IODP Proposal Cover Sheet

1003 - Pre 2

N. CAVA Volcanic Ash

Received for: 2021-10-01

Title	Rhythms, Magnitude, and Impacts of Volcanic Ash from Explosive Central American Arc Eruptions
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Keywords	Volcanic ash, Paleo-volcanism, geochemistry, biosphere
Area	Southern Mexico and Northern Central America

Proponent Information

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Abstract

Forecasting volcanic hazards is essential for protecting society, but the drivers and rhythms of eruptions are not well understood and limit predictive models. Alteration of volcanogenic material in marine sediment has been shown to play an important role in carbon cycling with consequences that may impact climate, but the extent of these interactions is far from clear. To move forward we need to understand the feedback mechanisms and relationships of volcanic ash with deep earth processes, the biosphere, and climate. This project proposes to test four hypotheses: (1a) The rhythms of volcanic activity from the Southern Mexico and Northern Central American volcanic arcs are correlated with glacial-interglacial cycles and/or tectonic events. (1b) Changes in the composition of volcanogenic material deposited over time reflect the evolution of the volcanic arc and reflect changes in sediment composition being subducted to the arc. (2a) The presence of reactive silicates in volcanogenic material plays a major role in the carbon and silica cycles that determine whether CO2 is released from or sequestered in the sediment. (2b) Microbial abundance, composition, and activity are controlled by the presence of volcanogenic material and its degree of alteration and/or diagenesis. To test these hypotheses, we propose to (A) construct ~750kyr to 7.5Myr records of the frequency, magnitude, and composition of the volcanic ash (layers and dispersed) in the marine sediments offshore of Southern Mexico and Northern Central America; and (B) constrain the effects of subseafloor post-depositional alteration of volcanogenic material on carbon cycling pathways and the subseafloor biosphere. Completion of these objectives requires drilling 20 sites along the margin of Southern Mexico and the Northern Central American Volcanic Arc where a prolific amount of volcanic ash is buried in the seafloor. Utilizing modern drilling techniques, novel analytical approaches to characterize sediment and pore water, and state of the art biosphere sampling and analyses, the project will generate research opportunities beyond what can be achieved with the marine sediment drilled on earlier DSDP/ODP/IODP expeditions. The resulting research will reveal the role of volcanic ash in deep sea carbon preservation and the biosphere and decipher the relationship and strength of external factors modulating volcanic hazards, thereby helping improve predictions of future explosive volcanic hazards.

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Scientific Objectives

Hypothesis 1a: The rhythms of volcanic activity from the Southern Mexico and Northern Central American volcanic arcs are correlated with glacial-interglacial cycles and/or tectonic events.

Hypothesis 1b: Temporal changes in the composition of volcanogenic material reflect the evolution of the volcanic arc and reflect changes in sediment composition being subducted to the arc.

Hypothesis 2a: The presence of reactive silicates in volcanogenic material plays a major role in the carbon and silica cycles that determine whether CO2 is released from or sequestered in the sediment.

Hypothesis 2b: Microbial abundance, composition, and activity are controlled by the presence of volcanogenic material and its degree of alteration and/or diagenesis.

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

Mission Specific Platform for giant piston coring 60-75m of marine sediment with detailed stratigraphy intact in 1500-4800 m of water.

Have you contacted the appropriate IODP Science Operator about this proposal to discuss drilling platform capabilities, the feasibility of your proposed drilling plan and strategies, and the required overall timetable for transiting, drilling, coring, logging, and other downhole measurements?

yes

Science Communications Plain Language Summary

Using simple terms, describe in 500 words or less your proposed research and its broader impacts in a way that can be understood by a general audience.

Predicting volcanic hazards is essential for protecting society, but why or how often volcanoes erupt is not well understood and limits forecasting abilities. Additionally, when volcanic ash is blown by the wind into the ocean and sinks to the seafloor, there are chemical reactions that change the ash and affect the chemistry of carbon. For reasons not well understood, sometimes carbon is stored as a mineral that stays in the sediment below the seafloor and other times it returns to the surface world as carbon dioxide. These chemical reactions involving ash could also be a source of food and energy for microscopic lifeforms that live in the ocean floor. To understand the nature of life on our planet, the chemical reactions that decide how much carbon stays in the sediment below the seafloor, and why and how often volcanoes erupt we propose to study the biology, chemistry, and history of volcanic ash that sinks to the seafloor.

