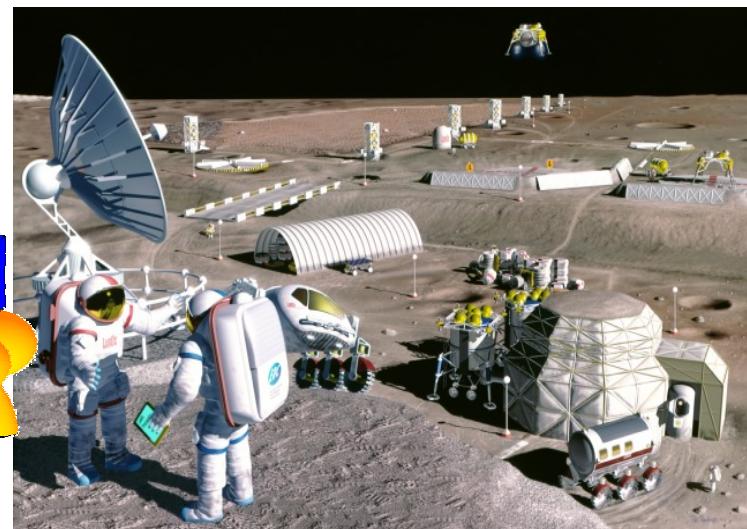
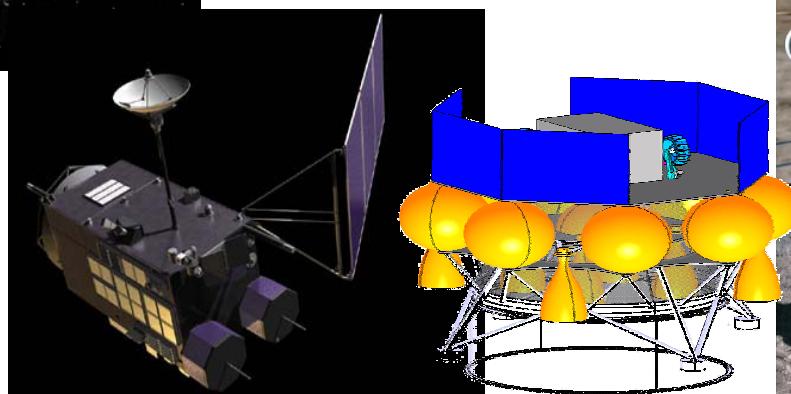


Global Robotic Village & International Lunar Bases

Bernard H. Foing, Pascale Ehrenfreund & ILEWG

International Lunar Exploration Working Group

- ILEWG Founded Beatenberg Int'l Conference 1994, **Hamburg 1995 (Charter)**
- Sponsored and members **appointed by agencies**, with **support by experts**
- To develop an **International Strategy** for the Exploration of the Moon
- Forum and mechanism for communication and **co-ordination**
- To **implement international co-operation** and report to COSPAR and agencies
- Website: <http://sci.esa.int/ilewg>



ILEWG

ILEWG Task Groups (2000 -) & NASA/GES themes 2006

- **ILEWG Executive Bureau & Steering Group**
- **Science of, on and from the Moon -> Scientific Knowledge**
Pursue scientific activities that address fundamental questions about the history of Earth, the solar system and the universe - and about our place in them.
- **Technologies and Resource Utilisation -> New Technologies**
Test technologies, systems, flight operations and exploration techniques to reduce the risks and prepare future missions to Moon, Mars and beyond.
- **Human Aspects, and International Lunar Bases -> Human Civilization**
Extend human presence to the Moon to enable eventual settlement.
- **Collaborative Roadmap & Moon-Mars Synergies -> Global Partnerships**
Challenging, shared and peaceful activity that unites nations
- **Social, Economical, Commercial, Societal Aspects -> Economic Expansion**
Expand Earth's economic sphere, and conduct activities with benefits to home
- **Education Public Outreach & Young Lunar Explorers -> Public Engagement**
To engage the public and youth students, and help develop the high-tech workforce required to address the challenges of tomorrow.



