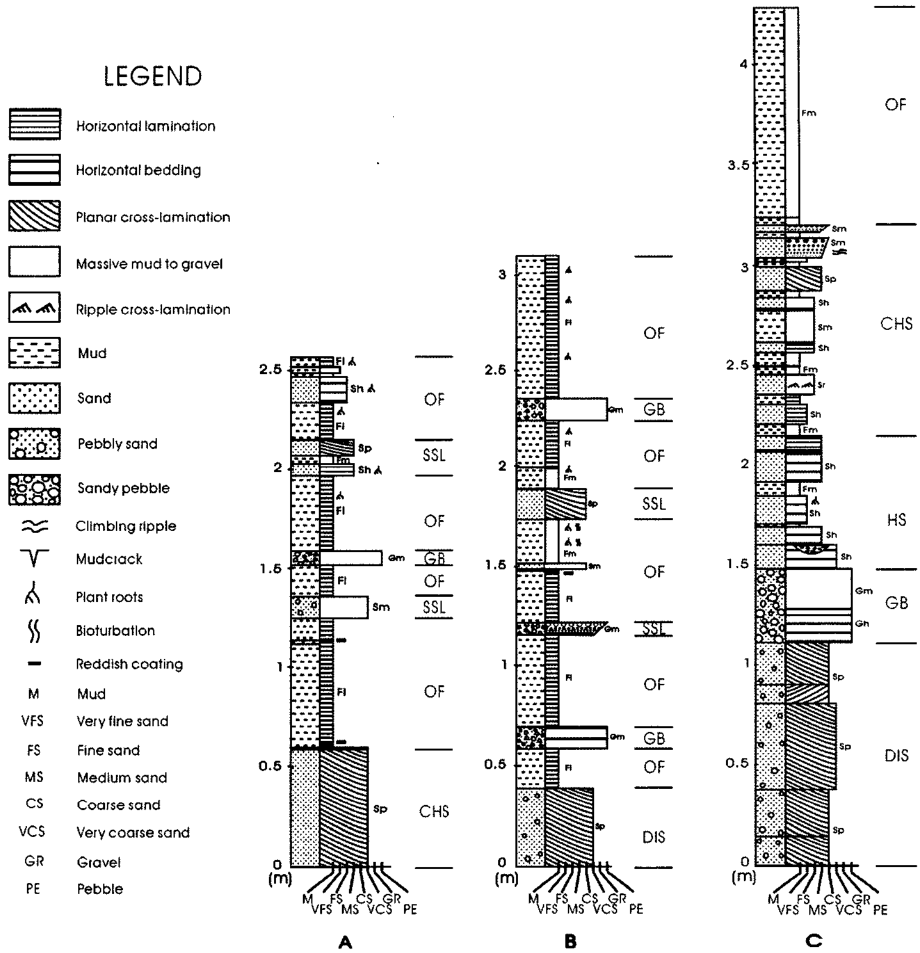


Fig. 3. Stratigraphic sections measured at localities A to H.

cross-stratified and horizontally stratified sets, and horizontally stratified sets. The gravel bedforms were deposited as channel lag deposits during periods of high discharge. Pebble-sized grain up to a few cm in diameter might have been transported by flood event. Downcurrent-dipping inclined strata sets and cross-stratified and horizontally stratified sets were formed as the sand dunes on the channel floor migrate in downstream direction within the channel. Downstream migration of straight-crested bed waves produces planar cross stratification (Bridge, 2003). Planar cross stratification in architectural elements of channel bar of the Yeongsan River is thought to have been formed by downstream migration of straight-crested dunes on the channel floor. Planar laminae are produced by upper stage plane bed (Best and Bridge, 1992). Movement of sand dune in transitional stage from low flow regime to upper flow regime seems to have produced facies of horizontally stratified sand in architectural elements forming channel bar. Association of cross-stratified facies with horizontally stratified facies in architectural elements of channel bar may reflect shift in mode of sediment transport from downstream migration of sand dune to upper stage plane beds. Ripple cross-laminated sand was formed on the surface of migrating dunes in downstream direction. Architectural element of horizontally stratified sets consist of horizontally stratified sands and horizontally laminated muds. Horizontal laminae were formed by movement of sands in upper stage plane beds and horizontally laminated muds were thought to have been deposited

