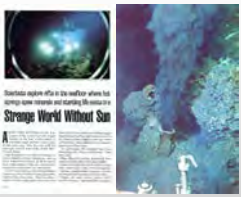
Black smokers in the Deep Sea

GEOMAR

Discovery in the late 1970's

February 1977:
near the Galapagos Islands;
water depth: 2500 m; temperature: 17°C



April 1979: East Pacific Rise near 21°N
2600m water depth, temperature: ~ 350°C

Black smokers in the Deep Sea

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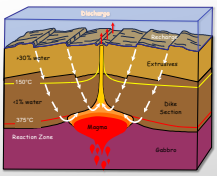
Formation



- recharge of cold seawater
- heating of seawater to > 400°C
- leaching of metals from host rocks
- formation of black smoker at the contact of ascending hot fluids with cold seawater

Black smokers in the Deep Sea

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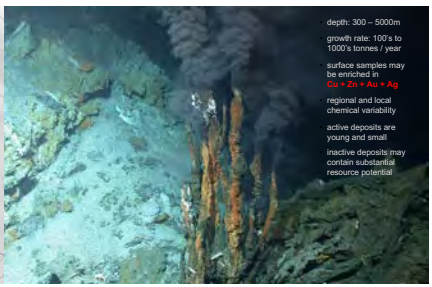
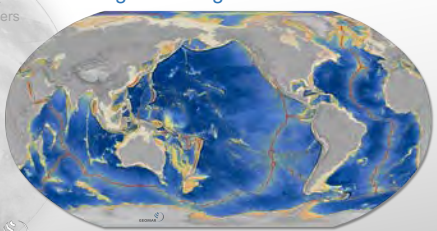


- depth: 300 – 5000m
- growth rate: 100's to 1000's tonnes / year
- surface samples may be enriched in **Cu + Zn + Au + Ag**
- regional and local chemical variability
- active deposits are young and small
- inactive deposits may contain substantial resource potential

Black smokers in the Deep Sea

GEOMAR

Geological setting

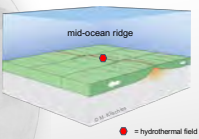


location of spreading ridges relevant to seafloor massive sulfide formation

Black smokers in the Deep Sea

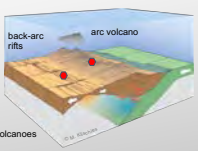
GEOMAR

Geological setting



- Systems forming on axis
- Basalt-hosted

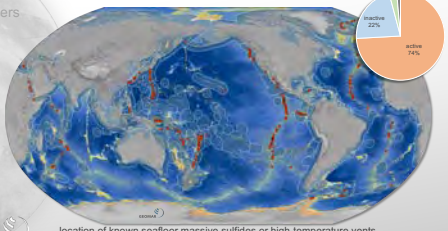
= hydrothermal field



- Subduction influence
- Host rocks are variable
- Magmatic degassing abundant
- Systems forming on axis or at volcanoes

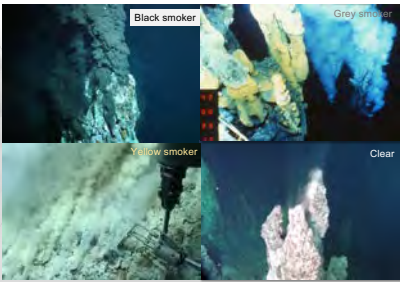
Black smokers in the Deep Sea

Global distribution



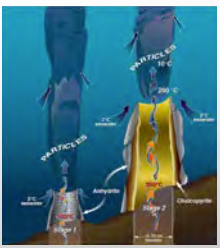
location of known seafloor massive sulfides or high-temperature vents
(N = 435; source GEOMAR)

Black smokers in the Deep Sea



Black smokers in the Deep Sea

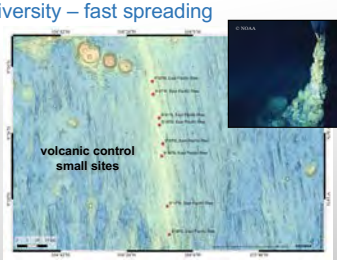
Chimney growth



Tivey 1998 (Oceanus)

