Flysch turbidite shelf model

Higgs, Roger

Geoclastica Ltd, Bude, Cornwall EX23 8LQ, UK (rogerhiggs@geoclastica.com)

By general accord, the HAM (Hecho, Annot, Marnoso-arenacea) flysch accumulated on a deep-sea fan and basin plain in 3 foreland-basin axial gulfs, supplied longitudinally. Shared published traits include: flysch hallmark cyclicity of alternating thinner-bedded (e.g. cm or dm) and thicker-bedded (dm or m) turbidite "packets" 1-30m thick; intra-HAM incised "channels" (m-km wide; 5m to over 100m deep); *Nereites*, *Zoophycos* and *Cruziana* ichnofacies; bathyal-type forams; common HCS beds (cm-dm) and mud-draped scours (MDSs). Consensus on 400-800m water depths poses a problem: if not storm erosion, what prevented further shallowing while over 4km (H, M) accumulated? This and the HCS suggest a possible shelf origin for flysch, with implications for its use as reservoir outcrop analogues.

HAM flysch bathymetric reassessment must ignore ichnofossils, to avoid circularity, as Seilacher's original *Nereites*-type formations are flysch; moreover, *Nereites*- and *Zoophycos*-type associations are known in shelf deposits. The HCS beds, inferred by most HAM workers to be internal-wave-modified turbidites, are interpreted here as shelf tempestites, while HAM turbidites (Lowe-, Bouma-type) are megaflood hyperpycnites supplied to the shelf via a gulf-head delta. The shelf was long (epeiric gulf), confined laterally by orogen and forebulge, and ended at a continental slope (into a remnant ocean) or intermediate slope (cf. modern Adriatic foreland basin's 200km NW shelf, passing SE into two "pits" and ocean beyond). The "fan" was just a sandier inner shelf (gulf). The "channels" are shelf-indenting submarine canyons. Tsunamis moving up-gulf deposited "megaturbidites" (H, M) of forebulge carbonate debris. HAM "bathyal" forams reflect upwelling-slope conditions (seabed organic-rich, dysoxic) replicated on the shelf by prolific hypopycnal inflow (nutrients) causing high phytoplankton productivity, hence bottom dysoxia, enhanced by thermohaline stratification (hypopycnal fresh water; subtropical lack of winter overturn). Hypo- and mesopycnites are expected. Many HAM "linked debrites" and "slumps" are probably in situ seismites, predictable in any foreland-basin, low-gradient environment.

HAM flysch cyclicity records glacioeustatic water-depth oscillations; the thinner-bedded packets represent highstands (interglacials). Much of the shelf remained submerged at lowstands as Eocene-Miocene long-term (1-5Ma) glacioeustatic amplitude was low (30-80m) and axial-delta progradation limited (see below). The sharp change in bed thickness from packet to packet suggests falls and rises large enough (2-20m?) to significantly alter the proximality, yet too brief (0.1-1ka?) for more than 1 or 2 events to occur during each fall or rise, implying rapid fall/rise rates (c. 2 cm/yr) like those of Quaternary sub-10ka cycles (2ka solar cycle?). Milankovitch- and solar-cycle convolution explains packet-thickness variability. Accentuating the bed-thickness jump, hyperpycnicity was 'easier' at lowstands, as the basin-axial trunk river was more incised, curbing its expansion (deceleration) onto the interfluves during floods, ensuring higher river velocity (turbidity, density); thus, lowstand hyperpycnal flows were so frequent and sustained that most river-supplied sediment bypassed the shore, slowing delta advance in favour of shelf aggradation. Each fall forced a simultaneous increase in seabed storm-wave power (shallowing) and proximality (subtly coarser fairweather mud), conserving the shelf equilibrium profile. During low- and highstands alike, each megastorm shaved the aggrading shelf back down to equilibrium, removing a thin (cm-dm) fairweather layer of mud and/or hyperpycnite sand, leaving behind a subsidence-accommodated increment capped by a MDS or a tempestite with or without HCS. The flysch-shelf model is non-actualistic (Quaternary eustatic amplitude too high).

International Association of Sedimentologists
Abstracts, 30th IAS Meeting of Sedimentology
University of Manchester, UK, Sept 2013