UNIVERSITÉ DE GENÈVE

Archive ouverte UNIGE

https://archive-ouverte.unige.ch

Article scientifique | Article | 2023 | Published version | Open Access

This is the published version of the publication, made available in accordance with the publisher's policy.

Mixed depositional processes in coastal to shelf environments: Towards acknowledging their complexity

Zuchuat, Valentin; Gugliotta, Marcello; Poyatos-Moré, Miquel; van der Vegt, Helena; Collins, Daniel S.; Vaucher, Romain

How to cite

ZUCHUAT, Valentin et al. Mixed depositional processes in coastal to shelf environments: Towards acknowledging their complexity. In: The depositional record, 2023, vol. 9, n° 2, p. 206–212. doi: 10.1002/dep2.229

This publication URL: https://archive-ouverte.unige.ch/unige:170619

Publication DOI: 10.1002/dep2.229

© The author(s). This work is licensed under a Creative Commons Attribution (CC BY 4.0) https://creativecommons.org/licenses/by/4.0

Received: 28 February 2023 | Revised: 6 March 2023 | Accepted: 23 March 2023

DOI: 10.1002/dep2.229

The Depositional Record
A journal of the International Association of Sedimentologists
Open Access
IAS
WILEY

ORIGINAL RESEARCH ARTICLE

Mixed depositional processes in coastal to shelf environments: Towards acknowledging their complexity

Valentin Zuchuat[1] | **Marcello Gugliotta**[2,3] | **Miquel Poyatos-Moré**[4] | **Helena van der Vegt**[5] | **Daniel S. Collins**[6] | **Romain Vaucher**[7,8]

[1]Geological Institute, RWTH Aachen University, Aachen, Germany
[2]Faculty of Geosciences, University of Bremen, Bremen, Germany
[3]Center for Marine Environmental Sciences (MARUM), University of Bremen, Bremen, Germany
[4]Departament de Geologia, Universitat Autònoma de Barcelona, Cerdanyola del Vallés, Spain
[5]Department of Resilient Ports and Coasts, Deltares, Delft, The Netherlands
[6]Shell International Ltd, London, UK
[7]Institute of Earth Sciences (ISTE), University of Lausanne, Geopolis, Lausanne, Switzerland
[8]Department of Earth Sciences, University of Geneva, Geneva, Switzerland

Correspondence
Valentin Zuchuat, Geological Institute, RWTH Aachen University, Aachen, Germany.
Email: valentin.zuchuat@geol.rwth-aachen.de

KEYWORDS
hydrodynamics, sedimentology, shallow-marine

1 | WHAT ARE MIXED-ENERGY DEPOSITIONAL PROCESSES?

Mixed-energy depositional processes refer to the interplay of hydrodynamic processes controlling sedimentation dynamics in a certain sedimentary environment. When referring to the coastal to shelf realm, three main suites of processes are considered the major players: river, tide and wave (Ainsworth et al., 2011; Dalrymple et al., 1992; Dashtgard et al., 2021; Zuchuat et al., 2019). In addition to the cyclical or punctual intrinsic variations in these processes, aeolian processes, contour currents, seasonal ice cover, nature and mechanical characteristics of the substrate and confinement and physiography of the basin, climate oscillation (e.g. El Niño and La Niña) and relative sea-level fluctuations can interact with or affect the three major processes and should also be considered in sedimentary analyses. In modern settings, the qualification of depositional processes relies on direct measurements (e.g. current velocities, water-level changes, wave heights, suspended sediment concentration, clay concentration). Quantitative measurement can then be integrated with more qualitative descriptions of the resulting sedimentary products (i.e. morphologies, bedforms) and biogenic elements (i.e. trace fossils) (Dashtgard et al., 2009; Vaucher et al., 2018; Vaucher & Dashtgard, 2022; Yang et al., 2008; Yang & Chang, 2017). In addition, experimental studies have helped refine the interpretation of individual and combined processes from bedforms, which, although not diagnostic of a specific depositional environment, can be used to reconstruct sedimentary processes and, therefore, aid palaeoenvironmental interpretations (Arnott & Southard, 1990; Baas et al., 2021; Cummings et al., 2009; Dumas et al., 2005; Dumas & Arnott, 2006; Myrow et al., 2018; Perillo et al., 2014; Sato et al., 2011; Southard et al., 1990; Southard & Boguchwal, 1990).

Stratigraphic models and facies interpretations were historically developed for the major end-member processes

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.
© 2023 The Authors. *The Depositional Record* published by John Wiley & Sons Ltd on behalf of International Association of Sedimentologists.

