Climate Controlled

An interactive sonic installation based on 5.3 Million years of global climate change from the geologic record

by Arvid Tomayko-Peters

This installation is a constant concert - come and sit, stay a while, think, explore (play with the controller) and enjoy. Consider the millions, nay, billions of years of Earth's history that have come before you, of which this installation shows only a very small part. In deep time, our lives are the blink of an eye – and 5.3 million years is not even very long by geologic standards.

Each of the 8 speakers present represents a single deep ocean sediment core, data from which have now become sound. Speakers are placed geographically.

In front of the projection you will find a timeline with a touch sensitive strip. Press it firmly to move to any time, or slide your finger along it slowly to move through time. When you let go, you will continue to travel through time at the last speed of your finger.

You may ask "why Geology and Music?" In geology, if you find yourself measuring vertical distance, you are most likely measuring time. Similarly, music is created from events over time. Since earth processes proceed in many complex cycles and natural feedback loops, patterns should emerge in geophonic music, creating not only an edifying listening experience, but also possibly something that makes sense scientifically.

Sources

Global δ^{18}O Record (as seen in projection)
Lisiecki, L. E., and M. E. Raymo (2005), A Pliocene-Pleistocene stack of 57 globally distributed benthic d18O records, Paleoceanography,20, PA1003, doi:10.1029/2004PA001071.

Sea surface temperature records from alkenones at ODP site 846
Lawrence, K.T., Z. Liu, and T.D. Herbert, 2006, Evolution of the Eastern Tropical Pacific through Plio-Pleistocene glaciation, Science 312: 79-83.

Liu, Z., and T.D. Herbert, 2004, High latitude signature in Eastern Equatorial Pacific Climate during the Early Pleistocene Epoch, Nature, 427: 720-723.

Sea surface temperature records from alkenones at ODP site 982 and $CaCO_3$ data site 661
Kira Lawrence, Ph.D. 2006

ODP Sites 665, 925, 926, 927, 928
Dating and Calcium Carbonate approximation from proxy data by Hans Dejong, Brown University, under Tim Herbert, Summer 2006.

Original Deep Ocean Core Data from drilling by the Ocean Drilling Program (www-odp.tamu.edu).

Thank You

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Jim Moses - Gear
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AEA-Loccioni
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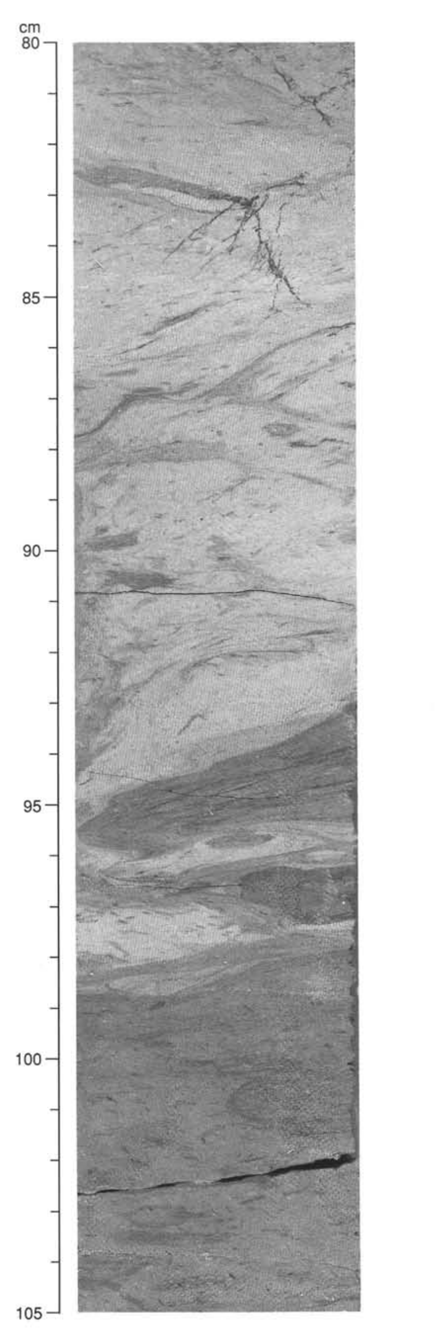
About Cores

The Ocean Drilling Project uses a specially outfitted ship to drill deep ocean sediment cores throughout the world's oceans. These cores are studied by geologists and climate scientists to unravel the history of the Earth's climate.

As is usually the case in geology (though not always) depth corresponds roughly to time: deeper sediment is always assumed to be older. However various factors such as changing sedimentation rates, differing ocean chemistry and sediment compaction from burial make this a very non-linear relationship. Oxygen isotopes read from the cores are usually used to date them by matching them up with a global average, such as the Lisiecki stack seen in the projection. For these cores, most of this work was done by Hans DeJong and Prof. Tim Herbert. Once dates are assigned to depths, data can be fitted to time and analyzed.

An important datum is the amount of $CaCO_3$: it shows a cyclic record of the biological productivity of calcarous organisms and hence the local climate. Measuring $CaCO_3$ in sediment is a time consuming process, so often various proxy data that can be more easily collected are combined and used to estimate $CaCO_3$ content. In many of these cores this is done using a combination of Reflectance (how light or dark a core is), Magnetic Susceptibility (how well it can be magnetized - show show much Iron) and Wet Bulk Density (basically how heavy it is).

To the left you can see some photos of sections of core 925, drilled in the wester equatorial Atlantic. This is used in the piece.



otograph showing folded layers and contorted laminae in a slump
rval 154-925A-56R-3, 80–105 cm).

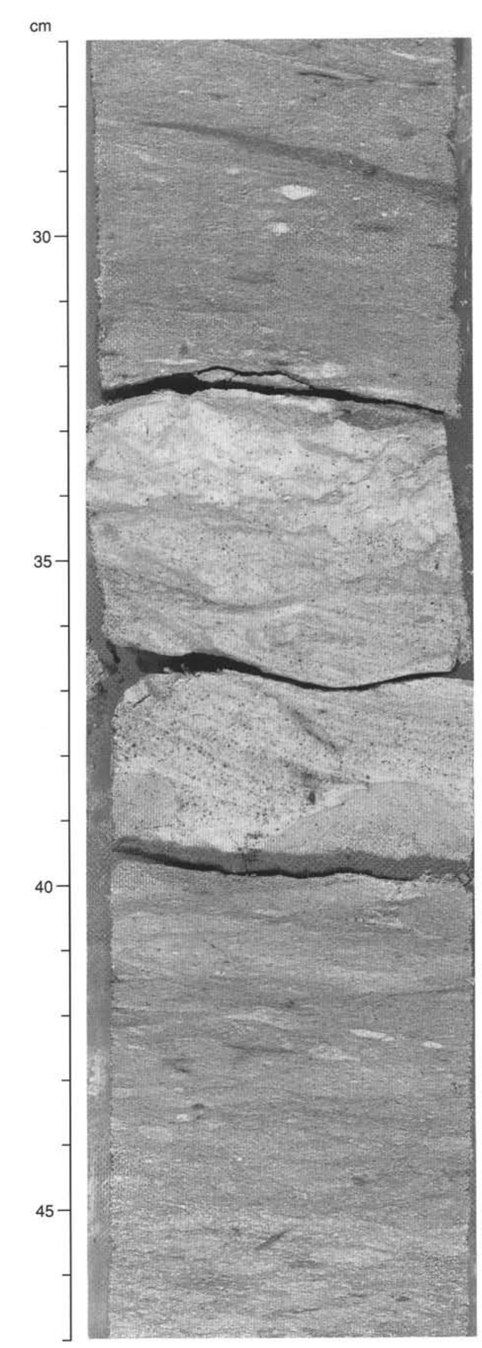


Figure 7. Photograph of a turbidite (interval 154-925A-63R-2, 27–47 cm).

Musical Mapping

Creating sound from data is ostensibly easy. Using a computer, any type of digitized data can, in theory, be converted to any other type. This is the process of 'mapping' - of taking input data and defining how it will control the generation of sound or images. Transmutation, if you will. Computer musicians tend to be interested in synaesthesia - a disorder that results in the mixing of the senses.

