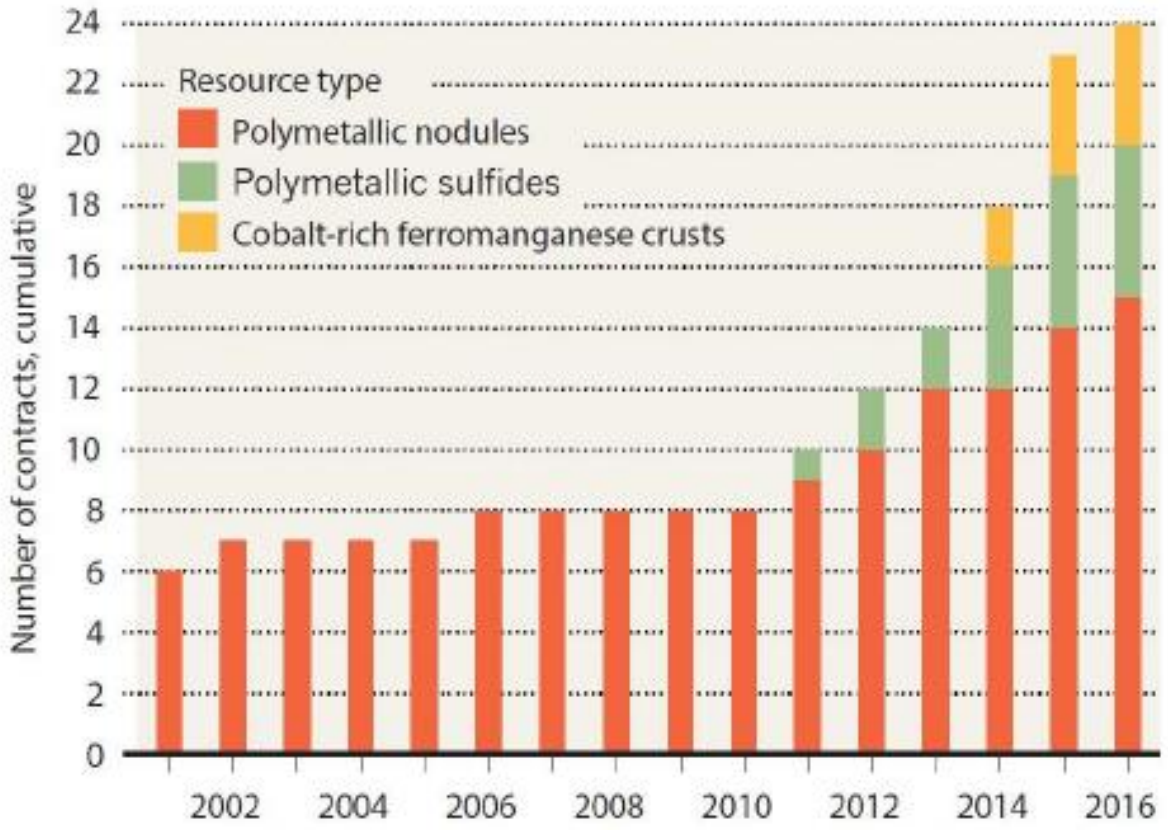
Seabed Mining Heats Up

GEOMAR

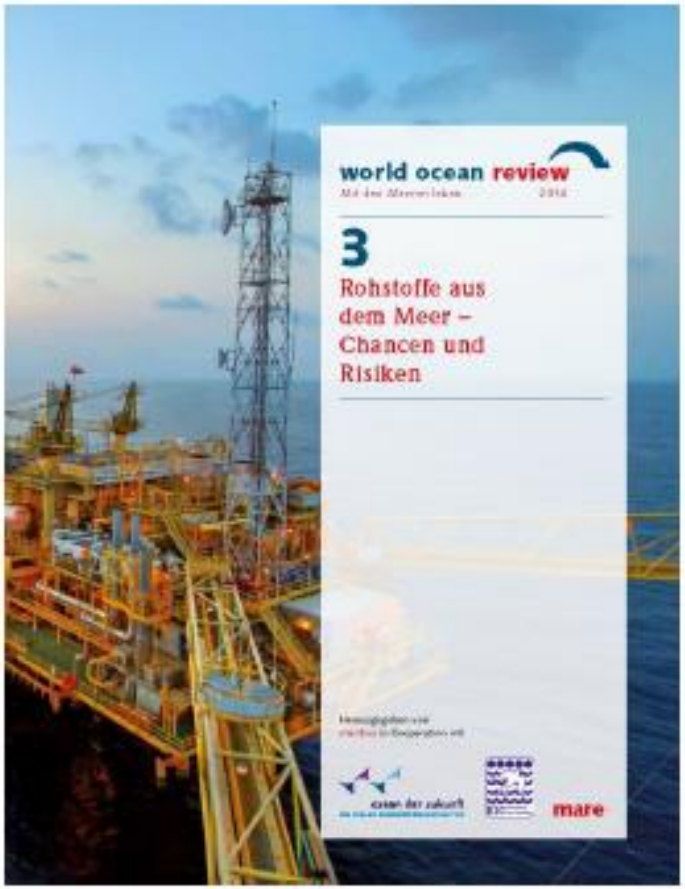
The number of contracts with the ISA shows growing interest in the exploration of mineral resources under the seas.

