



# *Rock and Fuma-roles*

CONSIDERATIONS IN  
MOUNTAIN RESCUE

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When Things Go Wrong in the Outdoors  
OHSU CME Conference  
August 16, 2024

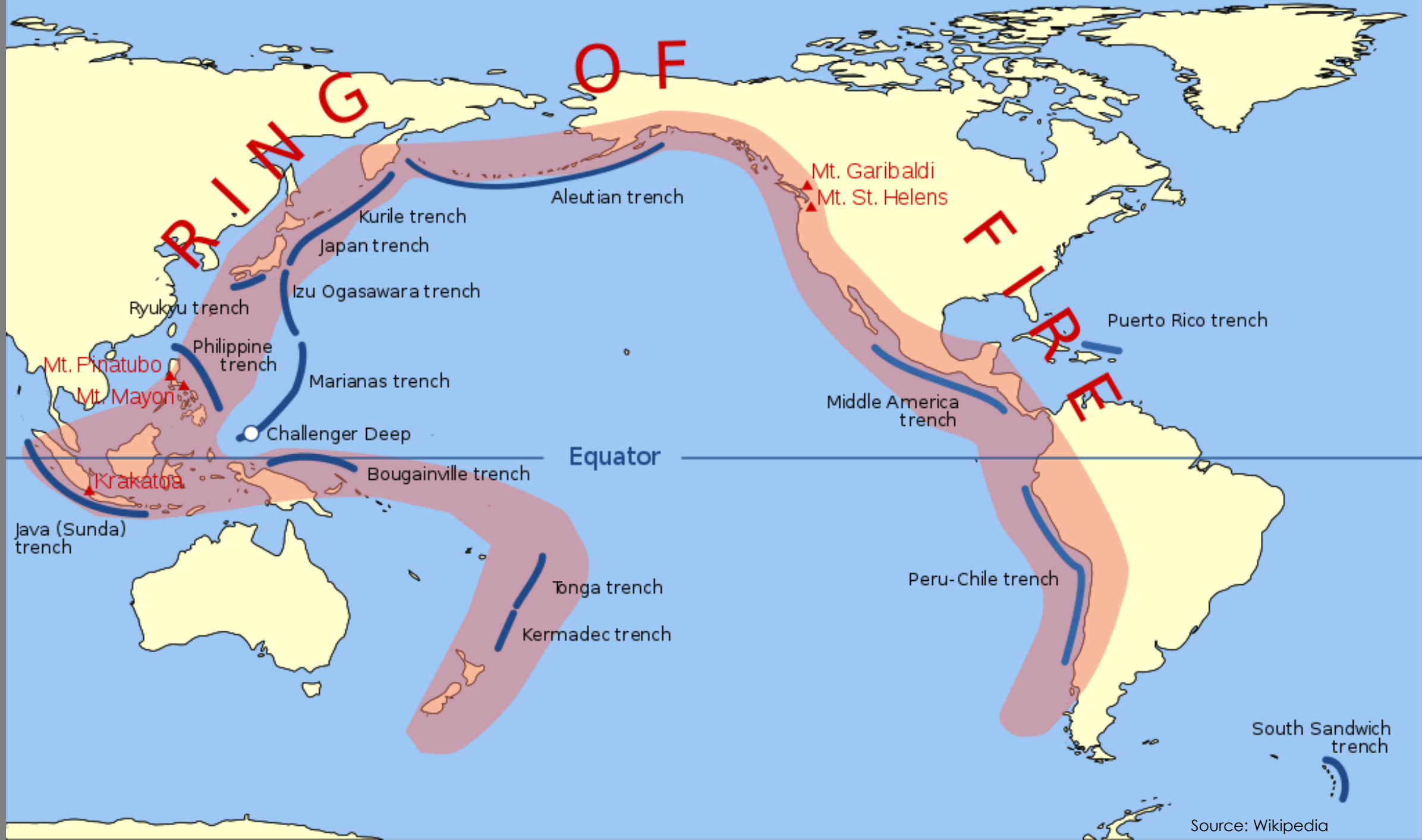
# *Where in the World*



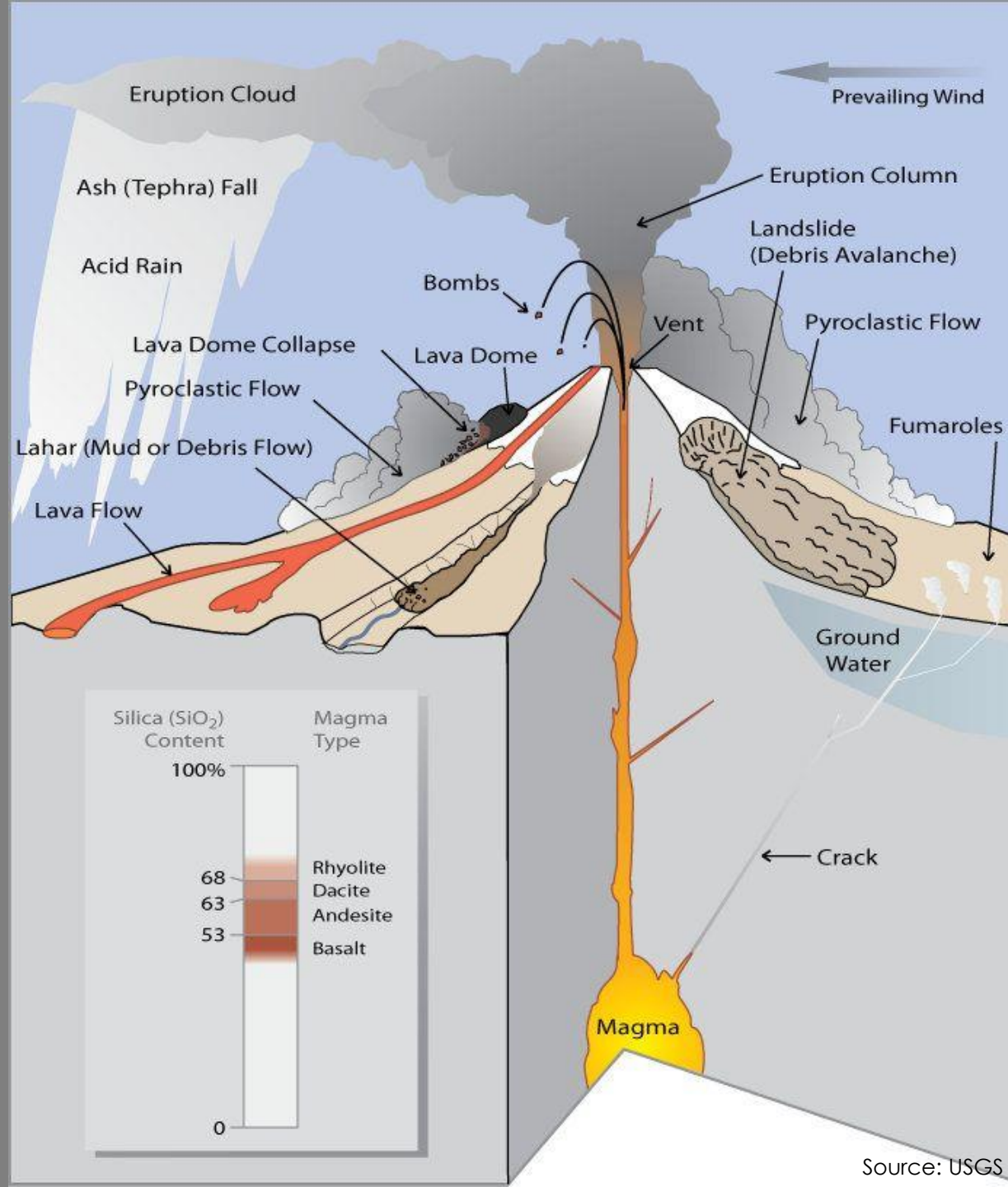
Public Domain Cyrus Read USGS



Source: Wikimedia Commons



# Volcano Anatomy



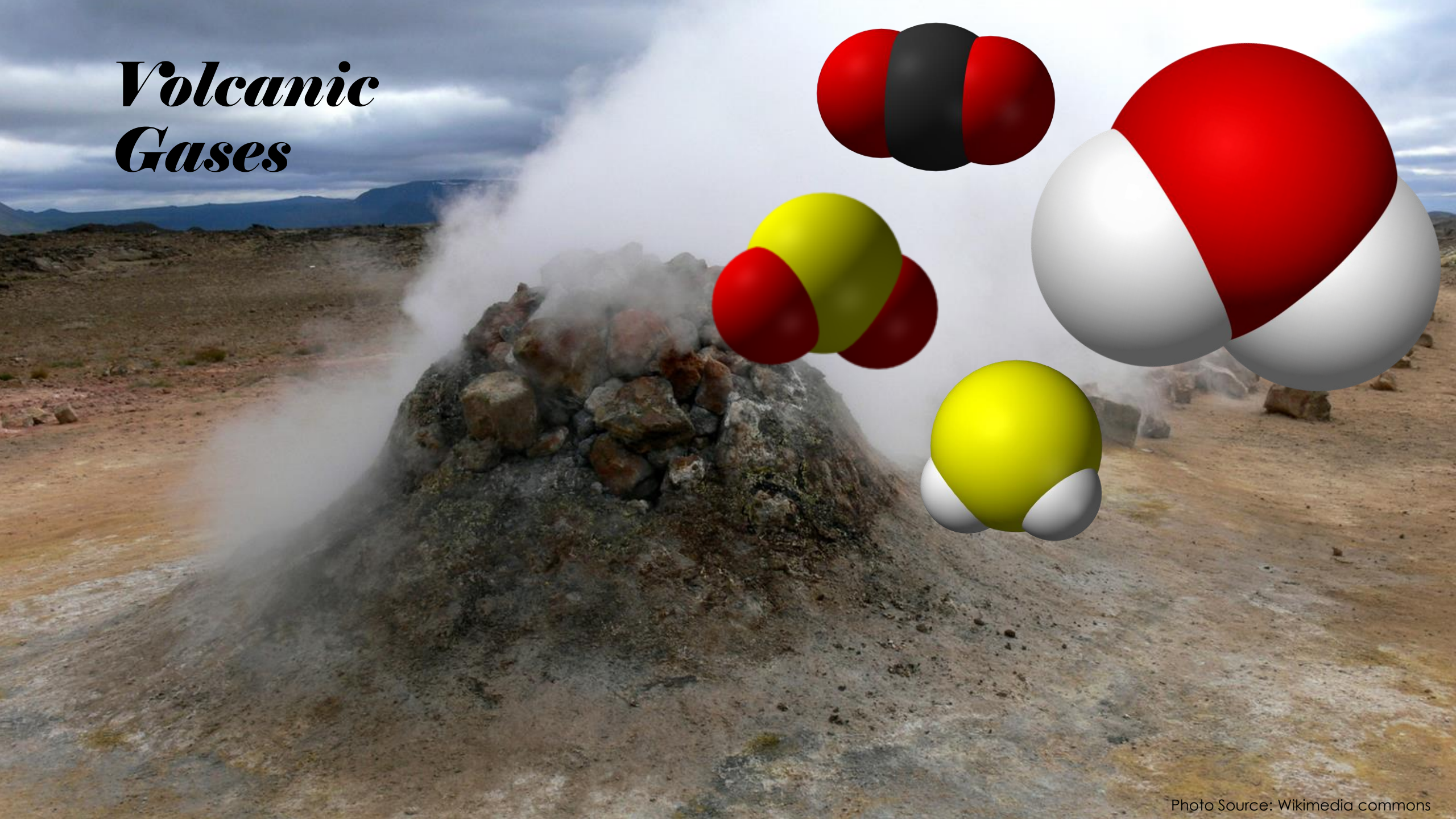
# *What's a Fumarole?*

- Geothermal vent that emits **steam** and **volcanic gases** through holes, cracks, or fissures
- Can vent for centuries or quickly go extinct



