September 20–24, 2009
Chennai, India

The Eighth (2009) ISOPE
Ocean Mining (& Gas Hydrates) Symposium

ISOPE
OMS-2009
National Institute of Ocean Technology
Chennai, India, September 20–24, 2009

Final Program
Invited and Peer-reviewed Papers

- Nodules, Crusts, Sulphide
- Gas Hydrates and Engineering
- Exploration & Environment
- Deep-Ocean Water Utilization
- Deep-Ocean Mining Programs
- Mining and Economics
- Mineral Processing
- Mining Systems and Technology
- Ocean Energy
- Underwater and Subsea Systems

Organized by:
International Organizing Committee

Sponsored by:
International Society of Offshore and Polar Engineers (ISOPE)
National Institute of Ocean Technology (NIOT)
with cooperating organizations (listed inside)

ISOPE OMS-2009 Local Secretariat
Attn.: Dr. Atmanand, National Institute of Ocean Technology
Pallikaranai, Narayanapuram
Chennai - 600100, India
Fax: +91-44-2246-2038; E-mail: atmanandma@hotmail.com
Welcome to ISOPE OMS-2009

We greatly appreciate the excellent responses and help we have received from colleagues around the world in the successful organization of the 8th ISOPE Ocean Mining Symposium (ISOPE OMS-2009), NIOT, Chennai, India, September 20–24, 2009. The symposium features 13 sessions of 52 peer-reviewed papers and 6 additional oral presentations from 11 countries. This year the symposium continues to introduce gas hydrates and upwelling of deep-ocean water in addition to deep-ocean exploration, environment, mining systems, and processing systems.

The 1st (1995) ISOPE Ocean Mining Symposium (ISOPE OMS-95) was held in Tsukuba. An informal organizational meeting of Ocean Mining Working Group (OMWG) was held in Tsukuba, Japan, on November 22, 1995. At the meeting, representatives from 7 countries agreed to establish the group for a close international cooperation and more exchange of the individuals’ progress, which can also act as an informal channel among the governments. The group concept got blessing from director generals of the participating governments. The U.S., Germany, Japan, IOM, Korea, India, and China (joined later).

The primary objectives of the OMWG are:

- to advance, at an international level, technological progress in the interdisciplinary field of ocean resources, environment and mining and related technologies, through international cooperation and participation;
- to disseminate scientific knowledge and provide timely exchange of technical knowledge and information;
- to provide opportunities through its programs for interested individuals to maintain and expand their knowledge in these fields for the benefit of engineering and scientific profession;
- to facilitate opportunities for the members to interact with their governments. The International Society of Offshore and Polar Engineers (ISOPE) facilitates the group activities.

The 2nd OMS-97, 3rd OMS-99, 4th OMS-2001, 5th OMS-2003, 6th OMS-2005 and 7th OMS-2007 were successfully held in Seoul, Korea, Goa, India, Szczecin, Poland and Tsukuba, Japan, Changsha, China and Lisbon, Portugal, respectively, with participation from 17 countries.

On behalf of the International Organizing Committee, it is our pleasure to welcome all participants to the ISOPE OMS-2009 Symposium in Chennai.

<table>
<thead>
<tr>
<th>Co-chairmen of the ISOPE OMS-2009 Symposium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Jin S. Chung, USA</td>
</tr>
</tbody>
</table>
SUNDAY September 20

14:00
OMS-2009 Participants Registration  Sagar Sangamam, NIOT

17:00
OMS-2009 IOC  Rajendra Chola Hall, NIOT

For Tour Information  (see the bulletin board in the foyer to confirm participation on or before 21 September)

MONDAY September 21

Bus departs 08:30 from Hotel Savera and GRT Grand to NIOT

07:30–08:30
Symposium Registration  Sagar Sangamam, NIOT

09:00
Inauguration  Panikar Hall

09:35
1. OPENING SESSION

10:35
2. EXPLORATION  Panikar Hall

13:00-14:00
OMS Lunch  Manthan Hall

14:00
3. OCEAN ENERGY  Panikar Hall

15:30
4. ENVIRONMENT  Panikar Hall

18:00 Bus departs from NIOT to DAKSHINACHITRA Auditorium Lobby

19:00 – 21.00
Banquet Dinner  Dakshinachitra

21:35 Bus departs from Dakshinachitra to Hotels

TUESDAY September 22

Bus departs 08:30 from Hotel Savera and GRT Grand to NIOT

07:30–08:30
Symposium Registration  Sagar Sangamam, NIOT

09:00
5. GAS HYDRATES I  Panikar Hall

10:20
6. GAS HYDRATES II  Panikar Hall
13.00-14.00
OMS Lunch Manthan Hall

14:00
7. MINERAL PROCESSING: SCIENCE AND ENGINEERING I Panikar Hall

16.00
8. MINERAL PROCESSING : SCIENCE AND ENGINEERING II Panikar Hall

18:00 Bus departs from NIOT to Kalakshetra SagarSangamam Lobby

18:30 -20:00
Indian cultural evening at KALAKSHETRA Kalakshetra
– Cultural Programme

