

# David Sangster

## — A Life in Science

by Dr Ron Clarke

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After 20 years as an honorary research associate within the School, the time has come (“the walrus said”) for David Sangster to finally hang up his gloves and his lab coat. David’s career in chemistry has spanned more than 60 years, since he first enrolled as a science student at the University of Adelaide in 1942. In this article I would like to present a brief outline of David’s career, firstly as a way of honouring his significant contributions to chemistry, but also simply because David’s story is a fascinating one in the way that it mirrors postwar changes in both international and Australian science and society.

David’s childhood and youth was spent in country South Australia during the 1920’s and 30’s, first in Balaklava, a small country town in South Australia’s Mid-North, and later in Victor Harbor, a popular weekend seaside destination for

inhabitants of Adelaide, situated on Encounter Bay on the Fleurieu Peninsula south of Adelaide. The reason David grew up in the country was that his father was an area manager for the stock and station agents Goldsborough-Mort (which later merged with its then competitor Elder-Smith). David's father's job often involved him visiting farmers' properties, arranging livestock auctions and organising cattle and sheep sales between farmers. David went with his father on many of these trips, but he always took a book to entertain himself while the business was being transacted. It was David's voracious appetite for reading (sometimes by weak torchlight) which probably induced his bad eyesight and caused him to have to wear very strong glasses for most of his life.

When David's father was transferred to the company's South Australian head office in Adelaide, David settled with his parents and brother Bob and sister Heather in the Adelaide Eastern suburbs. Although Adelaide is the capital city of South Australia, then and still now, it has some of the characteristics of a big country town. In the past, a relatively small number of wealthy families (Bonython, Elder, Ayers, Barr-Smith, Downer) dominated Adelaide society, many of whose names are commemorated in buildings of the University for which they were benefactors. Adelaide's most well-known inhabitant (at least locally) was, however, for many years George the Orangutan, who lived at the Adelaide Zoo and who endeared himself to the Adelaide public with his amusing behaviour. As in a country town, it seems that in Adelaide everyone knows everyone else or at least they have common acquaintances. An example of this is that when David's father moved to Goldsborough-Mort's office in Adelaide, his personal secretary was

a young woman named Vera Clarke, the mother of the author of this article.

David completed his schooling at St. Peter's College, the same school which the Nobel prizewinners Lawrence Bragg and Howard Florey had previously attended and which the prominent South Australian Labor premier Don Dunstan would also later attend. From there David entered the University of Adelaide and began studying chemistry in 1942. At an early stage he must have made quite an impression amongst his lecturers, because while he was still a first year student he was appointed by Dr. S. W. Pennycuik, Reader in Physical Chemistry, as a "cadet" and the following year he was already virtually running the second and third year practical classes in Physical Chemistry. Apparently at that stage in his scientific career Dr. Pennycuik was more interested in promoting chemistry for the masses rather than actively carrying out chemical research, and he was happy to let David take over the task of running the teaching labs. Apart from his studies and his work as a cadet, David was also actively involved in student politics. He was elected chairman of the Men's Union and served as a delegate to a Student Conference held at that time in Brisbane. On his way back to Adelaide he took advantage of this travel opportunity by calling in on the Physical Chemistry departments of the Universities of Queensland, Sydney and Melbourne to have a look at their practical classes and gather ideas for the teaching labs at his home university.

In 1946 David first began work in the field to which he would later devote most of his career, radiation chemistry, when he started his honours project in chemistry on the topic of "Making and using radioactive elements to

study chemical kinetics". During his honours year he made his own radiobromine using radon from the Royal Adelaide Hospital's radium source and reacting it with beryllium. The neutrons produced were slowed down in a small tank of water and reacted with potassium bromate in solution. The excess energy obtained following capture of the neutrons ejected the radiobromine from the bromate anion and could thus be separated. With valuable help from Harry Oliphant (brother of Sir Mark Oliphant) in the Physics Department, David constructed his own Geiger counter in order to measure the radioactivity of his radiobromine. In 1947 he graduated with a B.Sc. with first class honours.

While David was at Adelaide University he met his future wife, Christobel, who was studying for a B.Sc. in botany at the time. They were married in Adelaide in January 1948 and she was his companion in all of his life's adventures for the next 59 years. Together they had 3 sons, Antony (born 1953), Nicholas (born 1955) and Peter (born 1960). Both Antony and Nicholas were born in Cowley, just outside of Oxford in England. Peter was born at the King George V Hospital, Sydney, which closed at the end of 2002, but which was located across Missenden Road from the Royal Prince Alfred Hospital. Sadly, Christobel passed away in May 2007.