Roaring Mountain, Yellowstone National Park, Source: <https://www.nps.gov/articles/fumaroles.htm>

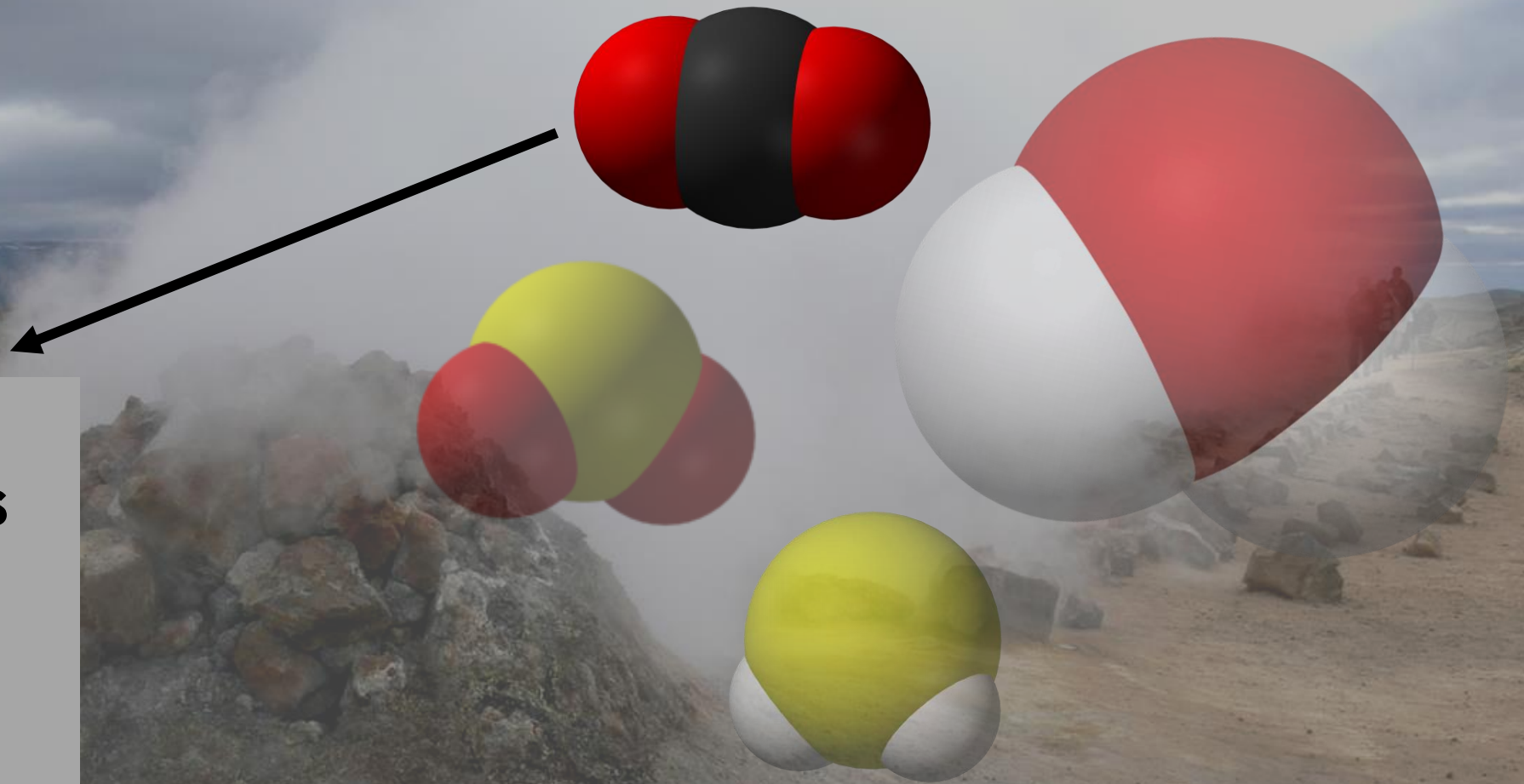
# *Volcanic Gases*



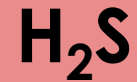
# *Volcanic Gases*

## CO<sub>2</sub> Clinical Features

- Headaches
- Dizziness
- Tachycardia
- Tachypnea
- Altered mentation

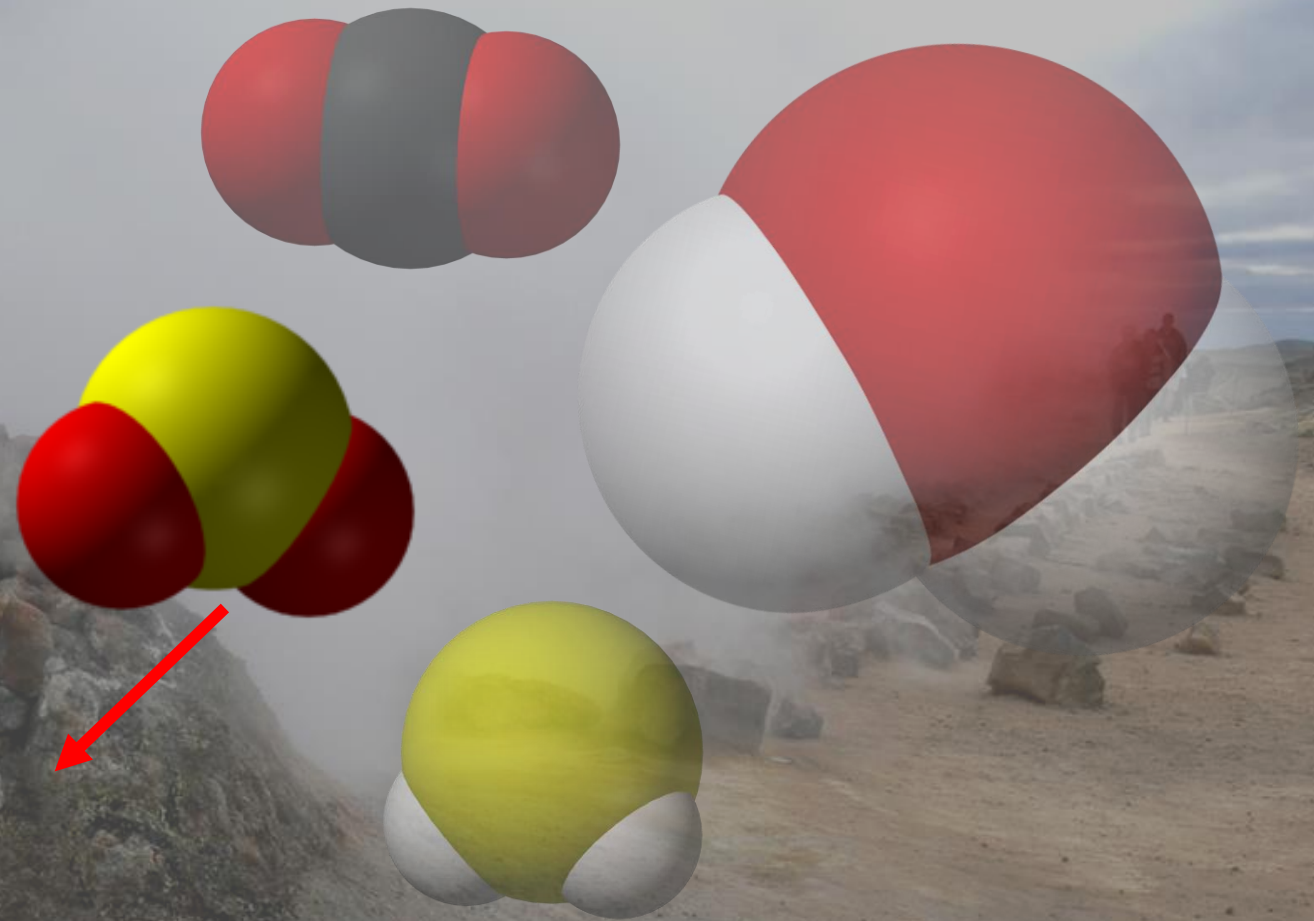


# *Volcanic Gases*



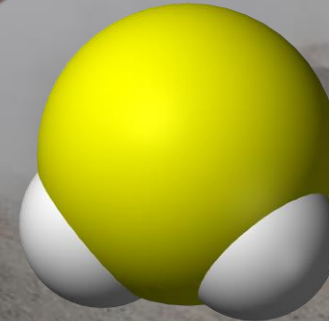