ILEWG Executive Bureau

- Executive Director: Prof Bernard Foing (President 1998-2000)
- ILEWG President (2009-2010): Dr Mike Wargo
- Past-President (2006-2008): Prof Wu Ji
- Vice-Presidents: Dr Simonetta di Pippo, Dr R. Richards
- Past Presidents: H.Mizutani, E.Galimov, B.Foing, M.Duke, C.Pieters, N.Bhandari
- **Founding agencies (1994) :** ASA, ASI, BNSC, CNES, DARA, ESA, ISAS, NASA, NASDA, RSA
- **Joining agencies:** ISRO (2000), CNSA (2002), CSA, DLR (2005), Ukraine (2008)
- **Links to institutions:** COSPAR, IAF, IAA, IISL, EGU, IAU, Europlanet, ESF, GES, ISEC, NASA LEAG, Lunar Science Institute
- **Organisation of symposia, ICEUMs (300 participants/year)**
- **Follow-up of ILEWG declarations and recommendations**



ILEWG Community events

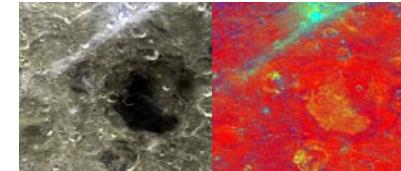
- ICEUM ILEWG Int'l Conferences on Exploration & Utilisation of the Moon:
Beatenberg 94, Kyoto 96 , Moscow 98, ESTEC 2000, Hawaii Nov 2003, Udaipur Nov 04, Toronto Sept 05, Beijing Jul 2006, Sorrento Oct 07,
ICEUM10/LEAG/SRR Port Canaveral 27-31 Oct 08, GLUC/ICEUM11 Beijing 10
- COSPAR: Washington 92, Hamburg 94, Nagoya 98, Warsaw 00, Houston 02, Paris 04, Beijing 06, Montreal 08, Bremen 10
- IAF/IAA: Houston 02, Bremen 03, Vancouver 04, Fukuoka 05, Valencia 06, Hyderabad 07, Glasgow 08, Daejong 09, Global Lunar Beijing, Prag 10, Cape 11
- EGS/EGU/Europlanet EPSC lunar sessions: Hamburg 95, Vienna 97, Nice 98, The Hague 99, Nice 00 – 04, Vienna 05-06-07-08-09, EPSC Berlin 07, Muenster 08, Potsdam 09
- Website & ICEUM declarations : <http://sci.esa.int/ilewg>
- Publications: 10 ICEUM proceedings + 7 books (Adv. Space Res.)
- Outreach: 18000 Google quotes



ILEWG Task Group on Science: Key questions

SCIENCE *OF* THE MOON: HOW DO EARTH-LIKE PLANETS WORK?

GEOPHYSICS: volcanism, tectonics, craters, erosion, space weather , ices



SCIENCE *OF* THE MOON: HOW DO ROCKY PLANETS FORM AND EVOLVE?

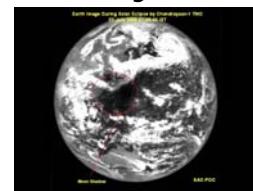
GEOCHEMISTRY: chemical composition, Earth-Moon origin,
Moon evolution, accretion, collisions, impacts, giant bombardment



