

Lessons for South African science: perspectives on QUADRU

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The Quaternary Dating Research Unit (QUADRU) in Pretoria has conducted dating and isotope research for more than 25 years under the management of Dr John Vogel. There are essentially two reasons for this remarkable record. The first was the decision to establish a radiocarbon dating facility in South Africa when the technique was still very young and its potential was not fully appreciated. The second critical factor was the choice of a man of superb intellect to run it. The success of the unit has been a major reason for the elevation of southern African Quaternary science to its highly esteemed position in world Quaternary science. It is a tribute to John Vogel's achievement that QUADRU is widely considered as a national asset. The articles on pages 163–208 have been written by his friends and colleagues to mark John's recent retirement.

QUADRU's initial activity was radiocarbon dating. This technique is used to date organic material and has a range of approximately 50 000 years. The detectors that are used for this purpose are in a chamber deep underground, where cosmic radiation is greatly diminished. This makes the facility one of a relatively small number of laboratories worldwide that can offer extremely high precision radiocarbon dates. In addition to radiocarbon dating, the capability to measure isotopes of hydrogen, oxygen and carbon was soon established. This provided a unique combination of techniques that could be used to great effect in understanding hydrological cycles. The dating of groundwater is still a key activity that is used by water resource managers to assess the sustainability of this scarce commodity in South Africa.

More recently, the repertoire of dating techniques was supplemented with the ability to do uranium series dating of carbonates, and luminescence dating of sediments. The practical ranges of these

techniques are 300 000 years and approximately 1 million years, respectively.

The scientists in QUADRU are part of a network of key players from around the world. This ensures that the most up-to-date methods are always applied. When accelerator mass spectrometry dating began to prove itself, an alliance was forged with Groningen University in the Netherlands, so that the technique could be more readily available in South Africa. In addition, alliances with organizations such as Oxford Authentication in England, an antique-ceramic dating facility, were formed to deal with this commercial component of dating.

The legacy that John created is one of superb science and the articles in this issue are testimony to that. But its scientific reputation alone is not sufficient to ensure that QUADRU is sustainable. The context in which science is conducted is changing, and there are factors that militate against the formula that led to past success being the blueprint for the future of the unit.

The changing context of science in South Africa

The perception of science as a mystical process in which eccentric individuals chisel away at the boundaries of knowledge is increasingly misguided in South Africa. Science as a luxury was dealt a significant blow when the White Paper on Science and Technology ('Preparing for the 21st Century') was published in October 1996. This laid the foundation for a restructuring of the way in which research administrations are constituted in this country. Many of the nation's scientific activities fall under the Department of Arts, Culture, Science and Technology. Two of the large research funding agencies, the Centre for Science Development of the Human Sciences Research Council and the Foundation for Research Development, have been merged into the National Research Foundation. The way in which funds are administered has changed too. For example, research fund-

ing has been redirected into initiatives such as the Technology for Human Resources in Industry Programme and the National Innovation Fund; it is difficult to access these funds if the research is not focused on declared national priorities. Government support is there for those who can demonstrate their ability to address what is written on the funding label. The benefit of research can no longer be the random spin-off of knowledge generation. Instead it has to be the outcome of carefully designed programmes in which there is little risk of failure. The emphasis has shifted from the generation of knowledge to its implementation. 'Innovation' involves extracting knowledge from dusty annals, where it was seldom accessed, and applying it so that it makes a difference to the lives of the average citizen.

In addition to changes in *what* is researched in South Africa there has been a major shift in *how* research is conducted. Projects now need to be lean to get the maximum mileage for the research funds. Scientists now have to be managers of scientific programmes with a plethora of abilities that range from human and communication skills to financial savvy. The slightest mistake in labour relations, even though it may seem incidental to the research project, can bring about the demise of a unit. Projects must now be planned as businesses, executed and managed with scrupulously detailed and financial accounting. It is no longer possible to leave university with a Ph.D. and a head full of scientific knowledge and expect to succeed. Besides a market for the research and the ability to deliver, even the smallest research unit requires a new kind of support to be viable and sustainable.

Conducting research with the support of human-resources and financial experts is just another part of doing research as a business where globalization is a buzzword. Everyone knows everyone else and if you want something done it is easier to get the expert to do it than to develop the skills yourself. Research units are unlikely to conduct an entire project from start to finish without involving others, so subcontracting, with its associated nightmare of bureaucratic red tape and legal jargon, is the norm. To be a part player in the big picture means that you have to be specialized, and recognized as such.

