EAG Distinguished Lecture Program 2014
Lecture Abstracts

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Lecture 1:

Weathering, ocean chemistry and climate change: New insights from non-traditional metal stable isotopes

Many lines of evidence, from both marine and terrestrial records, suggest that there have been dramatic changes in the Earth's climate system during the last 65 Myr that occur on both long (geological) and short timescales. The mechanisms that are responsible for these changes are less well established, but there is growing evidence that amongst the primary controls is the concentration of atmospheric carbon dioxide (CO_2), the principal greenhouse gas.

Weathering of continental rocks leads to drawdown of atmospheric CO_2. Weathering rates are controlled primarily by temperature and rainfall, creating a dynamic link between weathering and climate that represents an important feedback process in the Earth's climate system. As weathering products are ultimately delivered to the oceans via rivers, weathering also regulates ocean chemistry which, in turn, affects primary productivity and also levels of atmospheric CO_2.

We have identified a number of metal stable isotopes, including lithium and magnesium, which are sensitive to changes in continental weathering and erosion. In this talk, we will discuss their strengths and weaknesses, their potential for preservation in marine sedimentary records, and how these analyses have opened up new perspectives in understanding the linkages between weathering and climate.

Lecture 2:

Linkages between methane release from Arctic shelf sediments and climate change

Methane hydrate is a solid ice-like substance composed of methane and water molecules. Methane hydrates occur naturally in marine environments, where methane gas is available and temperatures are relatively low and pressure is relatively high. Estimates of the quantity of hydrate-bound gas in marine sediments range from 500 to 3000 Gt of carbon; additionally, hydrates are frequently underlain by free gas reservoirs that may contain another ~1800 Gt of carbon. Together, the hydrate and underlying free gas reservoirs comprise almost half of the Earth's organic carbon. Release of methane from hydrate may have contributed to rapid climate change in the past, and it is considered to be a significant natural hazard because hydrate decomposition could destabilize sediments, creating landslide and tsunami risk.

Most climate models predict a rapid increase in Arctic air and surface water temperatures within the next decades, and direct observations of waters at 250 m depth in the eastern Fram Strait record a +1˚C increase between 1998 and 2006. In 2008, we discovered more than 250 plumes of methane

gas bubbles rising from the seabed west of Svalbard. Many of these plumes were discovered close to the depth at which the gas hydrate stability zone is predicted to intersect with the seafloor in this area (close to 400 m water depth) suggesting that the bubble plumes may be the result, at least in part, of methane release by the dissociation of gas hydrates beneath the seabed, due to increases in water temperature.

A key question, which will be addressed in this talk, is how much of this methane escapes into the atmosphere where it has the potential to affect climate? To this end, we assess the extent to which fluxes of methane from Arctic sediments are modified by anaerobic oxidation (in sediments) and aerobic oxidation (in the water column). We will also discuss the evidence for gas hydrate as a source of Arctic methane, and characterise the carbon isotopic signature of the methane flux to the atmosphere from the Arctic seafloor.

Lecture 3:

Monitoring and impacts of leakage from sub-seafloor CO_2 storage sites

Anthropogenic emissions of carbon dioxide (CO_2), from fossil fuels and other industrial sources, are perhaps the biggest threat to the climate system yet many economies will remain reliant on these technologies for several decades. Carbon capture and storage (CCS) in deep geological formations provides the only effective option to prevent these emissions from entering the Earth's atmosphere. Many potential CCS sites are located offshore, hundreds of meters below economically and culturally important shelf seas. However, there is widespread concern about the possibility of leakage, and its potential environmental impact, which is currently unknown.

To address this gap, we have conducted the world's first controlled sub-seafloor release of carbon dioxide. 4.2 tonnes of CO_2 were released over a period of 37 days, and the migration and impact of this release was assessed using a variety of geophysical, acoustic, chemical and biological techniques. In this talk, we will describe the experiment, evaluate different methods for monitoring the migration of CO_2 through the seafloor sediments and into the water column, and assess the impacts of CO_2 release on sediment biogeochemistry and the benthic ecosystem. We will also discuss the importance of communicating this experiment to the local community.