4 The Second Decade 1969 - 80 – the inflationary seventies

Contrasting with the political and economic stability of the previous decade, the 70s brought massive changes to Australian society. The Labor Party led by Gough Whitlam won the 1972 election and became the focal point for some of this change. Australian servicemen and women returned home from Vietnam, the Nuclear Non-Proliferation Treaty was ratified, 18 year olds were given the vote, the white Australia policy was rescinded, the notion of multiculturalism was introduced to Australian society and university tuition fees were abolished.

Mineral prospecting and the search for natural gas and oil produced results that demonstrated Australia had sufficient coal, natural gas and some oil reserves which could be used for power production and heating. Australia also proved to have huge deposits of uranium and other minerals. This led to the minerals boom of the early 70s. One example of the frenzy that accompanied this boom is the mining company, Poseidon, whose share price surged from 80 cents to $280 before collapsing. This mining boom brought with it the beginnings of inflation.

The AAEC, during this decade, was forced to realign its research goals. Although the Jervis Bay power reactor complex had been cancelled in 1971-2, work on uranium enrichment at Lucas Heights continued. The cancellation of the Jervis Bay reactor impacted on some universities, which in anticipation of the development of nuclear power, had been considering the possibility of providing nuclear engineering courses. The University of New South Wales, for example, was already providing such courses, in which Leslie Kemeny played a major part.

The Whitlam Government wanted Australia to develop and control its own mineral resources especially uranium, even though nuclear power production was no longer being considered. Australia exported uranium in the form of uranium oxide (yellow cake) but by processing this into enriched uranium or even as uranium fuel pellets it was thought that the export price could be greatly increased producing a value-added export. To this end, the uranium enrichment work in the AAEC was encouraged by government. Furthermore, at Whitlam's instigation, the AAEC became a part owner of uranium reserves and the company, Energy Resources of Australia (ERA). This situation meant that the AAEC was also engaged in uranium exploration. Once Whitlam was out of office, the AAEC was required to divest itself of its mining ownership and operations.

At the AINSE secretariat, work continued as before under the stable stewardship of Bill Palmer. Conferences and seminars continued to be organised, and studentships, postdoctoral fellowships and research awards continued to be allocated. By 1974 Philip Baxter as Chairman and Maurice Timbs' stewardship of the AAEC as Executive Member had been replaced by R M Boswell as (Executive) Chairman.

AINSE presidents in the decade were

1969 and 1970	David Caro, The University of Melbourne
1971 and 1972	Max Brennan, Flinders University
1973 and 1974	Ernest Titterton, Australian National University
1975 and 1976	Peter Parsons, La Trobe University
1977 and 1978	Eric Hall, University of Newcastle
1979 and 1980	Ralph Parsons, University of Queensland.

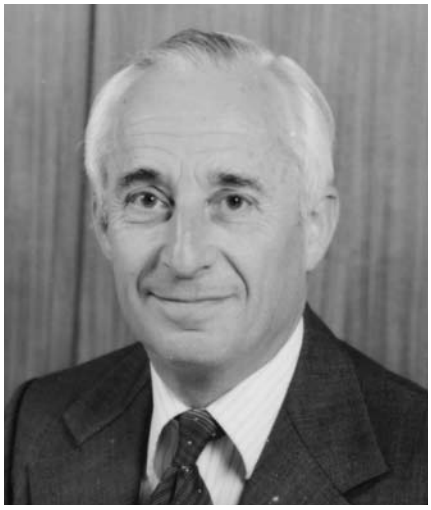


Photo courtesy of the University of Melbourne Archive

Professor David Caro AO

David Caro's career at the Universities of Melbourne, Tasmania and Northern Territory is long and distinguished. He was Professor of Experimental Physics at the time of his term as AINSE President from 1969 to 1970. Later he was appointed Deputy Vice-Chancellor at the University of Melbourne from 1972 to 1978, Vice Chancellor, University of Tasmania from 1978 to 1982, Vice-Chancellor University of Melbourne from 1982 to 1987 and interim Vice-Chancellor of the Northern Territory University from 1988 to 1989.

David Caro served as AINSE Councillor from 1965 to 1973.

His strong leadership through a period of major change assisted AINSE in maintaining its activities and its funding despite the effects of high inflation. During his time on the Council, the AAEC had to abandon its plans for building a nuclear power reactor at Jervis Bay.

4.1 Membership

AINSE expansion continued to follow growth of the tertiary sector throughout the seventies, albeit being more subdued than in the previous decade. Three new universities were formed during the decade and all joined AINSE: James Cook University in 1970; Griffith University in 1974; and the University of Wollongong (previously a college of the University of New South Wales from 1951 to 1974) in 1975.

4.1.1 University of Papua New Guinea

Towards the end of the 60s, Australia's stewardship of the Territory of Papua New Guinea was nearing an end. To assist this fledgling nation educate and develop its own people, universities and tertiary colleges were established. These institutions were small and were not particularly well-funded.

In 1970 the University of Papua New Guinea sought information concerning membership of AINSE. In response, the Institute advised the University that should it proceed its membership fee would be set at the lowest level. This response did not result in an application to join AINSE.

4.2 Finances - inflation begins to affect AINSE

In August 1969 the AINSE Council agreed to increase the annual subscriptions by 25% from 1 January 1970. This seemed like a huge increase but at the time it was assumed that this would carry AINSE through a period of three years. The Council also agreed to

> *...request the AAEC to increase its annual subscription to the Institute … to an amount at least equal to the total amount payable as annual subscription by the member universities ...* and *... to request the AAEC to ask the Commonwealth Government to increase the annual 'Contribution for Research and Training' … to $200,000 … from 1st January 1970.*

The Australian Federal Cabinet[55] on 23 July 1970 approved an increase of $50,000 in the annual contribution be made to the AINSE technical program by the AAEC from $150,000 to $200,000 with effect from 1 January 1970. The Cabinet[56] then agreed that the AAEC subscription to AINSE *be increased to match the sum of university contributions on a dollar for dollar basis,* an increase of $24,500.This was possibly the last time that the Commonwealth Government agreed to the requests from AINSE passed through the AAEC for increases in AAEC subscriptions and the Commonwealth contributions. As will be seen in subsequent years these requests would not be met and if increases were agreed, they were substantially less than those requested.

Inflation was a persistent factor in early 70s but by 1976, inflationary pressures required that drastic action be taken. While AINSE had maintained a surplus each year and held it in reserve to act as a buffer, it was becoming apparent that the Institute could no longer budget for more than a year in advance, let alone three years, as had been the case in previous years. The ultimate solution was to index all AINSE subscriptions but it is worthwhile to follow the challenging journey that the AINSE Council and Executive Committee took during those economically turbulent times.

