

TABLE 3.- CRITERIA FOR RECOGNITION OF SELECTED SANDSTONE DEPOSITS

	ALLUVIAL SYSTEMS				COASTLINE SYSTEMS		SHALLOW MARINE SYSTEMS
	BRAIDED STREAM SYSTEMS	COARSE GRAINED MEANDER BELT SYSTEMS	FINE GRAINED MEANDER BELT SYSTEMS	DELTA DISTRIBUTARY CHANNELS	TIDAL FLAT-CHANNEL SYSTEMS	BARRIER BAR SYSTEMS	SHALLOW MARINE BAR SYSTEMS
DEPOSITIONAL SETTING	commonly developed in areas of steep gradients; low but flashy discharge and high bed load	develops under conditions of locally higher gradients; generally moderate to high bed load and flashy discharge; channels are stabilized by vegetation	developed in low gradient areas with high uniform discharge; high suspended load	built on delta plain of high-constructive delta under very low gradients; high suspended load and continuous discharge; an aggrading system	may occur along gently sloping coastlines with marked tidal range where enough sediment is available and strong wave action is not present; this may be along the open sea or in areas associated with deltas, estuaries, lagoons, bays, barrier islands or other sand bars	develops from reworking of sediments by waves and longshore currents which redistribute sands parallel to depositional strike; may form as destructive facies of high constructive or destructive deltas; or as independent systems far from the source	normally develop on high energy shelf usually tide dominated
TREND-LENGTH-WIDTH-THICKNESS FOR COMPLEX	trend is perpendicular to regional strike of coastline; length may extend for 1000's km. and widths may range up to several km; thickness for complex may vary up to 100's of meters; multilateral sand body	trend perpendicular to shoreline; composite multilateral sand body ranging up to 60 m. thick and 50 km. wide	trend is perpendicular to depositional strike for complex; length 1000's of km. and width varies from stream widths 20 times stream width; thickness extends up to 100's of meters; multistoried body	average orientation is perpendicular to the depositional strike; length up to 10's of km.; widths up to 8 km; thicknesses up to 100's; multistoried sand bodies	flats are parallel to depositional strike; North Sea tidal flats are 450 km. long, 5-7 km. wide and exhibit a lenticular cross sectional shape; tidal channels are perpendicular to strike; length commonly width of flats; width of tidal channels range up to several hundred meters; multistoried and multilateral deposits develop	parallel to depositional strike; length many times greater than width; width ranges from several hundreds of meters to several km.; large width to thickness ratio	elongate bodies are variably oriented with respect to depositional strike
GEOMETRY OF INDIVIDUAL UNITS	individual channels are wide, shallow tabular, flatbedded bodies	individual channels are wide shallow, slightly sinuous to straight migrating at rapid rates; essentially flatbedded bottom; discontinuous channel fill units	individual channels are asymmetrical convex downward; thickness averages 10 to 25 m. and width 8-16 km; moderate to highly sinuous in plan view	individual channels are symmetrical in cross-section with a convex-downward base and a flat top; minimum width is stream width; small width to thickness ratio	individual channels show an asymmetrical downward shape, display a branching pattern and rapidly migrate; width is stream width; small width to thickness ratio	commonly a sloping flattened base and a convex upward shape; symmetry dependent upon sediment supply, rate of subsidence, and sea level fluctuation	size and shape variable from irregular small sand through elongate ribbons to widespread sheets
BOUNDARIES	upper, lateral and lower boundaries sharp	lateral and lower contacts are sharp; upper contact sharp or gradational	lateral and lower boundaries sharp; upper boundary commonly gradational	sharp lower and lateral contacts; initial scour along channel-mouth bar yet subsidence distorts boundary	sharp lateral and lower contacts; upper contact sharp or gradational	lower and lateral boundaries commonly gradational	Sharp lower and lateral contact
VERTICAL SEQUENCE OF SEDIMENTARY STRUCTURES IN THE SANDSTONE	characterized by extremely variable flow directions; medium scale tabular or trough crossbedding and horizontal bedding; ripples are rare; no decrease in the scale of sedimentary structures	generally large scale troughs or channel lag at base; medium scale troughs and tabular; wedge sets or avalanche beds; parallel inclined laminae and thin tabular; no decrease in scale of sedimentary structures; flow indicators constant	channel lag at base; medium scale planar crossbeds or trough beds in lower point bar; horizontal or small scale asymmetrical current ripples; clay drapes formed on point bar; decrease in scale of sedimentary structures; flow indicators highly variable	contorted trough beds or massive sands; mud diapirs are common; scale of sedimentary structures constant	shell lag deposits at base of retic sequence; up to large or medium scale trough beds; up into a zone of flaser, lenticular and interbedded muds or sands; upward decrease in the scale of sedimentary structures	the underlying shelf muds are highly bioturbated and deformed with inter-laminations of fossil pellets; the transitional phase consists of strongly bioturbated fine sand; the lower shoreface is strongly bioturbated with minor laminations; the middle shoreface contains burrowed sands with shell debris, thin layers of silty clay are also present; the surf zone contains differing types of cross-stratification; beach sands are characterized by sub horizontal and low angle cross stratification; eolian dunes may top the sequence; ophiomorphic barrows are characteristic	symmetrical and asymmetrical ripple bedding and abundant medium to large scale crossbedding; orientation of directional features highly variable; trails, burrows, minor channels and washouts