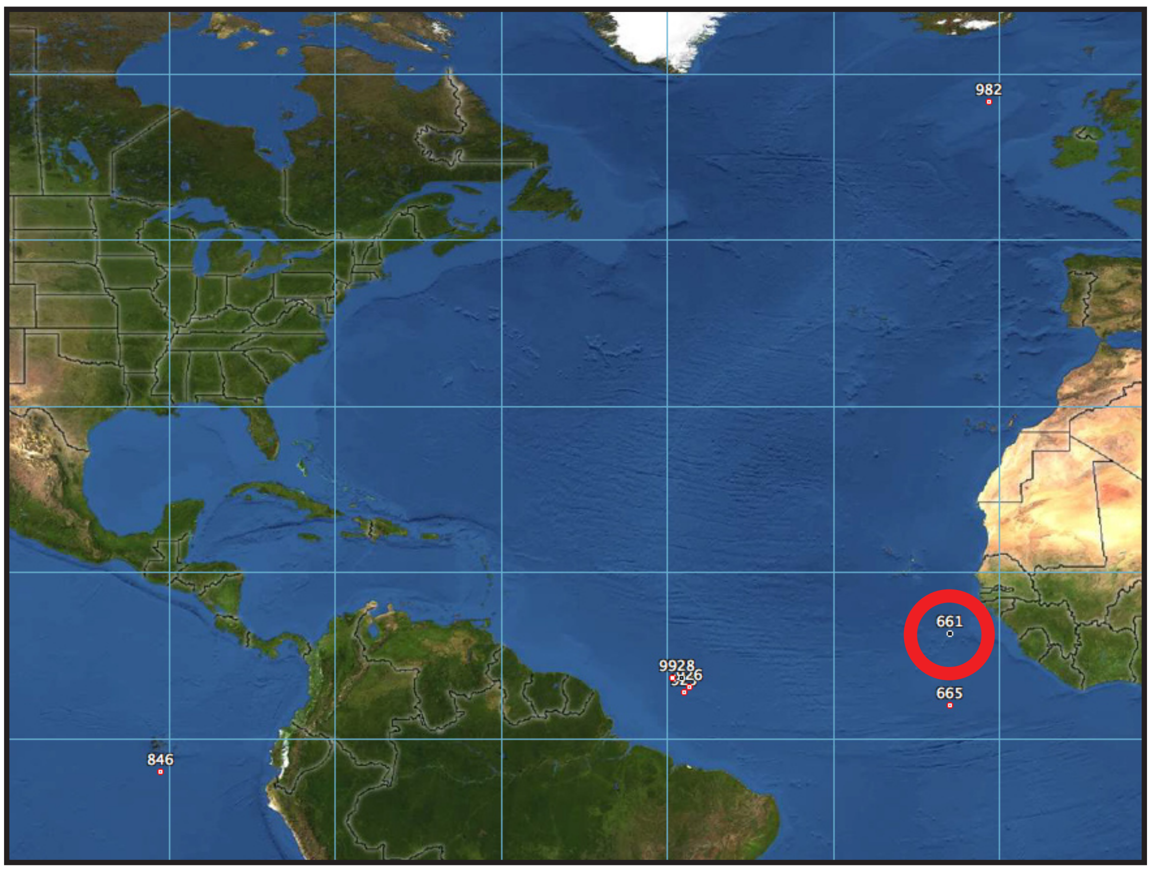
A number of different mappings are used in this project. Some are very direct: for instance converting global $d^{18}O$ data (which has, as you can see and hear, a periodic pattern) directly into sound waves by speeding it up billions of times its original speed. Because musical sound is just periodic data. Some mappings are less direct: for instance mapping Magnetic Susceptibility to the center frequency of a filter that is applied to the above mentioned sound waves.

The first step in mapping is to find a meaningful parameter that you want to control with your data. In the case of this project, I built the sound generation engine around the data, so I would try to create a sonic or visual process that could be meaningfully controlled by some type of data I had. The next step is scaling, either linearly or otherwise, of the data to a suitable range, and outtputing it at a suitable rate (audio rate (44.1 kHz) or varying data-rates). Sometimes you want to extract logical information from data - are we in a cold period, or not? Or find its rate of change, etc. Finally, there is the continual tweaking to get it to sound right!

Some of the primary mappings used in *Climate Controlled* are as follows:

Global Ice Volume/Global Temperatute (through $\delta^{18}O$)	➟	Color, Ice cracks, base core waveforms
Sites 661, 665, 925-928		
Fraction of $CaCO_3$	➟	Speed (and pitch) of waveforms (more $CaCO_3$ = lower pitch)
Magnetic Susceptibility	➟	Filter 1 Center Frequency
Reflectance	➟	Filter 2 Center Frequency
Wet Bulk Density	➟	Filter Q (more dense = sharper filter)
Sedimentation Rate	➟	Amplitude (High Sed. Rate = Loud)
$CaCO_3$ Accumulation Rate	➟	Amplitude Modulation
Sites 846, 982		
Sea Surface Temperature	➟	Oscillator Pitch (hotter = higher)
Mass Accumulation Rate	➟	Delay Time on Oscillator
Sedimentation Rate	➟	Amplitude (High Sed. Rate = Loud)

