

ANU ELECTRON MICROSCOPY UNIT

2002 Annual Report

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1. THE ANUEMU AND ITS OBJECTIVES

The purpose of the ANU Electron Microscopy Unit is to provide access to modern equipment, training and consultation in electron microscopy and some other forms of microscopy, imaging and analysis to the University community and to external users where appropriate. The Unit is encouraged to provide leadership in the development and implementation of new EM equipment and methodology. It is an objective of the University to maintain the standard of the facility at a level commensurate with the University's heavy commitment to research and to the major research and teaching objectives within the programs of the National Institutes. (adapted from the establishment paper 2498/1988)

The unit is a central facility housed mainly in the Research School of Biological Sciences. It provides access to electron microscopy and related techniques to staff and students from all areas of the ANU. There are seven electron microscopes (four scanning EMs and three transmission EMs), basic light microscopes, a small STM and a range of ancillary equipment for specimen preparation, analysis and image processing. A 300kV TEM is housed in the Research School of Earth Sciences. A full description of the operation of the facility can be found in a handout for users available from the unit, and through the web page <http://www.anu.edu.au/EMU/index.htm>

2. OVERVIEW OF THE YEAR

In common with much of the rest of the university, financial problems were a preoccupation during 2002. ANUEMU survived a further cut in base funding, not sustainably but surprisingly well, through growth in income from users' research grants and from external earnings. Casualties were the loss of a part-time administrative assistant, the level of equipment maintenance and small equipment purchases, and the time available for direct support and training of staff and students. On the positive side (to anticipate next years' report) by early 2003 the situation has improved, and we should be able to work under the new arrangements without compromising the ease of access that is the ANUEMU's strong point.

The hours for which equipment was used and the publications produced using the facility continued to increase. For the first time we are likely to reach 100 or more publications in a year.

Support infrastructure for nanotechnology will be boosted by a dual beam Focused Ion Beam/SEM, funded in 2001, and commissioned in 2002 from JEOL. The configuration is an Orsay Physics Camion gallium ion gun on a JEOL 6460 SEM, with 3-gas injection. A cold stage will be fitted at the ANU. Arrival of the instrument has been delayed until June 2003 in order to incorporate the latest model of SEM.

The trend towards digital image processing continued with the installation of a widefield CCD camera on the Hitachi 7100 TEM, which has proved very popular with users. A colour CCD camera on the Wild Macroscope and a basic CCD camera on an epifluorescence microscope has removed the need to switch the existing CCD camera between three light microscopes. Very high dynamic range (20 log unit) TEM negatives are now possible using a small number of imaging plates, which can be sent to the University of Melbourne to be read on a Ditabis Imaging Plate System. The use of photographic techniques has now declined to the point where one of the Unit's two remaining darkrooms is being converted to other uses.

3. RESEARCH AND TEACHING ACHIEVEMENTS

A. LEVEL OF USE

The number of number of publications produced using the facilities of the ANUEMU continues to rise (93 in 2002 notified to date). Time on the electron microscopes (RSBS site) increased slightly to 7365 hours. Within this, scanning electron microscope (SEM) usage increased by 6% to 6448 hours, while transmission electron microscope (TEM) usage decreased by 20% 917 hours. However use of the CM300 TEM in RSES increased 39% to 801 hours. Light microscope usage increased 24% to 1541 hours, ultramicrotome and computing use decreased slightly.

Distribution of use by School and Department is given in the appendices.

B. NEW EQUIPMENT

2003 saw the installation or ordering of significant major equipment items funded through the EM Reserve, ARC and ANU Major Equipment Funds.

Installed:

Widefield CCD camera on TEM. An SIS Megaview III camera funded from the EM Reserve in 2001 was installed on the Hitachi 7100 in January. It has made routine TEM work much more convenient and less expensive, as well as making it easier to work with low contrast and beam-sensitive specimens.