4.2.1 AINSE Council and Executive Committee responses to inflationary pressures

In May 1972 the Council faced a situation whereby the Institute's practice of drawing on reserves to meet operational needs had resulted in the effective depletion of such reserves. The AAEC Director of Finance advised AINSE he regarded the situation to be serious. While the Executive Officer suggested that the situation could be alleviated by deferment of some commitments, the Council agreed to a 25% increase in university subscriptions effective from January 1973. The Council was looking at an income for 1973 of $390,000 made up of $70,000 from university contributions, $70,000 from the AAEC and $250,000 from the contribution to research and training. The latter two amounts were dependent

55 A5873 (A5873/1) 548M (order as A5873 Volume 2) Ministry – Cabinet Minute – Proposed increase in AAEC payments to the AINSE Submission 3777, 23 July 1970

56 ibid

Photo courtesy of the Australian Academy of Science

Professor Max Brennan AO FAA

Max Brennan represented Flinders University on the AINSE Council for over fourteen years from 1966 to 1969 and from 1971 to 1980, with two of these years as AINSE President in 1971 and 1972. During this extended period, he was actively engaged in AINSE and supported plasma physics research in collaboration with the AAEC.

Max Brennan played a valuable part in AINSE Plasma Physics conferences, by serving on the organising committee over many years and as Conference President in 1971 and 1987. He also provided invaluable advice to AINSE on awards for fellowships, studentships and grants. As Chairman of the AAEC from 1983 to 1987 and as Chairman of the International Fusion Research Council (International Atomic Energy Agency) from 1987 to 1995, Max Brennan played a significant part in establishing the high status of nuclear science and plasma physics research both internationally and nationally.

He moved back to the University of Sydney as Professor of Physics (Plasma Physics) in 1981 and later became Pro Vice-Chancellor until 1991.

In 1991 he took up an appointment as Chair of the Australian Research Council, a position he held for six years, after which he took up chairmanship of the Physical Sciences and Engineering Panel in the Cooperative Research Centres Program for several more years.

He was the inaugural Chief Scientist for South Australia from June 2005 to December 2007.

Max Brennan's research, over a period of about 35 years, covered the fields of cosmic ray air showers, nuclear physics and plasma physics.

on the AAEC's agreement to pay an increased amount and also on the Commonwealth Government's agreement to increase its contribution.

The situation at the Council at its February 1973 meeting was somewhat confusing. The AAEC had yet to respond positively to AINSE's request for additional funding and the projected income for 1973 was now being expressed as ranging from a minimum of $329,000 to a maximum of $393,000.

In May, Council received advice from the AAEC that it was prepared to match the universities' contribution and that it would recommend to the Commonwealth Government that it increase its contribution as requested. While this was positive news AINSE had to face the real possibility of generating a deficit in its operation.

The uncertainties surrounding AINSE's income continued until February 1974 when *Council noted the advice received from the AAEC on 16/1/74 that the Commission's membership subscription to AINSE is increased to $70,000 pa from 1/1/73 and the contribution to research and training is increased to $250,000 pa from 1/1/74.* This seemed to be good news but as Council had already sent a request that this contribution be increased to $300,000 from 1 January 1975, Council considered the state of its budget and it foresaw that the contribution for research and training would need to be increased even further. The Council further

> *... agreed that consideration should be given at a later meeting to formulating a request to the Australian Atomic Energy Commission to obtain an increase in the annual contribution for Research and Training to bring it to at least $375,000 pa from 1/1/76.*

The response from the Commission was relatively swift. At the second Council meeting of the year in May the *President drew Council's attention to the letter from the AAEC dated 1/4/74 … that the AAEC could not support the AINSE Council's request that the contribution for Research and Training be increased by $50,000 pa to a total of $300,000 pa from 1 January 1975.*

It now appeared that a request for an amount of $375,000 would not be successful. The next alternative was to increase subscriptions for 1976 and beyond. This increase amounted to a staggering 50%.

In September 1975 the Executive Committee noted that the AAEC would pay

> *... annual membership subscription of $105,000 and grants in aid of the technical program, $250,000 … will be made at the beginning of January 1976.*

The request to increase the research and training contribution had not been agreed to but at least the AAEC subscription had increased.

It was becoming apparent that subscriptions could not be adjusted by 50% or even 20% on a regular basis. It was time to reconsider which AINSE activities would be given priority and to consider the overall issue of the allocation of funds.

In February 1976 the President of AINSE at the Council Meeting noted that

> *Professor R.W. Parsons, expressed support for an overall review of the AINSE operations to determine where its priorities should lie, so that we are in a position to argue strongly for the 'Contribution of Research and Training' to be increased to a level which restores the value lost by inflation.*

By the time the Executive Committee met in April 1976 news was indeed grim:

> *The President advised the Committee that there appeared to be very little prospect of the Institute obtaining from its usual sources any significant increase for 1977 above the funds obtained in 1976 ($112,500 as university subscriptions + $105,000 as AAEC subscriptions and + $250,000 as AAEC contribution for Research and Training). All membership subscriptions had increased by 50% from 1/1/76, with the 'contribution' remaining unchanged at the level effective from 1/1/74.*

These concerns on inflation were serious and there was a discussion on whether to index the annual subscriptions. The AAEC was also hit by inflation which resulted in changes to its rules governing charges to AINSE for facilities access.

> *The Committee noted that the new rules included provision for many AAEC services to be charged to AINSE at 50% of AAEC's standard rates, and … the AAEC will not charge AINSE for the use of the 3 MeV and 1.3 MeV accelerators and the neutron*

Professor Eric Hall

Eric Hall, a New Zealander by birth was born in October 1925. After completing his degree at Victoria University of Wellington he was awarded a PhD in 1952 from Cambridge University where he conducted research in the Cavendish Laboratory. He was a research assistant at the University of Cambridge for a year before taking up a lectureship in physics at the University of Sheffield (1952-1959). He then moved to the Newcastle College of the University of New South Wales as Associate Professor (1959-1962) then foundation Professor of Metallurgy (1962-1972).

His long association with AINSE continued after a secondment to the Universities Commission (1972-1978) when he returned to the University of Newcastle as Deputy Vice-Chancellor of Research in 1976 until his retirement in 1988.

He received his first AINSE research award, on the 'Structure of transition alloys' in 1961. Between 1961 and 1983 he held 36 AINSE research awards. Initially he was interested in radiation damage in alloys and the effect on mechanical properties. Later he used neutron diffraction techniques to elucidate the structures of metal hydrides and deuterides.

Eric Hall was AINSE Councillor from 1965 to 1988, Vice President in 1972, 1973 and 1974, President in 1977 and 1978 and was the Councillor responsible for AINSE neutron diffraction activities for most of this time. He represented AINSE on the ASNT Board.

diffraction facilities.