SCIENCE *FROM* THE MOON

ASTRONOMY: Very Low Frequency, High Energy, Variability, Dark Matter Lensing

EARTH GLOBAL SENSING: radio emission, climate



SCIENCES *ON* THE MOON

LIFE: Radiation studies, Astrobiology, Early Earth, Growing plants

MATERIALS: Regolith, Volatiles, Extraction and Processing

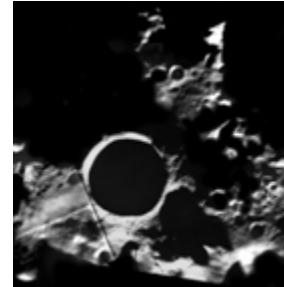


PREPARING FUTURE LUNAR/PLANETARY *EXPLORATION*

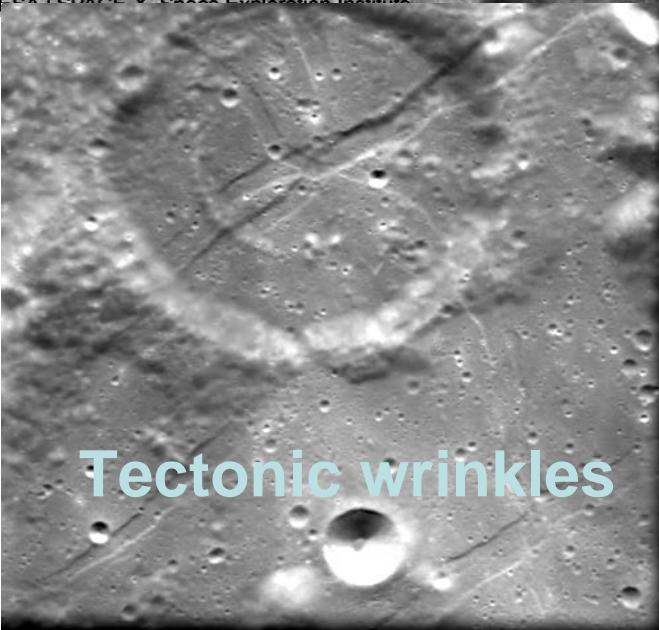
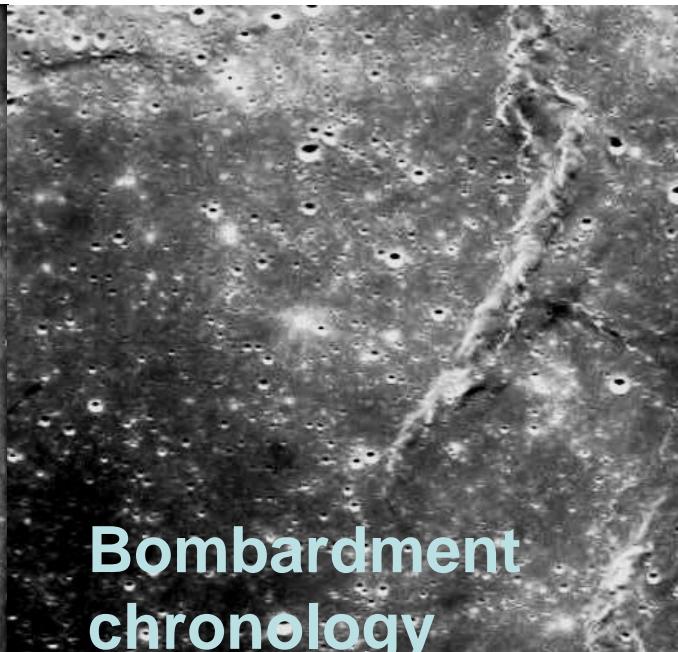
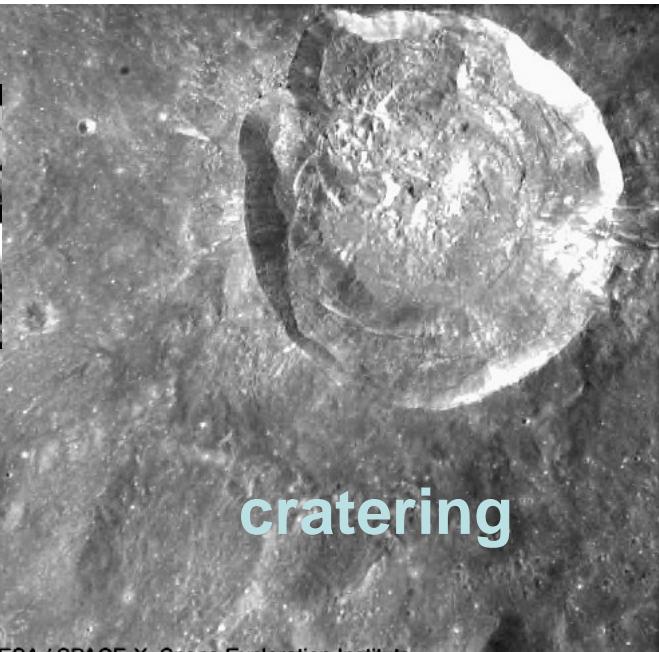
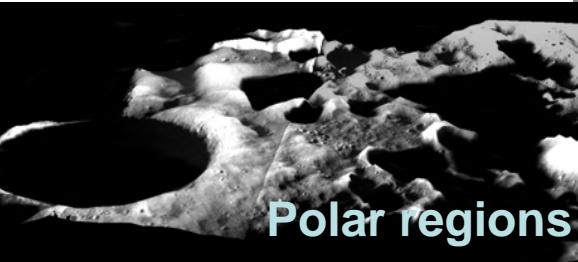
LUNAR **RESOURCES** SURVEY (minerals, volatiles, ices, illumination)