IATIA QPm Phase Tube and SPOT AINSIGHT® CCD Camera. IATIA is a new Australian high-tech company, formed to develop and market an image processing system developed at the University of Melbourne by Prof. Keith Nugent and his associates. The device uses a non-interferometric system of phase measurement and fast algorithms to generate images equivalent to a wide range of optically produced light microscope images. ANUEMU has bought the phase reconstruction system and a monochromatic CCD camera and is acting as a beta applications development site. The camera can also be used to photograph reasonably bright fluorescence images.

MicroPublisher colour mosaic CCD camera. This camera, installed on a stereomicroscope, allows convenient acquisition of low-magnification images.

Ordered:

FOCUSED ION BEAM/SEM. This instrument was funded by an ARC Linkage Infrastructure grant (Principal Investigators Sally Stowe and Tim Senden, ANU, and Paul Munroe, UNSW). It consists of a fine (10 nm) beam of gallium ions which can carve away or deposit material so precisely that one of the major uses is in the preparation of ultrathin sections for transmission electron microscopy. The SEM column, focused at the same part of the specimen, allows real-time monitoring of the action of the ion beam and higher-resolution viewing of the result. Some of the immediate uses will be in the preparation of customised tips and cantilevers for scanned probe microscopy, and stress-free sectioning of composites and polymers. The instrument will have a cold stage, available in few other places in the world, which will aid in working with beam-sensitive materials including organic polymers and biological samples. It should arrive mid 2003.

C. STAFF PUBLICATIONS

Six publications were produced by EMU staff in 2002 with three in press (NB for reporting purposes, these are already listed in official School and Departmental reports) :

Brink FJ, Withers RL, Friese K, Madariaga G; Noren L (2002) An Electron Diffraction and XRPD Study of Superlattice Ordering in the Elpasolite-Related Oxyfluoride $K_3MoO_3F_3$. Journal of Solid State Chemistry, 163(1): 267-274.

Brink FJ, Withers RL, Noren L (2002) An Electron Diffraction and Crystal Chemical Investigation of Oxygen/Fluorine Ordering in Niobium Oxyfluoride, NbO_2F . J Solid State Chemistry 166: 73-80

Heady RD, Banks JG, Evans PD (2002) Wood anatomy of Wollemi pine (*Wollemia nobilis*), Araucariaceae. IAWA Journal 23:339-357

Heady RD (2002) Microstructure of the Araucariaceae. In "Australia's Everchanging Forests V" Proceedings of the Fifth National Conference on Australian Forest History. ed John Dergavel, Denise Gaughwin and Brebda Libbis. CRES, ANU 90-101

Stange G, Stowe S, Chahl JS, Massaro A (2002) Anisotropic imaging in the dragonfly median ocellus: a matched filter for horizon detection. J Comp Physiol 188: 455-476

Withers RL, Noren L, Liu Y, Brink FJ (2002) Electron Microscopy and its application to the study of incommensurately modulated compositionally and/or displacively flexible phases. Microscopy and Microanalysis 8 (Suppl. 2), 306-307.

(in press)

Ghoddusi J. Ultrastructural Changes in Feline Dental Pulp with Periodontal Disease. Microscopy Research and Technique.

Withers RL, Welberry TR, Brink FJ; Noren L Oxygen/fluorine ordering, structured diffuse scattering and the local crystal chemistry of $K_3MoO_3F_3$. Journal of Solid State Chemistry.

Noren L. Withers RL, Brink FJ . Te for two. Ordering phenomena in doped $Ni_{1+x}M_yTe_2$ (M = Ag, Cu, In). Journal of Alloys and Compounds:

D. Teaching.

ANUEMU continued to run annual Microscopy, Imaging and Analysis (MIA) workshops. In MIA 2002 Sally Stowe organised and lectured in a 6-day series with Ted Maddess and Eldon Ball from RSBS, Frank Brink, and Nick Ware from RSES.

Roger Heady lectured in Basic SEM and EDXA for the University of Canberra Conservation and Materials Course, in the Structure and Taxonomy of timbers (School of Art), tutored in Wood anatomy and wood identification in Forestry 3016, and with Frank Brink taught laboratories in FEIT Materials Characterization course.

