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MICHAEL JOHN O’HARA
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Elected FRS 1981

BY DAVID RICKARD

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Michael John (Mike) O’Hara was born in Sydney, Australia, but came to the UK when he was one year old. He received his BSc and PhD degrees from Cambridge University. He was appointed assistant lecturer at the Grant Institute of Geology at Edinburgh University in 1958, where he rose to a personal chair in 1970. He moved to the University College of Wales Aberystwyth in 1978 as Head of Department and was appointed Distinguished Research Professor at Cardiff University in 1993. Mike O’Hara was one of the leading igneous petrologists of his generation, a pioneering mountaineer and eminent science administrator. He made fundamental contributions to a wide range of topics in igneous petrology, including identifying rocks from the Earth’s deep mantle, experimental petrology, the primary magma problem and mathematical modelling of igneous rock formation. Mike O’Hara’s name is legendary in climbing circles because he made the first ascents of 39 of the finest rock climbs in the UK. As a national science administrator he was mainly responsible for the present profile of Earth science teaching and research in UK universities.

FAMILY BACKGROUND

Early history

Mike was the only son of Michael Patrick O’Hara OBE (1896–1981) and Winifrid Dorothy O’Hara (née Avis) (1900–97).

Mike’s father was London Irish, the illegitimate son of an Irish labourer in east London. He was raised in an orphanage and had no formal education. Mike discovered his aunt Sophy, his father’s sister, in the early 1970s. His father was working as an eight-year-old with his younger brother skinning rabbits and selling them from a barrow to theatre crowds in the West End of London before World War I. They were drafted into the army in 1915 and went straight from the orphanage to the trenches. His brother was killed and O’Hara senior was buried alive in a
trench after being shelled. He returned to the UK and met Mike’s mother, Winifred Dorothy Avis, on the up train to London: she regularly caught the Waterloo train at Staines station at the last minute, and Mike’s father, who was a passenger on the train, delayed the train’s departure by holding the door open. Dorrie Avis, as she was always known, was the daughter of a broken marriage who wanted to become an architect but who left school at 16 years of age to become a secretary at the Prudential Insurance Company. She was one of a large family of three daughters, two sons and one half-brother.

They married in 1922 and made two trips to Australia. Michael Patrick O’Hara was advised by his doctor to go to Australia: the long sea voyage itself would be good for his health. The first trip was to find Dorrie’s younger brother, who had emigrated to Australia earlier. He had settled in the Sydney area and was joined later by his elder brother. The family still live in Sydney.

Mike was born in Sydney, Australia, on 22 February 1933, during the second trip. The discovery that Mike was born in Australia came as a surprise to his colleagues in later life. It led Ted Ringwood FRS, his great Australian rival in subsequent debates on the origin of the Moon, to threaten ‘to get his passport revoked’. However, wherever he may have been born, Mike was a British citizen.

Mike travelled back to the UK with his mother in 1934 when he was just 11 months old. The journey, which used to take at least six weeks, must have been an extraordinary odyssey for Dorrie with her small toddler. She recounted later that she had Mike tied to her arm with a cord for the whole trip. Mike’s father followed on later. They moved back to the Avis family home in Staines until the beginning of World War II, when the family moved to Bournemouth on the south coast in 1940 when Mike was seven years old. Mike remembered hearing the declaration of World War II with his father while they were staying in a caravan at Hastings.

Mike’s father was the construction manager for Butlin’s and had been involved in building the first Billy Butlin holiday camp at Skegness on the English east coast in 1936. At the outbreak of World War II the Skegness camp was taken over by the Admiralty, and Butlin was asked by the War Ministry to build further military camps at Ayr in Scotland, Filey in North Yorkshire and Pwllheli in North Wales and at the aerodrome at Wootton Bassett. Michael Patrick O’Hara was appointed construction manager of the Pwllheli camp, and the family moved to Pwllheli in 1940. Mike was to regard Pwllheli as home until 1958.

At the end of the war the camps were reopened to holidaymakers, and Mike’s father managed their redevelopment to form the basis of the Billy Butlin holiday camp empire. In 1948 he was appointed general manager of the Battersea Gardens of the 1951 Festival of Britain and received an OBE for his services. He was appointed director of the Forte Catering Unit in 1953 before settling down as the builder and developer of a caravan camp at Pwllheli.

Mike’s mother, Dorrie, managed a troop canteen at Pwllheli during World War II and later ran a café and boarding house. On Good Friday, 1945, his mother took the 12-year-old Mike to the funeral of David Lloyd George on the banks of the River Dwyfor near Llanystumdwy in Eifonydd, north Wales. This was to presage Mike’s long association with Wales and lifelong support for the Welsh rugby team.

**Early life**

Mike’s memories of his childhood were centred on Pwllheli, which was his home between the ages of 7 and 25 years. He remembered it as an idyllic time and spent his first year at boarding school developing schemes to escape and get back to Pwllheli. His passion for mountaineering was formed there. Accounts of the 1938 Everest expedition by Lawrence Rickard Wager (FRS
1946) and the discovery of Irvine’s ice axe were an inspiration. In one of those quirks of fate, Mike was to tread in Wager’s scientific as well as mountaineering footsteps in later life. Pwllheli itself is situated near the mountains of Snowdonia and Mike spent many days in the school holidays walking the hills. He was able to take the workmen’s bus to Snowdonia in the early morning, spend a day in the mountains and return to Pwllheli later in the same evening. In the Christmas vacation of 1951 when he was 18 years old, he slid some 500 feet down an ice gully above Cwm Stwlan, Moewyn Mawr. He escaped with some bruises, a loss of some skin and an understanding of the importance of having an ice axe handy when glissading.

Pwllheli held other attractions to a young lad interested in the outdoor life. Mike spent many hours on the seashore and tidal flats of Pwllheli harbour, bird nesting and bird watching. He also encountered Arthur Mee’s *Children’s encyclopedia* (Mee 1922) when he was seven years old. This wonderful work originally inspired Mike’s interest in geology.

**Education**

**School, 1939–51**

Mike attended a convent school in Bournemouth and an infant school in Pwllheli between 1939 and 1940. In 1940–41 he was at the Troederach school, a Welsh-language primary school in Pwllheli. This was a bad year for young Mike. He was bullied in Welsh and could not understand exactly what the arithmetic teacher wanted him to do. He came bottom of the class. Luckily, the Dulwich College Preparatory School was relocated to Betws-y-Coed just 40 miles from Pwllheli because of the London blitz. Mike’s parents took him out of the Troederach school and enrolled him in the private Dulwich College boarding school. The school moved to the Royal Oak Hotel, a Victorian coaching inn in Betws-y-Coed in the heart of Snowdonia. Betws-y-Coed is situated at the conflux of several mountain rivers just 6 km from the national centre for mountain climbing at Plas-y-Brenin. The school banned climbing, so naturally the boys spent much time climbing the rocky crags and inadvertently produced a disproportionate number of mountaineers.

In 1945 Dulwich school moved back to London, together with Mike. He won a scholarship to Cranleigh School, Surrey. At that time the entrance examination—often called the 11-plus—was regarded as a pure IQ test. Mike was given an IQ of 153, which is high whatever scale was being used. The fees at Cranleigh were £40 per term, even with the scholarship, and there were additional charges for activities and facilities. Cranleigh traditionally has strongly encouraged sports activities among its pupils, and Mike benefited from this regime. He played rugby for the school First XV as a loose-head prop and was awarded colours in both 1950 and 1951; he said he was too slow to be a back. He won a St Nicholas scholarship, a minor internal divinity scholarship dating back to the 1870s, and ended up as Senior Prefect or Head Boy. The prerequisites of this position included a study of his own, an extra coal allowance and the right to keep a pet.