Many of these neutron diffraction facilities were actually owned by AINSE, so there would be no charge for the neutrons used in neutron diffraction. In November a somewhat concerned Council agreed*:*

> *To request the Commission's assistance towards obtaining an increase in the annual 'Contribution for Research and Training' from the present level of $250,000 pa to $375,000 pa from 1 January 1978.*

The issue of the indexation of subscriptions was discussed at many of the Executive Committee meetings in 1976. In May 1977 the Council agreed to a formula for the indexation of annual membership subscriptions based on the Universities Commission's[57] General Salary Index. The AINSE Index used to determine each university's subscription would be derived as follows, at first for the calendar year 1979:

AINSE Index = (1/2 x Universities Commission General Salaries Index) (+ 1/4 x Universities Commission Non-Salary Costs Index) (+ 1/4 x Universities Commission Equipment Grants Index)

The Council also agreed that consideration be given at a later stage to adopting a more detailed formula for determining membership subscriptions for ensuing years as follows

$$\text{Membership subscription for year X} = \text{Membership subscription for year (X-1)} \times \frac{\text{Index for June quarter in year (X-1)}}{\text{Index for June quarter in year (X-2)}}$$

AINSE now had a workable mechanism by which subscriptions could be adjusted on a regular basis and could keep up with inflation. Requests were now made with greater potency to the Commission to both increase its subscriptions and increase its contribution for research and training. This latter component had remained unaltered at $250,000 for the four years from 1974 to 1977 despite the increasing inflation rate.

In 1977 the AAEC advised the October Executive Committee meeting that it agreed to increase its membership subscription from $105,000 to $117,000 and also increase its contribution to research and training from $250,000 to $300,000. It was still below the $375,000 requested the year before but at least it was a tangible increase.

The income for 1978 was $112,500 from university subscriptions, $117,000 from the AAEC and $300,000 from the AAEC contribution for research and training. In May 1978, the inflationary pressures were such that an increase of subscription fees was on the table again. In July 1978 the Executive Committee recommended to Council that an increase be approved. By this time the number of university members had increased and the degree to which they used AINSE varied to such an extent that there were six levels of membership with a subscription ranging from approximately $4,000 to $15,000 (Table 6).

Table 6. Annual Subscription levels 1978 and 1979

Level	1978 ($)	1979 ($)
I	3,750	4,150
II	4,500	4,950
III	6,000	6,600
IV	7,500	8,250
V	10,500	11,550
VI	13,500	14,850

For quite some time direct grants provided funding for universities to buy chemicals and instruments. This practice was eventually reduced in the 90s to a point where it became a very small proportion of total funds allocated to grants. Subsequently materials and equipment purchases were supported only if they were to be installed and used at Lucas Heights.

57 The Universities Commission was at that time charged with regulation of university emoluments.

Professor Peter Parsons AM

Following an agriculture degree at the University of Adelaide, Peter Parsons obtained PhD and ScD degrees from the University of Cambridge, where he was Fellow of St. John's College from 1959 to 62. After a period at the University of Melbourne, he became a Foundation Professor of Biology at La Trobe University in 1967.

He represented La Trobe University on AINSE Council for 17 years from 1970 to 1988, was Vice-President from 1973 to 74 and President in 1975 and 1976. He became an Honorary Fellow in 1991. He contributed to biennial radiation biology conferences while on the Council and beyond, including acting as conference president in 1975, 1977 and 1987.

His major research interests concern evolutionary adaptation under environmental stress. AINSE-supported research on stressful levels of ionising radiation helped these endeavours based upon ANSTO facilities.

Contacts on the AINSE Council led to an interest in the biological consequences of low levels of ionising radiation which continues to today. He developed an evolutionary model to explain why radiation exposures substantially in excess of normal background are not normally deleterious, but the reverse.

These researches led to his membership of the Australian Ionising Radiation Advisory Council (AIRAC) from 1987 to 1993, which advised the Government on the effects of actual and potential sources of ionising radiation on the Australian population and the environment.

Peter Parsons became a Distinguished Scholar to the UK under the Commonwealth University Interchange Scheme, 1976, Fellow of the Linnean Society of London, 1979, Vice-President of the Society of Evolution, 1984, Fellow of the American Association of the Advancement of Science, 1986, and 31st Galton Lecturer in London, 1994.

In 2006 he was awarded an AM, for his services to science including radiation biology and scientific organisations.

4.3 Governance and process

During the 70s AINSE became more involved in supplying and maintaining equipment at the AAEC, particularly for the accelerators and neutron-scattering instruments. However, as inflation increased, the scale of AINSE activities continued to suffer restrictions, although essential operations were maintained.

The public lectures continued to be delivered at the roving Council meetings, and at the University of Adelaide in 1974, the Institute arranged for the Governor of South Australia, His Excellency, Sir Mark Oliphant KBE to speak on 'The Energy Problem'. In the same year, the Monash University Council meeting was marked by discussions with representatives of the State Electricity Commission of Victoria, and other organisations on the question 'Is nuclear power inevitable for Victoria?'. A full list of these lectures is at Appendix 8.

In 1971 AINSE had nine full-time staff comprising five scientists and technicians and four administrative positions. This was later adjusted to eleven full-time and three part-time positions in 1974 only to be reduced to ten full-time staff including three professional, four technical and three administrative in the following year. This staffing level remained constant throughout this and the next decade. The professional and technical people facilitated the projects of the visiting researchers on the AINSE instruments at Lucas Heights.

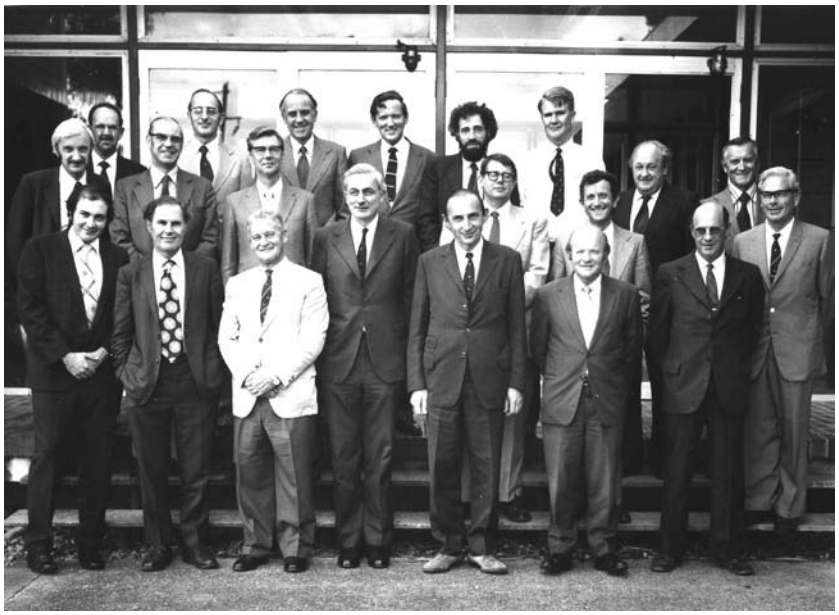
In 1979 AINSE made submissions to two government reviews: first to the Australian Science and Technology Council (ASTEC) Sub-Committee on the Examination of Interaction between Government, Academic and Industrial Research and Development Activities; and secondly, a comprehensive submission to the National Energy Research, Development and Demonstration Council (NERDDC) Review of AAEC Research Establishment.

