frontiers | Frontiers in Earth Science

TYPE Editorial
PUBLISHED 29 September 2022
DOI 10.3389/feart.2022.1042473

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OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Sedimentology, Stratigraphy and Diagenesis,
a section of the journal Frontiers in Earth Science

RECEIVED 12 September 2022
ACCEPTED 13 September 2022
PUBLISHED 29 September 2022

CITATION
McArthur AD, Gamberi F, Maniscalco R and Butler R (2022), Editorial: Source or sink? Erosional and depositional signatures of tectonic activity in deep-sea sedimentary systems.
Front. Earth Sci. 10:1042473.
doi: 10.3389/feart.2022.1042473

Editorial: Source or sink? Erosional and depositional signatures of tectonic activity in deep-sea sedimentary systems

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KEYWORDS

seafloor topography, sediment-gravity flow, deep-water fan, submarine channel, submarine canyon

Editorial on the Research Topic
Source or sink? Erosional and depositional signatures of tectonic activity in deep-sea sedimentary systems

Introduction

A recent break-through in sedimentological research is the application of 'source-to-sink' type studies to aid our understanding of continental margin evolution (e.g., Sømme et al., 2009; Carvajal and Steel 2011; Helland-Hansen et al., 2016; Snedden et al., 2018). "Source-to-sink" being the study of sediments from their source area, their transport to, and deposition in a sink or basin. Whilst the continental slope was conventionally perceived to primarily experience sediment bypass in source-to-sink studies, the net bypass character of the slope is the result of alternation of deposition and erosion over various magnitudes and time-scales (e.g., Prather et al., 2017). Although the basin-plain is typically considered as a sink, the same concept applies, with varying degrees of erosion and deposition occurring in the deep-ocean (e.g., Talling et al., 2022). Hence, the deep-sea has a diverse capacity for sediment storage but also great potential for redistribution (e.g., Shumaker et al., 2018). Consequently, sediment routing may be divided into discrete cells with different sedimentary behaviour, due to a variety of processes, some affecting the land and the shelf, some the slope, and others the basin-plain (e.g., Gamberi, 2020). Amongst those occurring in the deep-sea, a major role is played by tectonics, which modify seafloor topography; this in turn dictates where and when sediments are generated, stored, and remobilised in the deep-sea (e.g., Butler et al., 2020; McArthur et al., 2022).

This Research Topic aimed to assemble contributions that investigated the distribution of erosion and deposition in the deep-sea and to explore its linkage with tectonic activity. A diverse range of fourteen papers cover the sedimentary processes (e.g., turbidity currents, mass-wasting), geomorphic elements (e.g., canyons, basins) and stratigraphic architectures (e.g., channels, lobes) that are indicative of tectonic shaping of the deep-sea environment across a range of tectonic settings, e.g., extensional, convergent, and strike-slip. Contributions covered a range of modern studies to those in deep geological-time and utilised a range of research approaches, from fieldwork to subsurface studies, to yield new insights on one or more of the research areas highlighted above. The resulting collection forms an anthology of Original Research and Reviews, which better constrain sediment routing systems in the slope and basin-plain and develops new concepts for the advancement of future source-to-sink studies. Hence, this Research Topic documents sedimentary processes, geomorphic elements and stratigraphic architectures of erosional and depositional signatures of tectonic activity in deep-sea sedimentary systems.

Sedimentary processes

The sedimentary processes that drive erosion and deposition in tectonically active deep-sea systems were given particular attention, from shelf incising submarine canyons, through deep-sea channels, their transition to terminal deposits, and into the abyssal plain.

Ikehara et al. considered the sedimentary processes in submarine canyons, giving particular attention to sediment transport and deposition by large tsunamis, which transferred carbonate material from the shelf to the deep-sea offshore of the Ryukyu subduction zone, Japan. This work highlights the source-to-sink transfer of carbonate material through the marine environment.

Scacchia et al. examined the deposits found overbank of submarine channels in a zone of active extensional tectonics, in the south-eastern Tyrrhenian Sea, Italy. This enabled documentation of how variation in flow type and flow interaction with tectonically modified seafloor topography act as a major control on the amount of overspill from a channel and the location of overbank depocenters.

Hodgson et al. reviewed modern seafloor studies of deep-sea channel mouths initially to explore the erosional and depositional processes and products of the channel-lobe transition zone (CLTZ). However, in doing so they recognised a new type of transition between channels and their terminal deposits, which they term 'channel mouth expansion zones' (CMEZs), which exhibit long and flared tracts between channels and lobes. These authors suggest previously documented CLTZs may need to be re-examined in light of the recognition of CMEZs.

Martínez-Doñate et al. Recorded erosion, transport and deposition by turbidity currents on top of kilometre-scale submarine landslides, with examples from Middle Jurassic deep-water deposits from the Neuquén Basin, Argentina. This paper highlights the role of mass-transport deposits in generating seafloor topography, which may influence the erosional and depositional signatures of subsequent flows.