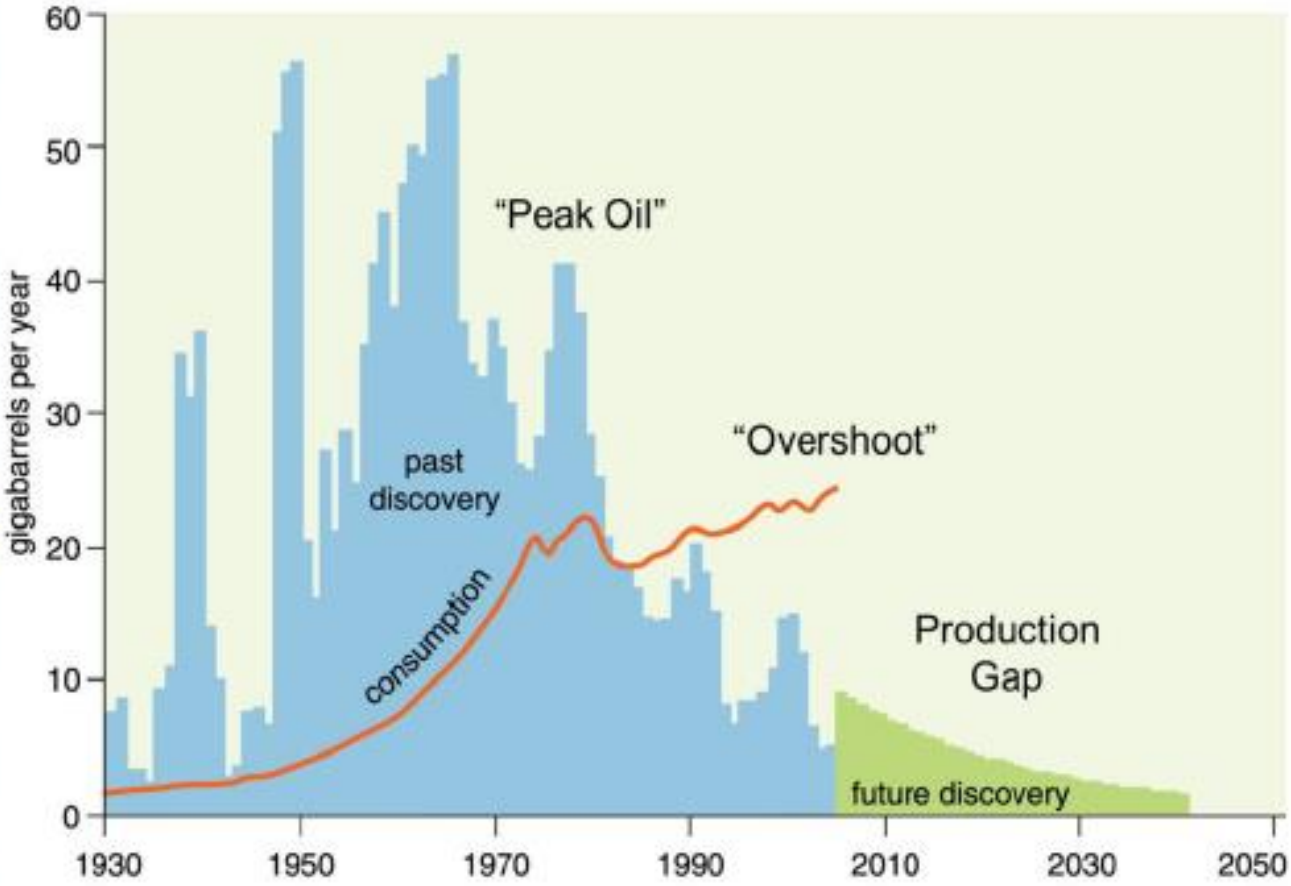


14 APRIL 2016 | VOL 532 | NATURE | 153

An Underlying Motivation

GEOMAR





Critical shortages (or fear of shortages) of strategic metals

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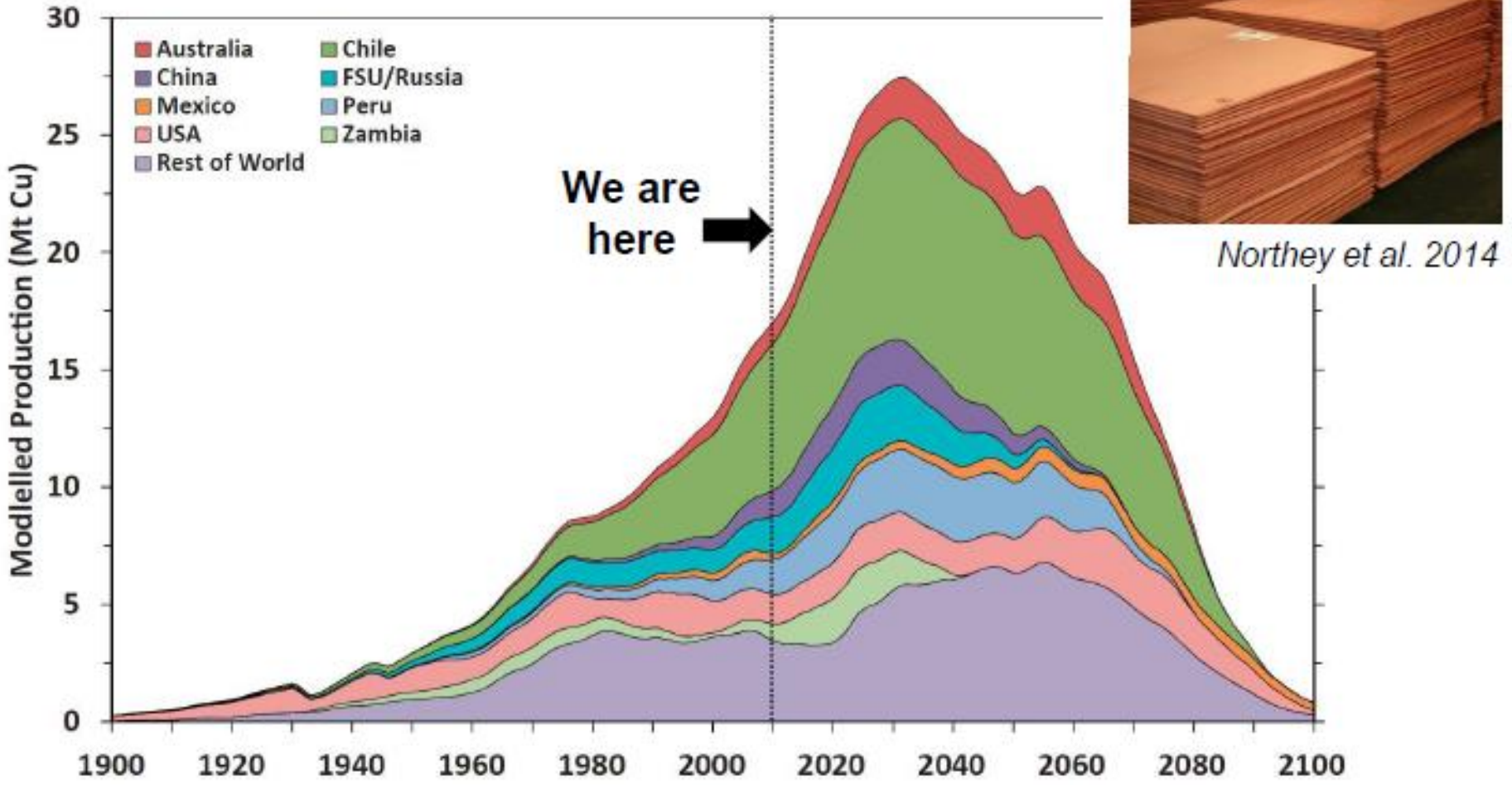
Peak Copper?

