BIOGRAPHICAL MEMOIRS OF FELLOWS OF THE ROYAL SOCIETY

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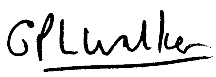

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George Walker was one of the most creative, inspirational and influential volcanologists of the twentieth century. Born in Harlesden, London, on 2 March 1926 in a respectable working-class neighbourhood, he was the first member of his family to take an interest in science and to attend university. His father, Leonard Walker, an insurance salesman, was badly wounded at Passchendaele in World War I as a sergeant bomber and never fully recovered. He died in 1932, when George was six years old. His mother, Evelyn Frances (*née* McConkey), was a nurse. George had no siblings. He attended Acton Lane Elementary School and recollected a lesson on the making of iron as being memorable. Other influences included natural history, adventure books and visits to the South Kensington Museum and London Zoo. He did well at school and in 1937 won a scholarship to Willesden Secondary School.

His mother came from a farming family in Ballinderry, County Antrim, and the family usually went to Northern Ireland for summer holidays. In the summer of 1939 World War II broke out while George and his mother were in Northern Ireland. They decided to stay at the Ballinderry farm and George was placed in Wallace High School, seven miles from the farm. The Headmaster, Mr Nunan, was a very good chemistry teacher and introduced George to the scientific method. George recalled him showing how to observe and describe a piece of coal. George had a fascination with maps and wanted to be a surveyor or map-maker. As soon as he arrived in Antrim he made a map of the farm using the number of turns of his bike wheel to estimate distance.

George identified, with characteristic precision, 16 November 1942 as the time he took an interest in geology. From his pay working in greenhouses he bought a book on botany and *Geology for beginners* by W. W. Watts. Eight days later he visited a nearby chalk quarry, recognized a dyke and identified calcite in basalt lava. He was hooked and spent much of his spare time visiting geological sites, collecting minerals and making frequent visits to Belfast City Museum to look at the mineral collections. A lifelong friendship began at this time with

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Des McConnell (FRS 1987), who attended the same school in Lisburn. The two teenagers spent much time together hunting for minerals and exploring the local geology. George effectively started research as a schoolboy, and during 1943 and 1944 mapped dykes on the Antrim plateau and determined the intensity of dyking. His immaculate field notes of the summer of 1943 show that he had already learnt to recognize the common zeolite minerals as a 17-year-old.

George went to read Geology at Queen's University Belfast, obtaining a BSc in 1948 and an MSc in 1949. He then moved to Leeds University to start a PhD under the direction of Professor W. Q. Kennedy FRS on the subject of the amygdale-filling minerals in the Tertiary basalt lavas of Northern Ireland. He established that the zeolite mineral assemblages of the Antrim Plateau lavas were systematically related to depth as a result of burial metamorphism. His time at Leeds was a happy period. He became close friends with fellow student Phillip Leedal, with whom he spent much time geologizing and hill-walking. He spent the summers of 1952 and 1953 on Leeds University geological expeditions organized by Professor Kennedy to the Ruwenzori Mountains of Uganda and the then Belgian Congo. George also spent a summer studying rare niobium and lithium minerals in the pegmatite at Alto Ligohna mine, Mozambique.

He was appointed to an assistant lectureship in mineralogy at Imperial College, London, in 1952 on a salary of £400 per year, but did not complete his PhD until 1956. He was to spend a substantial part of his career at Imperial as Lecturer (1954–64) and then Reader (1964–78).

In his early career George developed his skills as a mineralogist and brilliant field geologist, but these talents were only recorded in a modest output of publications on the geology and minerals of Northern Ireland and Scotland, which were mainly presented in a series of papers published in *Mineralogical Magazine* between 1951 and 1960. What turned these abilities and skills into work of outstanding importance resulted from his focusing his attention on the geology of Iceland, after a month's visit in the summer of 1954. He was encouraged to work in Iceland by Professor Leonard Hawkes FRS, who had written a series of papers on the geology of eastern Iceland before the war.

Between 1955 and 1966 George spent every summer in eastern Iceland mapping the mountainous fjord terrain, often under extremely rigorous conditions. He lived in a small tent and initially out of the back of an old Austin A40 van, which was shipped to Iceland every summer. George became well known to many of the local farmers, who were kind and hospitable, sometimes dragging his disabled van out of flooded rivers.