20.00 – 21.00
Dinner Kalakshetra

21.05 Bus departs from Kalakshetra Hotel

Monday – Wednesday
Author Practice Varuna Hall
On-site Registration Sagar Sangamam Lobby

WEDNESDAY September 23

Bus departs 08:30 from Hotel Savera and GRT Grand to NIOT

09:00
9. DEEP-OCEAN MINING SYSTEMS & TECHNOLOGY I Panikkar Hall

10:30
10. DEEP-OCEAN MINING SYSTEMS & TECHNOLOGY II Panikkar Hall

13:00-14:00
OMS Lunch Manthan Hall

14:00
11. DEEP-OCEAN MINING SYSTEMS & TECHNOLOGY III Panikkar Hall

15:30
12. DEEP-OCEAN MINING SYSTEMS & TECHNOLOGY IV Panikkar Hall

17:00
13. CLOSING SESSION Panikkar Hall

18:30 Bus departs from NIOT to Hotel

Co-sponsored by:
International Society of Offshore and Polar Engineers (ISOPE)
National Institute of Ocean Technology (NIOT)
Ministry of Earth Sciences, Govt. of India (MoES)
Financial sponsors
National Institute of Ocean Technology (NIOT)
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Seatechrim, Moscow, Russia
Experimental Design Bureau of Oceanological Engineering, Russian Academy of Sciences, Moscow, Russia
Williamsons Associates, USA
International Submarine Engineering, USA
Institut für Konstruktion (IKS), University of Siegen, Siegen, Germany

Co-operated by:
International Society of Offshore and Polar Engineers (ISOPE)
U.S. National Science Foundation (NSF)
Mining and Materials Processing Institute of Japan (MMIJ)
Korea Association for Deep Ocean Minerals Development (KADOM)
Korea Society of Ocean Engineers (KSOE, formerly KCORE)
National Institute of Oceanography (NIO, India)
Interoceanmetal Joint Organization (IOM, Poland)
Japan Society of Naval Architects and Ocean Engineers (JSNAOE)
China Ocean Mineral Resources R&D Association (COMRA)

Supported by:
National Institute of Ocean Technology (NIOT)
Ministry of Earth Sciences, Govt. of India (MoES)

Local Secretariat:
Dr. M.A. Atmanand, National Institute of Ocean Technology, India
Dr. G.A. Ramadass, National Institute of Ocean technology, India

Technical Executive Committee:
Prof. Jin S. Chung, ISOPE, Cupertino, California, USA
Dr. M.A. Atmanand, National Institute of Ocean Technology, India

International Organizing Committee
Prof. Jin S. Chung (Chairman), ISOPE, Cupertino, California, USA
Dr. M.A. Atmanand, National Institute of Ocean Technology, Chennai, India
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Dr. Ning Yang, Changsha Research Institute of Mining and Metallurgy, Changsha, China
Dr. C. H. Yoon, Korea Institute for Geosciences & Mineral Resources, Daejeon, Korea

Symposium Co-chairmen
Prof. Jin S. Chung, ISOPE, Cupertino, California, USA
Dr. M.A. Atmanand, National Institute of Ocean Technology, Chennai, India
ISOPE OMS-2009 Chennai  
NIOT, Chennai, India  
September 20–24, 2009  

TECHNICAL PROGRAM

MONDAY 09:00

INAUGURATION
Monday 09:00 Panikkar Hall

OPENING ADDRESS
Monday 09:30 Panikkar Hall
Prof. Jin S Chung, Chair, ISOPE OMS-2009 Symposium, ISOPE, Cupertino, California, USA

1. OPENING SESSION
Monday 09:35 Panikkar Hall

Chair: Prof. M. Ravindran, Former Director, NIOT, India  
Co-Chair: R Kotlinski, Interoceanmetal Joining Organization, Szczecin, Poland

Deep Sea Mining - Indian Scenario (Invited)  
Dr. S. K. Das, Advisor, MoES, India

Gas Hydrates Research in India (Invited, Oral Presentation)  
Harsh K. Gupta, Former Secretary (MoES), India

Deep-Ocean Mining Technology III: Developments (Invited)  
Jin S Chung, ISOPE, Cupertino, California, USA

