Multi-Scale Depositional Successions in Tectonic Settings

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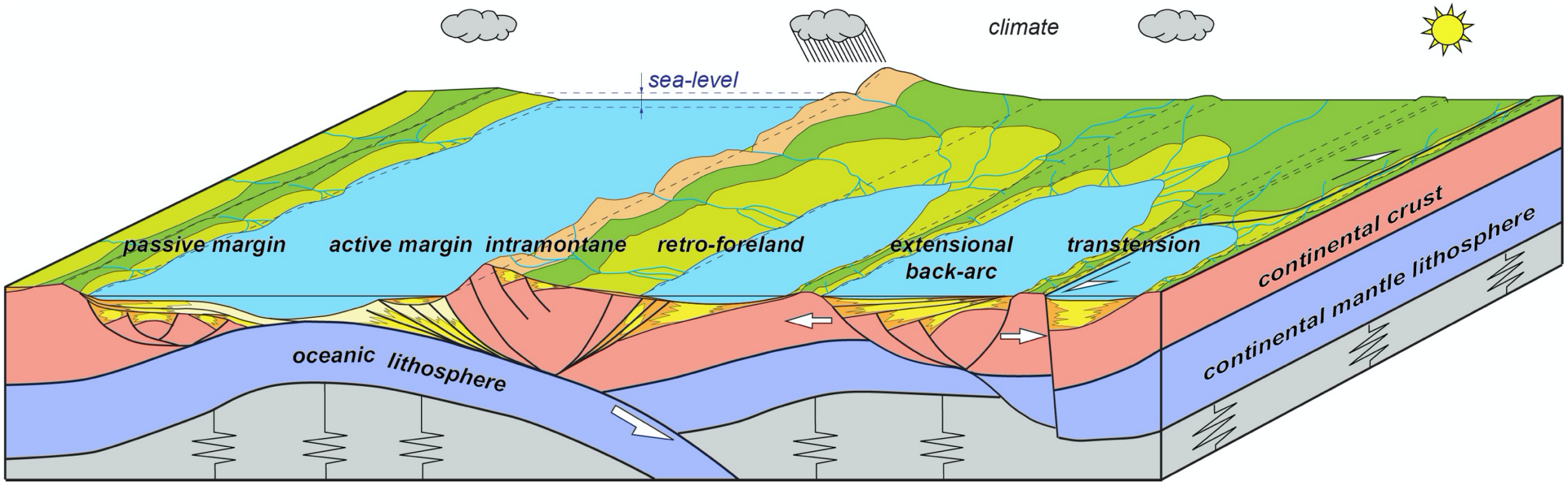
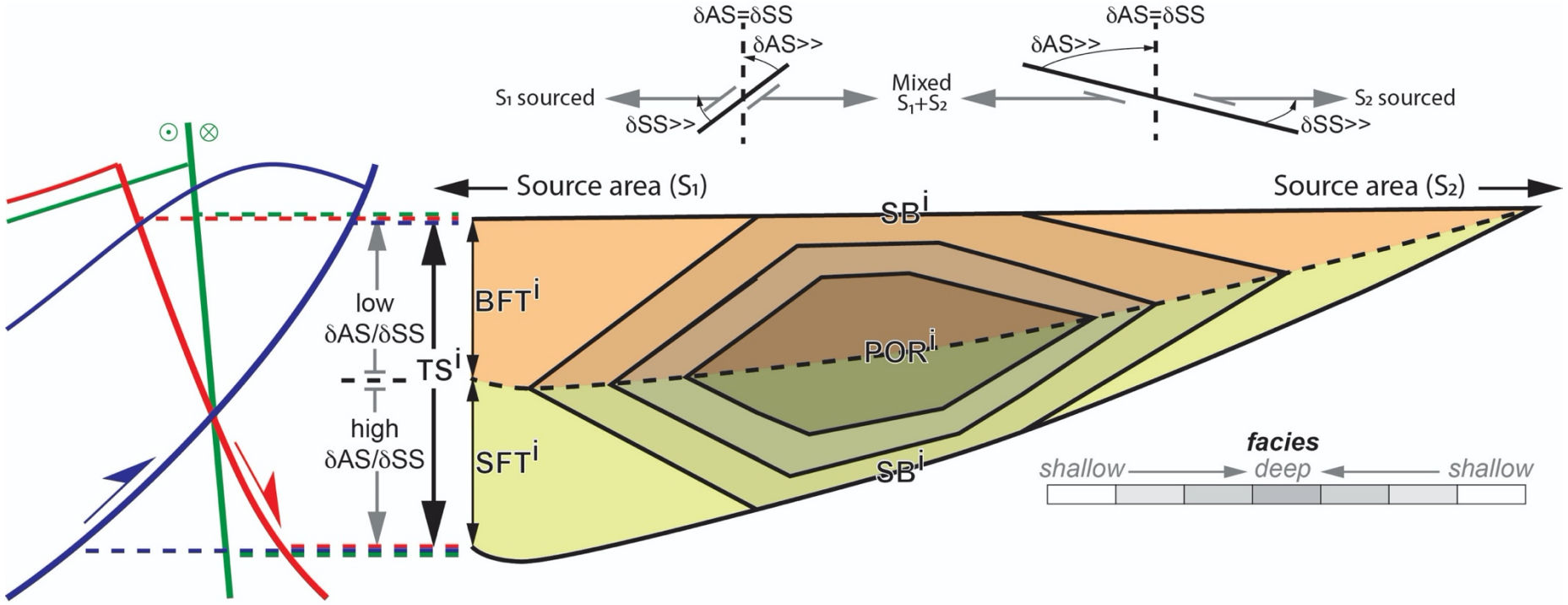
Tectonic versus sea-level control on sedimenation