Site 661

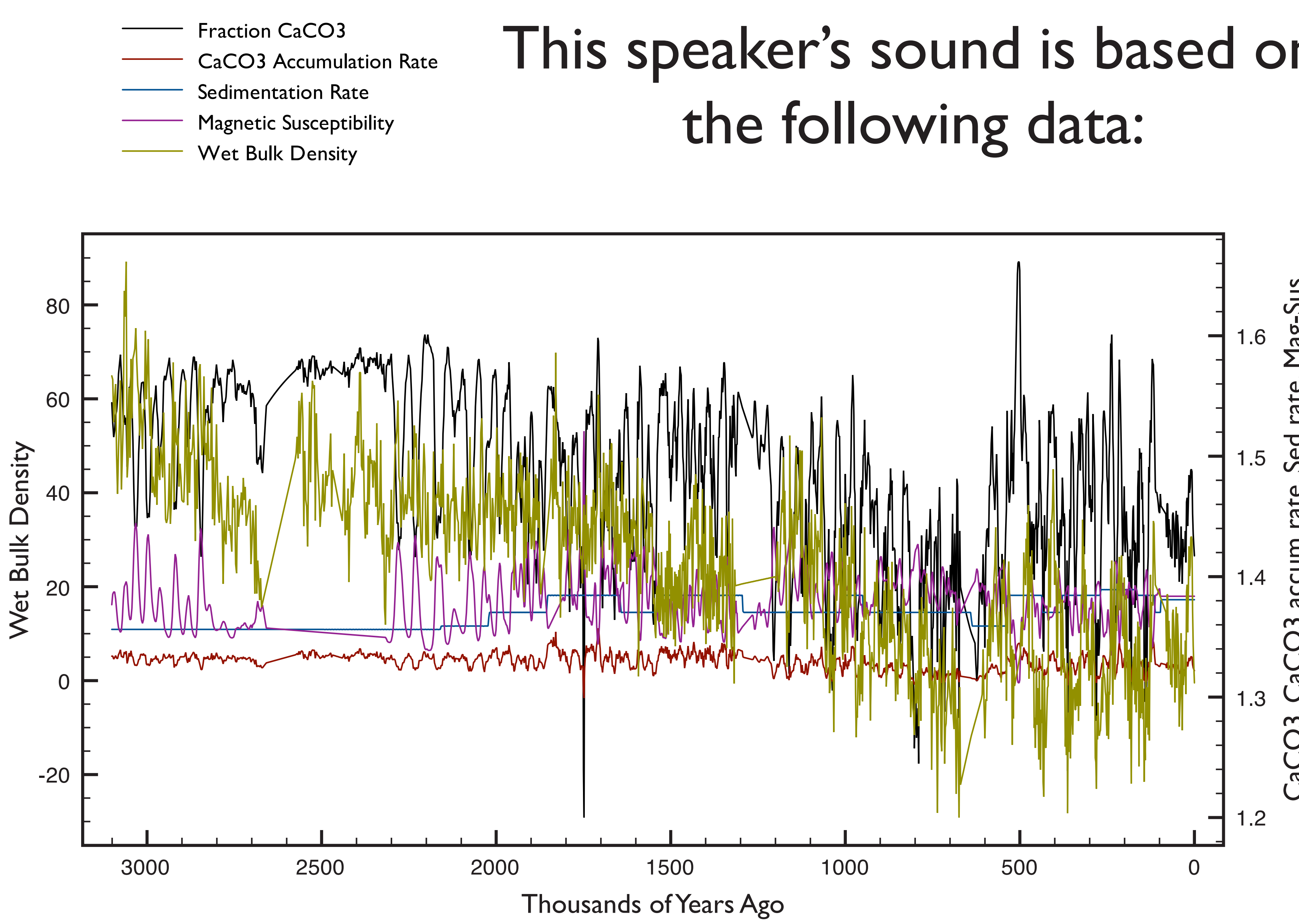


Location:
9° 27'N , 19° 23'W

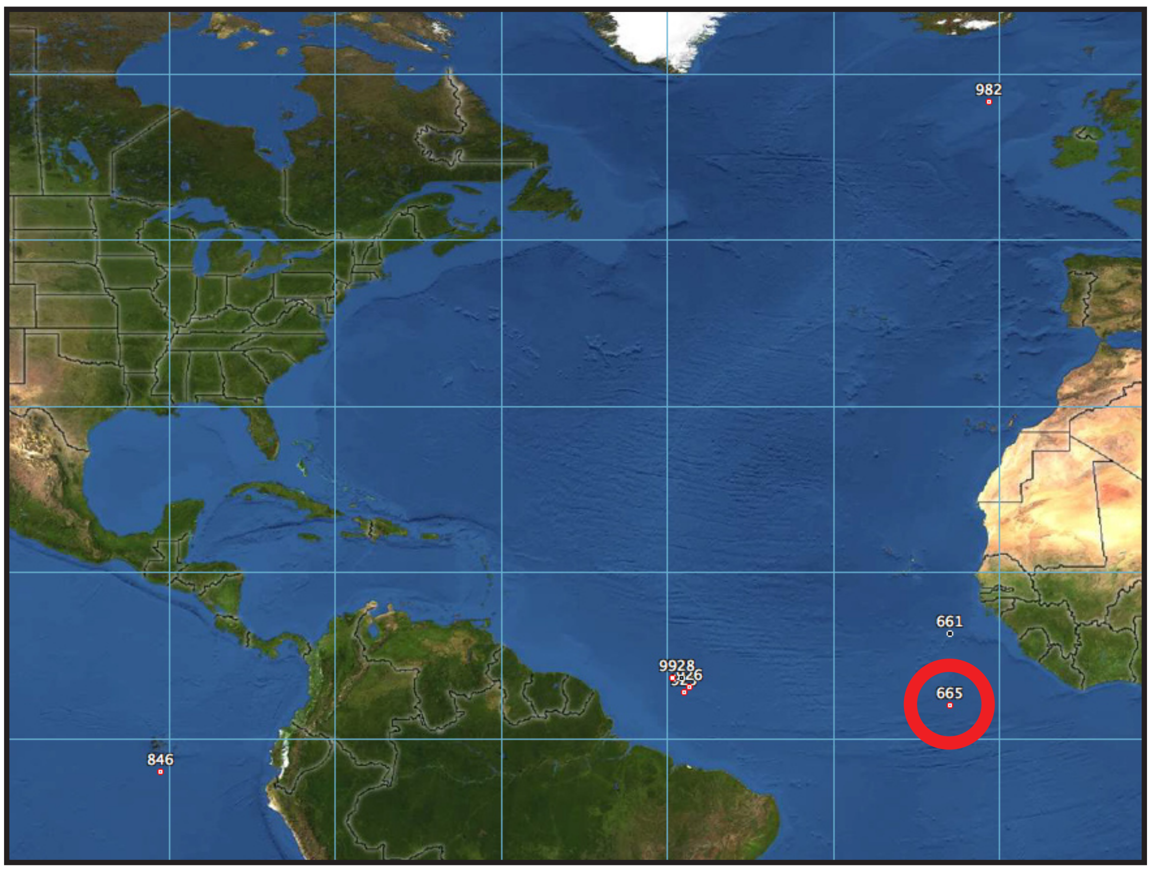
Drilled:
03/17/86 - 03/20/86

Sound from this speaker is derived from ODP site 661, a deep ocean sediment core drilled off the coast of western Africa.

This speaker's sound is based on the following data:



Site 665

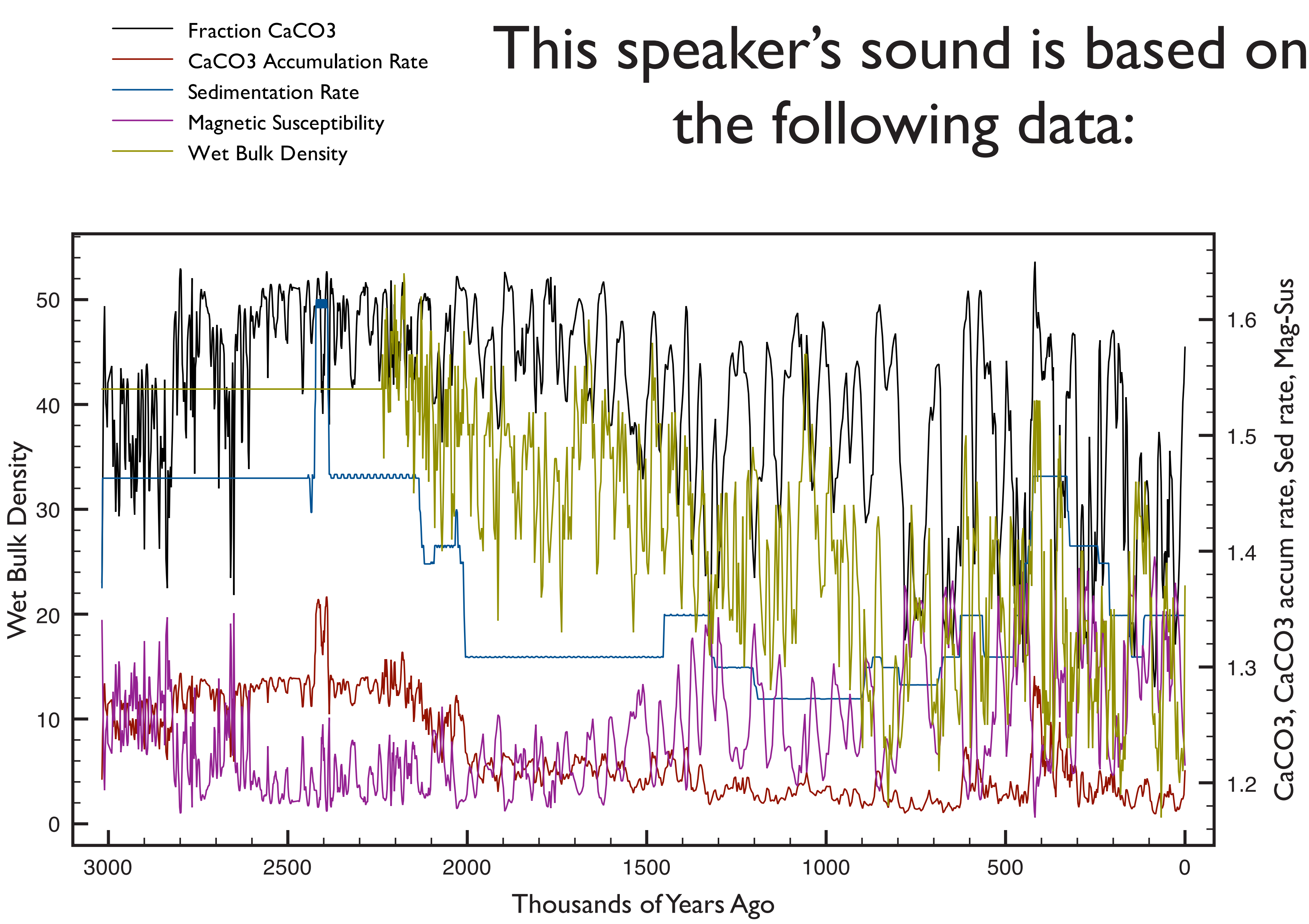


Location:
2° 57'N, 19° 40'W

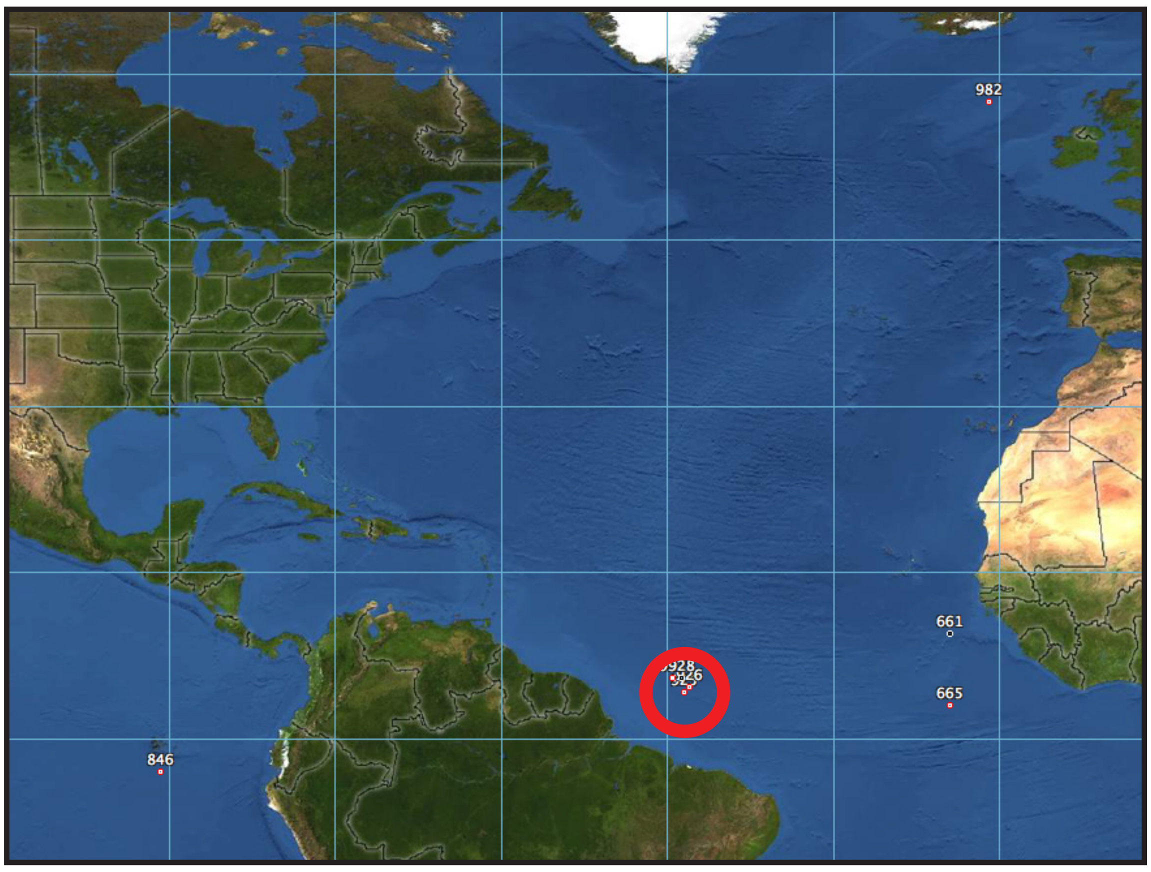
Drilled:
04/03/86 - 04/04/86

Sound from this speaker is derived from ODP site 665, a deep ocean sediment core drilled off the coast of western Africa.

