Climatic response to forced regressions through sub-sea gas systems

Dr. Uri Schattner
Dept. of Marine Geoscisnecs
Charney School of Marine Sciences
University of Haifa, Israel
Sedimentary Responses to Forced Regressions

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Posamentier and Morris, 2000
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Filling up the shelf — A sedimentary response to the last post-glacial sea rise

U. Schattner a,*, M. Lazar a, G. Tibor a,b, Z. Ben-Avraham a,c, Y. Makovsky a

a Dr. Moses Strauss Department of Marine Geosciences, Charney School for Marine Sciences, University of Haifa, Israel
b Israel of Oceanographic and Limnological Research, Israel
c Department of Geophysics and Planetary Sciences, Tel-Aviv University, Israel

Active gas migration systems offshore northern Israel, first evidence from seafloor and subsurface data

Uri Schattner *, Michael Lazar, Dana Harari, Nicolas Waldmann
Dr. Moses Strauss Department of Marine Geosciences, Charney School of Marine Sciences, University of Haifa, Mount Carmel, 31905 Haifa, Israel

The great escape: An intra-Messinian gas system in the eastern Mediterranean

Michael Lazar,1 Uri Schattner,1 and Moshe Reshef2
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Multi-channel section – gas chimney

Seismic attribute analysis:
Amplitude
Similarity

Schattner and Lazar, 2009
Backscatter ➔ suspected pockmarks

After Sade et al., 2006
Bathymetry ➔ suspected pockmarks

After Sade et al., 2006
Data

5 VHR new surveys
4 MCS available surveys
Single channel survey configuration

Hydrophone

Sparker

GeoSpark 200 sparker by GeoResources
Data types

Schattner et al., 2010
Gas seeps – at ~75m depth
Low cohesion – at ~35m depth
Low cohesion
Findings

**Seafloor**
- 720 suspected pockmarks
- Active seeps – 3 consecutive years
- Low cohesion zone

**Subsurface**
- Bright spots
- Gas masking
- → Gas front - ~72 km²
Widespread indications for cold seeps

Schattner and Lazar, 2009
Gas signature

Climatic implications

Permeability

Lithology + conditions

Reservoir / emission

Path

Source
Gas chimney
2 major unconformities
Gas chimney
2 major unconformities
Mid Pleistocene unconformity

Well interpretation – Derin, 2002

Harari, 2010, MSc
Correlation between seismic markers – unconformities and sea level

After Paillard, 2006; Lisiecki and Raymo, 2005

Mid Pleistocene transition

After Paillard, 2006; Lisiecki and Raymo, 2005

Harari, 2010, MSc
Gas emission response to sea level change

Sea level drop

Exposure

Wetland formation

Drainage channels

Possible source for organic matter

Channel incision

Likely correlation to glacial maxima

Rapid channel fill

Burial of organic rich sediments
Gas emission response to sea level change

Sea level drop → Removal of hydrostatic pressure → Gas release → Warming

Sea level rise (highstand) → Seepage burial under water and sediments → Seepage to atmosphere stops → Negligible warming effect

Lambeck and Chappell, 2001

Relative sea level

Time (x1000 years) before present

Relative sea level (m)

OIS-5 OIS-4 OIS-3 OIS-2
Exposure during LGM

Schattner et al., 2010
LGM negative climate feedback

- The active gas system -- not unique to offshore Israel

- It represents the usually underestimated marine methane contribution from mid-latitude continental shelves into sea water and maybe into the atmosphere.

- Global warming and sea level rise induces a negative, restraining feedback for gas emission across mid-latitude continental margins
Data

2D seismic reflection – time migrated
3D seismic reflection – pre-stack depth migrated
Giant pockmark

Formed on Messinian seafloor

Lazar, Schattner and Reshef, 2012
Base Messinian over Jonah structure
Top Messinian

Lazar, Schattner and Reshef, 2012
Mid-Messianian climatic shift

Rouchy and Caruso, 2006
Climate is not the direct cause of the Mediterranean desiccation
Climate feedback

- Tectonic forces
- Isolation of Mediterranean
- Messinian Salinity Crisis
  - Massive drop in sea level
  - Exposure of seafloor
  - Emission of gas to shallow sea and atmosphere
  - Spontaneous gas emission
  - Increased runoff from land areas
  - Terrigenous sediment supply + increased channel incision
  - Gas seepage continues as long as sea level is low

- Warming → Mid-Messinian climatic shift

- Tectonic opening of Gibraltar

- Major flood

- Covers seafloor with water and sediments

- Stops emission to atmosphere
Conclusions

- **Continental shelf** – gas system active today
- **Basin** – Messinian gas emission
- Widespread seepage
- Negative climatic feedback cycles
  - Shelf – LGM
  - Basin – Mid Messinian climatic shift
- **Climatic** response to forced regressions through sub-sea gas systems
Thank you