We will study ash that erupted from volcanoes in Southern Mexico and Northern Central America, one of the most volcanically active regions in the world. We propose to core 75 meters of sediment from the seafloor in 20 different locations, some of which will have sediment as old as 750 thousand years and other sites that have sediment as old as 7.5 million years. We will look at how frequently layers of ash sank to the seafloor and how much of the ash is mixed into the surrounding sediment (not in a layer). The amount of ash in the different layers of sediment is a history of volcanic activity that we will compare to known changes in climate and tectonic events to see if there is a relationship. When the tectonic plate below the ocean collides into the tectonic plates of Mexico and Central America, some of the marine sediment goes into the mantle and is melted back into lava, which can be re-erupted another time. We will figure out if there was enough volcanic ash transported below Central America in the past to change the composition of volcanic ash (re-)erupted over time and possibly into the future. Analyzing the water squeezed out of the sediment and the sediment itself will allow us to determine what chemical reactions are occurring in different types of sediment and if carbon is stored in the seafloor or escapes. We will also analyze the amount and genetic makeup of the microscopic lifeforms living in the volcanic ash layers and see how they are different from the lifeforms living in the other types of sediment on the seafloor. The results of the study will make significant advances in the chemistry, biology, and history of volcanic ash and help society understand how carbon behaves in different parts of the seafloor, the nature of life in remote parts of Earth, and the future of volcanic hazards.

Proposal History

Submission Type: Resubmission from previously submitted proposal

Review Response

After discussing the reviews of the original pre-proposal with the SEP and ECORD watchdogs, we have changed the plan for coring logistics. We reduced the number of primary sites and are now proposing to use the giant piston coring system, the Calypso, on the RV Marion Dufresne to recover 60-75m of marine sediment. We have been in touch with coring operations personnel of the RV Marion Dufresne to confirm their interest and the feasibility of the project. Details regarding sedimentation rates predicted for each site have been added to elaborate on how these 60-75m cores will allow us to achieve our objectives over multiple timescales. Additionally, we have submitted a separate proposal for an independent cruise that would collect the site survey data required by the “Guidelines for Site Characterization Data” for this MSP proposal to proceed.

In the main text, we have clarified the volcanic mechanisms involved in hypotheses 1a and 1b and added additional detail as to how we will test these hypotheses. We also added text mentioning how intertwined the chemistry and microbiology are in the system we propose to study. Finally, we clarified why offshore Southern Mexico and Northern Central America are the ideal locations to test our hypotheses and included more explicit reasons why the existing cores that have been recovered are inadequate to achieve the objectives of this proposal.

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Proposed Sites (Total proposed sites: 56; pri: 20; alt: 36; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
CA-01A (Primary)	10.4360 -87.4909	2845	75	0	75	Site CA-1 records the recent to Late Pliocene (35m/Myr=~ 2.14Ma) volcanic history of Central Nicaragua. The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mafic and felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.
CA-02A (Alternate)	10.4300 -87.4764	2884	75	0	75	Site CA-2 records the recent to Late Pliocene (35m/Myr=~2.14Ma) volcanic history of Central Nicaragua. The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. Ash composition is both mafic and felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.
CA-03A (Primary)	11.3345 -87.3061	1208	75	0	75	Site CA-3 records the recent to Late Pliocene (100m/Myr=0.75Ma) volcanic history of Central Nicaragua. The record of proximal deposition will contribute to the volumetric estimates of erupted material. The ash composition is mafic and felsic and deposited in a methanic environment on the continental slope (landward side of trench), creating a distinct combination of variables that can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.
CA-04A (Alternate)	11.3332 -87.3064	1220	75	0	75	Site CA-4 records the recent to Late Pliocene (100m/Myr=~ 0.75Ma) volcanic history of Central Nicaragua. The record of proximal deposition at this site will contribute to the volumetric estimates of erupted material. Ash composition is mafic and felsic and deposited in a methanic environment on the continental slope creating a distinct combination of variables that can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.
CA-05A (Primary)	11.1007 -87.8345	3354	75	0	75	Site CA-5 records the recent to Late Pliocene (35m/Myr=2.14Ma) volcanic history of Central Nicaragua. The record of mid-distance deposition will contribute to the volumetric estimates of erupted material. The ash composition is mafic and felsic and deposited in a suboxic/ sulfidic environment on the incoming plate (seaward side of trench), creating a distinct combination of variables that influences the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.
CA-06A (Alternate)	11.1007 -87.8383	3327	75	0	75	Site CA-6 records the recent to Late Pliocene (35m/Myr = ~ 2.14Ma) volcanic history of Central Nicaragua. Mid-distance deposition at this site will contribute to the volumetric estimates of erupted material. Ash composition is mafic and felsic and deposited in a suboxic/sulfidic environment (incoming plate, seaward side of trench), creating a distinct combination of variables that can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.