This speaker's sound is based on the following data:



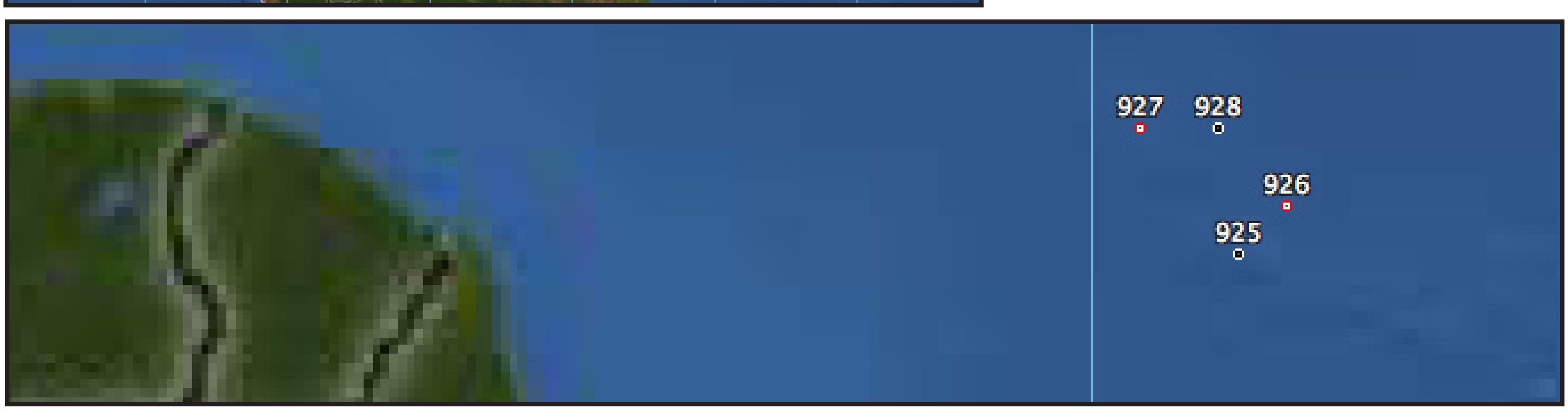
Site 925



Location:
4° 12'N, 43° 29'W

Drilled:
02/08/94 - 02/19/94

Sound from this speaker is derived from ODP site 925, a deep ocean sediment core drilled off the north-eastern coast of South America, near the mouth of the Amazon.



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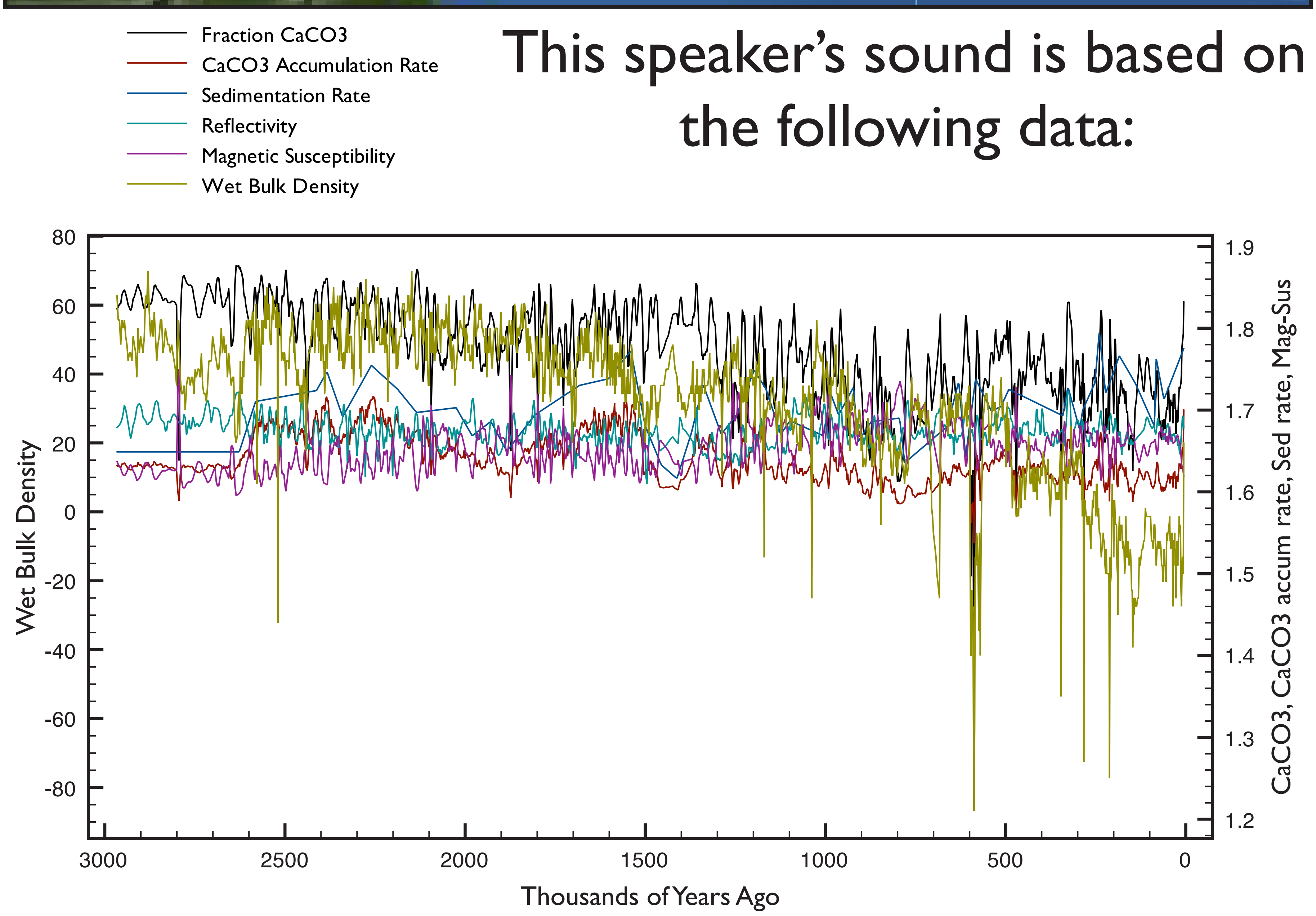
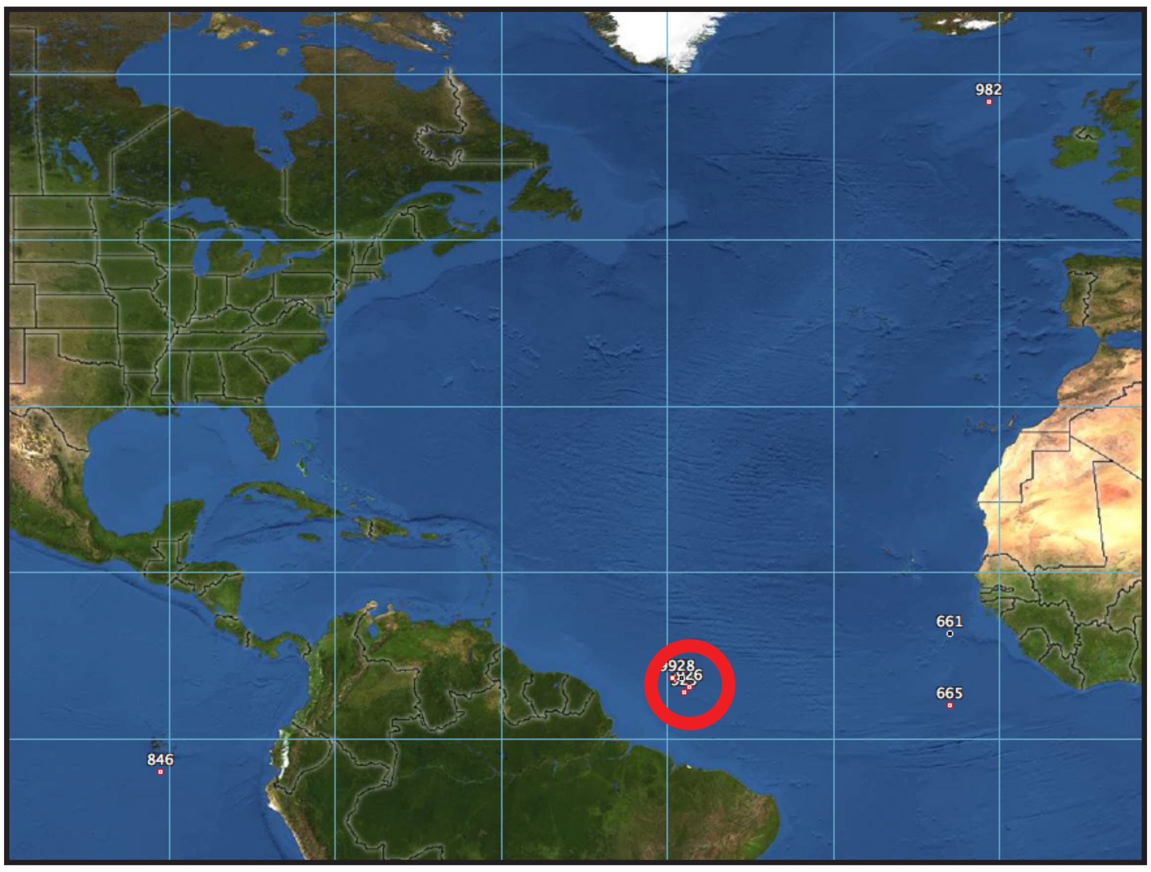


