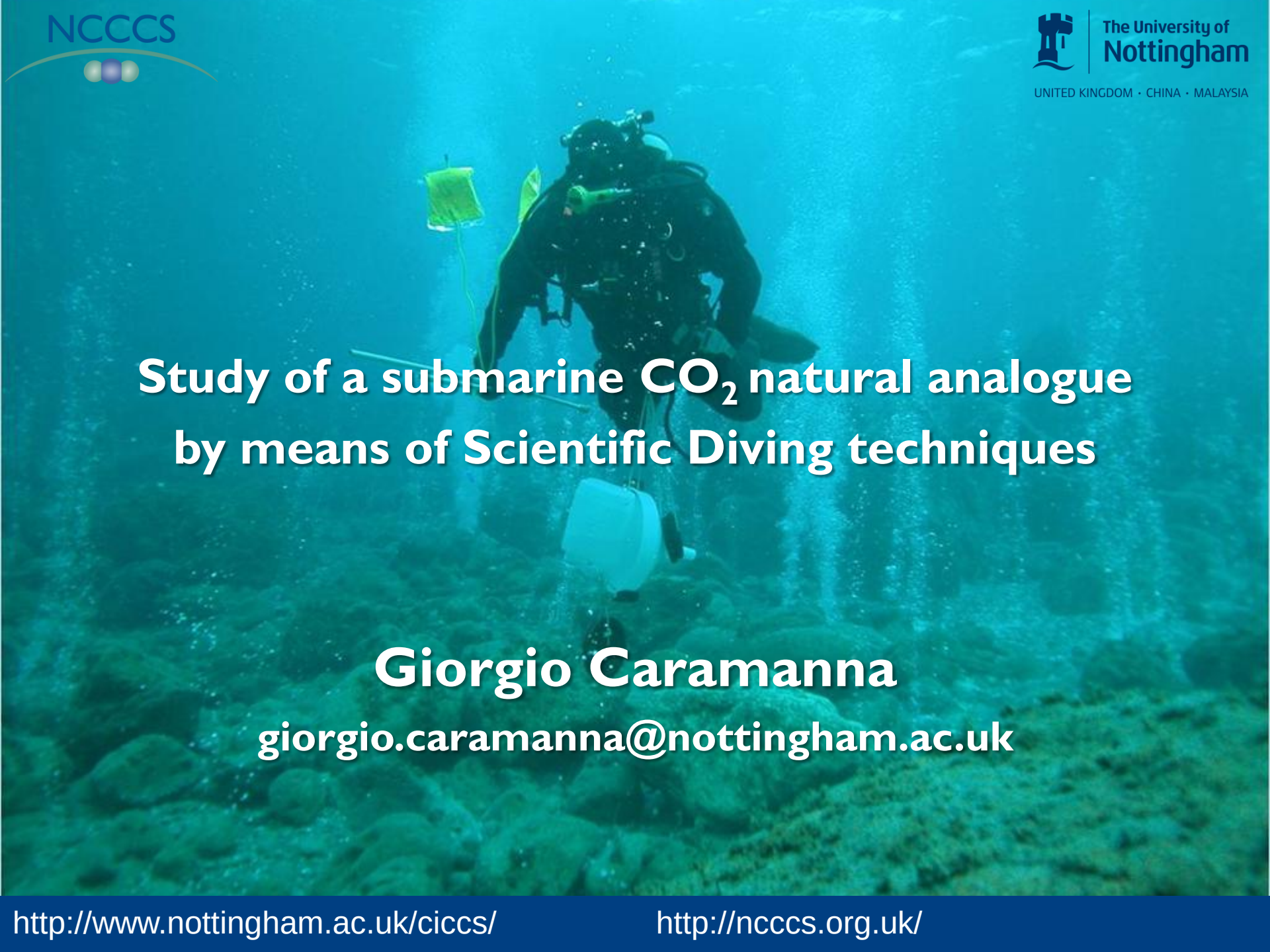

Study of a submarine CO_2 natural analogue by means of Scientific Diving techniques

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Outlines

- Natural analogues: learning from nature
- What is Panarea?
- The techniques: a very wet science!
- Results
- Future work

Natural analogues

- There are areas where, for natural reasons, seepage of CO_2 is present
- It is possible to use these areas as "field-labs" to validate monitoring techniques
- The volcanic island of Panarea (Mediterranean Sea, Italy) is considered a natural analogue for potential seepage from sub-seabed CO_2 storage sites

