

IODP Proposal Cover Sheet

1005 - Full

Sunda Sea Level and Weathering

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Title	Carbon Storage, Climate, and Continental Weathering on Plio-Pleistocene Low Latitude Shelves: Evidence from the Sunda Shelf		
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Keywords	Weathering, Sea level, Biodiversity, Carbon	Area	Sunda Shelf, South China Sea

Proponent Information

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Abstract

The low-latitude tropics are affected by repeated emergence and submergence of some of the world's largest continental shelves. Initial studies suggest that enhanced chemical weathering and growth of rainforests during times of exposure have a significant effect on global atmospheric CO₂ levels. Unlike their high latitude equivalents, tropical shelves appear to have played a key role on regulating global climate since the Pliocene, but this is presently poorly understood because previous drilling has largely been on the continental slopes making measuring the weathering state of the exposed shelf difficult. The Sunda Shelf in SE Asia is the largest tropical shelf worldwide well-suited for comprehensive, high-resolution studies designed to reconstruct major geomorphic changes on a "Maritime Continent" and to assess associated interactions with global climate. Coupled with regional seismic data drilling will permit a weathering and CO₂ consumption budget to be reconstructed. Moreover, the Sunda Shelf has been the site of extensive methane-emitting wetlands during sea-level highstands that are eroded during regressions and that may further amplify climatic cycles. The sedimentary sequences will be used to evaluate the contribution of the glacial exposure of this major tropical shelf functioning as an enormous CO₂ and methane sink/source and as a second set of "Lungs of the Earth".

Scientific Objectives

Constrain the magnitude and timing of major sea-level variation across the Sunda Shelf in Southeast Asia and use this to better model global variations.

Constrain the duration of shelf exposure and measure of the amount of chemical weathering that occurs each time the continental shelf is exposed during sea level low stands.

Use volumetric estimates derived from the seismic survey to convert the degree of alteration determined from sediment geochemistry into a chemical weathering flux estimate and determine contribution to atmospheric CO₂.

Use a combination of organic chemistry and palynology to determine the type of vegetation that grew on the exposed continental shelf during periods of low sea level.

Measure of the amount of buried organic carbon in the exposed shelf sediments and use the regional seismic data to infer total amounts of carbon storage and recycling.

Constrain the development of river systems across the exposed shelf and in particular determine the boundary between the Johore and Mekong rivers.

Construct a carbon budget for SE Asia and determine its potential impact on the global cycles of warming and cooling since the start of the Pliocene.

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

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.

Cycles of global cooling and warming are largely driven by variations in the orbit of the Earth, which controls the amount of warmth that the planet receives. However, these cycles can be accentuated as a result of feedbacks. We explore the idea that tropical continental shelves play an important role in the waxing and waning of icesheets. Because the climate is warm and wet in the tropics, even during ice ages, the minerals in the sediments that are exposed when the sea level drops are prone to decay and this process removes CO₂ from the atmosphere. In addition, falling sealevel destroys coastal wetlands which are a major source of methane to the atmosphere. Methane is an even stronger greenhouse gas than carbon dioxide. Continental shelves exposed during glacial times provide ideal locations for the growth of tropical forests which store carbon and further reduce CO₂ in the atmosphere. While those in Africa and the Amazon remain much of the forest in SE Asia was drowned as sealevel rose after the last ice age. SE Asia has one of the largest continental shelves on Earth and is currently the largest source of methane to the atmosphere. Rising and falling of sea levels, together with the development of large river systems when the sea level is low, is thought to contribute to biological speciation and the development of the biodiversity hotspot in Southeast Asia. We propose to drill a series of holes across the Sunda Shelf, between Borneo and Vietnam, in order to quantify the amount of chemical weathering that occurs during each sealevel cycle. By drilling a transect of holes from shallow water towards the shelf edge we will be able to establish the magnitude and time of major sealevel cycles and in turn quantify the impact they had on the paleogeography, river systems and chemical weathering over the past five million years when sealevel variation has been most extreme.

Proposal History

Submission Type Resubmission from declined proposal

Declined Proposal Number 970

Review Response

A whole series of new sites have been chosen based on a new, digital seismic database with accurate navigation addressing most of the questions that came up during the first review. Furthermore the scientific objectives have been focused to concentrate on the issues of chemical weathering and sea level which form the primary attraction of this particular area. Drilling in deep water has been dropped from the proposal. Our objectives now also consider the significance of coastal wetlands as sources of atmospheric greenhouse gases during the sea level cycle reflecting their importance in SE Asia to the modern budget.