GEOMAR

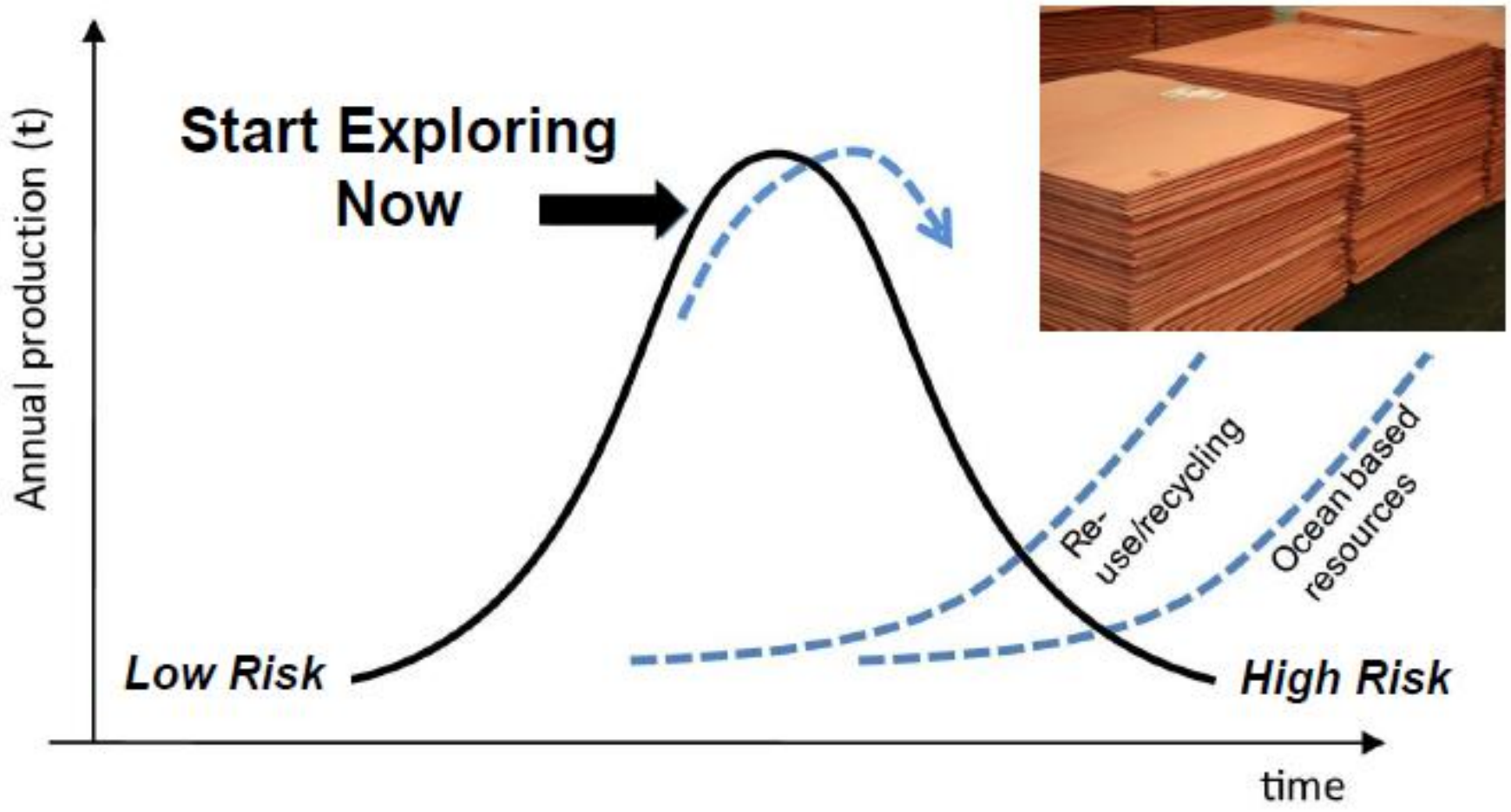


Northey et al. 2014

Critical shortages (or fear of shortages) of strategic metals

The Exploration Imperative

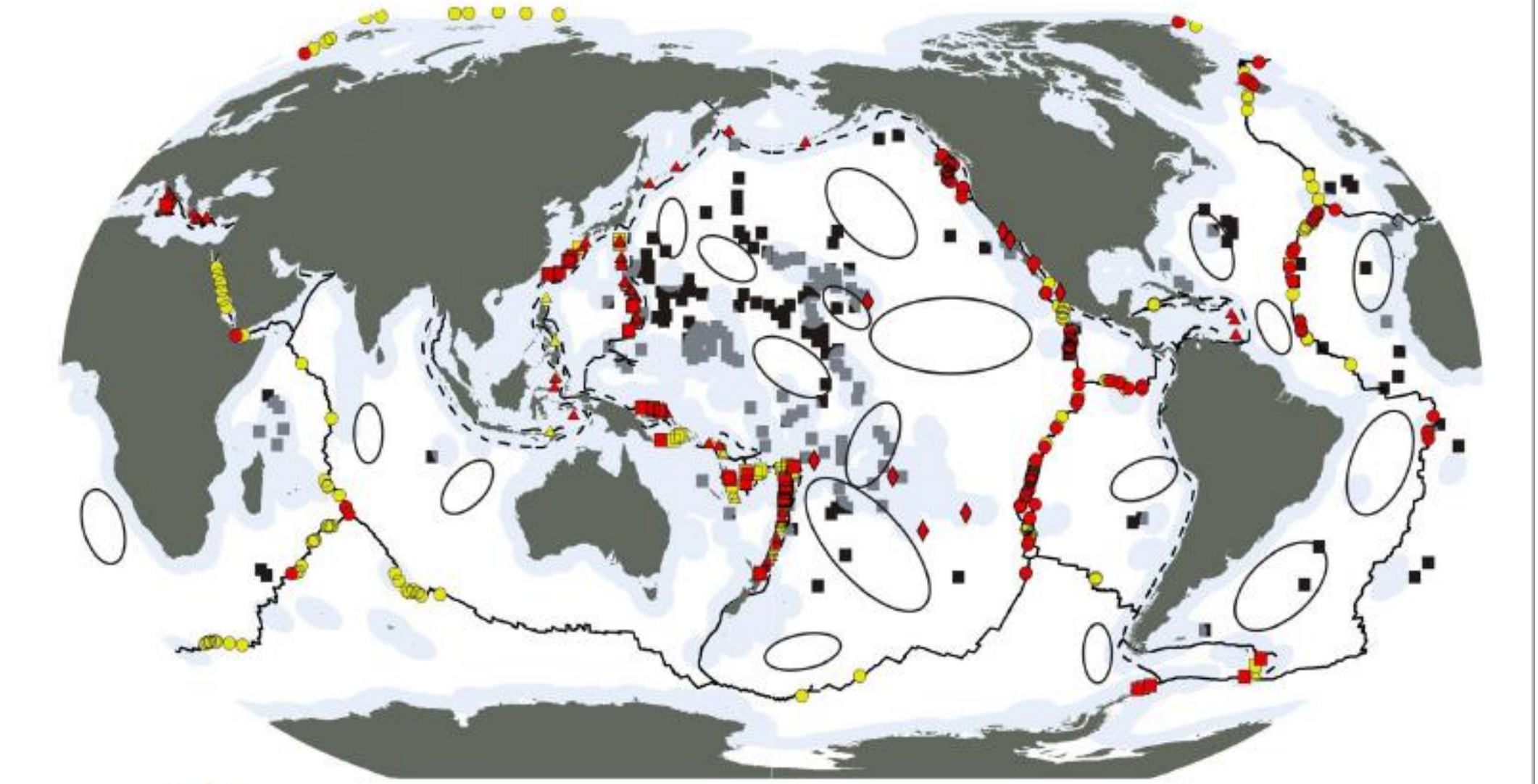
GEOMAR



How big a contribution can ocean resources make?

