

Title	Deep drilling of the Amazon continental margin: The evolution of Cenozoic neotropical biodiversity, climate, and oceanography		
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Abstract

We propose a set of three carefully chosen drill sites located in shallow water (289 to 441 m) on the uppermost continental slope to the west of, and apart from, the Amazon Fan. Here we will drill the upper part of the long-lived Foz do Amazonas basin of the equatorial margin of Brazil. Together, these sites will recover a complete, high-resolution sedimentary sequence spanning nearly the entire Cenozoic. Their particular outer shelf/upper slope location minimizes the (still-significant) influence of sea level variation on the sedimentary record. Their location proximal to the continent and down-current of the outlet of the modern Amazon River ensures that these sediments will contain an abundance of terrigenous materials including pollen, organic matter, zircon grains, and clay minerals, which will allow a detailed reconstruction of the biodiversity, climate, and hydrology of the adjacent tropical South American continent. At the same time, an abundance of well-preserved marine microfossils and organic matter will allow accurate determination of the age and oceanographic conditions of the western equatorial Atlantic that partly forced the climate of the adjacent continent.

Our reconstructions of the spatial patterns of biodiversity and climate through time will be interpreted with the knowledge that the geometry of the watersheds that contributed water and sediment to the coastal Atlantic was itself rearranged through time. For example, a trans-continental proto-Amazon did not likely reach the Atlantic until somewhere between 11 and 2 Ma, a date that we expect to determine very accurately. Prior to that event, terrigenous sediments at our sites were derived from smaller coastal rivers draining watersheds limited to the eastern tropics of northeastern South America.

This record is the marine complement to a transect of continental drill sites proposed in a related IODP proposal (funded in June 2017), which together form the "Trans-Amazon Drilling Project" (TADP). This undertaking addresses fundamental questions about the Cenozoic climatic evolution of the Amazon region, the origins and evolution of the neotropical rain forest and its incomparable biodiversity, the paleoceanographic history of the western equatorial Atlantic, and the origins of the transcontinental Amazon River. These studies will transform our understanding of Amazonian geological, climatic, and biological history.

Scientific Objectives

- (1) To generate the longest and most continuous record of Cenozoic South American climate at unprecedented resolution.
- (2) To reconstruct the oceanographic conditions of the western tropical Atlantic that, in part, were responsible for forcing the climate of the adjacent continent.
- (3) To generate a continuous palynological record of the biodiversity and composition of the forests and savannahs of eastern tropical South America from the early Cenozoic until the late Cenozoic establishment of the trans-continental Amazon.
- (4) To obtain an integrated record of the more recent history of the forests and savannahs of the entire Amazon and tropical Andes, commencing with the establishment of the trans-continental Amazon drainage into the Atlantic.
- (5) To determine the timing of the onset of trans-continental drainage of the proto-Amazon River into the Atlantic and the changing rates of proto-Amazon discharge.
- (6) To provide critical marine biostratigraphic control for correlation with Trans-Amazon Drilling Project continental drilling sites in the Marajó and eastern Amazonas basins.
- (7) To test major hypotheses about the originations and extinctions of the biota of tropical South America in the context of the changing climate, hydrology, tectonics, and oceanography.

Non-standard measurements technology needed to achieve the proposed scientific objectives