Panarea natural analogue

- Volcanic marine area with emission of gas (mainly CO_2) close to the island of Panarea (Italy)
- In 2002 the area was affected by a gas burst with a strong increase in the CO_2 flow
- Due to the environmental conditions and the relatively shallow water it is possible to use the island as field-lab for the development of monitoring techniques and to verify the impact of high levels of CO_2 on the marine ecosystem at costs almost negligible if compared with any high-seas research

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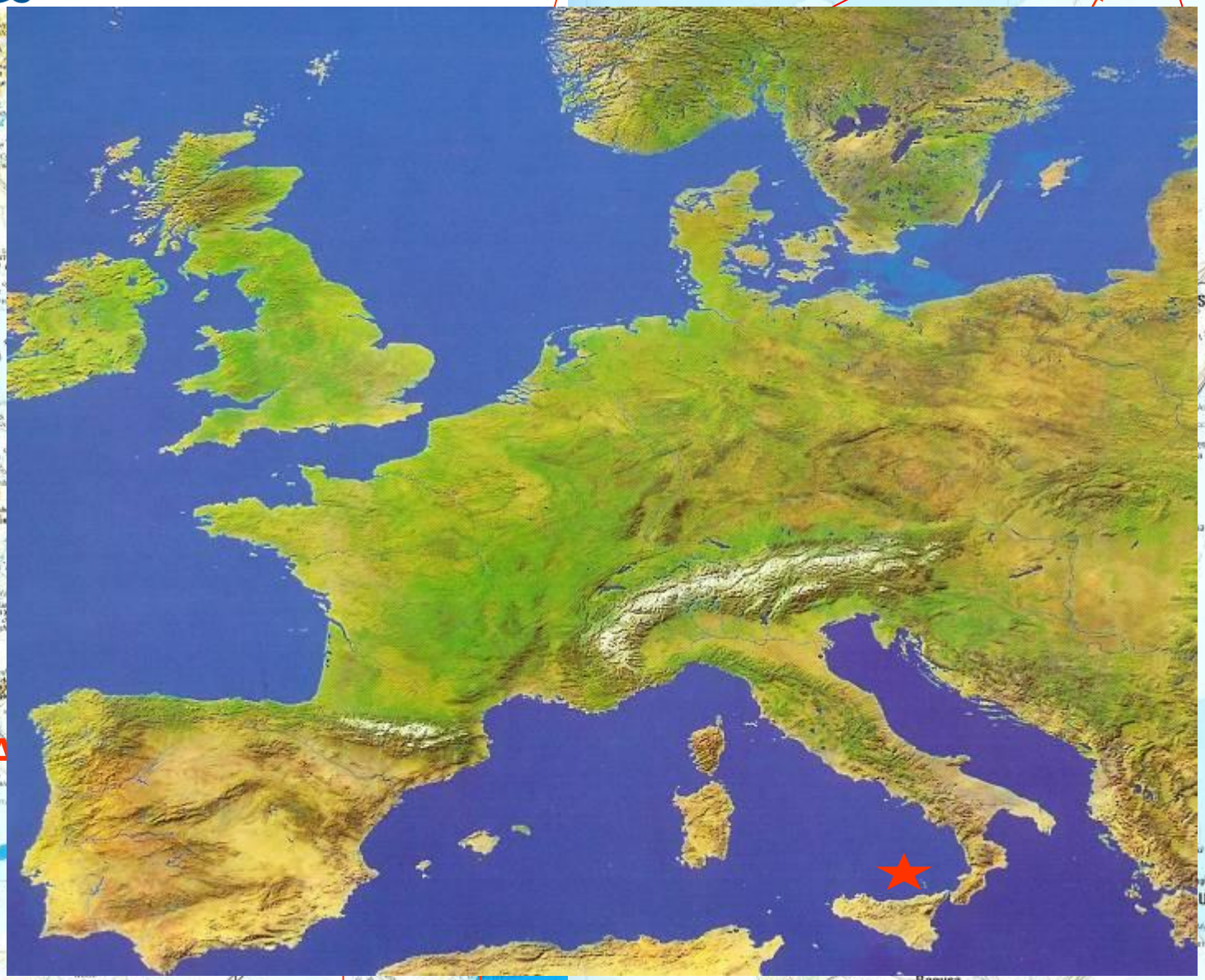