Although zeolites first attracted George to eastern Iceland, he immediately started to map all facets of the geology, including the attitude and stratigraphy of the tilted lava pile, the distribution of the dykes, the distribution of the zeolites and other secondary minerals, and geomorphological features such as glacial stria, massive landslides, raised beaches and large dry valleys that seemed to result from river capture. George did most of this work alone. Observations were recorded in meticulous detail in black ink in a series of notebooks and on field slips. In the absence of detailed topographic maps, these slips were usually overlays of old wartime photographs from the air. As much of the country was continuously exposed, mapping took the form of a series of traverses, which were horizontal along the fjord shores and along narrow gently sloping lava benches high in the mountains, and vertical up steep stream gullies. Altitude was carefully recorded at all times using a small Swiss altimeter. This allowed useful information to be obtained in zero visibility on vertical traverses because the weather was often poor. Although George did not map in continuous rain, he was notorious for starting work at any time of the day or night, especially if he had been 'shut in' for a day or so. Continuous daylight allowed this eccentricity.

Although, at first sight, the tilted-basalt-flow geology of the area north of Reydarfjordur looked dull and uninteresting, it was the first flood basalt region anywhere in the world to be mapped in such detail, and gradually unusual, subtle, features became apparent. The inclination of the lavas was always greatest at sea level, decreasing upwards along with the thickness of the lava flow groups. Dyke intensity was greatest at sea level and declined upwards, and the generally horizontal zeolite mineral zonation cross-cut the tilted lava stratigraphy, with the intensity of zeolitization diminishing upwards. These observations were integrated into an elegant and novel model for the formation, tilting and secondary mineralization of the lava pile, published in the *Journal of Geology* in 1960. His interpretation envisaged the lavas as originating at the spreading axis about 100 km to the west and gradually spreading away from the eruptive zone. This account of 'sub-aerial sea-floor spreading' pre-dated the publication in *Nature* of the interpretation of magnetic stripes (Vine & Matthews 1973). It has subsequently become clear that this model for the structure and origin of the tilted lava pile applies to other regions, such as eastern Greenland and Ethiopia, where older flood basalts veneer the continental margins.

The documentation of the geology of eastern Iceland was seminal work founded on his recognition that some zeolite minerals occurred in broad zones whose depth below the former ground surface could be inferred. By mapping out the zeolite zones and their relationship to lava structures and dykes, George was able to gain insight on dry land into how oceanic crust is formed. This work came to fruition at an auspicious time, when the plate tectonic revolution in Earth sciences was taking place. George pioneered research to infer the geological processes involved, recognizing how the geology of eastern Iceland could be explained elegantly by spreading at the ridge axis, together with tilting, erosion and uplift of the lava succession as the ocean crust drifted away from the spreading centre. His Icelandic work elucidated the major geological processes that formed that country. The concepts culminated in his classic paper with G. Bodvarson on crustal drift in Iceland in 1964, with the first account of crustal spreading by dyke injection. The importance of his Icelandic research was later recognized when, in a rare honour for a foreigner, he was elected to the Icelandic Order of the Falcon (Knights Class), conferred by the President of Iceland in 1980.

The regional mapping, which was gradually extended southwards to the area south and east of Vatnajokull, resulted in the discovery of some striking mineralogical and geological features. This led to several papers for the Mineralogical Society on zeolites, a paper describing the Skessa tuff, an unusual highly welded rhyolitic ash-flow, the first account of composite lavas and their feeding composite dykes, and a paper with some of his students on the general problem of the interaction of rhyolitic and basaltic magmas. The latter highlighted the geological significance of basaltic magma being injected into higher level silicic magma chambers, described the resulting magma mixing phenomena, and included pioneering descriptions of the characteristic features that result, including net-veined complexes, composite intrusions and mixed magma pyroclastic rocks.

