UK-IODP 2016

Subduction of High Relief Seafloor Driving Subduction Accretion:

A seamount flexural moat origin for the Osa Mélange, Costa Rica

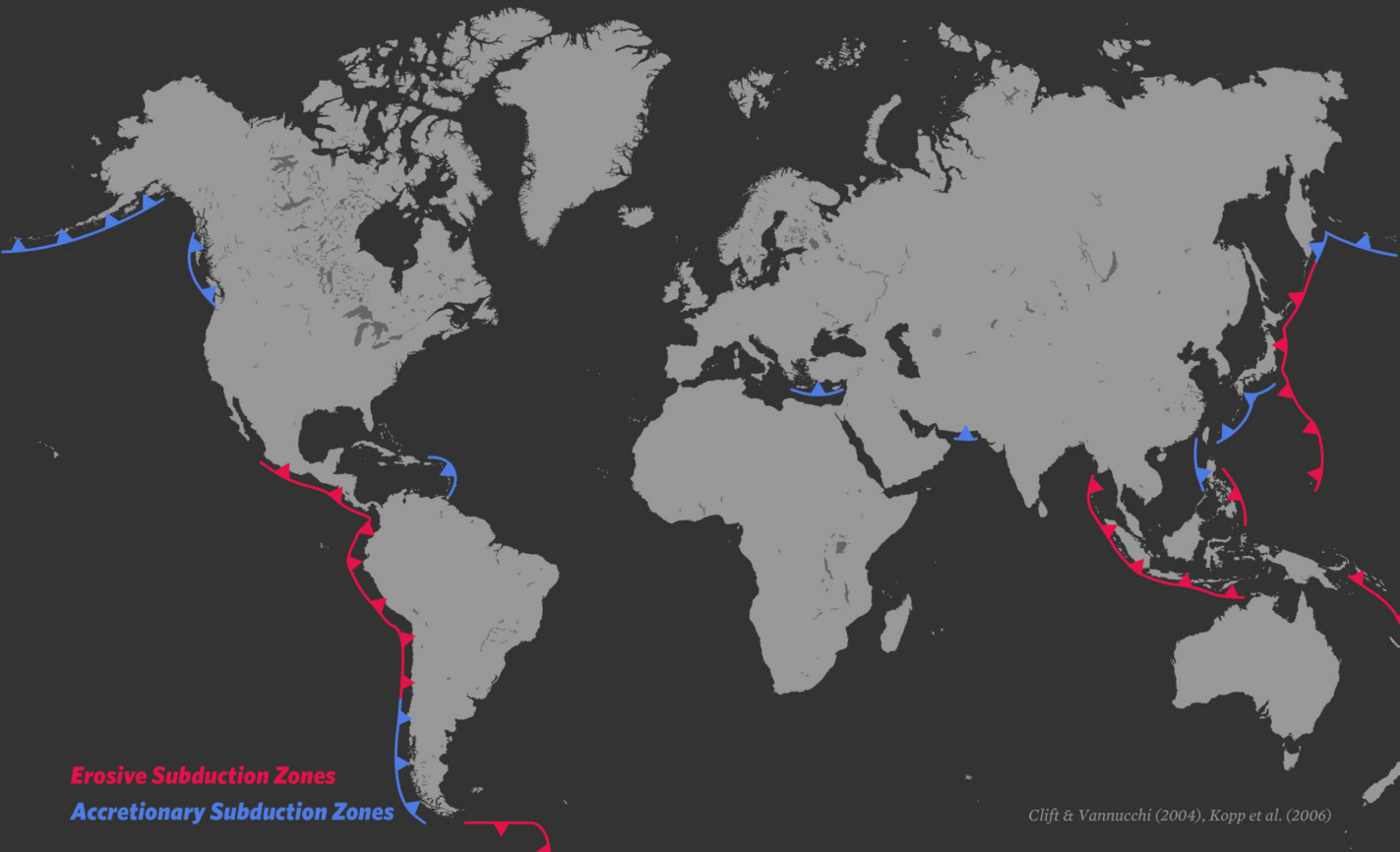
Alexander P. Clarke

@beardyscientist

Paola Vannucchi, Jason Morgan

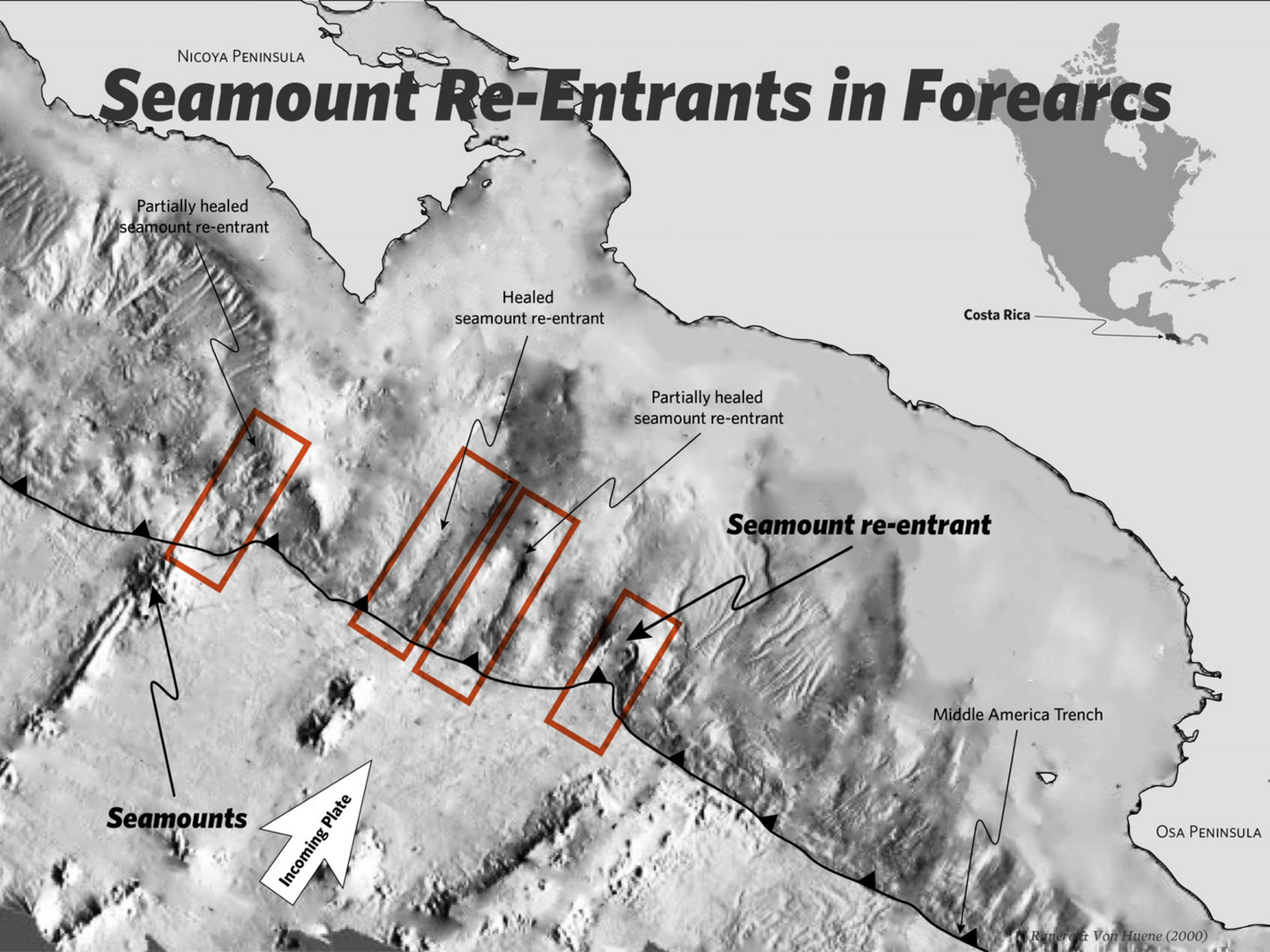
ROYAL HOLLOWAY UNIVERSITY OF LONDON

Erosive & Accretionary Subduction Zones



