Seeing gas hydrates in a new light: spectroscopy on the sea floor, and new insights into massive hydrate formation in nature.

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Clathrate hydrates of natural gases occur abundantly in the shallow geosphere, and are now widely recognized both as a future potential fuel source, and as a possible geo-hazard. The tools for investigation of hydrates have long been isolated into two distinct and separate groups – elegant laboratory spectroscopic studies of fundamental properties; and field programs of acoustic exploration and sample recovery by coring. We have sought ways to bridge this gap through the development of novel *in situ* spectroscopic techniques, carried by ROVs, and deployed both for critical controlled experiments, and for the examination of natural systems. Our first efforts used the Schlumberger NMR tool for controlled deep-sea studies of hydrate-sediment interaction. We then developed a highly modified laser Raman spectrometer for direct measurement of the cage occupancy and structure of hydrates exposed on the sea floor, and this tool is now fully operational. I report on the use of this "point and shoot" laser system for examination of the massive complex hydrate structures exposed at 850m depth on the sea floor at Barkley Canyon, offshore Vancouver Island with real-time detection of Structure II hydrates with methane, ethane, propane, and trace isobutane, all readily distinguishable.

Carbon sequestration, ocean acidification, and the quest for a public awareness of the real role of the ocean in global change.

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Public awareness of the role of the ocean in regulating Earth's CO_2 state is confused. Plans for reducing the growth rate of atmospheric CO_2 levels frequently refer to allowing "natural processes" time to catch up, as a way of possibly reaching a new equilibrium. This is a euphemism for continued ocean uptake of fossil fuel CO_2, now proceeding at about 1 million tons CO_2 per hour. I review here the science behind rapidly-changing awareness of this from the perception of passive ocean uptake as a great blessing, through the execution of small-scale direct injection studies for evaluating ocean CO_2 sequestration, to the emergence of ocean acidification as an independent environmental threat. In order to objectively evaluate this we will need to carry out sophisticated controlled CO_2 enrichment experiments in the ocean in much the same way as is done on land. I report on the first attempts to do this, and the technical and policy challenges that emerge.