

The PMEL Vents Program

25 Years of Excellence

*Ocean Environmental and Ecosystem Exploration,
Discovery, Research, and Technology Development
for NOAA*

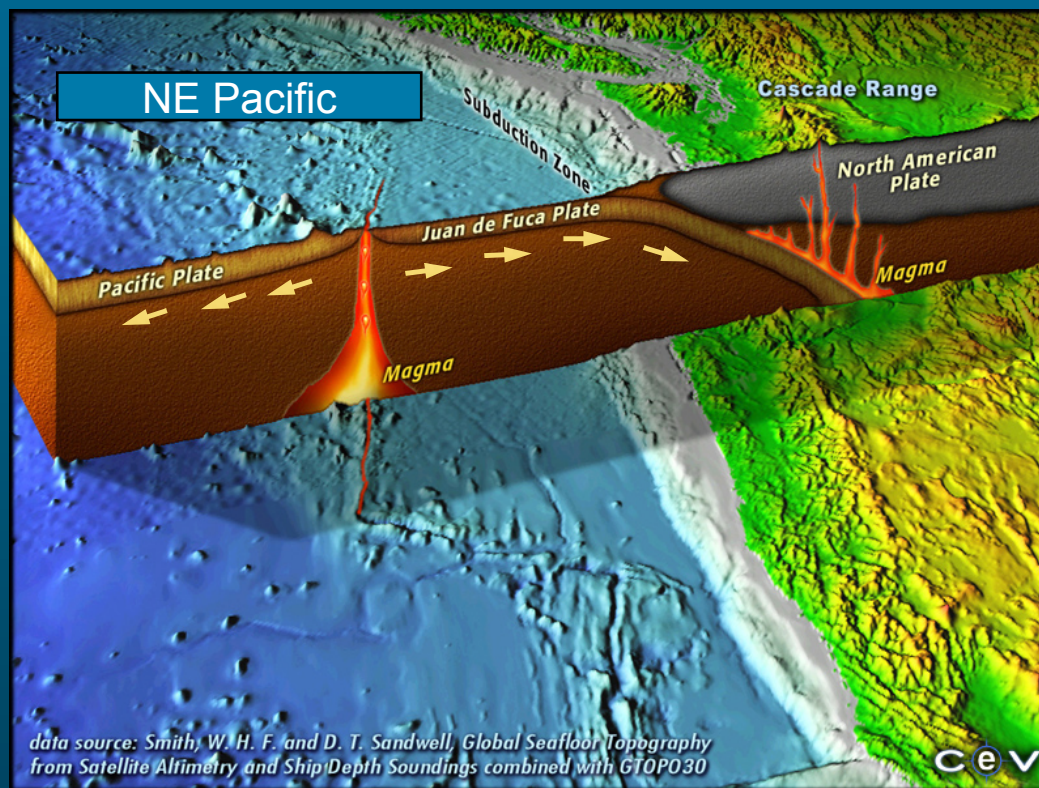
Presenter: Stephen R. Hammond
Leader, PMEL Ocean Environmental Research Division



NOAA PMEL's Vents Program

Ocean Ecosystems on Submarine Volcanoes

Understanding ocean environmental impacts of the Earth's most extensive and active volcanoes



NOAA PMEL Vents Program

Ocean Ecosystems on Submarine Volcanoes

Why are submarine volcanoes worth studying?