Mike’s headmaster at Cranleigh was the Reverend David Gordon Loveday, who left Cranleigh in 1954 to become the Suffragan Bishop of Dorchester. He wrote in his final report that Mike was ‘a very original, able and excellent senior prefect of the driving rather than the leading type’. Those who experienced Mike’s implementation of the government’s rationalization of university Earth science departments in the 1980s might regard the Reverend’s words as prescient.
Mike won a state scholarship to university on the basis of A-level results in physics and chemistry and was awarded a minor scholarship to Peterhouse College, Cambridge.

**University, 1952–58**

Mike was a student at Peterhouse between 1952 and 1958, the first three years as an undergraduate and the final three as a postgraduate research student.

Peterhouse is the oldest and smallest of the Cambridge colleges and the most traditional. It was to be immortalized in the novel *Porterhouse blue* by Tom Sharpe, published in 1974. Sharpe was actually at Pembroke College in 1948–51, the period immediately before Mike’s arrival at Peterhouse. Peterhouse alumni include several distinguished scientists, including seven Nobel laureates, five of whom were awarded the chemistry prize. Earlier alumni included Henry Cavendish FRS, Lord Kelvin FRS and James Clerk Maxwell FRS. Peterhouse is one of the richest colleges in Cambridge with extensive endowments, and the college provides extremely generous travel grants (which may be awarded for activities entirely unrelated to the degree); Mike took full benefit of the opportunities offered by these grants to further his mountaineering experiences. The college, with fewer than 250 students, is historically weak at sports but takes rowing seriously. Mike played a few games of rugby at Cambridge and tried rowing but had no success at either sport. He concentrated on mountaineering and climbing. Mike recalled that the college operated a strict 10 p.m. curfew policy enforced by Proctors (who were responsible for student discipline), bulldogs (the top-hatted university constables), the porters (possibly the true etymological source of Porterhouse *blue*) and high walls topped by rotating spikes. These latter held little fear to climbing aficionados such as Mike and his roommate Eric Langmuir, nor did climbing a drainpipe to get into their third-floor room after curfew (27)*.

In 1954 Mike was awarded an upper second-class honours degree in geology, mineralogy and petrology, and physics in Part 1 of the university degree examinations. In 1955 he was awarded a first-class honours degree in geology with mineralogy and petrology, and physics in Part 1 of the university degree examinations. In 1955 he was awarded a first-class honours degree in geology with mineralogy and petrology.

Mike claimed that he was persuaded to follow a career in geology, rather than becoming a mountaineering instructor, by Stuart Olof Agrell, the outstanding mineralogist who was a lecturer at Cambridge University. Agrell had done a PhD on Scottish metamorphic rocks and persuaded Mike that it was possible to merge geology and rock climbing in Scotland. Mike signed up for a PhD on the Scourie gneisses†, high-grade metamorphic rocks in the far northwest of the Scottish Highlands. The project was suggested by Mike’s supervisor, Cecil Edgar Tilley FRS, the famously taciturn Australian Professor of Mineralogy and Petrology at Cambridge and the founding Head of the Department of Mineralogy and Petrology. Tilley became progressively terser in later life and Mike recalled his supervision consisting of essentially being given the classic paper by Sutton and Watson on the Lewisian of the NW Highlands (Sutton & Watson 1951) with the instruction ‘Go and take a look at that.’ This launched Mike on research into extremely high-pressure–high-temperature rocks. The sting in the tale here is that in his second meeting with his supervisor after two years of research to recount his progress Mike was told he was looking at the wrong rocks: Tilley had meant Mike to research the Scourie dykes, a swarm of younger sheet-like igneous intrusions that penetrated the Scourie gneisses. His PhD thesis, which he successfully defended in 1958, was entitled ‘The metamorphic petrology of the Scourie District, Sutherland’.

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* Numbers in this form refer to the bibliography at the end of the text.
† Natural materials have a range of compositions and textures and are classified into groups with esoteric names. These are listed in the Appendix.
Michael John O’Hara

PROFESSIONAL CAREER

Grant Institute of Geology, Edinburgh University, 1958–62

After his success in gaining a PhD, in 1958 Mike was appointed as an assistant lecturer at the Grant Institute of Geology at Edinburgh University. The Grant Institute was a leading international geological research institute, and Mike’s office was next to that of Professor Emeritus Arthur Holmes FRS, one of the greatest geologists of the twentieth century. Under Professor Frederick Henry (later Sir Frederick) Stewart (FRS 1964), who had also been one of Tilley’s doctoral students, Mike continued his work on the Scourie rocks and described and characterized what was to become the world’s first ultra-high-temperature–high-pressure granulite facies terrain: rocks from the lower crust of the Earth that had been cooked to more than 1200 °C under a pressure of more than 2 GPa. He also gave a belated nod to his ancient supervisor’s original wishes and described the Scourie dykes. Astonishingly these turned out to be the only known occurrences of dolerite dykes intruded into hot, rigid crustal rocks at depths of more than 15 km.

His interest in these ultra-high-temperature–high-pressure rocks led him naturally to Norway in 1959, where the great Finnish geologist Pentti Eelis Eskola had originally described these rocks in the Western Gneiss region of Norway in his classical study of 1921 (Eskola 1921). Most significantly for Mike’s future work, they provided samples of the upper-mantle rocks from which the rocks that constitute the bulk of the Earth’s surface—the basalts—were thought to have been derived. Holmes gave Mike further access to these rock types from his collection of South African kimberlite diatremes, the blue rocks that had risen from 200 km depth in the Earth, carrying with them their precious cargo of mantle diamonds.

In 1960 Mike was promoted to lecturer, teaching mineralogy, crystallography, geological timescale and field mapping. He had maintained his fitness at Edinburgh by playing squash. His field classes were held in Antrim and Donegal and are remembered by students as involving tough route marches. Even in later years he would spend eight or nine hours out in the horizontal Highland rain with students and then continue his field teaching in the pub in the evening. This was after being out by himself for two or three hours in the early morning, looking at rocks. They are also remembered for Mike’s sense of fun and complete lack of pomposity: he delighted in slamming on the brakes and shouting ‘My God!’ whenever he spotted a student passenger temporarily unsighted by pulling off a sweater or anorak.

Geophysical Laboratory of the Carnegie Institute, Washington DC, 1962–63

Mike married Janet Prudence Tibbits on 5 May 1962 in Wareham, Dorset, and the newlyweds went off to Washington DC, where Mike spent a year at the Geophysical Laboratory of the Carnegie Institute.

Mike’s PhD supervisor, C. E. Tilley, had worked with John Frank Schairer at the Geophysical Laboratory in 1933. In 1961 Tilley was appointed a Research Associate of the Geophysical Laboratory and produced the classic 200-page paper on the origin of basalt magma in 1962 with Hatton Schuyler (Hat) Yoder (Yoder & Tilley 1962). The idea seems to have been for Mike to learn the experimental techniques at the Geophysical Laboratory with a view to establishing a high-temperature–high-pressure laboratory in the UK, at Edinburgh University.

