

Seabed Diamond/Gold Mining

More glamorous - but similar dredging

techniques, in depths up to 150 m

Exploration activity off South Africa,

Diamond mining off Namibia (De Beers)

Vertical – suction drilling (water jets)

Australia & Asia, Alaska... -

Various mining techniques

•

Horizontal – seabed crawlers

• Airlift – compressed air jets



Global Continental Shelves - General Perspective



Continental Shelves Current Offshore Mining and Drilling Project Zones



2.000 1.80

hot





Diamonds from offshore Namibia (www.imdhgroup.com)

LEGEND Onshore Offshore

www.boostdam.net

Historic Namibian Diamond Production (thousands of carats)

Calendar Years

source: www.mnlconsulting.com





Seabed Treasure Hunting

Glamorous! Salvage companies involved in raising wrecks (e.g. Costa Concordia) or in looking for 'sunken treasure' – using the remote and direct techniques of seabed mapping



Source: www.osirisprojects.co.uk

Offshore Libya, 50 m of water, 91 m long



http://subseaworldnews.com/2013/07/25/hms-echo-finds-18-wrecks-in-mission-offshore-libya/





http://shipwreck.net/



Shiperreck Explora





RMS Titantic debris field on sonar imagery (3800 m) (www.dailymail.co.uk 09.03/2012)





Earth's deep biosphere

- Postulated by Thomas Gold (1992, 1999) -The Deep, Hot Biosphere (Springer)
- Earth's crust to depths of kilometers sustained by thermally-driven fluid circulation : geosphere-biosphere coupling
- Microbial life, ½ to 2/3 of all biomass
- Largely chemosynthetic (primitive) life forms, living in 'extreme environments'



Source: Oger & Jebbar 2010, Research in Microbiology

(Geo-) Bio-prospecting

- "The development of drugs [pharmaceuticals] from marine organisms" UN Atlas of the Oceans
- There already exist (highly profitable) 'bioactive compounds' from sponges and corals (primitive organisms, metabolic pathways in many ways similar to ours)
- Modern genetic methods simplify the search \rightarrow growing commercial interest
- Japan spends a billion dollars a year (80% private sector)... big business
- Opposing views on whether genetic resources beyond the 'shelf' are covered by UNCLOS/IAS
 ("the common heritage of mankind") or are private? <u>See World Ocean Review</u>





Finding

oil & gas

Sedimentary Basin Analysis vs Petroleum System Analysis

The academic geologist sees...

- deposition of strata
- folding
- faulting
- uplift & erosion

The petroleum geologist looks for...

- source rocks (organic rich)
- migration pathways
- reservoirs
- traps & seals



Understanding Earth systems

Source: petroleumsupport.com/reservoir-system-to-accumulate-hydrocarbon.html/petroleum-system/





Academic and petroleum geologists use basically the same tools...

Geophysics (remote)

- Gravity & magnetic fields
- Seismic data (2D & 3D)



- Sediment cores
- Drillsites/wells



Source: seriousgamesmarket.blogspot.it/2010/09/seriousgames-as-oil-drilling-3d.html

http://www.bgs.ac.uk/sci ence/CO2/home.html

> Industry tools are almost always bigger & better (with eventual benefits to science)



2000

2002

2004

2006

2008

2010

2012

2014



Hydrocarbons = by far the biggest offshore industry

because industrial society runs mainly on petroleum...



23.00%

World Energy Demand – Long-Term Energy Sources

Source: triplehelixblog.com/2012





Hydrocarbons – are we at peak production?



Campbell & Laherrre 1996, Scientific American – The End of Cheap Oil



Green: discoveries peaked in the 1960s **Red**: production peaking now?





Deep water production is peaking?





Global oil & gas discoveries





Shallow : 0-400 m Deep : 400-1500 m Ultradeep : >1500 m

Most global discoveries are offshore in deep and ultra-deep water (and cost a lot more)

- Petroleum industry is progressively moving into ultra-deep water, 3174 m in
 2013 (offshore eastern India)
 - Still within national jurisdictions – EEZ/'Continental Shelf'



Source: www.energyandcapital.com/articles/oil-rigs-drilling-ever-deeper/







Types of Offshore Oil and Gas Structures (in 2005)

- 1 & 2) Conventional fixed platforms (deepest: 412 m GOM, 1991)
- 3) Compliant tower (deepest: 534 m GOM, 1998)
- 4 & 5) Vertically moored tension leg platforms (deepest: 1,425 m GOM, 2004)
- 6) Spar (deepest: 1,710 m GOM, 2004)
- 7 & 8) Semi-submersibles (deepest: 1920 m GOM 2003)
- 9) Floating production, storage, and offloading facility
 - (deepest: 1,345 m Brazil, 2005)
- 10) Sub-sea completion and tie-back to host facility
 - (deepest: 2,307 m GOM, 2004)

Source:

http://commons.wikimedia.org/wiki/File:Types_of_offshore_oil_and_gas_structur es.jpg





OGS

Enormous investments, technical challenges, and achievements by offshore industry in exploration, drilling and (only in some cases) production...



1 Semi-submersible platform. Buoyed by large pontoons. An anchor or its own engine keeps it in position. The sunken Deepwater Horizon was one of these types of platforms.

Shaft towe

Helipad

Source:

www.spiegel.de/

- Oil production pipe

Wellbore valve

2 SPAR platform. Rests on a huge cylindrical hull that also serves as a temporary storage area for the oil being produced. 4 Jack-up rig platform. Stands on a solid three or four-legged frame. The platform can be jacked up or down. This sort of platform can only be used in depths of up to around 150m.

