TOPIC:
Science and Technology Imperatives Created by Deep-Ocean Industrialization.

TERMS OF REFERENCE:

(1) Define the science that must underpin comprehensive, ecosystem-based management of deep-ocean environments subject to increasing industrialization via human extraction, harvest, disposal and contamination. Consider the science needed to maintain ecosystem functions in areas within and beyond national jurisdiction.

(2) Identify the state of scientific knowledge and knowledge gaps critical for effective stewardship of deep-seafloor environments. Consider influences of changing climate, cumulative human impacts, and biogeographic classifications.

(3) Evaluate technology and innovations needed for deep-ocean observations, monitoring and assessments in the face of seafloor industrialization.

POTENTIAL PRODUCTS:

(1) Short publication identifying growing industrialization of the deep seafloor and the need this generates for scientific knowledge (to enable sustainable ecosystem-based management of deep-sea ecosystems).
(2) Special contributed volume on the science of deep-sea stewardship. Possible venues: J. of Marine Systems, Marine Ecology, Biogeosciences. The volume may include papers on deep-sea classification, connectivity, recovery from disturbance, resilience and stability, susceptibility to climate change, marine protected areas.
(3) Group of themed papers on technology needs and options in the deep sea: Ocean observing, Long-term monitoring, Ocean enforcement. Possible link to DOOS group (Eric Linstroem).
(4) Special session at AGU or EGU "Science and technology gaps and opportunities linked to industrialization of the deep ocean"
(5) Development of "Deep-Ocean School of Excellence" course material for use in deep-sea regional training in less developed countries

RATIONALE:
The deep waters and seabed of the world ocean constitute the largest biosphere on this planet, supporting a wealth of species and habitat diversity, performing key ecosystem functions and providing valuable food, energy, pharmaceutical, and potentially mineral resources. Once considered pristine, the deep sea (from 200-11,000 m) is of growing economic interest. There is increasing pressure on deep-sea

ecosystems from extraction activities such as fishing, oil and gas exploitation, bioprospecting, and minerals mining (for polymetallic nodules, massive sulfides, cobalt-rich ferromanganese crusts, phosphorites, and rare earths), as well as from waste disposal, CO_2 storage, and contamination. Large-scale leasing of the seabed is occurring in some parts of the world with little or no existing baseline studies. Concurrently, CO_2-driven climate change is altering ocean temperatures, oxygen and pH with effects on deep-sea species distributions and ecosystem processes, and on their services and functions. All of this occurs out of sight, and thus out of mind. There is a pressing need for scientific information to enable sustainable management of deep-water ecosystems that reside within EEZs and international waters. Scientific themes such as biogeography, endemism and connectivity, disturbance and restoration ecology, resilience of ecosystem function, multiple stressors and cumulative impacts all emerge as important for making decisions and about deep-ocean activities.

This proposal is timely because the deep seafloor is undergoing rapid industrialization by oil and gas extraction, deep-water fisheries, and seabed mining. Exploitation activities are outstripping the available science needed to maintain the integrity of deep-ocean ecosystems and their functions. **This topic should be a high priority for SCOR** because many of the industrialization activities in the deep ocean target less developed countries, where the science knowledge base is limited or non-existent. This working group can help to identify and define the types of information needed and stimulate international programs to generate the needed knowledge. **Thus it provides an excellent mechanism to advance this topic**. The terms of reference are seen as gathering and synthesizing information that is ultimately needed to engage the global science community in long-term research efforts. The deep-sea community is fairly small, and practically non existent in developing countries. **The suggested membership** includes a mix of genders, ages, and representatives from countries in different stages of development. All are scientists who have identified an interest in and actively engaged in the issues. We envision that this science core working group would team with **associate members** expert in policy and economics to help apply the science to environmental management issues, and with scientists from additional countries to broaden the global reach of the information gathering and its application**. Capacity building** will take the form of member engagement, identification of regional deep-ocean science needs for less developed countries, and development of 'Deep-Ocean School of Excellence' course materials for use in regional training.

POSSIBLE MEMBERSHIP (up to 10)

Elva Escobar, Mexico (Lead)
Lisa Levin, USA (Co-lead)
Maria Baker, United Kingdom
Cindy Van Dover, USA
Hiroyuki Yamamoto, Japan

Lenaick Menot, France
Javier Sellanes, Chile
Ashley Rowden, New Zealand
Andrew Sweetman, Norway
Aquila Tawake, Fiji
Bronwen Currie, Namibia

POSSIBLE ASSOCIATE MEMBERS:

Kristina Gjerde, Poland
Tony Koslow, USA (biology)
Baban Ingole, India (biology)
Andrey Gebruk, Russia (biology)
Linwood Pendleton, USA (economics)
Dale Squires (economics)
Paul Snelgrove, Canada (biology)
Tracey Sutton, USA (biology)
Jeff Ardron, Germany (policy)
Kathryn Mengerink, USA (policy)
Ursula Witte, United Kingdom (biology)
Christian Neumann, Norway (communication)

TIMELINE:
Year 1: Workshop to consider Reference term 1 and organize data gathering for reference term 2; Formation of subgroup to address 'Deep-Ocean School of Excellence'

Year 2: Workshop to present/synthesize material for reference term 2 and organize data gathering for reference term 3. Organize Special Volume for publication in year 3. Gather resources for 'Deep-Ocean School of Excellence'

Year 3: Workshop to present and synthesize reference term 3. Organize/hold themed session at international meeting; organize technology papers for publication in year 4. Hold 'Deep-Ocean School of Excellence' test sessions.

Year 4: Complete publications. Develop workshop follow on activities.