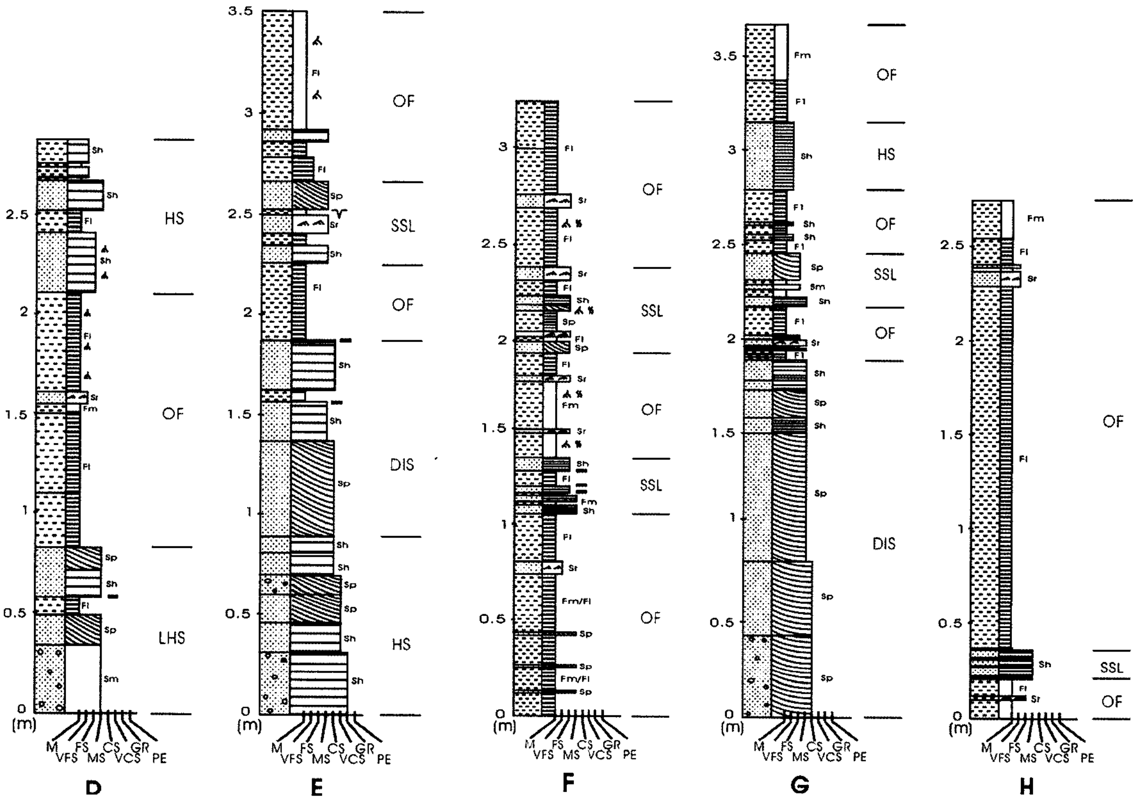
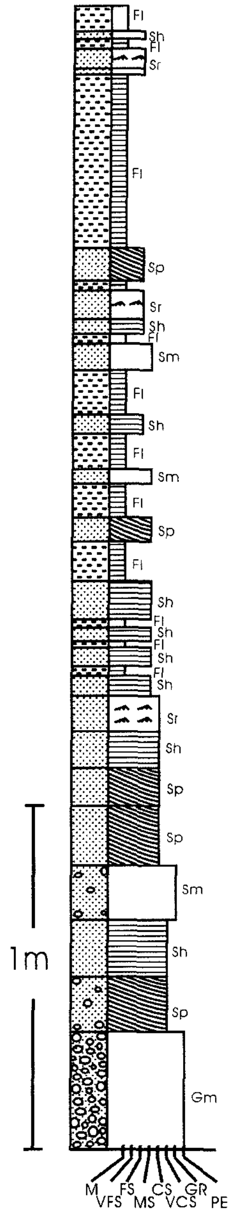


Fig. 3. Continued.

as downstream migration of sand bedform ceased and settling of suspended muds occurred. Part of this muds were buried and preserved by the dunes migrated in downstream direction, which produced plane-bedded bedform.

In point bar downstream migration of sediments as well as lateral and vertical accretion of sediments produced architectural elements. The architectural elements formed as point bar deposits are down current-dipping inclined strata sets, horizontally stratified sets, cross-stratified and horizontally stratified sets, and laterally inclined and horizontally stratified sets. Development of architectural elements as point bar deposits resulted from flow dynamics of erosion on the outside parts of bends and accretion of sediments on the inside, which leads to migration of whole channel (Leeder, 1999). Architectural element formed largely by lateral accretion is laterally inclined and horizontally stratified sets. This architectural element is thought to have been formed by combined effect of migration of sand dunes and formation of horizontal lamination in upper flow regime plane bed conditions (Davies, 1992; Miall, 1996). Down current-dipping inclined strata sets, horizontally stratified sets, and cross-stratified and horizontally stratified sets can be formed both by downstream and lateral accretion of bedforms of point bar. Decreasing bed shear stress from the deep bottom to the shallow top of the point bar resulted in an upwards fining of grain size (Allen, 2001).