HIGH RESOLUTION **MAPS**: for future LANDING SITES and OUTPOSTS

SUPPORT TO FUTURE MISSIONS AND EXPLORATION

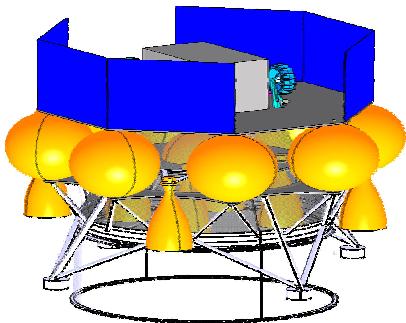
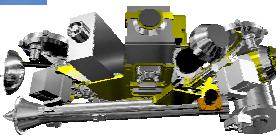
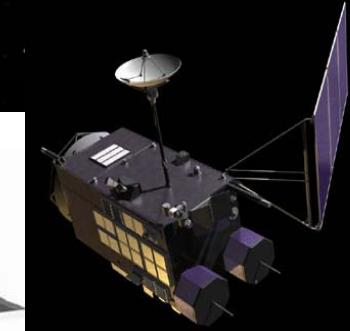


What shapes rocky planets?



ILEWG Task Group on Technology & Resources

- Coordination
- Lessons from previous missions
- Preparation for future lunar orbiters and landers opportunities
- Instruments
- In-Situ Utilisation of lunar resources
- Cooperative robotics & deployment
- ExoGeoLab pilot project
- Field Technology Demonstration
- Collaboration with Google Lunar X Prize GLXP



ILEWG Task Group on Roadmap and Global Partnership

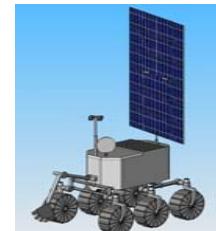
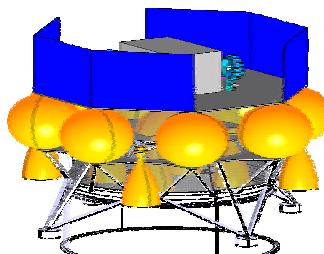
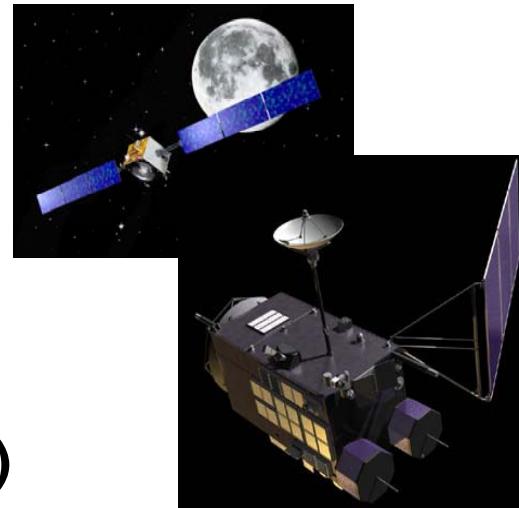
Data analysis & Interpretation