Cheng Huang was involved with the CSIRO PI /GRDC workshop in Root/soil biology in agriculture.

ANUEMU facilities were also used for undergraduate laboratory sessions by BoZo and Geology Departments.

5. PUBLICATIONS

PUBLICATIONS using the ANUEMU facilities, 1990-2002

(Not including abstracts, theses or papers in press. NB For statistical and reporting purposes items are not in addition to those listed in Departmental and School reports)]

YEAR	RSBS	OTHER	TOTAL
av. 1990 - 1993	9.75	19.25	28.5
av. 1994 - 1997	10	50.5	60.5
av. 1998 - 2000	10	61	71
2001	15	68	88
2002 to date	10	83	93

2000 not previously listed

De Kock GS, Eglinton B, Armstrong RA, Harmer RE, Walraven F (2000) U -Pb and Pb-Pb ages on the Naauwpoort rhyolite, Kawakeup leptiite and Okongava diorite: implications for the onset of rifting and of orogenesis in the Damara belt, Namibia. *Comm. Geol. Surv, Namibia*, 12, 81-88.

Hoal KO, Hoal BG, Griffin WL, Armstrong RA.(2000) Characterization of the age and nature of the lithosphere in the Tsumkwe region, Namibia. *Special Issue, Comm. Geol. Survey of Namibia: Henno Martin Memorial*

Jacob RE, Moore JM, Armstrong RA (2000). Zircon and titanite age determinations from igneous rocks in the Karibib District, Namibia: implications for Navachab-style mineralization. *Special Issue, Comm. Geol. Survey of Namibia: Henno Martin Memorial Volume (vol. 12)*, 157-166.

Pirango F, Phillips D, Armstrong RA (2000) Volcanology and eruptive histories of the Erongo Volcanic Complex and the Paresis Igneous Complex, Namibia: Implications for mineral deposit styles. *Special Issue, Comm. Geol. Survey of Namibia: Henno Martin Memorial Volume (vol. 12)*, 301-312.

2001 not previously listed

De Waal, S.A., Maier, W.D, Armstrong, R.A. and Gauert, C.D.K (2001). Parental magma and emplacement of the stratiform Uitkomst Complex, South Africa. *Canadian Mineralogist*, 39, 557-571. *Volume (vol. 12)*, 21-28

Key, R.M. Liyungu, A.K., Njamu, F.M., Somwe, V., Banda, J., Mosley, P.N. and Armstrong, R.A. (2001). The western arm of the Lufilian Arc in NW Zambia and its potential for copper mineralization. *Journal African Earth Sciences*. 33, 503-528.

Hodzic A, Stachurski ZH (2001) Droplet on a fibre: surface tension and geometry. *Composite Interfaces* 8: 415-425

Hodzic A, Kalyanaundaram S, Kim JK, Lowe AE, Stachurski ZH (2001) Application of nano-indentation, nano-scratch and single fibre tests in investigation of interphases in composite materials. *Micron* 32:765-775

Hodzic A, Stachurski ZH, Kim JK (2001) An analysis of microdroplet test: effects of specimen geometry, matrix type, fibre treatment and water ageing. *Polymers and Polymer Composites* 9:499-508

2002

1. Aleinikoff JN, Horton JW Jr., Drake AA Jr. Fanning CM (2002) SHRIMP and Conventional U-Pb ages of Ordovician granites and tonalites in the central Appalachian Piedmont: Implications for Paleozoic tectonic events. *American Journal of Science* 202: 50-75.

