

Kevin Russel Tate FRSNZ

1943 – 2017



New Zealand and the international scientific community were saddened by the tragic loss on 22 January 2018 of Kevin Tate, who made a tremendous contribution to science and who was such a good friend and tutor.

Kevin began his scientific career teaching chemistry at Victoria University in Wellington before becoming a soil scientist at the New Zealand Soil Bureau, DSIR, in 1968. Following a number of years leading major research programmes on greenhouse gas exchange with the terrestrial biosphere, Kevin retired in 2005 but continued working at Manaaki Whenua – Landcare Research as a Research Associate. In retirement he applied his research to the development of mitigation technologies for greenhouse gas emissions from agriculture.

Kevin was the essence of a great scientist, as well as a mentor, with a strong commitment to family, and a lifelong Christian faith. His vast intellect, and his dedication and passion for research led to major breakthroughs in our understanding of the complexities of the importance of carbon in plants and soils. He kept New Zealand soil science at the leading edge through his research on soil organic matter.



Kevin talking about Soil Organic Matter to the Minister of Science, Dr Ian Shearer with Director of Soil Bureau, Dr Mike Leamy September 1981



Kevin receiving the Grange Medal from Professor Mike Hedley (Massey University)

This work is recognised by the many colleagues and friends in the international science community. Throughout his career Kevin received many accolades and awards. He was elected to Fellowship of the New Zealand Institute of Chemistry in 1980. He was the recipient of all the New Zealand Soil Science Society (NZSSS)'s major awards. He gave the Norman Taylor Memorial Lecture in 1988. He was an inaugural Fellow of the NZSSS in 1995 and received the M.L. Leamy Award in 2002 for the most meritorious publication by a New Zealander on soil science between 2000 and 2002. In 2011, Kevin was awarded the NZSSS's Grange Medal, the top recognition for making an "outstanding contribution to New Zealand soil science".

Elected a Fellow of the Royal Society of New Zealand in 1995, Kevin was active in the Society's Academy, serving on many of its committees. In particular, he served many times on the Fellowship Selection Committee where he highlighted the contribution to 'science excellence' by Crown Research Institutes. In 2005, he was awarded the prestigious Marsden

Medal by the New Zealand Association of Scientists for research into ecosystem processes and climate change – a testament to his outstanding professional achievement.



Kevin at the Marsden Medal Award ceremony at Te Papa Museum, Wellington, 2005.

While Kevin was much ‘medalled’ with prestigious awards, at the other end of the scale he also worked to mentor and encourage the younger generation of scientists, as well as working with school children to show them the ‘excitement of science’, ready to engage and offer balanced opinion and advice. Between 2008 and 2011 Kevin was the Chief Judge at the Fonterra Manawatū Science & Technology Fair.

Kevin’s work continued with renewed enthusiasm after his official retirement, when he was excited to have the opportunity and freedom to start new projects. This research resulted in the development of biofilters to mitigate methane produced from dairy farm waste ponds. Most recently, he worked extremely hard editing the book *Microbial Biomass – a paradigm shift in Terrestrial Biogeochemistry* (World Scientific Publishing, 2017), which celebrates 50 years of research in soil biology. Publication of the book represents Kevin’s pinnacle of scientific achievement.



Kevin (in red jacket) explaining the use of soil as a biofilter to remove low concentrations of methane produced from animal wastes to international delegates

Kevin's skills and experience allowed him to communicate the findings from his research through his impressive list of scientific publications. But, much more than that, Kevin was highly respected by science managers and policy-makers, and was able to transform New Zealand's approach to accounting for changes in carbon stored in plant and soil. This work formed the basis for government policy that earned New Zealand the reputation for its world-leading approach to the mitigation of the impacts of climate change.

Kevin was passionate about the need to change the way we live to slow the rate of climate change. He advocated the need for action to fellow scientists, policy-makers and school groups, provided advice to the Church and, through lectures, to the general public. Kevin was also passionate about a sustainable lifestyle – he biked to work, drove a hybrid car, and had solar panels installed on his house for power generation.