Clift & Vannucchi (2004), Kopp et al. (2006)

Seamount Re-Entrants in Forearcs

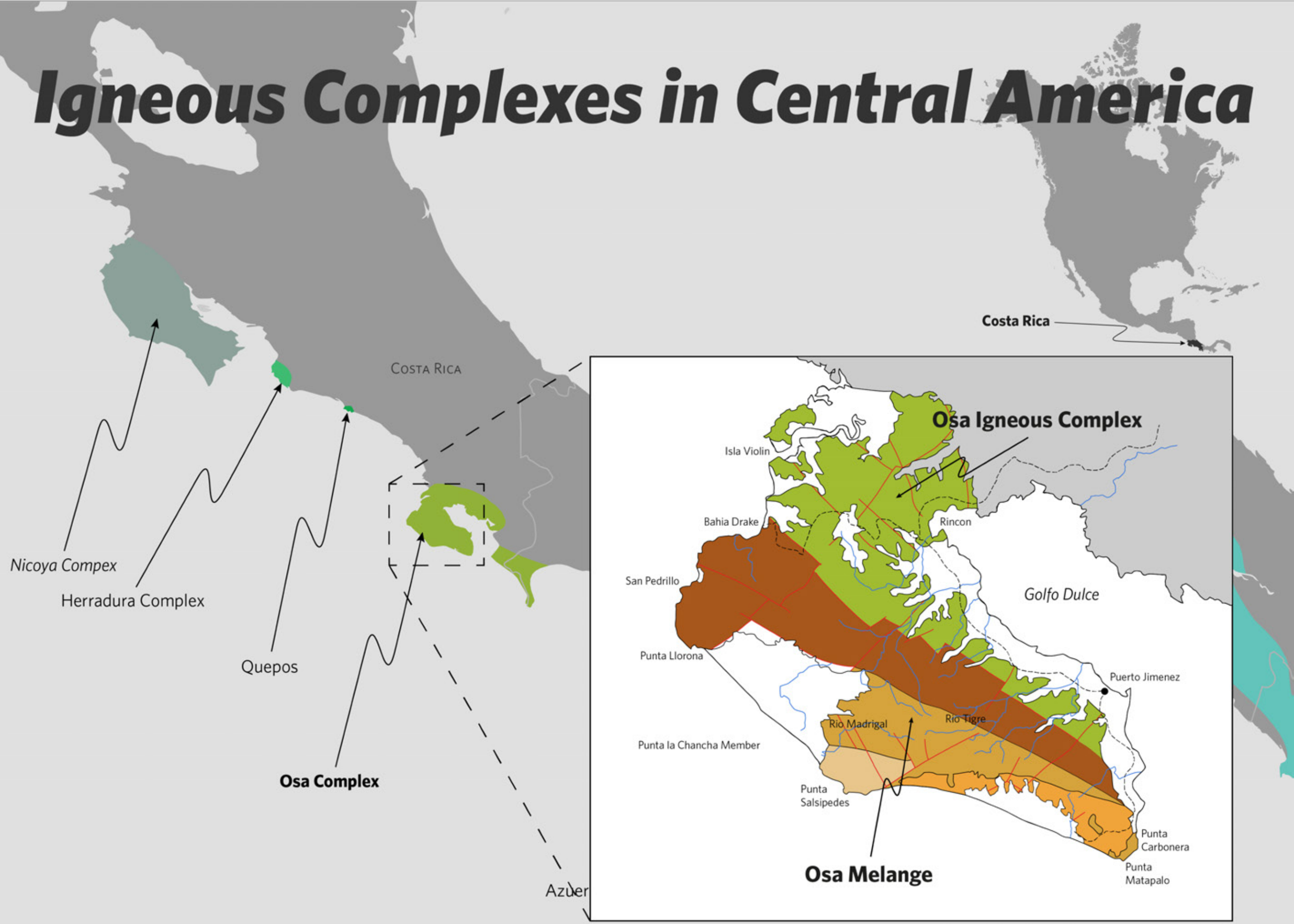


Ranero & Von Huene (2000)

Igneous Complexes in Central America

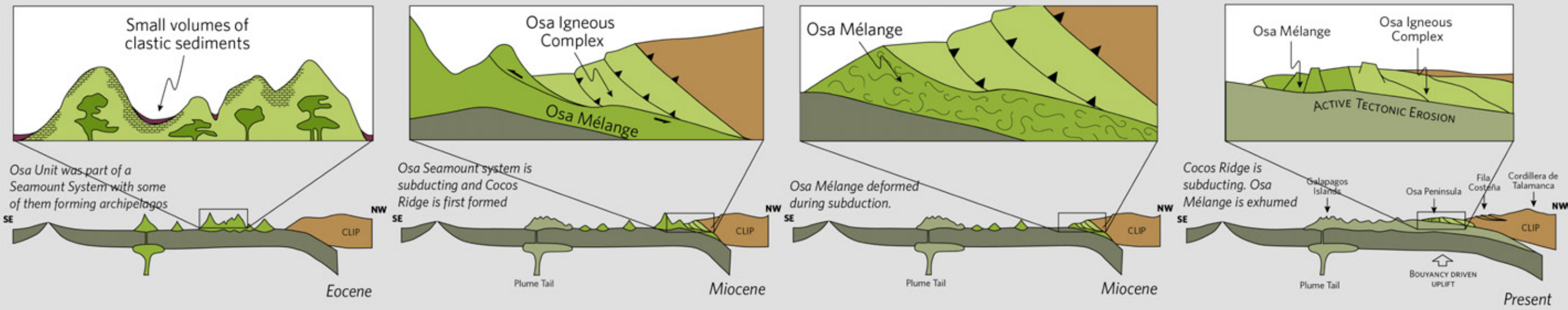
Buchs et al. (2010)

Igneous Complexes in Central America



Buchs et al. (2010); Buchs & Baumgartner, (2007)