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3. Andème-Onzighi C, Sivaguru M, Judy-March J, Baskin TI, Driouich A (2002) The *reb1-1* mutation of *Arabidopsis* alters the morphology of trichoblasts, the expression of arabinogalactan-proteins and the organization of cortical microtubules. *Planta* 215:949-958
4. Armstrong RA, Vishnevsky S, Koeberl C (2002). U-Pb analyses of zircons from the Popigai impact structure, Russia: first results. In: *Impacts in Precambrian Shields*, eds. Plado, J. and Pesonen, L.J. Springer-Verlag, Berlin Heidelberg, 109-116.
5. Bagai Z, Armstrong R, Kampunzu AB (2002) U-Pb single zircon geochronology of granitoids in the Vumba granite-greenstone terrain (NE Botswana): Implications for the evolution of the Archaean Zimbabwe craton. *Precambrian Research* 118/3-4, 149-168.
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5. PERSONNEL STATISTICS

Staff List

Facility Coordinator

Sally Stowe, MSc Hons(Auck), PhD

Senior Technical Officers

Frank Brink, BAppPhys (SA) MSc(LaTrobe)

Roger Heady, BappSc (CCAIE), GradDipElec(CCAIE), GradDipResMan(CCAIE), PhD

Cheng X. Huang, MSc (Beijing Agricultural), PhD (La Trobe)

David Llewellyn, DipEng(Bruce TAFE)

Technical Officer

Ruolan (Lily) Shen, DipTCM(Guangzhou)

Administrative Assistant

Meg Mitchell BSc. (Macquarie) (to February)

Visitor

Dr Jamileh Ghodousi (Mashad University, Iran) to March

6. FINANCE

In 2002 the ANUEMU received a total operating grant of \$409,125 to cover salaries and on-costs, operating expenses, instrument maintenance and minor equipment. Overheads such as electricity, water, most administration and part of staff development costs are covered by RSBS. Additional non-capital income in 2002, comprising contributions from grants awarded to ANU staff and external earnings, totaled \$51,148.

Funds sources: (>\$1000, funds actually received in 2002)

From ANU users:

RSES

PRISE Precise Radiogenic Isotope Services	\$4,000
Geophysics Australia/RSES	\$3,000
Jackson ARC	\$3,400
Rubatto APDF	\$1,500

Geology

Ellis	\$1000
Mavrogenes	\$1000

RSBS

Stange	\$4000
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FEIT

Materials Characterisation Course	\$4000
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External Earnings:

Robson Laboratories (fibre monitoring, via ANUTECH)	\$4455
ProSciTech	\$5900
Commonwealth Serum Laboratories	\$2400
CSIRO	\$2600
Fort Dodge	\$1675
University of Canberra	\$1000

Budget outlines from the RSBS Finance Officer are given on the following page.

Note that the ANU recurrent funding "R" account was balanced by transfer of \$30,000 from the "other income" Q account, leaving approximately \$5K less to carry forward in the Q account than the previous year, in spite of increased earnings and minimal spending on maintenance and small equipment. Q account is "normally" used for major maintenance expenses and small to medium equipment.

ELECTRON MICROSCOPE UNIT
Financial Report (Internal)
For the year ended 31 December 2002

(Prepared by RSBS Finance
Officer)

(Account R41540)

Source of Funds

Initial Budget	\$407,400	
C/Fwd from 2001	-\$974	
Salary supplementation	\$18,689	
Tfr of funds to Computer infrastructure	-\$2,000	
ARC entry levy 4%	-\$16,964	
Total Funds Available		\$406,151

Expenses

Salary & Oncosts	\$385,380	
Equipment	\$71,754	
Other	\$48,285	
Total Expenses		\$505,419

C/Fwd to 2003 **-\$99,268**

Note: Equipment purchase \$69,500 expense needs to be transferred to R4154001 to match up with funding from EM Reserve

(Account Q41540)

Source of Funds

Initial Budget	\$0	
C/Fwd from 2001	\$66,837	
Recoveries / internal sales income 2002	\$51,148	
Total Funds Available		\$117,986

Expenses

Salary & Oncosts	\$0	
Equipment	\$18,332	
Other	\$7,717	
Total Expenses		\$26,049

C/Fwd to 2003 **\$91,937**

Income opportunities:

From ANU users grants etc:

The number of users allocating funds from their grants to ANUEMU is increasing. \$15,500 was obtained from this source in 2002, a substantial increase over the \$10,700 recovered in 2001, and the indications in 2003 are that it will continue to increase. However the mechanism is haphazard, and a better form of interaction with the ANU's grant monitoring procedures may be needed in future.