Proposed Sites (Continued; total proposed sites: 56; pri: 20; alt: 36; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
CA-07A (Primary)	10.7212 -88.9028	3292	75	0	75	Site CA-7 records the recent to Late Pliocene (40m/Myr = ~ 1.875Ma) volcanic history of Central Nicaragua. The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more mafic than felsic and deposited in a oxic/ suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-08A (Alternate)	10.7213 -88.9031	3292	75	0	75	Site CA-8 records the recent to Late Pliocene (40m/Myr = ~ 1.875Ma) volcanic history of Central Nicaragua. The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more mafic than felsic and deposited in a oxic/ suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-09A (Primary)	11.6226 -89.1228	3633	75	0	75	Site CA-9 records the recent to Early Pleistocene (60m/Myr = ~ 1.25Ma) volcanic history of Northern Nicaragua (Cosiqüina volcano) and Southern El Salvador (San Miguel). The record of mid-distance deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more mafic than felsic and deposited in a suboxic/sulfidic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-10A (Alternate)	11.6223 -89.1227	3633	75	0	75	Site CA-10 records the recent to Early Pleistocene (60m/Myr = ~ 1.25Ma) volcanic history of Northern Nicaragua (Cosiqüina volcano) and Southern El Salvador (San Miguel). The record of mid-distance deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more mafic than felsic and deposited in a suboxic/sulfidic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-11A (Alternate)	11.9125 -89.7769	3950	75	0	75	Site CA-11 records the recent to Late Miocene (12m/Myr = ~ 6.25Ma) volcanic history of Southern El Salvador (San Miguel and Berlin and Pacaya Caldera). The record of mid-distance deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more mafic than felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy. It will also be used for comparing microbial communities amongst sediments of various ages.
CA-12A (Alternate)	11.9126 -89.7763	3947	75	0	75	Site CA-12 records the recent to Late Miocene (12m/Myr = ~ 6.25Ma) volcanic history of Southern El Salvador (San Miguel and Berlin and Pacaya Caldera). The record of mid-distance deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more mafic than felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-13A (Primary)	11.3836 -90.5815	3691	75	0	75	Site CA-13 records the recent to Late Miocene (10m/Myr = ~ 7.5Ma) volcanic history of El Salvador and distal Nicaragua eruptions. The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mafic and felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy. It will also be used for comparing microbial communities amongst sediments of various ages.
CA-14A (Alternate)	11.3762 -90.5750	3695	75	0	75	Site CA-14 records the recent to Late Miocene (10m/Myr = ~ 7.5Ma) volcanic history of El Salvador and distal Nicaragua eruptions. The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is both mafic and felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.

Proposed Sites (Continued; total proposed sites: 56; pri: 20; alt: 36; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
CA-15A (Alternate)	11.7453 -90.5184	3593	75	0	75	Site CA-15 records the recent to Middle Miocene (8m/Myr = ~ 9.375Ma) volcanic history of Central El Salvador (Ilopango Caldera). The record of mid-distance deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more felsic than mafic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy. It will also be used for comparing microbial communities amongst sediments of various ages.
CA-16A (Alternate)	11.7486 -90.5156	3651	75	0	75	Site CA-16 records the recent to Middle Miocene (8m/Myr = ~ 9.38Ma) volcanic history of Central El Salvador (Ilopango Caldera). The record of mid-distance deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more felsic than mafic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-17A (Primary)	12.9366 -90.8378	2745	75	0	75	Site CA-17 records the recent to Mid-Pleistocene (100m/Myr=0.75Ma) volcanic history of Southern Guatemala and Northern El Salvador (Coatepeque/Ayarza Calderas). The record of proximal deposition will contribute to the volumetric estimates of erupted material. Ash composition is more felsic than mafic and deposited in methanic (gas hydrates) environments on the continental slope (landward side of trench), which influences the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.
CA-18A (Alternate)	12.9357 -90.8451	2809	75	0	75	Site CA-18 records the recent to Mid-Pleistocene (100m/Myr = ~ 0.75Ma) volcanic history of Southern Guatemala and Northern El Salvador (Coatepeque/Ayarza Calderas). The proximal deposition will contribute to volumetric estimates of erupted material. Ashes are more felsic than mafic and deposited in a methanic (gas hydrates) environment on the continental slope, creating a distinct combination of variables that can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.
CA-19A (Primary)	12.4920 -91.0349	4176	75	0	75	Site CA-19 records the recent to Pliocene (23m/Myr = ~ 3.26Ma) volcanic history of El Salvador and Guatemala (Coatepeque/Ilopango/ Ayarza Calderas). The record of mid-distance deposition will contribute to the volumetric estimates of erupted material. Ash composition is more felsic than mafic and deposited in a sulfidic environment on the incoming plate (seaward side of trench), which influences the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.
CA-20A (Alternate)	12.4922 -91.0364	4200	75	0	75	Site CA-20 records the recent to Pliocene (23m/Myr = ~ 3.26Ma) volcanic history of El Salvador and Guatemala (Coatepeque/Ilopango/ Ayarza Calderas). Record of mid-distance deposition will facilitate volumetric estimates of erupted material. Ashes are more felsic than mafic and deposited in a sulfidic environment on the incoming plate (seaward side of trench), creating a distinct combination of variables that influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.

