Volcanoes
15th April 2024 at the University Women's Club, Audley Sq.

The Discussion was introduced by Clive Oppenheimer, Professor of Volcanology in the Dept of Geography at Cambridge. Clive is a geoscientist and filmmaker. His interests include volcanic processes and hazards, the climatic and societal impacts of eruptions, geoarchaeology, paleoclimatology, sensors and atmospheric science.

The first recorded use of technology in volcanology was probably An Lazzaro Spallanzani, (1729 – 1799) who was an Italian naturalist, biologist and physiologist who climbed Stromboli when he was aged 60 in 1788, primarily to correct deficiencies in the volcanic collections of the Pavia museum.

In 1800 a review of his career was published in English in an Edinburgh magazine, which included the first use of the term volcanology. He could also be called the founder of experimental biology because he discovered that bats navigate by echo location. He knew how to plan an expedition and was a strong climber, when geology did not really exist as a subject. He wondered what was that it that animates a volcano, what was it that fuels it and makes it erupt? This was also when there was a raging argument between rationalists and empiricists. Spallanzani was very much an empiricist; he identified hydrogen chloride in volcanic gas and observed the action of Stromboli at very close quarters from which he made a number of deductions.

One aspect of Clive's research has been to understand how volcanoes work by measuring gases using spectrometers, and by coincidence he climbed Stromboli almost 200 years after Spallanzani did so. The biggest eruptions change the climate globally and one of the first reports of the impact of these was from Krakatoa in 1888. This led Clive into historical research on past eruptions with historians, ice chemists, dendrochronologists and he discovered the joy of working with allied scientists in an interdisciplinarity way.

He has visited what must be one of the most inaccessible volcanoes in the world, Erebus in Antarctica, which is continually active, entirely ice covered, but once there it is easy get around on a snowmobile as it is a mere 30 km from the US McMurdo station. This research came about during his PhD, when the quest was to find out the temperature and nature of its lava.

A field station 3,500m high was set up with about 10 scientists, and it was found to have a 10 minute pulse. The origin of this cyclic process was unusual because the local environment would not provide a water based hydraulic system, as seen in a surface geyser in Iceland for example. Consequently, the gases were most likely to come directly from the magma rather than from near surface contamination.

By a lovely coincidence, the first scientific expedition from the Scott expedition led by Raymond Priestley to Erebus, took place on 12/12/1912 and as Clive was there exactly a century later, he wondered how to commemorate this first ascent? In one of Shackleton's books he found a photograph of a tent with the label *'the highest camp in Antarctica'*. This was set in an earlier caldera to which the present cone sits, but wondered where it could have been. After memorizing this image he actually found the half circle of rocks from their camp! The rocks they brought back were not studied until the 1950s because two world wars had intervened.

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The James Clark Ross expedition in 1841 (along with the young botanist James Hooker and Robert McCormac, the surgeon general who later travelled with Darwin on his Beagle voyage) was hoping to locate the South Magnetic pole (which was on land so never located by that expedition), but witnessed the first sighting of Erebus erupting. Some rocks were brought back by McCormac and given to the British Museum, although they had mostly originated from the gizzards of birds they they had shot!

Erebus is actually an alkaline and is the only known volcano to be erupting phonolite (from a basanite source), which is a probably a residual melt from basanite, set in a continental rift environment (analogous to East Africa). The gas emitted is particularly CO2 rich, with some fluorine, an unusual combination. The CO2 is thought to be fluxing up from the mantle perhaps 16km down; the phonolite magma is very water poor because HT&P experiments reveal those lavas without water were most like those from Erubus. Altogether Clive spent 13 field seasons monitoring Erebus.

However, all expeditions need funding and the funding agencies have different approaches; some are hypothesis driven (e.g. the US NSF) but no such hypothesis could be written for Erebus – they simply wanted to make the best observations and so it was really a a data-driven project with a lot of outreach in association with historians, teachers and modellers!

The 'fertile land' for historic eruptions proved to be that which lies between the major disciplines, particularly data from Irish, Icelandic, Arab and Chinese records and even old paintings which have evidence of how much dust there was in the atmosphere at the time.

However, caution has to be made in this interdisciplinary world: in a seminar in Cambridge a scientist was giving a talk about coastlines in the post Ice-age world, and concluded that there had been a volcanic eruption about 15,000 yrs ago in Scotland, based on an ash deposit in a peat bog, ignoring the great distances that ash clouds can travel across the globe!

Extending the discussion between the arts, humanities and science there was a lovely story about a renowned British philosopher who was working in London at the beginning of the 1900s philosopher named Collingwood. He was working in rooms of the Geographical Society, at the top of the Exhibition Road, and every day he had to walk across the park to work and back again in the evenings. Sadly as he passed the Albert Memorial, he realised that he hated it to the point where he couldn't even look at it. However, when he sat down one evening and wondered how he could get to the bottom of this phenomenon, he realised that it had catalysed his thinking about the philosophy of science and aesthetics.

As far as predictability is concerned, one of Clive's favourite historical characters is Frank Perret (born 1867) who, by the 1940s, was was an American entrepreneur, inventor and volcanologist, who was particularly well known for his studies of the eruptions of Vesuvius, Kilauea, Monsterrat and Mount Pelée on Martinique. He had worked for Edison and invented an electric motor and built elevators, but in 1902 fell ill and went to Naples(!) to recover, where he soon made friends with the Director of the Vesuvius Volcano Observatory.

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By 1906 he had become an honorary assistant there, and observed a major eruption including the eruptive phenomena of St Elmo's Fire. By that time also been to Kilauea, Stromboli, Etna, Mt Teide and after spending 4 months on Kilauea, suggested the establishment of a monitoring station there. When Mt Pelee erupted in 1929, (some years after the devastating eruption of 1902), Perret was one of the first scientists to visit, established a volcanological museum in 1933 and concluded that there was a 30-year cycle to its eruptions.

On the Reykjanes peninsular it seems it is most likely that the recent eruptions will go on for a long time because the historic lavas have been dated precisely with activity periods that last between 200 and 500 years, and predated by periods of quiesecence of 700 yrs or so. There also seems to be a link between eruptions, the removal of ice loading and reduction sea level after the Ice-age.

There are other factors too: if Tambora erupted now, following significant climate change, it would likely have a different plume height, kinetics and how far the dust will travel.

In answer to a question about volcanism in the centre of the Sahara, Clive had met Dick Grove (from the same Dept) who had been part of a British Landrover expedition travelling from Libya to the Tibesti mountains in southern Algeria in the 1970s. The primary aim had been to determine the age of some of the river valleys, and collect samples of diatomite (from freshwater lake beds) and fluvial deposits for radiocarbon dating. They also collected obsidian (or meteorite impact glass). In 2016 Clive had the opportunity to visit the same area.

Another interesting area he went to in the 1990s was Eritrea with one of his first PhD students to visit the Nabro stratovolcano, part of the E African Rift, which erupted for the first time in recorded history in 2011. They collected rocks and obsidian and put in a seismic monitoring network. The interesting thing about the obsidian is that an archaeological friend had collected obsidian from Yemen, but it did not match samples from local cources. However the obsidian from Nabro was a perfect match, indicating that there had been an historic maritime trade route across the Red Sea to Yemen.

The Nabro obsidians in this rifting environment, one assumes, are a direct fractional crystallization product from a basalt source, and there were also panelleritic (peralkaline) lavas found in Ethiopia – possibly direct analogues with the peralkaline arfvedsonite-aenigmatite-aegirine granites in Nigeria.

John Bennett