At the time David finished his undergraduate studies at the University of Adelaide it wasn't possible for Adelaide B.Sc. graduates to continue postgraduate studies towards a PhD. Students who wanted to obtain a PhD had to continue their studies in England. In David's case he obtained a position as a Research Officer with the CSIR (before the Organisation was added) in its Section of Nuclear Research due to the experience he'd already gained in radiochemistry.

He worked at CSIR Soils Division at the Waite Institute, Adelaide until, in November 1948, he was seconded to the Atomic Energy Research Establishment (AERE) at Harwell, England, which was short of qualified chemists. The intention was to assist Britain with its atomic energy programme and to form the nucleus for any future Australian programme.

David's first assignment involved investigating the swelling of cans containing uranium metal fuel elements by the adventitious production of gas. The British used the Australians as a task force to investigate problems which needed urgent solutions. Later David worked on the chromatographic separation of Group 8 fission products and the separation and purification of  $^{210}\text{Po}$ , the same element recently allegedly used to poison the former Russian spy Alexander Litvinenko. David's work often involved very long hours. One year between Easter and Whitsun he worked every day, sometimes getting home when the lark was high in the sky heralding the dawn, and then having a short sleep before he was off again to work before his wife even woke up.

Some of the work David carried out in Harwell was potentially very hazardous. In one project he calculated that if one part in  $10^{17}$  escaped into the laboratory atmosphere, it would exceed the allowable limit. It did happen one time and the laboratory had to be evacuated. The next fortnight was then spent cleaning and monitoring every surface before normal work could resume. Much of the work they carried out was in vented glove boxes with double arm-length gloves in addition to surgical gloves. If the light in the lab was off, the reagent bottles and centrifuge tubes in the glove boxes glowed in the dark because of the intense radioactivity.

The work which was then



being carried out at Harwell was certainly given a high priority by the British Government. One example demonstrating this is that one of the projects that David worked on was deemed so important that the lab received a visit from the Duke of Edinburgh and Lord Louis Mountbatten. Because of the large number of Australians working at the establishment, they were also visited by Australian politicians on official visits to Britain, including the then prime minister Sir Robert Menzies and the premier of South Australia Sir Thomas Playford.

Living and working in Harwell in the late 1940's and

1950's must have been a very exciting time. The AERE was a very interdisciplinary place and David's colleagues had a variety of talents. Some were physicists, some chemists, some engineers, some spies, or a combination of these. One of the most famous of the last was Klaus Fuchs, who had emigrated to Great Britain in the 1930's to escape the Nazi regime and during the war had worked on the Manhattan Project in the USA. After the war he returned to England and, at the time David started work in Harwell, Fuchs was the Head of the Theoretical Physics Division there. In 1950 he was arrested by



British MI5 officers and convicted of passing secret information on the development of the bomb while he was still in the USA to Russian KGB agents. He was imprisoned for nine years, after which he left England for East Germany where he was still able to successfully pursue a prominent scientific career within the Communist regime there.

During David's time in Harwell, Great Britain and Australia had much stronger ties than nowadays. Direct evidence for this is that the British were allowed by the Australian Government of Sir Robert Menzies to conduct atomic bomb tests at Maralinga in the Far North of South Australia. During the second and third of these tests David returned temporarily to South Australia in 1953 as part of a small team to the Weapons Research Establishment (now known by the more politically correct name of the Defence Research Centre) in

Salisbury, north of Adelaide. Perhaps luckily, however, David missed out on actually visiting the test site because of a dinner invitation from Professor Macbeth, then Professor of Chemistry at Adelaide University. While he was at Salisbury David carried out radioanalyses of nuclear weapons' clouds in order to determine the distribution of fission products. At Harwell David also carried out such analyses, at one stage on the cloud of a Russian bomb.

The handsome young man shown above is David at his desk in Harwell in 1957. He spent a total of 8 years there, at the same time mastering the various British accents. At the time David left Harwell there were 49 Australians who either had trained or were training there. When they left they took up a collection and presented two oil paintings (including one by Russell Drysdale) and twenty prints

by other Australian painters as an expression of their gratitude and in memory of their time at Harwell.