Mike arrived in Washington in 1962 and embarked on an inspiring year with two greats of experimental petrology, Frank Schairer and Hat Yoder. He also learned a new intensity of...
research. Frank Schairer would greet Mike at 0800 with numerous overnight experimental runs already quenched: ‘Well, if it isn’t the late Dr O’Hara again!’ Hat Yoder threw Mike into the deep end of research with his instructions to Mike to ‘see Frank Schairer, make up your compositions and predict what you are going to find at atmospheric pressure and at 30 kb [kbar].’

Two months later Mike had developed a new technique for interpreting phase equilibria in multicomponent systems and had shown a discrepancy between the phase assemblages produced and those expected from calculation. Frank Schairer, with characteristic brio, immediately prepared new experimental charges for longer runs and demonstrated that the problem was the metastability of the products.

Experimental Petrology Unit, Edinburgh University, 1963–78

Mike returned to the Grant Institute in Edinburgh to set up a laboratory for experimental petrology. He planned a specialized building of 500 m² and the addition of a further 175 m² of adjacent space. The building had three sides around a shallow pool to source the cooling water, and two blast towers to direct any explosive gases safely upwards. Mike planted a eucalyptus tree by the pool—appropriately remembering his Australian heritage. The eucalyptus is still there some 50 years later, although it has bowed to the excesses of the Scottish climate by not poking its head up above the building. The process of designing and setting up the laboratory cost around £6 million in 2015 prices. Between 1964 and 1966 he was mainly concerned with setting up an atmospheric pressure laboratory (figure 1).

He then established four high-pressure piston–cylinder and gas media laboratories between 1966 and 1969, together with an engineering workshop. The laboratories employed four research assistants and five technicians. The laboratories are still operating today and form the core of the Natural Environment Research Council Recognised Experimental Geoscience Facility at Edinburgh University.
Mike and Janet had three children during the Edinburgh years: Eleanor Mary was born on 29 April 1965, Katherine Sophia Elizabeth on 7 November 1967 and John Christopher Patrick Michael on 15 March 1972.

Mike was appointed as one of 14 NASA Principal Investigators in the UK to investigate the lunar rocks returned from the Apollo 11–17 missions. He led the experimental petrology team for the Apollo 11 samples. Mike’s team at Edinburgh investigated the melting behaviour and quench products of lunar samples and synthetic equivalents heated up to 1200 °C under various pressures. The goal was to discover the processes that led to the formation of these lunar rocks, especially the basalts. The experimental work was backed up by extensive mineralogical and geochemical studies of the samples and theoretical analyses of the phase equilibria.

The lunar samples were posted to Edinburgh under high security. And this, in turn, prodded Mike’s insatiable curiosity into finding out how things worked. He discovered that the Post Office had a special system for transporting high-value items. These secretive services were used by UK bankers to consign new and used banknotes from head offices to branch offices and vice versa. He played a major role in the survival of historical material from these services. In 1978 he sold one collection of Scottish material (1696–1860) to finance the purchase of carpets for the new house in Aberystwyth. By 2006 he had assembled a new collection that included 99% of all known quality items, apart from that material held by the police as evidence after the Great Train Robbery. He published an article on the subject in 2006 (28). His exhibit ‘Movement of money from bank to bank by post in Scotland 1955 to 1993’ won a silver medal in the postal history section on the National Philatelic Exhibition at Torquay in 2006.

Mike was promoted to Readership in 1967 and awarded a Personal Chair in 1970 at just 37 years of age. In 1969 he was elected a Fellow of the Royal Society of Edinburgh.

A confluence of events led to Mike’s leaving Edinburgh in 1978 to take up the position of Head of Department at the University College of Wales Aberystwyth. He had separated from Janet and their divorce was finalized in 1977. He married a Welsh petrologist, Susan (Sue) Howells, in April of that year. The new couple were looking for a house and found that the prices in Aberystwyth were far more accessible to their budget than in Edinburgh. Mike was also concerned about the future of the Experimental Petrology Unit at Edinburgh. High-pressure–high-temperature experimentation was getting to be very expensive, and keeping up in the international equipment race single-handedly in the UK was getting more difficult. Mike had raised about £10 million to maintain the Edinburgh facility over the previous 10 years and in the UK of the 1970s it looked as though this would be impossible to maintain. He was also getting more interested in mathematical approaches to solving petrological processes and this could be done with a computer at relatively low cost.

Soon after Mike’s appointment at Aberystwyth, the department was buffeted by both internal and external financial storms. The external storms were initiated by Mrs Thatcher’s government, which introduced a policy of increasing the ‘efficiency’ of the UK university system—that is, a series of successive funding cuts. The Aberystwyth department was graduating some 40 students per year in 1981–84. However, one direct effect of the cuts was the removal of the hypothecated vacation grants, which came from the students’ own local
councils and which funded their fieldwork programme. The fieldwork costs became embedded in the annual departmental budget. The internal storms were caused by mismanagement of these decreasing funds by the University College, which decided to freeze all posts—academic, technical and administrative—as a way of managing the funding shortfall. In the end the University College decided, perversely, to cut the numbers of students. The number of students graduating in geology decreased to 25 per year, or a decrease of 40%. This situation deteriorated to such an extent that Mike suggested that the department should refuse to take any new students in 1983. Inevitably, this decrease in student numbers led to a decrease in the number of academic staff in the University College until, in the mid 1980s, staff were being encouraged by the management to take voluntary redundancy.

In 1981 Mike was elected a Fellow of the Royal Society. He was the first Aberystwyth geologist to be elected to the Royal Society while at Aberystwyth: the great Aberystwyth geologists such as Jones, Pugh and Williams had been elected after they had left the university. His election was, as usual, followed by several appointments to committees for the national administration of Earth science, culminating in his being chairman of the National Committee for the re-organization of Earth sciences.

Mike and Sue had three children in Aberystwyth. Padrig James was born on 25 October 1981, and the twins Roderick Sion and Fionn Susannah were born on 28 December 1983.

California Institute of Technology and Harvard University, 1984–86

Mike was awarded a Sherman Fairchild scholarship in 1984 and took his young family on a well-earned year out from the tribulations of an Aberystwyth Head of Department as a Visiting Professor at California Institute of Technology (Caltech). An important occupation during the year was travelling around institutions in the western USA giving lectures. He ran a series of evening seminars at his home in Pasadena for students and younger researchers. He also travelled on geological expeditions, revisiting the Navajo diatremes in the Four Corners region (figure 2) where he had discovered the first mantle xenoliths in 1963.
He returned to Aberystwyth for a short time in the autumn of 1985 but was invited to Harvard University to give a postgraduate course in igneous petrology during the spring and summer terms in 1986.

National science administration, 1986–89

On his return to the UK in 1986 he was immediately immersed in national science policy. He was appointed to the Council of the Royal Society and chair of the Earth Science Committee of the Natural Environment Research Council (NERC), which included membership of the Council itself, for the period 1986–88. The NERC is the major government funding agency for the Earth and environmental sciences in the UK. Mike’s committees ran the British Geological Survey, the British Antarctic Survey and the Marine Research Vessels as well as being the main source of funding for university research in the Earth and environmental sciences. Mike’s experience in this role led him to develop extreme views about research funding—including the idea that research grants should be awarded after the research had been published. He was concerned that large expensive projects were swallowing so much money at the expense of smaller institutions and projects.

