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OH 794

Full transcript of an interview with

KEITH NORRISH

on 05 October 2006

by Peter Donovan

for the

EMINENT AUSTRALIANS ORAL HISTORY PROJECT

Recording available on CD

OH 794 **KEITH NORRISH**

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J.D. SOMERVILLE ORAL HISTORY COLLECTION, STATE LIBRARY OF SOUTH AUSTRALIA: INTERVIEW NO. OH 794

Interview with Dr Keith Norrish conducted by Peter Donovan on the 5th October 2006 for the Eminent Australians Oral History Project of the National Library and the State Library of South Australia.

DISK 1

This is tape one of an interview with Dr Keith Norrish, one time Chief Research Scientist with the CSIRO[1] in its Division of Soils. Keith has followed a distinguished career in soil science and related fields, has since retired. Now, Keith will be speaking to me for the Eminent Australians Oral History Project conducted by the National Library of Australia and the State Library of South Australia.

On behalf of the Director General of the National Library and the Director of the State Library of South Australia, Keith, I would like to thank you for agreeing to participate in this program.

Keith, you do understand that copyright is shared by you and the Libraries?

Yes.

This being so, may we have your permission to make a transcript of this recording, should the Libraries decide to make one?

Yes.

We hope you'll speak as frankly as possible, knowing that neither the tape nor any transcripts produced from them will be released without your authority. This interview is taking place today, the fifth day of October, at the home of Keith Norrish in Grandview Avenue at Urrbrae, the interviewer being Peter Donovan.

Righto, Keith, can we begin at the very beginning: when were you born, and where?

Ninth of July, 1924, in Kojonup, Western Australia.

What generation are you, in terms of Australian? Third-generation Australian, second-generation Australian?

[1] CSIRO – Commonwealth Scientific and Industrial Research Organisation.

Well, it would be third or fourth – probably fourth, I think. The Norrishes – I'm looking at a family history here – the Norrishes originally came to Kojonup in about 1840.

Where is Kojonup?

It's on the main road going from Perth to Albany, more or less halfway. It's about a hundred and sixty miles from Perth.

So tell me a little bit about your family. Was it a farming family?

Farming, yes: wheat and wool, mainly. As I grew up, I spent time with the various families in the area. There were quite a few Norrishes farming in the area. I think their numbers perhaps have decreased – there are more Norrishes around Australia, but not so many in Kojonup now. There are still some of the original ones there.

Now, you were saying you were brought up by your mother.

Yes. While I was in Kojonup I lived with her at my grandfather's place, which was on a farm, and about when I started school she took me to Perth.

Any brothers and sisters?

No. Although I did see a lot of various cousins as I grew up.

So you didn't go to school at Kojonup?

No. But my mother was educated there, but it was just a single room for the whole school, I suppose a typical country school in those days. And the main thing I remember of my mother is that she liked poetry and could recite very long poems. But I attended a convent school in Subiaco, that was my first education.

So you were living around Subiaco?

Yes. We were probably living where Wembley is now, but the next suburb was Subiaco.

How do you look back on your schooldays?

I quite enjoyed them, I guess.

Were you one of the brighter people in the class?

Well, certainly in those years I don't recollect that; I'm not sure whether I was or not, but I've no recollection of that. The main recollection I have was that I was absolutely no good at music or singing. Every time there was a new choirmaster they'd put me in the choir and I would say, 'But please, sir, I can't sing.' And they would say, '*Everybody* can sing.' Next year I'd be out picking up papers because that's what you did if you weren't in the choir.

Did you get much chance to have sport, to engage in sport, while at the convent school?

At the convent it wasn't so organised, but I played. I played tennis and – I don't think at that age I was playing football or anything much; but tennis, swimming.

So you must have moved to Perth when you started school, that must have been just about the time of the Depression.

Yes, I guess it was, yes. I know times were tough. I remember at the local station women would be there sending hampers of food to their menfolk who were working a long way away.

So what was your mother doing? Was she a working mother at this stage?

Yes. While we were in Perth, probably the whole time she was a cook in Foy and Gibson's and she stuck at that for, I don't know how many years, but many years. And she looked after me well and gave me plenty of encouragement.

Did you show any, I suppose, tendencies towards sciences at school? We're talking primary school still at this stage.