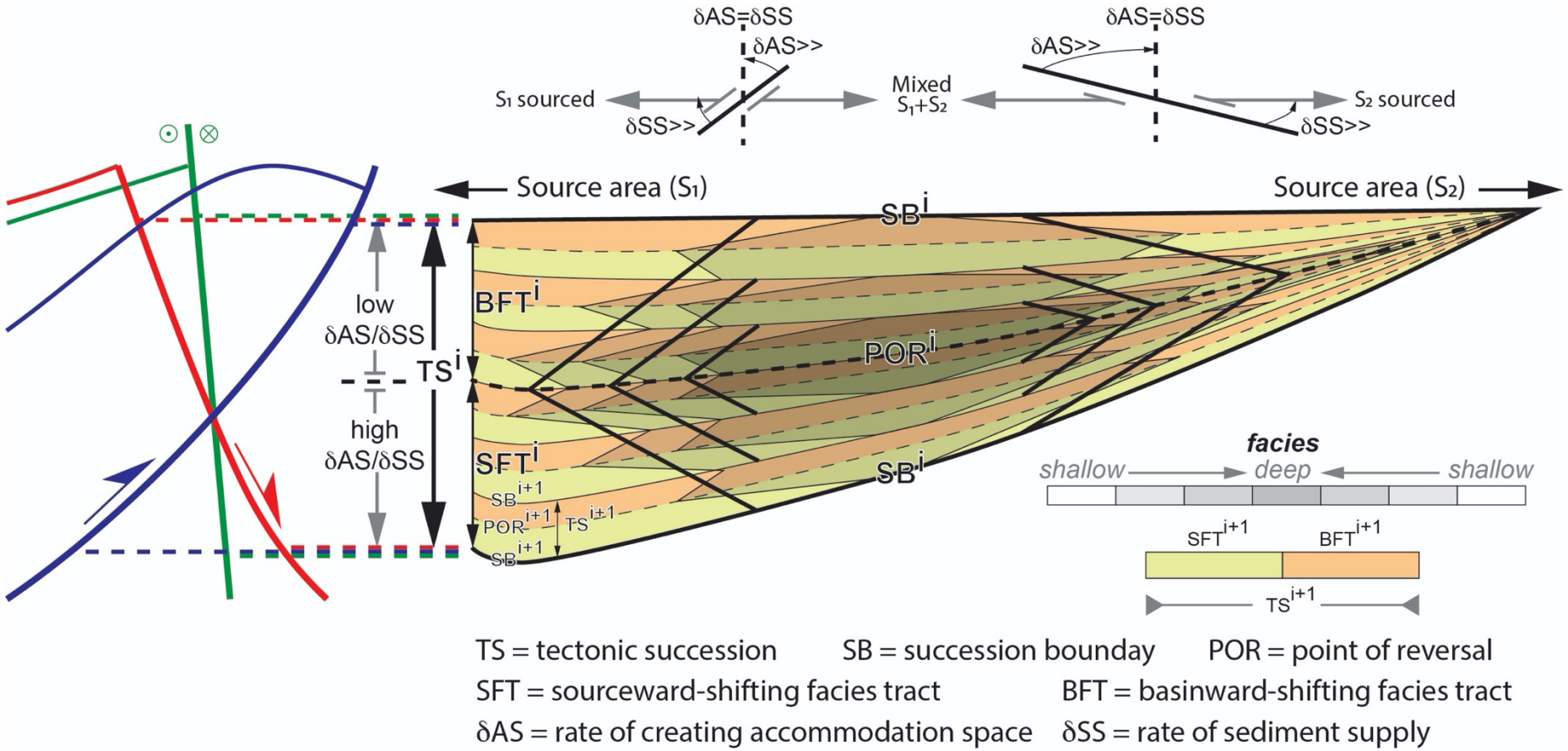
- Depositional space and depositional facies sedimentary basins in plate tectonic settings, from passive to active margins, intramontane, continental retro-foreland, extensional back-arcs and continental strike-slip settings.
- Depositional space appears triangular in cross-sectional view against active faults, even when individual sub-basins are ultimately connected, and can be sourced from multiple directions at various elevations.
- When tectonics play a subsidiary role, the sediment source tends to be unidirectional, e.g., in passive margins.

Tectonic Successions, one order



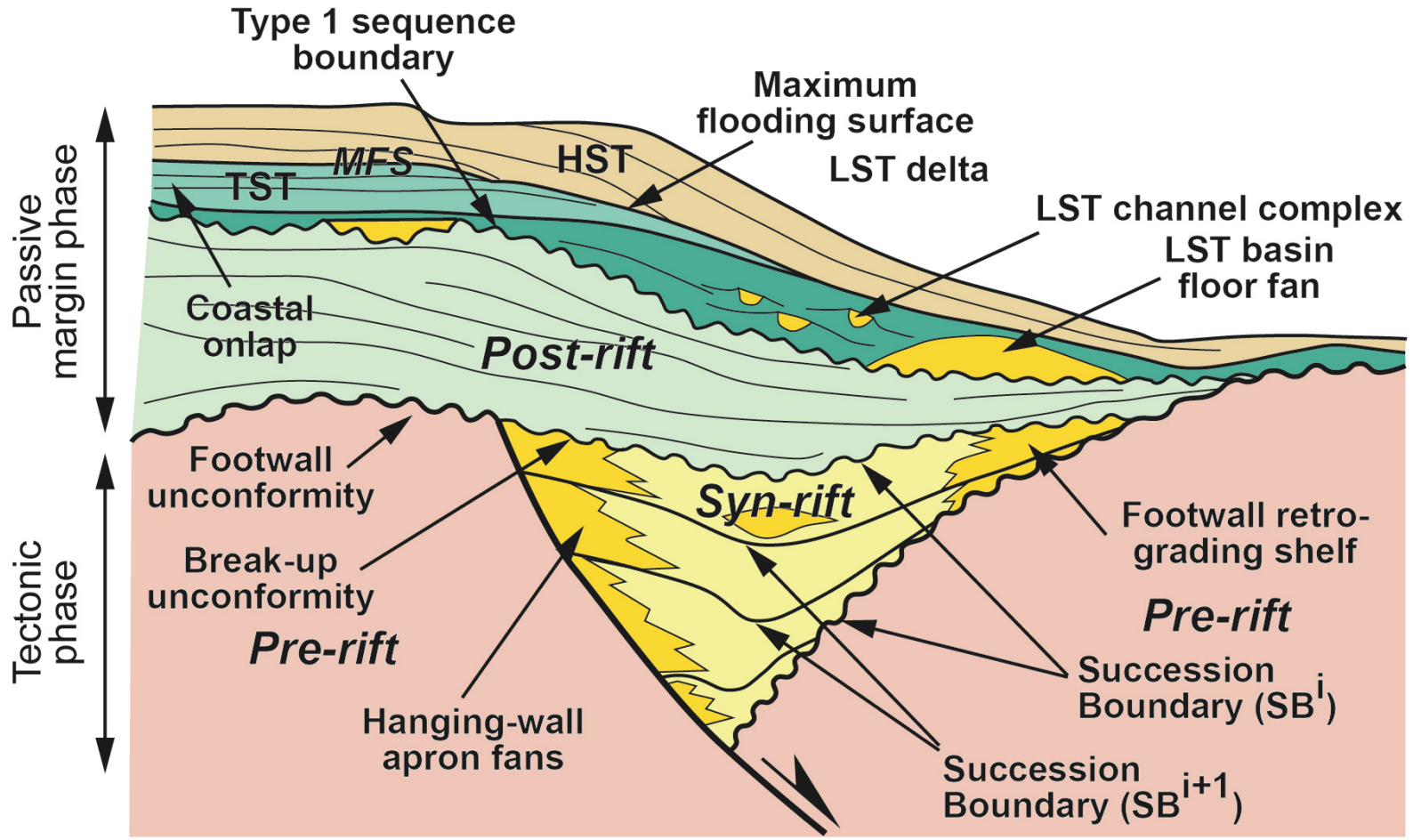
- Conceptual definition of lower-order (i) tectonic successions (TS) in fault-bounded sedimentary basins that are composed of a sourceward-shifting facies tract (SFT) and a basinward-shifting facies tract (BFT).

Tectonic Successions, two orders



- Conceptual definition of lower-order (i) and higher-order (i+1) tectonic successions (TS) in fault-bounded sedimentary basins that are composed of a sourceward-shifting facies tract (SFT) and a basinward-shifting facies tract (BFT).