George, although an enthusiastic and skilled mineralogist, was never particularly interested in petrology and geochemistry. In eastern Iceland, this gap was filled by I. S. E. Carmichael (FRS 1999), George's first graduate student. Carmichael was given the daunting task of mapping the Thingmuli silicic complex, an isolated and largely uninhabited mountainous area at the head of Reydarfjordur characterized by notoriously poor weather. Carmichael completed this work, although the subsequent geochemical investigation was handicapped by George's forcing the student to discard half of his samples on the long way back to Reykjavik when the excessive weight caused one of the wheels on George's long-suffering van to fall off! Carmichael was undeterred and his 1964 paper in the *Journal of Petrology* on Thingmuli has become a landmark in petrology.

George's work in eastern Iceland had the hallmark of his best efforts: wonderful detailed observations and a deep intuitive feel for the dynamic processes responsible, allowing innovative interpretations that advanced the understanding of major igneous processes. He passed all of this to his students, usually only one or two in any summer, sometimes supplemented by a student helping with the regional mapping as an undergraduate project. Life in the field did not always go smoothly. George was occasionally terrorized by overzealous farm dogs. Iceland was hard on cars, and twice George found himself with two punctures (flat tyres) and only three inflatable tyres. On one of these occasions, sheep dip (a sticky insecticide) proved to be an effective agent for repairing punctures. He also undertook parallel studies in the British Tertiary Igneous Province, reconstructing the geometry of the Antrim Lava Plateau and the Mull volcano, Scotland, using zeolite zones. These accomplishments, and George's remarkable skill in identifying rare minerals in Iceland, are now legendary. He could recognize more than 60 different zeolite minerals in the field. He mapped several thousand square kilometres of eastern Iceland, an extraordinary physical feat. George as a young geologist was phenomenally fit, notwithstanding a field diet that seemed to consist largely of Kendal Mint Cake and macaroni and cheese, washed down by Instant Postum (a coffee substitute). There are stories of his missing an occasional night's sleep when the geology became too interesting. George had married Hazel (*née* Smith) in 1957 and she sometimes accompanied George to Iceland, camping, cooking on a Primus stove, and carefully wrapping delicate zeolite specimens in moss when they had run out of paper.

In 1965 George became interested in active volcanoes, influenced by witnessing the eruption of Surtsey (1963–67) in the Atlantic south of Iceland. He first studied the active lava flows on Mount Etna, Sicily. There he realized that the rheological properties of lava were a key to understanding their emplacement and was one of the first to recognize that non-Newtonian rheology had an important influence on volcanic processes. In particular, he proposed that lava thickness was governed by the yield stress of the flowing, molten material. His lava research continued during the 1971 eruption of Etna. One of the authors (S.S.) remembers a long, highly undulating night-time trek with George to find one of new *boccas* (vents) of the 1971 lava flows, guided through a low shrub-forested area by the glow of the vent area. Real pioneering stuff, or so it seemed, but George was visibly deflated to find, on finally arriving at the vent at about 4 a.m., a small group of Sicilian mountain men who had already made a small pile of ashtrays from the lava by scooping out globs of the active flow with an iron bar and pressing them into a mould! After that, George and his colleagues studied an ash-producing flank satellite vent and crater high on the volcano for a few days while the lava flow made its way down to lower, more accessible areas. His research students at Imperial College were always encouraged to visit active volcanoes whenever an opportunity arose, which was several times in the 1970s as Etna entered a particularly active period. They soon learnt that George put science above personal expenditure. These trips were partly self-funded, as they were for much of his field research over his entire career.

On a three-month visit to India in 1969 to study the Deccan Traps (a huge, ancient basalt lava field) George gathered evidence to propose the idea of compound lava flows. His basaltic

Figure 1. George cleans an outcrop of pyroclastic fall deposits with his spade.

lava research culminated in his 1973 paper 'Length of lava flows', which was a contribution of outstanding innovation and influence. Viscosity had hitherto been considered to be the main control on the distance that lavas travelled. George, however, showed that discharge (effusion) rate was a far stronger control on lava length by systematically gathering data on lava lengths and flow rates, especially on the lavas of Mount Etna. In retrospect this result is now obvious and has been explained by some basic fluid mechanics concerning the competition between flow and cooling. George had no training or background in physics, and his mathematics was rudimentary, yet he had a profound intuitive understanding of natural processes, based on acute observation and creativity in interpretation.

