V31F-3082 Exploring the Toba Eruption: Impacts on Biological Productivity and Global Climate Dynamics

Wednesday, 11 December 2024

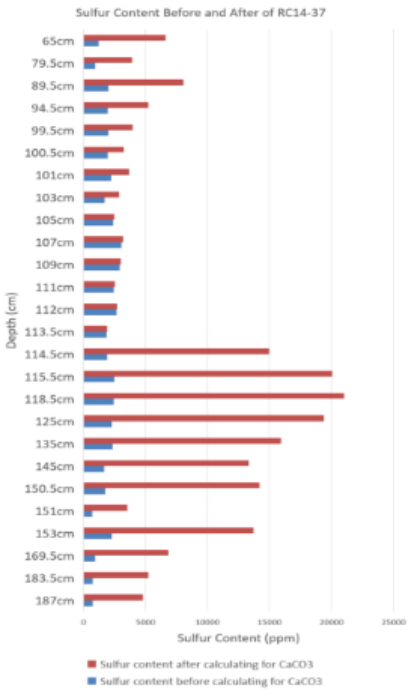
08:30 - 12:20

Hall B-C (Poster Hall) (Convention Center)

Abstract

Volcanic ash layers impact Earth's environment and climate. Our study examines their effects on carbon, cadmium, and sulfur content in deep-sea sediment. We focus on the Toba super eruption (~74,000 years ago), the largest Quaternary explosive eruption, releasing 2,800 cubic kilometers of material. The eruption's sulfur dioxide formed sulfate aerosols, reflecting sunlight and perhaps causing a volcanic winter. High magnetic susceptibility in core RC14-37 indicates a 15 cm thick Toba ash layer at 100-115 cm depth, with the highest ash concentration at 102-104 cm. Sulfur signal dilution by ash is pronounced at 102-106 cm, potentially lowering sulfur peak appearance. Elevated sulfur just below the top suggests rapid deposition after most ash settled, decreasing towards the base, implying additional atmospheric sulfur. We used X-ray fluorescence (XRF) to measure sulfur and cadmium contents above, within, and below the ash layer. High cadmium concentrations in the ash layers suggest enhanced marine productivity. The SiO_2 contents in the ash are variable (66%-78%) with no clear patterns versus depth. Because the Toba ash contains 12 ppm S (Black et al.), we find that the range of bulk S contents in the Toba ash layer (1700ppm to 3100 ppm) corrected for dilution by carbonate is much too high for most of the S to come from the ash. Instead, most of the S comes from seawater or most likely from sulfate aerosols that settle out of the atmosphere. Results show increased biological productivity and sulfur in ash layers especially near the top of the layers, providing insights into ecological and biogeochemical impacts. Because estimates of the overall amount of sulfur emitted by the Toba eruption range from 1800ppm to 3600ppm, our data can help to constrain the true amount of S emitted. Current oxygen isotope data analysis on benthic foraminifera and carbon isotopic analysis on pelagic foraminifera will further refine dating and environmental interpretations.

*The plot is not corrected for the deposition rate



Plain-language Summary

Our study examines how volcanic ash layers affect Earth's environment and climate, focusing on carbon, cadmium, and sulfur changes in deep-sea sediment from the Toba super eruption 74,000 years ago. This eruption, the largest of the Quaternary period, released 2,800 cubic kilometers of material and sulfur dioxide, which formed sulfate aerosols, potentially causing a volcanic winter. In sediment core RC14-37, we found a 15 cm thick Toba ash layer at 100-115 cm depth, with the highest ash concentration at 102-104 cm, significantly diluting the sulfur signal from 102-106 cm and masking the sulfur peak. Elevated sulfur levels just below the top of the ash layer suggest rapid deposition after most ash settled, with levels decreasing towards the base, indicating additional atmospheric sulfur. We used X-ray fluorescence (XRF) to measure sulfur and cadmium content. High cadmium levels in the ash layers suggest increased marine productivity. The SiO2 content in the ash ranged from 66% to 78%. Given that Toba ash contains 12 ppm sulfur, our corrected sulfur content (1700-3100 ppm) suggests most sulfur came from atmospheric sulfate aerosols. These results indicate increased biological productivity and sulfur in the ash layers, providing insights into the eruption's ecological impacts.

First Author

G

Romin Gairhe

Hudson County Community College

Authors

A

Dallas H Abbott

Lamont -Doherty Earth Observatory

B

Benjamin C Bostick

Lamont-Doherty Earth Observatory of Columbia University