In 1986 Professor Ernest Ronald (Ron) Oxburgh FRS (now Baron Oxburgh of Liverpool) had presented his findings and recommendations for the reorganization of UK university Earth sciences and, in 1987, Mike was appointed to the University Grants Committee (UGC, the government body responsible for UK university funding) and chair of the implementation phase of the Earth Sciences Review. He spent the next two years travelling around the country meeting UGC members, regional group representatives, university Vice-Chancellors, visiting departments and interviewing departmental representatives. The idea behind the Earth Science Review was to investigate whether it would be possible to rationalize science teaching and research in UK universities into larger, more efficient, world-leading units. The Oxburgh report had laid out the limits of the scheme, which included governmental support for Earth science departments based on their staff numbers: there would be around 12 research and teaching departments with more than 30 staff and 12 teaching-only departments with 15 staff; the remaining departments with less than that number would not teach to degree level. Mike O’Hara was charged with implementing this system, or ‘driving it’ as the Reverend Loveday would have phrased it. Each university was invited to apply for one of the resource levels and, not surprisingly, all except one of the universities applied to be research and teaching centres. The result was a round of visits by Mike’s committee, interviews with representatives and intensive political discussions. The end product was that the number of Earth science departments in the UK was decreased to just 19 through closure and mergers. The other outcomes were unforeseen but more dramatic: the government realized that the costs of imposing the same process on the giant physics, chemistry and biology departments would be prohibitive and the scheme was quietly dropped; the UGC was closed down after 70 years of managing UK universities and was replaced by Higher Education Funding Councils.

Sultan Qaboos University, Oman, 1988–89

One of the recommendations of the Earth Science Review was that the University College of Wales Aberystwyth should create an interdisciplinary centre for teaching and research in Earth studies by merging its geology and geography departments. Professor David Quentin (‘DQ’) Bowen from Royal Holloway College of the University of London was appointed as Director of the new institute and consequently Mike gratefully stepped down as Head
of Department. He was invited to set up a new geology department at the Sultan Qaboos University in Oman. There was a nexus of reasons why Mike accepted the post. Foremost among these was simply exhaustion with the continual politics that had occupied his waking hours for the previous two years as chair of the Earth Science Review. Aberystwyth would provide no peaceful refuge because the mismanagement that had characterized its history over the previous decade continued and the opportunity offered by the Earth Science Review was rapidly dissipated. The Oman post gave Mike an opportunity to teach in a positive and welcoming environment. It was also in the desert and Mike had a particular predilection for desert environments ever since his early work in the Four Corners region of the USA. The post also removed Mike from the immediate flak resulting from the implementation of the Earth Science Review. In those days, email was in its infancy and telephone calls were through landlines and expensive. In Oman, Mike was only reachable through snail mail and personal visits.

**Cardiff University, 1994–2003**

Mike returned to Aberystwyth in 1990 only be embroiled in a farrago of in-fighting both with the university authorities and within the institute he had helped create. By this time, the University College was well on its way to dissipating the world-class science departments that had been built up in their institution. DQ Bowen was surprised to find that, between his being appointed and taking up the post of director of the new interdisciplinary institute, not only had the distinct departments of geology and geography been retained but heads of these departments had been appointed. This was directly contrary to the agreement between the University College of Wales Aberystwyth and the UGC. This agreement, which Mike had largely engineered, had resulted in the University College receiving considerable financial benefit from the UGC on the understanding that this financial support was to enable the establishment of a new interdisciplinary institute. The decision by the University College administration to retain the two departments created an intrinsic flaw in the financial and academic structure of the new institute that was to have significant long-term effects. In particular the heads of the two departments and some of their academic staff were continuously in competition. The geology side of the institute was science-based and thus relatively expensive. Mike worked with DQ Bowen in an attempt to get the Aberystwyth authorities to rebalance the financial allocation for the institute, but to no avail. It became apparent that the geology side of the interdisciplinary institute was destined for the same fate as other science departments at Aberystwyth. Indeed, in 1997 Aberystwyth decided to close the geology degree course, and the associated academic staff were made redundant.

Meanwhile the new Principal at the University of Wales Cardiff, Brian Smith, had cut his administrative teeth at Stanford University under the inspired leadership of John Ewart Wallace Sterling. President Sterling had changed Stanford from a pleasant backwater to one of the academic powerhouses of the USA. He had done this in part by hiring academic stars, and Smith introduced the same idea to Cardiff. He announced that he would appoint academics who were international leaders in their fields to any department and the university would fund them. Keith O’Nions FRS was an advisor to the Earth Science Department at Cardiff and a long-time associate of Mike, and he advised the Head of Department to contact Mike with a view to hiring him. The result was that Mike O’Hara and DQ Bowen came to Cardiff. This finally brought all the major Earth science academics in Wales under one roof, because the leading Earth scientists in University of Wales at Swansea had moved to Cardiff some four
years previously as a result of the UGC Earth Science Review. By 1996 Cardiff was the only Earth science research and teaching university left in Wales.

Mike’s job at Cardiff was to form the hub of a new international centre for research in igneous petrology. Yaoling Niu was brought in from Brisbane, Australia, and Julian Pearce from Durham to join Chris McCleod, Hazel Prichard, Norman Fry, Andrew Kerr and Lawrence Coogan. Mike worked with all these to produce a string of high-quality papers that continued well past his retirement.

Retirement, 2003–14

During his period at Cardiff, Mike and Sue had retained their house in Aberystwyth, but soon after retirement they moved to Monmouthshire. Mike was diagnosed with Parkinson’s disease in 2004 that made him a bit unsteady although his mind remained as sharp as ever. He was elected a Fellow of the American Geophysical Union in 2004 and was invited by the Chinese Academy of Sciences to undertake a lecturing tour of China (figure 3), where he received honorary professorships at the China University of Geosciences in Beijing, Northwest University and Nanjing University.

In 2007 Mike was awarded the Hess Medal of the American Geophysical Union for ‘outstanding research on the constitution and evolution of Earth and other planets’. Mike was delighted with the award, not least because this was the first of the major medals in his field that he had been awarded. After retirement he was involved a further 15 publications.
In spring 2014 he developed complications from the Parkinson’s disease and died on 24 November 2014. His last papers were published posthumously in 2015 by Lawrence Coogan on differentiation processes in basalts and by Yaoling Niu on lunar petrogenesis.

Mike is survived by his first wife, Janet Prudence O’Hara, and their children Eleanor Mary O’Hara and Katherine Sophia Elizabeth O’Hara. Their son, John Patrick Christopher Michael O’Hara, predeceased him. He is survived by his second wife, Susan O’Hara, and their children Padrig James O’Hara and the twins Roderick Sion O’Hara and Fionn Susannah O’Hara. He had six grandchildren.

**SCIENTIFIC CONTRIBUTIONS**

Mike’s major contribution was to demonstrate that the basaltic rocks that cover most of the Earth’s surface and form the ocean fundment were not pristine samples of the Earth’s interior but had developed their characteristic compositions through a complex history of mantle melting, chemical interaction, sequential crystallization, open-system magma chambers and contamination both by reactions with the country rock and re-reactions with early formed crystals. In this he developed the work of the great pioneers of the subject such as Norman Levi Bowen (FRS 1949), Cecil Edgar Tilley and Lawrence Rickard Wager. The chains that bound geologists to the Earth were broken when the first lunar samples were brought back by the Apollo 11 team and it became apparent that similar rocks formed the stuff of the Moon. Mike’s discoveries of how these rocks evolved became cornerstones for discussions about the origin of the Moon and planets as well as the Earth.