The NERDDC Council's report on its review was positive for the Institute:

> *AINSE provides an important mechanism whereby Universities can have access to the nuclear facilities and specialist services at Lucas Heights for research processes and for development of students of the universities.*
>
> *The Committee noted that AINSE has a fine record of promoting effective cooperation between universities and the Lucas Heights Establishment.*[58]

The Committee recommended that AINSE continue with its present role.

Researchers from member universities who attended the courses at the Australian School of Nuclear Technology operated by the AAEC throughout the 70s were also able to have their travel and accommodation costs paid by AINSE.



AINSE Council 1976 From Left to Right,

Third Row: Mr Bill Palmer (Executive Officer, AINSE), Professor Geoff Richards (JAM), Professor Ian Polmear (MON), Professor Ross Miller, (ADE), Professor Robert Segall, (GRI), Professor Ralph Parsons (QLD, AINSE Vice President), Professor Charles Watson-Munro (SYD), Dr Robert Cairns (AAEC)

Second Row: Associate Professor Gerry Woolsey (UNE), Professor Brian Spicer (MEL), Dr Brian Rotsey, (AAEC), Professor Peter Fisher (WOL), Professor Max Brennan (FLI), Professor David Allen-Williams (UWA)

Front Row Professor Robert Antonia (NCT), Professor Peter Mason (MAC), Professor Sir Ernest Titterton (ANU, AINSE Immediate Past President), Professor Peter Parsons (LAT, AINSE President), Professor Harry Bloom, (TAS, AINSE Vice-President), Dr Jack Gregory (AAEC), Mr Keith Alder (AAEC)

58 NERDCC [AAEC] Research Establishment. Review of Research Activities and Capacity and Proposals for the Future, p7

4.4 Research achievements

4.4.1 Neutron scattering research

Neutron scattering research in Australian universities expanded dramatically during AINSE's second decade due predominantly to the vigour of AINSE's promotion. Throughout the 70s AINSE maintained four staff members in the AINSE Neutron Diffraction Group. Continuing members at the end of the decade were Dr Frank Moore (leader), Dr Lindsay Davis and Mr Clyde Bock. The salaries and associated costs for this activity were a significant part of the AINSE budget.

The total number of 111 neutron papers for the period amounted to a five-fold increase from the first decade. The work of Dr Frank Moore, leader of the AINSE Neutron Diffraction Group, was one of two major factors responsible for the expansion of research using neutrons, as shown by Frank Moore's co-authorship of many papers with newcomers to neutron diffraction. Also significant was AAEC collaborative work with AINSE member universities led by Terry Sabine, involving universities in the Sydney basin and also Melbourne University. The second major factor was the intensification of effort at Monash in the use of neutrons for magnetism research, under the leadership of Jack Smith and young staff member Trevor Hicks who had returned to Australia after serving as a research fellow at Harwell. The Monash team published some 40% of the AINSE-supported neutron papers during the decade.

Structural crystallography using neutrons flourished at the University of Queensland and at James Cook University in Townsville. The University of Queensland research emerged in physics under the leadership of Brian Lucas and in chemistry under Colin Kennard. While structural studies involved miscellaneous small-molecule studies, the work in Physics concentrated on inorganic nitrate structures for which publications have been widely cited in the explosives technology literature.

Les Power established the substantial neutron diffraction activity at James Cook University in close collaboration with Frank Moore. Notably, the research included site occupancy determinations in mineral structure studies. The postgraduate students involved in this research who were to develop substantial reputations in materials characterisation included John Parise, now at New York State University, Stony Brook (see Section 4.8), Ian MacKinnon and Ken Turner (formerly at BHP Research). Les Power's death in a plane crash in 1977 was a tragic loss for AINSE.

The proximity of the University of New South Wales and the University of Sydney to Lucas Heights accounted for the emergence of their substantial neutron diffraction use in this period. The AINSE publications point to the emergence of biocrystallography at the University of Sydney under the direction of Hans Freeman (including metal-protein interaction research).

At the University of New South Wales, Jack McConnell led a team doing biophysical work. Significantly, the neutron diffraction research at this university included early work on hydrogen storage by George Paul and Ken Taylor. One of the students to later achieve a substantial reputation in research was Veronica James, who received an OAM award in 1991 for services to science education. She has led research on the development of diffraction methods for medical diagnosis.

Eric Hall and David Browne of the University of Newcastle did research on the ordering in intermetallic compounds and interactions between interstitial solute atoms in alpha-iron.

Neville Fletcher's widely cited research at the University of New England on the physics and chemistry of ice included AINSE-supported neutron diffraction studies, for example, 'Neutron diffraction study of ice at 77K' J S Chamberlain, F H Moore and N H Fletcher in *Physics and Chemistry of Ice*, ed. E Whalley *et al*, Ottawa: Royal Society of Canada 1973 pp 283-84.

The magnetism research at Monash University using neutron diffraction and spectroscopy was extraordinarily successful during this period thanks in substantial part to AINSE support, particularly through the work of AINSE's David Wheeler and Roy Ebdon with Monash's Trevor Hicks and Jack Smith in the development of powder diffractometry for characterising polarisation distributions in ordered materials, and in long wavelength neutron spectroscopy using the LONGPOL. It was, at that time, one of only three

Photo courtesy of Monash University Archives, by Terry Martin (1962)- IN5501

Dr Trevor Hicks

Many of the 21 PhD students who worked with Trevor Hicks in his research group at Monash University have gone on to make significant contributions to neutron-scattering and condensed matter physics. Some, such as Shane Kennedy, John Osborn, Leo Cussen and Tunay Ersez have gone on to work at ANSTO in a range of roles including running instruments at HIFAR, designing instruments at OPAL and modelling neutron fluxes during the design of OPAL. Others have moved to Australian universities, establishing their own strong research groups. These include John Davis in the Department of Physics at Monash University (he has since moved on), and Stewart Campbell at ADFA, and others elsewhere. Andrew Wildes is an instrument scientist at the ILL and Kirrily Rule is a research fellow at the Hahn-Meitner Institute. Oscar Moze is a Professor at the University of Modena.

Trevor Hicks was a PhD student of Jack Smith at Monash University, and Jack held 23 AINSE research awards between 1969 and 1984. Other PhD students supervised by Jack Smith included Lindsay Davis (leader of the AINSE Neutron Diffraction Group), Lou Vance (now a senior principal research scientist at ANSTO), Evan Gray (now an academic at Griffith University), Paul Rossiter (an academic at Monash University who became DVC (Research) at Curtin) and Peter Wells (Monash University).