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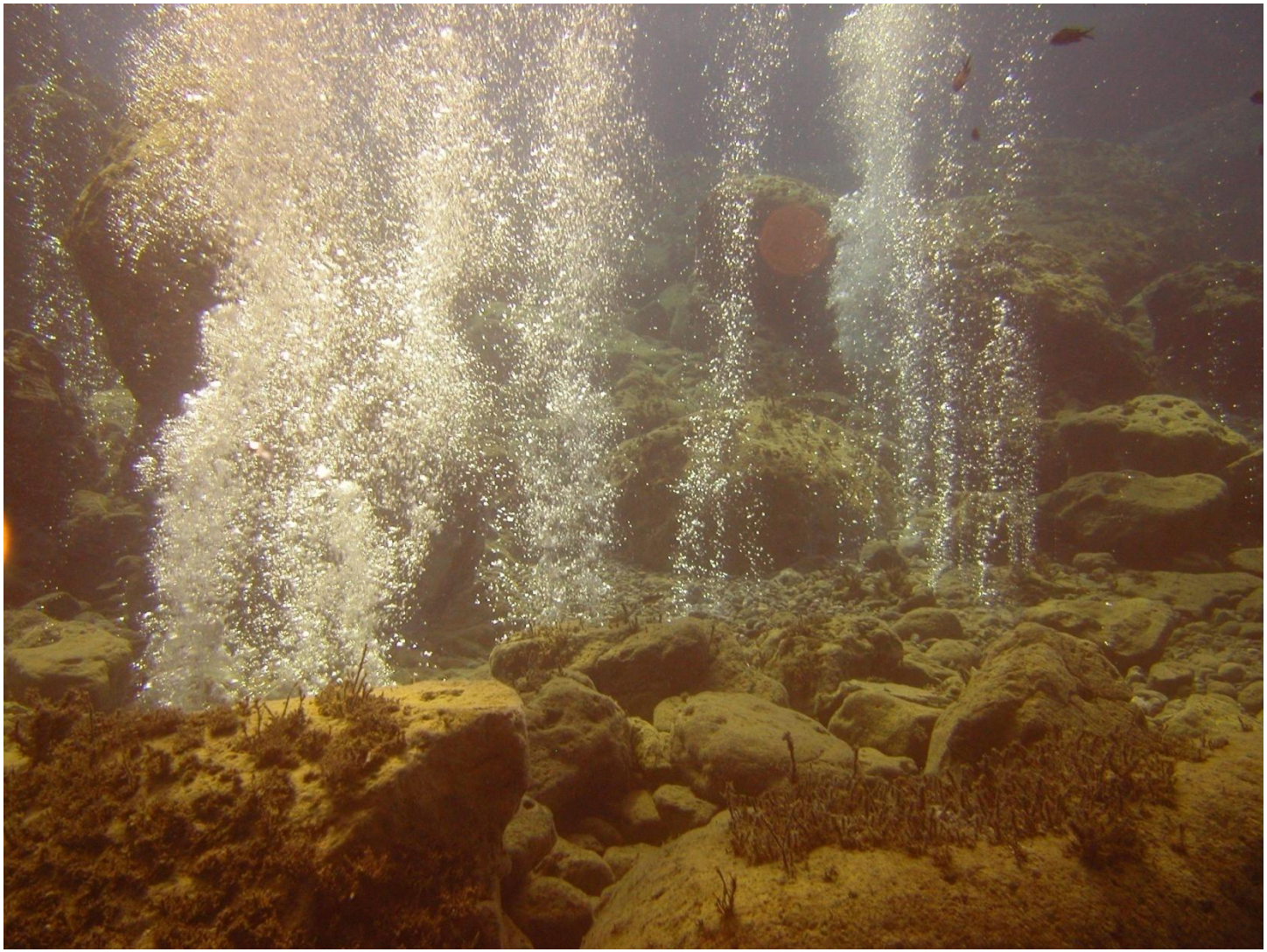
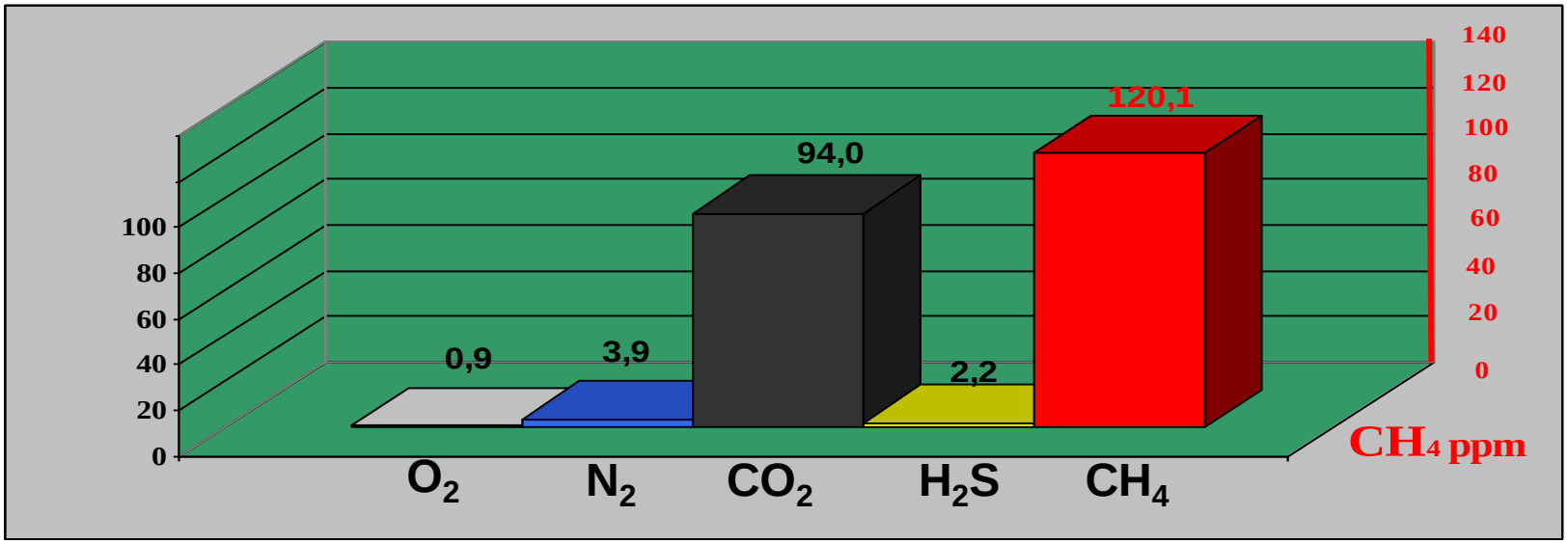