Proposed Sites (Continued; total proposed sites: 56; pri: 20; alt: 36; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
CA-21A (Primary)	12.2510 -91.5107	3693	75	0	75	Site CA-21 records the recent to Early Pleistocene (60m/Myr = ~ 1.25Ma) volcanic history of Southern Guatemala and Northern El Salvador (Coatepeque/Ilopango/Ayarza Calderas). The record of distal deposition will contribute to the volumetric estimates of erupted material. Ash composition is more felsic than mafic and deposited in a oxic/ suboxic environment on the abyssal plain, which can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.
CA-22A (Alternate)	12.2507 -91.5103	3693	75	0	75	Site CA-22 records the recent to Early Pleistocene (60m/Myr = ~ 1.25Ma) volcanic history of Southern Guatemala/Northern El Salvador (Coatepeque/Ilopango/Ayarza Calderas). Distal deposition at this site facilitates volumetric estimates of erupted material. Ashes are more felsic than mafic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.
CA-23A (Alternate)	12.5650 -92.0340	3843	75	0	75	Site CA-23 records the recent to Middle Miocene (8m/Myr = ~ 9.375Ma) volcanic history of Central Guatemala (Ayarza, Amatilán and Atitlán calderas). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mostly felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy. It will also be used for comparing microbial communities amongst sediments of various ages.
CA-24A (Alternate)	12.5660 -92.0331	3844	75	0	75	Site CA-24 records the recent to Middle Miocene (8m/Myr = ~ 9.375Ma) volcanic history of Central Guatemala (Ayarza, Amatilán and Atitlán calderas). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mostly felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-25A (Primary)	12.3280 -92.7074	3933	75	0	75	Site CA-25 records the recent to ~Late Miocene volcanic history of Central Guatemala and distal N. El Salvador . The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mostly felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-26A (Alternate)	12.3203 -92.6974	3932	75	0	75	Site CA-26 records the recent to ~Late Miocene volcanic history of Central Guatemala and distal N. El Salvador . The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mostly felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-27A (Alternate)	12.8990 -92.6549	3946	75	0	75	Site CA-27 records the recent to ~Pliocene volcanic history of Central and Northern Guatemala (Amatilán and Atitlán). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mostly felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.