ASSOCIATED FACIES	levees with silt and clay are poorly developed; may occur in older inactive channels stabilized by vegetation; little organics preserved	poorly developed natural levees; generally interbedded muds and sand	well developed overbank muds; levees consist of intercalated clay, silt and fine sand with small scale trough beds and wavy laminations; root mottling and concretions are common; channel fill sediments consist of fine sand, silt and clay and are commonly burrowed, also contain small scale troughbeds; irregular laminations and root marks are common; floodbasin sediments contain interbedded silts and clays, are commonly burrowed and contain root marks and slickensides; crevasse splay deposits contain sand and muds, small to large scale trough crossbedding, and irregular laminations; soft sediment deformation is present throughout the system	deltaic plain deposits consist of natural levees, channel fill, back-swamp and crevasse splay deposits as described in fine grained meandering systems; in the distal prodelta muds burrows soft sediment deformation, pyrite, siderite and glauconite; the proximal prodelta muds contain interbedded sands; the delta front sands are normally massive and highly distorted because of connection into underlying muds; lakes with burrowed muds may form between distributaries; or on abandoned lobes; a destructive facies consisting of barrier bars, marine limestones, bays or lagoons may form on abandonment of the delta lobe	subtidal zone of tidal flats are characterized by large scale tidal channels and sand bars consisting of shell debris and medium scale trough beds; intertidal zone generally has a slow net rate of sedimentation and consists of three zones; sand flats are characterized by well developed current and wave ripples, flaser bedding and intercalated mud and sand are common in mixed flats; mud flats have algal mats and sea grass present at the high water mark; surface markings and wave ripples are common on flats	normal marine sediments on the seaward side with shell debris and glauconite; on the landward side lagoons normally contain burrowed laminated muds and silts, washover fans and marsh type sediments; small tidal deltas may build out between bars; also tidal pass channels with medium scale trough crossbedding at the base and smaller scale trough bedding higher on the slope showing a multiplicity of directions	marine shale or carbonates underlying sand; lateral facies are uniform silt free shales or carbonates
DEPOSITIONAL PROCESSES	developed from infrequent flooding; unidirectionally flowing stream is incompetent in moving bedload; sediment moves as a series of transverse bars; longitudinal bars are winnowed deposits; scour is slight; banks are low and water overflows channel easily; poorly developed levees are formed by vertical accretion; for more detail see the last two references	developed from flooding; lower part of sequence is formed similar to point bar in fine grained meander belt; banks are stabilized by vegetation confining flow to channel; chutes are scoured on point bar	Develop from flooding and unidirectional flow; erosion along the concave bank where flow velocities higher and lag deposit is developed by winnowing fines; helicoidal flow set up in meander bend and winnowed sediment is moved across channel to downstream convex bank; sediment is deposited on a sloping surface; as bar is ascended during flood flow velocity decreases and coarser material is dropped out giving fining up sequence in grain size; larger scale bedform developed at base of point bar under higher flow conditions while ripples form higher on the point bar under low flow conditions; Due to sinuosity of stream directional parameters are highly variable; overbank deposits are formed by vertical accretion as flood overflows banks; crevasse splay develop as water escapes through a low in the bank	generally straight unidirectional flow in channels because of extensive levee formation which stabilizes banks; minor deposition on point bars but mainly on the channel floor; where delta meets sea reworking in delta front facies by waves creates a coarsening up sequence from the prodelta muds; bidirectional features may form channel shows strong unidirectional character; no decrease in scale of sedimentary structures; abundant contortion due to rapid subsidence into underlying muds; scour is very slight	tidal channels form in a similar fashion as meandering systems; numerous bidirectional or wave features may develop from the influence of tides; scour is prominent	barrier bars form from interaction of waves, longshore currents with local or extensive sediment redistribution along the coastline; normally the sediment supply is low; may form by building out during periods of normal weather from longshore currents or build up in storms; there also be an eolian influence; bars may also build at one end in tidal passes by lateral migration similar to a point bar; grain size coarsens upward because of increasing influence of waves as bar builds up; a fining up sequence in grain size may be present in tidal passes	processes involve reworking and transport of sands already on the shelf and inherited from earlier paralic deposition; transport and deposition from storm ebbs, wave action, tidal currents and turbidity currents; helicoidal flow is important; also suspension deposits from deltas add the major influx of fines to system