Science and Technology Lessons Learned

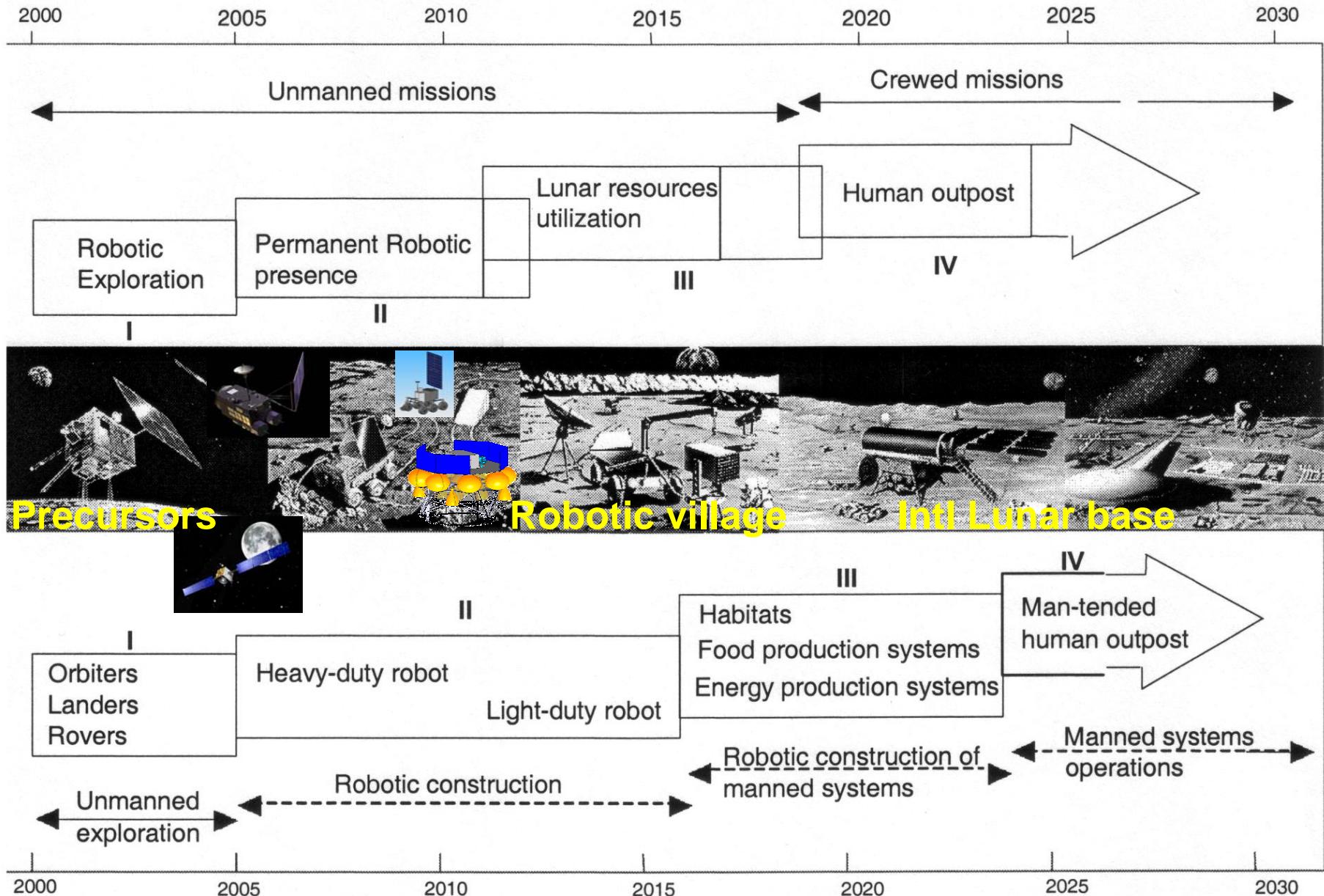
Preparation for robotic and human lunar missions