Yes. The main thing I remember is that I always wanted to know how things worked. I had two books I can remember that I saved up and bought: one was called *How it works* and the other was called *How it is made*, and I would say that's still almost the basics of physics, I think you could still say that's what physics does, how it works.

Just to clear up one little matter, you said you went to a convent school; most of the Norrishes, I think, were Church of England.

I don't know if the religion changed with the local priest or pastor, but certainly a lot of the Norrishes that I was in contact with were Catholics – not to say saints, but Catholics.

Moving on a little bit, where did you do your high school?

Two Christian Brothers schools – this is in the city of Perth now – firstly St Patrick's for a couple of years, but they didn't go on to matriculation so then I went to what was called 'The Terrace', it was on St George's Terrace. It used to be a boarding school but there were no boarders when I was there. It was where the Perth City Council is now, they were bought out many years ago by I think an American chain going to build a big hotel on the spot, and then that fell through and the City Council took it over. But its grounds ran almost into the Swan River.

How was high school?

Good. I liked it all right. And that was really the first chance I had to study any form of science, so I was quite happy with that. Chemistry, Physics, Maths, Applied Maths, these were some of the subjects that I liked very much.

So you had a facility for these?

Yes, I guess.

Were there any particular people that gave you encouragement at this stage? Have you got a favourite brother who always looked after you – 'brother' in the sense of a Christian Brother?

Yes. Now, this was quite a few years ago and I'm trying to think of who it was. I can't think of his name, he'd be long since dead, I guess.

I guess I'm asking if somebody recognized your traits and encouraged you in them, more so than he might have done to someone else.

Yes. Well, I wasn't aware of that, but maybe it was there anyway. I remember arguing with a science teacher on odd occasions when I reckoned they were wrong.

So was a step to university taken for granted? At this stage it's probably late '30s, I suppose, is it?

Yes.

There are questions of going out to work or going to university: how did you resolve that?

Well, certainly there was no university background in our family. I'm not sure if any of the Norrishes at that stage had ever gone to university. And I did reasonably well at school and my mother – I guess we must have discussed it. But I got a Hackett Scholarship to go to the University of Western Australia. The University in Perth has always been a free university – that and the scholarship helped. And I guess, looking back, I was a bit surprised that I went because it's not like for some years I'd always thought, 'I will be going'.

Did the school have a tradition of sending their senior people to university? Was it an academic school, in that sense, or was it a sporty school?

I'd say it was a bit of both but I don't think particularly academic in that sense. From our matriculation class I guess there was only two or three of us went to university.

So when did you go to university? What was year one?

Well, it must have been about – I've got to work backwards now – (pauses) be very early 1940s, I would say.

What was it like?

Pleasant. Perth was much smaller than it is now and certainly smaller than the eastern states universities. Spacious grounds. Perth University had moved – I guess it was many years before – from the city well out of the city to its present location on the river, and it had very attractive grounds with lots of space, for lying around on nice spring days and just talking and passing the time. I enjoyed it.

How did you decide what subjects to study?

I think this was decided by my interest in 'how it works', and so Physics was always the main aim. And I did more or less the standard Science degree to start with, just Physics, Chemistry, Maths and also did Geology. I enjoyed all those subjects.

Did you do anything else at the University? You obviously weren't President of the Choral Society or anything like that, but – – –.

No, I guess that part of life I didn't do that much. I played a little football but not too seriously. I played tennis, I played tennis quite a bit there, but I wasn't in the squads or anything like that. I did a lot of swimming in my last years at school, and I continued that at the University for a while. But in terms of the various societies and things I didn't do a lot.

When did you leave the University of Western Australia, and with what did you leave it?

I did honours – after finishing my degree I got first-class honours – and then I did an MSc[2], and that was completed around the end of 1946, and in 1947 I came to Adelaide to join CSIR Division of Soils.

And you spent your whole career with CSIR?

More or less, yes. They had bought – at that time, clays were little understood. They were too fine-grained for ordinary techniques to study them properly and there was a lot of controversy over whether they were even crystalline or just amorphous mess or what. And it had just been shown, by X-ray diffraction, you could identify these things: they were crystalline. And the Division, there was a Physics section in the Division of Soils, and Dr Tim Marshall had bought an X-ray diffraction unit for studying these and they were looking for someone who could do this. And this was the type of work I'd done for my MSc, so I got that job.