**Field geology**

As befitted one of the UK’s pioneering rock climbers, Mike was an excellent and prolific field geologist. He had that particular knack, common to all leading field geologists, of stumbling across key rocks on ground that had often been walked over by legions of professional geologists before.

His first contribution to science was his discovery of the first Lower Cambrian fossils in the Hecla Hoek formation in Spitsbergen. Previously they had been considered to be entirely Precambrian in age. At that time Mike was a first-year student in the 1953 Cambridge Spitsbergen Expedition (Harland & Wilson 1956). He did not follow this up. Had he done so, he would have found that his discovery of Cambrian marine fossils in the horizons above the Eocambrian tillites were the first inkling of Snowball Earth, a period of Earth history when almost the whole of the Earth was ice-covered, and the Harland & Wilson (1956) paper has become a seminal contribution to our understanding of how the Earth, and life itself, evolved.

His PhD work on the Scourie gneisses resulted during the 1970s in a series of publications that described the world’s first ultra-high-pressure–high-temperature rocks, basically a section of the Earth’s deep crust. The key feature of the Scourie gneisses was their exceptionally slow average cooling rates of just 0.7 °C per million years, reflecting a slow uplift to the surface from depths of about 70 km over a period of 1.8 billion years (Ga) (6, 17–19). Mike went on to demonstrate that the garnetiferous peridotites currently exposed at the surface in many mountain belts were not extremely metamorphosed crustal rocks but were instead samples of the Earth’s mantle that had been emplaced by ‘cold’ tectonic processes (7).
Michael John O’Hara

His supervisor’s comment that he really should have been working on the Scourie dykes led to the discovery of the deepest dykes in the Earth’s crust, replete with garnetiferous chill zones reflecting their deep origin rather than the glassy margins of dykes that have been intruded nearer the surface (5). He was the field man for Keith O’Nions’s isotope group in 1990–94, which fixed the age of the Scourie dykes between 1.98 and 2.03 Ga (22).

Walking the dog in the Northwest Highlands, Mike and Sue stumbled across the largest continuous outcrop of Archaean metasedimentary rocks more than 2.8 Ga old in the whole of the North Atlantic craton, while stopping to breast-feed an infant (21).

His field skills were further demonstrated when he stopped the car—as elderly gentlemen need to do occasionally—on an outcrop in the Northwest Highlands that turned out to contain relics of the oldest rocks in Britain, about 3.03 Ga in age (23).

Experimental petrology

Mike contributed a stream of results from his experimental petrology investigations initially at the Geophysical Laboratory in Washington and then from his own laboratory in Edinburgh. His research was aimed mainly at how basaltic lavas at the surface were derived from the peridotites and eclogites of the deep crust and upper mantle. The key chemical system is the CaO–MgO–Al₂O₃–SiO₂ system, which is petrologically ubiquitous and earned its own acronym of CMAS.

In 1968 Mike published the first CMAS projection to analyse phase relationships and compositional paths of basaltic magma generation and evolution up to 3 GPa (12). The scheme converts natural rock analyses into a form that can be directly comparable with experimental results. The molecular proportions of CaO–MgO–Al₂O₃–SiO₂ are modified to take account of the occurrence in rocks of P₂O₅, Na₂O, K₂O, FeO, MnO, NiO, Cr₂O₃, Fe₂O₃ and TiO₂. Rock and mineral compositions can then be plotted within a tetrahedron in which C, M, A and S constitute the apices.

The power of the CMAS projection is that most common igneous mineral assemblages can be plotted within this three-dimensional space. Partial melting trends and fractional crystallization can then be probed by examining suites of rocks and minerals. These pseudo-quaternary projections have been widely used because they are the simplest way to represent the major element composition of mafic and ultramafic rocks, the major crustal and mantle minerals, and extraterrestrial objects. They also serve as good models for dry basaltic melts and are widely used in experimental petrology.

Hat Yoder’s original instruction to Mike on his arrival at the Geophysical Laboratory in 1962 was to find a way of predicting what his experiments would produce, and this became Mike’s original inspiration. The CMAS projection became a powerful and adaptable tool widely used in research and teaching worldwide. Mike tried teaching it to students at Edinburgh with varying degrees of success.

Mike initially studied the CMAS system at high temperature and atmospheric pressure. He found that a pyroxene–spinel pair was the stable representative of low-silica regions of this system, overturning previous data which proposed that plagioclase feldspar, olivine and melilite were the stable combination (13).

Together with Hat Yoder, Mike showed experimentally in a seminal paper (8) that the basalts that erupted on to the ocean floors were silicate melts produced by the partial melting of olivine-rich mantle rocks (lherzolites) and that the process left behind one of the commonest rocks of the underlying oceanic crust and mantle (harzburgites). In that paper O’Hara and
Yoder had demonstrated how three of the most common rocks in the oceanic crust and mantle were linked genetically.

Mike’s high-pressure work included demonstrating that a thermal divide at 3 GPa prevented common basalts from being derived from the partial melting of peridotites in the Earth’s upper mantle (10). He found that garnet–peridotite stability was restricted to upper-mantle depths (15).

**Lunar studies**

Mike O’Hara’s views on the formation of igneous rocks were surprisingly classical— surprising because he subsequently developed a reputation for iconoclasm and contrarianism. He felt that, because all the elements in igneous rocks were contained in the minerals, the geochemistry of the rocks was controlled by the minerals that were present, and this in turn was due to the nature of the source material and the crystallization sequences on cooling. Fractional crystallization in silicate melts results in the successive removal of mineral precipitates and leaves behind a changing melt composition, relatively depleted in the elements that have been precipitated in the minerals and relatively enriched in those elements that were not precipitated in the minerals. In silicate melts, the process is especially complex because these changes in composition of the melt, together with changes in pressure and temperature, have significant effects on the evolution of the resultant rock.

In 1970 he explored multiple working hypotheses for the status of the first lunar samples and identified the effects of volatilization losses during eruption of these lunar volcanics (14). The loss of volatiles explained why the major minerals in mare basalts were not in equilibrium proportions, whereas they are in equilibrium proportions in the lunar soils derived by impact gardening of the basalts. This was not a popular hypothesis because at that time the Moon was assumed to be anhydrous. However, subsequently Saal et al. (2008) showed the presence of water in lunar minerals.

Mike concluded that the lunar rocks probably developed by the fractionation due to the crystallization of the coarse-grained equivalent of the basalts (gabbros) at depth in mare lava lakes. The rare earth elements are similar chemically except for Eu, which also occurs in the Eu$^{2+}$ valence state. This means that it can readily substitute for Ca$^{2+}$ in plagioclase feldspars. So as the plagioclase crystallizes, Eu is removed from the molten liquid relative to other members of the lanthanide group, which commonly show a +3 valence state. Mike suggested that the lunar basalts display a large negative Eu anomaly because Eu had been removed by the crystallization of plagioclase feldspar in the gabbros at depth in the mare lava lakes. This means that the Eu anomalies in the basalts were not part of any evidence for an early magma ocean resulting from the original impact-derived formation of the Moon. In 2000 he reviewed the accepted lunar model, returning to the problems of volatile losses, the primary magma models and the apparent positive Eu anomaly in the lunar highland rocks. The report of relative enrichment of Eu in the lunar highland rocks had led to the suggestion that the depletion of Eu in the mare basalts was due to the element being incorporated in the older lunar highland rocks, leaving the younger basalts depleted. This process would provide evidence for a magma ocean on the Moon and, in turn, supported the current preferred hypothesis for the formation of the Moon through collision of a Mars-sized object with the Earth. Mike argued that the Eu enrichment in the lunar highland rocks was a myth and that his explanation still stood (25). In his last years, Mike devoted much effort to examining recent whole-Moon-scale lunar remote-
sensing data and suggested that there was no evidence for a large-scale positive Eu anomaly in lunar highland rocks (30).