(i.e. river, wave, tide) and compared to modern systems in order to propose relatively simple and predictable sedimentary architectures applicable to ancient sedimentary successions (Ahmed et al., 2014; Clifton, 2006). This approach aimed to fit ancient sedimentary successions into these end-member schemes and the relative simplicity of these models has been useful in applied contexts, such as hydrocarbon exploitation. However, although most modern coastal to shelf environments are dominated by one of the three main processes, additional 'secondary' processes almost always operate and impact sedimentary dynamics. In turn, the term 'mixed depositional processes' is more frequently used to encompass the various hydrodynamic process at play and identified in the ancient sedimentary systems (Collins et al., 2017; Dashtgard et al., 2021; Gugliotta, Flint, et al., 2016a; Gugliotta, Kurcinka, et al., 2016b; Rossi & Steel, 2016; Vakarelov et al., 2012; Vaucher et al., 2017). In the literature, most workers use qualificative nomenclature to describe or define an environment in terms of processes, for example *tidally modulated shoreface*, or *wave-dominated delta*. The terms affected, influenced and modulated are often used to suggest that the secondary process is of relatively low, medium and high energy, respectively (Dashtgard et al., 2012, 2021).

The interplay of different processes in coastal-shelf systems can be cryptic to decipher, especially in the rock record. This is because the preserved sediments may only reflect the dominant processes active at the time of deposition, rather than background processes active over longer timescales (Collins et al., 2018; Van Yperen et al., 2020). Infrequent extreme events can also offset and erase decadal and potentially longer timescale trends from the sedimentary record (Harley et al., 2022). Furthermore, modern data seem to indicate that there is no linear correlation between the intensity of extreme events and the amount of sediment being eroded or deposited near coastal systems, which further complicates the interpretation of the preserved signals (Guisado-Pintado & Jackson, 2019). Finally, the amount of progradation-erosion along coastlines is extremely heterogeneous, which will impact the preserved sedimentary architecture (Zuchuat et al., 2023), despite documented long-term regressive or transgressive trends. Uncertainties in interpreting the exact nature of the hydrodynamics that generated specific sedimentary structures always remain when analysing the sedimentary record. Indeed, different hydrodynamic conditions can result in identical sedimentary signatures and one specific set of hydrodynamics can generate different bedforms ('non uniqueness' sensu Burgess & Prince, 2015). Furthermore, certain systems are or were dominated by a single depositional process, yet their deposits lack any characteristics commonly assigned to such systems: for example, the Venice lagoon is tide-dominated, yet no tidal rhythmites are preserved in the sediments (Ghinassi et al., 2018). However, despite these challenges and the impact of many other processes beyond river, wave and tide, several studies have used a proposed workflow based on historical process interpretations of sedimentary structures to quantify the influence of only these three processes on sedimentary successions and assign an environmental classification (Peng et al., 2018; Rossi et al., 2017).

The appraisal of mixed-process coastal to shelf depositional environments has moved forward significantly during the past two decades. Notably, a multitude of new depositional models for various types of mixed-energy environments and sub-environments now exist that: (1) have recognised relationships and patterns between sedimentary structures, facies, stratigraphic architecture and processes across numerous scales of stratigraphic observations; and (2) have been jointly developed for modern and ancient sedimentary systems, or at least calibrated from ancient to modern systems (or vice versa; Collins et al., 2017, 2020; Dashtgard et al., 2009, 2012, 2021; Gugliotta, Flint, et al., 2016a; Gugliotta et al., 2015; Pemberton et al., 2012; Vakarelov et al., 2012; Vaucher et al., 2017, 2018; Yang et al., 2005, 2006, 2008). The cumulative step forward offers a holistic, observation-driven toolset for palaeoenvironmental reconstructions for geoscientists, beyond simply focussing on the entrenched interpretation of the relationship between sedimentary structures and wave/river/tide processes. However, while these recent advances were significant, major aspects remain unclear, especially how mixed-process environments evolve in response to changing climate, sea level, sediment supply, accommodation, or basin physiography, among other factors (Zuchuat et al., 2022). These external factors are difficult to capture because they can occur away from the studied localities and because depositional models are often static.

After several technical sessions ran on this topic during past International Meetings of Sedimentology (Rome in 2019, Prague in 2021), the European Geosciences Union General Assembly (Vienna in 2020) and the International Sedimentological Congress (Bejing in 2022), we took the initiative of organising this special issue to gather and bring new data from experiments, numerical modelling and fieldwork, that define and refine the way sedimentologists and geoscientists in general, comprehend mixed-energy coastal to shelf environments.

2 | WHAT IS NEW IN MIXED-ENERGY DEPOSITIONAL PROCESSES?

This special issue includes seven contributions that show some of the key factors controlling the sedimentary

20554877, 2023, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/dep2.229 by Morocco Hinari NPL, Wiley Online Library on [29/05/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

dynamics of coastal to shelf environments (Figure 1). This is a brief summary of all of them.