Did you have many choices to make about where you wanted to go? Not to go off with further education, go overseas or anything like that?

At that stage I guess I was looking for a job. Probably the only job I applied for, I think. And I was happy enough with it, so – – –. There weren't *too* many people going overseas then. It was a fairly big deal.

Would there have been many competitors for that job?

I have no idea.

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[2] MSc – Master of Science.

Were there many others in that field? You said it was – – –.

Probably not. There was a lecturer at the University of Western Australia in Physics called Jack Shearer, and he was the one experienced in X-ray diffraction; and from what I know of the other universities there was probably little training in that field at all at that time.

So it was an attractive option for you?

Yes.

How big was the unit you joined?

Well, I'd joined – I guess Tim Marshall was the head of the Physics group, and he'd probably had maybe four or five research scientists under him and then some technicians. He was an excellent leader. He knew how to handle us.

Why was the Division in Adelaide?

Probably – well, I'm not sure. The Division started in the 1920s. Professor Prescott was Director of the Waite Institute, and it may have been partly – and he'd done a lot of soils work prior to coming to Australia; but I'm not sure if that's the reason they chose it. In fact, for some years he was – at the time I joined, he was Director of the Waite and Chief of the Soils Division. The other reason might have been that some of the earliest work the Division did was on the irrigation schemes for returned servicemen – you know, put returned servicemen on the land – and it may have been proximity to that. I'm not sure just how it wound up in Adelaide. Although even when I joined, parts of the Division were in other states – Canberra, Brisbane, Tasmania – so it's always been fairly widespread.

Was it a vibrant organisation? How academic was it?

I would say at the time, in those days, yes, it was. And there was a mixture, and for many years there was a lot of debate about how academic it should be or how applied it should be. And even that debate indicated a certain liveliness that's not necessarily there now. But I can remember in those days morning tea or lunchtime you'd talk about your work, if you had problems or you wanted to argue, disagreed on things, so it was quite a good environment.

Did you have any formal or informal links with the University [of Adelaide]?

In those early days, I guess there were informal ones; but we were housed in the Waite Institute when I came and so we were on University property, and they had various research workers doing not exactly the same thing but similar things, so there was a lot of interaction. And, as I say, Professor Prescott ran both shows.

How was the work that you were concerned with determined? Did someone like a Tim Marshall say, 'We need to be doing something on this now, go and do that'? Or did you generate it yourselves?

Ah! Well, it was mainly determined by Tim Marshall just saying that, I think. As I say, it was only just prior to this that they recognized that you could – they had a technique to study clays, and the equipment was in there waiting to be used when I arrived; not installed, but they'd bought it. I laugh about that because when I had to come from Perth I would normally have caught the train; they couldn't wait for this, I had to fly. But when I got here of course the rooms and everything had to be set up so I spent about three months just waiting before the equipment could be installed.

Now, how does this equipment relate to the work that you're renowned for? Was it sort of predecessor-type equipment, or was it something you developed into this X-ray, for instance?

No. Well, there's two types of work I've been involved with: X-ray diffraction; and X-ray fluorescence. Now, when we're studying clays, it's mainly X-ray diffraction, studying the minerals in soils or how the minerals behave. And I must say in this work, and particularly under Tim Marshall, he gave us virtually all the freedom we wanted, as far I was concerned, or there might have been some directions, but if I wanted to do something I did it, basically. I'm not sure if I answered your question.

Well, I suppose we're getting on to this X-ray fluorescence, for which you're particularly renowned.

You were asking me about how well-developed the technique was. Well, in the clay work, a lot of that was just establishing what minerals (telephone

rings) were in the various soils of Australia. I didn't anticipate that – – –. (break in recording)

Okay, we're on again.

I think you were asking about the clay work in X-ray diffraction, was that an established science. It was, but there was quite a bit of – we made progress, and one of the ways was improving the equipment side. Although X-ray diffraction at that stage was an established technique, clays require certain – well, studies could be improved by changing equipment. And one of the things that I suppose I'm more known for is understanding the clay called montmorillonite or bentonite that's used for oilwell drilling and it forms a gel. I did work that established how it swells. Its crystal structure is like a mica, it's like all sheets of paper. When it swells, these sheets move away from one another, so when they're touching there's a sheet every ten Angstroms, but when you put a lot of water in, it goes between and it may be they swell up to several hundred Angstroms apart. And that required all special equipment.