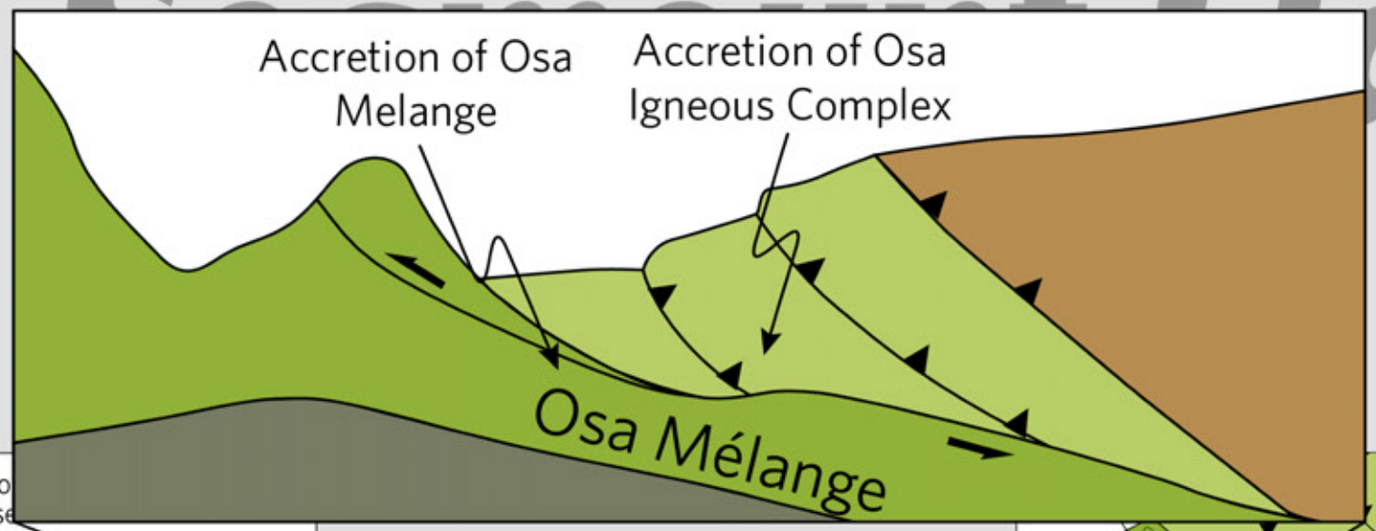
Mélange as Tectonised Seamount Flanks?

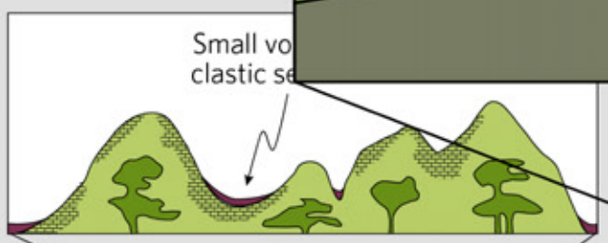


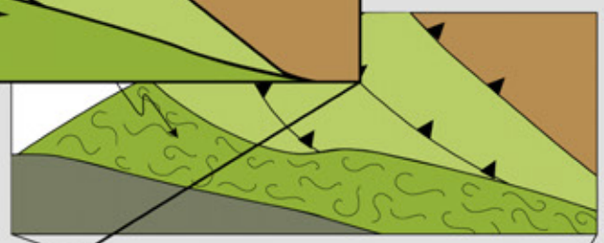
Vannucchi et al. (2006)

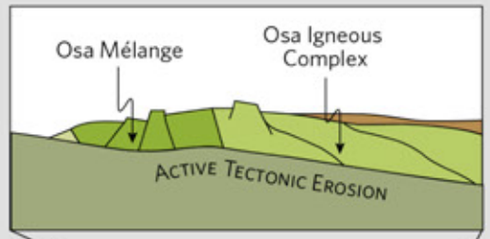
Mélange as Tectonised Seamount Flanks?

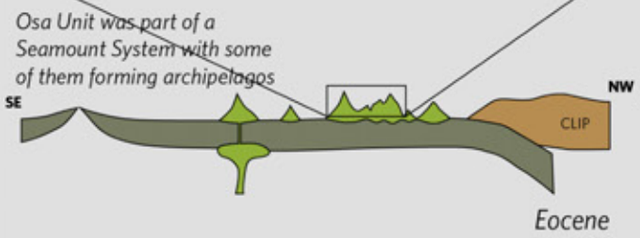
Direct seamount accretion

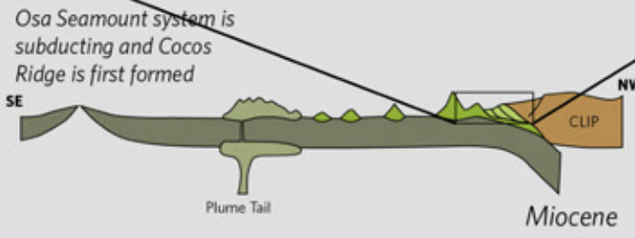


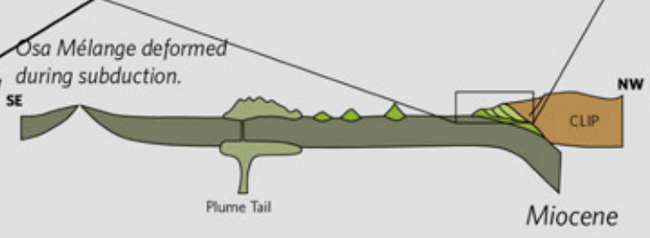


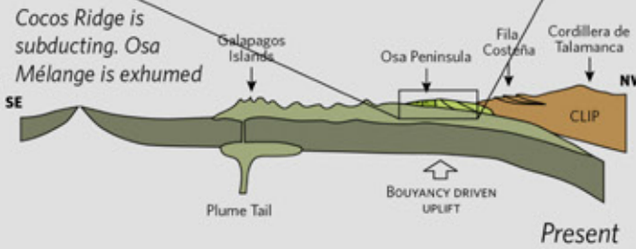












Vannucchi et al. (2006)