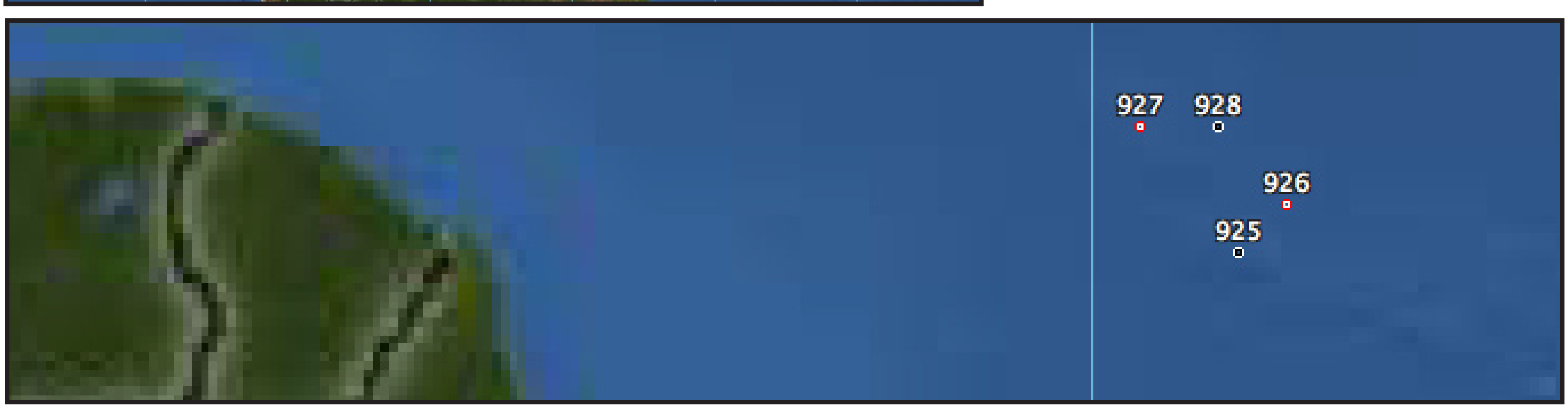
Site 926



Location:
3° 43'N, 42° 54'W

Drilled:
02/19/94 - 02/27/94

Sound from this speaker is derived from ODP site 926, a deep ocean sediment core drilled off the north-eastern coast of South America, near the mouth of the Amazon.



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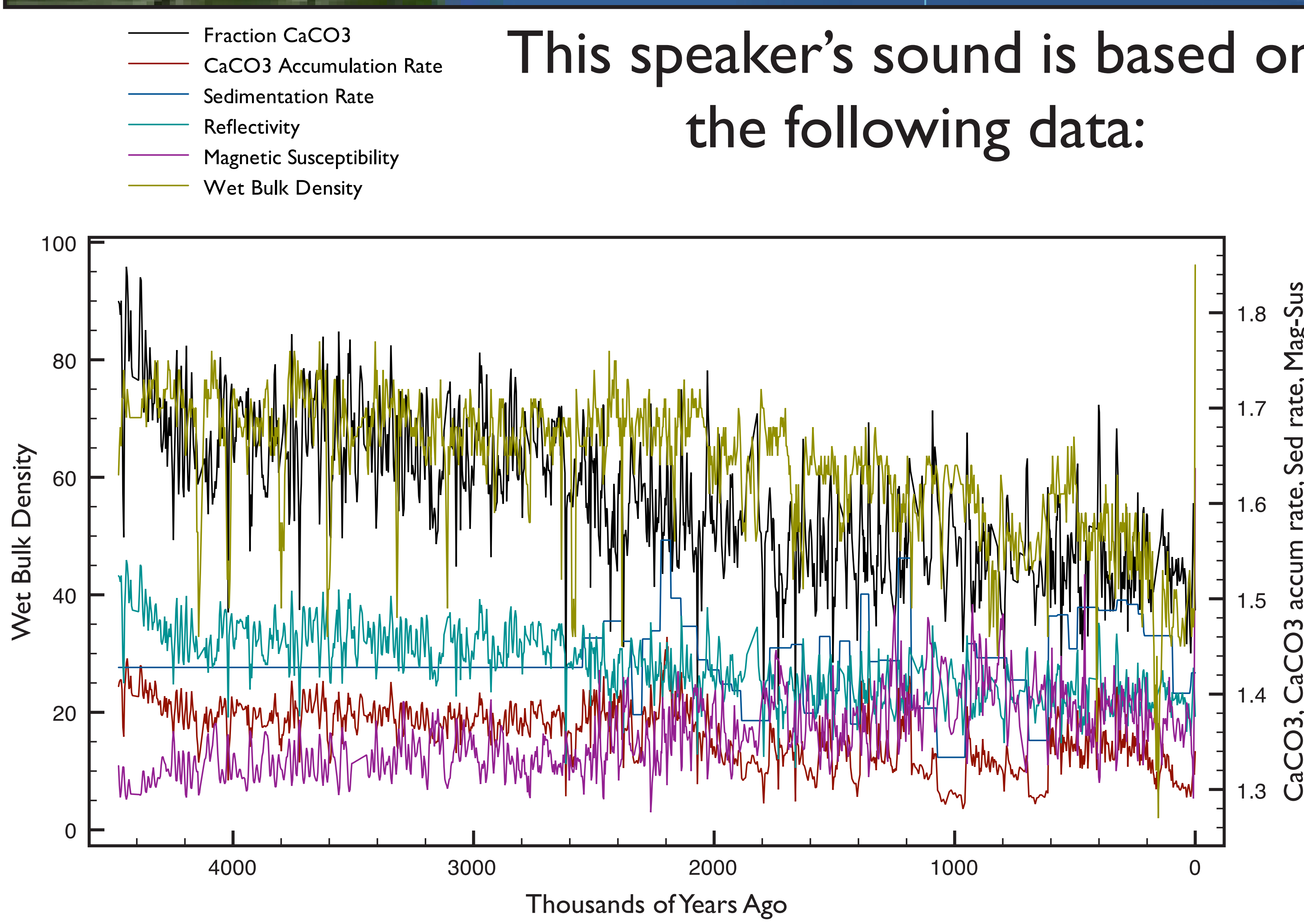
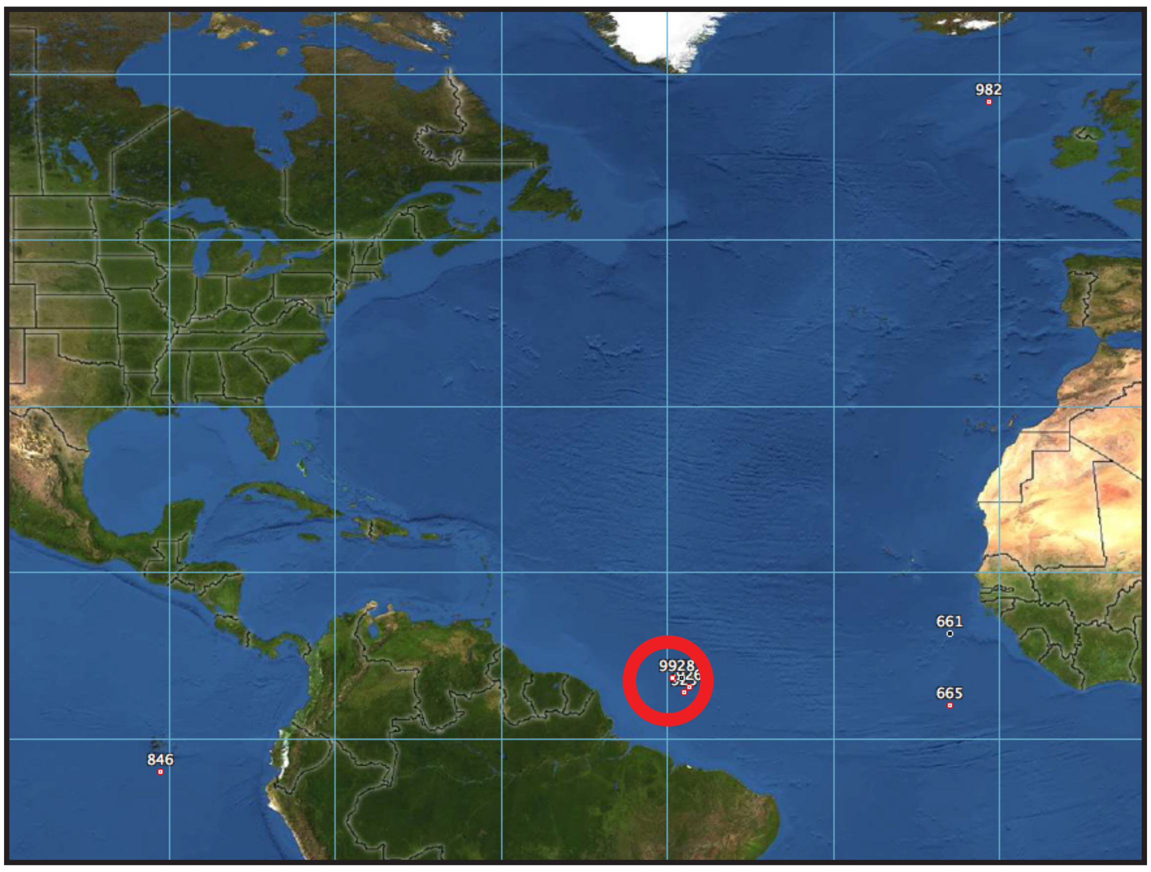