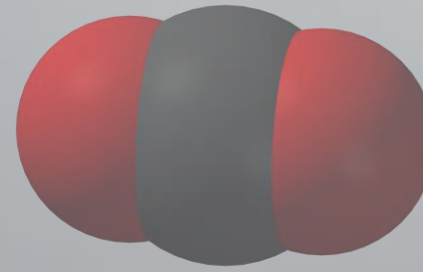
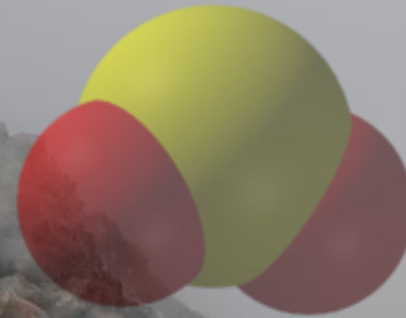
## **Clinical Features**

- Eye irritation
- Respiratory irritation
- Headache
- Vomiting
- Dizziness





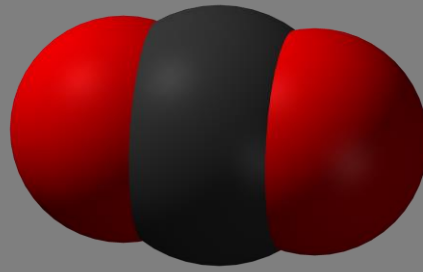
# *Volcanic Gases*



## **SO<sub>2</sub> Clinical Features**

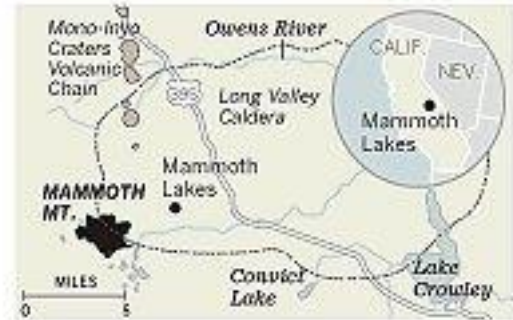
- Mucous membrane irritation
- Cough

# Volcanic Gases



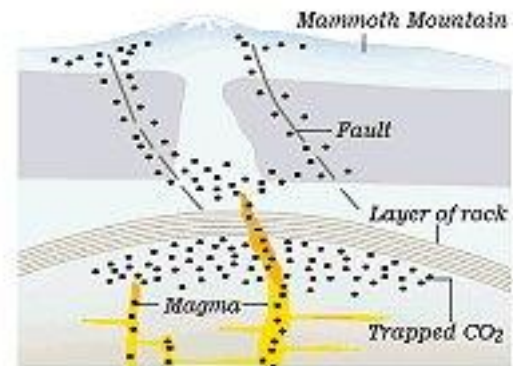
## Deadly accident

Three ski patrollers were killed Thursday when they fell into a volcanic vent on Mammoth Mountain. Gases released through the vent, or fumarole, may have melted the heavy snow on top and formed a cavity, into which the skiers fell. Mammoth is within the Long Valley Caldera, the large volcanic depression that extends to Mono Lake.



### Danger from below

Carbon dioxide gas trapped underground escapes through natural vents, but can become trapped under heavy snow in winter.