At the beginning of 1957 David returned to work permanently in Australia at Lucas Heights with the Australian Atomic Energy Commission (AAEC), predecessor of ANSTO. There he worked as the Radiation Chemistry Group Leader within its Isotope Division and later as Section Head of Reactor Chemistry and of Irradiation Research and Technology. During the early days at Lucas Heights, David and others had to turn their hands to all sorts of tasks to make up for absent skills, e.g. radioactive lab design, construction of efficient fume hoods, furniture, effluent and waste disposal, recruiting and the building up of a first class scientific library. In 1958 he also organized the Australian Symposium on Atomic Energy, which with 5 parallel sessions plus 5 general plenary

talks may well have been the first major postwar Australian scientific conference held on any subject. After many years of working with the AAEC, David officially transferred to the CSIRO in 1982 although he stayed at Lucas Heights and became the Officer-in-Charge of the Lucas Heights Unit of its Divisions of Chemical Physics and Materials Science and Technology. From 1988 he was working for the Division of Chemicals and Polymers.

One of David's major scientific contributions while at Lucas Heights was the introduction of the technique of pulse radiolysis to Australia. Pulse radiolysis is the radiation analogue of flash photolysis. A burst of electrons is injected into a system such as an aqueous solution and the appearance of early products and their disappearance in real time is monitored by fast spectrometry. This gives valuable information on the nature of the intermediates, their reactions and their kinetic rate constants. He was able to arrange a 6 week stay with Ed Hart at the Argonne National Laboratory, where he learnt the technique. This was followed by brief inspections of other centres in the USA. He had already supervised the installation and use of a 1.3 MV van de Graaff electron accelerator at Lucas Heights. Although nobody had attempted pulse radiolysis with a machine of such low power (Argonne used 16 MV, known as "The Iron Maiden"), David resolved to adapt the facilities at Lucas Heights for pulse radiolysis. The electronic engineers at Lucas Heights succeeded in doing this and in constructing the necessary fast detection system. David developed the optics, and together with Ron Cooper (who had been inspired to spend a sabbatical at Argonne) they made and detected the first hydrated electron in the Southern Hemisphere. David had come to the realisation that in Australia it would not be possible

to compete with other countries like the USA with more resources and make a worthwhile experimental contribution to the fundamentals of radiation chemistry, but that there was certainly scope in this country for using radiation techniques in other fields of chemistry. The pulse radiolysis system proved to be very successful; there were waiting times of up to 6 weeks to use it and many papers and theses resulted. Through these collaborations David was appointed to honorary positions, actual or de facto, at 13 different universities.

In getting involved in polymer chemistry David was influenced by the late Jim O'Donnell, who had joined the University of Queensland and who was extolling the importance and fascination of polymers. David didn't need much convincing, though, because he was aware from his work at Lucas Heights that polymers were the chief commercial application of radiation and Australian industry was spending more money on the irradiation of polymers than on any other aspect of the nuclear age except uranium mining. Jim and David were later to write an introductory text book, *Principles of Radiation Chemistry* which was most successful in Japanese translation (1980).

It was through David's attendance at Australian Polymer Symposia and Physical Chemistry Conferences that he first met Don Napper and Bob Gilbert. David's connections with the School of Chemistry at Sydney University started in the early 1960's, shortly after his return to the Australian Atomic Energy Commission at Lucas Heights. While he was there he supervised the research of PhD students and postdocs from universities all around Australia, including Sydney. One of his most fruitful collaborations was with Don Napper, who was later appointed

professor of physical chemistry, and with Bob Gilbert, until last year Director of the Key Centre for Polymer Colloids. One of Don's and Bob's major areas of research was the kinetics and mechanism of free radical emulsion polymerisation. They had a PhD student, Brian Hawkett (now Development Manager at the Key Centre), who had obtained results contrary to some ideas they had on the mechanisms of emulsion polymerisation and to a report in the literature. This report involved gamma radiation and they wished to repeat the experiment.