Kevin speaking at the Climate Change demonstration in The Square Palmerston North 2015 and a photo of some of the placards

The scientific community, colleagues and friends, grieve the loss of Kevin, but we are encouraged that his enormous contribution has provided us with a legacy to better understand how we use our land-based resources to feed the worlds' growing population, protect our environment, and ensure the well-being of all people.

As we say, a great tōtara has fallen in our forest at Manaaki Whenua. Many seedlings have been nurtured by Kevin and will grow up stronger people and scientists because of him. We at Manaaki Whenua shall miss him. But we celebrate his life and time with us and assure you that his memory will live on in our values, goals, and work.

In particular, we have appreciated his humanity and concern. He is one of the people who we think of most, keeping Manaaki Whenua true to its values of caring for people and the land.

Our best tribute to Kevin will be to keep his dream alive through developing technologies, strategies, and policies that slow the rate of climate change.

Kevin's early scientific experiences (by Kevin's brother Warren Tate FRSNZ)

Kevin began studies at Victoria University of Wellington in the early 1960s, already with a strong interest in chemistry. This passion continued throughout his time at university and he



Kevin at Victoria University 1963 with Graeme Tobin

eventually embarked on a PhD embracing a 'carbon recycling' project. The precision of clarifying and determining the chemical mechanism for a specific decarboxylation reaction appealed to Kevin's attention to detail and his highly disciplined approach to life. Amazingly, carbon recycling in a different form would become the 'touchstone' of his extensive scientific career.

While completing his PhD, Kevin combined his test tube research project using pure chemicals, with a brief experience of academic life. He was appointed as a Junior Lecturer specialising in physical chemistry and kinetic mechanisms. While he thoroughly enjoyed these experiences, something about the distance of academic life from 'real life', and the esoteric chemistry of the time from 'real life' problems led him to seek an appointment outside the university environment.

He joined the New Zealand Soil Bureau, a division of the government agency of the then Department of Scientific and Industrial Research, specialising in soil-related research and development. There he was able to advance his knowledge and experience of carbon recycling in an environment far away from the simple test tube. He loved being able to track carbon immersed in the complex chemistry of soils and with the added complication of being within a context of biological microorganisms. He embraced the field trips to collect soils and monitor experiments that grounded him in the natural world, and fuelled his interest in sustainability. This inspired him through a subsequent career of 50 years in carbon recycling framed more recently around greenhouse gas emissions and climate change.



Tom Speir, Kevin Tate, Roger Parfitt, Karina Whale and Des Ross of the Soil Biochemistry team, New Zealand Soil Bureau DSIR, Taitā.

Kevin's DSIR research (by Benny Theng FRSNZ)

Kevin was appointed to the New Zealand Soil Bureau, DSIR, Taitā, by Morice Fieldes in 1968. Fieldes, the then director of Soil Bureau, referred to Kevin as a budding soil biochemist, a description that proved so true.

At the time as my appointment in 1970, Kevin was working on the structural constitution of soil organic matter (SOM). I recall his using sodium amalgam as a chemical hammer to break up SOM, and then characterising the constituent parts by gel chromatography. Later Kevin used instrumental techniques for this purpose, such as pyrolysis-mass spectrometry and solid-state nuclear magnetic resonance (NMR) spectroscopy. In collaboration with Roger Newman of Chemistry Division, DSIR, Kevin was able to show by ^{31}P -NMR spectroscopy that

soils under tussock grass contained a variety of phosphate esters, including a previously unknown phosphonate species. In some of these tussock-grassland soils, the organic matter had penetrated into the interlayer space of a peculiar clay mineral that Jock Churchman had previously identified as a regularly interstratified mica-beidellite.

At the New Zealand Soil Bureau, collaborative research among its scientists was encouraged. At the time, I was concerned with the behaviour of organic compounds at clay and mineral surfaces. My interest thus dovetailed with Kevin and Jock's research results. Assisted by Peter Becker-Heidmann of Hamburg University, Germany, Kevin and I were able to establish that the organic matter intercalated into the mica-beidellite clay, was nearly 7,000 years old. This finding strongly indicated that the material was physically protected from both microbial attack and contamination by 'modern' carbon, and would therefore qualify as the so-called inert component of soil organic matter.