Was that an issue, getting equipment? Or was funding relatively fairly easily [found]?

No. At that time – well, money's always a *bit* short, but I think that probably means we're always a bit greedy, too. But no; in those days I'd say I was well-treated for equipment. You may have to wait a year or two to prove that you're serious, you didn't get everything on demand. And of course a lot of equipment was made in the workshop because you couldn't buy it.

So you had an extensive workshop, too?

Well, a *good* one, not that extensive. But a couple of the people in the workshop were very skilled and they could generally make whatever you wanted.

So describe the breakthrough nature of this X-ray fluorescence that seems to be identified with you.

Well, this is probably because it was, I was going to say an interest that I've had for many years, so to speak, the second part of my life, if you like – although, strangely enough, my first contact with this was in doing my MSc. I was doing my MSc using diffraction and I suspected an X-ray tube which had

a cobalt target had an impurity in the target. And I checked this by building what's called a Bragg spectrometer, which you can build with just a cylindrical bit of brass and a clock motor in the centre and a crystal, and I was very impressed when I did this because I was looking for *one* impurity, I found about twenty of them – they were probably only present in parts per million – and this left an imprint in my brain as to how good this could be. But I must confess my experiences with Chemistry weren't that great: the analytical methods in Chemistry were tedious to the *n*th degree.

So I went on a scholarship to Rothamsted Experimental Station, a CSIR scholarship, in 1950. Prior to that, Ted Radoslovich joined my group and I was going to be away for two years on the scholarship and he was to, I suppose, take my place while I was away, although it was a permanent appointment. We discussed what should be done while I was away, and one of the things was to try and build a fluorescent spectrograph, which he did while I was away. It was, compared to modern instruments, very primitive, but it worked, and when I came back I used it a lot. And having helped build it and then used it – this technique was just starting to be used, although the technique went a fair way back. It was used quite a bit in the early '30s. There were many things made it hard to use. There were no – film was the only method of registering things – endless series of – – –. Now, during the War, Geiger counters came in and then scintillation and proportional counters, and these are much better. These are quantitative measures, way of registering intensities of X-rays. There are many things that improved by that, many technical things. So for many years we used this technique within the Division for quick chemical analysis. Fluorescence doesn't identify minerals, it gives you a chemical analysis.

Now, the thing that changed my life quite a bit was one of the guys in our Division was talking to someone that worked at Port Pirie lead smelter one weekend, and they told a member of our Division that they'd just got a – yes, I think they'd just got an X-ray spectrograph and were wondering what to do with it, they didn't know anything about it. And he said something [like], 'Oh, Norrish has got one of these and has used it.' So they asked me to help get

them going, basically. And at that time there was probably almost no-one in Australia with any expertise in this. Now, I helped them.

Now, the mining industry chemists move around and it's like a big grapevine. Well, the next moment, the Broken Hill people wanted me to help them, which I did, then the sort of floodgates opened.

What were you helping them to do?

At this stage you could buy commercial equipment, so it wasn't so much the equipment. But developing techniques that gave them quantitative analyses. The equipment was there and reasonably good in lots of ways, but these techniques hadn't been sorted out properly. So, after that, there were a whole series of mining companies, basically involved: British Phosphate Commission, Brown Coal in Victoria, ultimately Mount Isa; the iron ore companies; mineral sands companies. So most of these I've had people into the lab to work with me or worked on samples and then gone to instruct people in their own laboratories. I enjoyed it, actually. And mostly it's been successful. In other words, people have been in trouble and can't get things right and I've left them reasonably happy. At the same time, we've been developing – *all* the time we've been improving things, until now we have very sophisticated and very good analytical techniques. The equipment has improved greatly, too, so that X-ray fluorescence, if you can use it, is a preferred method of analysis. It can be exceedingly accurate [and] very, very quick.

From the brief bit of reading I did, one got the impression you came up with some patentable type of device, practice, piece of equipment – is that not so? Or, is what you did patentable? If so, was it patented?