Primary magmas

Basalts that have erupted on Earth were produced by variable conditions of partial melting of a mantle source and by partial crystallization, assimilation and magma mixing/recharge during transit to and within the crust (9, 11, 16, 20, 26). If the effects of partial melting and subsequent crystallization processes can be isolated, then it is possible to identify primary magma compositions to use them to distinguish hot from cold mantle sources, and to directly constrain the geochemistry of the mantle source, implications that are far-reaching for understanding the nature and evolution of the Earth.

However, extracting this information from a lava to constrain a primary magma composition is not straightforward even if the a priori assumption—that primary magmas exist—is valid. This is the primary magma problem in mantle petrology, and it has a long and fascinating history. In the 1960s the geological community had decided that the common basalts were primary magmas directly extracted from the mantle because they were so common. But this view was not consistent with constraints imposed by experimental phase diagrams, as had been shown by Mike at the Geophysical Laboratory in Washington in 1962–63. On his return to Edinburgh University, Mike critically re-evaluated the primary magma problem in his seminal 1965 paper (9). He concluded that basalts do not have the compositions of partial melts of mantle peridotites at high pressures, and they therefore cannot be primary magmas. Using the CMAS projections he had developed, he showed that common ocean floor basalts—usually referred to as mid-ocean-ridge basalts or MORB—could not be primary magmas of mantle peridotites because they contained insufficient olivine (11). Furthermore, the occurrence of phenocrysts of plagioclase, olivine and pyroxene in common basalts meant that they were low-pressure, cotectic rocks, saturated simultaneously at eruption with these three minerals. He demonstrated that the compositions of almost all basalts have been modified, commonly substantially, after formation by partial melting. This idea is now widely accepted to the extent that the original arguments between Mike and his primary magma adversaries are becoming lost in the mists of time. Mike wrote that the ideas, which were to inform much of his professional life, came together at a campsite in Dakota in the late summer of 1963.

Mike continued to construct successively more complex projections and developed a sophisticated topological mathematics to compute them. Mike’s projections were sometimes challenging. This led to one Fellow of the Royal Society remarking after one of Mike’s lectures at Carlton House Terrace, ‘can I ask you about the first slide, the only one I understood?’

Most geologists did not initially accept Mike’s views about primary magmas mainly on the grounds that the ocean floor basalts were so voluminous and so homogeneous in their compositions that they had to approximate the compositions extracted as partial melts from their mantle source. However, during the late 1970s and 1980s, most experimental petrologists had come to agree with Mike. But progress was slow in understanding what, exactly, was the primary magma composition for basalts, and even modern computational methods have their limitations (26). Furthermore, it became evident that experimental petrology could only partly constrain the primary magma problem: the real world was physically far more complex, with convection causing early formed minerals to redissolve and the magmas to become contaminated with the rocks through which they were passing on their way to the surface.
Geochemical models

During the 1980s attention shifted away from mineralogy towards the chemistry of basalts. This was driven in part by the development of ever more accurate chemical analytical methods. Those elements that were not incorporated into the early precipitating minerals from the silicate melt become enriched in the formation of the final minerals. These are the incompatible elements, and they are not easily incorporated because of their relative ionic charges or sizes. The chemistry of these incompatible elements became a powerful probe into the processes involved in the formation of basalts. From the 1980s, most petrologists and geochemists assumed that low-pressure differentiation of basalts has a minor role in changing the ratios of their incompatible elements because they are difficult to fractionate from one another during perfect fractional crystallization. Basalt compositions were therefore assumed to be a reliable record of upper-mantle composition and its partial melts.

The way in which the composition of basalts developed could be described mathematically and these results compared with the chemical analyses of natural basalts. Mike developed equations that provided analytical solutions for understanding trace-element abundances in magma chambers (16, 20). The earlier models had been based on closed systems, but real-world systems were open: the magma chamber could be replenished by fresh molten rock or tapped so that a part of the magma was lost. Mike developed an analytical mathematical approach to key magma chamber processes that included tapping, replenishment and mixing as well as crystallization. Incompatible trace elements could become much more enriched than conventional single-stage fractionation models would predict. Consequently, reconstruction of parental magma compositions applied to such rocks might be misleading or just plain wrong. Much of this seminal work was duly noted but remains largely ignored by many in the geological community even though modern petrology suggests that magma mixing and open-system dynamics are widespread in most volcanic samples.

Many basalts also display compatible trace-element enrichments that are difficult to explain by fractional crystallization or source enrichment. Mike’s new role as leader of the newly created Cardiff Igneous Petrology group soon paid off scientifically. Working with Norman Fry, Mike developed an in situ crystallization model to explore the effects of crystallization of melt within a crystal mush boundary layer followed by expulsion of interstitial melt (24). They called this ‘small packet’ crystallization and developed equations to show that it leads to high abundances of compatible elements that can fractionate from each other, in contrast with simple fractional crystallization.

Mike had always accepted that the composition of the erupted basalts can tell us something about the mantle source and processes as long as the crustal level processes can be effectively evaluated. In later years, he joined several petrological research teams (listed in the bibliography), mostly led by Yaoling Niu, which showed that, when these processes had been accounted for, global basalt compositional variations could be used to probe several key whole-Earth processes. These included contributing to understanding the controls on ocean ridge processes, the long-term fate of subducted oceanic crust, the major sites for net crustal growth and the cause of the initiation of subduction.

The recent acquisition of accurate trace-element data on basalt glasses—the rapidly quenched silica melts that typically form on the margins of lavas erupted into seawater—has renewed interest in magma chamber processes (O’Neill & Jenner 2012). The data demonstrate the importance of in situ crystallization in replenished-tapped magma chambers as discussed in one of Mike’s final papers. This paper has far-reaching implications concerning possible
ambiguities of interpretation that can arise from the identification of the chemistry of the upper mantle with the chemistry of basalt glasses (29). It is a fitting final chapter in Mike O’Hara’s legacy that erupted basalts cannot be used to probe the deep mantle without due consideration being given to the many compromising processes in crustal magma chambers.

MOUNTAINEERING

Before going up to Peterhouse, Mike took a job working with the Forestry Commission in Scotland. The three days he spent together with John Morrison at Achnacarry, northeast of Fort William in the Highlands in January 1952, had a lasting effect. They were snowed in and decided to get out whilst they could and walked out westward toward the rugged pass known as Mam na Cloiche Aird and then on a well known track to Loch Nevis, a route that Bonnie Prince Charlie wandered. This seems to me to have been completely the wrong direction. Luckily they were blocked in by the snow and found shelter with a friendly shepherd in Upper Glendessary at the western end of Loch Arkaig. Mike’s base was then moved to Barcaldine, north of Oban on the west coast of Scotland. Barcaldine is just 30 km from Glencoe and Mike went up at weekends to climb from the Youth Hostel there. He returned with a friend later that summer to Ben Nevis and Skye. They got involved with a mountain rescue team trying to save a climber who had fallen on the Sgurr MhicChoinich, a mountain on the Isle of Skye. He spent a chilly, wet night on the pass or bealach at the base of the King’s Chimney, a very difficult rock climb on the precipitous south face of the mountain.

