Seamount – Subduction Zone Interactions:

Implications for Accretionary & Erosive Subduction Zone Behaviour

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Introduction

The processes of subduction erosion and accretion are traditionally thought to operate uniformly along convergent margins. Sediment thickness at the trench exerts a major control on this behaviour[1]. Subduction of seamount chains & surrounding basins introduce local perturbations in sediment thicknesses (Fig.1).

The southern Central American margin contains several accretionary complexes composed of accreted seamounts derived from the Galapagos hotspot[2] (Fig. 4b). This study investigates the setting of formation of one of these complexes: the Osa Melange.

Aims

- Explain formation of the Osa Melange.
- Characterise structure & physical properties of the Middle America SZ hanging wall lithologies.
- Describe interaction of Galapagos seamounts with Costa Rican margin.

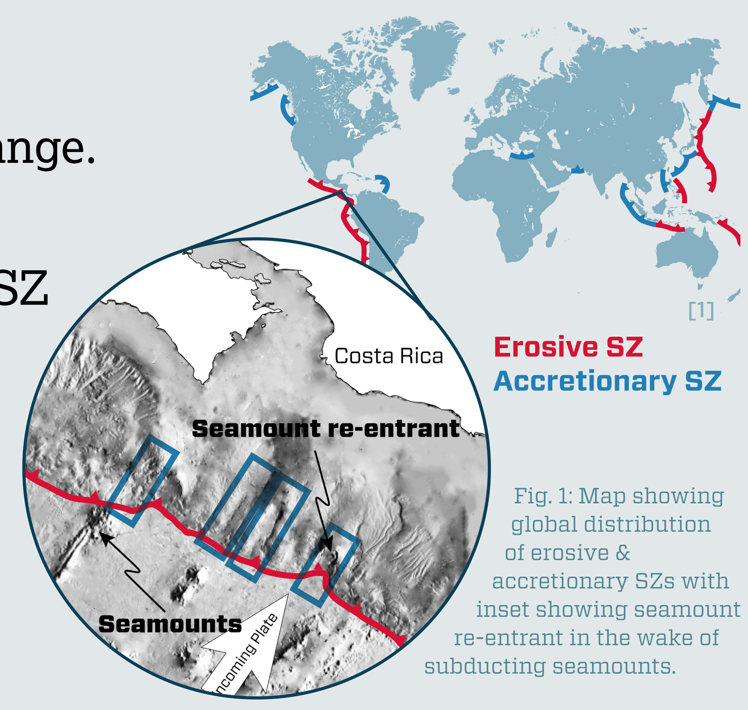


Fig. 1: Map showing global distribution of erosive & accretionary SZs with inset showing seamount re-entrant in the wake of subducting seamounts.