In the late 1960s George saw an opportunity in studying the products of explosive eruptions, (pyroclastic deposits and rocks) and in using the information obtained to infer eruption and deposition mechanisms (figure 1). Notwithstanding earlier notable work in the USA, Japan and Iceland, and good contemporary research groups, pyroclastic geology remained largely a Cinderella subject, with the big names of the time in igneous geology being attracted into petrology and geochemistry. Volcanology texts at the time reflected the fact that the study of pyroclastic rocks was non-systematic, largely qualitative, and a backwater of Earth sciences, which was by then in the midst of the revolution caused by the elucidation of plate tectonics. Understandably, many of the brightest minds were attracted into research on global scale tectonic issues. Those interested in volcanoes were largely concerned with petrological and geochemical studies, whereas physical processes, especially those controlling the products of explosive eruptions, or phases of eruptions, were often ignored. Many of the important questions of how and why volcanoes erupt had not been addressed or even asked.

Research projects in Italy, the Azores and Tenerife in the period from 1967 into the 1970s developed Walker's interest in young pyroclastic deposits and, arguably, this interest led to his most brilliant and long-lasting, influential contributions. His approach was strongly influenced by the pioneering studies of tephra deposits by S. Thorarinsson in Iceland. He also held in high regard the work of Japanese volcanologists such as S. Aramaki, H. Kuno and I. Murai, who had developed quantitative approaches to documenting pyroclastic deposits. In the USA the pioneering work of R. L. Smith and J. G. Moore of the US Geological Survey also influenced George's approach. At the time H.-U. Schmincke in Germany and R. V. Fisher in Santa Barbara, California, were also developing important programmes of research on pyroclastic geology and provided some competition. George built on the pioneering studies of Thorarinsson and the Japanese groups and introduced his own rigorous and prolific field skills, physical intuition and imaginative gifts to revolutionize global understanding of pyroclastic geology and explosive volcanism.

In no more than eight years (1968–76) he created and laid down the basic methods that are still used today to describe and interpret pyroclastic deposits. For pyroclastic fall deposits he provided systematic criteria for recognizing deposits from different styles of eruption and produced a classification that allowed geologists to understand the relationships of geological characteristics, such as grain size, thickness and structures, to volcanic processes. For pyroclastic flow deposits (particularly ignimbrites) he established the major kinds of facies, and documented grain size variations systematically. His approach provided a framework of systematic field documentation and interpretation that forms the foundation of modern physical volcanology.

During this period at Imperial College he collaborated with excellent colleagues as postdoctoral researchers, such as Ron Croasdale and Basil Booth, and inspired a new generation of graduate students (including the authors of this memoir). Another inspiration was to involve Lionel Wilson, a physicist at University College and later at Lancaster University, who had developed an interest in planetary volcanism. George realized that he did not have the background in physics and mathematics to develop quantitative models of the dynamics of volcanic flows that were now essential as complements to his field data and intuitive ideas. The collaboration between George and Lionel, together with the more quantitative approach of his research students at Imperial College, pioneered physics-based models of explosive eruptions, pyroclastic flows and fall-out of tephra. This time of innovation saw such Walker–Wilson experiments as dropping pieces of pumice and other volcanic fragments and timing their fall, first down an old and abandoned lift shaft in the Royal School of Mines (Imperial College), and later from the roof of the tallest building on the Lancaster campus. By such simple experiments and methods, George put the UK at the forefront of an international revolution that turned volcanology into the quantitative science that it is today. Also, at this time, with Wilson, he started a series of papers colloquially known as EVE (explosive volcanic eruptions) in the *Geophysical Journal of the Royal Astronomical Society*: EVE is still going today, with number 10 being the most recent addition.

In the mid-1970s George became profoundly disillusioned with the UK science scene and university life at Imperial College, believing that the burdens of administration, bureaucracy and teaching were inhibiting research and his ability to do creative science. An opportunity opened up in 1977 when he was awarded a Captain James Cook Fellowship under the aegis of the Royal Society of New Zealand, and he chose to take this up at the University of Auckland. This was a three-year visiting research fellowship, and he initially took leave of absence from Imperial College. However, he ended up making a complete break, resigning from Imperial College, selling his house and taking his redoubtable mother (aged 70 years), Hazel and the two children (Alison and Leonard) to a new life in early 1978. He was joined there for a year by the last of his Imperial College research students, Colin Wilson, who had been told about the emigration plans within three weeks of starting as a graduate student.