Trevor and his students spent long periods at Lucas Heights working in close collaboration with AINSE staff and ANSTO staff. He was responsible for the development of the LONGPOL neutron spectrometer on HIFAR, to which AINSE contributed considerable funds.

In 1997 he was awarded an AINSE Gold Medal and in 2007 he received an AINSE Honorary Fellowship.

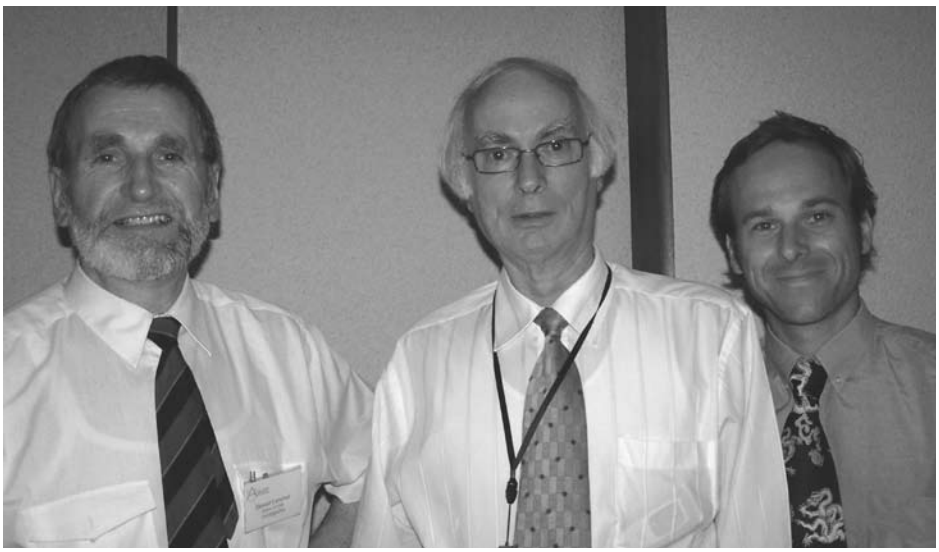
instruments worldwide with polarisation analysis capability and the only one on a medium flux reactor. Based on an initial concept from Dr Trevor Hicks of Monash University, the facility was developed and constructed over the period 1970-1973 by Dr Hicks and his research students Naeem Ahmed and Stewart Campbell, with significant input from Roy Ebdon and David Wheeler from the AINSE Neutron Diffraction Group and the technical staff of Monash University. The first results from LONGPOL were presented at the International Conference on Magnetism[59] held in Moscow in 1973. An early success with LONGPOL was the observation by Trevor Hicks and students of the glassy nature of the magnetic structure in the archetypal spin glass Cu – Mn.

Distinguished Australian condensed matter scientists who emerged at this time under the mentorship of Jack Smith and Trevor Hicks included E R (Lou) Vance, Stewart Campbell, John Davis and Evan Gray. See Section 8.3 for further details of the Monash-AINSE story. In parallel with the Monash development, AINSE-supported research using neutrons was established at the University of Melbourne under the leadership of Zwi Barnea with support from Terry Sabine of the AAEC. The University of Melbourne neutron research in this period focused on anharmonic vibrational effects in crystals. Students working with Barnea included Sax Mason, who later became a prominent neutron-scattering scientist at ILL in France, and Sylvia Mair. Jimpei Harada, who became one of the foremost Japanese crystallographers, worked with Barnea at this time as an AINSE postdoctoral fellow.

The AINSE-supported research on charge density distributions in crystals at the University of Western Australia, led by Ted Maslen, made use of neutron diffraction for the determination of atom nucleus positions and thermal motion parameters which were then used to map charge densities with accurate x-ray diffraction data. One of the students trained through the research was Jose Varghese who later became one of Australia's foremost protein crystallographers.

In addition to LONGPOL, AINSE was involved in the development of a new single-crystal diffractometer (2Tan B) and effort was also directed in developing improvements in control and data collection for the evolving computer systems. Also the High-Resolution Powder Diffractometer (HRPD) was commissioned. For its construction, the AAEC relied heavily on the AINSE neutron diffraction group because of *the technical backup of the AINSE group* [60].

By the end of the decade[61] AINSE's cumulative investment in neutron diffraction equipment at Lucas Heights was $383,000.



On the occasion of medal presentations December 2007.
From left: Emeritus Professor Stewart Campbell who received the AINSE Gold Medal,
Dr Trevor Hicks who received an Honorary Fellowship, and Dr Darren Goossens AINSE Research Fellow

59 Ahmed N, Campbell S J, Hicks T J. Neutron Scattering From CuMn and CuFe. *Proc Int Conf Mag ICM-73* **4** 91-6. Publishing House, Nauka, Moscow 1974; Ahmed N, Hicks T J. Polarisation analysis of neutron scattering from CuMn alloys. *Solid State Communications* **15** 415 1974

60 Hicks T. The National Centre for Neutron Scattering. 38-45 *AINSE's 40th Anniversary Conference Proceedings* 1998

61 AINSE Annual Report 1979-80, p4

4.4.2 Archaeology – AINSE bridges the gap

AINSE's interest in archaeology had a halting start with the establishment of the Dating Project in the early 60s involving both the University of New South Wales and the Victoria Museum. AINSE was able to play a key role in establishing a new major area of research not only for Australian National University staff but also at many institutions throughout the world.

Initially archaeology was not a part of the Commission's suite of activities and preliminary approaches via AINSE in 1974 by researchers from the Australian National University and the University of Sydney produced only a lukewarm response. In 1975 a collection of obsidian (a volcanic glass) from Wal Ambrose in the Department of Prehistory at the Australian National University arrived at the AAEC with the idea that possibly neutron activation analysis might contribute to an understanding of trading patterns in the Pacific. AINSE was in a position to connect these researchers with Dr Roger Bird's Group in Physics Division at the AAEC. He suggested that accelerator-based IBA methods on the Van de Graaff accelerator would be the preferred analysis technique and established an accelerator beam line specifically for this area of research.

AINSE was quick off the mark to provide tangible support through the provision of research awards and arguing the case for AAEC involvement. AINSE's involvement also assisted in raising the profile of this research within universities.

> *AINSE co-operation has been invaluable for archaeological work in our region over the last 25 years and will be essential in the future.*[62]

Early tests using (p,γ) reactions (Proton Induced Gamma-ray Emission - PIGE) for fluorine, sodium and aluminium determinations were followed by later tests using (p,X) reactions (Proton Induced X-ray Emission - PIXE) for elements from Al to U. These PIXE/PIGE methods were reliable, fast, sensitive and non-destructive for a broad range of archaeological samples including obsidian glasses and pottery samples. Furthermore, they required no special sample preparation. The multi-elemental analysis capability of these techniques proved to be a tremendous advantage in distinguishing various sources of these materials and thus provided unique information to researchers on such things as historical trade patterns in the South Pacific.