2. EXPLORATION
Monday 10:35 Panikkar Hall

Chair: G S Roonwal, Inter-University Accelerator Centre, India

Exploration for Polymetallic Nodules in the German License Area  
Carsten Rühlemann, Udo Barckhausen, Stefan Ladage, Lutz Reinhardt, and Michael Wiedicke, Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, Germany

Exploration for Minable Nodule Sites: Some Methodological Aspects  
Ryszard Kotlinski, Interoceanmetal Joint Organization & Univ. of Szczecin; Valcana Stoyanova, Interoceanmetal Joint Organization, Szczecin, Poland
Bulk Polymetallic Nodule Collection in Central Indian Basin-
Implications of Acoustic Survey Technologies for Site Selection and Innovations to Maximize Nodule Recovery
Abhishek Tyagi, Maruthadu Sudhakar, and Ganesh Chandvale,
National Centre for Antarctic and Ocean Research, Goa, India

Possible «Polygenetic» Hydrocarbon Fields in Eastern Indian Ocean Triggering by Hydrothermal Activity along Deep Faults
Oleg V. Levchenko and Vladimir V. Matveenkov, P.P. Shirshov Inst. of Oceanology, RAS, Moscow, Russia

Preliminary Feasibility Study for the Commercial Development of Seafloor Hydrothermal Deposits in the EEZ of the Kingdom of Tonga
Se-Hun Park, Hee-Cheol Yang, Kyeong-Yong Lee, and Jai-Woon Moon, Korea Ocean Research & Development Inst., Ansan, Korea

Detailed Seabed Survey and High Precision Subsea Navigation in Deepwater Environment (Oral Presentation)
Roar Martiniussen, Kongsberg Maritime AS, Norway

Rock Physics Modeling of Shallow Marine Sediments in Eastern Continental Margins of India
P. Dewangan, G. Sriram, and T. Ramprasad, National Inst. of Oceanography, Goa, India

Response of Os Isotope to Paleoceanographic Changes in West Pacific as Recorded in a Ferromanganese Crust
Jiangshan Li and Xiangwen Ren, First Inst. of Oceanography, SOA & Inst. of Oceanology, CAS; Xuefa Shi and Jihua Liu, First Inst. of Oceanography, SOA, Qingdao, China

3. OCEAN ENERGY

Monday 14:00  Panikar Hall

Chair: Dr. S. K. Das, MoES, India

Techno-Commercial Study of Twin Unidirectional Turbine Based Wave Energy Plants
Krishnamoorthi Mala, Joseph Jayaraj, Job K. Ninoy, and Venkatraman Jayashankar, Indian Inst. of Technology Madras, Chennai, India

Performance Comparison of Power Modules in the Indian Wave Energy Plant
Krishnamoorthi Mala, Joseph Jayaraj, and Venkatraman Jayashankar, Indian Inst. of Technology Madras; Malayath A. Atmanand, NIOT, Chennai, India; T. Setoguchi, Saga Univ., Saga; M. Takao, Matsue National College of Technology, Matsue, Japan

Effect of Taut and Catenary Mooring on Spar Platform with 5 MW Wind Turbine
T. Seebai and R. Sundaravadivelu, Indian Inst. of Technology Madras, Chennai, India

Low Temperature Thermal Desalination Plants
Phanikumar VS Sistla, Venkatesan Govindarajulu, Purnima Jalihal, and Kathirol Subramanian, National Inst. of Ocean Technology, Chennai, India

4. ENVIRONMENT

Monday 15:30 Panikar Hall

Chair: V.V. Stoyanov, SEATECHRIM, EDB OE, Russian Academy of Sciences, Russia
Co-Chair: Koji Otsuka, Osaka Prefecture Univ., Japan

System for Monitoring of Underwater Radioactive and Chemical Waste Objects: Information Control System on Basis of Autonomous Devices
Vladimir V. Stoyanov, SEATECHRIM, EDB OE, Russian Academy of Sciences; O.V. Stepanets and A.N. Plishkin, GEOKHI, Russian Academy of Sciences, Moscow, Russia

Deepwater and Thru Ice (Oral Presentation)
Henrik Bang-Andreasen, Seaproof Solutions, Nesttun, Norway

Biomass Quantification of Ecosystems around Seafloor Massive Sulfide Deposit with Image Analysis
Naoki Nakatani, Masahito Ikemoto, Rei Arai, and Tetsuo Yamazaki, Osaka Prefecture Univ., Sakai, Japan

Combined Analysis of Ecology and Economy of Manganese Nodule Mining
Amon Yamada, Tetsuo Yamazaki, Rei Arai, Naoki Nakatani, Osaka Prefecture Univ., Sakai, Japan

Inclusive Environmental Impact Assessment for Ocean Nutrient Enhancer (Oral Presentation)
Koji Otsuka, Osaka Prefecture Univ., Japan

