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Insights into Seabed Fluid flows: Pockmark dynamics mapping and monitoring in Patras Gulf, Greece, Unveil Correlations to local tectonics and Earthquakes. The BLUEL project.

George Papatheodorou[1], Maria Geraga[1], Dimitris Christodoulou[1], Elias Fakiris[1], Efthimios Sokos[2], Zafeiria Roumelioti[2], Giuseppe Etiope[3], Sotiris kokkalas[4], Nikos Giannopoulos[1], Xenophon Dimas[1], Nikos Georgiou[1], Vasileios Giannakopoulos[1], and George Ferentinos[1]

[1]Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras, Patras, Greece (gpapathe@upatras.gr)

[2]Seismological Laboratory, Department of Geology, University of Patras, Patras, Greece

[3]Istituto Nazionale di Geofisica e Vulcanologia, Sezione Roma 2, Rome, Italy

[4]Laboratory of Structural Geology & Tectonics, Department of Geology, University of Patras, Patras, Greece

Seabed fluid flows (SFF) refer to the movement of fluids (gases and liquids) from sediments to seawater. SFF has broad implications for (i) human activity in the ocean, which is often associated with geohazards, (ii) global climate, and (iii) benthic ecology. BLUEL project aimed to long-term monitor the submarine active pockmark field in the Gulf of Patras, Greece, and investigate its relationship to seismic activity, examining the occurrence of changes in their fluid flow behavior during local earthquakes towards evaluating their potential for use as earthquake precursors. The pockmark field extends to an area of 2.4 km^2, in water depths of 17 to 45 meters and consists of 115 pockmarks of which 92 are visible and 23 are buried under the infrastructure of the recently constructed South Port of Patras. The formation and activity of the field appears to be controlled by tectonics (faults) while methane fluxes and fluid escapes into the water column were recorded in the past, increased after strong earthquakes.

A high-resolution mapping and monitoring of the Patras Gulf pockmark filed (PGPF) was carried out through high resolution acoustic mapping techniques, including swath bathymetry, sidescan sonar backscatter and sub-bottom profiling, revealing pockmarks morphological evolution through time and assessing the spatial patterns of bubble flares after major seismic events. Results showed that the main mechanisms for the development of the field are local tectonism and internal characteristics of gas-charged sedimentary layers. Sediment and water samples were collected and in-situ measurements of CH_4 concentration were performed using a methane sensor. The chemical composition and origin of the fluids in the seawater and the sediments were assessed and implications about the volume of greenhouse gases escaping to the atmosphere were made. The geochemical analysis showed that heavy metal concentrations are always higher in sediments collected inside the pockmarks than those collected outside the sites. Isotopic analysis also revealed that CH_4 of microbial origin is the dominant component of the released gas. The annual emissions of methane from the pockmark field wider area to the atmosphere have been also estimated between 7.6 to 8.4 tons per year.

A 200m long submarine optical fiber was installed inside a selected active pockmark to measure the water temperature through a Distributed Temperature Sensing (DTS) system, acquiring data over 1.5 years. Spectral analysis methods were applied to fill missing data, reconstruct the temperature time series along the cable length and reveal any underlying periodicities or anomalous events. The above measurements were supported by meteorological and tidal data collected in the area, as well as by a microseismic network to record the seismic activity over the corresponding period. Comparisons were performed between the above datasets, revealing significant relationships between anomalous thermal events and local seismicity.