Government organisations – income from government organisations (mainly AGSO and CSIRO) was at one time the principal regular source of external funds, but continues to decline, to \$3775 from a high of \$17,775 in 1999.

Commercial sources. The major income in 2002 was derived from the sale of value-added EM-related laboratory supplies (\$5900) and an analysis service, managed through ANUTECH, for airborne particles and other OHS-related samples from building sites (\$4455, down from \$10,455 in 2000). Total commercial earnings were around \$15,000. This work tends to be labour-intensive and directly competes for staff time with research and teaching support – while it has been a valuable source of funds, it would not be advisable to seek to increase it significantly.

Other Universities. This is probably the external source of funds which involves least distortion of the original aims of the Unit, and which impacts least on the service that can be provided to ANU users, but it remains roughly static. Researchers and students from other Australian universities may use the EMU on the same basis as ANU researchers. Income from other Australian universities was \$1,100 in 2002

Workshops - recoveries from workshop charges at best cover costs. Apart from their basic educational role, the main value of such workshops lies in publicising the facilities of the unit.

7. ORGANISATION

The ANUEMU is a central facility serving both the IAS and the Faculties and currently performing about equal amounts of biological and physical sciences work. The Unit is housed within RSBS and uses its administrative and support structures. The Facility Coordinator reports to the Director of RSBS, who has overall responsibility for the Unit's operation and chairs several advisory groups which have a role in monitoring the provision of microscopy infrastructure at the ANU:

The **Microscopy Strategic Advisory Group** (MSTAG) whose members are:

Professor Jonathan Stone (Director RSBS) *ex officio* (Chair)

Dr Sally Stowe Facility Coordinator *ex officio*

Dr Paul Cooper BOZO - (Nominee of the Dean of Science)

Professor Dr Ian Jackson RSES

Dr Tim Senden Applied Maths Dept, RSPHYSSE (Scanned Probe Facility Coordinator)

Dr Bruce Walmsley JCSMR

Dr Ray Withers RSC

Dr Zbigniew Stachurski, FEIT (Director of Centre for the Science & Engineering of Materials)

Dr Helen O'Neill BAMBI

Professor David Ellis Geology Dept, Faculty of Science

Dr Rosemary White Microscopy Centre, CSIRO Plant Industry - External Advisor

Associate Professor Simon Ringer, Director Sydney University EMU- External Advisor

and the **Microscopy Sub-Committee** of the Research Committee, which advises on support for capital equipment requirements.
(<http://www.anu.edu.au/cabs/researchcom/subcommittees.html>)

User Input. Feedback from users comes from responses to news and queries on the users' email list, and from written surveys conducted by the Unit to canvas requirements for equipment and various organisational matters. The ANUEMU website is used to solicit comment by users and advisory committee members on a range of matters including planned major equipment purchases.

8. COLLABORATION and OUTREACH

Collaborations within ANU

Frank Brink:

PhD project supervised by RL Withers and JG Thompson (RSC); "Crystal structure of metal oxy-fluorides".

Roger Heady:

School Research Associate of the School of Resources, Environment and Society, ANU. working with PD Evans on Callitroid thickening in *Callitris* pine and with J Banks, Forestry Dept on Wollemi Pine.

Sally Stowe:

with Gert Stange and Richard Berry (Visual Sciences, RSBS) ;
Stange G, Chahl JS, Stowe S, Ibbotson M. AFOSR International Research Initiative Grant. Title: "A Biomimetic Algorithm for Flight Stabilization in Airborne Vehicles, Based on Dragonfly Ocellar Vision." 2002-05 (A\$ 360,000)

Collaborations with other Australian Institutions

Cheng Huang:

with ME McCully, CSIRO Plant Industry. CryoSEM studies of dissolved element distribution and air embolism in roots.

with Dr Rana Munns, CSIRO Plant Industry, Ion distribution in salt tolerant durum wheat genomes.