18:00 – 21.00 Banquet Dinner Dakshinachitra

TUESDAY 09:00

5. GAS HYDRATES I

Tuesday 09:00 Panikar Hall

Chair: Takeshi Komai, AIST, Japan
Co-Chair: M. Subbaiah, Inst of Minerals and Materials Tech, India

Field Scale Simulation on Gas Production Behavior during Depressurization Process in Methane Hydrate Sediments located at Nankai Trough Area in the Adjacent Sea of Japan
Yasuhide Sakamoto, Takeshi Komai, Kuniyuki Miyazaki, and Norio Tenma, National Inst. of Advanced Industrial Science and Technology (AIST), Tsukuba; Tsutomu Yamaguchi, Toho Univ., Funabashi, Japan
Carbonatite Emplacement and Localization of Gas Hydrates in the Ocean Floors of Eastern Hemisphere
Ramachandran Ramasamy, Subramanian Subramanian, and Ranganathan Sundaravadivelu, Indian Inst. of Technology Madras, Chennai, India

Seabed Sulphides, Gas Hydrates, and Hydrocarbon Resources in the Andaman Sea, North-East Indian Ocean
Ganpat S Roonwal, Inter- Univ. Accelerator Centre, Aruna Asaf Ali Marg, New Delhi, India

6. GAS HYDRATES II

Tuesday 10:20 Panikar Hall
Chair: Harsh K. Gupta, Former Secretary (MoES), India
Co-Chair: Ram Prasad, NIO, India

Investigation of Deformation Mechanism for Methane Hydrate Sediment based upon Mechanical Properties in Unloading and Reloading Process under Triaxial Compression
Kuniyuki Miyazaki and Akira Masui, National Inst. of Advanced Industrial Science and Technology (AIST), Tsukuba; Tsutomu Yamaguchi, Toho Univ., Funabashi; Yasuhide Sakamoto, Yuji Ogata, and Kazuo Aoki, National Inst. of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan

NMR Measurement and Analysis of Porosity and Permeability for Hydrate-bearing Sediments
Takeshi Komai, Yasuhide Sakamoto, and Yoshito Nakashima, National Inst. of Advanced Industrial Science and Technology (AIST), Ibaraki; Naoya Takahara, Akishima Laboratories, MitsuiZosen Inc., Akishima; Hideki Minagawa and Norio Tenma, National Inst. of Advanced Industrial Science and Technology (AIST), Sapporo, Japan

Electrical Heating of Hydrate Sediment for Gas Production
Hideki Minagawa, Yasunori Nishikawa, Yoshie Takahashi, and Hideo Narita, National Inst. of Advanced Industrial Science and Technology (AIST), Sapporo, Japan

Investigation for High Concentration Inhibitor Injection into Artificial Methane Hydrate Bearing Sediment
Taro Kawamura, Michika Ohtake, Yoshitaka Yamamoto, Hironori Haneda, Yasuhide Sakamoto and Takeshi Komai, National Inst. of Advanced Industrial Science and Technology (AIST); Satoru Higuchi, Nihon Axis Company Ltd., Tsukuba, Japan

7. MINERAL PROCESSING I

Tuesday 14:00 Panikar Hall
Chair: Yanqing Fan, Beijing General Research Inst. of Mining and Metallurgy, China
Co-Chair: Vladislava P. Stefanova, Univ. of Chemical Technology and Metallurgy, Sofia, Bulgaria

Use of Process Optimization and Cost Model for Metal Recovery from Manganese Nodules: The Role of Manganese Recovery
Arijit Biswas, Nirupam Chakraborti, and Prodip Kumar Sen, Indian Inst. of Technology, Kharagpur, India

Recovery of Cu, Ni, Co and Mn from Sea Nodules by Direct Reduction Smelting
Sanjay Agarwal, Kamalakanta Sahu, Ranjit Kumar Jana, and Surya Pratap Mehrotra, National Metallurgical Laboratory, Jamshedpur, India

Precipitation of Manganese from Manganese Nodule $SO_2$-Roast Ammoniacal Ammonium Leach Liquor
Kailash Chandra Nathsarma, Inst. of Minerals & Materials Technology (CSIR), Bhubaneswar, India

Production of Silicomanganese Alloy from Low Manganese Containing Leached Sea Nodules Residue
Ranajit Kumar Jana and Navneet Singh Randhaw, National Metallurgical Laboratory, Jamshedpur, India

Electrolytic Manganese Dioxide (EMD) from Manganese Cake - A Byproduct of Nodule Process
Jyolti Prakash Pandit, Kali Sanjay, Malay Kumar Ghosh, and Tondepu Subbaiah, Inst. of Minerals and Materials Technology, Bhubaneswar, India