No. No, I don't think what I was doing was patentable. It was a matter of techniques rather than specific bits of equipment. At various times we had modified equipment and so on, and some of this might have been patentable, but whether it was worth – by hindsight I'd say it wasn't worth .... because it's really overtaken now. But it was mainly a matter of – on the whole, management was aware that X-ray techniques should be used in the mining industry and if they look over their shoulder and the guy down the

road, who mines the same thing, is using it successfully, so they say, 'We must get one of these.' Now, the poor chemist who is in charge of this equipment has never seen one, he's afraid of it and doesn't want to use it, and nobody knows anything. So they could have it for a year or two and not get anything useful. And this is where I would typically be asked, 'Can it be used for our samples?' And I would get a bunch of their samples and demonstrate it could be used, generally finding out that their results they thought were very accurate were nowhere near as good as they thought.

But this work ultimately became channelled in this way: that the Standards Australia, for chemical analysis, have standards. The idea of making standards – ...., but if everybody just used their own technique to analyse things and you give it to ten labs you might get ten different answers, and so they will take a technique that may be used by industry and they will get industry to participate in analysing it and then they will refine it and refine it down until they know precisely how accurate and how precise the technique is. And they give very detailed instructions then, so that if you follow this technique the labs will agree. Well, they'd been doing this for wet chemistry for years, and then, about the time I was doing this work, they decided, 'Well, we ought to have a similar thing using X-rays.' And so now, for many, many years, I've been involved in this way. We've produced Standards for analysing bauxites, for analysing mineral sands – that's the high-titanium products and also for zircon from mineral sands. We've made a standard for analysing iron ores, and that's been superseded – – –. Making a standard – and these are, the iron ores is an international standard, which means that you work with twenty or thirty labs overseas as well as Australian labs – and they're like the mills of God: they are thorough, but God they're slow. So we made a standard for iron ores and they said, 'These are the elements we want to analyse.' I say, 'Are you likely to add to this?' 'Oh, no, no.' By the time you've made that standard they're yelling out because they want to add another half a dozen elements or something. So we made a second iron ore standard, and we're still improving the iron ore one. And that's been the main thing I've done by the industry for the last quite a few years. And I'm still involved in a bit of that work.

Perhaps asking the same question in a different way, though: how did your work change over time? When did you retire, Keith?

Well, formally, '89, I guess.

Well, how did your work change from 1947 to 1989? Obviously a lot of contracting to the mining industry.

It was mainly clay work, for which I was employed. And then I don't know. I suppose after I returned from overseas, which would have been about 1952, I guess a year or so after that I was using the spectrograph and decided it worked quite well and we started doing analyses using that. And then I suppose without much formality but generally agreed that we could do this work. What gave it a boost is after the work I did for BHP and Zinc Corporation and some of the others, I got an AMIRA grant – AMIRA is Australian Mineral Industries Research Association – and they provided the money to buy a commercial spectrograph. The earlier work had all been done on this home-made thing. And of course if you get money like that from industry you get lots of ticks for it and that gave approval. And when that instrument was ultimately replaced, the same thing happened, virtually: we got a lot of money from industry to replace it. And up until I formally retired, I was still doing clay – I was doing a mixture: I was certainly still doing clay work, but since I've retired I've been mainly doing fluorescence, but *via* the Standards Association.

Harking back to something you alluded to, this scholarship you received in 1950, where did you take that up, and what did you study?

That was for two years at Rothamsted Experimental Station. This was an agricultural research station north of London, in Harpenden, and you can do your PhD at London University there, and that's what I did.

Studying what, at that stage?

At that stage I was studying diffraction, again of clays. And in fact this work I mentioned on swelling of montmorillonite, formally that wasn't part of my thesis, I'd put in some other work. And ultimately when I had to write my thesis I could have gone to the trouble of changing what I was submitting for a

thesis. It would have been a whole lot of bureaucratic red tape, but this work was very much better, but I didn't bother. So the work I submitted for my thesis was the work I'd proposed, which was more mundane; and the better work that I did at that time was this other work.

How did CSIRO change in that forty years? Was it easier to do what you wanted?

Dramatically. It's changed, I'd say, very much.

By this time, presumably you were – you came to become Chief Scientist, presumably?