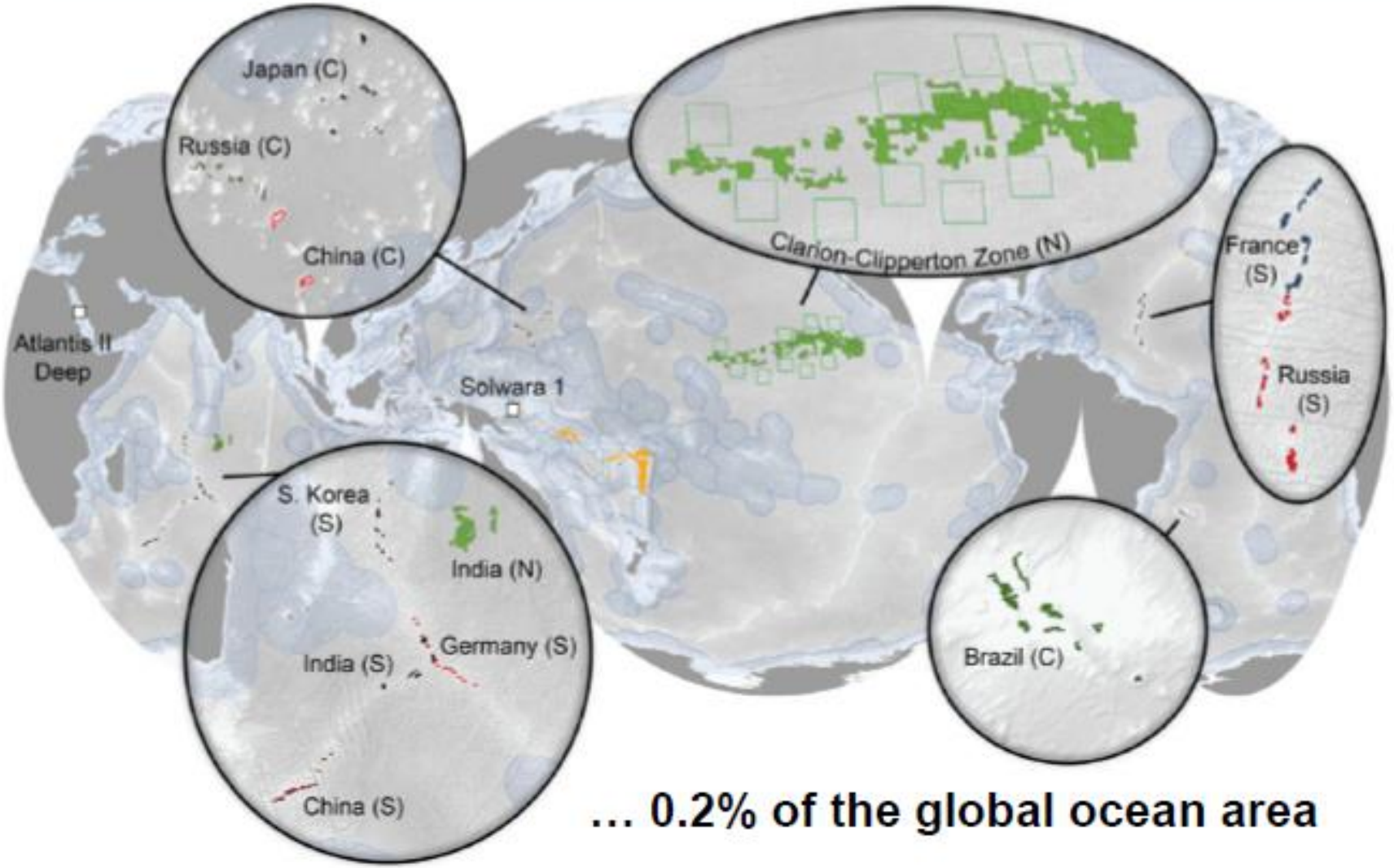
Deep Sea Resources

GEOMAR



The Exploration Imperative

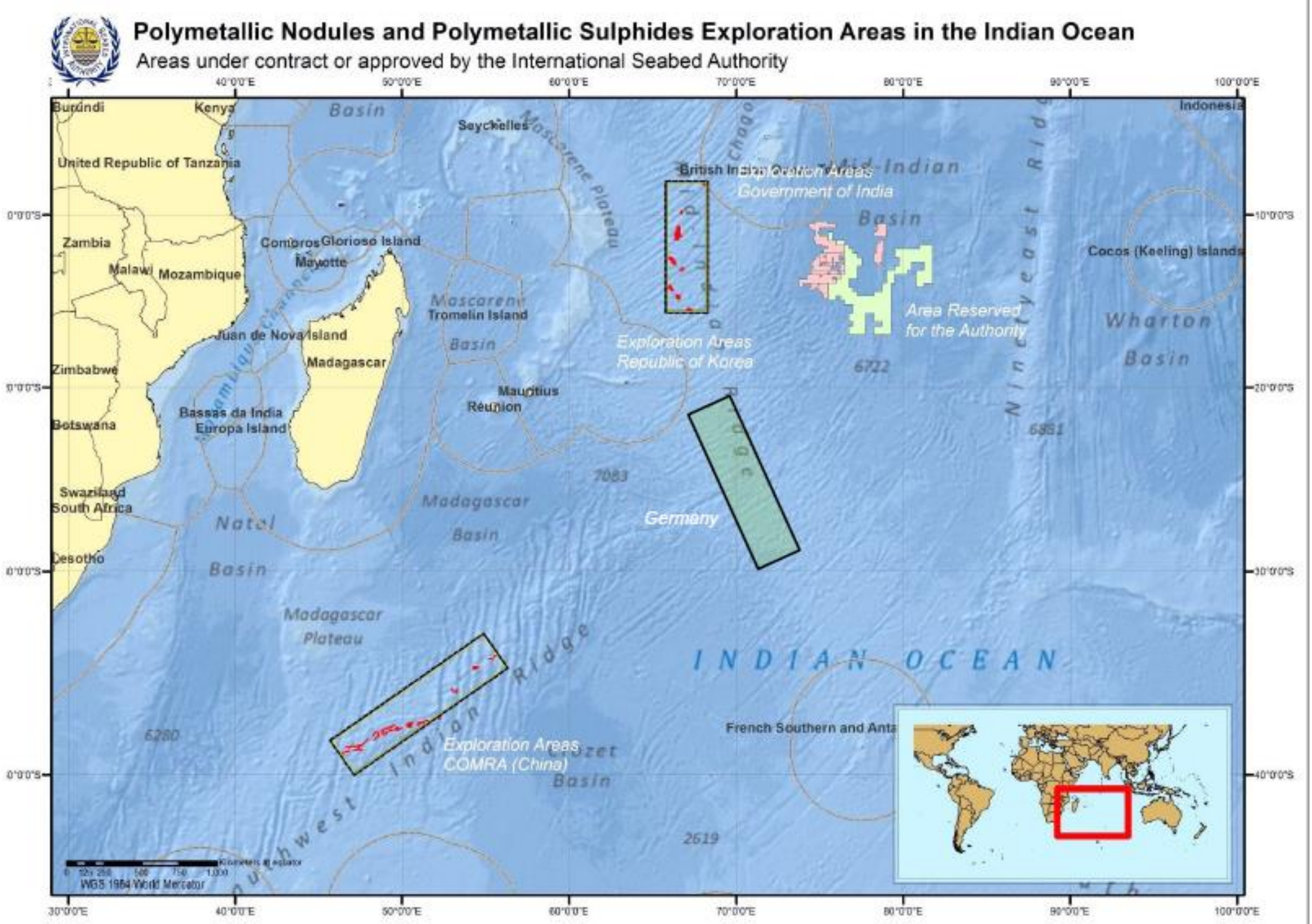
GEOMAR



… 0.2% of the global ocean area

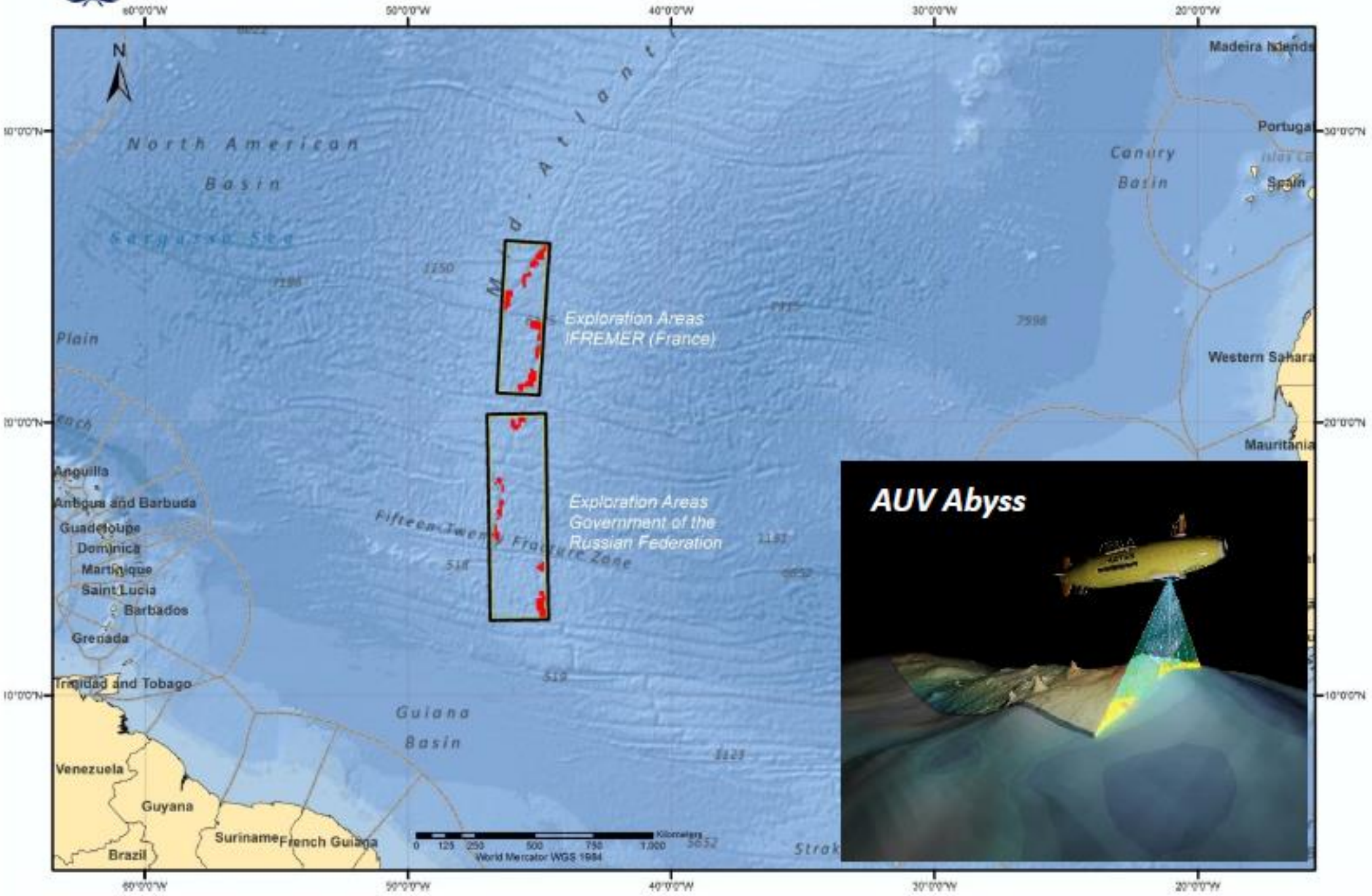
Petersen et al., Marine Policy, 2016

HELMHOLTZ ASSOCIATION


Polymetallic Nodules and Polymetallic Sulphides Exploration Areas in the Indian Ocean
Areas under contract or approved by the International Seabed Authority
Burundi
Kenya
United Republic of Tanzania
Zambia
Malawi
Mozambique
Zimbabwe
Botswana
Swaziland
South Africa
Lesotho
Comoros
Glorioso Island
Mayotte
Juan de Nova Island
Madagascar
Bassas da India
Europa Island
Seychelles
Mascarene Plateau
Mascarene Basin
Tromelin Island
Mauritius
Reunion
Natal Basin
Madagascar Basin
Madagascar Plateau