The ANUEMU facilities were used by staff and research students from ADFA, the University of Canberra, Charles Sturt University, the University of Melbourne and the University of Sydney

Collaborations with international institutions

Sally Stowe with Professor Nicholas Strausfeld (Univ. Arizona) and Dr David Rowell (BoZo, ANU). Onychorphan neuroanatomy and phylogeny.

Outreach activities

Roger Heady exhibited a collection of SEM micrographs, "Levels of Structure" at the Wood Workshop, Canberra School of Art . March – April 2002.

Unit staff contributed to 2 days of activities of the National Youth Summer School, to the ANU Open Day, and to the FEIT, Engineering Workshop for Year 12 students.

Cooperation with Government, Industry and Commerce

The ANUEMU Facilities were used by a number of Government organisations - CSIRO Plant Industry and Entomology Divisions, GeoScience Australia, The Australian Federal Police, ANSTO, and the National Gallery of Australia. Commercial users included ProSciTech, Robson Laboratories, Fort Dodge, CSL and ADC Australia.

Involvement with professional bodies including service on committees, editorial activities, refereeing of grant applications, provision of expert advice

Roger Heady: served on a CSIRO Plant Industry Editorial Panel.

Sally Stowe:

- administers the Australian and NZ Microscopy listserver
- WISENET (Women in Science Enquiry Network) membership secretary.
- reviewed manuscripts for Measurement Science and Technology
- member International Advisory Board, Medical Electron Microscopy. (Springer Verlag Tokyo)

Conferences, International

Sally Stowe attended the 15th International Electron Microscopy Congress (Durban, September)

Conferences/Presentations, National

Roger Heady presented:

- An illustrated history of the wood anatomy of the Araucariaceae. Fifth National Conference on Australia's Forest History. Hobart February 2002
- The anatomy of Wollemi Pine. Wollemi Pine Symposium, Sydney, September 2002
- Wood anatomy of Wollemi Pine and the Araucariaceae. Mt Tomah Botanic Gardens, NSW. May 2002
- The micro-anatomy of the bark of Eucalyptus tetrodonta -a study of bark used in Australian Aboriginal paintings. Symposium on Current Research into the Conservation of Aboriginal Paintings" National Museum of Australia, March 2002

Sally Stowe chaired session and presented poster "Shared Research Infrastructure in Universities". 17th ASEM Conference, Adelaide 2002

Dr SJ Stowe
Facility Coordinator
ANU Electron Microscopy Unit
May 2003

APPENDICES

(i) School and Departmental Use of the ANUEMU-RSBS in 2002

Group(number of users)	'TOMES	PCs	LMs	ALL SEMs	ALL TEMs	weighted hrs	% use
Weight	0.1	0.2	0.2	1	1		
Commercial (9)	8	5	3	111	21	134.4	1.7
Government(9)		5		59	40	100	1.3
Other Universities(17)	8	11	6	163	8	175.2	2.2
BAMBI(4)		12	17		38	43.8	0.6
BOZO(6)	148	200	184	16	30	137.6	1.7
Chemistry (2)				11		11	0.1
FEIT(13)		43	24	697		710.4	8.9
Forestry (8)		251	182	178		264.6	3.3
Geology(34)		192	209	1314		1394.2	17.6
NITA(2)		3	2	10		11	0.1
RSES(31)		24	7	2217		2223.2	28
RSPAS(4)				76		76	1
RSPHysSE (28)	47	234	16	616	183	853.7	10.8
JCSMR(7)				110	35	145	1.8
RSBS(57)	1113	845	679	717	230	1363.1	17.2
RSC(4)		2		69	228	297.4	3.7
							100
Miscellaneous (unattributed, outreach) (7)		11	13	78	36	118.8	
Total	1472	2074	1541	6448	917	8230	