Yes. CSIRO has become much more bureaucratic and administration is the big section of the CSIRO. The Soils Division most of my life ran – the office consisted of one chief clerk and a whole lot of typists. Now there's clerks for everything, and they generate a whole lot of work that scientists have got to worry about which is irrelevant to the work. But I could operate most of my life by doing what I thought was best. I couldn't do that now. I can't remember when it came in, but there was a big change in science in Britain after a certain report – and I'm trying to think of the name of the report and I can't – but what came in is you have to fill in yearly projects and you virtually had to say what you were going to do, what the results would be, how much money it was going to make for Australia, all this sort of thing. Now, science doesn't work like that. The *best* science is something you don't predict. And in a way this kills it, because if you want to get all the ticks that you can get for doing this sort of science you pick something that needn't be done but which – you know, if someone finds that putting a certain fertiliser on potatoes makes them grow well in America you say, 'Well, I'll try that in Australia.' You know damn well it's going to work, you know how long it's going to take and what the result will be, so you can do exactly what you say. But whether that was worth doing is questionable.

The thing that frustrates bureaucrats is that you can't predict – the *big* things in science are not the little jobs that industry may want you to do. There's nothing wrong with that, but the big things are long-term things. People spend a lifetime. And the results are not always predictable. There've been many instances. I think the guy who did a lot with lasers at one stage

was a Canadian, he ultimately got a Nobel Prize, but he had been ordered off this 'useless' research by his supervisor, by his professors. And science is littered with this sort of thing. It's useless work till it's successful. And CSIRO's still very much in this state: if a thing doesn't pay, and pay almost instantly, it's out. And the old Division to which I belonged, which has now become Soil and Water, they're slowly losing their ability to do research because if equipment doesn't pay for itself – – –. I had fairly well all the equipment I wanted when I was doing my research, I was treated well. Nowadays, if equipment doesn't pay for itself, you get rid of it. So the whole campus up there, which includes several CSIRO Divisions, and the Waite Institute, which is very big, hasn't one electron microscope. That's a basic instrument for research these days. And I think they had about three or four at one stage, but they've slowly just got rid of them – 'They're not paying, get rid of it.' And that's happened with a lot of the equipment. Now, that means you can no longer do that work. The basic facility, it's – – –.

Have to stop you there, Keith, we've just about used up this little card.

END OF DISK 1: DISK 2

This is the second card of Peter Donovan interviewing Dr Keith Norrish for the Eminent Australians Project, the date the 5th October 2006. Now, Keith, if we can go back just a little bit, when you were working for the mining industry or doing work for the mining industry, how did that relate to the CSIRO? You're doing it under contract to the various mining companies?

Initially, my own philosophy was, 'These guys pay tax, and it's taxpayers that pay me', so I would generally just do the work. And I think both parties were happy. As I say, when I wanted the first commercial spectrograph we got, I spoke to various companies and they bought the instrument, and that happened a second time. Now, nowadays you've got to have contracts, a lot of lawyers are all involved, and it's got a very formalised business. How easy it was initially, I can remember I had an invitation to attend a Spanish clay conference years ago, and I wanted some finance for that. I rang up Zinc Corporation and said would they be able to help at all, and they said they'd let me know. Well, the next moment there's a cheque in my mail, and I rang

them up to thank them and the guy said to me, 'That's all right, Keith,' he says, 'but why do you want to go to a conference on plays?' (laughter) He was financing me for that when it was a clay conference. But that's all gone now. The lawyers take over and – – –.

There's endless bureaucracy now. I'm still involved a bit and I've got one person doing a PhD under me and another technician who works for me up there at present; often, it's convenient for me to go up there after work, particularly if I want to use equipment, I know it won't be used after hours. But you're no longer allowed to go up there by yourself any more, it's supposed to be a health and safety thing. I've done it for sixty years, but all of a sudden it's not allowed. And it's bureaucracy has first priority over science, everything must be done just according to them.

When did you become Chief Scientist? You mentioned there earlier Tim Marshall, so you're obviously in that line.