This work continues today with thousands of pottery, clays, aboriginal ochres and artefact samples have been analysed efficiently by nuclear techniques. On the basis of all of these wide-spread activities, Roger Bird was commissioned to write a book titled Ion Beams and Archaeology which is the accepted bible throughout the world and led amongst other things to the establishment of an accelerator laboratory in the basement of the Louvre.

Figure 2 is based on work undertaken by Wal Ambrose and others from the Australian National University and Roger Bird's group in the Physics Division at the AAEC and shows the results obtained for early traders (3,000-11,000 years BP) in obsidian by sourcing various artefacts to particular volcanoes in the region. Tens of thousands of archaeological samples, including Aboriginal ochres, were analysed by AINSE groups from around Australia. This work continues today with thousands of pottery, clays, aboriginal ochres, and artefact samples analysed efficiently by nuclear methods.

Wal Ambrose first received AINSE support for a prehistory project in 1974 and continued his research for two decades. He held 15 grants from 1974 to 1999.

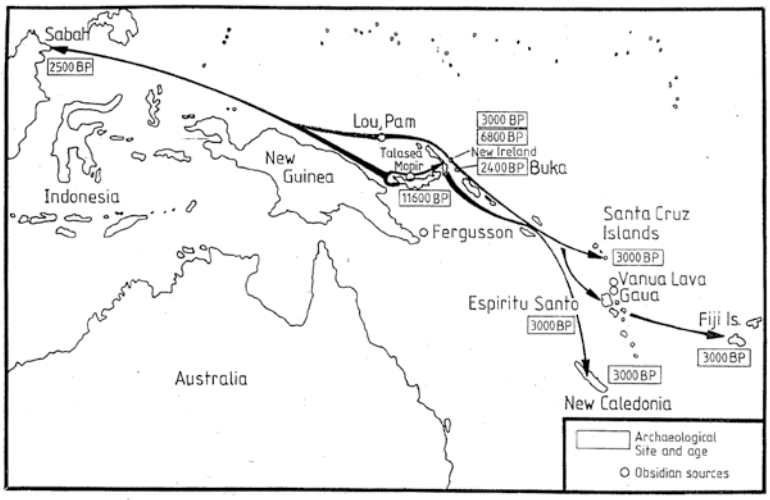


Figure 2. Early trade patterns from the multi-elemental IBA analysis of obsidian artefacts

62 ibid p 13

4.4.3 Biological science

Some of the earliest biological research on the 3 MV Van de Graaff generator was performed in the early 70s in collaboration with D J D Nicholas at the University of Adelaide (7 research awards between 1967 and 1974) and the Waite Agricultural Institute using the $^{12}C(p,\gamma)^{13}N$ reaction as a tracer to study the mechanisms employed by nitrogen-fixing bacteria. A 200μA 2.5 MeV proton beam was used on a carbon target to produce the short-lived ^{13}N isotope.

An AINSE Research Fellowship awarded to Barry Lee (1963-64) at the University of Melbourne marks the commencement of AINSE-supported research in the genetic analysis of radiation resistance. His first study was based upon the micro-organism *Pseudomonas aeruginosa*. His influence and collaboration was pivotal in early work from La Trobe University with the fly, *Drosophila melanogaster*, by Ian MacBean, Jane Westerman an AINSE Research Fellow (1971-73) and Peter Parsons. Paula Imray, a Research Fellow at the University of Melbourne with Barry Lee (1976-78), continued these efforts with the lower eukaryote, *Dictyostelium discoideum*.

A major research direction of La Trobe University in evolutionary adaptation under environmental stress partly derived from this period of AINSE support. Discussions with Ernest Titterton on the AINSE Council in the early 70s led to an interest in the biological consequences of low exposures of ionising radiation. An evolutionary model to explain the predominantly non-harmful consequences of radiation exposure around background and substantially above was published by Peter Parsons from 1989 onwards, and earlier discussions with Keith Brown from the AAEC were most helpful.

During 1978-79, studies on trace elements in human teeth by Roger Bird's group in collaboration with Flinders University using PIXE applied to healthy and decayed enamel, dentine and cementum were undertaken. These experiments were significant since, when published in 1981 they showed for the first time, that theoretical thick-target PIXE yields could be successfully used to predict experimental yields in thick biological matrices. Prior to this, many PIXE users, requiring quantitative analysis, were analysing thin targets only. The agreement between theory and experiment for thick-target elemental yields was ±3% for all elements from aluminium to uranium. An AINSE staff scientist, David Cohen had a key role here. This success was the start of quantitative thick-target PIXE analysis at the AAEC which continues routinely today at ANSTO.

4.4.4 Radiation chemistry

Jim O'Donnell was always keen to involve others in his research. In the 70s he, David Hill and Peter Pomery, formed the Polymer Chemistry and Radiation Group, the first focused research group in the Chemistry Department at the University of Queensland. As well as these researchers, other radiation polymer chemists were attracted to other Queensland universities, including Ernie Senogles at James Cook University (1964) who held 18 AINSE research awards from 1968 to 1983, Ken Busfield at Griffith University (1976) who held 18 AINSE research awards from 1977 to 1994 and Graeme George at Queensland University of Technology (1987). Accordingly, Queensland became a nationally recognised centre for polymer radiation chemistry with a strong international reputation.

In the late 60s a new technique was brought into AINSE's domain. David Sangster and Ron Cooper used their experiences at Argonne National Laboratory (ANL) to convert the AINSE-owned 1.3 MeV Van de Graaff electron accelerator into a pulsed radiolysis facility. This meant that with a burst of high energy electrons of 1 microsecond duration, chemical reactions in solution could be initiated and the kinetics directly observed. It turned out to be a veritable workhorse for free radical and redox chemistry studies and attracted nationwide usage.

In 1973 AINSE financed a second facility for radiation chemistry at Lucas Heights. A nanosecond field emission electron beam generator - a Febetron. This instrument gave a 3-nanosecond pulse of 0.6MeV electrons. It took the kinetic timescale down by a factor of one thousand from the Van de Graaff facility. It was especially useful for gas phase work and thin films. Ron Cooper's group at the University of Melbourne used it for gas phase plasma studies and Terry Quickenden from the University of Western Australia started a program to investigate light emission from irradiated ice.

Professor Jim O'Donnell

Jim O'Donnell was AINSE Councillor, 1987 to 1995 and President in 1992 when ill health forced his retirement.

He was born in Perth in 1934 and educated at the University of Western Australia (BSc (Hons) 1954) and Leeds University (PhD 1963, DSc 1986). He worked as a research chemist at ICI Australia 1955-58 and then moved to University of Leeds 1959-62, as a postdoctoral fellow, and the Polytechnic Institute of Brooklyn 1963, as a Lecturer in Chemistry. He returned to Australia as Senior Lecturer in Chemistry, University of Queensland 1964-69, eventually being promoted to Professor of Chemistry in 1986.