Pierik et al. (2023) show how resistant layers can play a major role in controlling the dimension and position of estuarine channels and bars which, in turn, affect depositional and erosional processes and their interactions in these environments. In the Ems–Dollard estuary (The Netherlands), resistant layers (e.g. bedrock, consolidated peat, or stiff pre-Holocene clays and tills) can limit channel depth resulting in increased channel curvature and width and lead to the formation of a mid-channel bar. The authors show that these effects can be expected in other similar estuarine and deltaic systems worldwide, highlighting that resistant layer effects are essential to consider as part of mixed depositional processes in coastal environments, especially under current and projected sea-level rise.

Valencia et al. (2023) use numerical simulations to explore the influence of syn-sedimentary compaction on delta morphodynamics. The approach relies on a novel inclusion of simplified compaction algorithms within the Delft3D modelling package and subsequent morphometric analysis. The authors show that higher compaction rates result in increased accommodation which, in turn, causes lower rates of delta top area increase, more evenly distributed sediment across the delta and more sediment retention in the delta top compared to the delta front and prodelta. This study shows it is crucial to understand the impact of syn-sedimentary compaction on deltas, a largely unexplored relationship due to difficulties with collecting accurate field data and the previous lack of compaction algorithms in high-fidelity modelling packages (such as Delft3D). Understanding these relationships is essential to accurately predict coastal response to a changing global environment, for example the impact of sea-level rise on delta compaction. These questions are also necessary for better forecasting of deltaic responses to environmental variables and to increase our ability to characterise and model subsurface reservoirs and aquifers.

Wroblewski and Morris (2023) focus on the Upper Jurassic Red Shale Member of the Sundance Formation and the overlying Windy Hill Member of the Morrison Formation (USA). The authors illustrate how a careful sedimentological and ichnological study of outcrops can: (i) recognise the transition between storm-dominated to tide-dominated depositional processes in sedimentary basins, which, in turn, can (ii) confirm (or disprove) geochemistry-based basin-circulation hypothesis; and (iii) help understand the genesis of regional, composite stratigraphic surfaces. The robust ichnological and sedimentological analyses of these two stratigraphic units support the interpretation of a key stratigraphic surface as reflecting both forced regressions and normal progradations occurring simultaneously in different places at different times, with major implications on the timing and volume of reworked sediments in the basin.

Nugraha et al. (2023) combine extensive outcrop-based sedimentology with stratigraphic and palaeogeographical analysis to establish an improved depositional model and stratigraphic evolution of Neogene successions in the Kendari Basin, South-East Sulawesi, Indonesia. The stratigraphic relationships and onshore-to-offshore relationships of four formations are described and discussed and a wide variety of depositional facies and units are