Las Caletas Sub-Unit

Cover

Las Caletas Sub-Unit

Drake Package

Northwest Drake Parcel

Punta Aguijas Package

Cocolito-Caletas Package

La Paloma Parcel

Vista al Mar Parcel

Copa de Arbol Parcel

Playa Marenco Package

Punta Marenco Package

Playa Danta Package

Punta Danta Package

Rio Claro Package

Punta San Josecito Package

Punta Campanario Sub-Unit

Punta Campanario Sub-Unit

East Campanario Package

Punta San Pedrillo Sub-Unit

Punta San Pedrillo Sub-Unit

Large blocks

Syanite block

Chert block

Brecciated basalt mega-block

Punta Aguijas

Playa Caletas

Playa Cocolito

Bahia Drake

Punta Marenco

Playa Marenco

Playa Danta

Rio Claro

Punta San José

Pelitic mélange with basalt & carbonate blocks

Pelite & chert mélange

Turbiditic sediments

Pelagic sediments

Punta Campanario

Punta San Pedrillo

1 km

Isla Violin

Bahia Drake

Rincon

San Pedrillo

Golfo Dulce

Punta Llorona

Puerto Jimenez

Rio Madrigal

Rio Tigre

Punta Salsipedes

Punta Carbonera

Punta Matapalo

Charco Azul Group

Almuelles Formation

Burica Formation

Punta la Chancha Member

Peñita Formation

Osa Mélange

Salsipuedes Unit

Cabo Matapalo Unit

San Pedrillo Unit

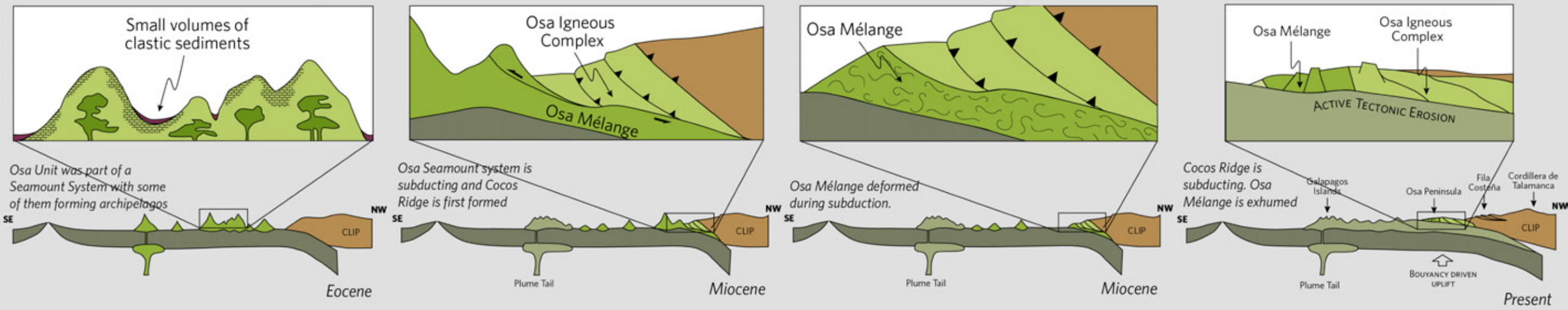
Osa Igneous Complex

Punta Llorona

Vannucchi et al. (2006); Buchs & Baumgartner (2007)

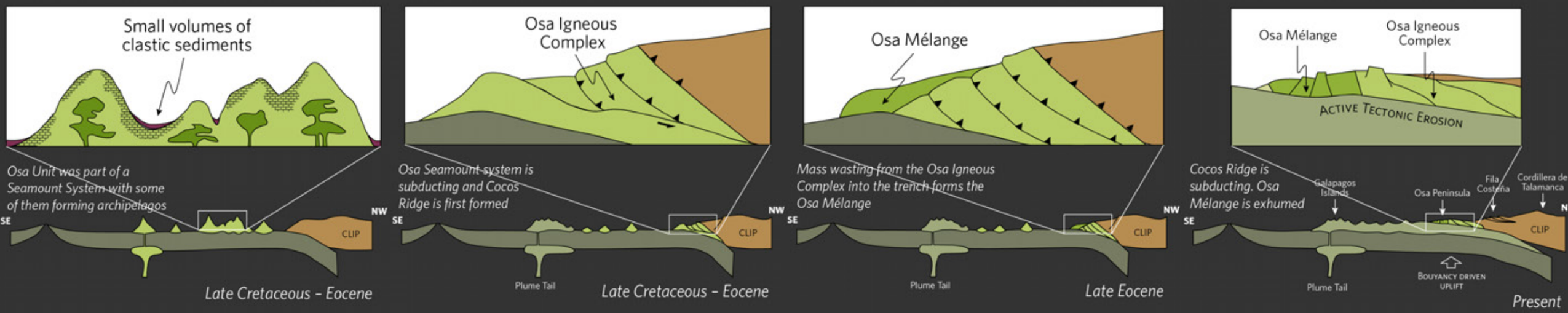
Mélange as Tectonised Seamount Flanks?

Problem: Too many sediments



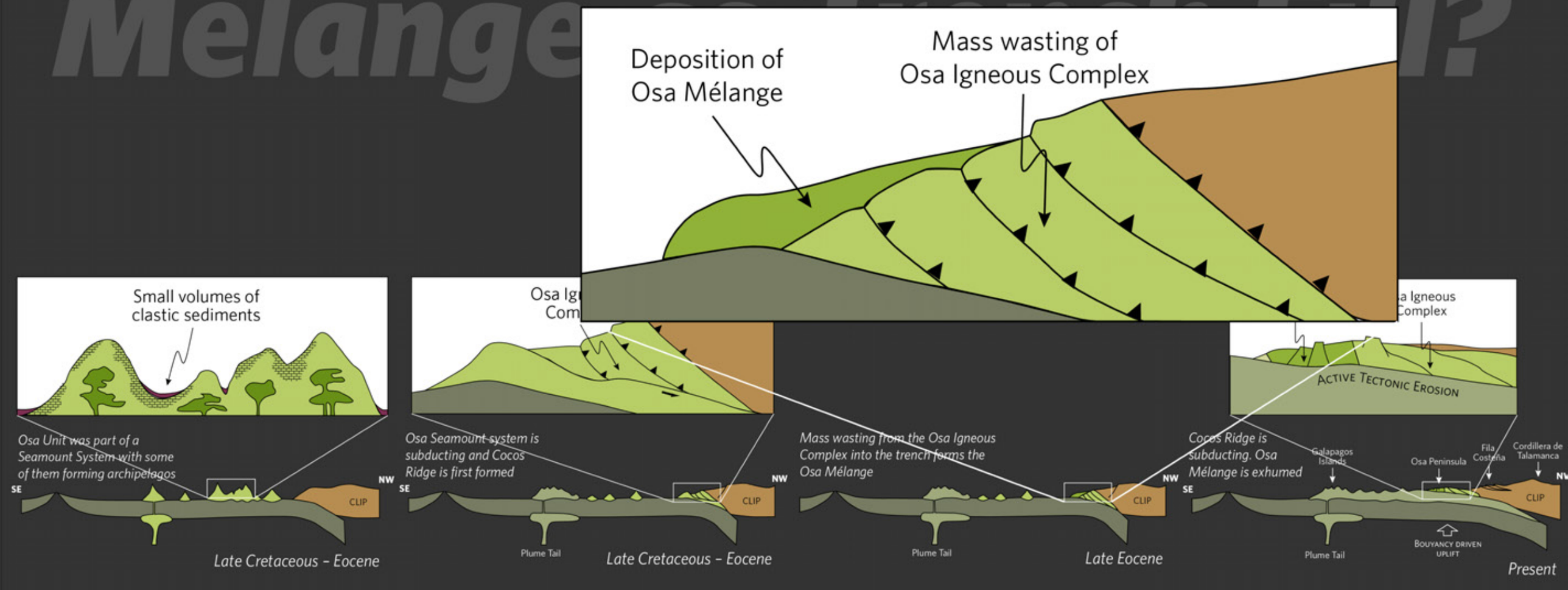
Vannucchi et al. (2006)

Mélange as Trench Fill?