Proposed Sites (Continued; total proposed sites: 56; pri: 20; alt: 36; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
CA-28A (Alternate)	12.8937 -92.6636	3954	75	0	75	Site CA-28 records the recent to ~Pliocene volcanic history of Central and Northern Guatemala (Amatilán and Atitlán). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mostly felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-29A (Primary)	13.3058 -93.3695	4005	75	0	75	Site CA-29 records the recent to ~Pliocene volcanic history of Southernmost Mexico (Chiapanecan Volcanic Arc, El Chichon) and Northern Guatemala (Atitlán Caldera). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more felsic than mafic and deposited in a oxic/ suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-30A (Alternate)	13.3021 -93.4010	4001	75	0	75	Site CA-30 records the recent to ~Pliocene volcanic history of Southernmost Mexico (Chiapanecan Volcanic Arc, El Chichon) and Northern Guatemala (Atitlán Caldera). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more felsic than mafic and deposited in a oxic/ suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-31A (Primary)	13.0064 -94.1796	4072	75	0	75	Site CA-31 records the recent to ~Late Miocene volcanic history of Southernmost Mexico (Chiapanecan Volcanic Arc, El Chichon) and Northern Guatemala (Atitlán Caldera). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more felsic than mafic and deposited in a oxic/ suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-32A (Alternate)	13.0002 -94.1849	4077	75	0	75	Site CA-32 records the recent to ~Late Miocene volcanic history of Southernmost Mexico (Chiapanecan Volcanic Arc, El Chichon) and Northern Guatemala (Atitlán Caldera). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more felsic than mafic and deposited in a oxic/ suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-33A (Alternate)	13.7058 -94.1048	4185	75	0	75	Site CA-33 records the recent to Pliocene volcanic history of Southern Mexico (Chiapanecan Volcanic Arc, El Chichon) . The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is predicted to be both mafic and felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-34A (Alternate)	13.7004 -94.1077	4180	75	0	75	Site CA-34 records the recent to Pliocene volcanic history of Southern Mexico (Chiapanecan Volcanic Arc, El Chichon) . The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is predicted to be both mafic and felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-35A (Alternate)	14.0833 -94.7295	3999	75	0	75	Site CA-35 records the recent to Pliocene volcanic history of Southern Mexico (Chiapanecan Volcanic Arc, El Chichon) . The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is predicted to be both mafic and felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.

Proposed Sites (Continued; total proposed sites: 56; pri: 20; alt: 36; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
CA-36A (Alternate)	14.0809 -94.7348	4044	75	0	75	Site CA-36 records the recent to Pliocene volcanic history of Southern Mexico (Chiapanecan Volcanic Arc, El Chichon) . The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is predicted to be both mafic and felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-37A (Primary)	13.7776 -95.5946	3949	75	0	75	Site CA-37 records the recent to ~Late Miocene volcanic history of Southern Mexico (Chiapanecan Volcanic Arc, El Chichon) . The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is predicted to be both mafic and felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-38A (Alternate)	13.7664 -95.5884	3957	75	0	75	Site CA-38 records the recent to ~Late Miocene volcanic history of Southern Mexico (Chiapanecan Volcanic Arc, El Chichon) . The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is predicted to be both mafic and felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-39A (Alternate)	14.4536 -95.3600	4075	75	0	75	Site CA-39 records the recent to Pliocene volcanic history of Southern Mexico (in between volcanic arcs, less volcanogenic input). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The partly ash-free sediment is in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. Sites CA-39 and CA-41 have relatively little volcanogenic deposition and will act as a reference or control to investigate the differences in the microbial community and geochemsitry when ash is minimal.
CA-40A (Alternate)	14.4563 -95.3689	4068	75	0	75	Site CA-40 records the recent to Pliocene volcanic history of Southern Mexico (in between volcanic arcs, less volcanogenic input). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The partly ash-free sediment is in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. Sites CA-39 and CA-41 have relatively little volcanogenic deposition and will act as a reference or control to investigate the differences in the microbial community and geochemsitry when ash is minimal.
CA-41A (Primary)	14.8428 -96.3616	3373	75	0	75	Site CA-41 records the recent to ~Late Pliocene volcanic history of Southern Mexico (in between volcanic arcs, less volcanogenic input); Maybe Trans Mexican Volcanic Belt. The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The partly ash-free sediment is in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. Sites CA-39 and CA-41 have relatively little volcanogenic deposition and will act as a reference or control to investigate the differences in the microbial community and geochemsitry when ash is minimal.
CA-42A (Alternate)	14.8194 -96.3629	3381	75	0	75	Site CA-42 records the recent to ~Late Pliocene volcanic history of Southern Mexico (in between volcanic arcs, less volcanogenic input); Maybe Trans Mexican Volcanic Belt. The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The partly ash-free sediment is in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. Sites CA-39 and CA-41 have relatively little volcanogenic deposition and will act as a reference or control to investigate the differences in the microbial community and geochemsitry when ash is minimal.
CA-43A (Primary)	14.3569 -97.1054	3584	75	0	75	Site CA-43 records the recent to Pliocene volcanic history of Southern Mexico (Southern Trans Mexican Volcanic Belt). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more felsic than mafic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.