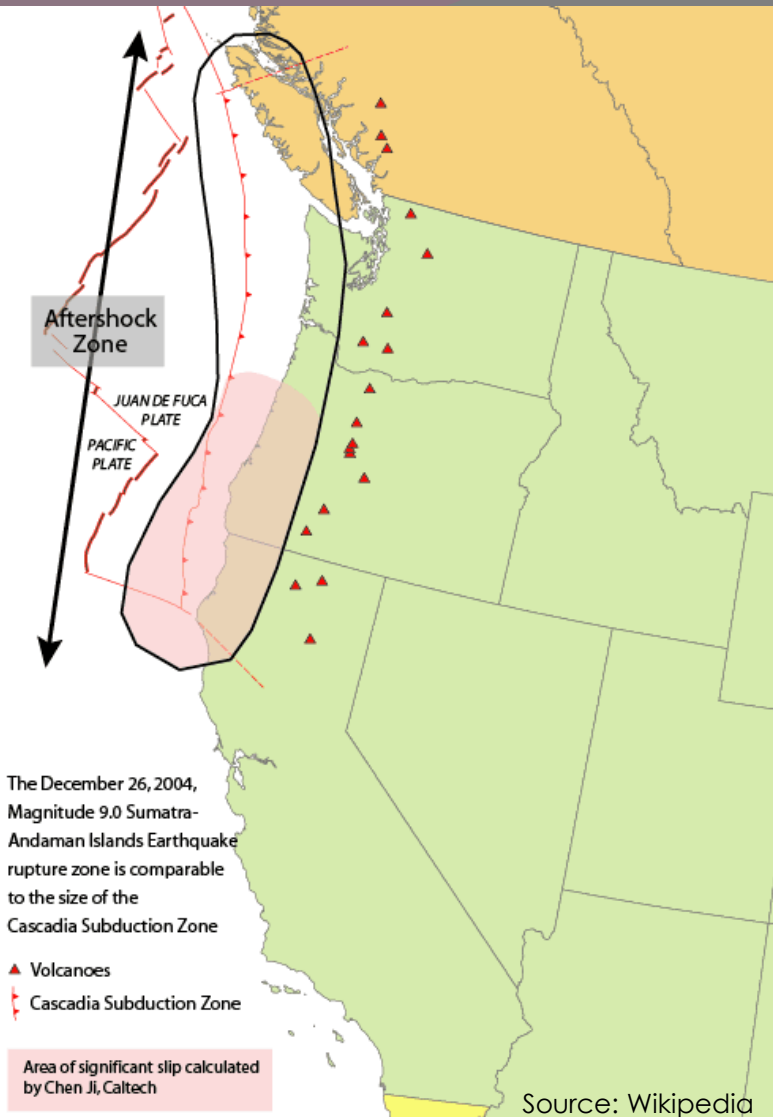
Source: Smokesman Review / AP

Sources: Mammoth Mountain, U.S. Geological Survey. Graphics reporting by JULIE SHEER