Consider the following:

- ▶ Volcanoes are the principal means whereby **heat and mass are transferred from the Earth's interior to its surface**
- ▶ **>80% of the Earth's volcanoes** are located in the deep ocean and the vast majority have never been studied
- ▶ Submarine volcanoes are often associated with **unique ecosystems**
- ▶ Submarine volcanism and hydrothermal activity creates and sustains **biological and mineral resources**
- ▶ Volcanoes are an important **natural source of CO₂**

Depth range: -525 to -3650 m

2 X VE

~1000 m foreground

North ←

NW Rota Volcano

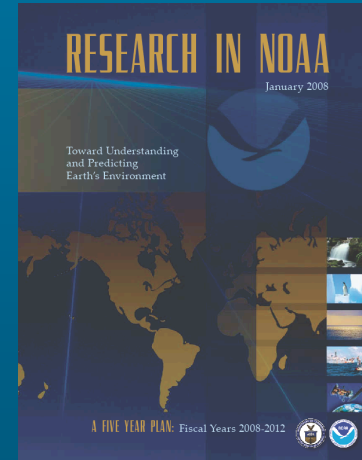
Vents Research Objectives

- ▶ Discover new ocean ecosystems
- ▶ Understand the impacts of volcanism and hydrothermal circulation on marine ecosystems
- ▶ Utilize hydrothermal environments as natural laboratories to understand globally important biogeochemical processes
- ▶ Utilize acoustics to monitor and understand geological processes and marine mammal distribution and behavior
- ▶ Identify potential living and non-living resources
- ▶ Develop cutting-technology to advance ocean science

Relevance: VENTS support of Agency goals

Research In NOAA: Toward Understanding and Predicting Earth's Environment

- ▶ VENTS interdisciplinary exploration and research supports objectives elaborated in NOAA's 5-year research plan:
 - *Advancing understanding of ecosystems to improve resource management*
 - *Exploring our oceans*
 - *Forecasting ecosystem events*



Ocean Research Priorities Plan and Implementation Strategy

- ▶ “Expanding the Scientific Frontier: The Need for Fundamental Science”

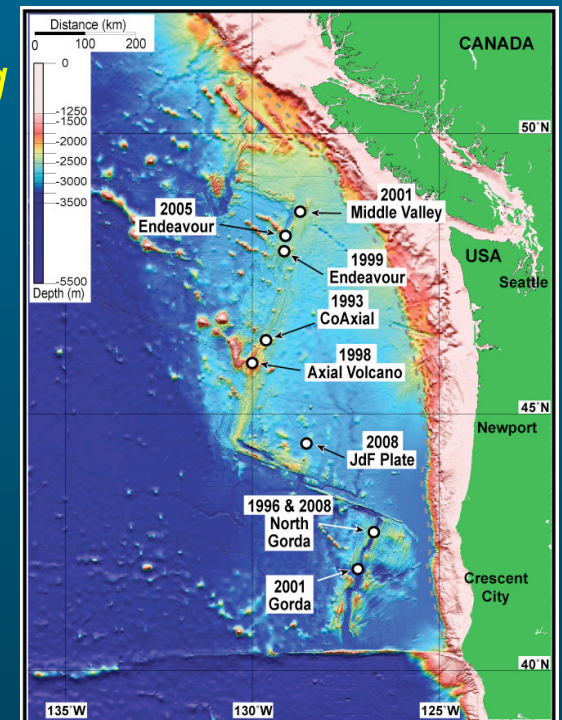
“It is essential that the nation cultivate and investigate new ideas about the ocean and new approaches for exploring the marine environment that may challenge existing interpretations. In doing so, society should recognize and even encourage risk-taking in supporting the most exciting and promising ideas for making progress in understanding the ocean.”

Performance: Some Notable Accomplishments During Preceding Years

- ▶ Utilization of the first civilian swath sonar bathymetric mapping system (nascent Vents program) – **Impact:** *Revolutionizes seafloor mapping*
- ▶ Began interdisciplinary exploration of volcanic and hydrothermal environments on mid-ocean ridges – **Impact:** *Established the first long-term effort to understand spreading center processes. Resulted in establishing the Axial Volcano observatory (NeMO)*
- ▶ Discovery of “megaplumes” – **Impact:** *Recognition of the importance of being able to find a way to study episodic submarine volcanic eruptions*

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- ▶ Discovery of “megaplumes” – **Impact:** *Recognition of the importance of being able to find a way to study episodic submarine volcanic eruptions*
- ▶ Access to military hydrophone arrays – **Impact:** *Enabled real-time detection, location, and study of active deep volcanic eruptions*



Performance: Some Vents highlights during the last four years...