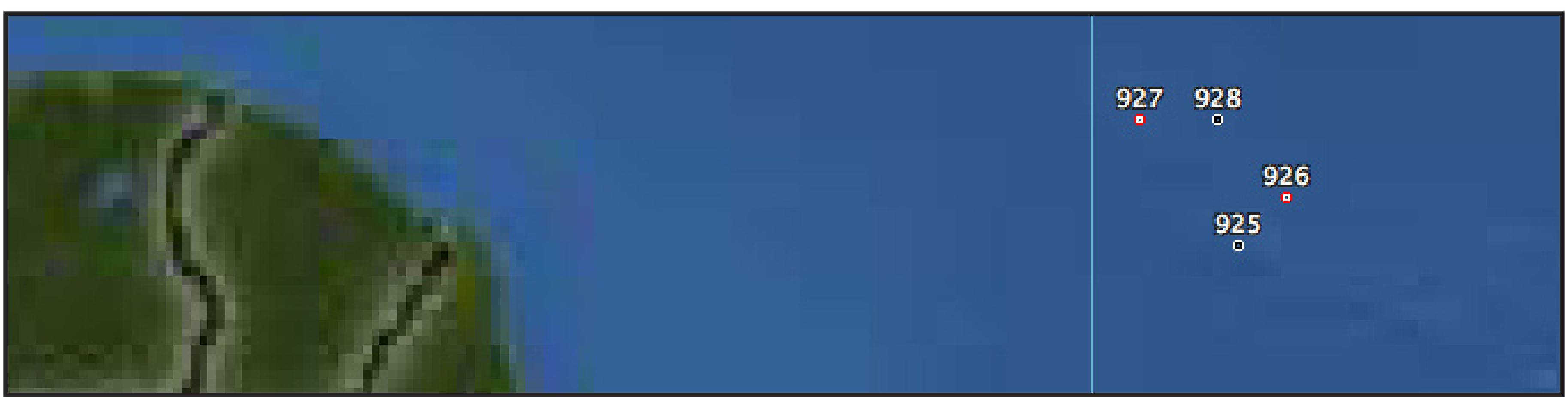
Site 927



Location:
5° 28'N, 44° 29'W

Drilled:
02/28/94 - 03/04/94

Sound from this speaker is derived from ODP site 927, a deep ocean sediment core drilled off the north-eastern coast of South America, near the mouth of the Amazon.



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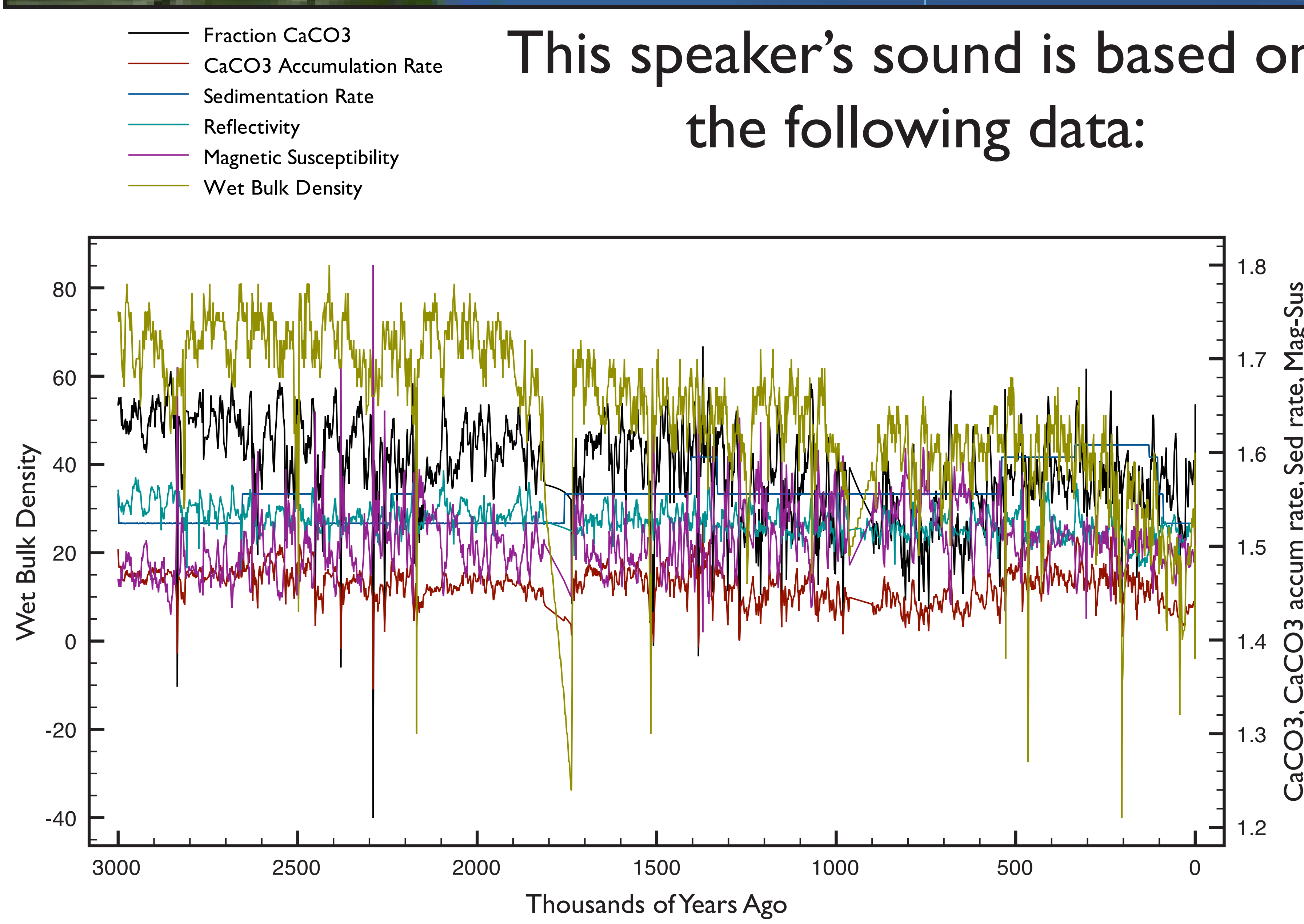
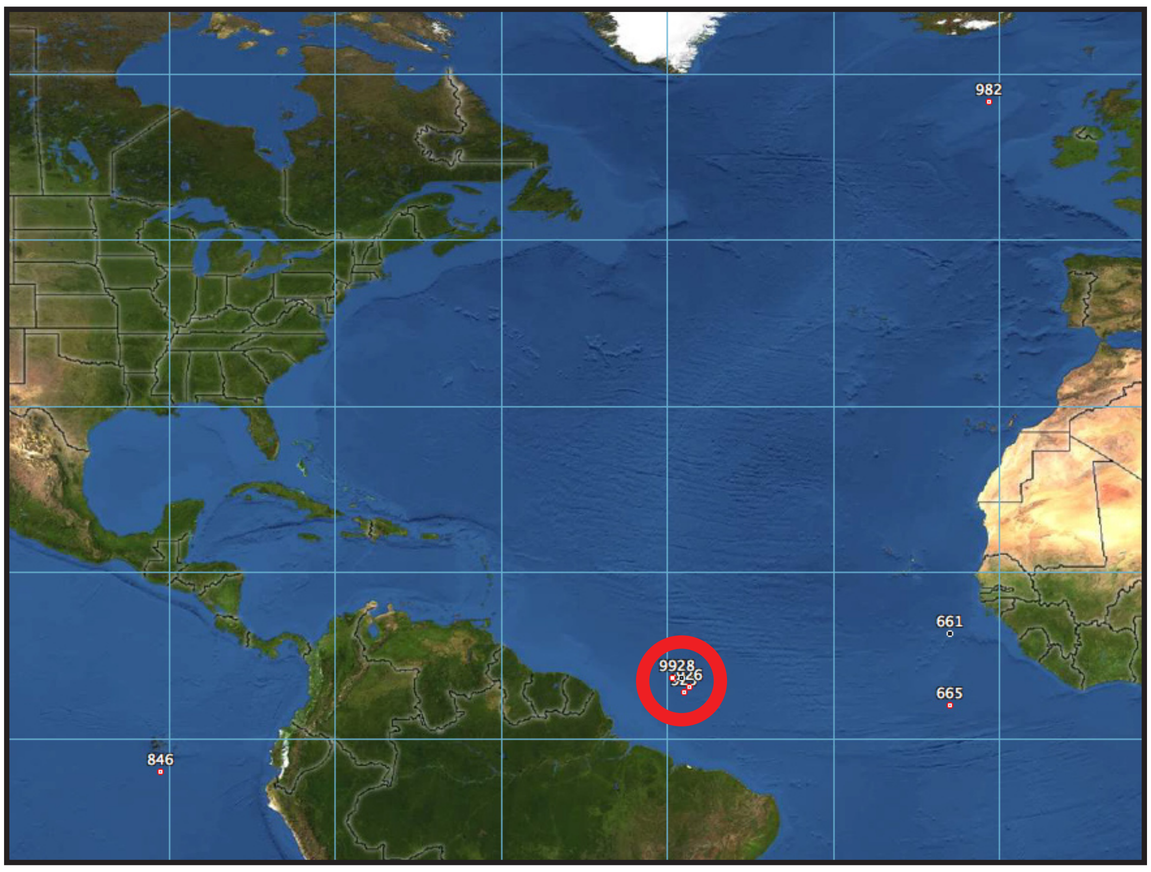