The mountains of the Scottish highlands exercised an irresistible attraction to the young Mike. His experiences in 1952 introduced him to Scottish Mountain climbing, where he was later to make his name.

Mike became successively Assistant Secretary, Secretary and President of the Cambridge University Mountaineering Club. In 1954–55 Mike was in his final undergraduate year and formed, with Eric Langmuir, Bob Downes and John Peacock, a group of highly active climbers.

John Peacock was the editor of the journal Cambridge Mountaineering, and Mike contributed an article recounting a summer expedition to Spitsbergen in 1953 led by Walter Brian Harland (1917–2003), the Cambridge geologist who revolutionized Arctic exploration and research (1). Mike took the opportunity of a fortnight of warm weather for rock climbing on hills near Tromsø (1).

In the climbing community Mike will always be associated with Carnmore. He was inspired to explore this area by a passage in J. H. B. Bell’s A progress in mountaineering (Bell 1950), which he had won as a school prize at Cranleigh in 1950:

the head of the Fionn loch would be a veritable paradise for the enthusiastic rock climber, for I do not know any other corner in the Scottish Highlands with so much opportunity in grand and imposing surroundings. It was the grandeur and beauty of the scene which held me spellbound ….

Mike wrote that this area of the northwest Highlands of Scotland between Ullapool and Torridon ‘is the most wonderful place in all Britain; remote, vast and beautiful in a fashion not found elsewhere in the Highlands’ (4). It is ‘the home to some of the finest mountain rock climbs in Scotland’ (Throw 2006). Mike made the first ascent of Fionn Buttress with
W. D. Blackwood in 1957. This has been described as ‘one of the finest outings in Scotland’ (Howett 1990). As a very severe 240 m climb on perfect rock, it has few equals for the keen mountaineer. Mike and Sue named their daughter (born in 1983) Fionn. With George Fraser he made the first ascent of the hard very severe grade 102 m Dragon in 1957 (4), of which Paddy Buckley wrote ‘you will remember it all the days of your life’ (in Wilson 1974).

Mike made the first ascent of Spartan Slab with Eric Langmuir and John (Toby) Mallinson in June 1954 (2). Spartan Slab is one of the Etive slabs (figure 4), on the eastern shore of Loch Etive some 10 km south of Glencoe. It has been described as ‘the easiest worthwhile route on the slabs and consequently very popular’ (Latter 2008). The fourth of the first ascents of which Mike was extremely proud was Minus One Direct, which Mike climbed on June 1956 with Bob Downes. This ascent on Ben Nevis has been described as ‘a fantastic route of almost alpine proportions…… it provides one of the finest routes in the country’ (Latter 2008) and ‘one of the most enjoyable climbs known to mankind’ (Cohen et al. 1993).

The intensity of Mike’s climbing activities during this period was extraordinary. For example, Mike climbed a couple of new routes with John Peacock and Arthur Muirhead on Ben Nevis in June 1955 (3) and was on a climbing expedition to the French Alps in July 1955. By August 1955 he was back in the Scottish Highlands between Shenavall and Carnmore. In the winter of 1955–56 Mike went ice-climbing in Ben Nevis, harking back to his experiences as a young lad in Snowdonia. His university studies at this time appear like an unwanted intrusion into his climbing adventures. It is remarkable that he passed his finals in 1955, let alone being awarded first-class honours.

This intense climbing activity continued through 1957. Altogether Mike made first ascents of about 39 rock climbs in the Scottish Highlands during this period, and many are

Figure 4. John (Toby) Mallinson, Eric Langmuir, Joyce Tester and Mike O’Hara at Loch Etive in June 1954 on the morning before making the first ascent of Sickle, one of the Etive slabs. (Photograph courtesy of John Mallinson.)
Michael John O’Hara

Michael John O’Hara described in the standard climbing guides (Cohen et al. 1993). In the summers of 1955 and 1956 he also made a number of noteworthy ascents in the Alps (figure 5), including the first British guideless ascent of the LaMeije traverse with John Peacock, the North Face of Ecrins and the NE Pillar of Les Bans with John Peacock (all in July 1955), the first British guideless ascents of the NNW Flatiron ridge, Couloir de Gaube and Pointe Chassenque NW Spur at Vignemale in the Pyrenees, and the North Face of the Pic de Midi with George Fraser (in July 1956).

In 1957 Bob Downes died high on Masherbrun and then, in 1959, George Fraser disappeared near the summit of Ama Dablam. The loss of these two close friends, together with the impending deadlines for the completion of his PhD thesis, caused Mike to give up climbing. However, he returned with all the old enthusiasm in 1972 when he revisited Carnmore, and continued climbing on rock and ice until 1977—although, with characteristic humour and self-deprecation he described himself, at 40 years old, as ‘a toothless tiger of yesteryear’.

I have spent some time in detailing this facet of Mike’s life because he regarded four of the first ascents in the Northwest Highlands—Fionn Buttress, Spartan Slab, Minus One Direct and the Dragon—as his most lasting achievements. He wrote, ‘people will still be enjoying these ascents … three hundred years from now’. He was a member of the Climbers Club and of the Scottish Mountaineering Club. He continued to have a keen interest in climbing throughout his life. He visited Carnmore again in 1999 with Eric Langmuir to scatter the ashes of Eric’s sister, Marjorie Langmuir, with whom Mike had made the first ascents of Zebra Slabs and Dishonour in 1956. His last visit to the Northwest Highlands was with his wife, Sue, in the spring of 2014, just six months before he died.
Michael John O’Hara: an appreciation

Mike O’Hara was a vigorous man about 6 feet tall with a solid build. He had a mop of long black hair that was brushed to one side in typical Cambridge style, which became more like a monkish tonsure with age. He looked like his mother: his father was tall and lean, taller indeed than Mike, with a long thin face. Mike had a round expressive face in which blue eyes twinkled with incipient amusement. He inherited his affability from his father and always seemed cheerful and energetic. He was a likeable and approachable man who hid his great scholarship and intense concern about the subject under a veneer of humour. Whether it was giving a lecture or beating his students at table tennis, he did it with great gusto. He spoke with a public school, Oxford accent appropriate to someone with his background and upbringing. He was exceptionally courageous. His early experiences as a pioneering mountain climber equipped him to face up to setbacks with equanimity and determination, none less exhibited than during his last illness. It was not a coincidence that his favourite hymns were ‘Onward Christian soldiers’ and ‘He who would valiant be’, which was sung at his funeral and which he was likely to break into at any moment when faced with a challenge. He was a Western film buff and could recite the dialogue of his favourite film The magnificent seven. His comment on the diagnosis of Parkinson’s disease was straight from Pernell Roberts in Ride lonesome: ‘there are some things a man just can’t ride around.’

Mike’s scientific success lay in his vision and an approach that did not follow bandwagons but continually challenged tradition and authority. In the 30 years from 1960 the world of igneous petrology was entertained and educated by the battles between Mike O’Hara and many of his contemporaries. Mike’s position was made difficult because he used mathematics to support his exceptional intuitive insights into multidimensional topological descriptions of phase equilibria, and few in the community were prepared to go through the rigours of his proofs. The more sweeping qualitative generalizations of his protagonists were more accessible to the geological community at that time. He first ran his original algorithms on a Hewlett-Packard programmable calculator, a fact that he related with much amusement and some pride in later years. He was often pleased to find his earlier work accepted or confirmed years later, when more sophisticated mathematical tools became more universally accessible. In many cases Mike’s critics read his conclusions but did not—and sometimes were not able to—follow the processes by which he reached them.