Study techniques

- Gas sampling techniques were developed to be used underwater
- Hundreds of diving hours were spent by the divers involved for the research
- A simple method was used to measure the flow of some of the main gas vents
- A multi-probe was used from the surface and directly by divers for detailed measurements around the gas plumes
- The impact of CO_2 on the marine life-forms was also studied

Free-gas composition



Dissolved-gas composition

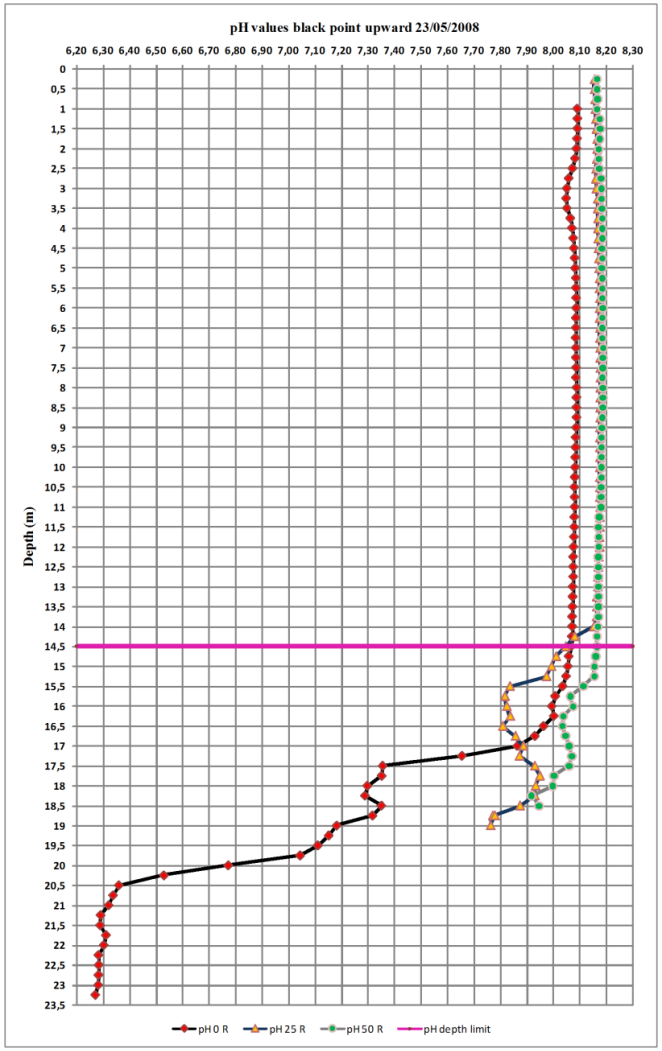
Vent	He (cc/l SPT)	H_2 (cc/l SPT)	O_2 (cc/l SPT)	N_2 (cc/l SPT)	CH_4 (cc/l SPT)	CO_2 (cc/l SPT)
Vent 8	8.88E-05	8.04E-05	1.70	15.28	3.32E-04	217.31
Vent 2	2.77E-02	4.97E-03	1.69	17.36	4.36E-04	189.14
Vent 2 hot	1.10E-04	2.16E-04	2.52	19.34	1.12E-04	120.55
Black Point	3.31E-04	6.20E-04	1.88	17.10	6.63E-03	203.58
Vent 1	1.25E-04	5.54E-04	2.13	17.25	4.47E-04	214.27
Sinkhole	1.14E-04	5.50E-04	2.11	19.54	5.07E-04	156.43

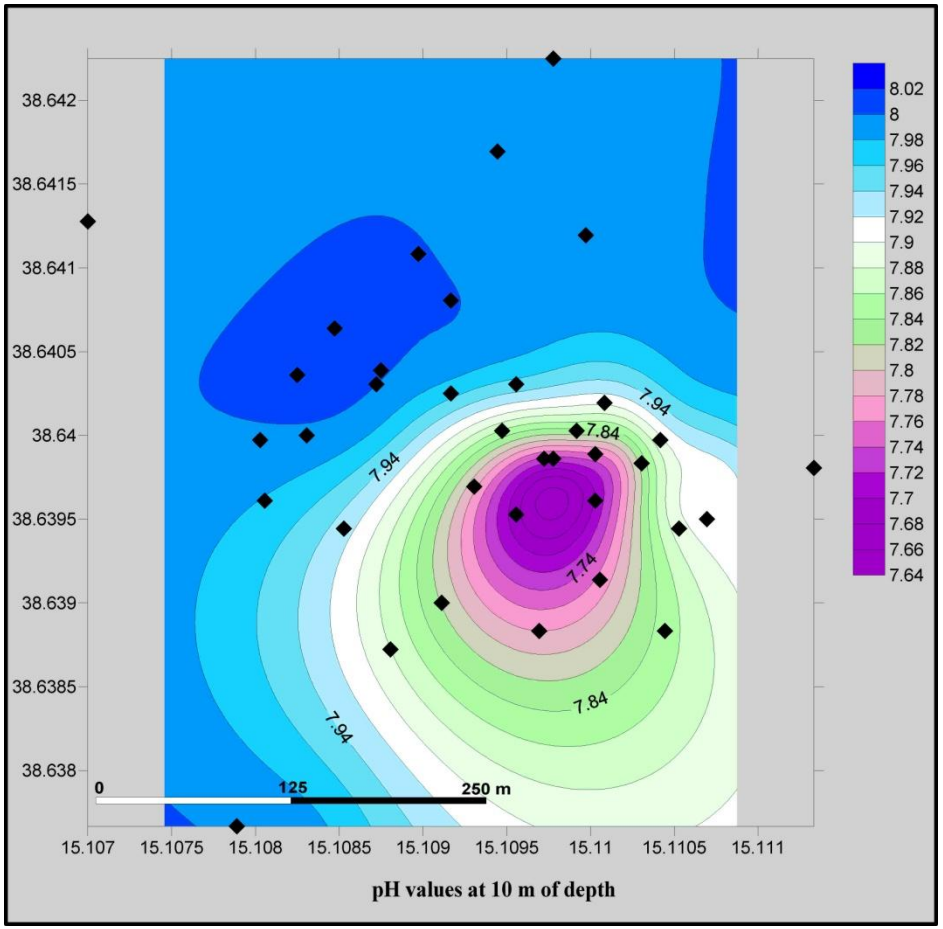
Gas released in one year

- CO_2 850,000 m^3/m^2 – 1,670 t/m^2
- H_2S 20,000 m^3/m^2 - 30 t/m^2
- CH_4 105 m^3/m^2 - 75 kg/m^2

