**Submarine fan**

* Deposited by sediment gravity flow processes ( channelized turbidity currents, debris flow)
* Components:
  + Upper fan – contains a major feeder channel
  + Middle fan – contains a network of distributary channels and associated overbanks
  + Lower fan – contains lobes or sheet sand
* Reservoir potential: channels and lobes

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|  | **Transport processes** | **Lithology** | **Sedimentary features** | **Turbidite facies** | **Grain size trend** | **Bed thickness trend** |
| **Channel** | Slumps, debris flows, turbidity currents | Conglomerate, sandstone, mudstone | Erosive bases, rip-up clasts, lenticular sand bodies | A (Sediments deposited from cohesive debris flows),  B (Coarse-grained sandy turbidites) | fining upward | thinning upward |
| **Lobe (lobe complexes)** | turbidity currents | Sandstone, mudstone | Complete and partial Bouma sequence, continuous sand bodies | C (Medium-grained sandy turbidites), D (Fine-grained sandy/muddy turbidites) | coarsening upward | thickening upward |
| **channel lobe transition zone** | Suspension |  | Erosional/bypass features  such as furrows, scours and sand waves | E |  |  |
| **Overbanks** |  |  |  |  |  |  |
| **Levees** |  |  |  |  |  |  |
| **Basin plain** |  | Hemipelagites |  | G |  |  |

**Facies classification** (Mutti and Ricci Lucchi, 1972,1975):

* Facies A – conglomerate, pebbly sandstones, pebbly mudstone
  + Moderate reservoir potential because of abundand depositional matrix
* Facies B – massive sandstones
  + Better reservoir than facies A, are better sorted and more continuous
* Facies C – classical turbidite
  + Best potential for reservoir development, sandstones form thickening upward lobe sequences with good lateral connectivity and high depositional porosity
* Facies D – sandstones lacking the lower division of the Bouma sequence
  + Moderate reservoir potential
* Facies E – ripple laminated and lenticular sandstones
  + Slightly better reservoir potential than facies D
* Facies F – slumps
  + Minimum potential for reservoir development
* Facies G – pelagic and hemipelagic
  + Minimum potential for reservoir development

**Architectural and morphological characteristics:**

**Channels**

* display sinuous, ribbon–like geometries in plan–form and overall concave morphologies with irregular/erosional bases in vertical profile

**Lobes**

* generally show lobate geometries in plan–form and overall convex–up morphologies with flat bases in vertical profile
* have much higher width to thickness ratios than turbidite channels
* have great lateral extent and continuity yet relatively limited thickness ( unconfined environment)
* sand amalgamation increases the connectivity od the sand bodies
* Lobe complexes are bounded by pelagic/hemipelagic shales, several meters to tens of meters thick, implying long sedimentation hiatus.

**Factors controlling the turbidites:**

**Geometries** of turbidite are strongly controlled by the shape of the basin:

* Low slope to basin relief – specific to continental margins
  + Show pragradation of the turbidite system
* High slope to basin relief – specific to areas tectonically controlled
  + Show aggradation and retrogradation of the turbidite system
* Sea level is the primary factor controlling the growth of submarine fans. Submarine fans are associated typically with periods of low sea level.

Based on efficiency to transport sand, there are 2 types of fan system:

* Highly efficient
  + Turbidity currents of a *mud-rich system* transport sand efficiently over long distances
* Poorly efficient
  + The transport efficiency of a *sand-rich system* is relatively poor

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| --- | --- | --- |
| **Characteristics** | **Highly efficient (Eocene Hecho system, Spain)** | **Poorly efficient** |
| **Sediment** | Mud rich | Sand rich |
| **Source area (size)** | Large | Restricted |
| **Sediment feeding system** | River - delta | Beach-canyon |
| **Size of fan** | Large (hundreds of km) | Small (tens of km) |
| **Gradient (slope)** | Low | High |
| **Distance of transport** | Long | Short |
| **Amount of fine in suspension** | Large | Small |
| **Channels** | Detached from lobes  Higher sinuosity | Attached to lobes  Low sinuosity |
| **Sandstone lobes** | Large | Small |
| **Lobe cycles** | Well developed, thickening upward trends | Poorly developed, thickening upward trends |
| **Zone of bypassing** | Present | Absent |
| **Lobe fringe deposits** | Well developed | Poorly developed or absent |
| **Basin plain deposits** | Well developed | Poorly developed or absent |
| **Net to gross** | Low | High |
| **Vertical connectivity of sand bodies** | Multiple reservoir – seal pairs | Amalgamation, vertical connectivity |