

**In Memoriam
Stephen White**

1950 to 2006



Stephen White was one of New Zealand's leading geothermal modellers, with an international reputation. His main research areas concerned applications to geothermal energy, and to the underground storage of greenhouse gases. Stephen's work has been published in over 100 articles, and applied widely in many geothermal fields throughout the world. Stephen's work has been published extensively in over 100 articles, and has been applied widely to many geothermal fields throughout the world. One unswerving passion in Stephen's life was his commitment to improving our knowledge of our environment.

Stephen Peter White was born in Nelson, New Zealand on 23 January, 1950. He graduated from Canterbury University in New Zealand, with a PhD in physics in 1976. Joining the New Zealand's Department of Scientific and Industrial Research (DSIR) in 1978, he began working on geothermal models in 1987. Most of Stephen's work since then has involved modelling transport in systems ranging from the nanometre to geological scales.

His first geothermal project was developing a model of the Kawerau Geothermal Field, New Zealand. He wrote his own computer program to simulate single-phase three-dimensional heat and fluid transport in a fractured reservoir. This was the first 3D model of a geothermal system developed by DSIR. It was also the beginning of Stephen's efforts to develop realistic models by utilising all the computational power that was available. This was to be a recurring theme through all his work.

He continued working on Kawerau until the present day, eventually migrating the model to MULKOM and then TOUGH2. Over the years he produced 12 reports on the system. Just before his death he finished preparing the evidence he was to present at an Environment Court appeal regarding Kawerau resource consents. This evidence, and the thoroughness with which it was prepared, was instrumental in the case being settled before the hearing. The work he undertook for the consent process was notable for its innovation linking the reservoir model to a subsidence model to estimate possible subsidence effects.

Stephen's next geothermal project was a series of papers, in conjunction with other members of the Applied Maths team, DSIR, on aspects of two-phase flow in geothermal reservoirs and flow in fractured porous media. One of Stephen's strengths was his ability to develop customised computer code specific to the problem under consideration.

Over the years Stephen's reputation and list of contacts grew, resulting in work on models of various systems in New Zealand (Rotokawa, Tauhara) and overseas (Kakkonda and Uenotai in Japan). He was a regular attendee at the World Geothermal Congress, New Zealand Geothermal Workshop and TOUGH Workshop.

In the early 1990's Stephen started working on reactive transport models. This was pioneering work incorporating geochemistry into reservoir simulation models, and was perhaps his key scientific contribution. The main focus of this work was the development of ChemTOUGH2, an extension of the TOUGH2 reservoir simulator, which simulates the transport and reactions of water, heat and many chemical species. Applications of the work to geothermal systems included using chemical signatures to calibrate reservoir models; calculating deposition of silica; looking at changes in mineralization resulting from magmatic intrusions; and incorporating chemistry into a wellbore simulator. An important application of ChemTOUGH2 was to the problem of sequestering greenhouse gases in underground reservoirs. By using ChemTOUGH2 Stephen was able to predict CO₂-rock interactions and predict levels of sequestration.

This research on reactive transport led to his being invited to Japan in 1995 as a Jistec Fellow at the Tohoku National Industrial Research Institute, Sendai, and the US in 1997 as a Research Scholar at Lawrence Berkeley National Laboratory. Between 1999 and 2003 Stephen was a Principal Investigator on a US Department of Energy funded study into natural CO₂ reservoirs.

In 2000, Stephen began working on his most challenging geothermal model — that of the Luise geothermal system on the Papua New Guinea island of Lihir, where an open pit goldmine is being dug into the geothermal system. The greatest challenges in the model are dealing with the changing ground surface as the pit is dug and the operational requirements of obtaining pressures on a 10m scale. Again this was an example of Stephen utilising all the computation power available to him to develop a physically realistic model.

As well as geothermal modelling, Stephen worked on modelling problems in other fields, many involving chemical reactions and flow. One significant contribution was his work on pitting corrosion where he modelled the formation of micro-pits in stainless steel. This involved modelling the electrochemistry, metal dissolution and ion flow. Stephen's computer modelling revealed the process through which these micro-pits grow — direct measurements destroy the conditions required for pit growth. The model used an adaptable finite element grid, to describe the evolving structure of the pit; solution of the electrical current flows, species migration and diffusion; all coupled to the strongly buffered chemical equilibria which hold between the chemical species in and about the pit. This model of pit growth also allowed a statistical model to be developed, involving multiple pits, and then a risk model to be developed which is presently used by corrosion engineers in their on-site inspections of large industrial plants.

This description is just a glimpse of Stephen's work on pitting corrosion. Bearing in mind the large number of research areas involved in this work gives some insight into the breadth of his work. He has made significant contributions to many research areas, several of them being of international standard, and in time some of Stephen's papers may become part of the folklore in these specialist areas.

Outside of work, part of Stephen's life was dominated by the rhythm of the seasons: over winter preparing his beloved Z class racing yacht Zephyrus for the coming summer competition and skiing on Mt Ruapehu; in summer racing Zephyrus on Paremata Harbour near Wellington; upgrading the Aorangi Ski Club lodge; fishing, tramping and canoeing with his family; painting his house before winter approached, but being frequently interrupted by the latest cricket broadcasts.

Some of the constants in Stephen's life were his deep love of his family; his commitment to his friends through his interests in badminton and the Toastmasters Club; his love of classic racing cars; growing roses, strawberries and new potatoes; brewing beer; drinking fine wine and creating and celebrating fine cuisine. He met his wife to be, Karen Garner, at the Applied Maths Division soon after he started working for DSIR in 1978, and they were married in 1980.

Stephen died suddenly and unexpectedly on September 17, 2006, which was a great shock to his many friends and colleagues throughout the world. Stephen loved life, especially the fine and natural aspects, he touched many people, enriched our lives, and provided an outstanding example of the best qualities of what it means to be human. The fundamental nature of Stephen's work, and his dedication to it, will be an inspiration to all his colleagues to continue to keep our heads raised and to focus on our aspirations, bearing in mind the need to treat our fellow travellers with dignity and compassion. There is a massive gap where Stephen once was, but our memory of him will remain an inspiration to us, in both our professional and private lives.

John Burnell and Graham Weir