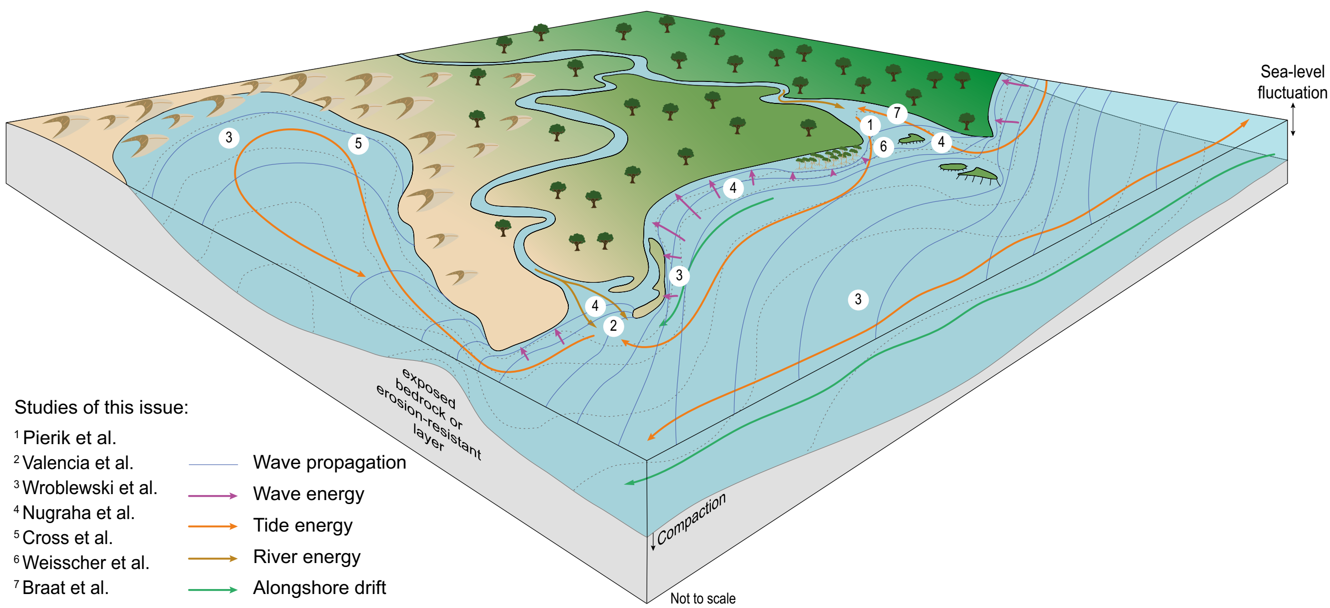

FIGURE 1 Sketch diagram illustrating the various hydrodynamic processes occurring in coastal to shelf environments, with numbers referring to articles from this issue.

20554877, 2023, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/dep2.229 by Morocco Hinari NPL, Wiley Online Library on [29/05/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

recognised. Clastic environments include braided river channels, fluvial-tidal channels, tidal flats, mouth bar complexes and shoreface deposits. Shallow-marine carbonates and transgressive, landwards-backstepping carbonate platform architectures are also described and interpreted. An important Miocene–Pliocene unconformity is interpreted to relate to uplift across the coastal plain and hinterland, resulting in base-level fall below the shelf edge, recognised by conglomeratic fluvial channel infills in proximal areas and forced regressive shoreline deposits in more distal areas. The subsequent phase of base-level rise is associated with transgressive lags, backstepping reefal carbonates, more tidally influenced clastic shoreline deposits and reduction of the channel/overbank ratio in delta plain strata. Overall, these outcrop-based insights provide the foundation for an onshore-to-offshore stratigraphic model extending into the unexplored frontier basin surrounding South-East Sulawesi.

Cross et al. (2023) investigate the Jurassic aeolian-marine Curtis-Summerville sedimentary successions of central Utah (USA) and focussed on the nature of the aeolian stratigraphic record. The authors assessed relationships between aeolian and marine sub-environments, which were influenced by repeated transgression (T) and regression (R) periods. They develop a novel sequence stratigraphic model for aeolian-marine systems combining photogrammetry and sedimentary analysis. This work suggests that the deposition and preservation of an aeolian-marine marginal succession is controlled by both the transgressive or regressive nature of the system and by the scale of the tidal influence. During normal regression, marine sediments are influenced by processes such as waves and tides while aeolian dune fields expand; during transgression, the aeolian system deflates. This is an intuitive relationship; however, if regressions are rapid and of high magnitude, this can also result in the retraction of the erg and sediment starvation in contemporaneous shallow-marine deposits. This complex interaction is modified by the particular physiography of the Curtis Sea Basin, which results in amplified tidal forces. The increased tidal influence can make the identification of sequence stratigraphic boundaries challenging. However, the authors overcome this limitation by attributing deflationary surfaces to major changes in relative sea level, with consequent changes in depositional environments at T-R sequence scale.

Weisscher et al. (2023) use scaled laboratory experiments to study the morphological and hydrodynamic development of filling estuaries during sea-level rise. The objective was to study how estuarine systems could adapt to sea-level rise and whether the land-level rise is likely to keep up with the sea-level rise in these environments. Their experiments looked at the deposition of sand and mud and their interaction with vegetation in a tilting flume, simulating the bi-directional tidal currents in estuaries. They present a mechanism through which natural systems could drown during the sea-level rise, even when enough sediment is available to fill the accommodation space. This is mainly observed furthest away from marine and fluvial sediment sources. Sediment is retained in the bay-head delta and close to the tidal inlet. The tidal embayment in between these locations drowned. This reduced vegetation survival and sprouting potential, as prolonged inundation increased mortality, negating the potential eco-engineering effect.

Braat et al. (2023) studied the relationship between the surface (horizontal) and subsurface (vertical) expression of mud in tidal bars and its morphodynamic and stratigraphic implications. Due to the limited availability of field data on the lateral and vertical depositional record of mud, new field data was gathered from the Shoal of Walsoorden (Western Scheldt estuary, the Netherlands) and analysed for this study. This was complemented with numerical modelling to better understand where mud accumulates. Results show that mud accumulation increases shoal elevation, which reduces flow over the shoal and, therefore, chute channel formation. This stabilises bar morphology and further promotes mud deposition and vegetation settling. Mud is therefore shown to play an important role in the development of estuarine morphology, but this effect may not be identified in the depositional record as only a small fraction of mud is preserved in the stratigraphy. Although mud cover at the surface was found to be relatively high (20%–40% of the intertidal area), mud constitutes only a small percentage of the total estuary volume (*ca* 5%), showing a mismatch between surface and subsurface expression of mud.

