A preliminary characterization of greenhouse gas (CH_4 and CO_2) emissions from Gulf of Cadiz mud volcanoes

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INTRODUCTION

Submarine mud volcanism represents an important migration pathway for **CH_4** and other long-lived greenhouse gases as **CO_2** from deeper reservoirs to the surface.

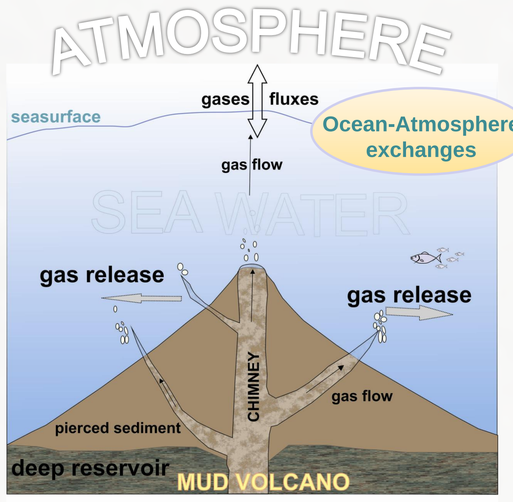


Fig. 1. Mud volcano schema illustrating fluid seepages processes and ocean – atmosphere exchanges.

We have been focused on **11 MVs** as a carbon source of degassing deeply reservoirs to offer an approach of the amount of gas releases to the hydrosphere in these active fluid flow environments.

CO_2 is the **most abundant greenhouse gas** whereas **CH_4** is more "virulent", approximately **300 more effectively than CO_2** (Naqvi *et al*., 2010).
Methane contribution to current global warning is estimated to be about **15 %** to the anthropogenic greenhouse effect (Houghton & Woodwell, 1990).

STUDY AREA : GULF OF CADIZ

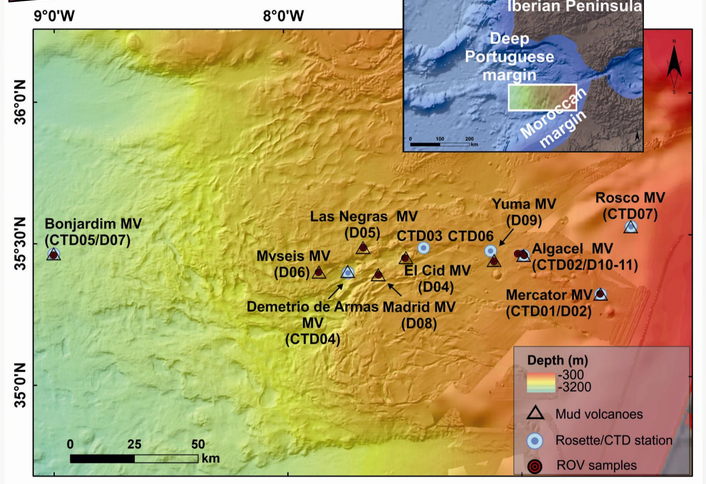
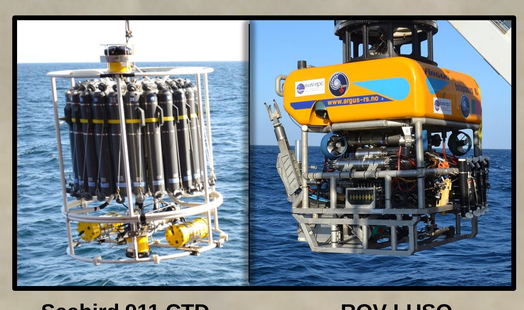


Fig.2. Mud volcanoes location and water samples collected during SUBVENT2 cruise are shown.

MVs of this study are widely located at the ***Moroccan field***, along the middle and upper slope of the Moroccan margin at water depths between 300 to 1600 m whereas Bonjardim is located at the deep-south Portuguese margin at 3100 m depth

MATERIAL AND METHODOLOGY

WATER SAMPLING



Seabird 911 CTD-Rosette Niskin bottles | **ROV-LUSO Niskin bottles**

During **SUBVENT2** cruise, water column over mud volcanoes and their tops were surveyed for gas seepage characterization

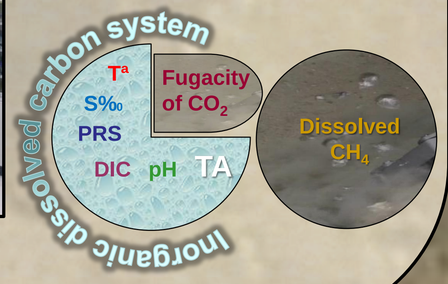
SUBSAMPLES

500 mL **SW** for CO_2 analysis | 20 mL **SW** for CH_4 analysis

ANALYTICAL METHODS

Potentiometric Titration (TA) | **Gas chromatography with flame ionization detection**

Fig. 3. Water samplers and Analytical equipments used in the gas seepage and water column characterization.