Southwest Indian Ridge
Crozet Basin
British Indian Ocean Territory
Exploration Areas
Government of India
Mid-Indian Basin
Area Reserved for the Authority
Exploration Areas
Republic of Korea
Germany
Exploration Areas
COMRA (China)
Ninetyeast Ridge
Indonesia
Cocos (Keeling) Islands
Wharton Basin
French Southern and Antarctic Lands
INDIAN OCEAN
6722
6851
7083
6280
2619
WGS 1984 World Mercator

Polymetallic Sulphides Exploration Areas on the Mid-Atlantic Ridge

Areas under contract or approved by the International Seabed Authority



34 Billion tonnes

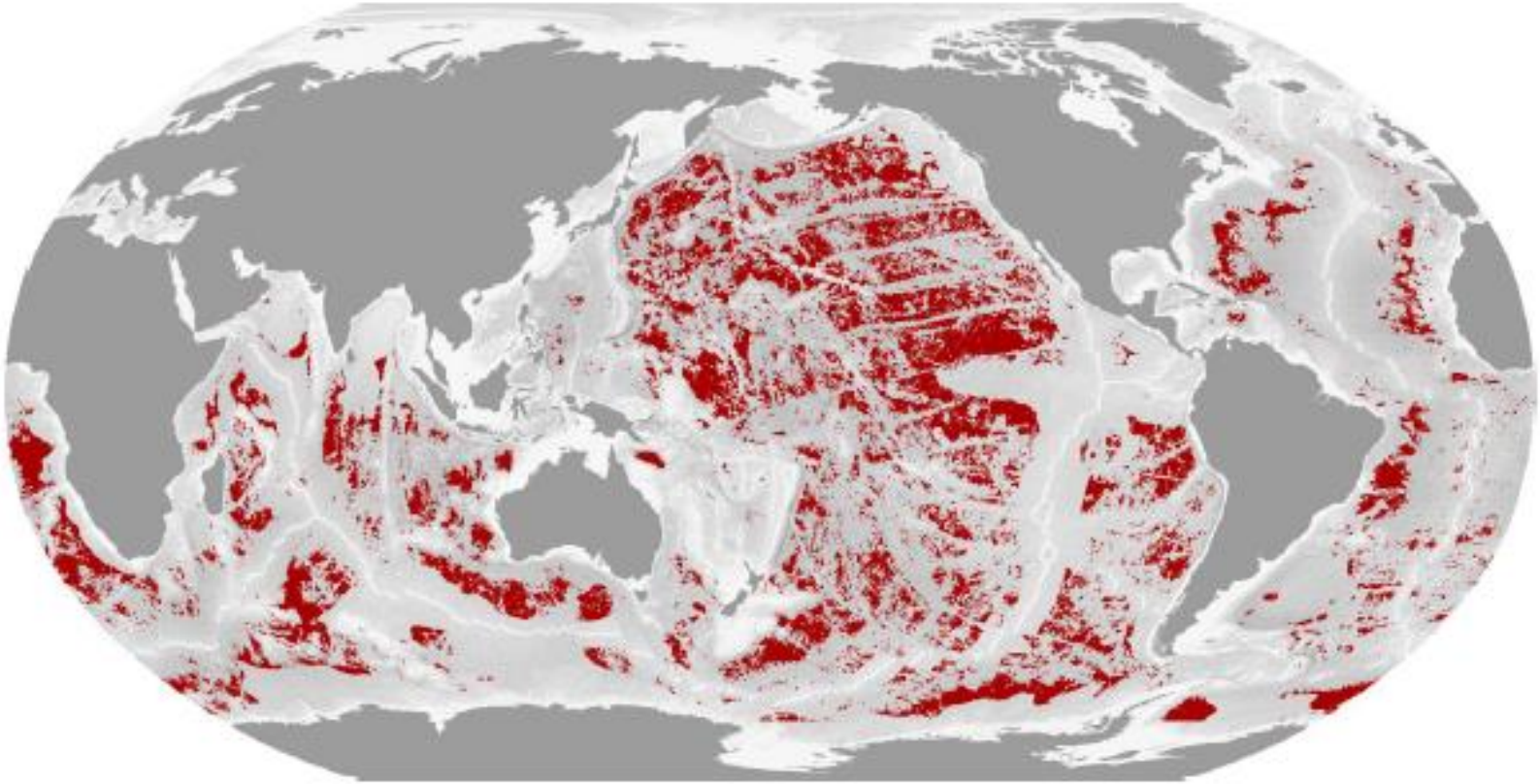
7,500 million tonnes Mn
256 million tonnes Cu
340 million tonnes Ni
78 million tonnes Co

Morgan, 2000

Assessing Geological Potential

GEOMAR

How do we know we are in the right place?