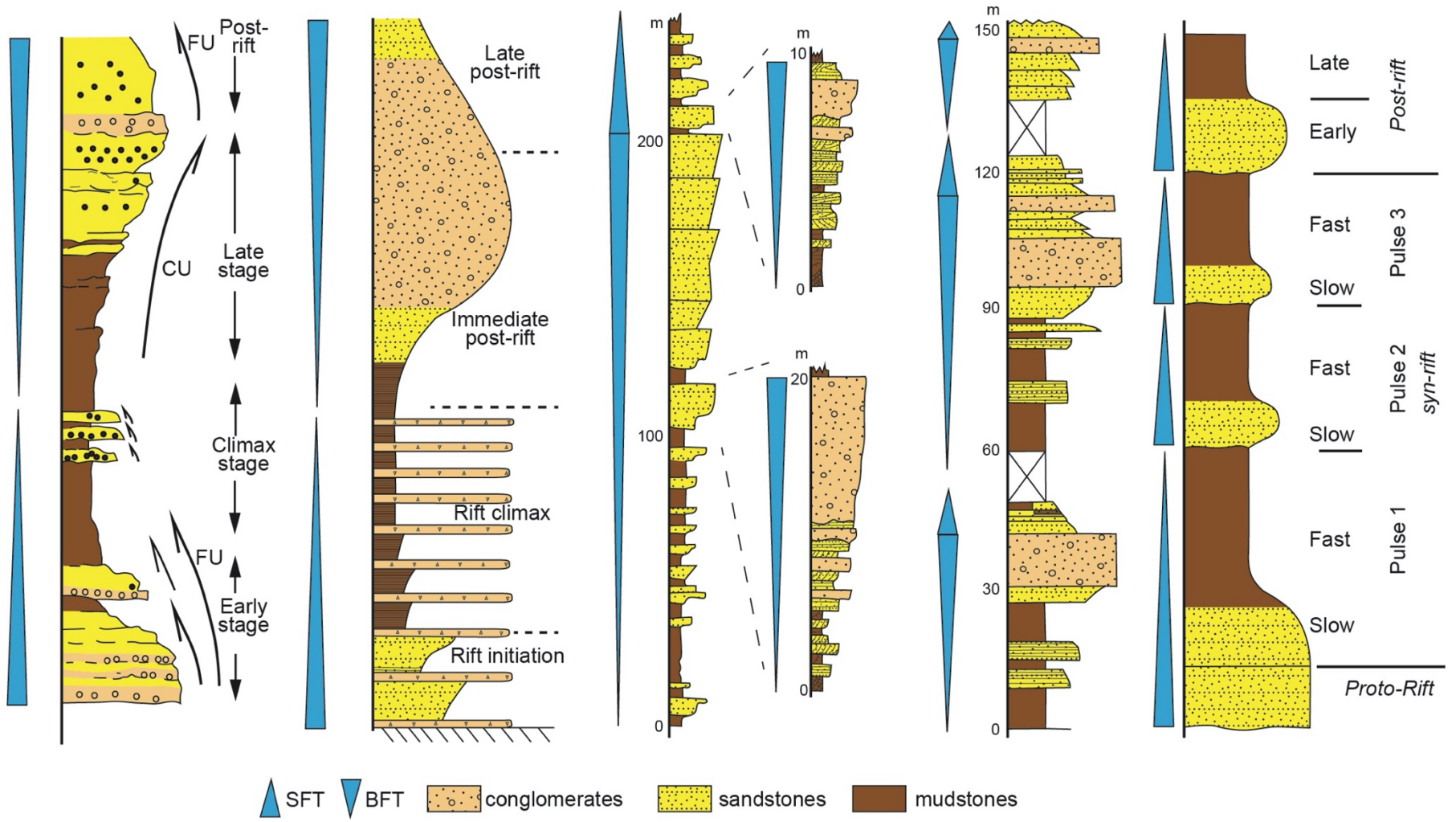
Extensional basins and passive margins



- Model of a continental rifting structure buried beneath the sediments of a passive continental margin, sediments respond to moments of the normal fault activations by producing retrograding-prograding patterns.

after Partington et al., 1993

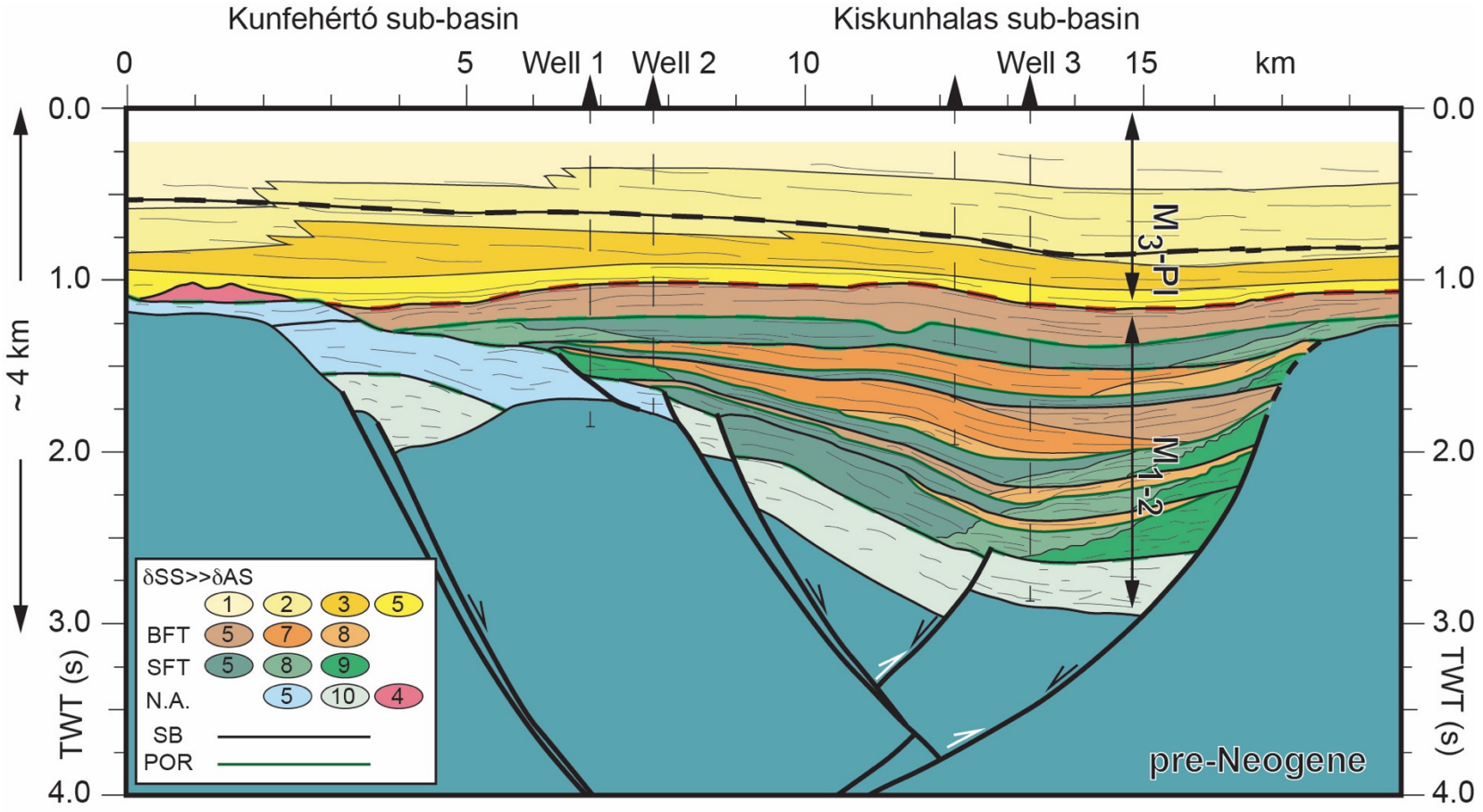
Depositional successions in rifted basins

