PREFACE TO THIS SPECIAL ISSUE

Dr Stephen White (1950–2006)

This Special Issue of the *ANZIAM Journal* arose from a conference held at Industrial Research, Gracefield, Lower Hutt, New Zealand, on 29 August 2006, to celebrate the research career of Dr Stephen White. Stephen was an international expert in the development and application of numerical methods to quantify fluid flow in porous media, especially those involving heat and chemical transport. As a mathematical modeller, Stephen White's work has been published extensively, and applied in many practical areas.

Stephen's research was of international standing, and has proved of great significance to New Zealand and internationally. It has been applied widely in the planning, development and maintenance of many geothermal fields in New Zealand, Japan and Papua New Guinea, and also to projects on the underground storage of greenhouse gases in Japan and the United States. One unswerving passion in Stephen's work was his commitment to improving our knowledge of our environment.

Reservoir simulations are critical to the assessment of the impacts of geothermal developments, and the mathematical modelling work of Dr White has been prominent in developing methods to undertake this assessment. His work also focused on predictions of the future behaviour of a geothermal system. Sufficient time has now elapsed for earlier predictions of the behaviour of exploited geothermal fields to be assessed. In a number of post-production assessments, the predictions of Dr White have been compared with actual behaviour, and found to be remarkably accurate.

Dr White appeared as an expert witness in several resource consent hearings, and as a key reviewer for several large geothermal programmes, both in New Zealand and internationally. He was widely regarded as one of the leading international experts on geothermal reservoir simulation.

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 were dealing with the changing ground surface as the pit is dug and the operational requirements of obtaining pressures on a 10 m scale. Again this was an example of Stephen utilizing all the computation power available to him to develop a physically realistic model.

Perhaps the key single contribution from Dr White has been his extension to the reservoir simulator, TOUGH2 (transport of unsaturated groundwater and heat), developed by Karsten Pruess, to include transport and reactions of chemical species. The resulting simulator, developed by Dr White and his collaborators, is called ChemTOUGH2, and allows numerical simulations to be performed of the key processes that occur in underground flow problems.

This important development has allowed many new problems to be analysed. For example, deposition of silica is a fundamental process in many geothermal fields, and Dr White was involved in key developments in this area. This work has been compared with many experiments, and found to be of considerable predictive value.

Another important new problem which was treated by Stephen concerned the changes in mineralization resulting from magmatic intrusions. His models show that buoyancy generated by the magmatic intrusion sweeps fluid into the region of the intrusion, where chemical reactions occur in this high-temperature environment, and pass new chemical species into the flow field. As the flow moves away from the intrusion, other chemical reactions occur in the lower-temperature environment, and a characteristic halo of mineralization and pH variation occurs. These predictions have some support from analysis of core samples where drilling has intersected a magmatic intrusion in the Taupo Volcanic Zone.

The development of reactive transport simulators is an important development in the last decade, or so, and international code comparisons and benchmarking have been developed. Dr White submitted ChemTOUGH2 to several such international comparisons, and the performance of his numerical simulator is now widely known to at least equal the performance of other simulators.

Dr White played an important and leading role in investigating, and quantifying, many of the mechanisms involved in trapping greenhouse gases for long-term underground storage. He was one of the top researchers in this field, with about fifteen years' experience, and completed research contracts funded by the Japanese, New Zealand and United States governments.

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 work was a significant contribution in this area and resulted in several new insights into mechanisms by which these pits can grow.

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Stephen was a highly skilled mathematical scientist, specializing in the application of numerical methods to solve key industrial and environmental problems. He performed research on both numerical methods, and on the quantification of aspects of many physically-based problems, and has over 100 publications as journal papers or conference proceedings. In addition, he also worked as a consultant on many important projects, which needed his specialized skills. Thus his work progressed from pure research to direct application. This involved not only the development and application of scientific methodology, at a very high level, but also the ability to work in multi-disciplinary teams, focused on the achievement of externally prescribed and important goals.

The papers in this Special Issue reflect some of Stephen's many research interests. Four papers, by Weir; Grant; McKibbin, Smith and Fullard; and McNabb report new results on geothermal phenomena. Two papers by Butcher and by O'Neale and McLachlan relate to numerical matters, a special passion for Stephen. The remaining papers by McGuinness; Burnell; Luo, Wake and Hawk; MacKay, White and Hendy; Young; Lund and Hendy; and Withers, relate mainly to industrial and reactive transport problems, one of Stephen's general areas of expertise.

John Burnell and Graham Weir
Guest Editors

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