- ▶ Discovered and began monitoring a deep eruption that appears to have been active for at least several years - **Impact**: Raises the possibility that submarine volcanoes may contribute more chemical and thermal flux than previously thought
- ▶ Discovered liquid CO₂ venting from an arc volcano - **Impact**: High concentrations of dissolved CO₂ can provide a natural laboratory for studying effects of ocean acidification
- ▶ Deployment of the initial elements of a global acoustic monitoring network - **Impact**: Ability to quantify geophysical and biological acoustic sources as well as variations in the global ambient sound field.
- ▶ Developed an inexpensive satellite-linked hydrophone sensor – **Impact**: offers possibility of global, real-time acoustic monitoring and event detection

Background: CO₂ venting from Eifuku Volcano

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Ocean Ecosystems on Submarine Volcanoes

Hallmarks of Vents Exploration and Research:

- ▶ Large-scale, NOAA-relevant issue(s)
- ▶ Comprehensive interdisciplinary approach
- ▶ Sustained focus
- ▶ Sustained funding and access to seagoing assets
- ▶ Long-term national and international partners
- ▶ Strong engineering, IT, and administrative support

Vents Staff

PIs

- 1 **E. Baker** *geophysics*
- 2 D.Butterfield *chemistry*
- 3 B. Chadwick *volcanology*
- 4 B. Dziak *acoustics*
- 5 **R. Embley** *geophysics*
- 6 **B. Lavelle** *num. Modeling*
- 7 **J. Lupton** *ocean tracers*
- 8 H. Matsumoto *o. engineering*

- Cooperative Institute
- Federal

Tech. Staff

- 1 A. Bobbitt
- 2 **J. Black**
- 3 L. Evans
- 4 M. Fowler
- 5 R. Greene
- 6 J. Haxel
- 7 **J. Klay**
- 8 A. Lau
- 9 N. Buck
- 10 S. Merle
- 11 K.Roe
- 12 **S.Walker**

Preeminence: Communication of Science Results Through Peer-Reviewed Publications

2004: 25

2005: 20

2006: 23

2007: 18

* 2008 total as of 8/1/08

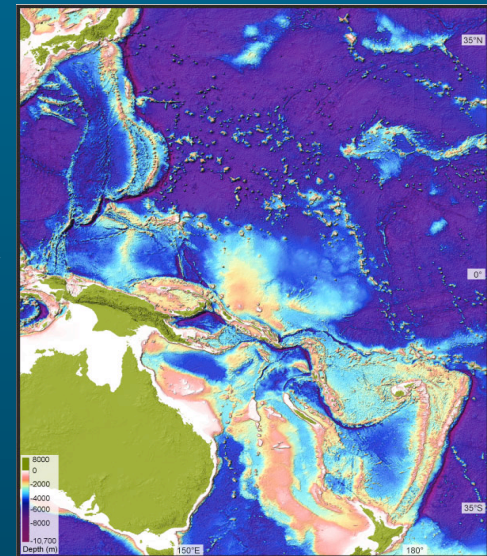
Special Issues

This year: 24*

- Axial Seamount: *JGR*, 1990
- Juan de Fuca Ridge: *GRL*, 1993
- V&H Processes on the S. JdF, *JGR*, 1994
- Volcanic Eruption on the JdF, *GRL*, 1995
- Detection/Response – Gorda Ridge, *DSR*, 1998
- 1998 Eruption of Axial Volcano, *GRL*, 1998
- Tect. And Hydroth. Proc...Arc Subm. Volc's , *JGR*, 2008

Total number of Vents peer-reviewed publications: 419
(average >17/year)

Currently 8 PIs (decreased by 4 during past 8 years)



Performance: Proposals funded during the past four years.