According to their reaction mechanism, in order for the propagation of such polymerisation reactions to occur an initiation reaction involving the formation of free radicals is first required. One method of forming free radicals is via gamma radiation from a radioactive source. This is an area where David is a world expert. Therefore, it was natural that David, Don and Bob should join forces. The investigation involved first exposing a sample of monomer to gamma radiation to initiate radical formation. Once polymerisation is proceeding at a steady state, the sample is then rapidly removed from the gamma source. This immediately causes a massive drop in the rate of new initiation and hence a relaxation in the rate of polymerisation. From the time dependence of the relaxation it is possible to gain valuable information on the rate constants and mechanism of the polymerisation. The method can be thought of as a free radical concentration jump technique. Another student set up the equipment at Lucas Heights and the resulting data confirmed Brian's results. Since David, Don and Bob developed the technique in 1979, essentially the same set-up but with automatic tracking and data collection developed by David is still being used to this day by researchers

from around the world.

During his time at Lucas Heights David was also active on the international stage. In 1967 he was invited by the International Atomic Energy Agency to be the Chairman of an Expert Panel on "Radiation Chemistry and its Applications", held in Vienna. At that time Austria was a neutral country. In 1955 after the Second World War it had been a condition for the withdrawal of all the occupying forces, i.e. both allied and Russian troops, and the establishment of a sovereign Austrian state that Austria remain neutral and never join either NATO or the Warsaw pact. In 1967 at the height of the cold war, how David came to be chosen as chairman of the International Atomic Energy Agency's meeting is unclear. Perhaps in the eyes of the Russians an Australian scientist was deemed to be more neutral than a British, American or French one. Since then he has attended and contributed to many international conferences and symposia.

It was while he was still a student at Adelaide University that David's long association with the Royal Australian Chemical Institute (RACI) began. He first joined as a student member in 1942, long before the existence of the RACI Polymer Division, in which he was later to be so active. The seventieth anniversary of his membership is, therefore, only a few years away. In 1975-76 he was NSW Branch President and a Member of the RACI Executive Council. The Polymer Division was not established until either the late 1950's or early 1960's, depending on whose account one reads. A polymer symposium was organized in 1957 in Adelaide by Prof. D. O. Jordan (widely referred to simply as "DOJ"), Professor of Physical Chemistry at the University of Adelaide, who was famous for his pioneering work on DNA. The Victorian Polymer

Group, headed by Dr. Hans Battaerd, Mr. Geoff Hardy and Dr. David Solomon, held a symposium in Mildura in 1964. Since that time David (Sangster) has a record of attending almost every Australian or Australasian Polymer Symposium. In 1980 David was elected Chairman of the National RACI Polymer Division and was the organizer of the 13<sup>th</sup> Australian Polymer Symposium held at Blackheath in 1981. He has received two citations for excellence from the Polymer Division. In 2006, in recognition of David's contributions to the field of polymer radiation chemistry and emulsion polymerisation, the RACI Polymer Division renamed its Polymer Science and Technology Achievement Award as the David Sangster Award for Achievement in Polymer Science and Technology Award. The purpose of this award, which is made every two years, is to recognize the achievements of Australian polymer scientists under 40 years of age while their careers are still developing.

David finally retired from Lucas Heights in 1989. In recognition of his long service and his contribution to radiation chemistry, a research conference was held and a special commemorative issue of the journal *Radiation Physics and Chemistry* was dedicated in his honour. Later he was elected an Honorary Fellow of the Australian Institute for Nuclear Science and Engineering (AINSE), which played an important role in his career.

At the time of his retirement David had become such a valuable research collaborator for Don Napper's and Bob Gilbert's group that they couldn't afford to lose him. Therefore, Don nominated him as an Honorary Research Associate within the Division of Physical Chemistry at the University of Sydney. He has been here now in that role for nearly 20 years. So actually one can

hardly say that he retired at all, merely changed jobs. During his time within the School, David has continued researching, supervising postgraduate students, writing research papers (approximately 100 to date) and giving presentations at conferences (roughly 200). In 1997 he was President of the Sydney University Chemical Society and in 2007 in recognition of his services to the society and his contributions to chemistry he was elected, together with Don Napper, to life membership.

Now at age 83 David is putting the finishing touches on what he thinks will be his last scientific paper. After that he has decided to bring his active research career in chemistry to a close and intends to embark on a new research career in family history, a career to which up until now he could only devote himself part-time. He also has a further active role as grandpa to seven grandchildren. We wish him much success in these new careers and we thank him for his dedication and friendship to everyone within the School and for all of his many contributions to chemistry.

David himself has asked me to record his appreciation and thanks to the many who have contributed to his life in so many ways. He is eternally grateful. ♦