Geological model of nodule distribution in international water

Petersen et al., Marine Policy, 2016

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Quality versus Quantity

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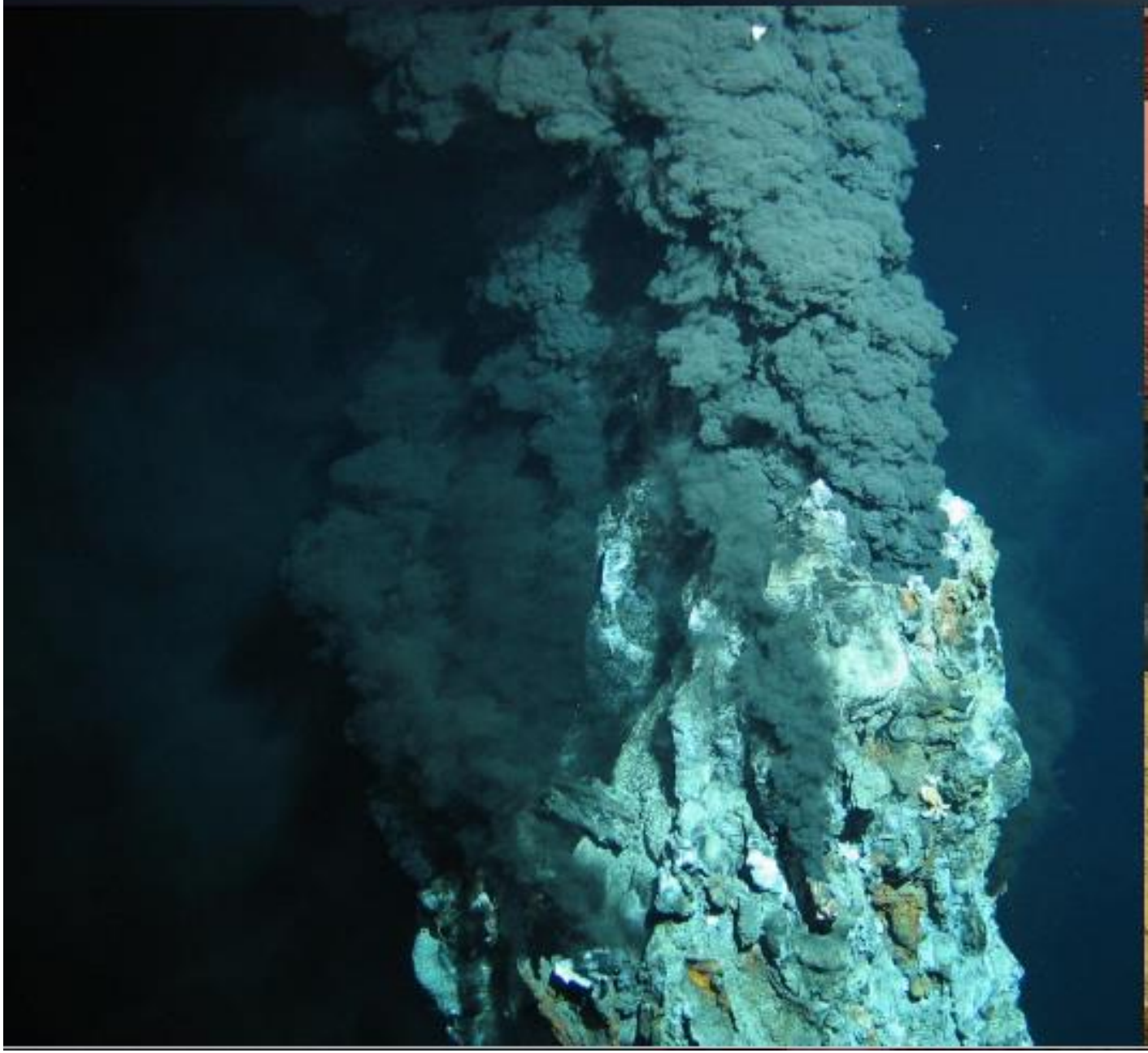
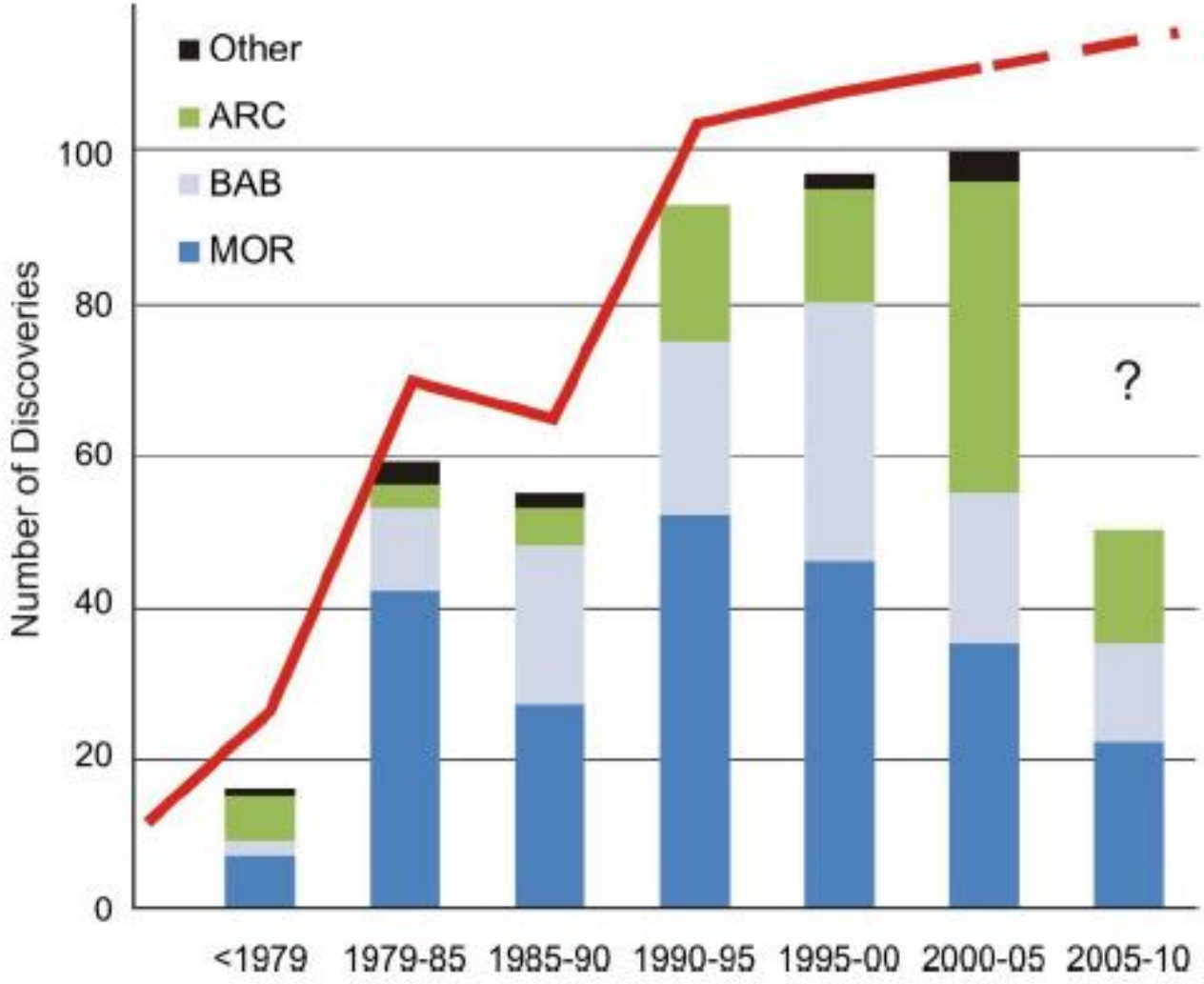