COMPOSITION AND TEXTURE OF SAND	mainly coarse sand and gravel; poorly sorted; transported fauna; wood fragments and plant debris; no fining up distribution in grain size	mainly coarse sand and gravel; poorly sorted; transported fauna; wood fragments and plant debris; no fining up distribution in grain size	silt to chiefly fine grained sand; locally coarse grained sand to conglomerate; poor to moderate sorting; reworked fossils; plant material; wood fragments; lignite; mud clasts; fining up sequence in grain size	chiefly fine to medium grained sand; poor to moderately well sorted; mud clasts, wood fragments; siderite concretions; turbid water fauna; no fining up sequence in distributary channel; overall coarsening up sequence in grain size in delta	chiefly fine sand and silt; sorting moderate to poor; glauconite abundant, brackish to marine water fauna; fining upward sequence in grain size in channel; overall coarsening upward grain size in flats	fine to medium grained sand; moderate to well sorted; glauconite; marine fauna; little organic matter	well sorted, well rounded fine grained sand; few fines; glauconite and rich varied marine fauna; grain size trends are irregular-may increase or decrease
DISTINGUISHING CHARACTERISTICS	1. develops a multilateral sandstone body; trend perpendicular to shoreline; channel units discontinuous, flat bedded, lenticular to tabular in cross section 2. mainly coarse sand and gravel; mud clasts and plant material; no fining up sequence in grain size; poorly sorted 3. unidirectional current features; few stratification types and no decrease in the scale of sedimentary structures; rare ripples 4. lack of biotic constituents or burrowing in the sandstone 5. sharp basal and lateral contacts; upper contacts also sharp	1. develops multilateral sand body; individual channel is wide, shallow flatbedded tabular body; trend is perpendicular to slope 2. fine to chiefly coarse grained sand; pebbles, wood fragments and plant material; no grain size distribution 3. few stratification types and no decrease in scale of sedimentary structures; slight scour 4. unidirectional flow features 5. sharp lateral and lower contacts; upper contact sharp or gradational	1. develops a multistoried sand body; trend perpendicular to shoreline; individual channels are sinuous in plan view and asymmetrical convex downward in cross section 2. chiefly fine grained sand; mud clasts and plant material; poorly sorted; fining up sequence in grain size 3. unidirectional current features; decrease in scale of sedimentary structures 4. lack of biotic constituents or burrowing in sandstone 5. sharp basal and lateral contacts; upper boundary commonly gradational	1. multistoried sandstone body; trend perpendicular to shoreline; straight in plan view; symmetrical in cross section 2. fine to medium grained sand; mud clasts, wood fragments, siderite concretions; poorly to moderately well sorted; no fining upward sequence in grain size 3. unidirectional current features in distributary; constant flow indicators; no decrease in scale of sedimentary structures 4. overall coarsening upward sequence in grain size of delta 5. Sand normally contorted because of subsidence 6. lower and lateral boundaries sharp; major influence on boundary is subsidence	1. generally develop perpendicular to shoreline as multistoried and multilateral deposits; individual channels are sinuous in plan view and asymmetrical convex downward in cross section 2. chiefly fine sand and silt; fining up sequence in grain size; aliochthonous marine fauna and abundant glauconite; sorting poor 3. bidirectional features; decrease in scale of sedimentary structures 4. lengths no wider than tidal flats 5. sharp basal lateral contacts; upper contact sharp or gradational	1. overall trend parallel to shoreline; sloping planar base and convex up top 2. chiefly fine to medium grained sand; well sorted; abundant glauconite, marine fauna, and plant material; grain size coarsens up 3. multidirectional crossbedding and low angle planar bedding 4. gradational lower and lateral boundaries	1. develops as irregular nodes, elongate ribbons or sheet sands; trend to shoreline highly variable 2. well rounded and sorted fine grained sand; marine fauna and glauconite; diverse grain size trends 3. wave and current ripples; multidirectional crossbedding and burrowing 4. sharp lower and lateral contacts
REFERENCES	Fisher and Brown (1972) Brown et al. (1973) Shelton (1973) Reineck and Singh (1975) Costello and Walker (1972) Eynon and Walker (1974)	Fisher and Brown (1972) Brown et al. (1973) McDowen and Garner (1970)	Fisher and Brown (1972) Visher (1972) Davies and Berg (1971) Brown et al. (1973) Shelton (1973) Reineck and Singh (1975)	Fisher et al. (1969) Fisher and Brown (1972) Brown et al. (1973) Reineck and Singh (1975) Shelton (1973) Swanson (1975)	Klein (1967) LeBlanc (1972) Reineck (1972) Reineck and Singh (1975)	Davies and Berg (1971) Fisher and Brown (1972) Pettijohn, Potter and Siever (1972) Shelton (1973) Howard (1972) Reineck and Singh (1975)	Pettijohn, Potter and Siever (1972) Spearing (1975) Shelton (1973)