

September 20–24, 2009  
Chennai, India

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



**Final Program**

Invited and Peer-reviewed Papers

Nodules, Crusts, Sulphide  
Exploration & Environment  
Deep-Ocean Mining Programs  
Mineral Processing  
Ocean Energy

Gas Hydrates and Engineering  
Deep-Ocean Water Utilization  
Mining and Economics  
Mining Systems and Technology  
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  
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## 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.

<i>Co-chairmen of the ISOPE OMS-2009 Symposium</i>	
Prof. Jin S. Chung, USA	Dr. M.A. Atmanand, India

**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**      Panikar Hall

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 <b>7. MINERAL PROCESSING: SCIENCE AND ENGINEERING I</b>	Panikar Hall
16.00 <b>8. MINERAL PROCESSING : SCIENCE AND ENGINEERING II</b>	Panikar Hall
18:00 Bus departs from NIOT to Kalakshetra	SagarSangamam Lobby
18:30 -20:00 <b>Indian cultural evening at KALAKSHETRA – Cultural Programme</b>	Kalakshetra
20.00 – 21.00 <b>Dinner</b>	Kalakshetra
21.05 Bus departs from Kalakshetra <b>Hotel</b>	

*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 <b>9. DEEP-OCEAN MINING SYSTEMS &amp; TECHNOLOGY I</b>	Panikkar Hall
10:30 <b>10. DEEP-OCEAN MINING SYSTEMS &amp; TECHNOLOGY II</b>	Panikkar Hall
13:00-14:00 OMS Lunch	Manthan Hall
14:00 <b>11. DEEP-OCEAN MINING SYSTEMS &amp; TECHNOLOGY III</b>	Panikkar Hall
15:30 <b>12. DEEP-OCEAN MINING SYSTEMS &amp; TECHNOLOGY IV</b>	Panikkar Hall
17:00 <b>13. . CLOSING SESSION</b>	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)**

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

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Dr. M.A. Atmanand, National Institute of Ocean Technology, India

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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 Panikar 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 Panikar 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 Movable 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 Paleooceanographic 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 Kathirolu 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; Naoyo Takahara, Akishima Laboratories, MITSUIZOSSEN 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<sub>2</sub>-Roast Ammoniacal Ammonium Leach Liquor**

Kailash Chandra Nathasarma, Inst. of Minerals & Materials Technology (CSIR), Bhubaneswar, India

**Production of Silicomanganese Alloy from Low Manganese Containing Leached Sea Nodules Residue**

Ranjit Kumar Jana and Navneet Singh Randhaw, National Metallurgical Laboratory, Jamshedpur, India

**Electrolytic Manganese Dioxide (EMD) from Manganese Cake - A Byproduct of Nodule Process**

Jyoti Prakasha Panda, 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

**WEDNESDAY 09:00**

**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/KORDI; 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; Willibald 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**

Qihua 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

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**E-mail:** [reservations@ertgrand.com](mailto:reservations@ertgrand.com); <http://www.ertgrand.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.isopec.org](http://www.isopec.org). You can also ask for a copy of the form from [isopec-riot@riot.res.in](mailto:isopec-riot@riot.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:

Category	Fee (US \$)*	
<input type="checkbox"/> Author, Co-authors	400	_____
<input type="checkbox"/> Session or Symposium Chair, Co-Chair	400	_____
<input type="checkbox"/> ISOPE Member	400	_____
<input type="checkbox"/> ISOPE member with new application (incl. 2009 membership fee and 1-year journal issues)	490	_____
<input type="checkbox"/> Non-Member	470	_____
<input type="checkbox"/> Full-time Student with 2005 student ID Card	300	_____
<input type="checkbox"/> OMS Banquet	Free	
<input type="checkbox"/> Reserve a seat for Symposium Tour	Free	
<b><u>TOTAL AMOUNT DUE</u></b>		_____

\* 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.isopec.org](http://www.isopec.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** Session 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 Pandy 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.isopec.org](http://www.isopec.org)**



**International Society of  
Offshore and Polar Engineers (ISOPE)**  
495 North Whisman Road, Suite 300  
Mountain View, California 94043, USA  
[meetings@isope.org](mailto:meetings@isope.org) : [www.isope.org](http://www.isope.org)



**HOTEL RESERVATION FORM (must use this form)**

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

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

Surname: \_\_\_\_\_ First (Fore)  
& 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 \_\_\_\_\_

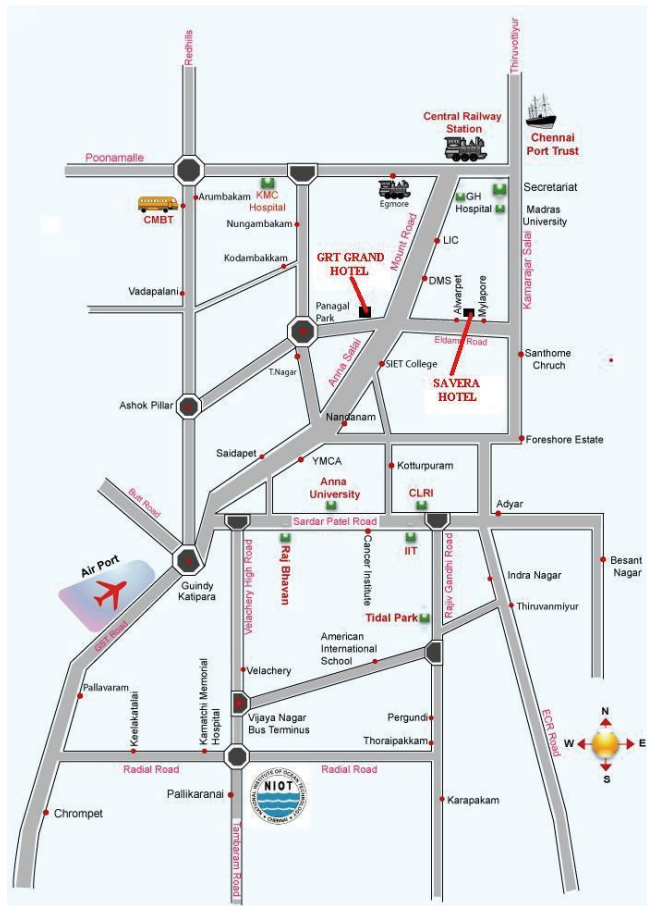
**Please, circle or mark [ X ] for the room you wish to reserve:**

<b>Hotel</b>	<b>Room Rates (Rs)</b>
Savera	[ 2500 ] 1-person room
	[ 3500 ] 2-person room
GRT Grand	[ 5500 ] 1-person room
	[ 6500 ] 2-person room

**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