RESULTS

Values varied widely within **50 to 200 nM for CH_4** and between **400 to 1500 µatm for fCO_2**

CH_4

Gases concentrations decreased **SIGNIFICANTLY** from :

Shallower to deeper mud volcanoes
Surface to bottom waters

ROV samples present **HIGHEST CONCENTRATIONS** and very similar /higher values where CTD-Rosette samples in 5 -10 m above seafloor were also collected.

CTD- Rosette present higher bottom than surface concentrations excepting at Bonjardim MV

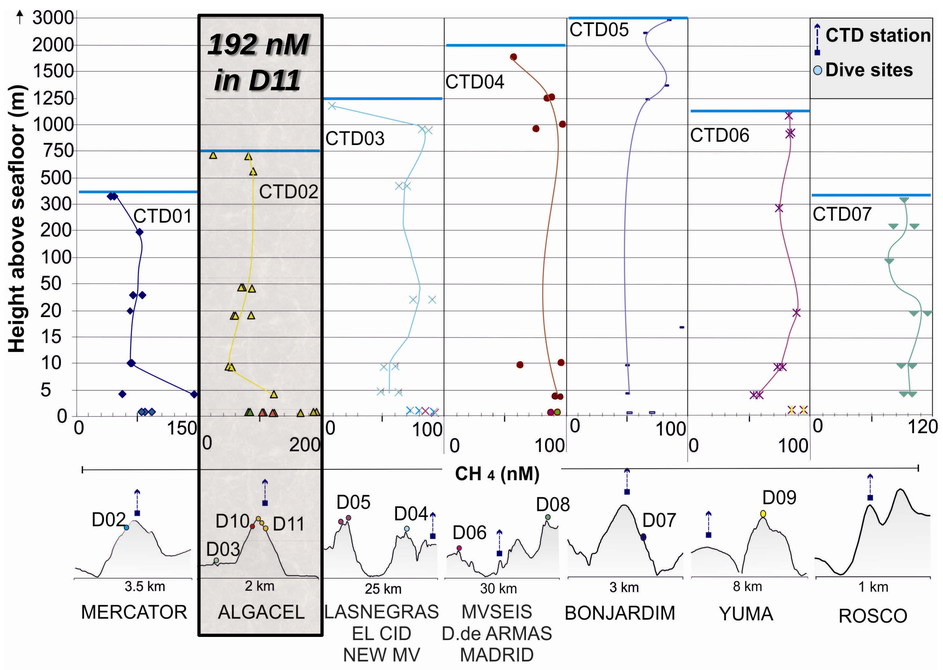
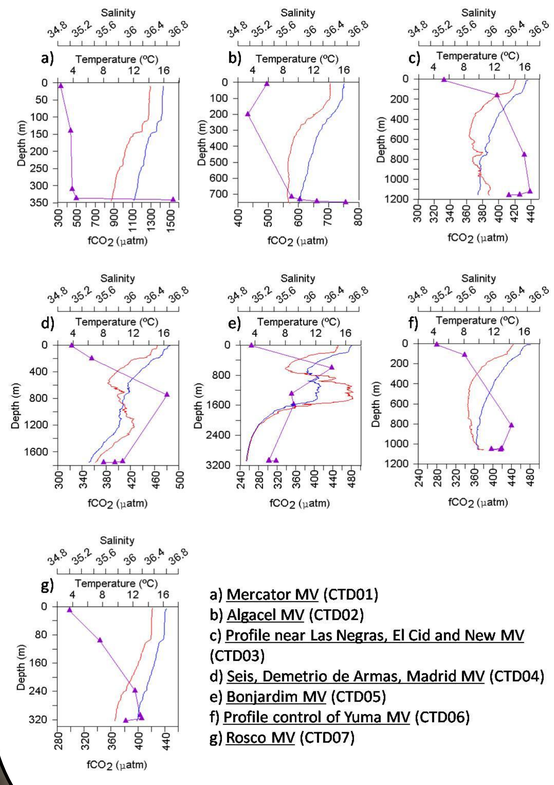


Fig.4. Water column profiles of methane concentrations in CTD stations and ROV sampling sites.

CO_2

Greenhouse **CO_2** concentration is **large influenced** by water column depth, temperature, salinity and geological processes.



a) Mercator MV (CTD01)
b) Algacel MV (CTD02)
c) Profile near Las Negras, El Cid and New MV (CTD03)
d) Seis, Demetrio de Armas, Madrid MV (CTD04)
e) Bonjardim MV (CTD05)
f) Profile control of Yuma MV (CTD06)
g) Rosco MV (CTD07)

Fig.5. Temperature, salinity and Carbon Dioxide concentration (fugacity of CO_2) vertical profiles in CTD-Rosette stations.