The gravel bedform on the sandy point bar deposits (laterally inclined and horizontally stratified sets) was formed as scoured channel fill on the surface of point bar. During periods of high stage flow water may take a short-cut over the top of a point bar and the shortening of convex side of meander loop resulted in the deposition of chute bar (Nichols, 1999). Relatively thin gravel bedforms were formed as gravel sheet during episode of high water. Occurrence of this architectural element in



AE*	Formation process of architectural element	Fluvial unit
OF	Suspension settling of mud from slack-water, rare occurrence of crevasse splay as thin sand bed, distal part of floodplain	Overbank
SSL	Vertical accretion of plane-bedded bedform or lateral accretion of overbank: dunes or ripples on crevass splay levee or thin crevasse channel, levee to proximal part of floodplain	
OF	Suspension settling of mud from slackwater, intermittent input of sand as crevasse splay and crevasse channel, intermediate to distal part of floodplain	
HS	Downstream migration of low-relief bedforms within channel or vertical accretion of plane-bedded bedforms on overbank	Channel
CHS	Vertical accretion and downstream migration of dunes and plane-bedded bedform within channel.	
LHS	Lateral accretion and migration of dunes and plane-bedded bedform within channel	
DIS	Downstream accretion of dunes with slipface within channel	
GB	Downstream accretion of gravel bed within channel	

*AE : architectural element

Fig. 4. Generalized stratigraphic section of the Yeongsan River fluvial sequence with channel deposits at the bottom and overbank deposits at the top. The sequence shows an overall fining-upward size distribution.

association with cross-stratified and horizontally stratified sets suggests formation as gravel bed on the point bar within channel.

Architectural elements formed on the overbank are overbank fines and sand sheet and lens. The architectural element of overbank fines which are composed of horizontally laminated muds was deposited by settling from suspension. The horizontally laminated muds are interbedded by discrete bed or beds of architectural elements of sand sheet and lens. The sand sheet and lens architectural element is cm- to dm-thick, which are interpreted to have been formed by discrete overbank flooding events (Perez-Arlucea and Smith, 1999; Farrell, 2001; and Bridge, 2003). This architectural element is thought to have been formed by lateral and vertical accretion caused by combined effects of traction current of channel overflow and settling from suspension. These strata sets showed a basal erosion surface suggesting erosion of the overbank prior to deposition. The facies of horizontally laminated mud, horizontally stratified sand, planar cross-laminated sand, and ripple cross-laminated sand in architectural element of sand sheet and sand lens are believed to be formed by multiple episodes of discrete flood events on the levee or on the proximal part of floodplain (Jones et al., 2001; Bridge, 2003). As the water overflows the levee, sediment moves across the levee as traction current at first and bedforms migrate to form several facies such as massive sand, horizontally stratified sand, and ripple cross-laminated sand. With cessation of overflowing of water, levee is under slackwater and horizontally laminated mud is deposited. This mud bed may be eroded by traction current of next flood event. Dm-thick bed is believed to be deposited at proximal to intermediate part of floodplain whereas cm-thick bed at distal part of the floodplain (Bridge, 2003). Occasional occurrence of purpled layer at the base of discrete bed and sand sheet and lens architectural element suggests oxidation of sediment caused by subaerial exposure on the overbank.

Conclusions

The meander bends of the Yeongsan River consist of the architectural elements of sand-mud meandering river deposits formed both within the channel and on the overbank. The fluvial deposits in general show an overall fining-upward size distribution. The channel deposits were formed either as channel bar or as point bar. The channel bar deposits might have been formed as channel lag deposits which are consisted of architectural elements of gravel bedforms, downcurrent-dipping inclined strata sets, cross-stratified and horizontally stratified sets, and horizontally stratified sets. These deposits were formed by downstream migration of gravel bedform and sand wave or downstream transport of sand by traction current in upper flow regime conditions within the channel. The point bar deposits are consisted of down current-dipping inclined strata sets, horizontally stratified sets, cross-stratified and horizontally stratified sets, and laterally inclined and horizontally stratified sets. These architectural elements are thought to have been formed by combined effect of the migration of sand dunes and the formation of horizontal lamination in upper flow regime plane bed conditions. Stratigraphic distribution of architectural elements in the meander bend was controlled by down-current and lateral migration of point bar deposits. The overbank deposits consist of the architectural elements of overbank fine and sand sheet and lens, which are formed by settling of mud from slackwater during flooding over floodplain and episodic influx of sands by traction from channel to overbank.