Potentiality of Indian Ocean Manganese Nodule and its Leached Residue as Oxidation Catalyst and Adsorbent
K.M. Parida, Saswati S Dash, and Amaresh Pradhan, Inst. of Minerals and Materials Technology, Orissa, India

8. MINERAL PROCESSING II

Tuesday 16:00 Panikar Hall

Chair: G. A. Ramadass, NIOT, India
Co-Chair: Ranjit Kumar Jana, National Metallurgical Laboratory, Jamshedpur, India

Lithium Ion Sieve Preparation from Reduction-Ammoniacal Leaching Residue of Polymetallic Nodules
Lei Zhao, Kaixi Jiang, Xunxiong Jiang, Yanqing Fan, and Shengdong Wang, Beijing General Research Inst. of Mining and Metallurgy, Beijing, China

Preparation of Lithium Ion Sieve from Polymetallic Nodules
Yanqing Fan, Xunxiong Jiang, Shengdong Wang, Lei Zhao, Kaixi Jiang, and Linyong Feng, Beijing General Research Inst. of Mining and Metallurgy, Beijing, China

Study on Continuous Leaching Hydrometallurgical Processes about Cobalt-rich Crust
Shengdong Wang, Xunxiong Jiang, Kaixi Jiang, Yanqing Fan, and Lei Zhao, Beijing General Research Inst. of Mining and Metallurgy, Beijing, China

Separation of Metal Ions from Manganese Nodule Bulk Sulphide Leach Liquor Using Hollow Fiber Membrane Module
Pankaj K. Parhi and Kadambini Sarangi, Inst. of Minerals and Materials Technology (CSIR), Bhubaneswar, India
Selective Dissolution of FeCuNiCoMn Alloy Obtained after Pyrometallurgical Processing of Polymetallic Nodules
Vladislava P. Stefanova, Peter K. Iliev, Boris S. Stefanov, and Avram G. Avramov, Univ. of Chemical Technology and Metallurgy, Sofia, Bulgaria

18:30 – 21.00
Indian cultural evening with Dinner
Kalakshetra

9. DEEP-OCEAN MINING SYSTEMS & TECHNOLOGY I
Wednesday 09:00 Panikar Hall
Chair: M. S. Nagar, Ex-CMD, Indian Rare Earths, India
Co-Chair: Enno Schulte, University of Seigen, Germany

Future of Deep Seabed Mining and Demand-Supply Trends in Indian Scenario
Maruthadu Sudhakar, National Centre for Antarctic and Ocean Research, Headland Sada, Goa; Syamal K. Das, Ministry of Earth Sciences, New Delhi, India

A Hardware-in-the-loop Simulation System of Heave Compensation of Deepsea Mining
Qiong Hu and Shaojun Liu, Central South Univ. and Changsha Research Inst. of Mining and Metallurgy, Changsha, China

Research on Physical Simulation Test Installation of Heave Compensation System of Deepsea Mining
Qiong Hu, Central South Univ. and Changsha Research Inst. of Mining and Metallurgy; Hao Zheng, Changsha Research Inst. of Mining and Metallurgy, Shaojun Liu, Central South Univ. and Changsha Research Inst. of Mining and Metallurgy; Ning Yang, Changsha Research Inst. of Mining and Metallurgy, Changsha, China

Modelling and Simulation of 6 DOF Motion Simulator for Underwater Research Applications
Thangavel Periasamy, Thondiyath Asokan, and Makaram Singaperumal, Indian Inst. of Technology Madras, Chennai, India

Self-Propelled Miner and Integrated Mining Test at Inshore Site (Oral Presentation)
Sup Hong, Hyung-Woo Kim, Jong-Su Choi, Tae-kyeong Yeu, Soung-Jea Park, and Suk Min Yoon, MOERI/KORDE; Chi-Ho Yoon, Jongmyung Park, Jung-Seok Kang, Young-Ju Kim, Sang-Bae Kim, and Wantae Kim, KIGAM, Daejeon, Korea

10. DEEP-OCEAN MINING SYSTEMS & TECHNOLOGY II
Wednesday 10:30 Panikar Hall
Chair: Chi-Ho Yoon, Korea Inst. of Geoscience & Mineral Resources, Daejeon, Korea
Co-Chair: Shaojun Liu, Central South Univ., Changsha, China

Conception of Nodules Feeder to Vertical Transport Pipeline
Jerzy Sobota, Wroclaw Univ. of Environmental and Life Science, Wroclaw, Poland; Wilibald Kolarcik and Pavel Marek, HYDROSYSTEM project a.s., Olomouc; Pavel Vlasak, Inst. of Hydrodynamics ASCR, Prague, Czech Republic