Buchs et al. (2008)

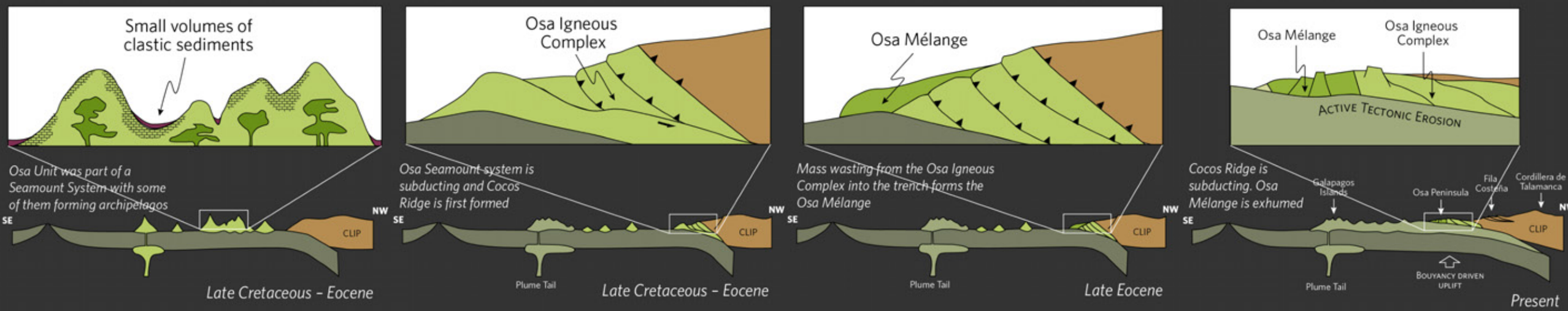
Mass Wasting into Trench & Subsequent Re-Accretion



Buchs et al. (2009)

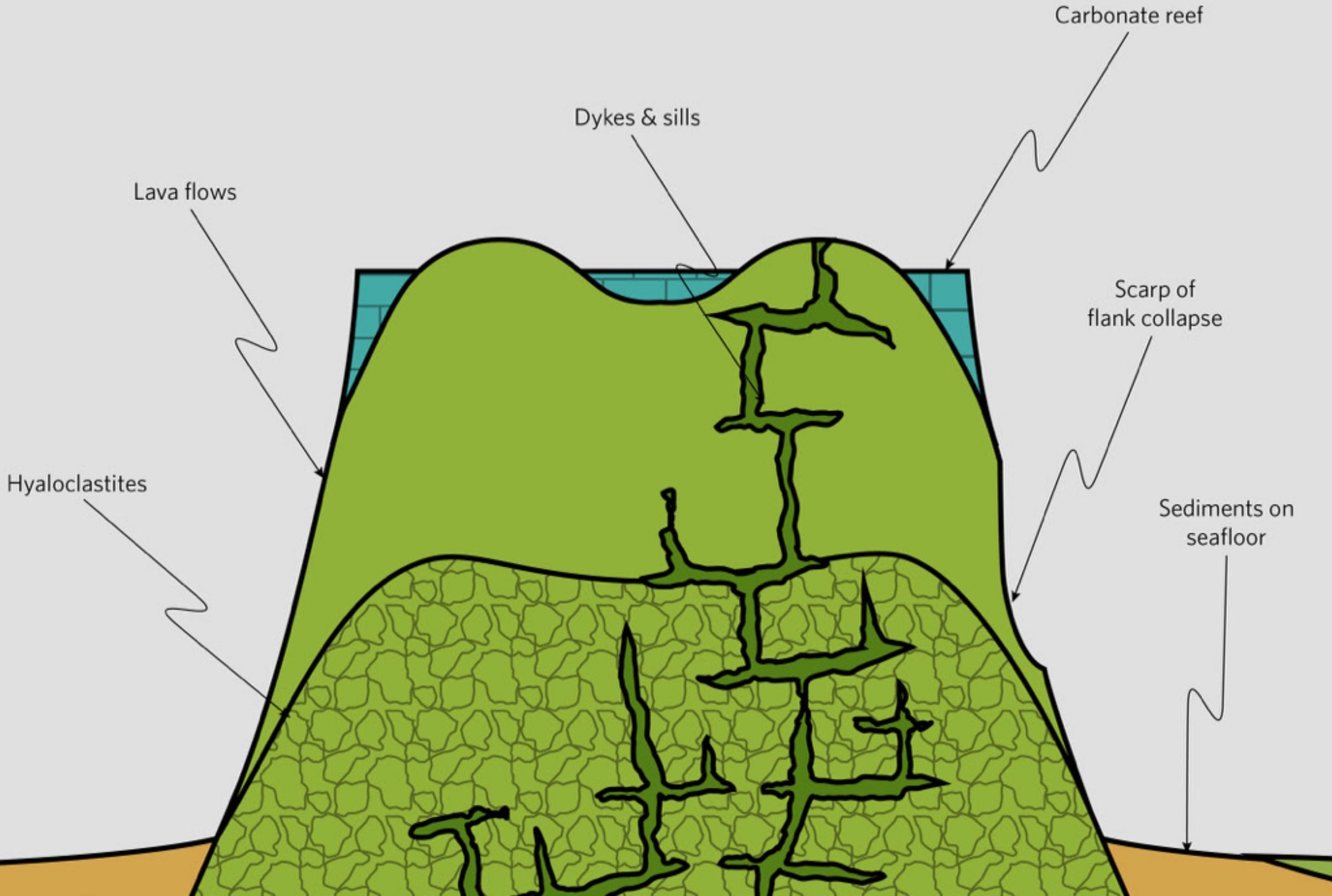
Mélange as Trench Fill?

Problem: No arc-derived material



Buchs et al. (2009)