New Zealand gave George a new surge of creative energy and he set about studying the explosive volcanism of the Taupo Volcanic Zone with great gusto. In his time there, he made important contributions to concepts of the eruptive styles and vigour of explosive eruptions. These contributions were based on deposits from four eruptions from Taupo and Okataina volcanic centres, including the wholly remarkable 1800-year-old Taupo eruption and the basaltic explosive Tarawera eruption in AD 1886. Studying the fall deposits, he devised a method of calculating their volumes with the use of mass balances of dense crystals in the deposits as a guide to 'missing' vitric material (blown away out to sea), outlined the characteristics of deposits from extremely powerful basaltic and rhyolitic explosive eruptions, and studied the 'wet' fall deposits from large-scale magma–water interaction. Studying the 1800-year-old Taupo ignimbrite he derived several new ideas, including recognition of the importance of the aspect ratio of ignimbrites to their emplacement conditions, definition of the landscape-draping veneer facies in low-aspect-ratio ignimbrites, and recognition of several depositional lithofacies of ignimbrites and relating them to the structure of individual pyroclastic flows. This landmark study of the Taupo ignimbrite with Colin Wilson has yet to be surpassed in terms of the quality and detail of the data. He also documented caldera systems such as Taupo as inverse volcanoes or calderas, proposing that their deposits were so widespread that the co-eruptive collapse was not compensated for and the volcano ended up as a huge downsag in the Earth's surface. George gave new names that are in current use today to many volcanic phenomena and deposits. In this work (and subsequently) he was given immense help by Hazel, who unstintingly undertook laboratory work and typed up manuscripts (usually in a corner of George's office).

The final stage of George's career took him to the University of Hawai'i at Manoa in early 1981 to take up the newly established Gordon Macdonald Professorship in Volcanology, a post he held until retirement in 1996. The position also embraced the title of Hawai'i State Volcanologist, a role under which he undertook a few obvious and many not-so-obvious duties. In Hawai'i, his interests naturally turned once again to basaltic volcanoes and eruptive processes. His contributions included masterful descriptions of dyke swarms in eroded volcanoes in the Pacific, detailed insightful studies of lava dynamics based on the young and, indeed, active lavas of Kilauea volcano in the 1980s and 1990s (with his PhD student and later colleague Scott Rowland), recognizing the importance of inflation of lava flows during emplacement (his so-called lava-rise mechanism) and the accompanying surface deformation structures such as tumuli. Other important studies were achieved on Toba volcano, where he worked on the palaeomagnetic properties of the huge ignimbrites formed by the three great eruptions that formed this caldera. After an early brush with magnetic properties of Icelandic basalt lavas, George returned to the relatively new technique (to volcanology) of anisotropy of magnetic susceptibility (AMS). He did this, first, to understand the Toba deposits with postgraduate student Michael Knight and other colleagues, and later to understand the flow of magma in dykes (again with Knight) and lava on the surface. In this work he had a fruitful collaboration with Emilio Herrero-Bervera and their postgraduate student Edgardo Cañon-Tapia (on basaltic lava flows in Hawai'i and the Columbia River province of Washington State, USA).

George remained impressively dynamic, managing to visit 17 Pacific island volcanoes in his mid-60s. As ever, he had the uncanny knack of making key observations. He also began to publish some 'big-picture' articles, capitalizing on an enduring desire to combine many aspects of his studies into coherent explanations of typical volcanic systems. Thus, his papers on basaltic volcanic systems and the Hawaiian Islands (both, however, published in rather obscure journals) introduced new concepts such as the influence of sub-summit dyke swarms in helping to create calderas on basaltic volcanoes. George also continued his interest in the Taupo Volcanic Zone, publishing his New Zealand work in the early years at Manoa. He supervised Zinzuni Jurado-Chichay's detailed studies of the huge *ca.* 50 000-years-old Mangaone deposits from Okataina volcanic centre, New Zealand.