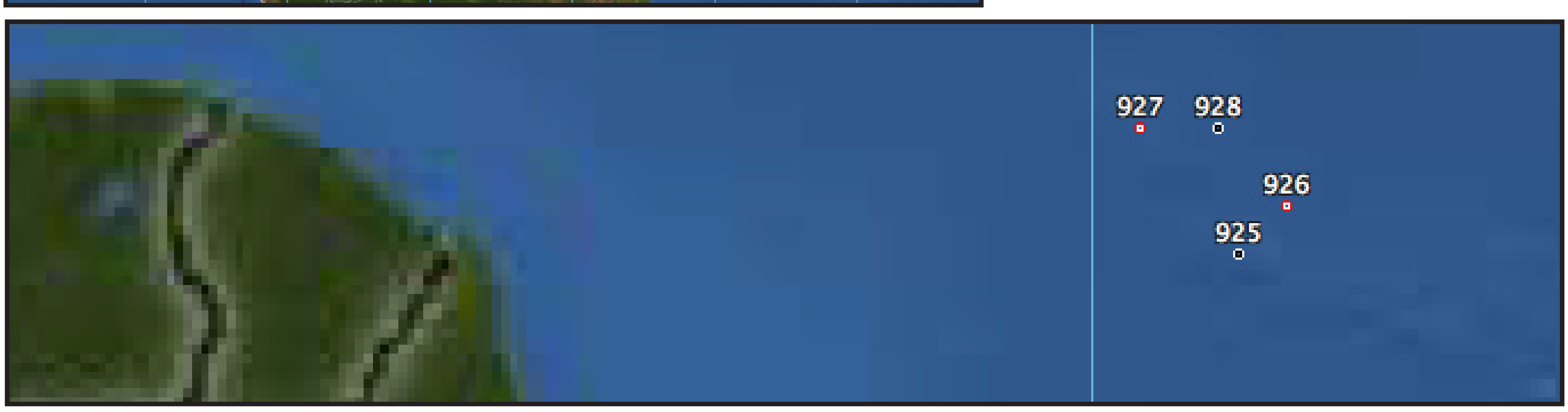
Site 928



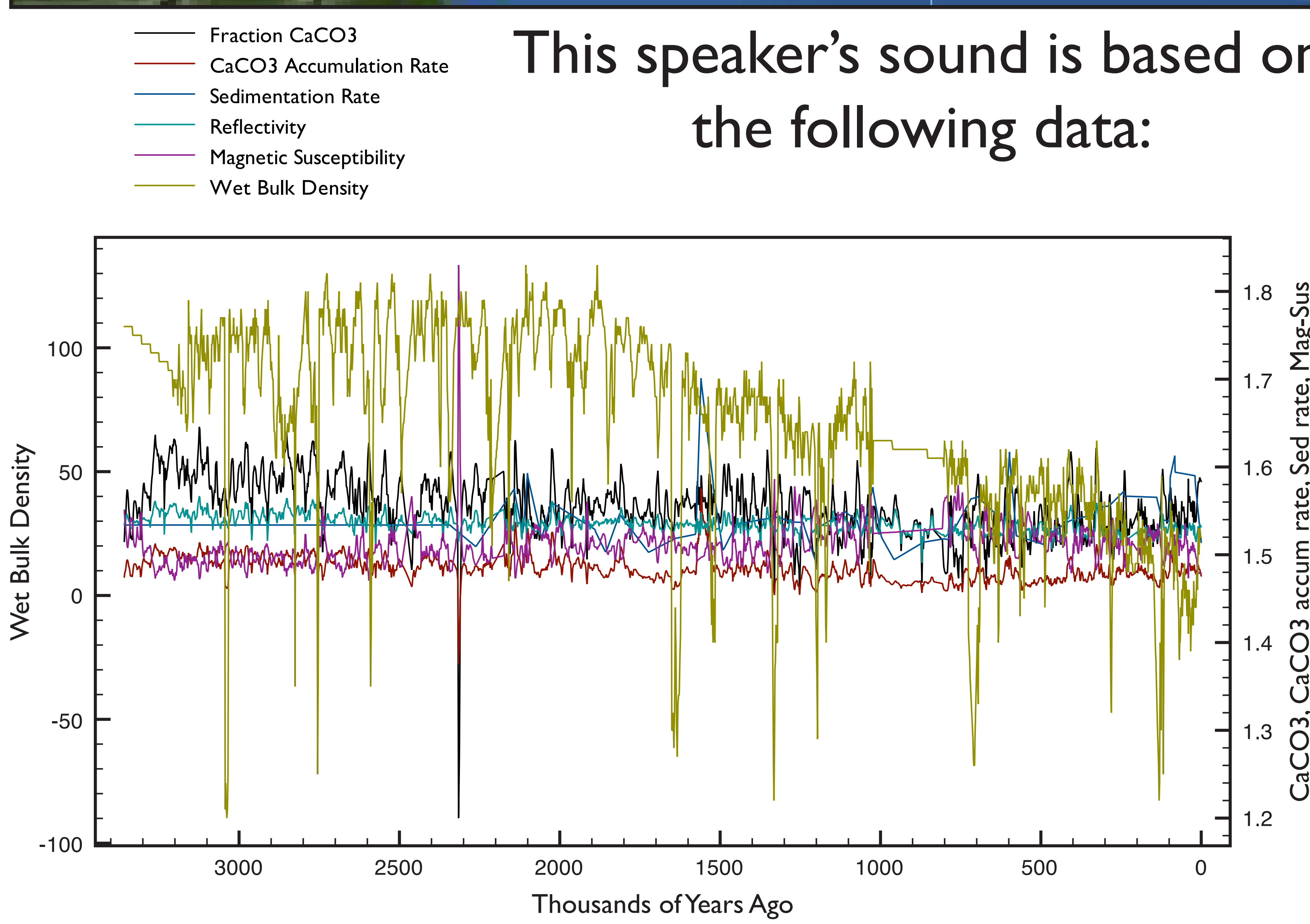
Location:
5° 27'N, 43° 45'W

Drilled:
03/04/94 - 03/10/94

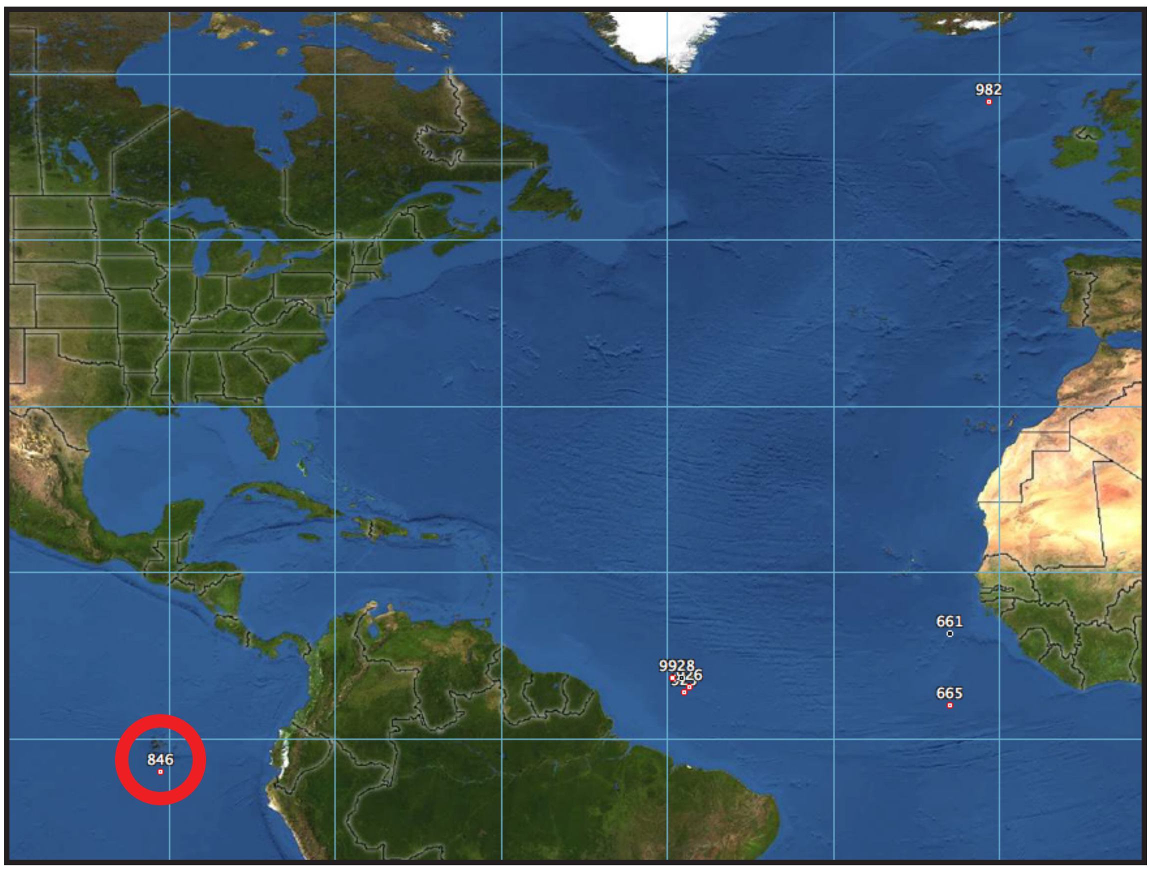
Sound from this speaker is derived from ODP site 928, a deep ocean sediment core drilled off the north-eastern coast of South America, near the mouth of the Amazon.