A Closer Look at Seamounts



Ocean Plate Stratigraphy

Sandstone

Mudstone

Pelagic Limestone

Chert

Volcanoclastics

Site of ODP
leg 136 drilling

Flexural Moat Sediments

Proximal debris avalanche deposits interbedded with lava flows

Distal debris flow deposits

Turbidite deposits

Pelagic sediments

Carbonate reef

Dykes & sills

Lava flows

Scarp of flank collapse

Hyaloclastites

Sediments on seafloor

Mass-wasted megablock

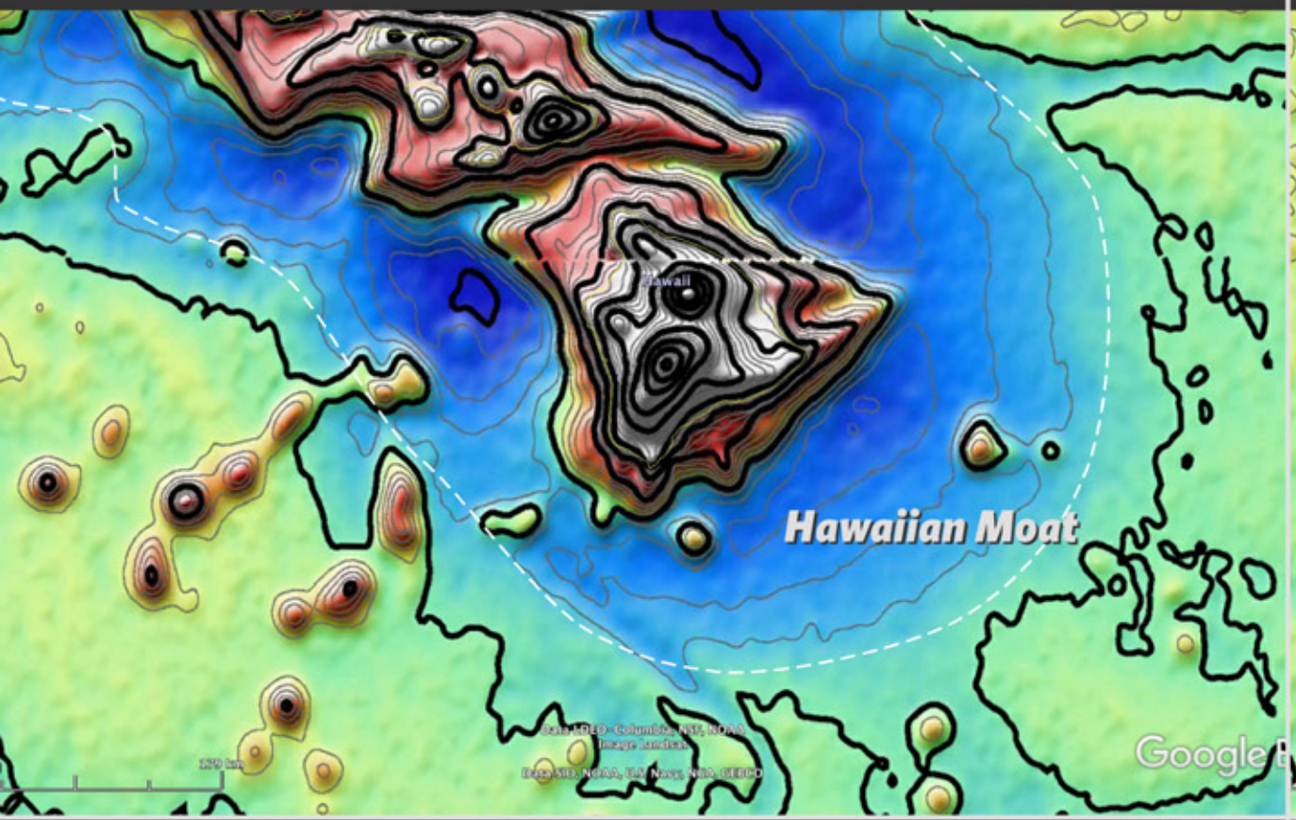
Crustal flexure

Altered oceanic crust

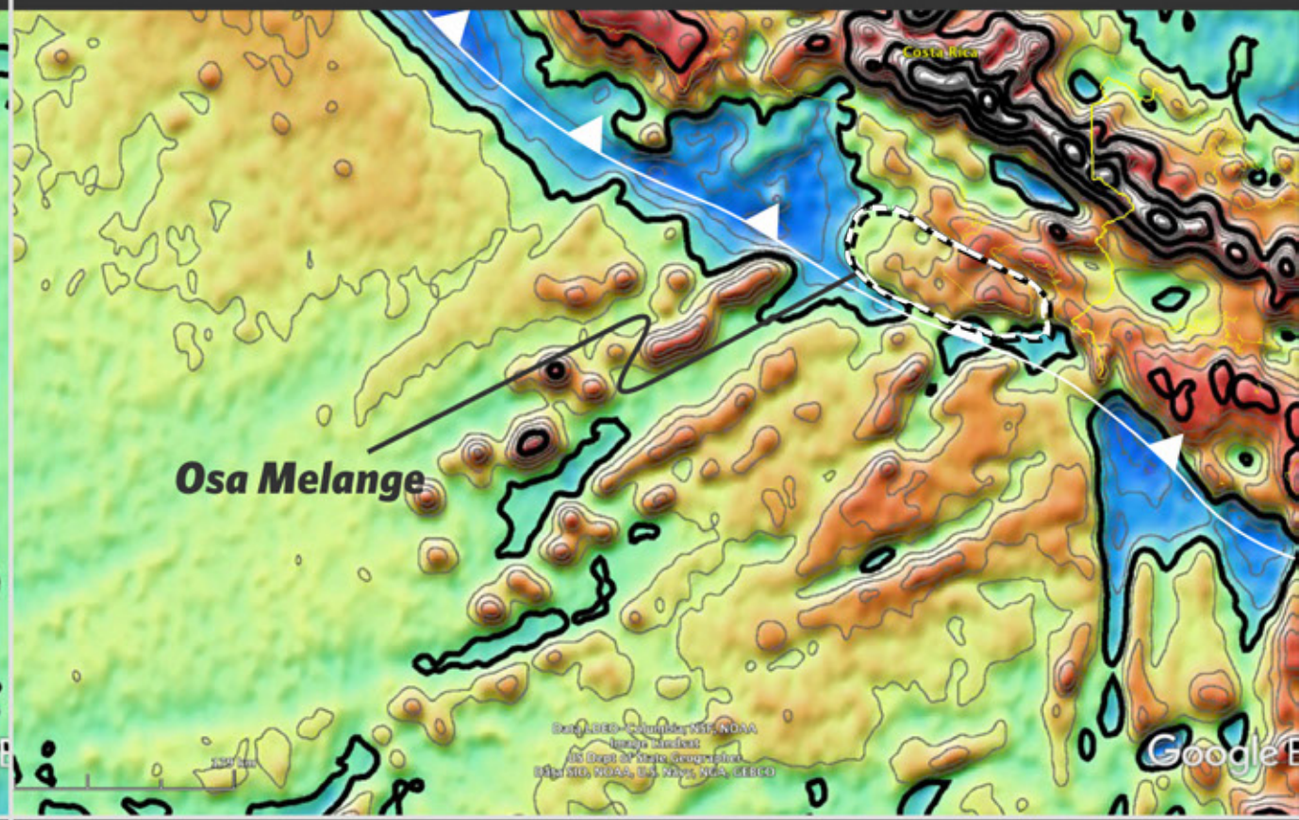
Background pelagic oceanic sediment

Isozaki et al. (2000); Tusky et al. (2013); Leslie et al., 2002; Tribble et al. (1993); Watts et al. (1985); Garcia & Davis (2001)