Proposed Sites (Total proposed sites: 11; pri: 3; alt: 8; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
AM-03B (Primary)	4.661765639 -50.025231	441	1631	0	1631	Drill a continuous Quaternary-to-late Eocene section from sea-floor down to 1631 mbsf to provide a record of the climatic and biotic evolution of the Amazon rainforest, the origins of the transcontinental Amazon River and Amazon Fan, and the paleoceanographic history of the western equatorial Atlantic. Investigate the changes in provenance of the terrigenous components to determine the changes from an Eastern Amazon forest signature to a basin-wide signature of the entire Amazon and Andean forest.
AM-04B (Alternate)	4.628938222 -50.08949344	227	2176	0	2176	Drill a continuous Quaternary-to-Paleocene section from sea-floor down to 2176 mbsf to provide a record of the climatic and biotic evolution of the Amazon rainforest, the origins of the transcontinental Amazon River and Amazon Fan, and the paleoceanographic history of the western equatorial Atlantic. Investigate the changes in provenance of the terrigenous components to determine the changes from an Eastern Amazon forest signature to a basin-wide signature of the entire Amazon and Andean forest.
AM-05A (Alternate)	4.590211167 -50.06301725	208	1591	0	1591	Drill a continuous Quaternary-to-Late Eocene section from sea-floor down to 1591 mbsf to provide a record of the climatic and biotic evolution of the Amazon rainforest, the origins of the transcontinental Amazon River and Amazon Fan, and the paleoceanographic history of the western equatorial Atlantic. Investigate the changes in provenance of the terrigenous components to determine the changes from an Eastern Amazon forest signature to a basin-wide signature of the entire Amazon and Andean forest.
AM-06A (Alternate)	4.620270472 -50.00417692	383	1705	0	1705	Drill a continuous Quaternary-to-Late Eocene section from sea-floor down to 1705 mbsf to provide a record of the climatic and biotic evolution of the Amazon rainforest, the origins of the transcontinental Amazon River and Amazon Fan, and the paleoceanographic history of the western equatorial Atlantic. Investigate the changes in provenance of the terrigenous components to determine the changes from an Eastern Amazon forest signature to a basin-wide signature of the entire Amazon and Andean forest.
AM-07A (Primary)	5.073426194 -50.40431625	373	2203	0	2203	Drill a continuous Quaternary-to-Paleocene section from sea-floor down to 2203 mbsf to provide a record of the climatic and biotic evolution of the Amazon rainforest, the origins of the transcontinental Amazon River and Amazon Fan, and the paleoceanographic history of the western equatorial Atlantic. Investigate the changes in provenance of the terrigenous components to determine the changes from an Eastern Amazon forest signature to a basin-wide signature of the entire Amazon and Andean forest.
AM-08A (Alternate)	4.68465323 -50.09770589	291	1605	0	1605	Drill a continuous Quaternary-to-Late Eocene section from sea-floor down to 1605 mbsf to provide a record of the climatic and biotic evolution of the Amazon rainforest, the origins of the transcontinental Amazon River and Amazon Fan, and the paleoceanographic history of the western equatorial Atlantic. Investigate the changes in provenance of the terrigenous components to determine the changes from an Eastern Amazon forest signature to a basin-wide signature of the entire Amazon and Andean forest.
AM-09A (Alternate)	4.604061167 -50.03590653	281	1668	0	1668	Drill a continuous Quaternary-to-Late Eocene section from sea-floor down to 1668 mbsf to provide a record of the climatic and biotic evolution of the Amazon rainforest, the origins of the transcontinental Amazon River and Amazon Fan, and the paleoceanographic history of the western equatorial Atlantic. Investigate the changes in provenance of the terrigenous components to determine the changes from an Eastern Amazon forest signature to a basin-wide signature of the entire Amazon and Andean forest.
AM-10A (Alternate)	4.949105111 -50.25615075	475	2236	0	2236	Drill a continuous Quaternary-to-Paleocene section from sea-floor down to 2236 mbsf to provide a record of the climatic and biotic evolution of the Amazon rainforest, the origins of the transcontinental Amazon River and Amazon Fan, and the paleoceanographic history of the western equatorial Atlantic. Investigate the changes in provenance of the terrigenous components to determine the changes from an Eastern Amazon forest signature to a basin-wide signature of the entire Amazon and Andean forest.

Proposed Sites (Continued; total proposed sites: 11; pri: 3; alt: 8; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
AM-11A (Primary)	4.76049915 -50.18515796	289	1995	0	1995	Drill a continuous Quaternary-to-Paleocene section from sea-floor down to 1995 mbsf to provide a record of the climatic and biotic evolution of the Amazon rainforest, the origins of the transcontinental Amazon River and Amazon Fan, and the paleoceanographic history of the western equatorial Atlantic. Investigate the changes in provenance of the terrigenous components to determine the changes from an Eastern Amazon forest signature to a basin-wide signature of the entire Amazon and Andean forest.
AM-12A (Alternate)	4.71438277 -50.13066275	291	2213	0	2213	Drill a continuous Quaternary-to-Paleocene section from sea-floor down to 2213 mbsf to provide a record of the climatic and biotic evolution of the Amazon rainforest, the origins of the transcontinental Amazon River and Amazon Fan, and the paleoceanographic history of the western equatorial Atlantic. Investigate the changes in provenance of the terrigenous components to determine the changes from an Eastern Amazon forest signature to a basin-wide signature of the entire Amazon and Andean forest.
AM-13A (Alternate)	4.69819453 -50.11117101	312	1519	0	1519	Drill a continuous Quaternary-to-Late Eocene section from sea-floor down to 1519 mbsf to provide a record of the climatic and biotic evolution of the Amazon rainforest, the origins of the transcontinental Amazon River and Amazon Fan, and the paleoceanographic history of the western equatorial Atlantic. Investigate the changes in provenance of the terrigenous components to determine the changes from an Eastern Amazon forest signature to a basin-wide signature of the entire Amazon and Andean forest.