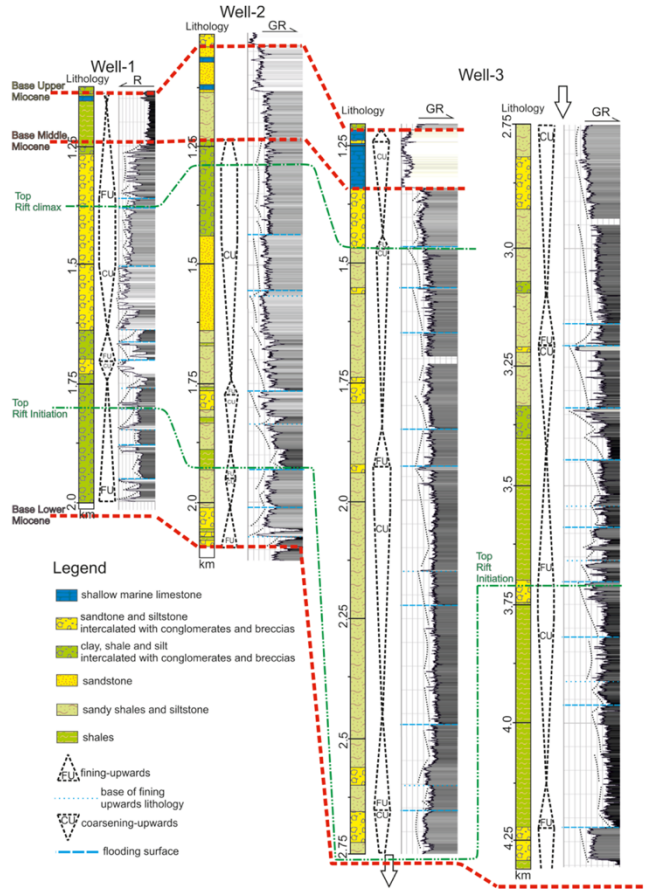


- Various expressions of tectonic successions, illustrated by previous research in worldwide examples of rift basins.

Ravnas and Steel, 1998; Prosser, 1993; Frostick and Steel, 1993; Martins-Neto and Catuneanu, 2010; Nottvedt et al., 1995

Depositional successions in extensional basins, Pannonian Basin

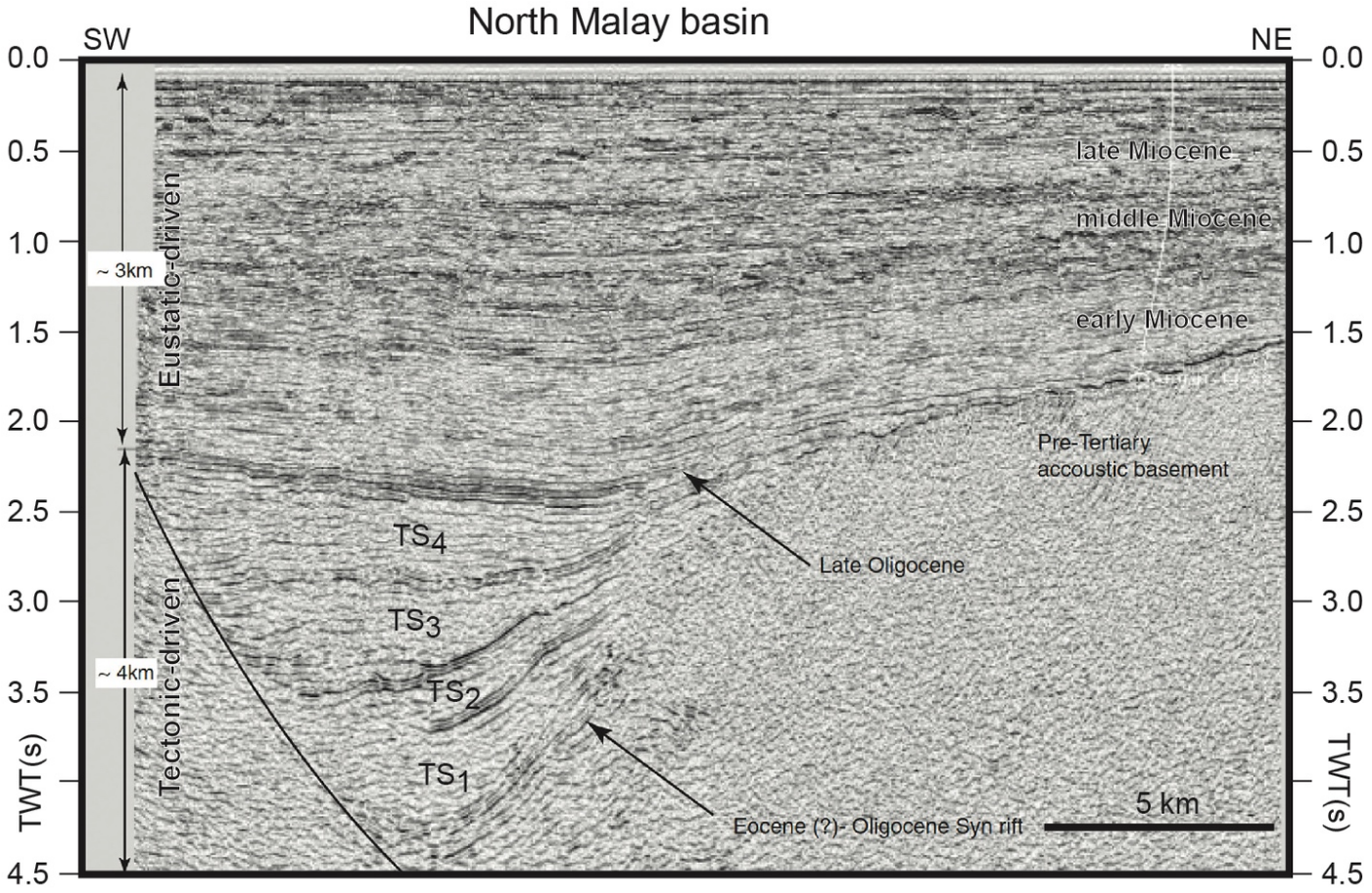




- Line-drawing interpretation of a reflection seismic line from the Kiskunhalas Trough (Pannonian Basin), which illustrates the interplay between a lower-order tectonic succession separated by basal and top (red line) succession boundaries and higher order tectonic successions created by individual movements along the basin boundary fault.

Balazs et al., 2016, Tectonics

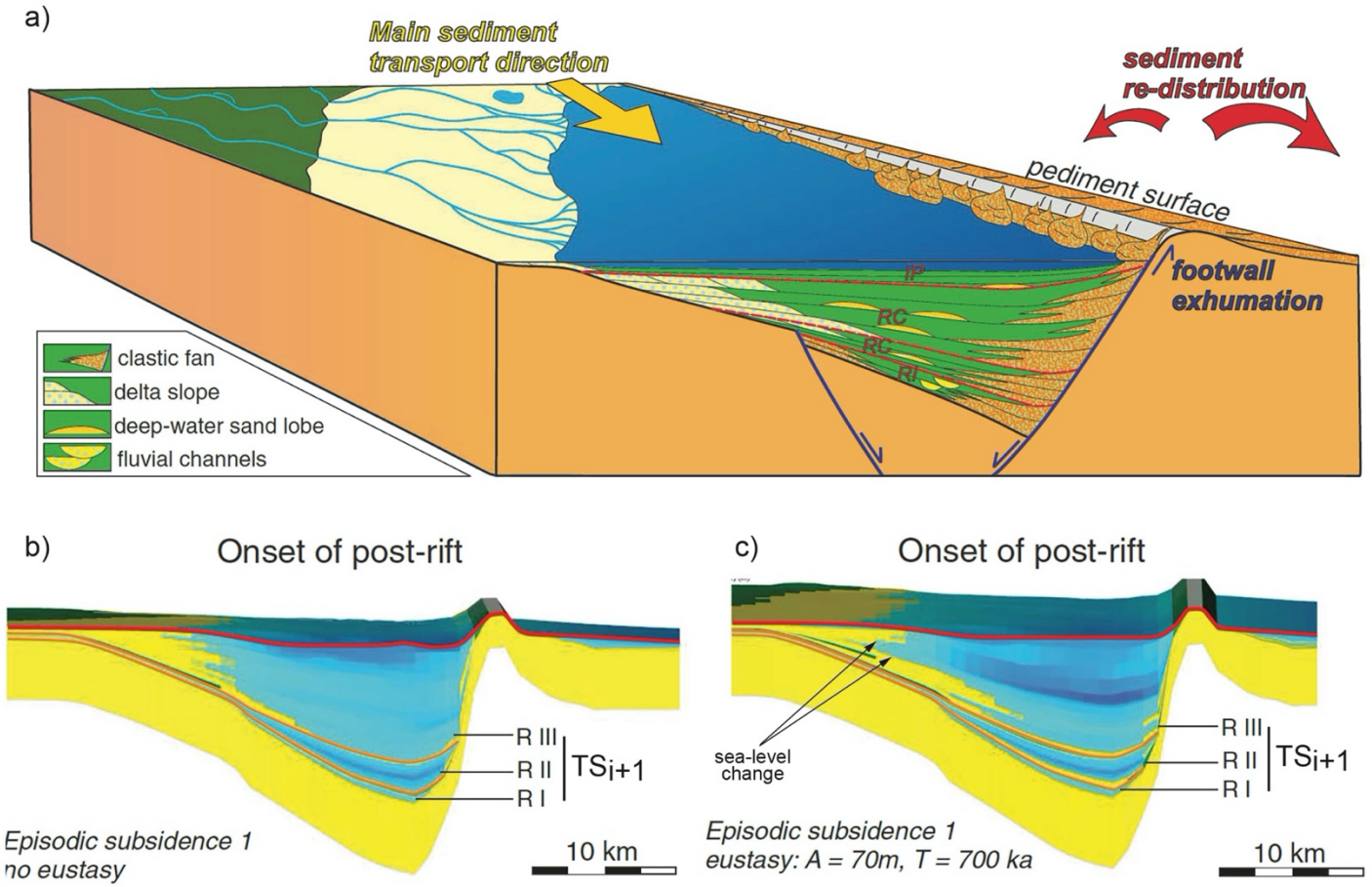
Tectonic successions, SE Asia reflection seismics example