Concurrent Accretion & Erosion

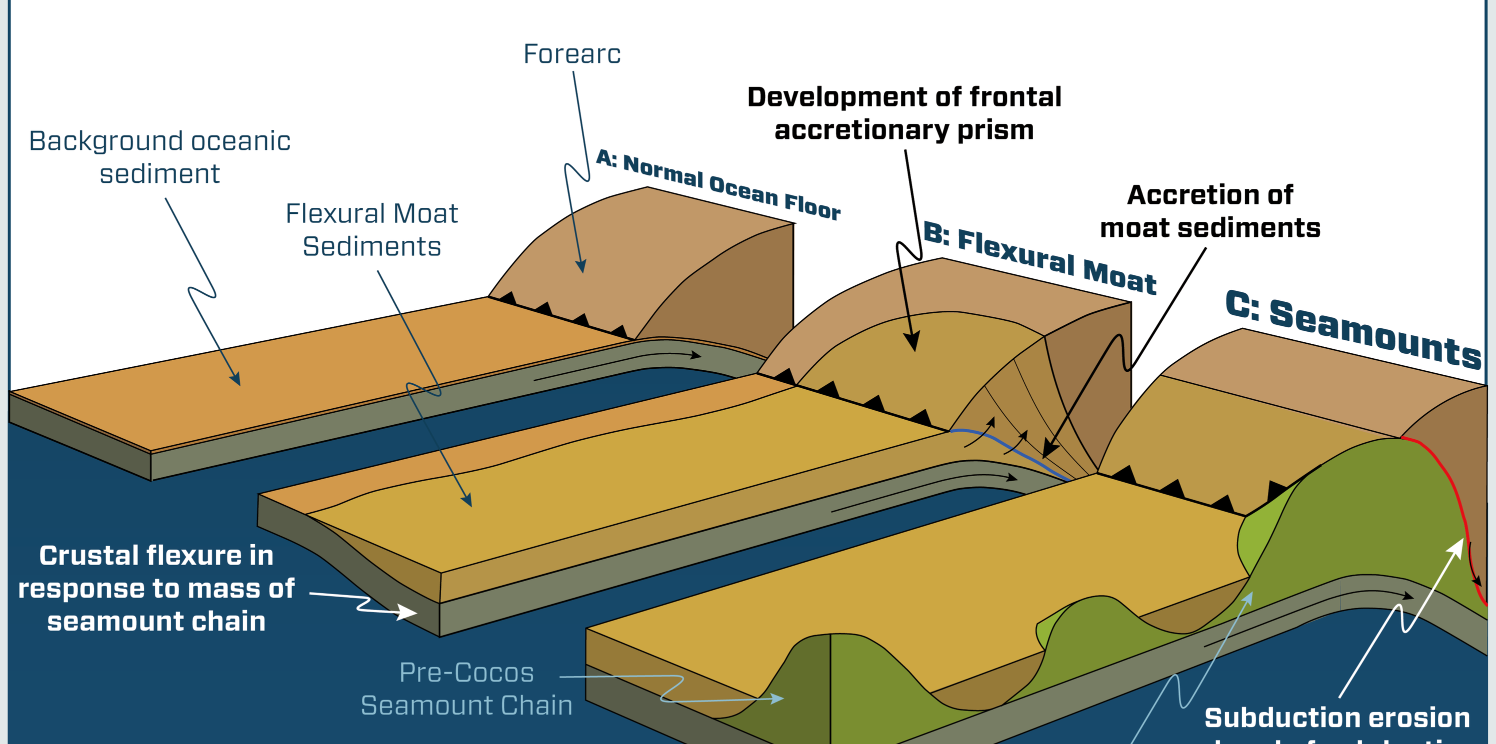


Fig. 2: Conceptual model of the frontal accretion of a seamount moat adjacent to the subduction erosion caused by subduction of the seamount.

Subduction of seamount moat basins provides more sediment to the trench than can be subducted, leading to the development of a localised accretionary prism even in otherwise erosive margins (Fig. 2b). This may occur immediately adjacent to the increased subduction erosion promoted by the subduction of the seamount (Fig. 2c).

Implications

The composition of the subduction channel is influenced by the accretionary or erosive behaviour of the SZ; erosion incorporates lithified upper plate material in contrast to the marine sediments in zones of subduction accretion. Variability in subduction zone behaviour in response to subducting seamounts leads to heterogeneity in subduction channel composition. Upper plate material may be eroded above a subducting seamount, mixed with moat sediments, and re-accreted.

Seamount Moats

Large seamount complexes are surrounded by broad depressions formed by lithospheric flexure in response to the mass of the seamount. These 'flexural moat' basins can accommodate deposition of up to 3 km of debris avalanche deposits derived from mass wasting of the seamount flanks and pelagic deposits derived from background sedimentation. Large-scale flank collapse can provide 100 m – km-scale olistoliths to the moats[3] (Fig. 3). Drilling of the distal Hawaiian moat by ODP leg 136 revealed clay-dominated sediment with high proportions of plagioclase and clinopyroxene[4].