Vertical CTD- Rosette profiles show **greater fCO_2 values at the bottom**

Dissolved CO_2 concentrations from **ROV samples are higher than CTD- Rosette samples**

fCO_2 concentrations in Algacel MV, Mercator MV and El Cid MV are higher that the standard limit.

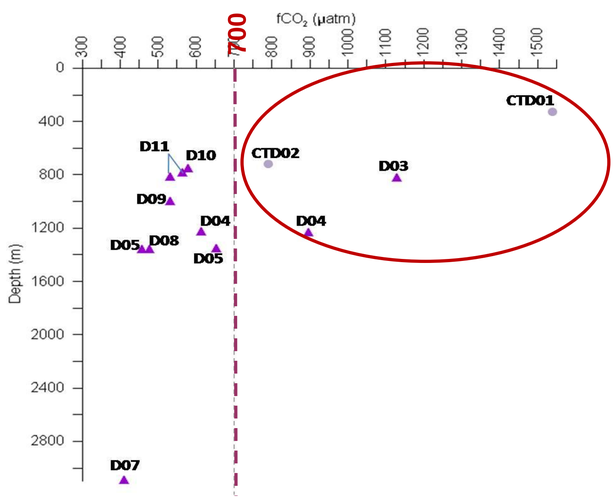


Fig.6. Carbon Dioxide concentrations in ROV sampling sites and CTD-Rosette stations. Samples where fugacity is higher than 700 µatm are enhanced

DISCUSSION

The regional background measured in other MVs in the Gulf of Cadiz appoints that the **methane release** from this study is **remarkably high**

Sommer *et al*. (2009)
8 nM in vertical profiles
20 nM in bottom waters

Sierra, A. (2014)
12,59 nM in vertical profiles
14.29 nM in bottom waters

Captain Arutyunov MV

San Petersburgo MV

Bonjardim MV → **DEEPEST**

Rosco MV
Algacel MV
Mercator MV → **SHALLOWEST**

El Cid MV
Algacel MV
Mercator MV

The lowest values of methane (50 nM) in bottom waters and fCO2 (265 µatm) are related with the distance to geological active Moroccan area **: DEPTH FLUCTUATIONS**

The high levels of methane (150 to 200 nM) in bottom waters imply that there are sites with localized, probably periodic, enhanced methane release in these mud volcanoes

Bottom dissolved CO_2 concentrations in three MVs are very high (1540 µ atm) and corresponds to values founded at depths higher than 1000m in other regions. → Pérez *et al*. (2010)

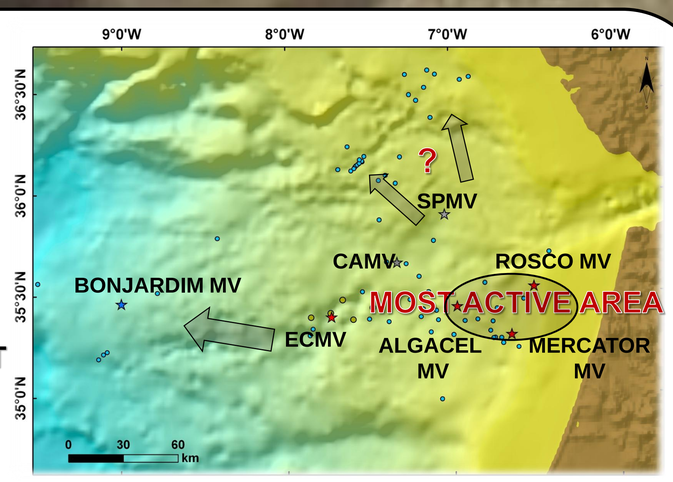


Fig.7. Schema of Gulf of Cadiz location of MVs studied in different biogeochemical studies related with greenhouse gases characterization.

CONCLUSIONS

Physico – chemical analyses indicate that 9 of the 11 sampling sites above MVs were seeping gases at the time of surveying, predominantly at Algacel, Mercator and Rosco MVs.

Our observations suggest that the emission of methane and carbon dioxide from the mud volcanoes structures studied here may be relevant at the present as a part of the carbon global cycle and to the global methane budget of the hydrosphere and possibly also to the atmosphere.

REFERENCES

Houghton & Woodwell (1990). *TISGLOW* 1, 1-8.
Naqvi et al. (2010). *Biogeosciences,* 7, 2159-90.
Pérez et al. (2010). *Biogeosciences* 7, 1789-1807.
Sierra, A. (2014). Tesis de Master
Sommer at al. (2009). *Mar. Eco. Prog. Ser*, 382: 69-86.

ACKNOWLEDGEMENTS

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