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Shelf Model for "Deep-Sea" Flysch Turbidites and Implications for Outcrop Analogs

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Published traits of classic Cenozoic 'HAM' (Hecho, Annot, Marnoso-arenacea) flysch of Europe include: peripheral foreland basins; hallmark flysch cyclicity of alternating packets of thinner/thicker "turbidites"; mainly axial flow (flutes); intercalated *Skolithos, Cruziana, Zoophycos* and *Nereites* ichnofacies; "bathyal" forams; intermittent beds with HCS; common mud-draped scours (MDSs; wave erosion?); and intra-HAM turbiditic canyons. Contrary to HAM's traditional deep-sea-fan/basin-plain interpretation, the MDSs and HCS suggest a shelf origin. All four ichnofacies are known in shelf strata.

The envisaged HAM flysch shelves were basin-axial epeiric gulfs 100s of km long (cf. modern Adriatic 200km NW shelf), confined laterally by orogen and forebulge, and indented by submarine canyons. The HCS beds are interpretable as tempestites; and HAM turbidites as flood hyperpycnites. The cyclicity is attributable to very rapid glacioeustatic rises/falls. Preventing subaerial exposure: (A) the shelf length exceeded the reach of axial-delta progradations; (B) published syn-HAM short-term (less than 1Ma) glacioeustatic amplitude was only 20-50m; and (C) each megastorm shaved the aggrading shelf back down to its intrinsic wave-graded equilibrium profile, sweeping the excess over the shelf edge. The "bathyal" forams reflect: (1) mimicking of slope OMZ conditions (muddy dysoxic bottom) on the flysch shelf by a fairweather mud blanket and permanent subtropical water stratification (river-diluted lid); and (2) reworking of near-coeval benthic forams (from true bathyal flysch mud/marl exposed in the adjacent accretionary-wedge mountains, offscraped from vanished remnant ocean), transported in suspension (tests empty, buoyant, unabraded) by river floods and deposited in hypo-/meso-/hyperpycnal shelf mud.

A restricted-glacioeustasy (again non-actualistic) shelf model also applies to 7 older flysch formations: Cerro Toro (Chile, U. Cret.) and Carbo-Permian Bude (UK), Ross (Ireland), Brushy Canyon, Jackfork (USA), Skoorsteenberg and Laingsburg (S Africa). Like HAM, most are popular as outcrop analogs for passive margin deep-sea reservoirs (base-of-slope fans; leveed sinuous channels; slope minibasins), despite 4 major contrasts affecting reservoir architecture: (1) syn-flysch tectonism; (2) flysch-gulf 3-way confinement (proximal, lateral), unlike passive-margin fans (1-way, hence contour-current reworking); (3) HAM flysch storm erosion; and (4) lack of proven HAM leveed channels.

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