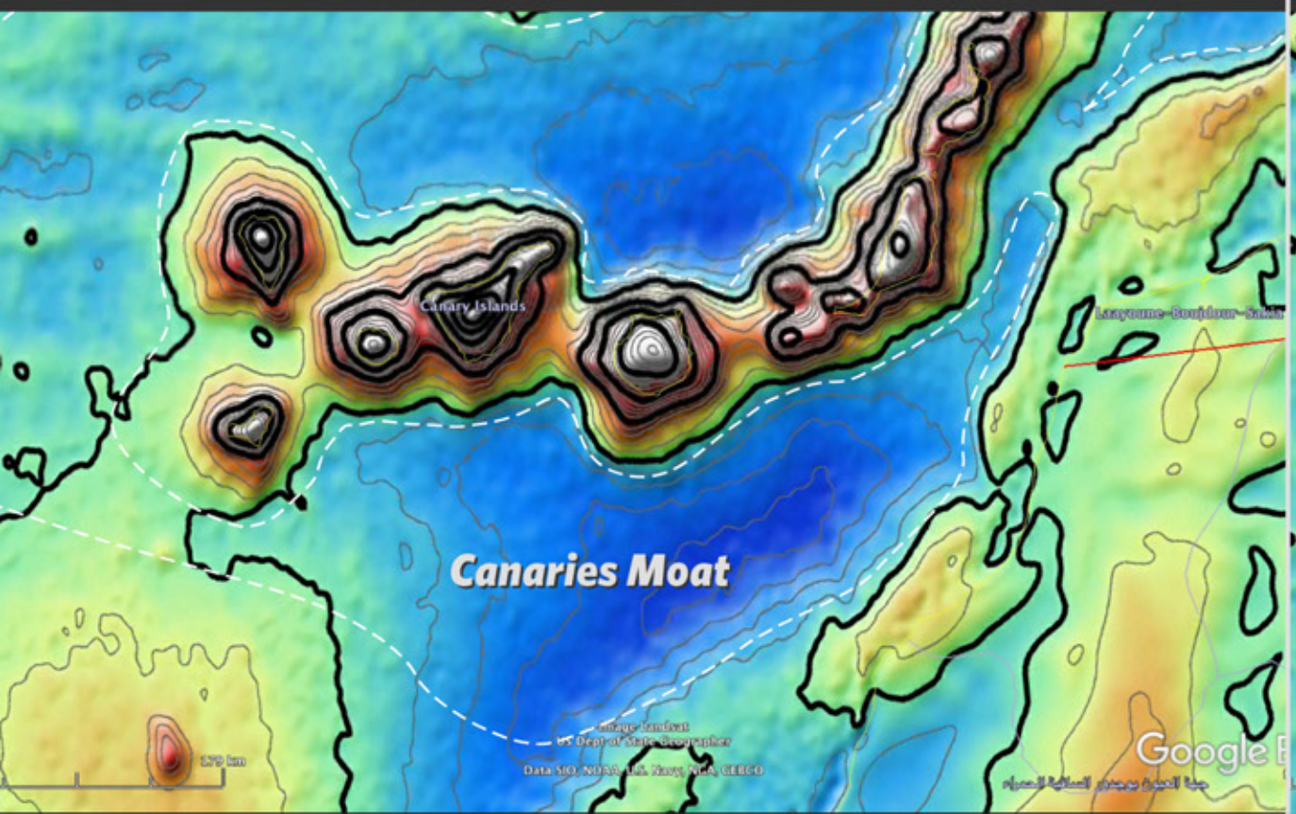
Hawaii



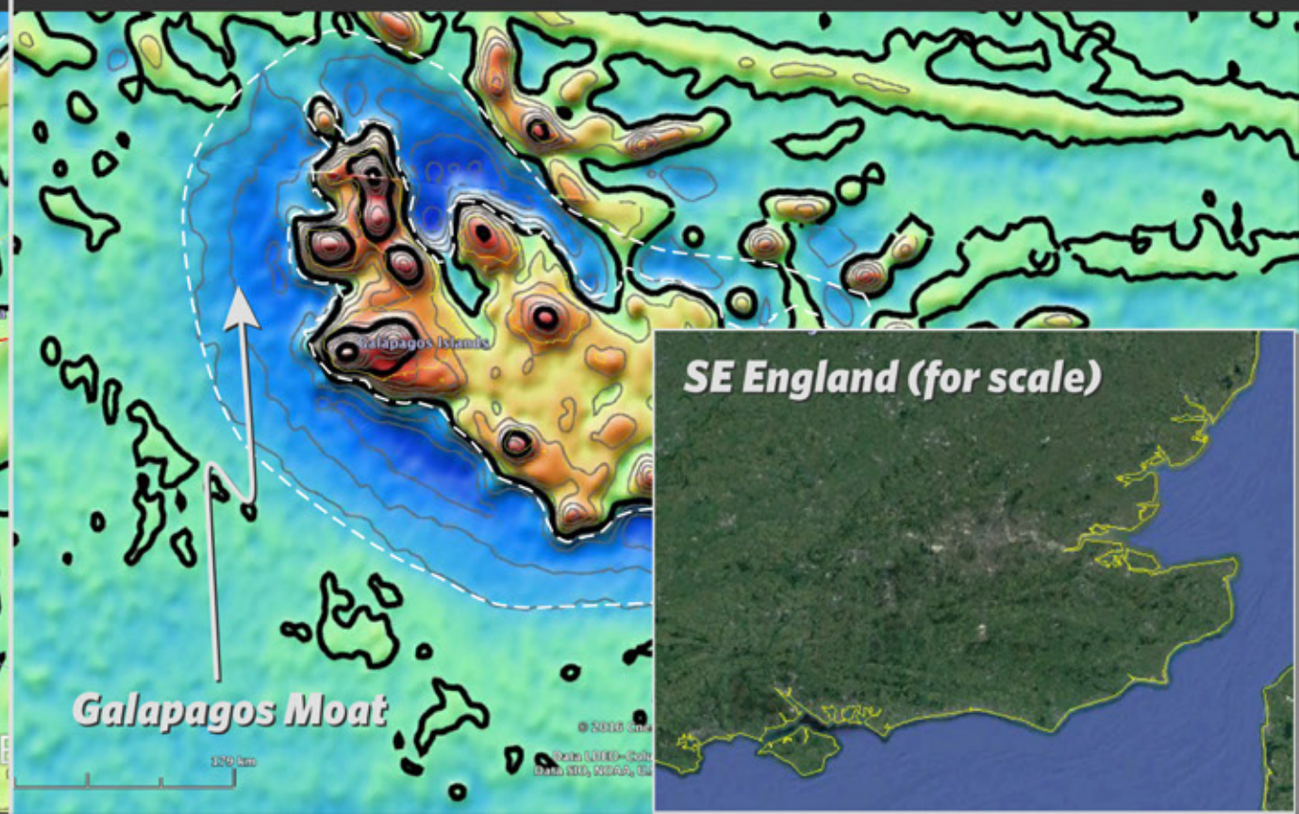
Costa Rica



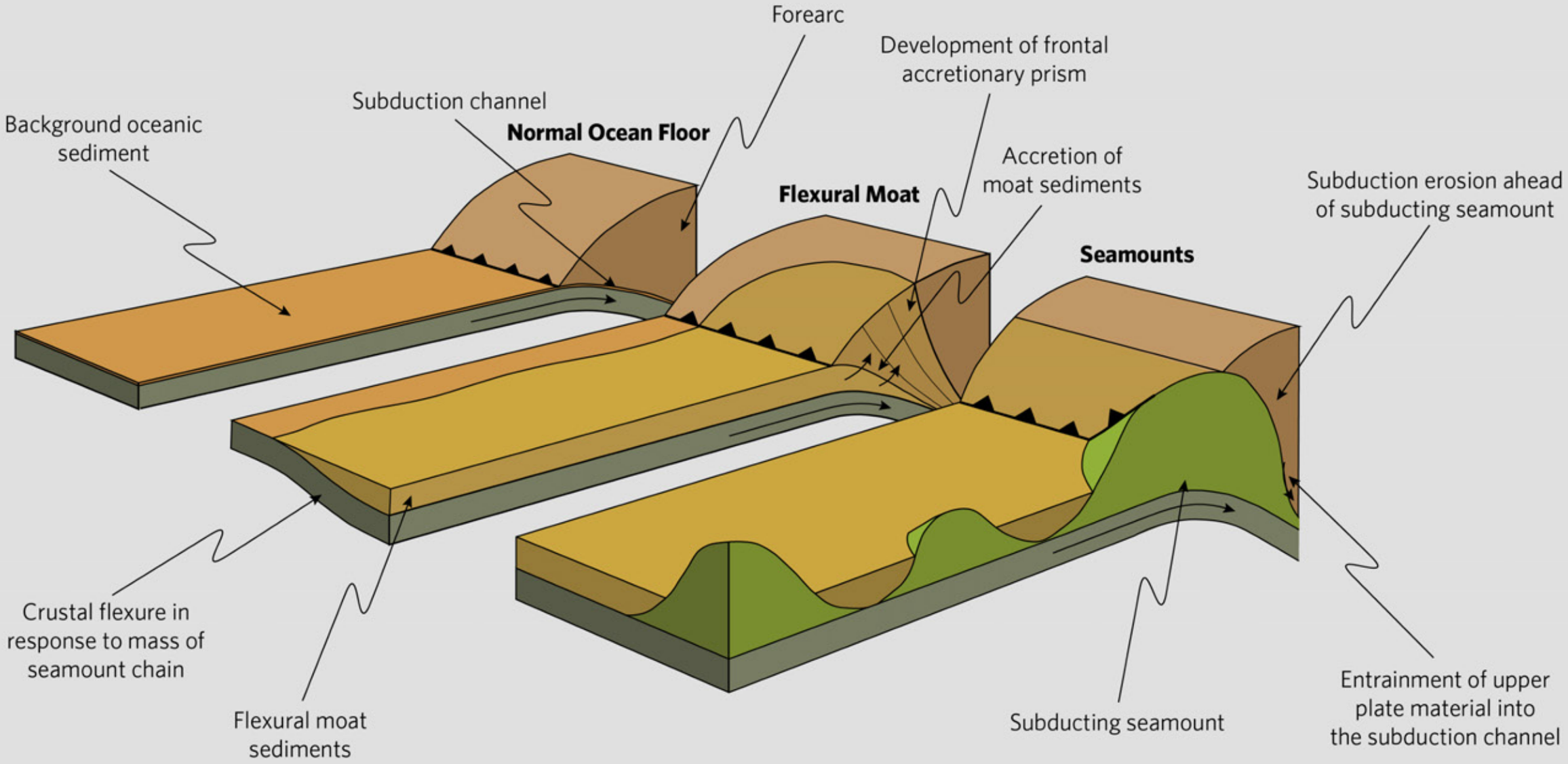
Canaries



Galapagos



Seamount Subduction Driving Concurrent Accretion & Erosion



Conclusions

*Osa Mélange has **too much sediment** to be derived from seamount flanks*

*Also **lacks arc or forearc material** expected in trench-fill*

Seamount chains are surrounded by moat basins

High sediments volumes make these likely to be preferentially accreted

Any Questions?

@beardyscientist

alexander.clarke.2014@live.rhul.ac.uk

Buchs, D.M., Baumgartner, P.O., Baumgartner-Mora, C., Bandini, A.N., Jackett, S.-J., Diserens, M.-O. & Stucki, J. 2009. Late Cretaceous to Miocene seamount accretion and melange formation in the Osa and Burica Peninsulas (Southern Costa Rica): episodic growth of a convergent margin. Geological Society, London, Special Publications, 328, 411–456, doi: 10.1144/SP328.17.

Buchs, D.M., Arculus, R.J., Baumgartner, P.O., Baumgartner-Mora, C. & Ulianov, A. 2010. Late Cretaceous arc development on the SW margin of the Caribbean Plate: Insights from the Golfito, Costa Rica, and Azuero, Panama, complexes. Geochemistry, Geophysics, Geosystems, 11, 1–35, doi: 10.1029/2009GC002901.

Clift, P.D. & Vannucchi, P. 2004. Controls on tectonic accretion versus erosion in subduction zones: Implications for the origin and recycling of the continental crust. Review of Geophysics, 42, doi: 10.1029/2003RG000127.