3 | WHAT IS NEXT IN MIXED-ENERGY DEPOSITIONAL PROCESSES?

For decades, geoscientists have tried to decipher the dynamics and controls of coastal to shelf depositional environments and summarise them in static facies and environmental models. Although these models have allowed comparisons between systems and advancement of the topic, there is still a need to develop new models that capture more fully the complexity and dynamic nature of mixed-energy coastal to shelf systems, notably by incorporating well-known oceanographical concepts and fluid mechanics into coastal to shelf depositional models. These depositional environments quite possibly show a higher inter-system variability, more complex intra-system dynamics and a higher susceptibility to external changes than other depositional environments. Consequently, studies of

20554877, 2023, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/dep2.229 by Morocco Hinari NPL, Wiley Online Library on [29/05/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

coastal to shelf environments require wide integrated approaches, perhaps more so than any other sedimentary environment: facies, stratigraphy, ichnology, palaeontology, geochemistry, numerical modelling, physical experiments, modern analogue studies and other approaches all provide unique insights for characterising coast to shelf erosion, transport and sedimentation. This special issue intends to showcase the breadth of ongoing research and strives to take our understanding of the complexity of these depositional environments a step further. Understanding this complexity is intensely relevant and a major challenge for future sedimentary research, with implications for climate change, coastal management, carbon cycling, coastal aquifers and the energy transition.

ACKNOWLEDGEMENTS

The authors thank all the contributors and the reviewers involved in this special issue, as well as Professor Peter Swart and his team at *The Depositional Record*. The authors and guest-editors of this special issue declare no conflict of interest.

DATA AVAILABILITY STATEMENT

This intro paper has no data attached to it, but all the submissions compiled in this special issue have. Please refer to the respective author's publication for details on their datasets.

ORCID

Valentin Zuchuat https://orcid.org/0000-0002-2029-6422
Marcello Gugliotta https://orcid.org/0000-0002-8618-0799
Miquel Poyatos-Moré https://orcid.org/0000-0001-7813-8868
Helena van der Vegt https://orcid.org/0000-0003-0506-8744
Daniel S. Collins https://orcid.org/0000-0002-3183-2825
Romain Vaucher https://orcid.org/0000-0003-3051-4128

REFERENCES

Ahmed, S., Bhattacharya, J.P., Garza, D.E. & Li, Y. (2014) Facies architecture and stratigraphic evolution of a river-dominated delta front, Turonian Ferron Sandstone, Utah, U.S.A. *Journal of Sedimentary Research*, 84, 97–121.

Ainsworth, R.B., Vakarelov, B.K. & Nanson, R.A. (2011) Dynamic spatial and temporal prediction of changes in depositional processes on clastic shorelines: Toward improved subsurface uncertainty reduction and management. *AAPG Bulletin*, 95, 267–297.

Arnott, R.W. & Southard, J.B. (1990) Exploratory flow-duct experiments on combined-flow bed configurations and some implications for interpreting storm-event stratification. *Journal of Sedimentary Research*, 60, 211–219.

Baas, J.H., Malarkey, J., Lichtman, I.D., Amoudry, L.O., Thorne, P.D., Hope, J.A., Peakall, J., Paterson, D.M., Bass, S.J., Cooke, R.D., Manning, A.J., Parsons, D.R. & Ye, L. (2021) Current- and wave generated bedforms on mixed sand–clay intertidal flats: a new bedform phase diagram and implications for bed roughness and preservation potential. *Frontiers in Earth Science*, 9, 747567.

*Braat, L., Pierik, H.J., van Dijk, W.M., van de Lageweg, W.I., Brückner, M.Z., van der Meulen, B. & Kleinhans, M.G. (2023) Observed and modelled tidal bar sedimentology reveals preservation bias against mud in estuarine stratigraphy. In: Zuchuat, V., Gugliotta, M., Poyatos-Moré, M., van der Vegt, H., Collins, D.S. & Vaucher, R. (Eds.) *Mixed depositional processes in coastal to shelf environments*. The Depositional Record, special issue. Hoboken, NJ: Wiley, pp. 1–23.

Burgess, P.M. & Prince, G.D. (2015) Non-unique stratal geometries: Implications for sequence stratigraphic interpretations. *Basin Research*, 27(3), 351–365.

Clifton, H.E. (2006) A re-examination of facies models for clastic shorelines. In: Posamentier, H.W. & Walker, R.G. (Eds.) *Facies model revisited*. SEPM Society for Sedimentary Geology, Special Publication, Vol. 84, pp. 293–337.