Superficially, at least, Mike enjoyed the cut and thrust of the debate. He thrived on the challenges it presented and appeared quite cheerful about the number of enemies he had made. Occasionally he seemed to be deliberatively perverse, such as when he adopted the position that the abundant plagioclase-rich basalts of the Lunar Highlands appeared to have been formed from a single melt by accident because their real compositions were masked by water, which had now been lost. This seems perverse because Mike had argued for years that the oceanic basalts on Earth were low-pressure residues and not deep mantle melts. Or perhaps we do not fully understand his reasoning.

By contrast, however, when he reached retirement Mike was quite upset when he realized that his rivals had garnered all the great medals and awards in the field but he had been quietly forgotten. This often happens in science, and many of the greats in the field have not been fully appreciated when at the fullness of their flow and, by the time this is realized, new champions had entered the lists. He was thus extremely pleased to have been awarded the Hess medal.
of the American Geophysical Union in 2007 for ‘outstanding achievements in research in the constitution and evolution of Earth and other planets’.

Unlike many other iconoclasts and contrarians, Mike was in no way a prickly character on a personal level. Indeed, he liked nothing more than working with individuals and small groups, teaching and guiding his students with immense patience and good humour and infecting them with his enthusiasm and boundless energy. He was a brilliant raconteur and was in his natural element among climbers in wild places. He was a good listener and always willing to hear ideas from students and explain things one more time. His time at Sultan Qaboos University in Oman was a great delight to him because of the wonderful students he tutored. In fact one of his earlier research students remarked that he got on better with his students than with many of his colleagues. His house in Pasadena became a mecca for the younger Caltech faculty and students as he held evening seminars. He was revitalized at Cardiff at 61 years old by his mission to work with younger colleagues. Time and time again, colleagues and students recall how Mike went out of his way to help them. Many Earth scientists worldwide owe much to his unstinting encouragement and advice. His was a rare personality that occurs once in a generation. We were fortunate to know him.

AWARDS AND HONOURS

1967 Clough Award
1969 Fellowship of the Royal Society of Edinburgh
1976 Associate Member, Société géologique de France
1981 Fellowship of the Royal Society of London
1983 Murchison Medal, Geological Society of London
1984 Sherman Fairchild Distinguished Fellowship, California Institute of Technology
Norman L. Bowen Award, American Geophysical Union
1997 Fellow of the Geochemical Society
Fellow of the European Society of Geochemistry
2004 Fellow of the American Geophysical Union
2007 Harry H. Hess Medal of the American Geophysical Union

ACKNOWLEDGEMENTS

I thank Susan O’Hara and Eleanor Mary O’Hara for their contributions. Martin Williamson, the Cranleigh School Archivist, provided key information about Mike’s schooldays, including digging up his record card. Several of Mike O’Hara’s students, now all distinguished geologists—Claude Herzberg, Brian Jamieson, Ian Cartwright, Andrew Barnicoat and Grant Cawthorn—provided valuable comments. Mike’s colleagues Brian Upton, Bernard Wood FRS, Stephen Sparks FRS, Peter Wyllie FRS, Yaoling Niu, David Bowen and David Walker not only contributed a string of reminiscences going back over 50 years but also provided invaluable insights into Mike’s scientific legacy. John Dewey FRS, Keith O’Nions FRS and an anonymous reviewer read drafts of the biography. Mike’s climbing and mountaineering exploits were reviewed by Ted Maden, Paddy Buckley and John (Toby) Mallinson, who is perhaps the oldest survivor from those heroic days of the 1950s. John Harwood contributed the view from a younger climbing generation who did not know Mike personally but knew the legend. Mike O’Hara left two autobiographical accounts in the archives of the Royal Society and I thank the Society’s Librarian, Keith Moore, for sending copies to me. Finally, the Editor, Trevor Stuart, managed the whole process with alacrity, smoothing over the bumps and ensuring the successful completion of the project.

The frontispiece photograph was taken in 1981. (Online version in colour.)
Biographical Memoirs

APPENDIX. A GUIDE TO SOME OF THE MINERALOGICAL AND PETROLOGICAL TERMS USED IN THE TEXT FOR THE NON-SPECIALIST READER

Natural materials have a range of compositions and textures and are classified into groups with esoteric, and often ancient, names.

Table A1. Minerals.

<table>
<thead>
<tr>
<th>name</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>garnets</td>
<td>silicates of magnesium, iron, calcium, aluminium and chromium</td>
</tr>
<tr>
<td>melilites</td>
<td>complex aluminosilicates of calcium, sodium, magnesium and iron</td>
</tr>
<tr>
<td>olivines</td>
<td>magnesium iron silicates</td>
</tr>
<tr>
<td>plagioclase feldspars</td>
<td>sodium and calcium aluminosilicates</td>
</tr>
<tr>
<td>pyroxenes</td>
<td>complex calcium magnesium ion silicates and aluminosilicates often</td>
</tr>
<tr>
<td>spinels</td>
<td>oxides of magnesium, iron, aluminium and chromium</td>
</tr>
</tbody>
</table>

Table A2. Rocks.

<table>
<thead>
<tr>
<th>name</th>
<th>composition</th>
<th>source</th>
</tr>
</thead>
<tbody>
<tr>
<td>tillites</td>
<td>rocks formed from the induration of glacial till, the unsorted and unstratified rock material deposited by glaciers</td>
<td>continental sedimentary rocks</td>
</tr>
<tr>
<td>basalts</td>
<td>fine-grained lavas, low in silica</td>
<td>erupted onto the surface</td>
</tr>
<tr>
<td>dolerites</td>
<td>medium-grained equivalent of basalt consisting mostly of plagioclase and pyroxenes (US: diabase)</td>
<td>usually relatively shallow intrusive rocks often occurring in feeder channels to eruptive basalts formed within the crust</td>
</tr>
<tr>
<td>gabbros</td>
<td>coarse-grained equivalents of basalt consisting mostly of pyroxene and plagioclase</td>
<td></td>
</tr>
<tr>
<td>harzburgites</td>
<td>peridotites consisting mainly of olivine and Ca-poor pyroxenes</td>
<td>product of partial melting of lherzolite common in oceanic crust</td>
</tr>
<tr>
<td>gneiss</td>
<td>banded rocks formed from the metamorphism of sedimentary or igneous rocks at high temperatures and pressures</td>
<td>lower crustal rocks</td>
</tr>
<tr>
<td>granulites</td>
<td>the products of high-grade metamorphism of sedimentary and igneous rocks, which are formed in the deep continental crust</td>
<td>lower crustal rocks</td>
</tr>
<tr>
<td>eclogites</td>
<td>coarse-grained igneous rocks consisting mostly of red garnet in a matrix of green, sodium-rich pyroxene</td>
<td>mantle rocks</td>
</tr>
<tr>
<td>kimberlites</td>
<td>peridotites with more than 35% olivine sometimes containing diamonds</td>
<td>mantle rocks</td>
</tr>
<tr>
<td>lherzolite</td>
<td>a rock containing 40–90% olivine and significant pyroxene</td>
<td>garnet lherzolites are major constituents of the upper mantle</td>
</tr>
<tr>
<td>peridotites</td>
<td>coarse-grained igneous rocks consisting mostly of olivine and pyroxene</td>
<td>mantle rocks</td>
</tr>
</tbody>
</table>

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Michael John O’Hara


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