Base funding leveraged by ~50%

NSF: 21 *

OE: 9**

* Note: Most NSF support is generated by Cooperative Institute PIs.

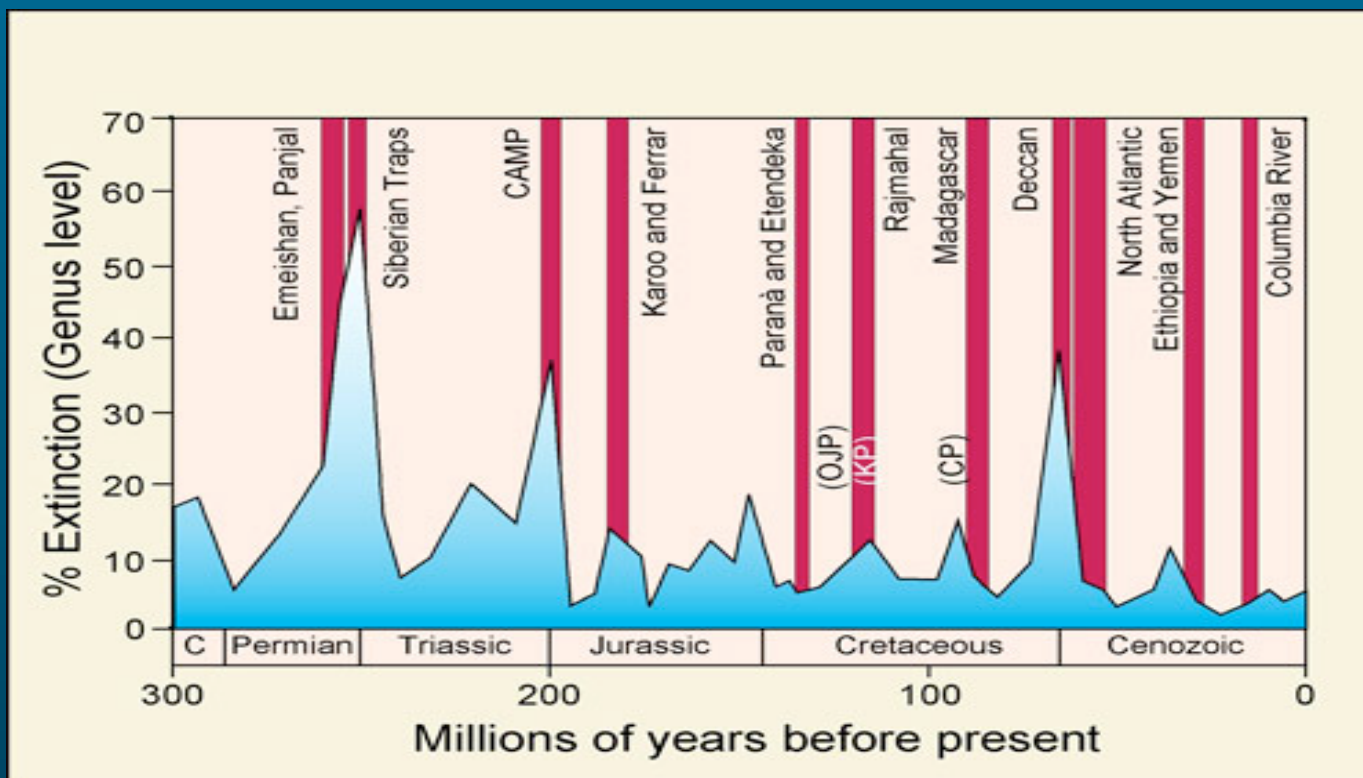
** OE proposals include the **Submarine Ring of Fire** series

Ocean Ecosystems on Submarine Volcanoes

Addressing uncertainties associated with the occurrence, extent, duration, and ecosystem impacts of submarine volcanic and hydrothermal activity