He helped establish the Polymer Materials and Radiation Group, in the 70s. He received the Battaerd-Jordan Polymer Medal, Polymer Division, Royal Australian Chemical Institute in 1982, the H G Smith Memorial Medal, Royal Australian Chemical Institute in 1983, and the Leighton Memorial Medal, Royal Australian Chemical Institute in 1990.

He was President, Royal Australian Chemical Institute in 1986, President, Pacific Polymer Federation in 1993, Chairman of the Australian Academy of Science's National Committee for Chemistry from 1992 to 1995, Chairman, International Relations Committee, Royal Australian Chemical Institute from 1992 to 1995, inaugural chairman, Royal Australian Chemical Institute National Chemistry Week Committee.

He maintained a close association with radiation chemistry research at Lucas Heights. This involved attachment of many research students to work there with David Sangster, with support from AINSE studentships and Research Awards.

His achievements are commemorated by the O'Donnell Schools Lecture, the Jim O'Donnell International Travel Awards, and the O'Donnell Young Polymer Scientists Prize (Polymer Division, Royal Australian Chemical Institute).

Jim passed away in 1995.

4.4.5 Plasma/fusion research

At the same time as Russia was developing the device which came to be known as the tokamak, Bruce Liley at the University of New South Wales independently constructed a series of 'theta-z pinches' which had essentially the same magnetic field structure as the tokamaks. Thus Australia was involved with the early development of what is recognised as the leading contender for practical thermonuclear fusion. This work at the Australian National University continued through the 70s, with AINSE support, culminating in the experiments on LT-4 which contributed greatly to the understanding of disruptive instabilities - dangerous plasma instabilities which could seriously damage operating tokamaks.

During this period, AINSE supported the secondment of two scientists from the AAEC, John Tendys and Geoff Durance, to Flinders University. This was primarily to help build up the expertise within the AAEC in plasma and fusion physics. These scientists were involved in all of the work at Flinders, which by that time was expanding its experiments to include work on the 'stabilized' z-pinch, magneto-acoustic oscillations and small and large amplitude hydromagnetic waves. All of this work and related studies at the University of Sydney contributed to the use and understanding of magnetohydrodynamic (MHD) waves in modern tokamaks.

4.4.6 Fission studies

The program within the AAEC studying aspects of the nuclear fission process strengthened during the 70s along with the complementary involvement of university researchers in this area. Jagdish Mathur and the AINSE postgraduate scholar John Caruana, from the University of Wollongong, collaborated with John Boldeman's physics group at the AAEC in measurements on the Van de Graaff accelerator of fission-fragment angular distributions following neutron fission through sub-threshold resonances in ^{230,232}Th. Following multi-channel analysis of these data and the corresponding neutron fission cross-Section data it was shown that the measured data were consistent with the concept of a triple-humped fission barrier for the thorium isotopes.

John de Laeter from Curtin University of Technology was, amongst many aspects of physics, a world leader in fission product yields especially in the symmetric region. In collaboration with John Boldeman's group, irradiations in HIFAR facilities were conducted to obtain better data on fission yields in the symmetric region for thermal neutron fission of ^{235}U.

4.4.7 Neutron-capture cross Sections

A number of the research groups had vigorous astrophysics programs. In particular, Brian Spicer, Douglas Sargood, and Ziggy Switkowski from the University of Melbourne worked on (p,γ) cross Sections. The AAEC was well placed to study a complementary process namely the (n,γ) reaction at keV energies. Therefore, there was considerable value for all parties to establish a collaborative program. Roger Bird's group at the AAEC, Ray Taylor, Ian Bubb and G C Hicks from James Cook University participated in keV neutron-capture cross Sections and gamma ray spectra using the Van de Graaff accelerator. The combined work contributed greatly to the understanding of the elemental composition of the universe. During the course of these measurements some non-statistical processes were identified. The AAEC established a collaborative program with the ORNL in which AAEC and University staff participated in the high-resolution measurements of the neutron-capture and total cross Sections of almost all nuclei. These data were analysed at Lucas Heights with the key university staff being Dr Ben Chan, Dr Sid Boydell and ANSTO staff including Barry Allen, John Boldeman, Michael Kenny and Tony Musgrove. The overall analysis of the data revealed the strong impact of direct neutron-capture near-closed shell nuclei. The AINSE Senior Fellow, Dr Tony Lane, contributed significantly to the interpretation of the data.

4.5 Specialist committees

Over the years, the titles and functions of the specialist committees have reflected the changing emphasis in research priorities in both national and international contexts. As these contexts have changed, so the committees also have been changed. In 1972 the first of many changes in the Specialist Committees occurred when the Heat Transfer Committee became the Engineering Committee, reflecting a broader interest in using AAEC facilities for materials science and engineering research. In 1979 the Radiation Chemistry Committee became the Radiation Committee. This change reflected the equal importance of radiation biology.

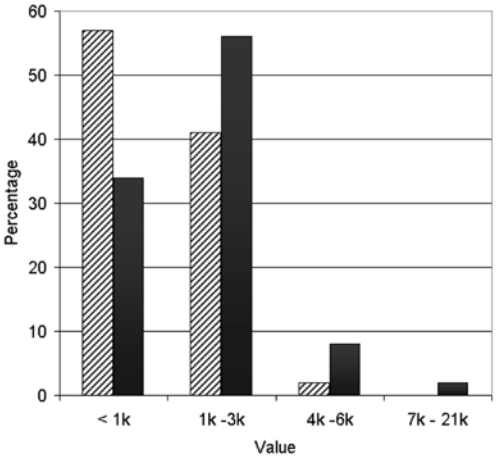


Figure 3. Distribution of research awards in 1969 and 1979
Shaded = 1969 Black = 1979

AINSE has essentially only funded projects that were scientific or engineering in nature, or projects that required the use of facilities at Lucas Heights. In 1978 the AINSE Council considered a proposal from Dr Ann Moyal of Griffith University who requested funding to support a researcher to undertake a study of science policy matters in areas relevant to the Institute's interests. She was interested in considering the sociological impact of nuclear science in Australia. The May 1978 Council, while supportive of the overall thrust of the studies, suggested that Dr Moyal *continue to explore all possible sources of funds.* In making this decision the Council, *inter alia* reinforced the Institute's commitment to according priority in providing support for the use of facilities at Lucas Heights.[63]

4.6 Research awards

In the decade 1969 to 1979 the number of research awards increased from 97 to 111. The overall value increased from $110,923 to $219,000 or roughly 10% per annum. In the period the monetary value of the awards, as reported in AINSE Annual Reports, increased at the upper end (Figure 3). These figures indicate that while the overall value of the grants increased significantly over the period, the bulk of each research award was more or less the same value when taking inflation into account. A positive trend in the period was the clear intention to invest resources into a small number of grants with values above the $6,000 upper limit that applied in 1969.