Tinterri et al. documented oversized deposits, here termed 'megaturbidites' from ancient outcropping deep-sea systems of the northern Apennines (Italy) and in the Pyrenees (Spain) to propose a new depositional model for such outsized events. The model proposes that deposition of these meters thick event beds occurs in confined basins by reflection of turbidity currents against obstacles, in these examples being basin margins.

Geomorphic elements

In this section geomorphic elements, such as carbonate shelves and volcanic arcs, canyons, and deep-water basins, were investigated for their erosional and depositional records across a range of tectonic settings. The role of tectonics is explored in: 1) shaping the seafloor and therefore creating an active topography interacting with flow dynamics, 2) changing the morphology from the shelf to the deep sea and the source to sink distribution; 3) modifying the source areas and therefore flow pathways.

Hansen et al. provided a unique outcrop example of scour field, preserved in the rock record, from the Permian Karoo Basin, South Africa, in a convergent setting (Cape Fold Belt). The scours and their subsequent sandstone fill at channel-lobe transition (with excellent sedimentary structures and architecture) inform of a change from erosion- and bypass-dominated flows to depositional flows.

Baudouy et al. delivered important evidence at outcrop for the interplay between tectonic deformation on the sea floor, slope instability and turbidity current behaviour. The strike-slip fault-controlled Deep Water Sub-Basin, Tabernas, SE Spain, is a case study revealing the role of tectonics on controlling basin morphology and stratigraphy.

Christie et al. explored the interplay between structural fold growth and sedimentation in mini-basins applying a fast computational method (Onlapse-2D) to basin forward modelling. Testing the match of model outputs to available subsurface control is performed through the case study of Sureste Basin, Gulf of Mexico.

Morena et al. discussed modern mixed carbonate/siliciclastic/volcaniclastic systems adjacent to carbonate platforms along active margins in the forearc zone of North Lesser Antilles. Sediment sources and pathways of gravity-driven currents from carbonate shelf, down to the slope and basin, reflect the major role played by tectonic activity and seismicity.

Bührig et al. Questioned the role of tectonic setting (active vs passive margins and across different plate-boundary types) on canyon geomorphology, building a database-informed meta-study of globally distributed submarine canyons.

Stratigraphic architectures as records of tectonic activity in deep-sea sedimentary systems

The sedimentary facies and stratigraphic architectures produced by interaction of deep-water sedimentary processes with structurally modulated geomorphology was the subject of the final four papers, which aimed to describe deposition in the 'sink', subsequent burial, modifications (e.g., fluid flow and diagenesis), and the economic potential of such deposits.

McHargue et al. explored the diversity of architecture in lobes from intra-slope and basin plan settings with 3D seismic data, particularly focusing on the presence and style of distributary channels. The key influence on presence and style of distributary channels is inferred to be the lobe forming processes and type of sediment, with mud-rich systems producing lobes with multifaceted, branching distributary channels; whereas mud-poor lobes tend to lack resolvable channels. Hence, sediment source and type are shown to have a fundamental control on the resulting depositional style and stratigraphic architecture.

Rohais et al. continue the theme of lobe architectures, here with examples from outcrops of exhumed lobe complexes, which were deposited in a structurally confined intra-slope setting. Their key finding is that lobes on this transform margin are particularly small (ca. 300–3,000 m wide, 500–5,000 m long) and relatively thin (and 2–22 m thick), likely due to limited accommodation in such settings.

Sun et al. consider the effects of mass-transport deposits (MTDs) generated by tectonically induced slope failures on fluid migration through deep-water sedimentary systems. Although such slope derived MTDs are often considered mud-rich and potential barriers to flow, this example documents how minor compressional faults within the MTD act as conduits, permitting fluid flow through deposits often thought as good seals.

Karaket et al. continue the theme of fluid migration through deep-water stratigraphy, diving down to the basin plain, where the terminal deposits of a basin floor fan are overlain by a paleo-pockmark field. The authors suggest progradation of clastic sediments in the deep-sea provides permeable layers through which fluids migrate.

Perspectives and future research

To conclude, this Research Topic presents multidisciplinary investigations into erosional and depositional signatures of tectonic activity in deep-sea sedimentary systems, with numerous implications for source-to-sink studies in the deep-sea. Seafloor, subsurface, and outcrop studies all contribute to demonstrating the diverse and dynamic nature of deep-sea sedimentation, with a variety of sedimentary processes, geomorphic elements and resulting stratigraphic architectures showcasing how tectonic forcing may alter the seafloor, driving both erosion and deposition.

Many of these studies will be of interest for academic and applied audiences, particularly for helping to understand subsurface sedimentary systems and seafloor hazards that may help or hinder the energy transition. However, avenues for future research remain to conduct source-to-sink studies in the deep-sea, including how coeval sedimentary systems evolve either side of active plate boundaries, how different sedimentary processes may interact (e.g., contour and turbidity currents), and how sedimentation and erosion may influence tectonics.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Acknowledgments

We sincerely thank all the authors and reviewers who have participated in this Research Topic.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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