- ▶ Volcanoes erupt over widely varying scales of time and volume

Flood eruptions
 10^3 to $>10^6$ years: $>10^5$ km³



Modified from White and Saunders, 2005)

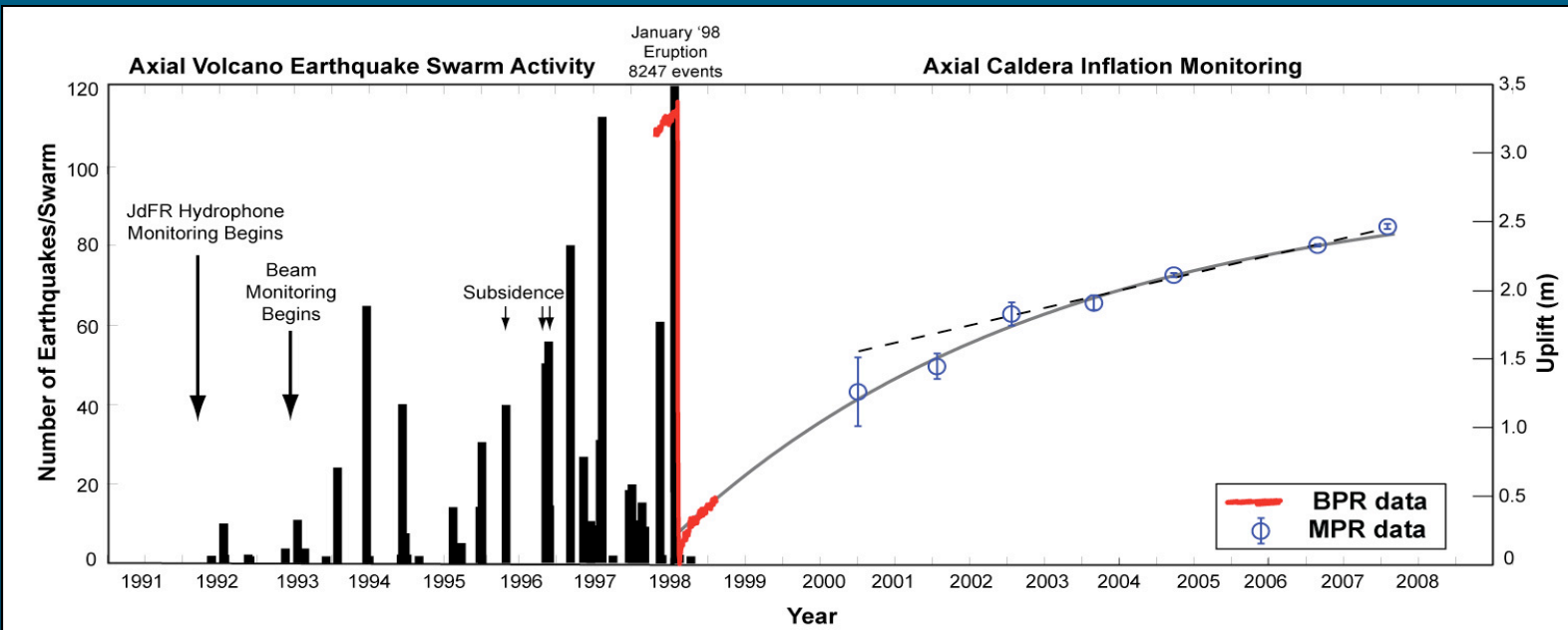
Ocean Ecosystems on Submarine Volcanoes

▶ Small, short duration events (what we've seen so far)

Days to weeks
<1 km³

▶ Bigger, longer duration events (what we want to detect and study)

Years to decades (?)
>1 km³ (?)