3 TL (tension leg) platform. Moored with vertical, high tension steel cables. Here, too, the large hull temporarily stores the oil extracted.

Deep Sea Monsters

Lavers at the mobile jack-up platforms, which rest on a solid concrete foundation or on a steel frame, as well as the mobile jack-up platforms, can only be used at moderate depths. In order to explore deep sea depths, special oil production ships as well as a variety of floating drilling and production platforms need to be used. These days, technologies exist that can drill beneath the ocean floor at a depth of more than 3,000 meters.

"The conquest of the deep offshore, the oil industry's latest and perhaps most extra-ordinary adventure..." (www.total.com)





And corresponding risks...

Blowout = uncontrolled release of hydrocarbons after pressure control systems fail

Deepwater Horizon drilling rig (semi-submersible), Gulf of Mexico, April 20 2010 : blowout

Sources: eijournal.com/2011/deepwater-horizon-revisited





Explosion, fire, 11 deaths, massive oil spill...



Source: <u>www.greenpeace.org</u> - Shrimp boat





Rig: GSF Adriatic IV Jack-Up Date: 10 August 2004 Location: Temsah, Mediterranean Sea, Egypt Operator: Platform run by Petrobel



GSF Adriatic IV at Temsa before the blowout



Blowout → explosion, fire, rig sank (no loss of life)





Rig: Smedvig West Vanguard Semi-Sub Date: 06 October 1985 Location: Haltenbanken, Norwegian Shelf Operator: Statoil

Blowout, explosion, fire, 1 death (missing); rig eventually restored







Source: home.versatel.nl/the_sims/rig/index.htm







Rig: Petromar V Drillship Date: 27 Aug 1981 Location: Off Natuna Island, South China Sea Operator: Mobil



Several dozen incidents (mainly blowouts) since 1964 – every year or so

Source: home.versatel.nl/the_sims/rig/index.htm





EU REGULATORY FRAMEWORK







Marine Strategy Framework Directive adopted on 17 June 2008.

SCOPE: to achieve Good Environmental Status (GES) of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. the Directive sets out eleven qualitative descriptors which describe what the environment will look like when GES has been achieved. **Descriptor 1.** Biodiversity is maintained **Descriptor 2.** Non-indigenous species do not adversely alter the ecosystem **Descriptor 3.** The population of commercial fish species is healthy **Descriptor 4.** Elements of food webs ensure long-term abundance and reproduction **Descriptor 5.** Eutrophication is minimised **Descriptor 6.** The sea floor integrity ensures functioning of the ecosystem **Descriptor 7.** Permanent alteration of hydrographical conditions does not adversely affect the ecosystem **Descriptor 8.** Concentrations of contaminants give no effects **Descriptor 9.** Contaminants in seafood are below safe levels Descriptor 10. Marine litter does not cause harm **Descriptor 11.** Introduction of energy (including underwater noise) does not adversely affect

the ecosystem





Descriptor 6. The sea floor integrity ensures functioning of the ecosystem

Main pressures on the sea-floor?

Human activities induce different kinds of pressures that can affect the sea-floor. The main pressures that directly impact the state of the sea bottom are:

- 1. Coastal infrastructures (ports, defenses against erosion, etc.) and offshore installations (oil and gas platforms, wind farms, etc.);
- 2. Offshore mining and sand extraction;
- 3. Release of dredged sludge;
- 4. Moorings;
- 5. Some fishing practices (trawling, dredging, etc.);
- 6. Aquaculture (unused fish feed, fish faeces, etc.);
- 7. Introduction of non-indigenous species (trough ballast water for instance);
- 8. Pollution (chemical pollution, litter);
- 9. Changes in riverine inputs (organic enrichment of particulate matter, etc.);
- 10. Sediment remobilization by fishing equipment (trawls, dredges);
- 11. Changes in freshwater riverine inputs as a consequence of damming and irrigation;
- 12. Changes in solid matter riverine inputs; and
- 13. Release of large quantities of warm (power plant cooling) or salty water (from desalination facilities)





DIRECTIVE 2013/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 June 2013 on safety of offshore oil and gas operations

PREVENTION OF MAJOR ACCIDENTS RELATING TO OFFSHORE OIL AND GAS OPERATIONS

- General principles of risk management in offshore oil and gas operations
- Safety and environmental considerations relating to licences
- Public participation relating to the effects of planned offshore oil and gas exploration operations on the environment
- Offshore oil and gas operations within licensed areas
- Liability for environmental damage

Among the documents submitted for carrying out offshore oil and gas operations:

Report on major hazards for a production installation Report on major hazards for a non-production installation

In the entire document the term 'geo' is used only for geographical meaning





National implementation of the EU Directive:

Italian Ministry of Economic Development Increased safety of offshore installations

Among other activities....

- Evaluation of the seismic hazard (including induced-seismicity) of current platforms based on their position with respect to tectonic structures and induced pressures (load)
- Feasibility studies for seismic monitoring and soil deformation
- Studies of geological and stratigraphic conditions of new marine areas open to research and cultivation of hydrocarbons

Increased royalties on Oil and Gas to fund research projects on (among other):

- Submarine geo-hazards (slope stability, enhanced erosion, gas emissions)
- Seismicity including induced seismicity





Recommended Reading

Law of the Sea

- <u>http://www.un.org/depts/los/convention_agreements/texts/unclos/UNCLOS-TOC.htm</u>
- <u>http://en.wikipedia.org/wiki/United Nations Convention on the Law of the Sea</u>
- <u>http://en.wikipedia.org/wiki/Maritime_boundary</u>

Marine Resources

• World Ocean Review (*worldoceanreview.com*)