Vertical Distribution of Concentration in Horizontal Pipeline – Density and Particle Size Influence
Jerzy Sobota, Wroclaw Univ. of Environmental and Life Science, Wroclaw, Poland; Pavel Vlasak, The Czech Academy of Sciences, Prague, Czech Republic; Grzegorz Strozik and Franciszek Plewa, Silesian Univ. of Technology, Gliwice, Poland

Flow Analysis by CFD Model of Lifting System for Shallow Sea Test
Chi-Ho Yoon, Jung-Seok Kang, Jong-Myung Park, Yong-Chan Park, Young-Ju Kim, and Seok-Ki Kwon, Korea Inst. of Geoscience & Mineral Resources, Daejeon, Korea

Numerical Prediction of a Lifting Pump for Deep-Sea Mining
Jongmyung Park, Chi-Ho Yoon, and Jung Seok Kang, Korea Inst. of Geoscience and Mineral Resources, KIGAM, Daejeon, Korea

Development and Testing of Remotely Operated Artificial Nodule Laying System at 500 m Water Depth
K Amudha, S Rajesh, NR Ramesh, MuthukrishnanBabu, Raju Abraham, CR Deepak, and Malayath A. Atmanand, National Inst. of Ocean Technology, Chennai, India

11. DEEP-OCEAN MINING SYSTEMS & TECHNOLOGY III

Wednesday 14:00 Panikar Hall

Chair: Jerzy Sobota, Wroclaw Univ. of Environmental and Life Science, Wroclaw, Poland
Co-Chair: Sup. Hong, MOERI/KORDI, Daejeon, Korea

Effects of Microtopography on Mining Possibility of Cobalt-rich Manganese Crusts
Koji Goto, Tetsuo Yamazaki, Rei Arai, and Naoki Nakatani, Osaka Prefecture Univ., Sakai, Japan

Development of Dynamics Model of Seafloor Mining System and Analysis of Influence Factors in the Deploying Process
Xiaozhou Hu, Shaojun Liu, and Bin Du, Central South Univ. and The State Key Laboratory of Deep Sea Mineral Resources Development and Utilization Technology, Changsha, China

Fluid-solid Coupled Dynamical Analysis of Deep-ocean Mining System
Qiuhua Rao, Zhi Wang, Shaojun Liu, and Min Fang, Central South Univ., Changsha, China

Interaction of Fluid-solid Coupled Flexible Hose and Mining Machine in Deep-ocean Mining System
Zhi Wang, Qiuhua Rao, Shaojun Liu, and Min Fang, Central South Univ., Changsha, China

12. DEEP-OCEAN MINING SYSTEMS & TECHNOLOGY IV

Wednesday 15:30 Panikar Hall
Chair: W. Schwarz, Univ. of Siegen, Siegen, Germany
Co-Chair: Deepak, NIOT, India

Method of Metamodel-based Multidisciplinary Design Optimization for Development of a Test Miner
Tae Hee Lee and Min Uk Lee, Hanyang Univ., Seoul; Jong-Su Choi, Hyung Woo Kim and Sup Hong, Maritime & Ocean Engineering Research Inst., KORDI, Daejeon, Korea

Simulation of Tracked Vehicle Performance on Deep Sea Soil Based on Soil Mechanical Laboratory Measurements in Bentonite Soil
Enno Schulte and W. Schwarz, Univ. of Siegen, Siegen, Germany

Application of Robust Design Techniques for Underwater Vehicle Control
Mohan Santhakumar and Thondiyath Asokan, Indian Inst. of Technology Madras, Chennai, India

Design of Interactive Simulation System and Graphical User Interface for Underwater Vehicle Control and Navigation
Mohan Santhakumar, Subramanian Saravanakumar, Thangaratu Thiruppathi, and Thondiyath Asokan, Indian Inst. of Technology Madras, Chennai, India

Research on the Path Planning for Deep-seabed Mining Vehicle
Sui-ping Wang, Wei-hua Gui, and Xiao-ling Ning, Central South Univ., Changsha, China

A Study on Steering Performance of Four-Column Tracked Vehicle on Extremely Cohesive Soft Soil (Oral Presentation)
Hyung-Woo Kim, Sup Hong, Chang-Ho Lee, Jong-Su Choi, and Tae-kyeong Yeu, MOERI/KORDI, Daejeon, Korea

13. CLOSING SESSION

Wednesday 17:00 Panikar Hall
Chair: Jin S Chung, ISOPE, USA
Co-Chair: Ramadass, NIOT, India
GENERAL INFORMATION