Life in Hawai'i strengthened George's appreciation of cafés as venues for facilitating thought processes. He found it increasingly difficult to do creative work in a university environment because of frequent interruptions and numerous committee meetings. George was very well known in both Hawai'i and in volcanological circles and much sought-after. This, combined with a delightful inability to turn away anyone who was interested enough in volcanology to want to discuss it with him, often led to a queue of people waiting outside his Manoa office to speak with him. The queue could include visiting volcanologists passing through Hawai'i, undergraduate students and their friends, postgraduate students, interested lay persons, and publishing house representatives wanting to sign George up to write a book. Increasingly he resorted to hiding in cafés. His routine in Hawai'i involved an hour at breakfast and sometimes an hour at lunch in a chain restaurant outlet called Zippy's. He estimated that he wrote 15 papers and numerous lectures courtesy of the hospitality of Zippy's. Another technique was to take a group of waiting people, often a quite disparate bunch (the 'importance' of the visitor being immaterial to George), to a café for coffee and discussion.

George's offices (whether at Imperial College, Auckland or Hawai'i) were too full to accommodate many people; they were full of books, journals, piles of teaching materials, poster and slide production tables, microscopes and other laboratory equipment. George mostly used his offices for sieving and separating components from pyroclastic deposits, and other simple laboratory work. His Imperial College office was a minefield of small samples of ash on soggy filter papers waiting to dry, and the shelves were liberally sprinkled with fine volcanic dust. God forbid the unaware intruder who peered into George's door on a day when the windows were open. Up went the driest (lightest) samples, which were lost to science! His offices in Auckland and Hawai'i also almost always contained Hazel and her typewriter, busy on another manuscript, teaching handout or booklet. Although George was proud to say that he was the second person in the Geology and Geophysics Department at Hawai'i to get a desktop computer, to our knowledge he never used one to type a manuscript. Instead, he (or more commonly Hazel) used a typewriter (electric, at least), gallons of white-out, scissors, glue, technical pens, and rub-on lettering. Even with these 'primitive' tools, each year George managed to out-publish most of his colleagues.

George was at his happiest and most creative in the field. His life involved visiting virtually every volcanic region of the world. A far-from-exhaustive list of field research includes Australia, the Azores, the Canary Islands, Chile, Costa Rica, Ecuador, Greece, Guatemala, Hawai'i, Iceland, Indonesia, Iran, Ireland, Italy, Japan, Madeira, Mexico, Micronesia, New Zealand, Nicaragua, New Guinea, Peru, the Philippines, Portugal, the UK, the USA and the

West Indies. He kept a careful record of his work in the period 1970–75, which records an average of 73 days in the field per year in 15 countries visiting more than 30 different volcanoes. This experience gave him an encyclopaedic knowledge of volcanic field geology and the world's volcanoes. Many of the areas were in the developing world, and George spent much time helping, collaborating and imparting his wisdom to scientists from these countries. After his death it was particularly noticeable that many geologists from the developing world acknowledged the huge influence that George had had on their careers and indicated their deep affection for him. Part of his work was on volcanic hazards in South America for the UN Disaster Relief Organization.

George Walker was an outstanding teacher as well as researcher. He taught in a deceptively simple style, getting across complex ideas and new concepts with uncluttered diagrams and clear exposition. His mineralogy lectures and practicals at Imperial College were inspirational, bringing to life the beauty of nature with systematic didactic lessons on crystal structure and the atomic architecture of minerals. His lectures on crystallography, atomic structures and optical mineralogy were of great clarity and made a traditionally dull subject exciting. In Hawai'i, his office and the halls of the building were covered with 'homemade' posters and information sheets, on all topics from general geology at basic undergraduate level to his latest research results in volcanology.