Proposed Sites (Continued; total proposed sites: 56; pri: 20; alt: 36; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
CA-44A (Alternate)	14.3583 -97.1245	3615	75	0	75	Site CA-44 records the recent to Pliocene volcanic history of Southern Mexico (Southern Trans Mexican Volcanic Belt). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more felsic than mafic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-45A (Alternate)	14.9925 -97.4532	3492	75	0	75	Site CA-45 records the recent to ~Late Pliocene volcanic history of Southern Mexico (Southern Trans Mexican Volcanic Belt). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more felsic than mafic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-46A (Alternate)	14.9830 -97.4429	3481	75	0	75	Site CA-46 records the recent to ~Late Pliocene volcanic history of Southern Mexico (Southern Trans Mexican Volcanic Belt). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is more felsic than mafic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-47A (Primary)	15.2169 -98.4423	3700	75	0	75	Site CA-47 records the recent to ~Late Pliocene volcanic history of Southern Mexico (Central Trans Mexican Volcanic Belt). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mostly felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-48A (Alternate)	15.2127 -98.4508	3567	75	0	75	Site CA-48 records the recent to ~Late Pliocene volcanic history of Southern Mexico (Central Trans Mexican Volcanic Belt). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mostly felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-49A (Primary)	15.4507 -99.3326	3539	75	0	75	Site CA-49 records the recent to Pliocene volcanic history of Central/ Southern Mexico (Trans Mexican Volcanic Belt). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mostly felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.
CA-50A (Alternate)	15.4472 -99.3210	4512	75	0	75	Site CA-50 records the recent to Pliocene volcanic history of Central/ Southern Mexico (Trans Mexican Volcanic Belt). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mostly felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-51A (Primary)	15.8504 -99.1735	4714	75	0	75	Site CA-51 records the recent to Pliocene (126m/Myr = ~ 0.6Ma) volcanic history of Central/Southern Mexico (Trans-Mexican Volcanic Belt). The record of mid-distance deposition will contribute to the volumetric estimates of erupted material. Ash composition is mostly felsic and deposited in a suboxic/sulfidic environment on the incoming plate (seaward side of trench), a distinct combination of variables that can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel microbiological and geochemical drivers and responses affiliated with ash alteration pathways.

Proposed Sites (Continued; total proposed sites: 56; pri: 20; alt: 36; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
CA-52A (Alternate)	15.8467 -99.1706	4699	75	0	75	Site CA-52 records the recent to Pliocene (~4Ma, non-linear sedimentation rate) volcanic history of Central/Southern Mexico (Trans Mexican Volcanic Belt). The record of mid-distance deposition facilitates volumetric estimates of erupted material. Ashes are mostly felsic and deposited in a suboxic/sulfidic environment on the incoming plate (seaward side of trench), creating a distinct combination of variables that can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.
CA-53A (Primary)	16.1560 -99.0546	1720	75	0	75	Site CA-53 records the recent to ~1Ma (100m/Myr = ~ 0.75Ma) volcanic history of Central/Southern Mexico (Trans-Mexican Volcanic Belt). The record of proximal deposition will contribute to the volumetric estimates of erupted material. Ashes are mostly felsic and deposited in a methanic (gas-hydrate) environment on the continental slope (landward side of trench), creating a distinct combination of variables that can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with ash alteration pathways.
CA-54A (Alternate)	16.1555 -99.0511	1708	75	0	75	Site CA-54 records the recent to ~1Ma volcanic history of Central/ Southern Mexico (Trans Mexican Volcanic Belt). The record of proximal deposition at this site will contribute to the volumetric estimates of erupted material. Ashes are mostly felsic and deposited in a methanic (gas hydrates) environment on the continental slope, creating a distinct combination of variables that can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.
CA-55A (Primary)	15.9297 -100.2825	3735	75	0	75	Site CA-55 records the recent to Pliocene volcanic history of Central/ Southern Mexico (Trans Mexican Volcanic Belt). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mostly felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. This site is key for connecting multiple records of regional stratigraphy.
CA-56A (Alternate)	15.9296 -100.2782	3753	75	0	75	Site CA-56 records the recent to Pliocene volcanic history of Central/ Southern Mexico (Trans Mexican Volcanic Belt). The record of distal deposition at this site will contribute to the volumetric estimates of erupted material. The ash composition is mostly felsic and deposited in a oxic/suboxic environment on the abyssal plain, creating a distinct combination of variables that can influence the geochemistry and biosphere. Collectively, the different combinations of ash compositions and geochemical environments at Sites CA-1, CA-3, CA-5, CA-17, CA-19, CA-21, CA-49, CA-51, CA-53 will unravel the microbiological and geochemical drivers and responses affiliated with various ash alteration pathways.