(ii) CM300 TEM on RSES site

GROUP	2000 Hours	2001 Hours	2002 Hours (n)
RSPHysSE	473	441	551 (11)
RSES	210	77	246 (5)
RSC	31	59	4(1)
Geology	25	0	0
Total	739	577	801(17)

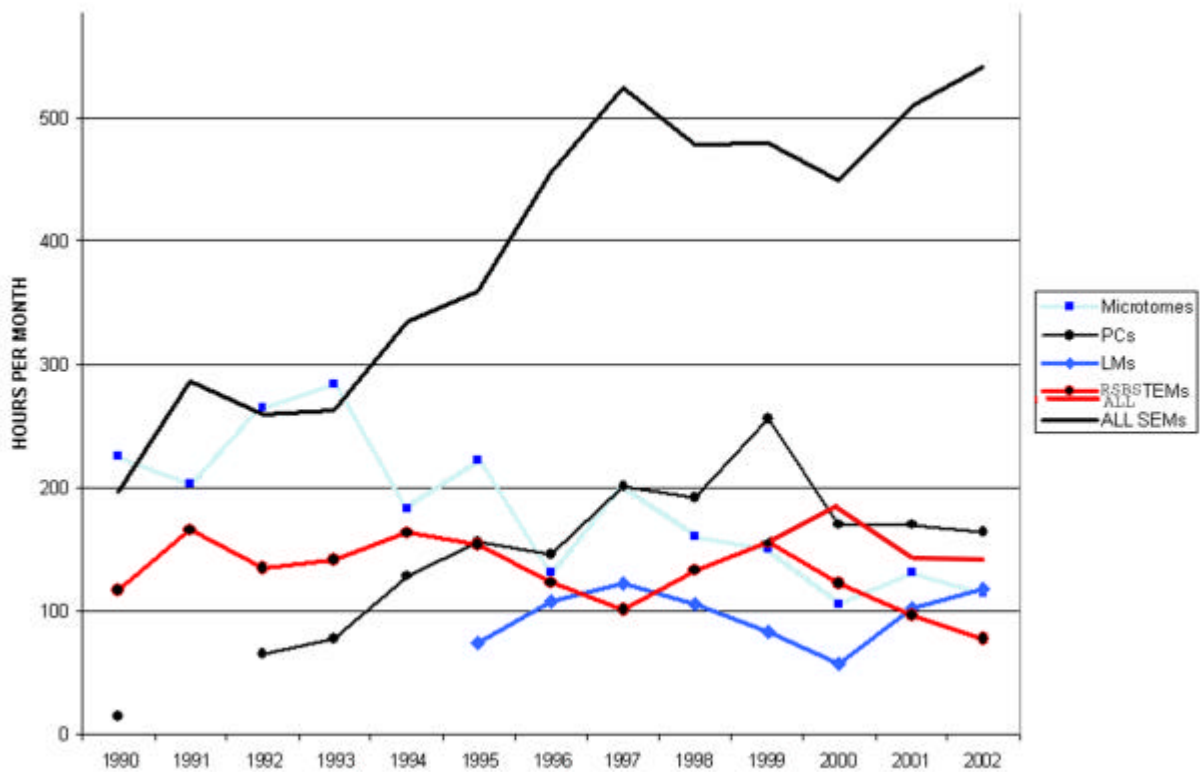
(iii) Number of ANUEMU Users (RSBS site) 1989-2002

YEAR	RSBS	OTHER IAS	FACULTIES	OTHER	TOTAL
1989	25	21	42	19	107
av. 1990-93	43	51.8	65.8	24.8	180.8
av. 1994-97	63.5	88.8	68.8	34.5	262.8
av. 1998-99	66	75	88	32.5	260
2000	63	91	85	38	277
2001	58	91	70	40	259
2002	57	74	69	42	242