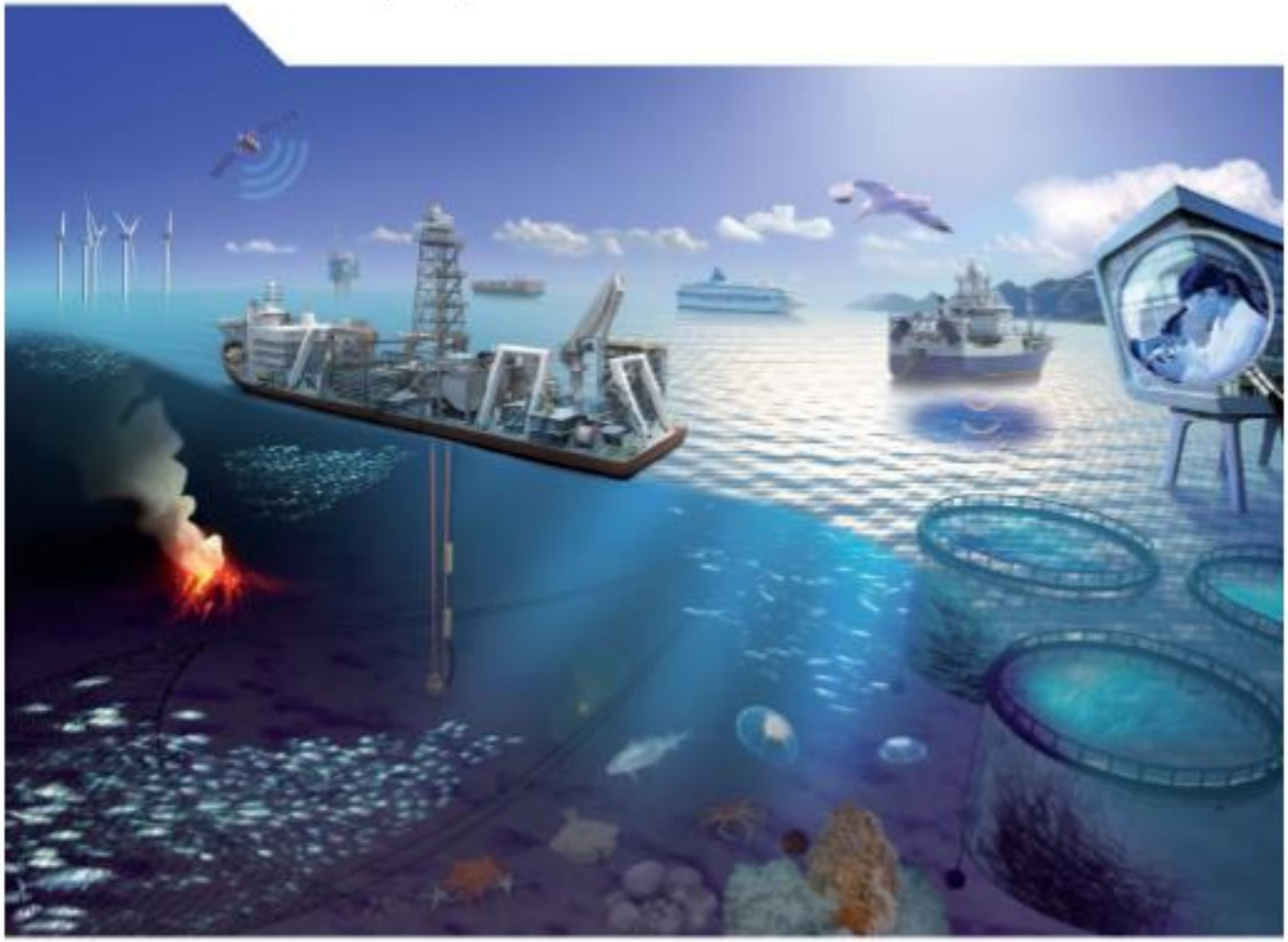
Massive Sulphide Discovery Rates

GEOMAR



The Ocean Economy in 2030

OECD
BETTER POLICIES FOR BETTER LIVES



"When it comes to managing economic exploitation, the current lack of knowledge leaves governments without even basic tools, such as ***a geological map of the seafloor*** – a tool at the centre of every land based minerals regulatory system …"

www.oecd-ilibrary.org/economics/the-ocean-economy-in-2030

Capacity Building

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UNEP

… 80 claims before the CLCS

An Opportunity for Europe

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EuroGeoSurveys
European Geoscience for Society
The Geological Surveys of Europe

AORA
ATLANTIC OCEAN RESEARCH ALLIANCE
THE ATLANTIC: OUR SHARED RESOURCE
MAKING THE VISION REALITY

ONE Geology Europe

AtlantOS

European Marine Observation and Data Network
EMODnet

EuroGOOS
European Global Ocean Observing System

Geoscience Service Sector

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Europe	92 companies *
Australia	258
USA	193
Canada	154
Brazil	72
China	15