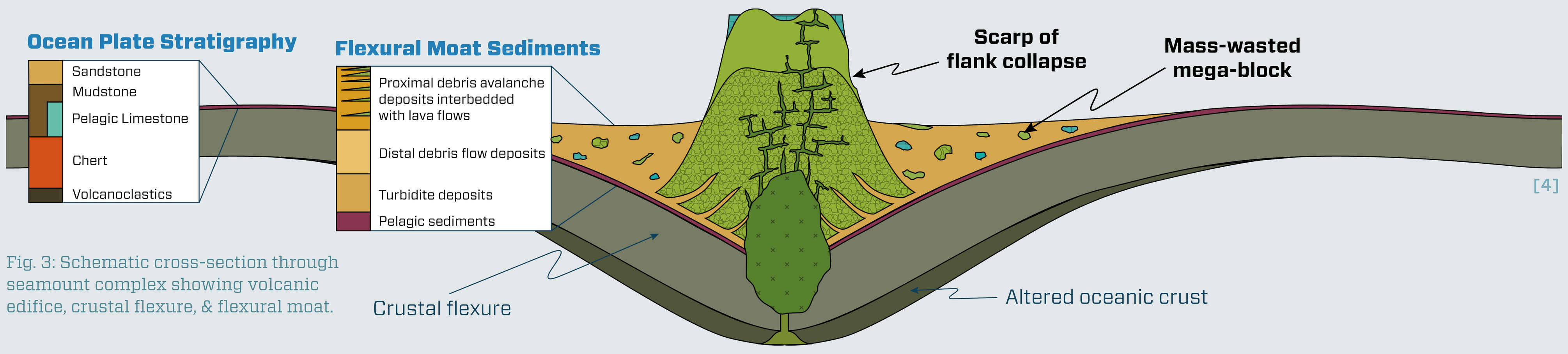
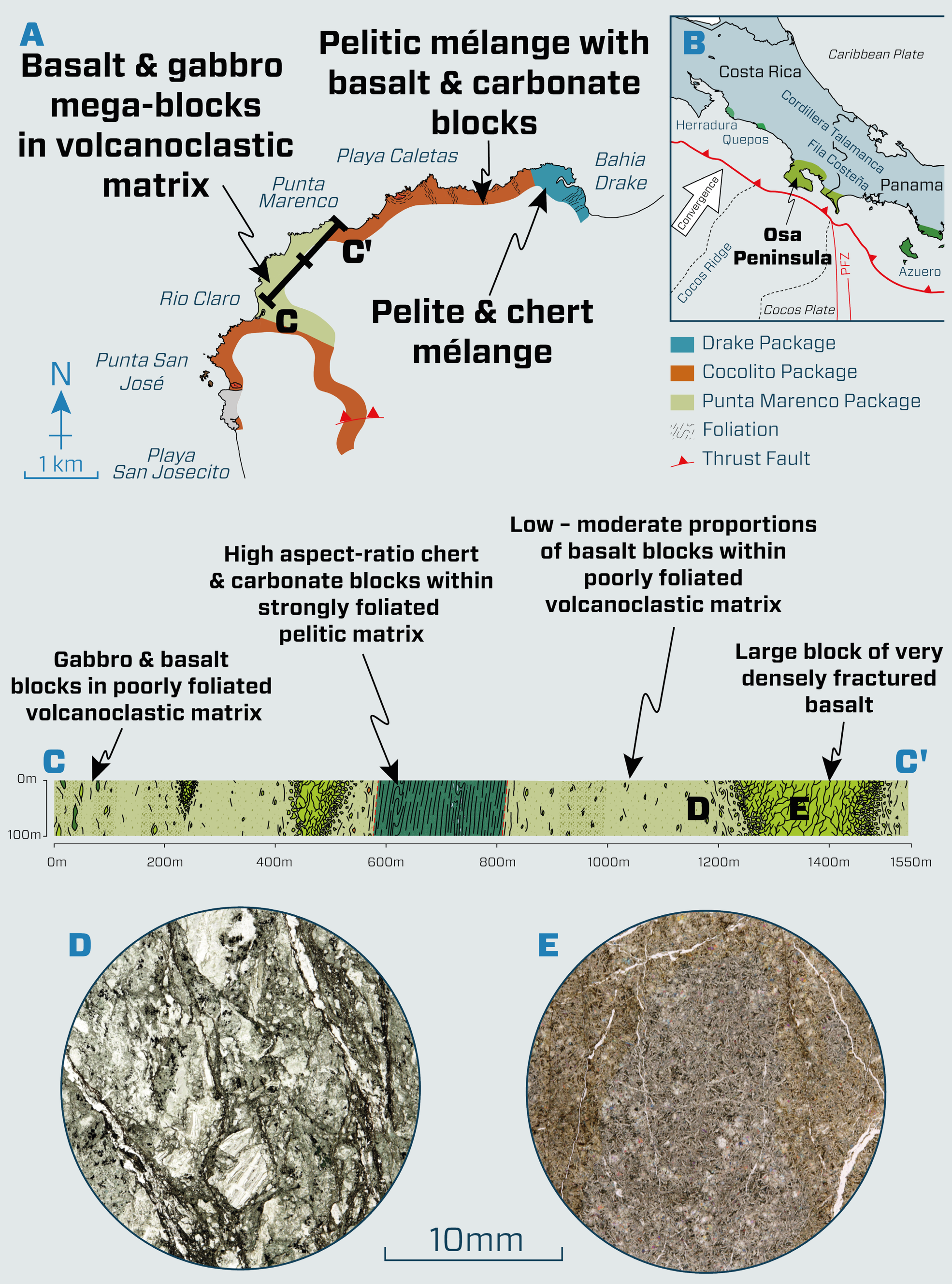