Total 900,000 m^3/m^2

Water acidification

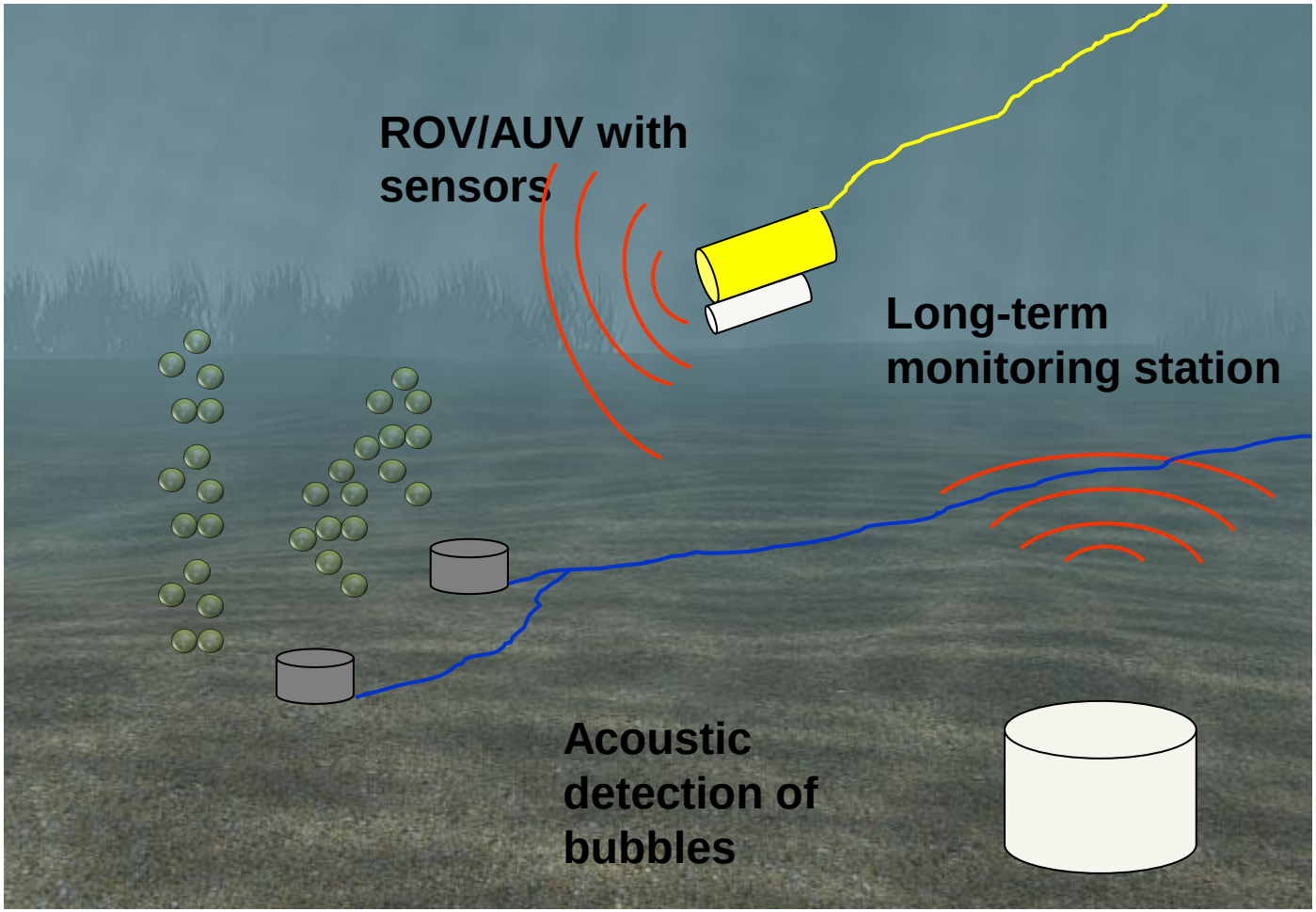




Future work

- Development of lab experiments on the interaction of CO_2 with sediments and water
- Validation of sensors response
- Identification of reliable techniques for CO_2 monitoring in aquatic environments
- Utilization of Panarea as field-lab for equipment testing and training site for specialized researchers
- Further development of a network of research institutes and business enterprises interested in the effects of CO_2 on the marine realm