My collaboration with Kevin extended beyond conducting field and laboratory investigations. In 1980 Kevin and I contributed a chapter on the mineral-organic interaction to the book *Soils with Variable Charge* that I edited for the NZSSS. More recently, we co-authored a chapter on climate change for the 2014 book *The Soil Underfoot*, edited by Jock Churchman and Edward Landa.

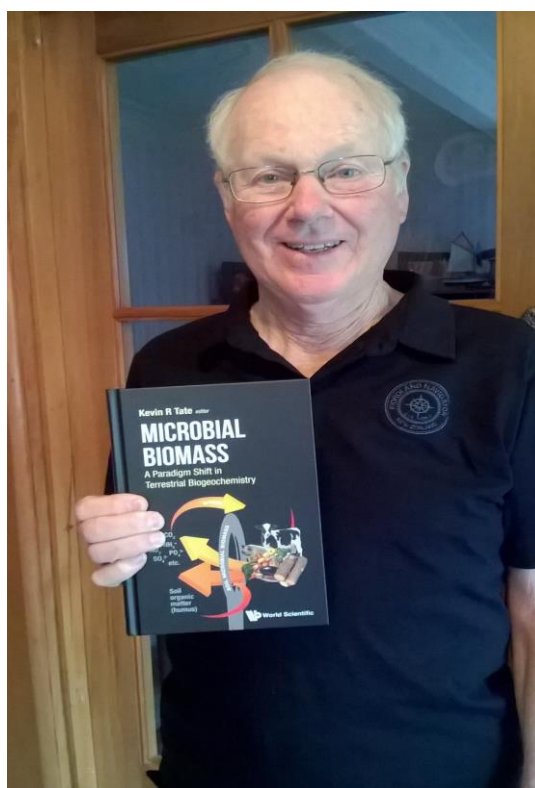
Kevin's humanity, his dedication to research, and his concern about the impact of human-induced climate change and pollution on the environment, are all linked to his deep Christian faith. His broad range of research interests has been an inspiration to all who have worked with him. I mourn the passing of a friend and colleague; at the same time I am very glad to have known, and worked with, Kevin over most of his scientific career.

Kevin's collaboration with Rothamsted Research (by Professor David Powlson)

Kevin spent a sabbatical at Rothamsted in 1980–81. He worked with David Jenkinson and his group on aspects of soil microbial biomass, specifically building on the method for measuring ATP in soil that David had developed during his earlier sabbatical in Australia. One publication (Tate & Jenkinson, *Soil Biology & Biochemistry* (1982) 14, 331–335) was an improved method for measuring ATP in soil. The second publication (Brookes, Tate & Jenkinson, *Soil Biology & Biochemistry* (1984) 15, 9–16) was highly significant. It showed that the soil microbial biomass maintained high values of both ATP and adenylate energy charge (AEC), values similar to organisms in active growth. Yet most soil organisms cannot be in active growth because the energy input into soil through plant material is far too small. This result implied that the soil population must have a previously unknown mechanism for survival in the harsh and substrate-poor environment of soil. This discovery has had a major influence on later thinking about soil microbes and their survival and physiology. To my knowledge, the details of this mechanism are still not fully understood.

An unplanned aspect of Kevin's sabbatical was that he inspired me to start research on the application of nuclear magnetic resonance (NMR) spectroscopy to soil with the aim of identifying functional groups present in soil organic matter. Kevin had already published the first paper on the application of ^{31}P -NMR while in New Zealand. This work, on acid tussock grassland soils, had identified an unusual form of organic P in these soils, namely phosphonate that contains a direct P-C bond. In most forms of organic P, P is bonded to C via O. After discussions on this with Kevin, I made contact with Professor Ed Randall, an NMR specialist at Queen Mary, University of London. Sodium hydroxide extracts of soils from various long-term experiments at Rothamsted were analysed at Queen Mary using ^{31}P -NMR, using the methods developed in New Zealand by Kevin and colleagues. Results showed that an acid soil from the Park Grass experiment did contain phosphonate (like the NZ tussock grassland soils) but a soil at near-neutral pH did not. The main forms of organic P were identified in these soils as well as the decline of the more labile forms in a soil converted from long-term grass to bare fallow. This unexpected collaboration with Kevin led me to embark on several years of NMR studies on soils, turning from identifying forms of organic P to organic C.

