Spectrophotometrical monitoring system, integrated in an Autonomous Underwater Vehicle, for continuous heavy metal detection near offshore sites.

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The constant growth of the offshore oil and gas industry raised questions about its impact on marine ecosystems and biological resources. Considering the potential adverse impacts on the marine environment, a greater level and continuous monitoring of the offshore sites, detecting the presence of pollutants, may be required. The here presented research was focused on the design of an autonomous system for detection of heavy metals in water by spectrophotometric analysis. The ground-breaking idea is the implementation of a system inspired to the latest innovative techniques in the field of the microfluidic analysis, based on Lab-on-Chip. Such a choice is due to the unique advantages in terms of reduction of sample and reagents volumes, energy budget and analysis times, besides the possible multi-element analysis on the same sample. Hexavalent Chrome, Zinc and Nickel were first considered as detected metal ions. Main process parameters were optimized, to be suitable for a miniaturized and portable device, for real time monitoring system, starting from the standard methods reported in literature. Involved volumes, manageable by a microfluidic device, suitable solvents and acid solutions, reagents amount, aging effect, reaction times and the radiation of the sample by a single wavelength visible source were considered. The influence of each parameter was investigated individually, all the optimized values were merged to test any possible mutual effects. In both cases, the optimized method provided a good agreement of the calibration curve with Lambert & Beer law, till metal concentrations of 5-10 ppb. The methods were implemented on the automated microfluidic system, where the filtered sample is suitably mixed with the reagents by automatic, electronically controlled syringes. Bubble traps and high-pressure draft valves, suited to work up to 100 bar, allow the system to be embedded, through a cylindrical plastic payload, in an Autonomous Underwater Vehicle (AUV), guided in deep water (down to 300 meters) near any interesting site. Test on the bench prototype confirmed the encouraging results obtained at laboratory scale, moreover, test on the field have demonstrated the validity of the system and its complete automation.