*Mining and mineral exploration services

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Training Imperative

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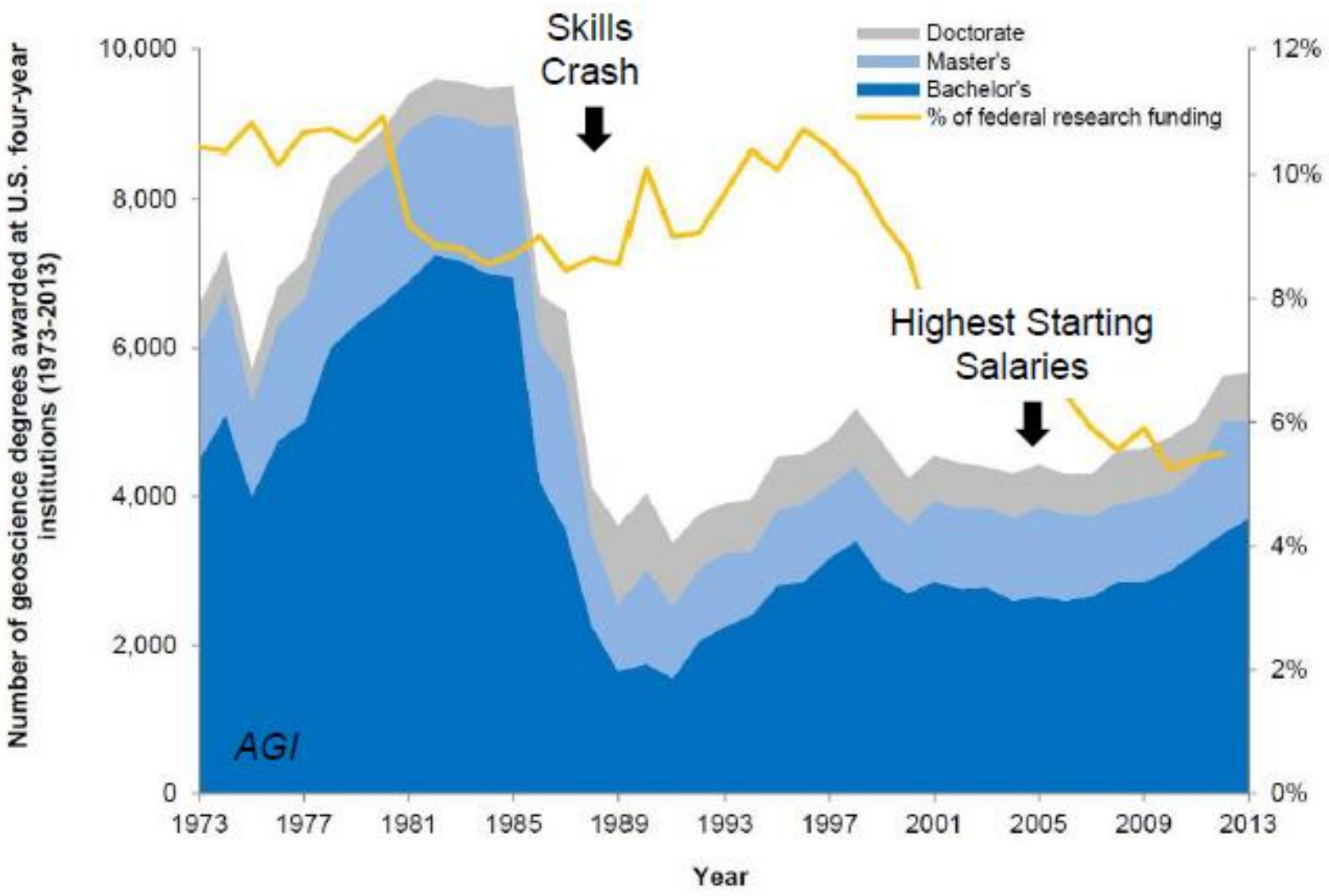

A Knowledge Industry

GEOMAR

Protect the deep sea

Edward B. Barbier and colleagues call for governance and funds for deep-sea reserves and the restoration of ecosystems damaged by commercial interests.

More than 1 million square kilometers of the sea below 200 meters in depth are being ploughed by trawlers, according to estimates[1], and the next decade will see expansion of oil, gas and mineral extraction into deeper and deeper waters[2] (see go.nature.com/hdbl8). At risk are ecosystems that contribute to the health and productivity of the oceans, that challenge our ideas of the extremes at which life can exist (such as hydrothermal vents), and that are habitats and nurseries for fisheries (resources, for example). Our knowledge of deep-ocean biodiversity only hints at thousands of undiscovered organisms and their benefits. Some threatened species, such as cold-water corals, have lifespans of hundreds or even thousands of years; habitats, including rock concretions called manganese nodule beds, can take millennia to form.

We call for formal governance structures and funds to be put in place by 2020 to create networks of deep-sea reserves that maintain and restore biodiversity and function in this vast and important biome[3]. To support these efforts, a global strategy must be framed under the aegis of national governments and an international body. For areas that are beyond national jurisdiction, the International Seabed Authority (ISA) is best suited to this task.

COSTS AND BENEFITS

Deep-sea restoration experiments have already begun. Cold-water corals from the northeast ern Atlantic survive and grow in laboratories[4] and experimental reintroduction to the sea floor has proved successful, with 76% of corals surviving after three

POLICYFORUM

ECOLOGY

Danger of Deep-Sea Mining

Jochen Halfar[1] and Rodney M. Fujita[2]

Tighten regulations on deep-sea mining

Extracting minerals from sea-floor vents should not go ahead without a coherent conservation framework, argues **Cindy Lee Van Dover**.

Deposits of gold are found along the Salmon River in the northwestern United States; during the 1860s attracted explorers to the hot mineral springs of the Yellowstone Basin. Soon after, speculators moved in intending to fence and claim the land containing the hot springs. Instead, by 1872, the Yellowstone geyser basin was set aside as the world's first national park. Remarkably, policy-makers in Washington DC, whose only knowledge of Yellowstone was based on photographs, paintings and stories, could by law fix to leave this wilderness pristine for future generations.

In the late 1970s, geologists discovered analogous, mineral-rich hot springs in volcanically active areas of the floor of the Pacific Ocean[1] (see map). These deep-sea hydrothermal vents support bacteria that use chemicals in the vent fluids to generate cellular energy. The bacteria feed faunal communities of bizarre animals and strange microbes as well as other exchanges occur. Scientists studying vents have gained insights into the cooling of Earth's interior, ocean chemistry and the extremes at which life can exist on Earth and potentially elsewhere in the Universe. Some national governments, such as those of Canada, Portugal, Mexico and the United States, have introduced maritime policies to protect vent fields of particular scientific interest within 200 nautical miles of their

POLICYFORUM

OCEANS

A Call for Deep-Ocean Stewardship

The precautionary approach and collaborative governance must balance deep-ocean use and protection.

Kathryn J. Mengerink,[1,2] Cindy L. Van Dover,[3] Jeff Ardron,[4] Maria Baker,[5] Elva Escobar-Briones,[6] Kristina Gjerde,[7] J. Anthony Koslow,[8] Eva Ramirez-Llodra,[9] Ana Lara-Lopez,[5] Dale Squires,[10] Tracey Sutton,[11] Andrew K. Sweetman,[12] Lisa A. Levin[13]*

INSIGHTS | *PERSPECTIVES*

OCEANS

Managing mining of the deep seabed

Contracts are being granted, but protections are lagging

By **L. M. Wedding,[1] S. M. Reiter,[1,2] C. R. Smith,[3,4] K. M. Gjerde,[4,5] J. N. Kittinger,[1,6] A. M. Friedlander,[7,8] S. D. Gaines,[9] M. R. Clark,[10] A. M. Thurnherr,[3] S. M. Hardy,[11] L. B. Crowder[1]**

entions have to be respected in making use of the international commons"; those interests include both resource exploitation and environmental protection (9).

At its July 2015 session, the ISA, for the first time, will consider a draft regulatory framework to manage exploitation of these (see the map). The CCZ has the largest known concentrations of high-grade polymetallic nodules, with potentially great commercial value (7). The scale of impacts that would be associated with nodule mining in the CCZ may affect 100s to 1000s of km² per mining operation per year (2). In 2005 an interna-

Seafloor Mining Plan Advances, Worrying Critics

If all goes as planned, the world's first commercial deep-sea mine will open for business in 2016, with engineers deploying a trio of robots to claw high-grade copper and gold ore from the sea floor 1500 meters down off Papua New Guinea (PNG). Last week, after years of dickering, PNG's government and Canada-based Nautilus Minerals signed an agreement to move forward with the ambitious project. "We were very happy" to get the deal done, says Nautilus CEO Mike Johnston.

Critics aren't so pleased. Some marine biologists worry the mining will start before researchers can assess how it will affect deep-sea ecosystems. Others argue that national and

reversible and moderate," says a 2008 company study, which predicts that seafloor populations would rebound within a few years after mining ended.

Opponents are skeptical, with some saying they doubt that the PNG government—which has a 15% stake in the project—has the technical expertise to conduct adequate and independent oversight. Oceanographer Cindy Van Dover of Duke University in Durham, North Carolina, who helped Nautilus conduct some of its preliminary studies, concedes that "there's no way to know what the impact" will be. Doing the studies that some