- Seismic line in the North Malay Basin (Gulf of Thailand). The fault-bounded part of the seismic line illustrates a good example where high-order tectonic successions and succession boundaries (TSi+1 and SBi+1) may be discriminated from the low-order tectonic successionsand succession boundaries (TSi and SBi).

after Morley and Westaway, 2006

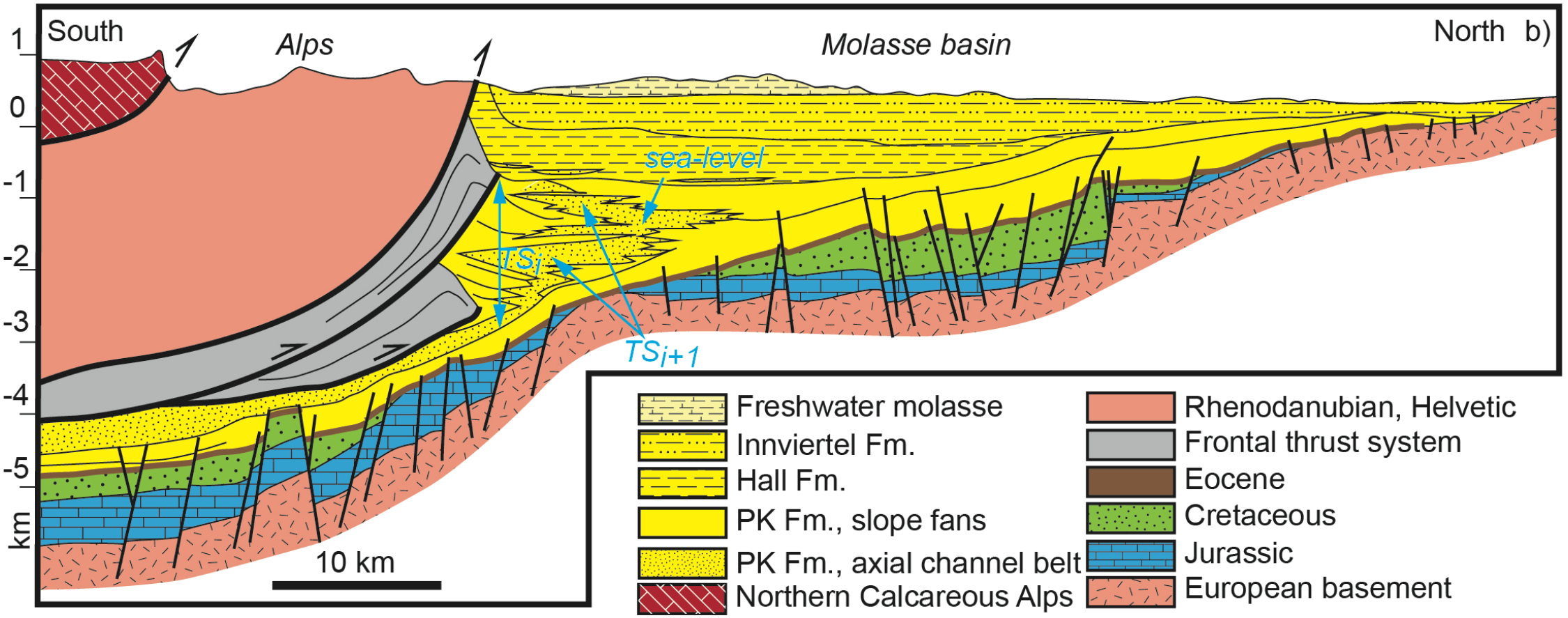
Depositional successions in extensional basins, numerical modelling



- Numerical modelling of extensional half-graben sedimentation during periods of fault activation and their interplay with sea-level changes in continental to lacustrine environments. The numerical modelling assumes a 9 Ma syn-rift period, followed by 4 Ma of post-rift subsidence.

Balazs et al., 2017, Tectonics

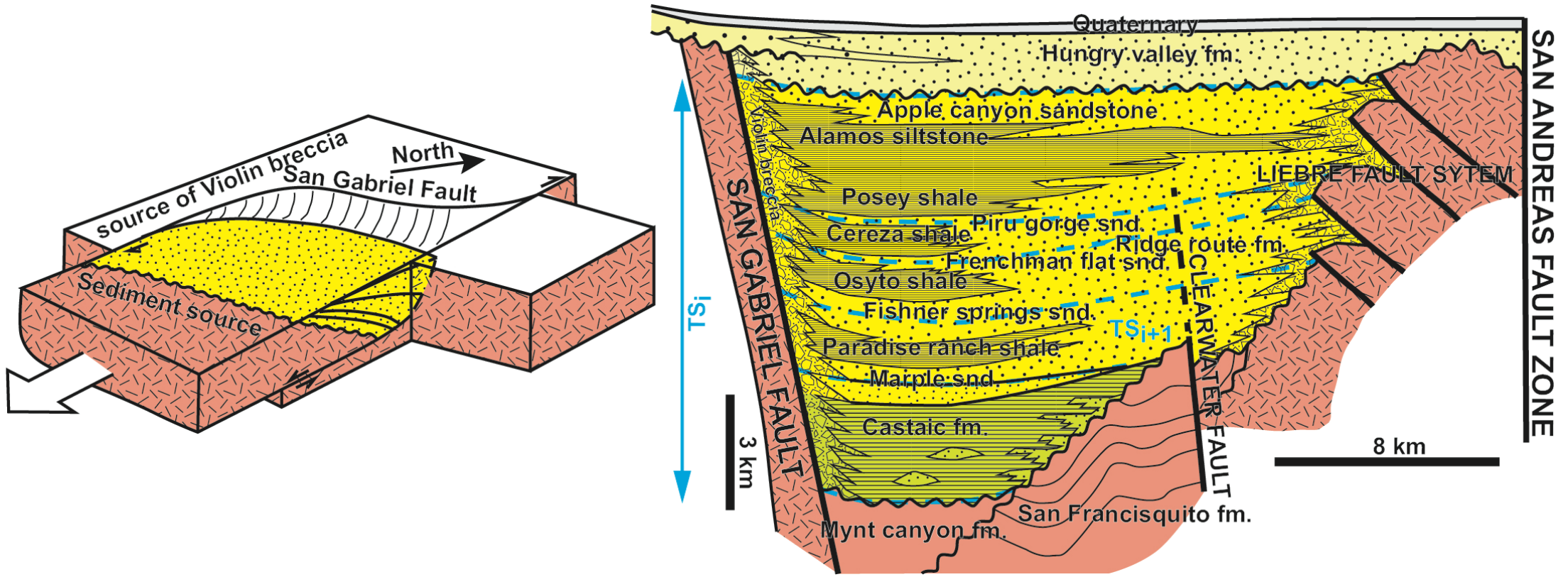
Depositional successions in compressional basins, Alps foreland