Collins, D.S., Johnson, H.D., Allison, P.A. & Damit, A.R. (2018) Mixed process, humid-tropical, shoreline–shelf deposition and preservation: middle Miocene–Modern Baram Delta Province, northwest Borneo. *Journal of Sedimentary Research*, 88(4), 399–430.

Collins, D.S., Johnson, H.D., Allison, P.A., Guilpain, P. & Damit, A.R. (2017) Coupled 'storm-flood' depositional model: Application to the Miocene–Modern Baram Delta Province, north-west Borneo. *Sedimentology*, 64(5), 1203–1235.

Collins, D.S., Johnson, H.D. & Baldwin, C.T. (2020) Architecture and preservation in the fluvial to marine transition zone of a mixed-process humid-tropical delta: Middle Miocene Lambir Formation, Baram Delta Province, north-west Borneo. *Sedimentology*, 67, 1–46.

*Cross, S., Pettigrew, R.P., Priddy, C.L., Zuchuat, V., Dodd, T.J.H., Mitten, A.J. et al. (2023) The sedimentological expression of transgression-regression cycles upon aeolian-marine margins. In: Zuchuat, V., Gugliotta, M., Poyatos-Moré, M., van der Vegt, H., Collins, D.S. & Vaucher, R. (Eds.) *Mixed depositional processes in coastal to shelf environments*. The Depositional Record, special issue. Hoboken, NJ: Wiley.

Cummings, D.I., Dumas, S. & Dalrymple, R.W. (2009) Fine-grained versus coarse-grained wave ripples generated experimentally under large-scale oscillatory flow. *Journal of Sedimentary Research*, 79, 83–93.

Dalrymple, R.W., Zaitlin, B.A. & Boyd, R. (1992) Estuarine facies models: conceptual basis and stratigraphic implications. *Journal of Sedimentary Research*, 62, 1130–1146.

Dashtgard, S.E., Gingras, M.K. & MacEachern, J.A. (2009) Tidally modulated shorefaces. *Journal of Sedimentary Research*, 79, 793–807.

Dashtgard, S.E., MacEachern, J.A., Frey, S.E. & Gingras, M.K. (2012) Tidal effects on the shoreface: Towards a conceptual framework. *Sedimentary Geology*, 279, 42–61.

Dashtgard, S.E., Vaucher, R., Yang, B. & Dalrymple, R.W. (2021) Hutchison medallist 1. Wave-dominated to tide-dominated coastal systems: a unifying model for tidal shorefaces and refinement of the coastal-environments classification scheme. *Geoscience Canada*, 48, 5–22.

Dumas, S. & Arnott, R.W.C. (2006) Origin of hummocky and swaley cross-stratification—The controlling influence of unidirectional current strength and aggradation rate. *Geology*, 34, 1073–1076.

20554877, 2023, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/dep2.229 by Morocco Hinari NPL, Wiley Online Library on [29/05/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Dumas, S., Arnott, R.W.C. & Southard, J.B. (2005) Experiments on oscillatory-flow and combined-flow bed forms: implications for interpreting parts of the shallow-marine sedimentary record. *Journal of Sedimentary Research*, 75, 501–513.

Ghinassi, M., D'alpaos, A., Gasparotto, A., Carniello, L., Brivio, L., Finotello, A., Roner, M., Franceschinis, E., Realdon, N., Howes, N. & Cantelli, A. (2018) Morphodynamic evolution and stratal architecture of translating tidal point bars: Inferences from the northern Venice Lagoon (Italy). *Sedimentology*, 65(4), 1354–1377.

Gugliotta, M., Flint, S.S., Hodgson, D.M. & Veiga, G.D. (2015) Stratigraphic record of river-dominated crevasse subdeltas with tidal influence (Lajas Formation, Argentina). *Journal of Sedimentary Research*, 85, 265–284.

Gugliotta, M., Flint, S.S., Hodgson, D.M. & Veiga, G.D. (2016a) Recognition criteria, characteristics and implications of the fluvial to marine transition zone in ancient deltaic deposits (Lajas Formation, Argentina). *Sedimentology*, 63, 1971–2001.

Gugliotta, M., Kurcinka, C.E., Dalrymple, R.W., Flint, S.S. & Hodgson, D.M. (2016b) Decoupling seasonal fluctuations in fluvial discharge from the tidal signature in ancient deltaic deposits: an example from the Neuquén Basin, Argentina. *Journal of the Geological Society*, 173, 94–107.

Guisado-Pintado, E. & Jackson, D.W. (2019) Coastal impact from high-energy events and the importance of concurrent forcing parameters: the cases of storm Ophelia (2017) and storm Hector (2018) in NW Ireland. *Frontiers in Earth Science*, 7, 1–18.