Fig. 3: Schematic cross-section through seamount complex showing volcanic edifice, crustal flexure, & flexural moat.

Osa Melange as Accreted Moat



Strongly deformed **volcanoclastic matrix** showing scaly fabric.

Highly altered **basalt block** showing core of 'fresh' basalt.

Fig. 4a: Geological map of the San Pedrillo Unit — the northern-most unit of the Osa Melange — showing main lithological units. b: Inset map showing the location of the Osa Peninsula and other Galapagos-affinity accretionary complexes in Central America. c: Schematic cross-section through the Punta Marenco Package showing fractured mega-blocks. d: Photomicrographs of block. e: Photomicrographs of matrix.

The Osa Melange is a heterogenous mixture predominantly composed blocks of Galapagos-derived basalt, carbonate, and chert within a pelitic matrix containing CPX & feldspar with rare quartz (Fig. 4).

This has previously been interpreted as forming either by tectonic dismemberment of the seamount flanks[5] or as trench-fill sediments derived from the previously accreted Osa Igneous Complex[2]. Seamount flanks are typically zones of sediment bypass and therefore lack the volumes of sediment found in the melange[6]. The predominance of seamount derived material and the rarity of quartz grains in this melange precludes a trench origin.

The basalt & carbonate blocks in the melange are consistent with mass wasting deposits found in seamount flexural moats. Flexural moats contain olistoliths derived from the collapse of the seamount flanks, accounting for the 10s to 100s of metre blocks in the melange. The matrix is consistent with sediments drilled from the Hawaiian moat during ODP leg 136[4].

Take Home Messages

1. Subduction of seamount moats bring large volumes of sediment to the trench, promoting localised frontal accretion.
2. Subduction of seamounts and moats results in concurrent accretion and erosion over short distances along the trench axis.
3. The Osa Melange consists of material consistent with seamount moats, making this the first recognised example of an accreted seamount moat.
4. Variable subduction zone processes results in a heterogeneous subduction channel.
5. Accretion of olistoliths in the moat provides a mechanism for passive incorporation of oceanic-derived igneous material within the accretionary complex.

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