The figures also illustrate the strength and weakness of the AINSE system. In 1969, 13 member institutions held research awards. In 1979 this had increased to 20. In both cases finite resources were allocated across the board. The weakness in this system is the possibility that the value of individual research awards would decrease to barely viable levels. AINSE met this challenge by reducing the number of grants relative to the number of universities; from an average of seven per university in 1969 to an average five in 1979. This allowed maintenance of the value of the research awards relative to inflation and also provided scope to resource some proposals at a higher level. The two largest awards were in the area of plasma research.

4.7 Fellowships

While senior fellowships had been established in 1966, no nomination had been received until 1971 and that nomination was not awarded. The Council in August 1971 decided that

> *the Senior Fellowship should only be awarded for a person who has a very high standing in his field'* and holds a Professorship or a Readership and '*be in a position to make a significant contribution to a research field of interest to the Institute … possibly by introducing Australian scientists to new techniques.*

Finally, in late 1973 AINSE appointed its first and only Senior Research Fellow. Dr Tony Lane, from Theoretical Physics Group at the Atomic Energy Research Establishment at Harwell had been nominated by the Australian National University where he was based from 5 November 1973 to 24 April 1974. Lane visited universities in Adelaide, Melbourne and Sydney and had spent a week at Lucas Heights from 25 Feb to 1 March 1974.

Table 7. Research Fellowship Topics 1969 and 1979

1969	1979
Gas bubbles in irradiated materials	Defect characterisation using high-resolution electron microscopy
Thermodynamic and structural studies of the curium oxide system	Tokamak diagnostics with laser scattering
Radiosensitivity of marsupial chromosomes in relation to stages of the cell cycle	Theoretical studies in radiation damage
Effects of irradiation on precipitation reactions	Ionisation cross Sections for the fusion program
Orientation of radioactive nuclei in solids at low temperatures	Creep fatigue of reactor structural materials
	Anharmonicity in the zinc blende compounds
	Spin density determination in transition metal complexes by polarised neutron diffraction

In contrast, the AINSE Research Fellowships program continued steadily throughout the decade. There were usually about six concurrent fellows over the period (Table 7).

The whereabouts of some of the research fellows from the 70s are known to us.

63 Just over a decade later AINSE agreed to provide support for the collation of the papers of Sir Ernest Titterton who died on 9 February 1990. On 16 July 1945 Titterton triggered the world's first nuclear bomb in a test explosion, code-named 'Trinity' at Alamogordo in the New Mexican desert. Titterton is also remembered for his stewardship of nuclear science activities at the Australian National University.

Geoff Anstis recently stepped down from the position of Head of the Department of Applied Physics at the University of Technology, Sydney.

Following her research fellowship, Yadurga Bick remained at the University of Tasmania in a tenured position. She passed away some years ago.

David McKenzie holds a chair in physics at the University of Sydney.

Graeme Murch held an AINSE postgraduate studentship (1970-1973) then an AINSE research fellowship (1973-1975). He was the first person to hold both. After completing the AINSE Fellowship in 1975 he worked at ANL until 1985, then Principal Research Scientist at ICI-Australia Research Labs in Melbourne until 1986, thereafter to the University of Newcastle. He has held a Personal Chair in Materials Engineering at Newcastle for almost 20 years.

Andrew Thornton stayed in Adelaide and is now a senior scientist in the thoracic unit at Royal Adelaide Hospital.

Warren Thorpe was a postgraduate student supervised by Dr Ian Smith, who became ANSTO's CEO. Following his doctoral studies, Warren took up an AINSE research fellowship. Following the fellowship he went to CSIRO and moved through a number of jobs with them in Adelaide, Brisbane and Melbourne. In 2001 he left the CSIRO and took up the Foundation Chair in Physics at Central Queensland University. He had already helped set up the CAST CRC, and continued to work with the local industry at Gladstone for 6 years until his retirement in 2007.

John Tibballs is currently a research scientist at the Nordic Institute of Dental Materials, University of Oslo.

4.8 Studentships

During the 70s the number of studentships remained more or less constant at about six concurrent studentships each year. In 1979 the projects undertaken by these PhD candidates covered aspects of radiation chemistry, development of radiation detection systems, study of radiation damage in glass and investigation of mineral structures using neutron diffraction techniques. The research students supported by these awards held tenure at five different universities and each was required to spend at least one quarter of his/her working time at the AAEC carrying out experiments. By June 1979, a total of 22 students had completed or were completing PhD research under the AINSE scheme which commenced in 1964.

Of the 1969 students, publication records indicate a subsequent career in scientific research for: H Struve, at the University of New England, Chemistry; G J Broomhall, at the University of Melbourne, Physics; D B Stroud, at the University of Melbourne; M L Golomb, at the University of Sydney, Chemistry; and S G Boydell, at the University of Melbourne.

One 1969 AINSE postgraduate student was Ian Smith from the University of Queensland (who commenced his studentship in 1967), and whose PhD thesis was entitled 'Behaviour of inert gas atoms in metallic lattices and their effect on metal properties' was to become Chief Executive Officer of ANSTO from 2004 to 2008.

Other people who held AINSE studentships in this decade included

- Graeme E Murch (1970) whose academic career culminated in a Personal Chair in Materials Engineering, Joint Leader, Diffusion in Solids Group, School of Engineering, the University of Newcastle
- Ronald Rosen (1971) is now a visiting fellow at the University of New South Wales in Risk and Safety Science
- Ken Turner (1971) worked at BHP Research until his retirement.
- John Caruana (1972) went to the Bureau of Meteorology
- Marcia Scudder (1973) is currently on the research staff, School of Chemistry at the University of New South Wales
- John Parise (1976) who became Professor at the State University of New York at Stonybrook in 1989.

Professor John Parise

John Parise, a student at James Cook University, commenced his AINSE studentship in 1976, with a study topic of *Crystalline Studies of Silicate and Hydrated Minerals* and concluded in 1980. His personal recollections follow.

I began at Stony Brook University in 1989; other appointments were with DuPont Chemical, University of Sydney (Chemistry) and NSW Institute of Technology (now the University of Technology, Sydney) also a chemistry lectureship.

I owe AINSE a great deal - after the death of my supervisor Les Power - in a plane crash in far north Queensland, I moved from James Cook to AAEC/AINSE full-time. AINSE pretty much became my home and intellectual family. In my time there I learnt quite a lot about science in Building 58 (Neutron Diffraction). I also discovered that there are many talented scientists but comparatively few exceptional managers.

I am grateful to have had the steady hands of several great scientists in Building 58, and wonderful mentors 'outside the gate' [AINSE]. I am only now really appreciating how very important this style of doing science is and I have worked for the last 30 years to emulate the sort of multidisciplinary, collaborative style of science championed by AINSE.

John Parise is currently Professor in the Department of Geosciences at the State University of New York.

Bill Palmer said

John Parise's presence as an AINSE student at Lucas Heights provided both intellectual and social stimulus both in the HIFAR precinct and in the AINSE lunchroom.