Proposed Sites (Total proposed sites: 14; pri: 7; alt: 7; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
SUNDA-01A (Primary)	7.61073047 104.2234113	424	389	0	389	Sample shelf sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site is the most landward in our transect and provides the opportunity to sample sediments from the paleo-Johore River.
SUNDA-02A (Primary)	7.45231003 105.5385922	41	258	0	258	Sample shelf sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site is one of the more landward in our transect and provides the opportunity to sample sediments from the boundary between the paleo-Johore River and the smaller catchments west of the Mekong.
SUNDA-03A (Primary)	7.56131545 107.8890359	77	286	0	286	Sample mid shelf sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site is one of the more seaward in our transect and provides the opportunity to sample sediments within the smaller catchments west of the Mekong. The sequence is more condensed here, with more unconformity and potentially the chance to sample the most weathered materials.
SUNDA-04A (Primary)	9.02517567 108.339456	74	349	0	349	Sample outer shelf sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site is one of the most seaward in our transect so that the facies are likely more marine and complete compared to further west. The site provides the opportunity to sample sediments within the Mekong drainage.
SUNDA-05A (Primary)	10.13315336 109.4143289	263	469	0	469	Sample upper slope sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site is the most seaward in our transect. The facies will be all marine and will provide the best biostratigraphic section of the transect, improving the age control. The site provides the opportunity to sample sediments deposited by the Mekong or smaller drainages to the north of the main river mouth.
SUNDA-06A (Primary)	7.41125556 106.8656126	46	297	0	297	Sample mid shelf sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site lies in the middle of our transect and provides the opportunity to sample sediments within the smaller catchments west of the Mekong. The sequence is more condensed here, with more unconformity and potentially the chance to sample the most weathered materials.
SUNDA-07A (Primary)	8.81288841 108.8396243	111	884	0	884	Sample upper slope sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site is the most seaward in our transect. The facies will be almost all marine and will provide a relatively complete section for the transect, improving the age control and constraining times of non-deposition on the shelf. The site provides the opportunity to sample sediments deposited by the Mekong.
SUNDA-08A (Alternate)	7.55681708 106.7742071	38	261	0	261	Sample mid shelf sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site lies in the middle of our transect and provides the opportunity to sample sediments within the smaller catchments west of the Mekong. The sequence is more condensed here, with more unconformity and potentially the chance to sample the most weathered materials. Alternate to SUNDA-06
SUNDA-09A (Alternate)	8.25446188 107.2232667	39	305	0	305	Sample mid shelf sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site is located in the middle of our transect and provides the opportunity to sample sediments within the smaller catchments west of the Mekong and/or the Mekong itself. The sequence is more condensed here, with more unconformities and potentially the chance to sample the most weathered materials.
SUNDA-10A (Alternate)	8.42038692 108.0578539	67	260	0	260	Sample outer shelf sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site is one of the more seaward in our transect so that the facies are likely more marine and complete compared to further west. The site provides the opportunity to sample sediments within the Mekong drainage. This is an alternate site for Sunda-04.

Proposed Sites (Continued; total proposed sites: 14; pri: 7; alt: 7; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
SUNDA-11A (Alternate)	10.01548904 108.4707236	62	426	0	426	Sample outer shelf sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site is one of the more seaward in our transect but also close to the Mekong River mouth. Nonetheless, the facies are likely more marine and complete compared to further west. The site provides the opportunity to sample sediments within the Mekong drainage. This is an alternate site for Sunda-04.
SUNDA-12A (Alternate)	8.69016194 103.677532	32	265	0	265	Sample shelf sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site is the most landward in our transect and provides the opportunity to sample sediments from the paleo-Johore River. This is an alternate site for Sunda-01.
SUNDA-13A (Alternate)	10.48938203 109.07379	141	615	0	615	Sample shelf edge sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site is one of the most seaward in our transect. The facies will be all marine and will provide the best biostratigraphic section of the transect, improving the age control. The site provides the opportunity to sample sediments deposited by the Mekong or smaller drainages to the north of the main river mouth. This is an alternate site for Sunda-05.
SUNDA-14A (Alternate)	7.15143823 108.0221048	76	342	0	342	Sample mid shelf sediments of Plio-Pleistocene age in order to determine the age of sedimentation, the degree of alteration, organic carbon content, provenance and paleo-water depth. This site is one of the more seaward in our transect and provides the opportunity to sample sediments within the smaller catchments west of the Mekong. The sequence is more condensed here, with more unconformity and potentially the chance to sample the most weathered materials. This is an alternate site for Sunda-03.