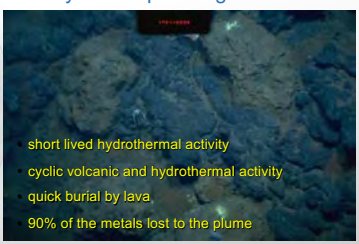
Black smokers in the Deep Sea

Diversity – fast spreading



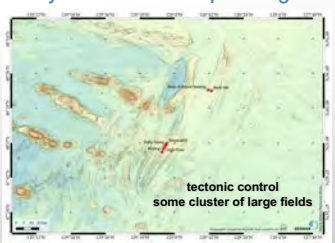
Black smokers in the Deep Sea

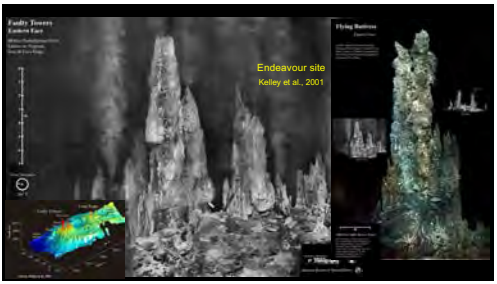
Diversity – fast spreading



Black smokers in the Deep Sea

Diversity – intermediate spreading

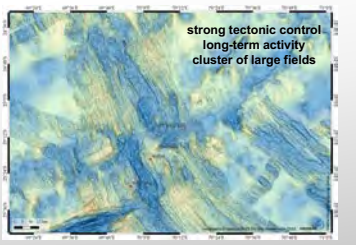




Black smokers in the Deep Sea

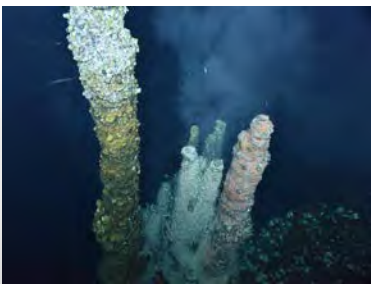
Central Indian Ocean

Diversity – slow spreading



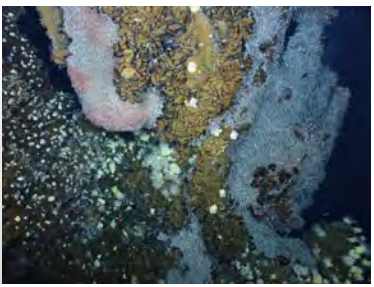
Black smokers in the Deep Sea

Central Indian Ocean



Black smokers in the Deep Sea

Central Indian Ocean



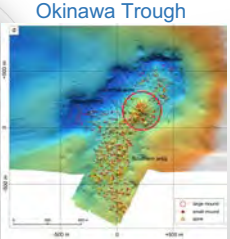
Black smokers in the Deep Sea

Central Indian Ocean

Okinawa Trough

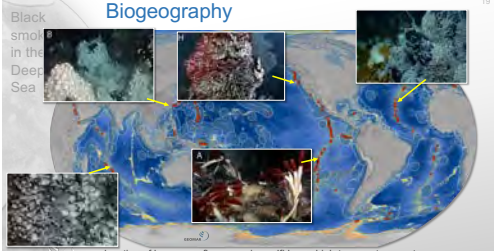
Black smokers in the Deep Sea

Okinawa Trough



One of the largest accumulations known

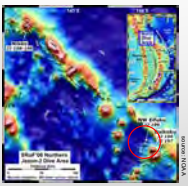
Biogeography



location of known seafloor massive sulfides or high-temperature vents
(N = 435; source GEOMAR)

Rare encounters ...

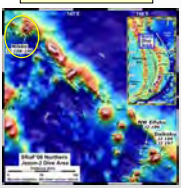
Mariana Arc – NW Eifuku



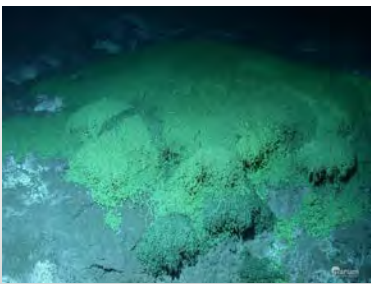
CO_2-rich vents

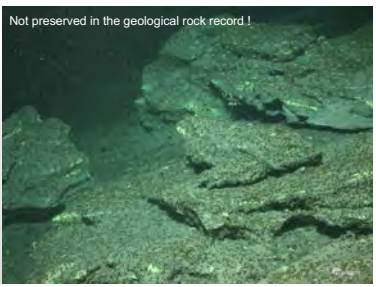
Rare encounters ...

Mariana Arc – Nikko



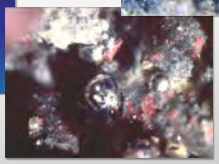
- T_{max}: 215°C (mostly <110°C)
- Molten S lakes @ 450m depth





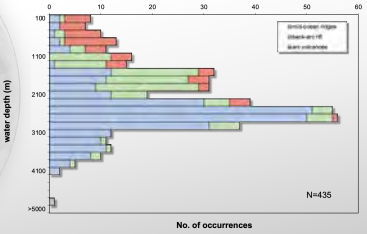
Rare encounters ...

Arsenic, antimony, mercury, ...

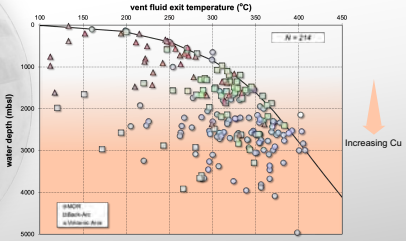


Calypso Vents
water depth: 170m

Depth distribution

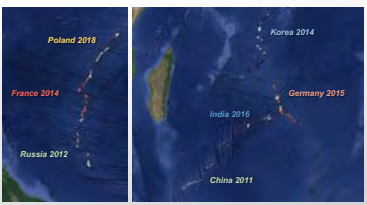


Depth distribution



Economic interest

Economic interest



Exploration targeted at inactive deposits at slow-spreading ridges