PLACE AND DATE: NIOT, Pallikaranai, India; September 20-24, 2009
All sessions of ISOPE OMS-2009 symposium will take place at:

National Institute of Ocean Technology
Sagar Sangamam
Pallikaranai
Chennai, Tamil Nadu 600100, India
Phone: +91-44-66783366

ACCOMMODATION

Savera (use Reservation Form)
146, Dr. Radakrishnan Road, Chennai 600 004 - India
Phone: +91-44-2811-4700   Fax: +91-44-2811-3475
E-mail: hotsave@mds.vsnl.net.in; http://www.saverahotels.com

GRT Grand (use Reservation Form)
120, Sir Thyagaraya Road,
T. Nagar, Chennai - 600 017
Tamil Nadu, India
Phone: +91-44 -2815- 0500 / 5500
Fax: +91-44 -2815 -0778.
E-mail: reservations@grtgrand.com; http://www.grtgrand.com

ACCESS TO NIOT
Chennai International Airport is the closest to Hotels. Many fleets of Metropolitan coaches and pre-paid taxi are available round the clock to reach the Hotels. OMS 2009 Local Secretariat has arranged transport from Hotels to NIOT.

PARKING
Hotel parking is free for guests.

LANGUAGE
The language for the symposium is English. No translation service will be arranged.

CURRENCY EXCHANGE
Currency can be exchanged either at the airport, banks or hotel for the most favorable rates. Exchange rate as of June, 2009 is: 1 USD = Rs 48.

HOTEL ACCOMMODATION:
To get the OMS-2009 discount rate, use the Reservation Form in this program or posted on www.isope.org. You can also ask for a copy of the form from isope-niot@niot.res.in; Write ISOPE OMS-2009 on Subject line. Only a limited number of rooms at ISOPE OMS-2009 rates are available. Guaranteed reservation must be received by August 15.

Electric Voltage: The electrical power supply voltage is 220 V, 50 Hz, for each room of the Hotel.

BUS TRANSPORTATION BETWEEN HOTEL AND NIOT
During the symposium, the OMS local secretariat will provide bus services in the morning and evening between the hotels and NIOT.

CITY TRANSPORTATION
City bus service and taxi service are also available.
ADVANCE SYMPOSIUM REGISTRATION BY MAIL OR FAX (use the Registration Form)

All persons attending the symposium are required to register, pay the appropriate fee, and get a symposium badge. Remember to send via airmail or Fax the Advance Registration (and Invoice) Form in this Program or a copy to reach before:

May 15 for one author per paper, and August 20 for non-authors from outside India:

ISOPE OMS-2009 Secretariat, 495 North Whisman Road, Suite 300, Mountain View, California 94043, USA: Fax+1-650-254-2038.

In case one charges to a credit card via FAX, the card number should be typed in bold face or written clearly to be readable in the transmitted fax copy. Use the Advance Registration Form in this program or a copy. Registration fees (note: US$50 surcharge after September 1 for on-site registration) are as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Fee (US $)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author, Co-authors</td>
<td>400</td>
</tr>
<tr>
<td>Session or Symposium Chair, Co-Chair</td>
<td>400</td>
</tr>
<tr>
<td>ISOPE Member</td>
<td>400</td>
</tr>
<tr>
<td>ISOPE member with new application (incl. 2009 membership fee and 1-year journal issues)</td>
<td>490</td>
</tr>
<tr>
<td>Non-Member</td>
<td>470</td>
</tr>
<tr>
<td>Full-time Student with 2005 student ID Card</td>
<td>300</td>
</tr>
<tr>
<td>OMS Banquet</td>
<td>Free</td>
</tr>
<tr>
<td>Reserve a seat for Symposium Tour</td>
<td>Free</td>
</tr>
</tbody>
</table>

TOTAL AMOUNT DUE

* The registration fee includes a symposium proceeding CD-ROM, NIOT Reception, OMS Banquet, lunches, Dinners and coffee/tea breaks.

** One author per paper is required to advance-register by August 5.

REGISTRATION CANCELLATIONS
Request for cancellation of registration must be received in writing by September 05, 2009 to be granted a refund minus US$50 processing charge. No refunds for the author whose paper is already included in the proceedings.

REGISTRATION BADGE
Registration badges are required for admittance to all the symposium activities, including the banquet and lunch.

ON-SITE SYMPOSIUM REGISTRATION
Participants who miss the advance registration may register at the Symposium Registration Desk, but there is a US$50 surcharge. The registration desk will be open from 08:30-16:00 hrs.

ISOPE PUBLICATION ORDER
The ISOPE OMS-2009 Symposium Proceedings (ISBN 978-1-880653-75-3) is included in the symposium registration fees: CD-ROM and Hard Copy. The proceedings volumes (300 pp. est.) can be ordered by mail at the rates of:

Mail order at $100 (ISOPE Member $80) including shipping charge.