This speaker's sound is based on the following data:



Site 846

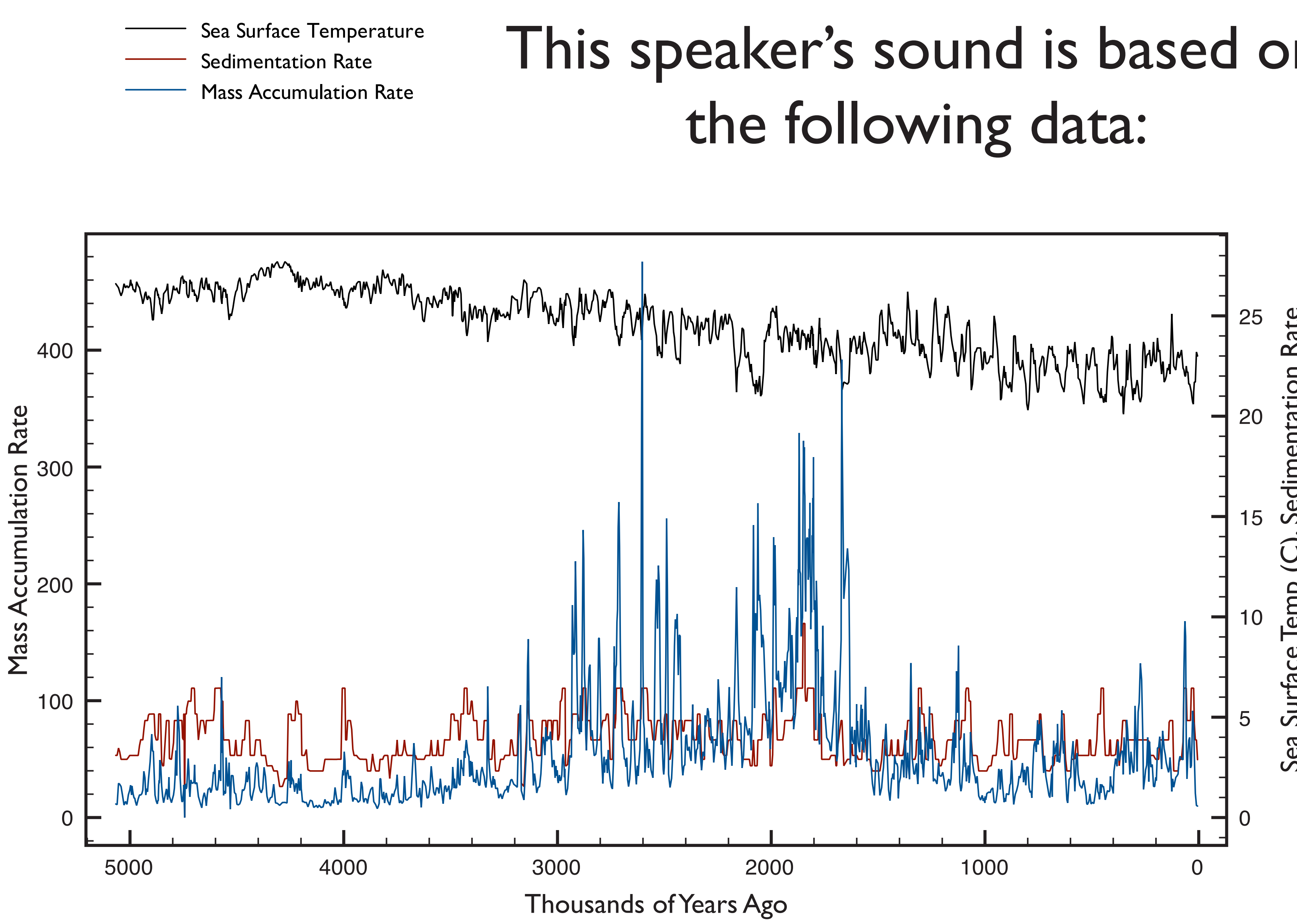


Location:
3° 5'N , 90° 49'W

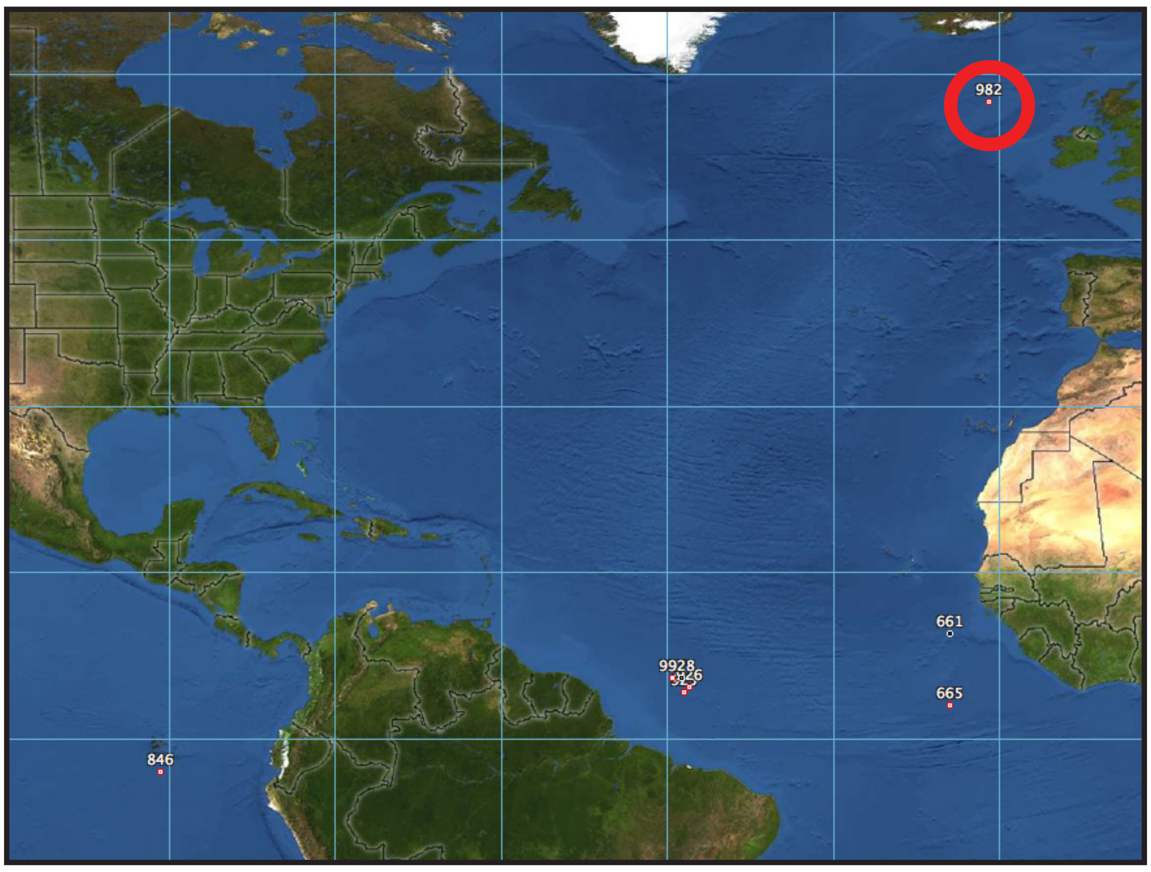
Drilled:
05/21/91 - 05/25/91

Sound from this speaker is derived from ODP site 846, a deep ocean sediment core drilled in the equatorial Pacific. This site was analyzed for alkenones, biogenic chemicals that can be used to accurately reconstruct past sea surface temperatures. These two sea surface temperature (sites 846 and 982) are the longest records, and can be heard by themselves between 5320 and 3000 Ka (thousands of years ago). Special thanks to Prof. Tim Herbert.

This speaker's sound is based on the following data:



Site 982



Location:
57°31.00N, 15°51.99W

Drilled:
07/15/95 - 07/19/95

Sound from this speaker is derived from ODP site 982, a deep ocean sediment core drilled in the northern Atlantic This site was analyzed for alkenones, biogenic chemicals that can be used to accurately reconstruct past sea surface temperatures. These two sea surface temperature (sites 846 and 982) are the longest records, and can be heard by themselves between 5320 and 3000 Ka (thousands of years ago). Special thanks to Kira Lawrence, Ph.D. 2006.

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