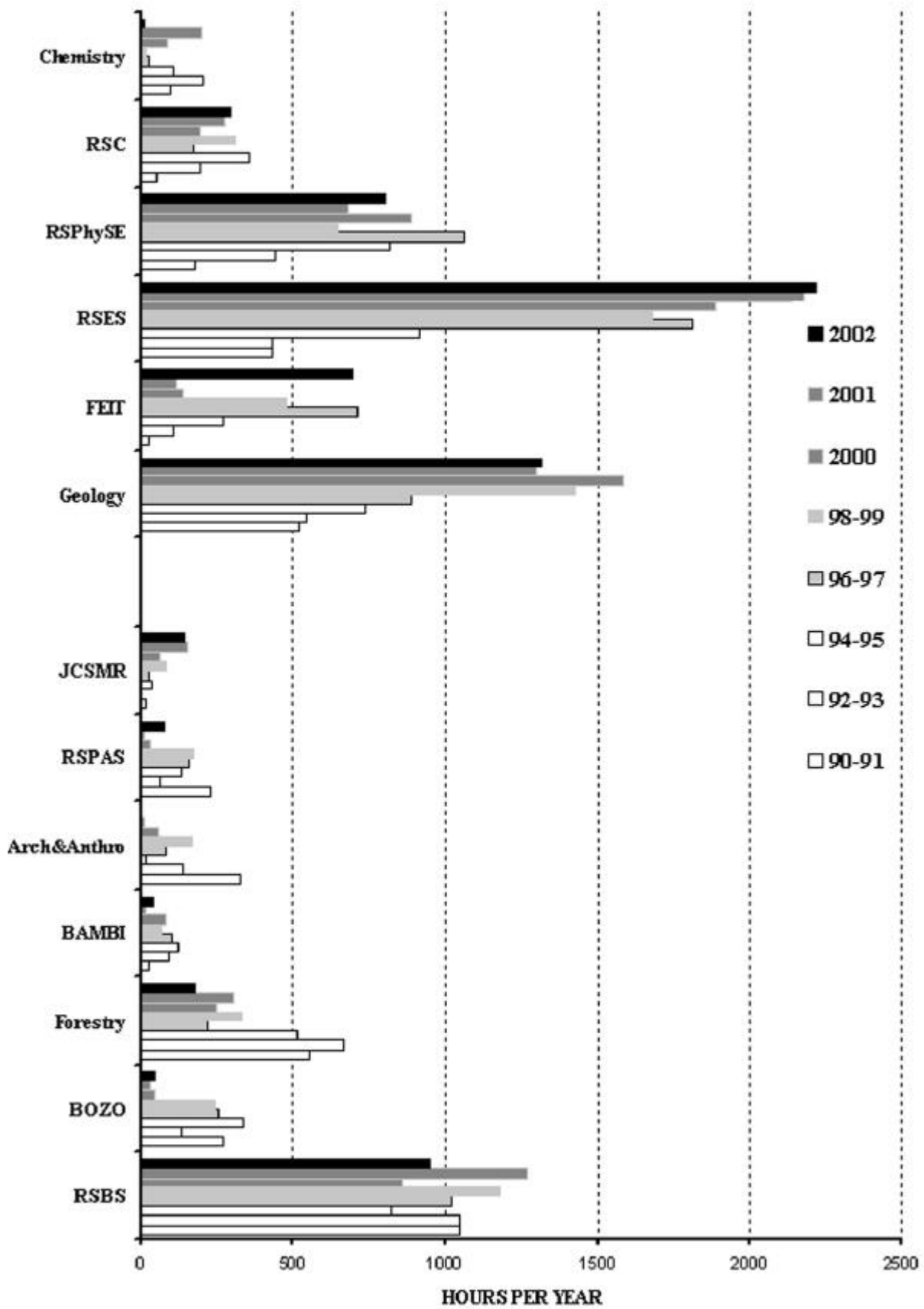
(Undergraduate courses and other student groups are counted as one user)

The numbers of users have been roughly constant for some time following a steep increase in the first few years of operation.

(iv) Trends in ANUEMU Equipment use 1900-2002



USE OF ANUEMU-RSBS ELECTRON MICROSCOPES



(v) Distribution of ANUEMU-RSBS Electron Microscope Use, 1990-2002