Harley, M.D., Masselink, G., Ruiz de Alegría-Arzaburu, A., Valiente, N.G. & Scott, T. (2022) Single extreme storm sequence can offset decades of shoreline retreat projected to result from sea-level rise. *Communications Earth & Environment*, 3(1), 1–11.

Myrow, P.M., Jerolmack, D.J. & Perron, J.T. (2018) Bedform disequilibrium. *Journal of Sedimentary Research*, 88, 1096–1113.

*Nugraha, A.S., Hall, R., BouDagher-Fadel, M., Todd, J.A. & Switzer, A.D. (2023) Neogene history of fluvial to shallow marine successions in the Kendari Basin, SE Sulawesi, Indonesia. In: Zuchuat, V., Gugliotta, M., Poyatos-Moré, M., van der Vegt, H., Collins, D.S. & Vaucher, R. (Eds.) *Mixed depositional processes in coastal to shelf environments*. The Depositional Record, special issue. Hoboken, NJ: Wiley, pp. 1–35.

Pemberton, S.G., MacEachern, J.A., Dashtgard, S.E., Bann, K.L., Gingrras, M.K. & Zonneveld, J.-P. (2012) Chapter 19: Shorefaces. In: Knaust, D. & Bromley, R.G. (Eds.) *Trace fossils as indicators of sedimentary environments*. Amsterdam: Elsevier, pp. 563–603.

Peng, Y., Steel, R.J., Rossi, V.M. & Olariu, C. (2018) Mixed-energy process interactions read from a compound-clinoform delta (paleo–orinoco Delta, Trinidad): preservation of river and tide signals by mud-induced wave damping. *Journal of Sedimentary Research*, 88, 75–90.

Perillo, M.M., Best, J. & Garcia, M.H. (2014) A new phase diagram for combined-flow bedforms. *Journal of Sedimentary Research*, 84, 301–313.

*Pierik, H.J., Leuven, J.R., Busschers, F.S., Hijma, M.P. & Kleinhans, M.G. (2023) Depth-limiting resistant layers restrict dimensions and positions of estuarine channels and bars. In: Zuchuat, V., Gugliotta, M., Poyatos-Moré, M., van der Vegt, H., Collins, D.S. & Vaucher, R. (Eds.) *Mixed depositional processes in coastal to shelf environments*. The Depositional Record, special issue. Hoboken, NJ: Wiley, pp. 1–20.

Rossi, V.M., Perillo, M.M., Steel, R.J. & Olariu, C. (2017) Quantifying mixed-process variability in shallow-marine depositional systems: what are sedimentary structures really telling us? *Journal of Sedimentary Research*, 87, 1060–1074.

Rossi, V.M. & Steel, R.J. (2016) The role of tidal, wave and river currents in the evolution of mixed-energy deltas: Example from the Lajas Formation (Argentina). *Sedimentology*, 63, 824–864.

Sato, T., Taniguchi, K., Takagawa, T. & Masuda, F. (2011) Generation of tidal bedding in a circular flume experiment: formation process and preservation potential of mud drapes. *Geo-Marine Letters*, 31(2), 101–108.

Southard, J.B. & Boguchwal, L.A. (1990) Bed configuration in steady unidirectional water flows; Part 2, Synthesis of flume data. *Journal of Sedimentary Research*, 60, 658–679.

Southard, J.B., Lambie, J.M., Federico, D.C., Pile, H.T. & Weidman, C.R. (1990) Experiments on bed configurations in fine sands under bidirectional purely oscillatory flow and the origin of hummocky cross-stratification. *Journal of Sedimentary Petrology*, 60, 1–17.

Vakarelov, B.K., Ainsworth, R.B. & MacEachern, J.A. (2012) Recognition of wave-dominated, tide-influenced shoreline systems in the rock record: variations from a microtidal shoreline model. *Sedimentary Geology*, 279, 23–41.

*Valencia, A.A., Storms, J.E.A., Walstra, D.J.R., van der Vegt, H. & Jagers, H.R.A. (2023) The impact of clastic syn-sedimentary compaction on fluvial-dominated delta morphodynamics. In: Zuchuat, V., Gugliotta, M., Poyatos-Moré, M., van der Vegt, H., Collins, D.S. & Vaucher, R. (Eds.) *Mixed depositional processes in coastal to shelf environments*. The Depositional Record, special issue. Hoboken, NJ: Wiley, pp. 1–20.

Van Yperen, A.E., Poyatos-Moré, M., Holbrook, J.M. & Midtkandal, I. (2020) Internal mouth-bar variability and preservation of subordinate coastal processes in low-accommodation proximal deltaic settings (Cretaceous Dakota Group, New Mexico, USA). *The Depositional Record*, 6(2), 431–458.