Acknowlegments

This study was possible by the financial support from the Ministry of Science and Technology of Korean Government. Authors thank to undergraduate students of the Sedimentary Geology Laboratory, Chungnam National University, who helped the field work and Woo Jin Shin, a graduate student who helped graphic work. Authors express special thanks to reviewers Professor Kim, Jeong Ryul, Dr. Park, Jeong Woong, and Professor Kim, Jong Heon who gave thoughtful and helpful comments.

References

Allen, J.R.L., 2001, Principles of physical sedimentology. The Blackburn Press, Caldwell, New Jersey, 272 p.

Benito, G., Sanchez-Moya, Y., and Sopena, A., 2003, Sedimentology of high-stage flood deposits of the Tagus River, Central Spain. Sedimentary Geology, 157, 107-132.

Best, J.L. and Bridge, J.S., 1992, The morphology and dynamics of low amplitude bedwaves upon upper stage plane beds and the preservation of planar laminae. Sedimentology, 39, 737-752.

Bridge, J.S. and Best, J.L., 1997, Preservation of planar laminae due to migration of low-relief bed waves over aggrading upper-stage plane beds: comparison of experimental data with theory. Sedimentology, 44, 253-262.

Bridge, J.S., 2003, Rivers and floodplains. Blackwell, Oxford, 491 p.

Collinson, J.D. and Thompson, D.B., 1989, Sedimentary structures. Unwin Hyman, London, 207 p.

Davies, R.A., 1992, Depositional systems. Prentice Hall, Englewood Cliff, New Jersey, 604 p.

Eberth, D.A. and Miall, A.D., 1991, Stratigraphy, sedimentology and evolution of a vertebrate-bearing, braided to anastomosed fluvial system, Cutler Formation (Permian-Pennsylvanian), north-central New Mexico. Sedimentary Geology, 72, 225-252.

Ethridge, F.G, Flores, R.M., and Harvey, M.D., 1987, Recent developments in fluvial sedimentology. SEPM (Society for Sedimentary Geology) Special Publication No. 39, Tulsa, USA, 389 P.

Farrell, K.M., 2001, Geomorphology, facies architecture, and high-resolution, non-marine sequence stratigraphy in avulsion deposits, Cumberland Marshes, Saskatchewan. Sedimentary Geology, 139, 93-150.

Harms, J.C., Southard, J.B., and Walker, R.G, 1982, Structures and sequences in clastic rocks. Society of Economic Paleontologists and Mineralogists Short Course No. 9., 8-51.

Jo, H.R. and Chough, S.K., 2001, Architectural analysis of fluvial sequences in the northwestern part of Kyongsang Basin (Early Cretaceous), SE Korea. Sedimentary Geology, 144, 307-334.

Jones, S.J., Frostick, L.E., and Astin, T.R., 2001, Braided stream and flood plain architecture: The Rio Vero Formation, Spanish Pyrenees. Sedimentary Geology, 139, 229-260.

Kraus, M.J. and Gwinn, B., 1997, Facies and facies architecture of Paleogene floodplain deposits, Wilwood Formation, Bighorn Basin, Wyoming, USA. Sedimentary Geology, 114, 33-54.

Leeder, M., 1999, Sedimentology and sedimentary basins. Blackwell Science Ltd, Oxford, 592 p.

Miall, A.D., 1996, The Geology of fluvial deposits. Springer, Berlin, 582 p.

Nichols, G, 1999, Sedimentology and stratigraphy. Blackwell Science, Oxford, 355 p.

Perez-Arlucea, M. and Smith, N.D., 1999, Depositional patterns following the 1870's avulsion of the Saskatchewan River (Cumberland Marshes, Saskatchewan). Journal of Sedimentary Research, 69, 62-73.

Ray, S. and Chakraborty, T., 2002, Lower Gondwana fluvial succession of the Pench-Kahnan valley, India: stratigraphic architecture and depositional controls. Sedimentary Geology, 151, 243-271.

Simons, D.B., Richardson, E.V., and Nordin, C.F., 1965, Sedimentary structures generated by flow in alluvial channels. Society of Economic Paleontologists and Mineralogists Special Publication 12, 34-52.

Sohn, Y.K., 1997, On traction-carpet sedimentation. Journal of Sedimentary Research, 67, 502-509.

The Geological Society of America, 1991, Rock-color chart. Boulder, CO, USA.

Todd, S.P., 1989, Stream-driven, high density gravelly traction carpets: possible deposits in the Trabeg Conglomerate Formation, SW Ireland and theoretical considerations of their origin. Sedimentology, 36, 513-530.

Yoshida, S., 2000, Sequence and facies architecture of the upper Blackhawk Formation and the Lower Castlegate Sandstone (Upper Cretaceous), Book Cliff, Utah, USA. Sedimentary Geology, 136, 239-276.

2005년 10월 6일 원고 접수
2005년 11월 10일 수정원고 접수
2005년 11월 17일 원고 채택