International collaborations

- 2003 SMART-1 mission and exploitation
- 2007 JAXA Selene Kaguya (science exchange)
- 2007 Chinese Chang'e 1 (ESA ground station)
- 2008 ISRO Chandrayaan-1 (ESA SIR2, C1XS, SARA; NASA M3, miniSAR)
- 2009 LRO & LCROSS (planning, impact campaign, outreach)
- 2011- Orbiters (Chang'e 2, GRAIL+LADEE, ESMO, LEO, BW, ASI)
- 2012- **Robotic village:** Landers, Rovers (GLXP, Chang'e 3, Selene2, Lunaglob-Chandrayaan 2, UK Moon Lite)
- 2014-2016 International Lunar Network, ESA Moon-NEXT
- 2017- ESA Logistics Cargo Lander, Chang'e 4 Sample return
- 2020- Human missions towards *International Lunar Bases*



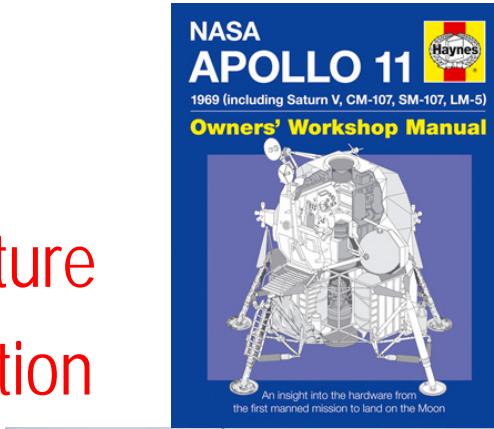
Roadmap: International Lunar Exploration Working Group



International Lunar Bases

ILEWG/COSPAR/IAF Task Group

- Coordination & information
- Workshops and symposia
- International Lunar Architecture
- Robots /astronauts cooperation
- ExoHab Pilot project
- Concepts and Field Studies
- Publications



ILEWG

ILEWG Education & Outreach activities

Hands-on



My Moon
drawings
& pictures
Competition
Galileo
Int'l Year of
Astro



Demo ExoGeoLab
telescope



ESMO



Students workshop



Google-X lunar rover

ILEWG Task Group on Social, Economical, Commercial, Legal and Societal Aspects

- **Economical aspects, cost studies**
- **Social: industrial, employment**
- **Commercial exploration**
 - **Google Lunar X Prize Competition**
- **Legal aspects, exploration vs environment**
- **Societal and political aspects, space security**
- **Link with IAF Itaccus, IAA Space & Society**
- **Artistic aspects and Multi-cultural Moon**



Join ILEWG Task Groups!

<http://sci.esa.int/ilewg>

Contact: Bernard.Foing@esa.int

- **Agencies representatives**
- **Conference/Events Organisation and Information Forum**
- **Science of, on and from the Moon**
 - Science questions, Missions Results, Data, Impacts
- **Technologies and Resource Utilisation**
 - Missions, Landers concepts, Instruments, ISRU, Robotic Village, ExoGeoLab pilot, Field tests
- **International Lunar Bases and Human Aspects**
 - Operations, Human factors, ExoHab pilot, Field tests, Architecture
- **Roadmap for Collaboration & Moon-Mars Synergies**
- **Societal, Social, Economical Commercial Aspects**
- **Education Public Outreach**
 - Public lectures, web contents, students missions, events
- **Young Lunar Explorers**



Upcoming ILEWG events

<http://sci.esa.int/ilewg>

ILEWG Field tests: Eifel Sep 09, MDRS (Nov 09, 2010 Feb-March, Sept)

ILEWG Technical Workshops: Oct 09, Apr 2010 (landers), Jun 2010 (hab)

ILEWG sponsored Symposia & Events in 2010:

- 3-7 May 2010 Vienna, European Geoscience Union (lunar session)
- 31 May-3 Jun 2010 Beijing, IAF/ILEWG Global Lunar Conference/ICEUM11
- 18-23 July 2010 Bremen, COSPAR2010
 - Symposia: Moon science and exploration , session on International Lunar Bases (COSPAR B, F, PEX, ILEWG)
- 19-25 Sept 2010 Rome, Europlanet Congress (incl. lunar sessions)
- 26 Sep-1 Oct 2010 Prag, International Astronautical Congress IAC
 - Symposia: Space Exploration, Human Endeavour