LORENA IRIQUEZ, PERRY PEREZ Los Angeles Times

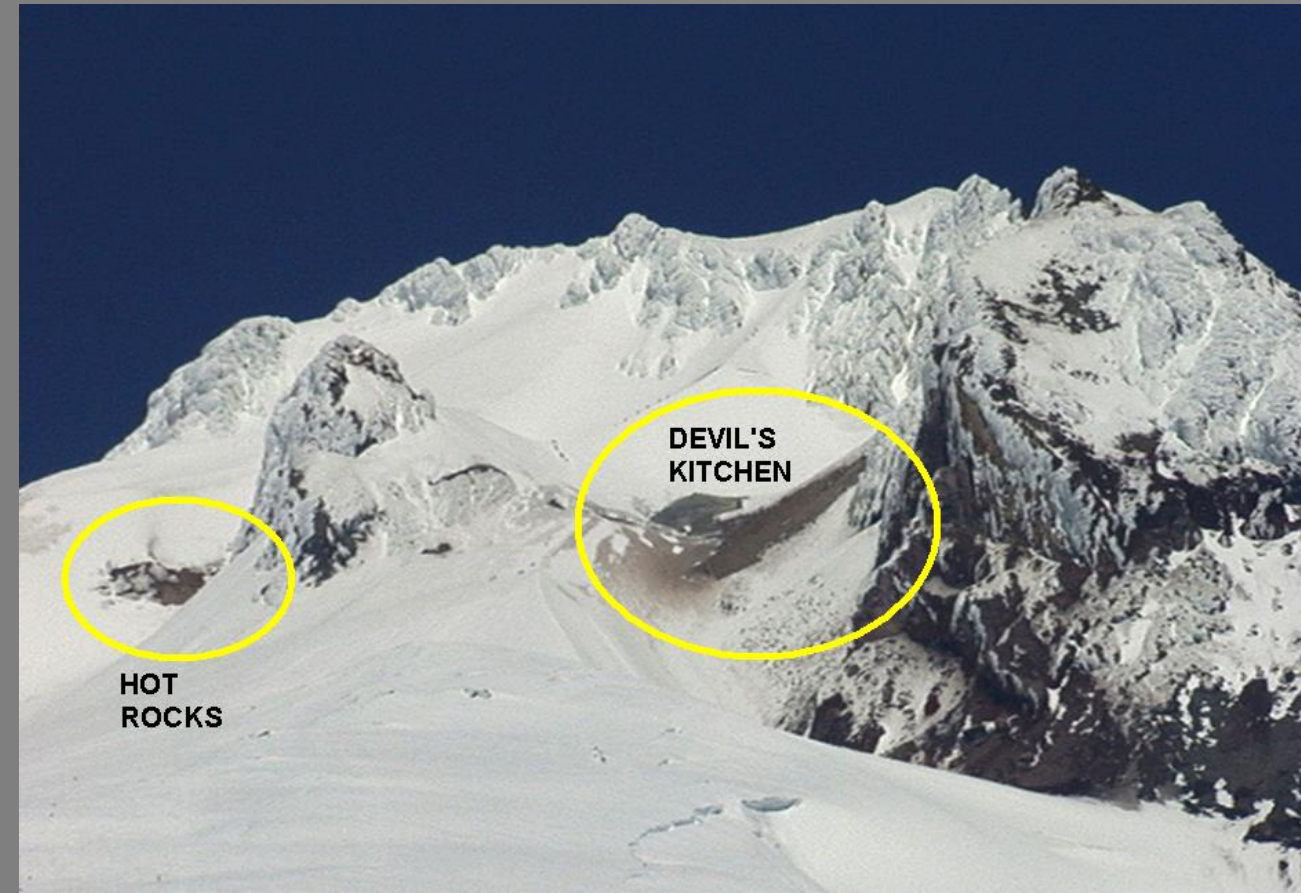
Source: <http://photos1.blogger.com/blogger/160/606/1600/mammoth.jpg>

# *Pacific Northwest*



Sampling gases at a fumarole on Mt. Baker in Washington

# *Mount Hood*



Source: <https://www.gsoc.org/news/2017/5/1/climbing-cascade-geology>

Courtesy of Schmidt, Mariek, public domain  
Source: USGS

# *Rescue Considerations*



Photo courtesy of Scott Norton, Portland Mountain Rescue  
Source: OregonLive



Rescue Radio by Portland...  
2014 Fumarole Rescue on  
Mt Hood

# *Rescue Considerations*



Photos courtesy Dave Clark and Erik Broms  
Portland Mountain Rescue  
Source: OregonLive

# *Rescue Considerations*

July 26, 2023

## Portland Mountain Rescue



**Over the Edge: Uncontrolled Slide Into an Active Volcanic Fumarole**  
Mt. Hood, Oregon



# Rescue Gear



**Air Purifying Respirator**  
Protects from H<sub>2</sub>S and SO<sub>2</sub>  
but not CO<sub>2</sub>



**Hazardous Gas Monitor**  
Aspiration  
Diffusion

Photo courtesy of Eddy Cartaya, PMR





# *Conclusions*

- Fumaroles create unique hazards in mountain rescue
- Volcanic gases include water vapor,  $\text{CO}_2$ ,  $\text{H}_2\text{S}$ , and  $\text{SO}_2$  that create toxicologic hazards
- Rescue teams need to consider specialized equipment when working around fumaroles



# References

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