- Regional geologic cross section through the Alpine thrust front and foreland basin system illustrating the interplay between lower and higher order tectonic successions of source-ward and basin-ward facies migration and higher resolution sea-level variations recorded by the basin.

after Covault et al., 2009

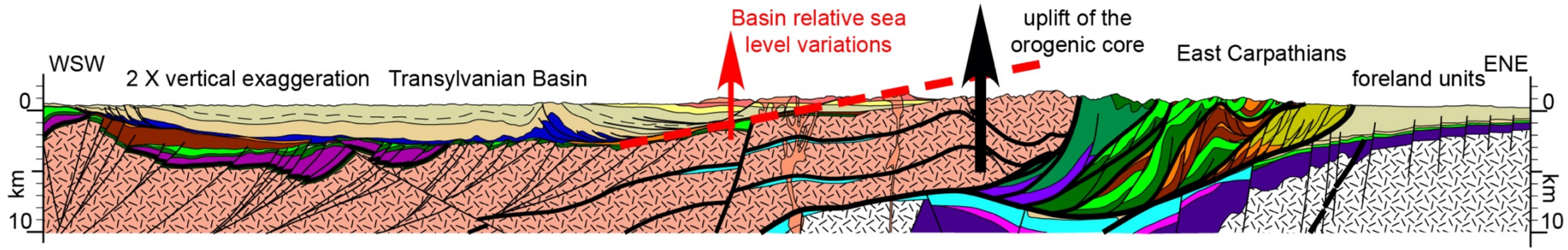
Depositional successions in strike-slip basins

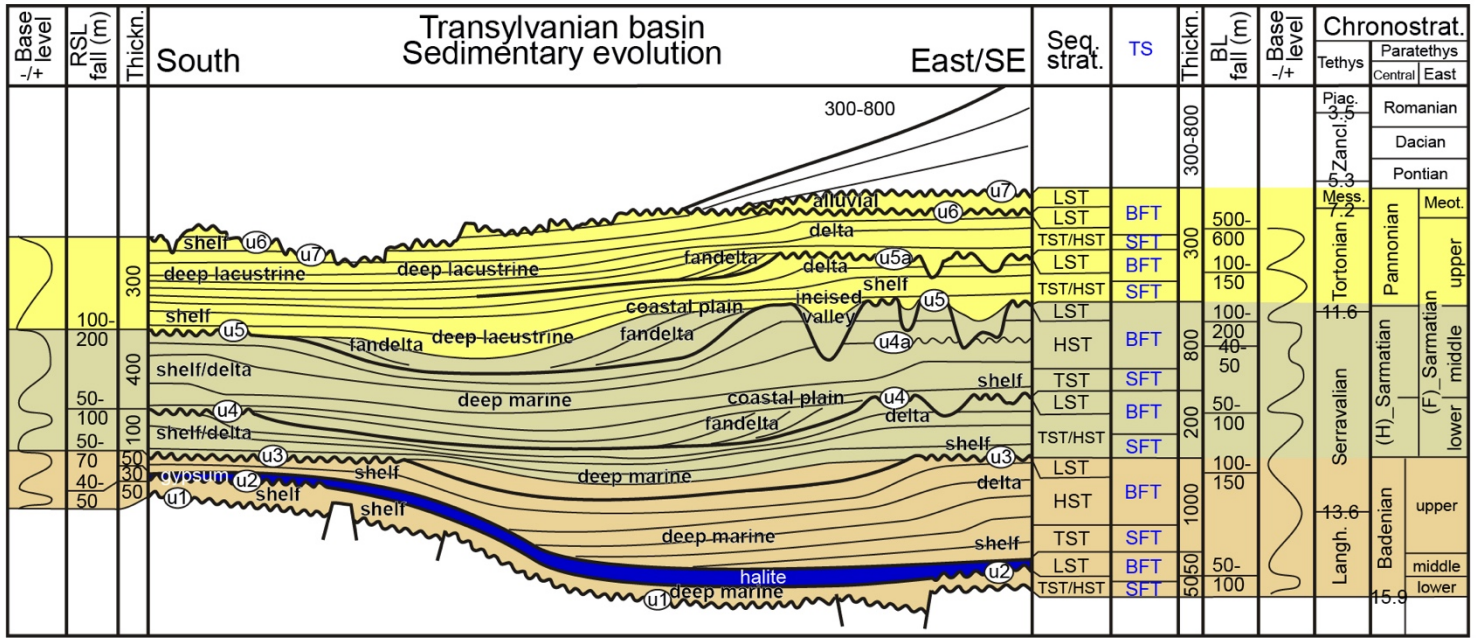


- Model and cross-section illustrating the development of tectonic successions in strike-slip to extensional deformation, applied to the transtensional Pliocene-Pleistocene San Gabriel Basin located in the San Andreas transcurrent system.