All ISOPE PUBLICATIONS (listed on www.isope.org) can be ordered from ISOPE, P.O. Box 189, Cupertino, California 95015-0189, USA: Fax 1–650–254–2038. Advance payment is required. MasterCard or VISA card, international money order or U.S. bank checks in US dollars payable to ISOPE will be accepted. Shipping (surface-mail) and handling charges are included (also see the ISOPE Publication Order Information.)
SYMPOSIUM HEADQUARTERS
SYMPOSIUM BANQUET
September 21, 18:30–20:30
Registration Desk
Dakshinachitra, Chennai

LCD Test ROOM
LCD projector, PC and screen (and an overhead projector,) will be set up in
the session room.

INTERNATIONAL PARTICIPANTS AND VISA APPLICATION
International authors, participants or attendees who need help (except
financial), especially invitation, can contact: Dr. M. A. Atmanand, OMS-
2009 Local Secretariat.
Dr. M A Atmanand, OMS-2009 Local Secretariat,
E-mail: atmanandma@hotmail.com; Fax: +91-44-2246-2038

Entry Visa: Most non-Indian participants may be required to apply for an
entry visa. Please get an application form at the Consulate of Republic of
INDIA in your country.

ABOUT CHENNAI
Chennai, formerly known as Madras, is the capital of the southern state of
Tamil Nadu in India, and is the country's fourth-largest city. It is located on
the Coromandel Coast of the Bay of Bengal. With an estimated population
of 7.45 million (2005), the 367 year old city is the 34th largest metropolitan
area in the world. It has the 2nd longest seashore (Marina Beach) in the
world.

Chennai's economy has a broad industrial base in the automobile,
technology, hardware manufacturing, and healthcare industries. The city is
India's second largest exporter of software, information technology (IT) and
information-technology-enabled services (ITES). A major portion of India's
automobile manufacturing industry is based in and around the city. Chennai
Zone contributes 39% of the State’s GDP. Chennai accounts for 60% of the
country’s automotive exports and is sometimes referred to as "the Detroit of
India".

Shopping Spots
The Thegaraya Nagar, know as “T Nagar” is a great place to shop,
especially at Pondy Bazaar and bustling markets around Pangal Park. Nalli,
Chennai silks, RMKV, Kumaran silks, etc., at Usman Road offers a wide
range of silks, cottons, saris, and more. Here you will also find huge, multi-
story shops like Lalitha Jewelry, GRT Thangamaligai, and Prince Jewelry
selling an astonishing range of gold, silver and diamond jewelry.

Climate and Clothes
Weather in Chennai during September is warm: 30°C–34°C.
For further more Information , http://www.chennaihub.com

Plan to Attend Other ISOPE Meetings
ISOPE–2010 Beijing, China
June 20–26, 2010
Abstract Deadline: October 15, 2009
For Online abstract submission, visit www.isope.org
HOTEL RESERVATION FORM (must use this form)

ISOPE OMS-2009 Symposium, September 20–24, 2009

Savera /GRT Grand are the official hotels for the Symposium. For guaranteed reservation and discount room rate, (1) this form must be directly mailed/Faxed to respective Hotel with “NIOT – CORPORATE” as a reference for booking, no later than August 20:

Surname: ______________ & Middle: ______________

Circle: Male Female; Title Mr. Ms. Mrs. Prof. Dr.

Company: _____________________________________________

Address ______________________________________________

_______________________________________________

Country __________________ Postal (ZIP) Code ____________

Fax ______________________: E-mail _____________________

Arrival: September __ Time _____;

Depart.: September __, Time ____

Please, circle or mark [ X ] for the room you wish to reserve:

<table>
<thead>
<tr>
<th>Hotel</th>
<th>Room Rates (Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savera</td>
<td>[ 2500] 1-person room</td>
</tr>
<tr>
<td></td>
<td>[ 3500] 2-person room</td>
</tr>
<tr>
<td>GRT Grand</td>
<td>[ 5500] 1-person room</td>
</tr>
<tr>
<td></td>
<td>[ 6500] 2-person room</td>
</tr>
</tbody>
</table>

Note: Room rate + 12.5% tax. Breakfast buffet is included.

Local Symposium Secretariat has already reserved the necessary number of rooms at Hotel Savera and Hotel GRT Grand at special OMS-discount-rate for all the participants and guests.

CANCELLATION: Email or fax room cancellation to Local OMS-2009 Secretariat, 15 days or earlier before your arrival date in the reservation.
NIOT Campus Route map from Airport (map not to scale)

Rajendra Chola Hall and Panikar Hall