Garcia, M.O. & Davis, M.G. 2001. Submarine growth and internal structure of ocean island volcanoes based on submarine observations of Mauna Loa volcano , Hawaii. Geology, 2, 163–166.

Isozaki, Y., Marayama, S. & Furuoka, F. 1990. Accreted oceanic materials in Japan. Tectonophysics, 181, 179–205.

Kopp, H., Flueh, E.R., Petersen, C.J., Weinrebe, W., Wittwer, A. & Scientists, M. 2006. The Java margin revisited : Evidence for subduction erosion off Java. Earth and Planetary Science Letters, 242, 130–142, doi: 10.1016/j.epsl.2005.11.036.

Leslie, S.C., Moore, G.F., Morgan, J.K. & Hills, D.J. 2002. Seismic stratigraphy of the Frontal Hawaiian Moat : implications for sedimentary processes at the leading edge of an oceanic hotspot trace. Marine Geology, 184.

Ranero, C.. & von Huene R. 2000. Subduction erosion along the Middle America convergent margin. Nature, 404, 748–752, doi: 10.1038/35008046.

Tribble, J.S., Wilkens, R., Arvidson, R.S. & Busing, C.J. 1993. Sediments Of The Hawaiian Arch: X-Ray Mineralogy And Microfabric. Proceedings of the Ocean Drilling Program, Scientific Results, 136, 65 – 76.

Vannucchi, P., Fisher, D.M., Bier, S. & Gardner, T.W. 2006. From seamount accretion to tectonic erosion: Formation of Osa Mélange and the effects of Cocos Ridge subduction in southern Costa Rica. Tectonics, 25, TC2004, doi: 10.1029/2005TC001855.

Watts, A.B., Brink, U.S. ten, Buhl, P. & Brocher, T.M. 1985. A multichannel seismic study of lithospheric flexure across the Hawaiian-Emperor seamount chain. Nature, 315, 105 – 111.