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Ocean Ecosystems on Submarine Volcanoes

1300: Patterns in Global Hydrothermal Activity (Baker)

Integration of results to yield estimates of global marine hydrothermal activity

1330: Exploration of Volcanism Along the Pacific
Submarine Ring of Fire (Embley)

Unexpected chemical and biological diversity of submarine arc volcanoes

1400: Tour of ECC, Video Highlights, Posters (Hammond)

A new paradigm in ocean exploration and research

1500: Natural CO₂ From Submarine Hydrothermal
Systems (Lupton)

Observations that reveal unstudied sources and impacts of ocean carbon

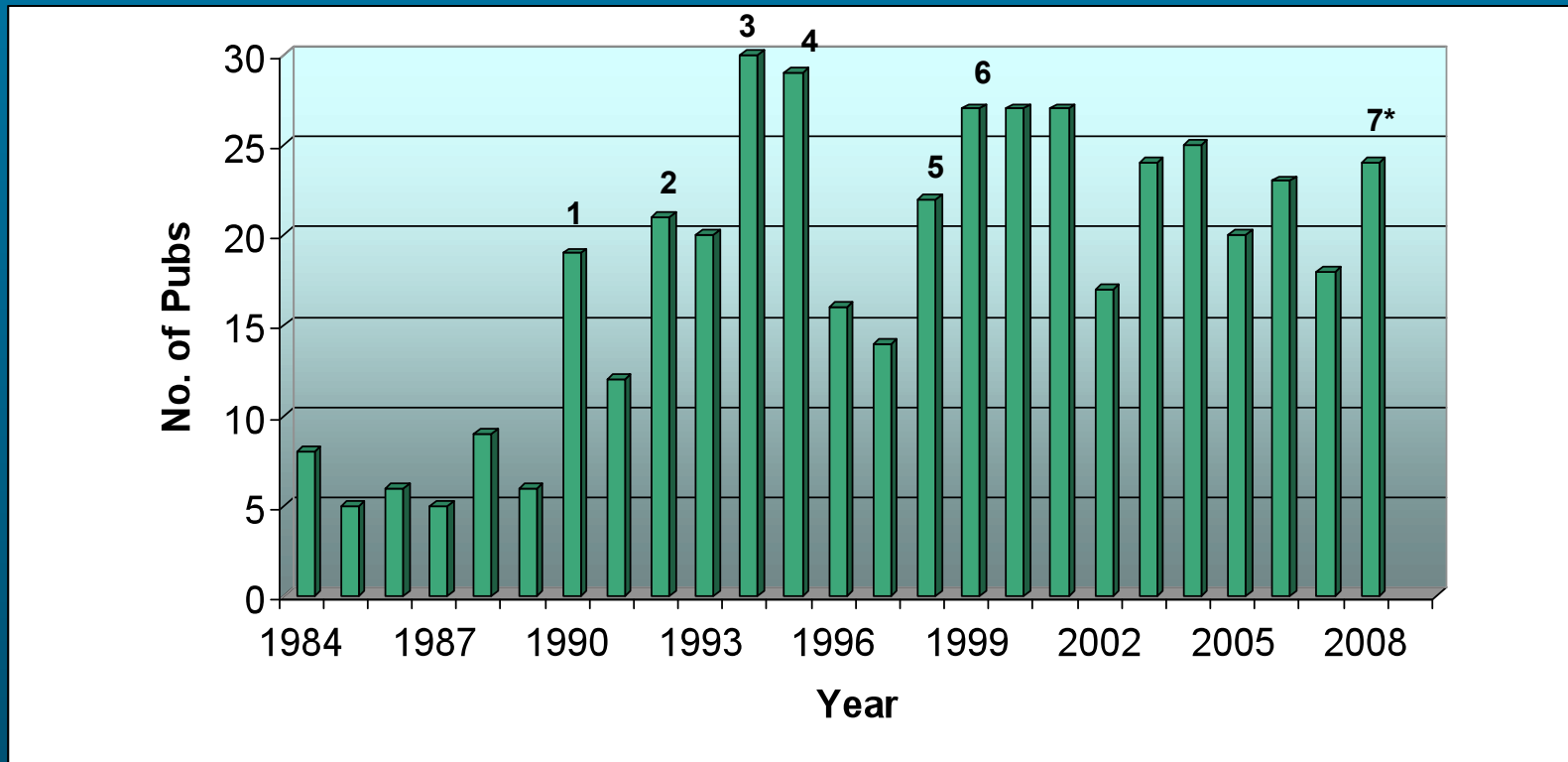
1530: PMEL Vents Ocean Acoustics Project (Dziak)