In about 2015–16 Kevin took on the role of editor of a book on soil microbial biomass planned to mark 50 years since Jenkinson's first paper introducing the concept in 1966. Attached is a photo of Kevin proudly displaying the first copy of the final product.



While staying in Harpenden, Kevin, Heather, and their children attended High Street Methodist Church, Harpenden, and made many friends there.

Microbes to national carbon accounting (by Neal Scott)

As a Postdoctoral Fellow fresh from Colorado State University I was one of many lucky individuals whom Kevin mentored in 1994. Kevin and Heather welcomed my wife and me to New Zealand, and were instrumental not only in helping us establish ourselves quickly in Palmerston North, but also steering us towards appropriate medical care – our first child was born 4 months after we arrived. Their kindness and generosity over this transition was never forgotten.

Our research initially focused on soil organic matter under different land-cover types. Subsequently the Ministry for the Environment contracted Manaaki Whenua – Landcare Research to scope and develop a national soil carbon monitoring system that could be used for international reporting under the United Nations Framework Convention for Climate Change.

As a relatively new scientist, this project, and Kevin’s leadership, taught me a lot about being an effective scientist and project leader. While incredibly knowledgeable about soil carbon dynamics, Kevin was quick to realise when he needed other expertise, and would seek out and engage people with the necessary skills. He easily made the transition from



microbial biomass to incorporating satellite and other spatial data into this system. Although a long step from the study of microbial processes, Kevin built an effective team of experts with the requisite knowledge base to produce a viable system for the Ministry. Witnessing his project management skills, and how he interacted with government officials, was perhaps some of the most valuable training I received while in New Zealand.

Kevin Tate (middle), the late Des Ross (left) and David Powlson (right) collecting forest soil and plant biomass data

Kevin was a great source of guidance in many ways. As a new father, he always had advice for me, emphasising the importance of family. He instilled the value of “practice what you preach” by relying on his bicycle for transportation (even when he got knocked off by a car). His management of paper, however, was something I tried not to emulate (but have failed). Kevin’s desk would slowly develop larger and larger piles of paper, to the point that you could barely see him when you walked by. When the piles reached critical height, it was time to clean the office! But the most important thing I learned from Kevin was the value of good colleagues, and how to work with teams of scientists from a range of disciplines so that everyone could do their best work and contribute to a project goal. We will miss his vibrant smile and personality.

From a colleague and family friend (Jock Churchman)

With the tragic loss of Kevin, we have lost a valued and reliable colleague, an internationally well-recognised scientist, a man of integrity, a natural leader who worked hard in the community to help make a better world, and, above all, a warm and loyal friend.

Kevin trained as a chemist and, on joining the Soil Bureau at DSIR, quickly became an expert on soil organic matter, at a time when research on soil organic matter was bogged down in archaic chemical dissolution procedures and was apparently getting nowhere. His reading, his great interest in new instrumental and analytical techniques and his scientific creativeness, together with the opportunity to travel for a year to the well-respected Macaulay Institute for Soil Research (now the James Hutton Institute) in Scotland in the early 1970s, meant that he was on the crest of a new wave that treated soil organic matter as a whole. This approach uses mainly NMR, but also such techniques as pyrolysis gas chromatography-mass spectrometry. Kevin pioneered work on both techniques. Among his most cited papers, several from the 1980s on ^{31}P -NMR for identifying organic phosphorus, important for plant nutrition, feature quite heavily. I recall that his work in this area was so highly prized that he was invited to set up a laboratory overseas on this topic. He stayed in New Zealand, for the sake of his family and also to the benefit of New Zealand science and the wider community.