It was in the field, however, that George was at his superb best, explaining how to make systematic descriptions and training his students to make measurements. The paradigm for him was that if something could be observed it could and should also be measured. His field sketches for students were famous for distilling complex ideas and relationships into forms that the novice geologist could immediately understand. Over the years he led more than 100 student field courses, an effort comprising spending more than 1000 days on field teaching. These included annual courses for schoolteachers and visiting foreign volcano observatory workers (though the University of Hawai'i at Hilo's programme at the Center for the Study of Active Volcanoes). Almost all of these field courses (and class field trips) were embellished by a 'homemade' booklet stuffed full of information sketches and maps, in the main hand-drawn by George. When he was in Hawai'i (that is, not in the field elsewhere) it seemed that George led a field trip most Saturdays—and Sundays, too, if an audience could be found!

George loved to teach at all levels, from primary school children through undergraduates to research students to eminent professors at conferences. His superb lectures were a paradox in that this reserved man, who was often uneasy in social situations, became authoritative, inspirational and brilliant on the lecture podium, despite a voice that often seemed barely to rise above a whisper. All shyness evaporated as he explained his latest results and ideas with enthusiasm, clarity and panache. A well-known (perhaps slightly envious) volcanologist was once heard to say that George lectured (and wrote) in the 'missionary' style! He was particularly helpful to scientists from the developing world, who felt he was approachable because of his modest demeanour. He influenced thousands of schoolchildren, young scientists, students and colleagues.

George was a modest and quietly spoken man who never sought the limelight. He possessed a beguiling manner that endeared him to several generations of students and colleagues and friends (figure 2). On an individual basis he often spoke in a near whisper. Listeners had to concentrate and they became gradually engaged and inspired by his clarity of thought and expression. He was happiest in remote parts of the world making observations that would profoundly change the understanding of volcanoes. Much of this work was done on a shoestring

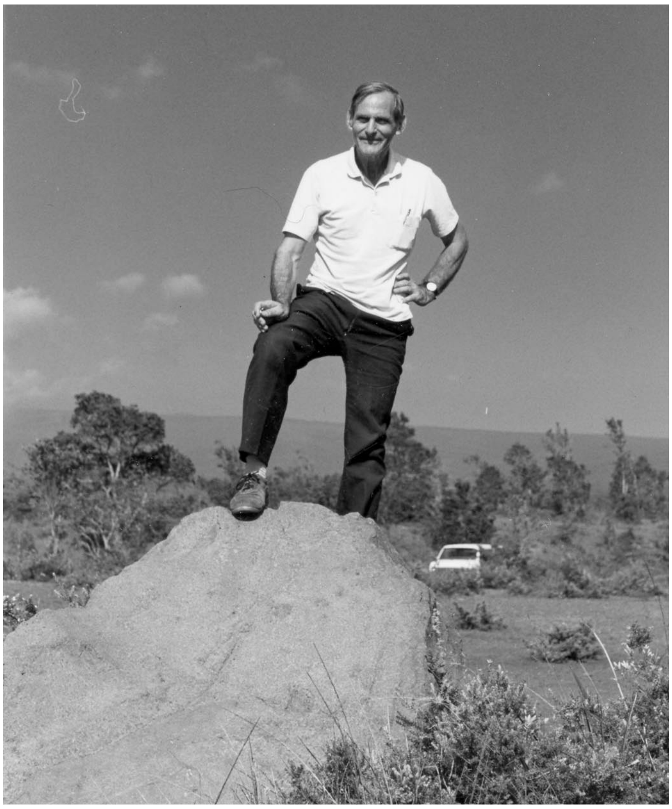

Figure 2. George stands on a rock, with a typical mischievous expression.

budget and sometimes out of his own pocket. One of his most memorable comments was: 'Writing proposals is a mug's game, Steve', reflecting his view that he would rather spend time writing a paper, which would have (in his case) a more than 80% chance of publication, rather than a proposal, which might have a less than 30% chance of success. Perhaps influenced by colleagues bemoaning the fact that an expensive and complex laboratory instrument was inoperative for a few months and no results could be obtained, George said, 'There's still a lot of good science to be done with a notebook, a pencil, and a ruler.' Those who had the good fortune to be with him in the field carry fond memories of a man in his element, sharing his acute observations and insights with a twinkle in his eye, and of struggling to keep up with him physically and mentally.