after Yeats, 2004

Depositional successions in sag basins, Transylvanian Basin

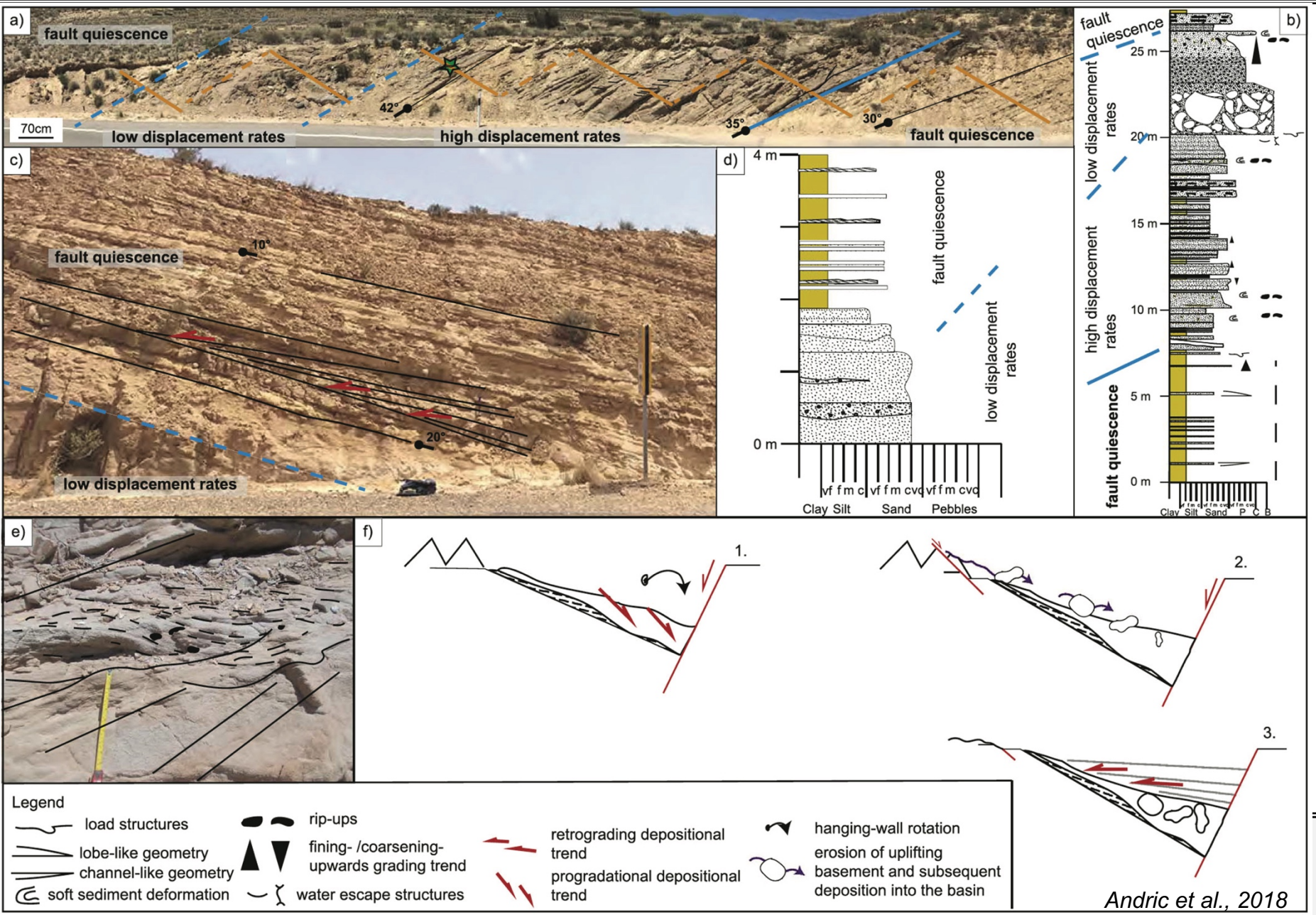




- Tectonic successions in a sag basin characterized by a gradual change in bathymetry and where an equivalence between the tectonic successions and sequence-stratigraphic nomenclature can attempted