Vaucher, R. & Dashtgard, S.E. (2022) Nearshore bedforms. In: Shroder, J.J.F. (Ed.) *Treatise on geomorphology*. Academic Press: Elsevier, pp. 230–246.

Vaucher, R., Pittet, B., Hormière, H., Martin, E.L.O. & Lefebvre, B. (2017) A wave-dominated, tide-modulated model for the Lower Ordovician of the Anti-Atlas, Morocco. *Sedimentology*, 64, 777–807.

Vaucher, R., Pittet, B., Passot, S., Grandjean, P., Humbert, T. & Allemand, P. (2018) Bedforms in a tidally modulated ridge and runnel shoreface (Berck-Plage; North France): implications for the geological record. *BSGF—Earth Sciences Bulletin*, 189, 5.

*Weisscher, S.A.H., Adema, P.H., Rossius, J.-E. & Kleinhans, M.G. (2023) The effect of sea level rise on estuary filling in scaled landscape experiments. In: Zuchuat, V., Gugliotta, M., Poyatos-Moré, M., van der Vegt, H., Collins, D.S. & Vaucher, R. (Eds.) *Mixed depositional processes in coastal to shelf environments*. The Depositional Record, special issue. Hoboken, NJ: Wiley.

*Wroblewski, A.F.J. & Morris, E.A. (2023) Unconformity generation and the shift from storm-dominated to tide-dominated processes in a Jurassic Retroarc Foreland Basin: insights from ichnology. In: Zuchuat, V., Gugliotta, M., Poyatos-Moré, M., van der Vegt, H., Collins, D.S. & Vaucher, R. (Eds.) *Mixed depositional processes in coastal to shelf environments*. The Depositional Record, special issue. Hoboken, NJ: Wiley, pp. 1–47.

20554877, 2023, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/dep2.229 by Morocco Hinari NPL, Wiley Online Library on [29/05/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Yang, B., Dalrymple, R., Chun, S., Johnson, M. & Lee, H. (2008) Tidally modulated storm sedimentation on open-coast tidal flats, southwestern Korea. In: Hampson, G.J., Steel, R.J., Burgess, P.M. & Dalrymple, R.W. (Eds.) *Recent advances in models of siliciclastic shallow-marine stratigraphy*, Vol. 90. SEPM Society for Sedimentary Geology, pp. 161–176.

Yang, B.C. & Chang, T.S. (2017) Integrated sedimentological and ichnological characteristics of a wave-dominated, macrotidal coast: a case study from the intertidal shoreface of the Dongho coast, southwest Korea. *Geo-Marine Letters*, 38, 139–151.

Yang, B.C., Dalrymple, R.W. & Chun, S.S. (2005) Sedimentation on a wave-dominated, open-coast tidal flat, south-western Korea: summer tidal flat—winter shoreface. *Sedimentology*, 52, 235–252.

Yang, B.C., Dalrymple, R.W. & Chun, S.S. (2006) The significance of hummocky cross-stratification (HCS) wavelengths: evidence from an open-coast tidal flat, South Korea. *Journal of Sedimentary Research*, 76, 2–8.

Zuchuat, V., Poyatos-Moré, M., Nyberg, B., Nanson, R.A., Sagar, S., Lymburner, L. & Bishop-Taylor, R. (2023) Use of remote-sensing to quantify the distribution of progradation/erosion along a forced-regressive modern coastline: driving factors and impact on the stratigraphic record. *The Sedimentary Record*, 21, 1–12.

Zuchuat, V., Sleveland, A.R.N., Pettigrew, R.P., Dodd, T.J.H., Clarke, S.M., Rabbel, O., Braathen, A. & Midtkandal, I. (2019) Overprinted allocyclic processes by tidal resonance in an epicontinental basin: The Upper Jurassic Curtis Formation, east-central Utah, USA. *The Depositional Record*, 5, 272–305.

Zuchuat, V., Steel, E., Mulligan, R.P., Collins, D.S. & Green, J.A.M. (2022) Tidal dynamics in palaeo-seas in response to changes in physiography, tidal forcing and bed shear stress. *Sedimentology*, 69, 1861–1890.

The * symbol highlights the contributions to the Special Issue.

How to cite this article: Zuchuat, V., Gugliotta, M., Poyatos-Moré, M., van der Vegt, H., Collins, D.S. & Vaucher, R. (2023) Mixed depositional processes in coastal to shelf environments: Towards acknowledging their complexity. *The Depositional Record*, 9, 206–212. Available from: https://doi.org/10.1002/dep2.229

20554877, 2023, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/dep2.229 by Morocco Hinari NPL, Wiley Online Library on [29/05/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License