George could, of course, be eccentric, reflecting independence of mind and thought. Eccentricity and creativity are close companions. He could become obsessed by an idea or problem, and his colleagues and students were usually unsuccessful at diverting him from his immediate passion. His car driving style was legendary and definitely not for those of nervous dispositions, conducted with often a greater interest in searching for new outcrops, or gazing at volcanic landscapes than in traffic conditions and hazards or the indications of the fuel gauge. George's escapades in the field continued throughout his life. When working in the Azores, George lost his backpack containing passport, money, travellers cheques, tickets, hotel key, field note book and map when a curious goat hooked his sack over its horns, ran off and discarded it over a cliff. He was deceptively fit and could easily outpace students half his age. A not uncommon sight on volcanic field trips was George striding out in front of a long line of exhausted students to find one last outcrop before the sunset. Those at the end of the line did not always arrive in time to receive the benefit of George's wisdom. His eating habits included a passion for very sweet coffee, chocolate bars, and cakes. We say coffee here, but it should be 'coffee' because the caffeine part of it was not of interest, only the liquid and sugar; this led to the most bizarre array of coffee substitutes in George's offices, including at one stage a Hungarian concoction made from beetroot!

George placed an interesting outcrop well above lunch in order of importance, a prioritization that was rarely shared by graduate students at outcrops in the mid-afternoon's searing heat in yet another quarry! One summer on field work in Italy supervising one of us (R.S.J.S.), George's daughter Alison, then aged 11 years, hid George's hammer and field notebook and refused to divulge their whereabouts until a firm commitment to ice cream had been negotiated, much to my relief. Incongruously, though, he would sometimes leave a perfectly good outcrop while on field work and drive a considerable distance into the nearest town or village searching for a coffee or ice cream shop (with a bemused student in tow not wishing to be left alone by an isolated outcrop wondering when George would return). Another habit of his was to take off on his own at official stops on organized field trips, to find something he remembered he had seen before or just to explore, ignoring the 'official' explanation but sometimes taking other trip members with him. He could be gone an hour or so, infuriating the trip leader and also, of course, causing concern as to his whereabouts! He would always turn up with a mischievous smile on his face and say as little as possible before getting back on the bus. The other trip members who had sneaked off with George were invariably glad that they had.

George retired to Gloucester in 1996. He was made a visiting professor at the Department of Earth Sciences at Bristol University and at Cheltenham and Gloucester College. Science and volcanoes remained George's main interests, which he continued until his final illness. He also had a passion for baroque music, and indeed did not consider much written after 1750 as worthy of being called music! In retirement he took a great interest in church architecture and history.

George was much honoured for his scientific achievements, including honorary membership of the Iceland Science Society in 1968, Fellowship of the Royal Society in 1975, the McKay Hammer Award of the Geological Society of New Zealand in 1982, Honorary Fellowship of the Royal Society of New Zealand in 1987, Fellowship of the Geological Society of America in 1987, an honorary degree from the University of Iceland in 1988, and Fellowship of the America Geophysical Union in 1988. He won the Lyell and Wollaston Medals of the Geological Society of London in 1982 and 1995, respectively, and the Thorarinsson Medal of the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) in 1989, the top medal in volcanology worldwide. In 2004 IAVCEI named the Walker Prize, to be awarded to outstanding young volcanologists, as a tribute to George.

The legacy of George Walker is immense and far-reaching. He published more than 150 original papers on different aspects of volcanism during a career of 50 years. Many of these are classics and are still highly cited. He educated 18 PhD students, and inspired hundreds of undergraduates and countless schoolchildren and members of the public. With a modest background, but armed with intense curiosity and ability to make critical observations, he was the key figure worldwide in changing volcanology from a largely qualitative descriptive science into a quantitative endeavour where the goal was to link geological observations and measurements with the dynamics of volcanic eruptions and volcanoes. He made significant contributions to understanding ocean ridge processes, seminal studies on pyroclastic geology and lava dynamics, and many major contributions to the regional volcanic geology of many parts of the world where the pioneering research will forever be linked to Walker. He was one of Britain's greatest field geologists and one of the world's most outstanding volcanologists of the twentieth century.

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Bibliography

A full bibliography is available as electronic supplementary material at http://dx.doi.org/10.1098/rsbm.2006.0029 or via http://www.journals.royalsoc.ac.uk.