QUADRU: the next 25 years

Although the forces that are shaping science in general in South Africa are also shaping the future of QUADRU, the

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tradition of providing dating services for southern Africa is unlikely to change. The contribution that Quaternary science makes to our understanding of the physical processes that shaped the world in which we live, and the archaeological perspectives that help us to understand the way humankind came to be the way it is, are important contributions to world science. On a local scale, South Africa's spectacular archaeological heritage addresses the history and prehistory of the majority of the country's citizens, and on a wider scale the archaeology of *Australopithecus* provides the reference point for the entire human species. Dating is a necessary part of the heritage science that is increasingly being highlighted for its contribution to nation building.

The heritage market, however, is insufficient to support the existence of a group such as QUADRU in the new scientific climate. It is the challenge of the new era that QUADRU's scientists ensure that dating and isotope technology is used outside of the traditional applications. Just as government has changed the 'how' and 'why' of science in South Africa, it has created many scientific opportunities. In particular, environmental legislation (presaged by such policy documents as the White Paper on Environmental Management Policy, the White Paper on a National Water Policy and the White Paper on Sustainable Forest Development) will create a situation in which entities ranging from industries to households will be required to satisfy environmental audits. A consequence of this is a looming need for scientific methods to address the impact of human activities on the environment. Dependence on government funding for research seems set to decline, with industry expected to take up the reins in order to remain competitive. This will have positive consequences for contract research. Where the potential saving on remediation costs for environmental impacts are significantly less than the cost of research done in good time, it will be good business to contract the specialists and pay for the research.

What contributions can QUADRU make in the future? Does it have the necessary support structures, and the skills and products that will be in demand for the next 25 years? The answer is yes! The unit has a comfortable home within an organization that has responded to changing scientific demands. The CSIR provides the infrastructure and strategic management support that is essential for survival. The diversification of activities, while protecting the traditional market,

will help to turn QUADRU into the home of the science of time and environmental isotope chemistry in South Africa. This is not luxury science. Without a time perspective it is not possible to research the frequency of devastating floods or spectacular earthquakes or the influence of global climate change; isotopes are ubiquitous in just about every chemical process that happens in nature. What will characterize the analytical facility in the future will be a changing understanding of what the technology can do. Instead of restricting QUADRU to dating, the aim is to associate the unit with innovative ideas that can be addressed from its technological base.

John Vogel has been one of the driving forces in isotope science in South Africa. With the changing of the guard, QUADRU will strive to live up to the legacy of this extraordinary scientist. From the perspective of a research unit that has its basis firmly in the past, it is a large conceptual shift to strategize about the future. The only thing that we can be sure of is that South Africa is changing and the science that we do will change too. The key to QUADRU's future lies in the ability to balance specialization with flexibility so that it will be there to do isotope science and dating for the benefit of South Africans in the future.

Beyond Y2000

M. Lawrie*

As the date of 1 January 2000 draws closer, so more and more concern is being expressed about the effect that the roll-over of the century and the millennium digits will have on computers (and thus on a computer-dependent society). There is very good reason for such concern, but that will not be discussed here.

What is surprising, though, is that the concern does not go considerably further. The problem has been dubbed 'the millennium bug'. However, it has little to do with the change of the millennium digits in the date, but it will occur each time the century digits change. As long as dates are stored and/or written with 2-digit years, so there will be a 'millennium bug' problem of the identical nature when a new century starts.

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That said, the next horizon is not 100-odd years away, it is much closer. Many a computer package has a horizon date built into it. For instance, a specific 2-digit number is chosen, say 29, and dates processed by that package are treated as being in the later century if the 2-digit representation is less than the chosen number, and as being in the earlier century if they are greater than the chosen number. In this example, a year writ-

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ten in 2 digits as anything between 00 and 29 will be treated as being actual years 2000 to 2029, respectively, and 30 to 99 as 1930 to 1999, respectively. That means that users of this program face a re-run of the 'millennium bug' within 30 years, not 100 years. This condition is propagated into some so-called 'Y2K compatible' standards, which specify that using a horizon date is an acceptable solution to the millennium bug problem, and that programs that do this are therefore 'compatible'. It is my opinion that they are not compatible, but are time bombs and the users do not necessarily know the length of the fuse.

What makes things worse, different programs (even from the same vendor) use different horizon dates. Thus, interchanging date-sensitive data within, say, a suite of office application programs will give rise to problems when a date lies between the different horizon dates.

Why is this problem not being put to bed once and for all? Are vendors of software investing in their future now? Does the present generation of program designers think that a horizon of, say, 30 years is so far into the future that it will not be their problem? However, 30 years is not a long time. I well recall discussion of millennium problems when coding computers in the 1970s, and am still in the computer game as the century ticks over.

One solution that is guaranteed to work is to use 4-digit dates. Well, that needs qualification; it puts the horizon at 8000 years. Dates need to be written by humans as 4-digit years, and stored within computer files as 4-digit years. Let us hope that the chaos that might arise in January 2000 (and 2030 and at other horizon dates) will not be so costly that legislators say, 'never again shall anyone omit the millennium and century digits when writing or recording a date'.

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