Kevin developed an interest in the measurement of respiration and the emission of gases from soils and has several well-cited papers on these topics dating from the 1980s but peaking in the 1990s. His work on these topics and their microbial origin had a considerable boost from his collaboration with the ‘father’ of soil microbial biomass studies, David Jenkinson, when Kevin gained a fellowship to work for a year at the then prestigious Rothamsted Research laboratories at Harpenden, UK in the early 1980s. Quite recently he was invited to edit *Microbial Biomass* (2017) with authors from around the world as a tribute to David Jenkinson’s memory, and this book stands also as a tribute to the high regard in which Kevin’s contributions are held world-wide.



Kevin in front of a building offering an exhibition on climate change on Jeju

It was a logical step for Kevin from his work on respiration and gases emitted from soils to work on greenhouse gases, carbon dioxide, nitrous oxide, and methane, and on climate change. Typically, Kevin decided to pursue this logical step with gusto so that he became not just a seeker after the truth in this area but a purveyor of that truth and its implications for us all through talks to community groups and chapters in appropriate books. I am personally grateful that, together with Benny Theng, Kevin wrote the opening chapter on climate change of a book I edited, and wrote it with typical enthusiasm.

Island, South Korea while attending the 20th World Congress of Soil Science in 2014



Kevin was a natural leader. He was friendly and wise. At Soil Bureau, he came to be the leader of the Soil Biology and Biochemistry group. In the wider community, he had considerable involvement in education, particularly when his four children, Lauren, Fraser, Andrew and Emma, were at their various schools. It is remarkable that Kevin not only served on the School Committee of Tawhai Primary School in Stokes Valley and the Taita College Council, but was also instantly chosen to be Chair of both these groups. He was never just an ordinary member.

Kevin and Heather at the 20th World Congress of Soil Science in Jeju, South Korea in 2014

Kevin was devoted to his family and was well supported in all of his activities by Heather, his wife of almost 50 years.

My lasting impressions of Kevin include his cycling to work, an activity he continued at



Manaaki Whenua – Landcare Research in Palmerston North, his keenness for conversation, and the fact that he never gave the impression of hurrying, albeit that he achieved so much. He always had time to listen to others. His office, not unlike those of many of us, was a busy place, replete with papers, journals and books, but he knew where to find anything. He was a good speaker – clear and logical – and this made him a good advocate for those causes in which he believed, particularly the importance of facing up to climate change.

Kevin's office – busy as usual

Kevin had a ready sense of humour and an interest in music, particularly jazz – I remember his delight when one of his overseas conferences took him to New Orleans. When he could find the time, he was a keen gardener. He was always encouraging and positive to work with and it was a pleasure to know him both in and out of the work environment. We will all miss him a great deal.

Kevin's funeral in Palmerston North was very well attended. It was not a sad occasion, but rather a celebration of his achievements. Kevin's brother, Warren, and several family members spoke, as did David Whitehead, Benny Theng, Surinder Saggar (Manaaki Whenua – Landcare Research), and Mike Hedley (Massey University, NZSSS Council Member). Mike Hedley thanked Heather and the Tate family on behalf of the wider soil science community in New Zealand for allowing Kevin to make his impressive contribution to the discipline of Soil Science in New Zealand. A contribution that advanced the strong international reputation held by New Zealand soil scientists, in particular the reputation for innovative science addressing globally relevant environmental problems. Mike reminded us of the role Kevin also played in mentoring young scientists and postgraduate students who worked in the DSIR Soil Bureau, Manaaki Whenua – Landcare Research and the wider University and Crown Research Institute networks. Mike also mentioned Kevin's dramatic presentation of *"Gathering Storm Clouds: Carbon and Nutrient Management for a Warmer World"* at the Fertilizer and Lime Centre Workshops at Massey in 2008 (and other public lectures). With this one talk, Kevin, armed with facts fresh from his European trip, raised the awareness of scientists, policy-makers, and rural professionals of the impact of man and agriculture on climate change. Mike concluded by farewelling Kevin the "biogeochemist".



The family celebrating Kevin's 70th birthday, all wearing T-shirts saying 'I love Methanotrophs'

Surinder Saggar¹ & David Whitehead²

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