An innovative approach to establishing a global acoustic event and ocean noise monitoring network

Backup Slides



Preeminence: Communication of Science Results Through Peer-Reviewed Publications



- | Special Issues | | |
|----------------|------------|------------|
| 1: Axial | 4: CoAxial | 7. Mariana |
| 2: JdF | 5: Gorda | |
| 3: SJdF | 6: Axial | |

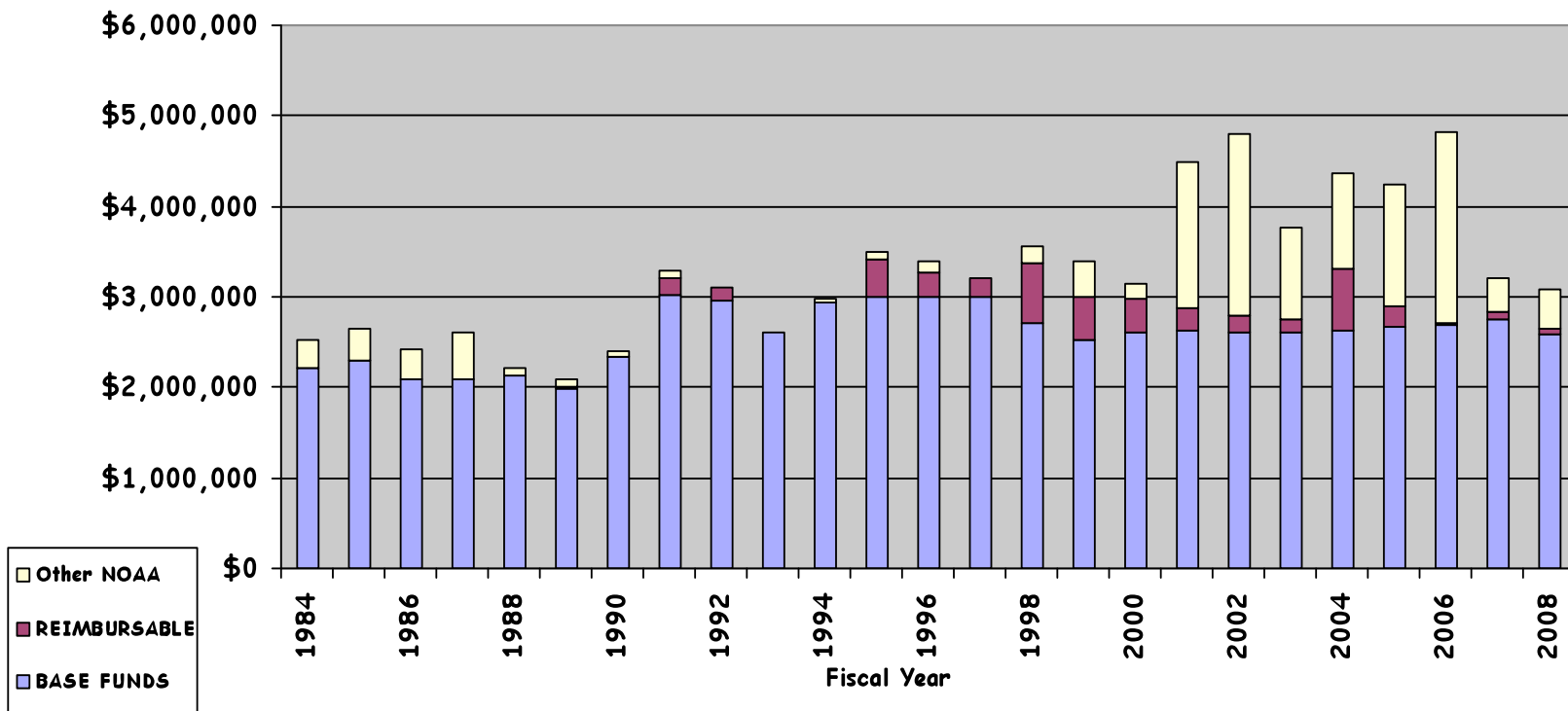
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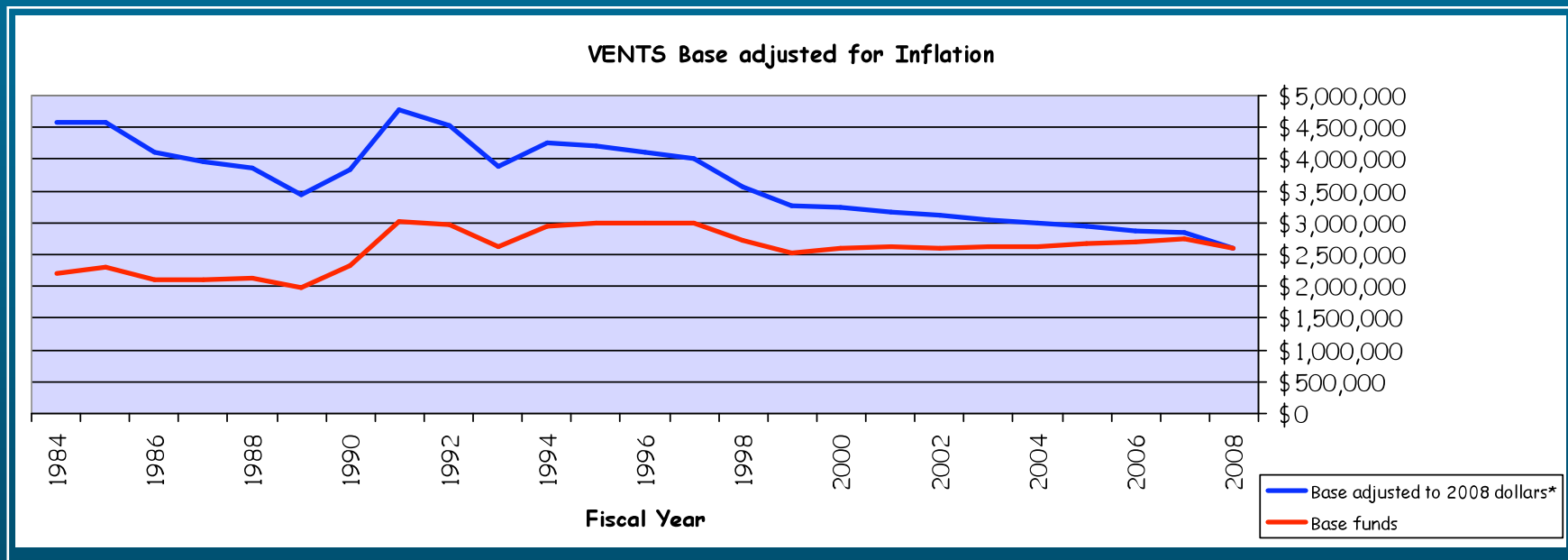
* 2008 total as of 7/1/08



Performance: VENTS Funding Profiles 1984 to Present



Vents Base Funding Adjusted For Inflation



Adjusted to 2008 dollars using the Consumer Price Index calculator (<http://www.dol.gov/dol/topic/statistics/inflation.htm>)