Instruments testing



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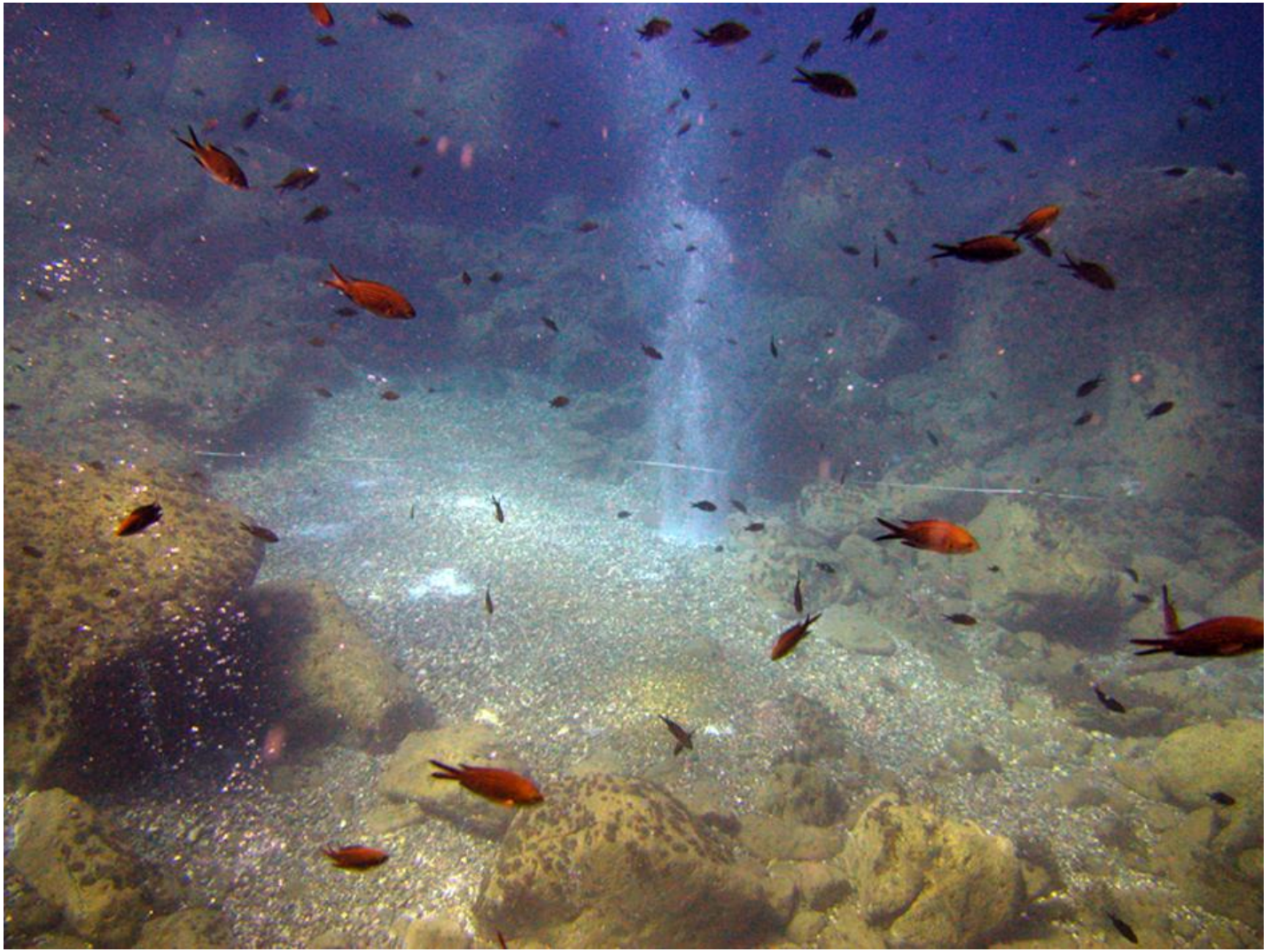
Thank you for your attention



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