Matenco et al., 2010

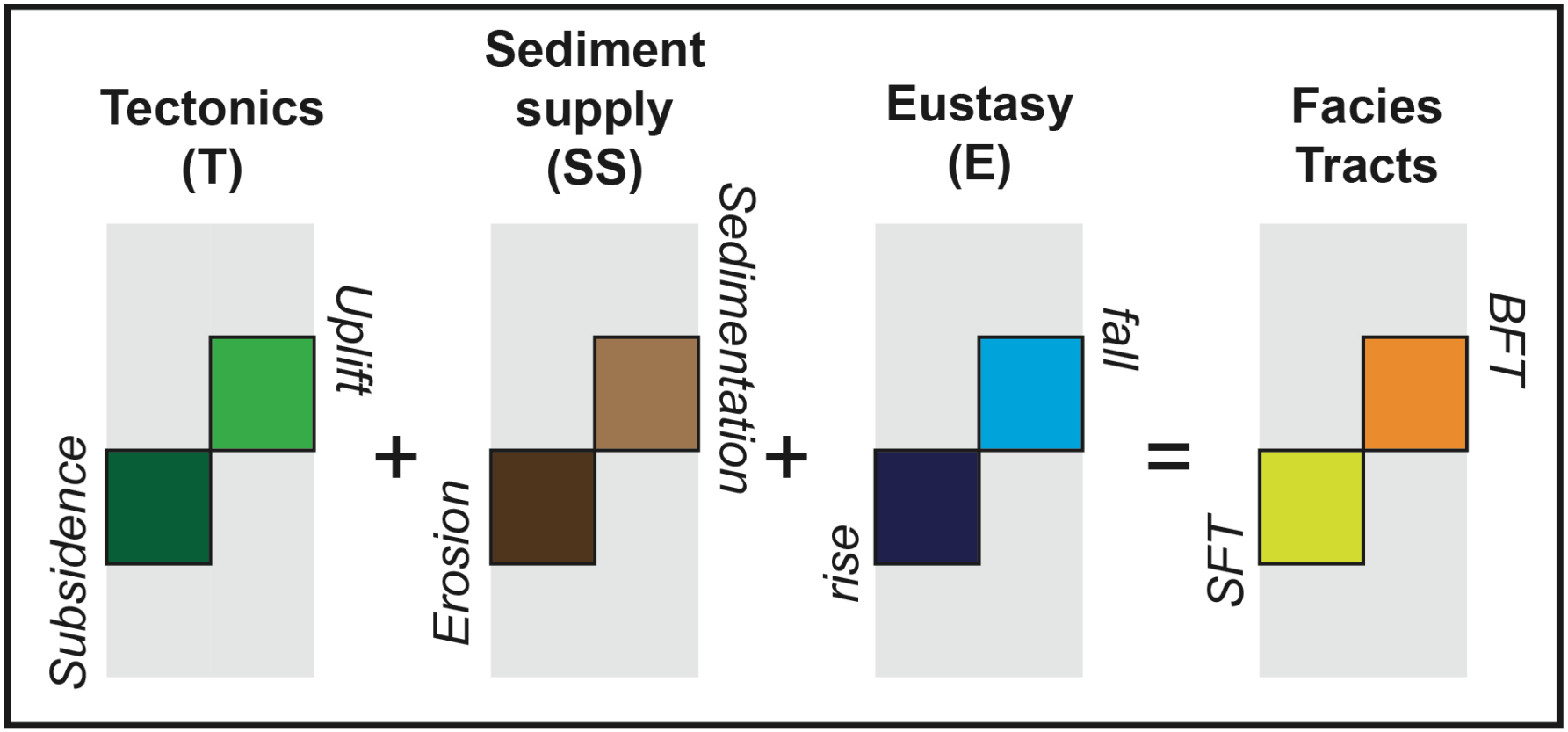
Tectonic-driven mass-transport



Andric et al., 2018

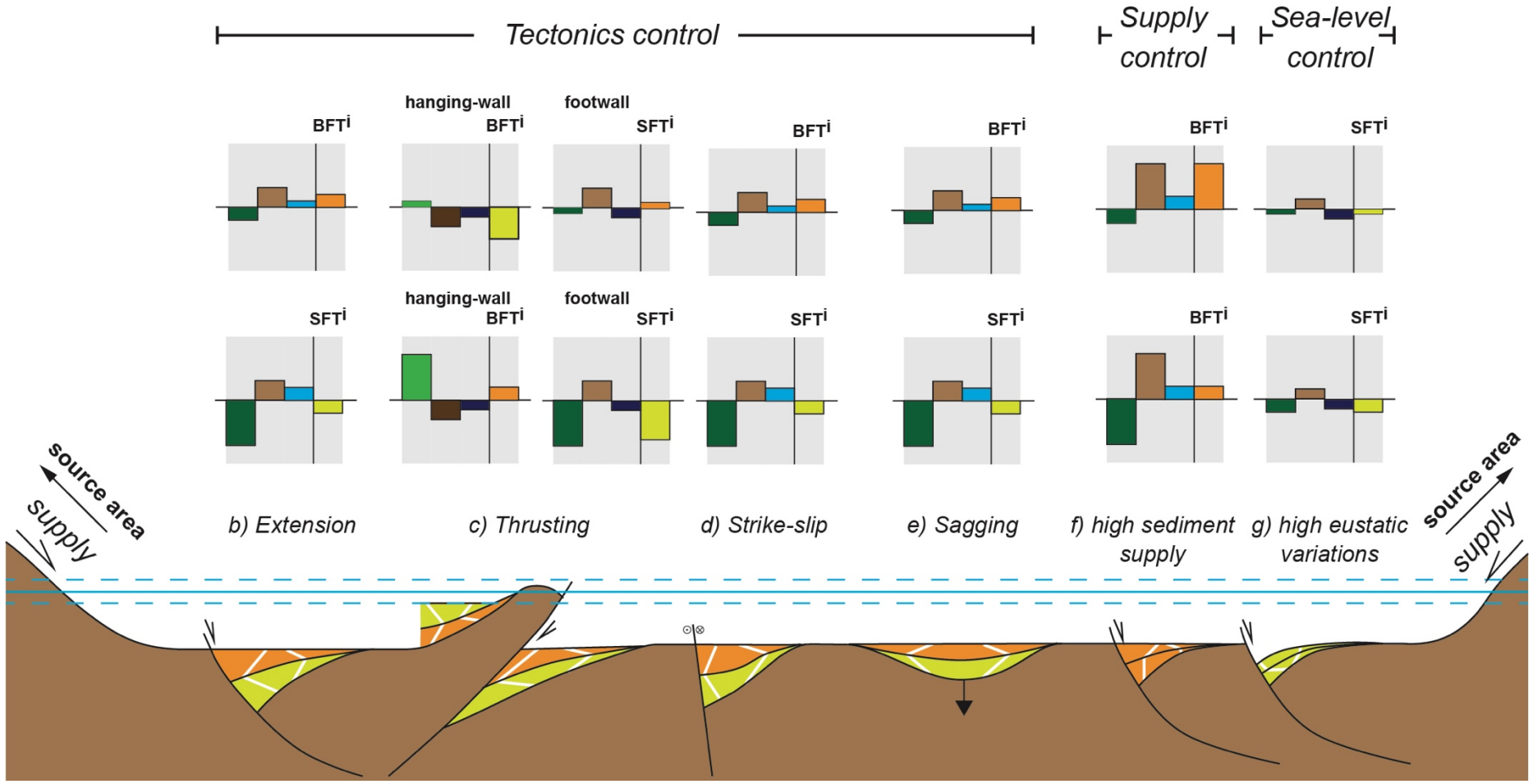
Outcrop-scale images and interpretation in the Sorbas Basin of SE Spain, illustrating the difference between the paleo-physiography controlling the distribution of basin-ward and source-ward shifting facies tracts and the grain size distribution of sediments in the basin

Controls on deposition



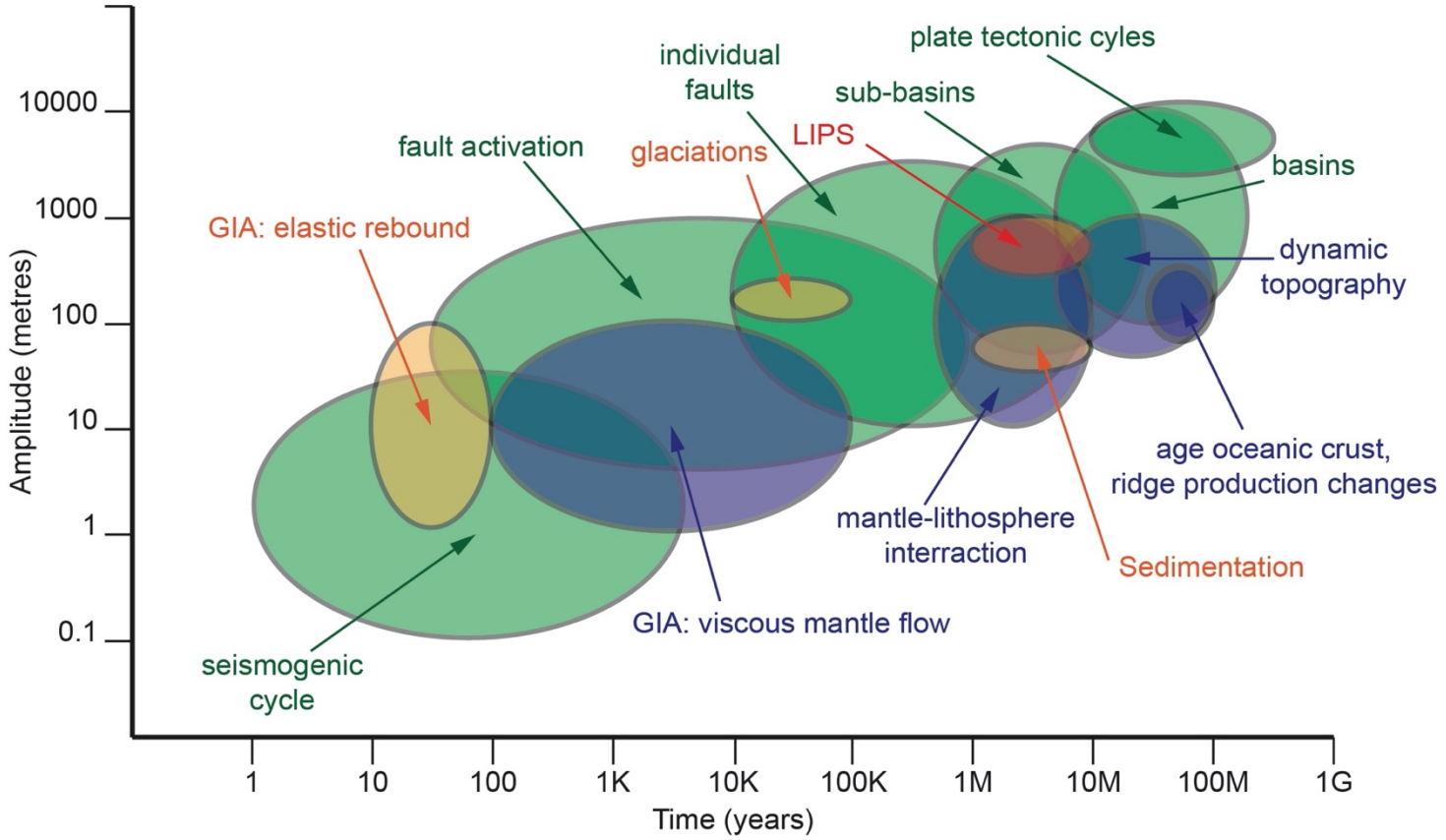
- Definition of tectonics, sediment supply, sea-level (eustasy) components, which cumulatively result in a creation of either a SFT or a BFT. Because the sediment supply and sea-level variations work against tectonic effects, erosion and sea-level rise are displayed increasing downwards, while sedimentation and sea-level fall are displayed increasing upwards, which is contrary to usual convention.

Controls on deposition



- Schematic representation of SFT-BFT tectonic successions in parts of the basins where tectonics, sediment supply or sea-level variations have a dominant control.

Time and amplitudes of mechanisms driving bathymetry changes



- Temporal and spatial variability of the mechanisms that drive observed sea-level variations and create or wipe out depositional space (note the logarithmic scale). Mechanisms that have a direct tectonic component are depicted in green. All other mechanisms have a primary impact in sea-level variations

Conclusions

- Tectonics is a key factor driving accommodation space for sedimentation at all spatial and temporal scales;
- The large overlap between temporal scales makes the assignment of tectonics in fixed temporal cycles rather impractical;
- Tectonic successions is a far better suited tool to quantify the link between tectonic and sedimentation in active regions;
- Sequence stratigraphy remains an important tool at passive margins where sea-level variations are higher and sediment input is dominantly unidirectional.

Thank you. Questions?

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