Well, when I returned from overseas, I'm not sure how long but maybe after a couple of years of still being the Soil Physics section there was a decision to make, and we were doing mineralogy, which wasn't really soil physics, and we decided to make a Mineralogy Group. So at that stage I took the people who worked with me and formed a separate group. And in fact probably about that time it was getting a bit crowded – we were all in the Waite Institute – and we were invited to go into the Mawson Building at the University, who'd just got a new Geology Building and had plenty of space. So we went and lived down there, my group, until about 1961 when the Division had its own buildings built.

So you were technically a Chief Scientist when you took over that group?

Oh, no. The Chief Scientist doesn't automatically mean any administrative position, and particularly in those days it was based on your own research. And I wasn't Chief Scientist then. I'm poor at saying how long ago things happened, but I guess I became a Chief Scientist, must have been maybe ten years or fifteen years before I retired.

Were you ever head-hunted to go elsewhere? Were you ever tempted to go elsewhere?

Not particularly. I think I could have if I wanted. But I say to people I had good times in CSIRO when it wasn't *flush* with money, but if you wanted to do something you could do it and the bureaucracy wasn't what it is now. So I never desired that particularly. I'm quite sure I could have had jobs elsewhere if I wanted to apply for them. I've never applied for another job, so – – –.

It's not bad when you're only applied for one job in your life. So you weren't tempted to a purely academic position? So the notion of an applied position probably appealed more, did it?

Well, in those days in CSIRO the universities were very jealous of CSIRO because we could do academic work, if you like – what you call academic; not applied work – and we didn't have to lecture, we didn't have to teach. So they thought we had the pick of it. And that suited me. At various times, I've taught bits and given courses at the universities, and for ten or fifteen years a professor at the ANU[3], and I've given courses each year to mining – well, to anyone, these are X-ray fluorescent skills, but it's mainly attended by mining people.

You say you have a PhD student at the moment. When did you start picking up PhD students?

Well, this guy's working for CSIRO and he works on standards work and largely financed by the mining industry, but the work he's doing we've encouraged him to use that for a PhD. Prior to that I've had others, I've never had a great number, and this is because over history CSIRO's been rather ambivalent about it. At various times they said they wanted you to have students, and at other times either they or the University don't want you to share students. So the universities don't necessarily like CSIRO getting involved, because if there's a shortage of students a PhD student becomes the lecturer's pair of hands and he doesn't want to be deprived of this by them going to CSIRO. So at present CSIRO encourages [staff] to take on students, but there's been no consistent policy, although we share buildings with the universities. But on both sides there can be, I suppose, rivalries or jealousies develop.

[3] ANU – Australian National University.

Moving on to another little aspect, sort of life outside CSIRO or whatever: what professional organisations did you belong to? Have you been active in other organisations like that?

I mentioned Standards. And I've been active in that for many years. That's not exactly – well, it's a professional organisation, but not in the sense that you mean it, perhaps, I think; but Standards has committees and I've been a member of various ones of those. But the Institute of Physics; the Clay Minerals Society of Australia, of Britain, of USA; there's an AXAA – Australian X-Ray Analytical Association, I'm a Life Member of that; so the normal sorts of societies I've – – –.

In an active capacity, or just as an ordinary member? Do any of them bear your stamp?

I don't know whether I'd be – where I've had most influence, I think, would be in the X-ray Analytical Association, but I've never been – I'm just trying to think, I don't think I've been office-bearing in that. But an awful lot of the membership are people who have worked with me at various times. I'm a Life Member of that. I'm a what they call a Distinguished Member of the Clay Minerals Society in America – I'm probably the only Australian, I think – and there's a Birks Medal and I've got that for spectography, and that's like an international thing. It's American, but they give it to anyone. I'm fairly sure I'd be the only Australian with that.

Now, I've got a list of honours here, I guess. One was the Prescott Medal from the Soils Society of Australia, 1977.

Yes. That's for contributions to soil science, which would be mainly my clay work. Apart from just identifying minerals in soils, my group – well, I have in my group done a lot of work on what properties they confer to the soil.

As an example, cobalt deficiency exists in lots of Australia, and plants don't need it but if it falls below a certain level in plants then the animals become sick. And this happens all over the world and it's got local names, but I think we call it 'coastal staggers' is one – there are a whole not of names. Now, one of the ways of curing this was to put super[phosphate], lace your super with cobalt, and CSIRO developed another way, which is just to put a cobalt bullet into the sheep and it sits in the stomach and releases tiny amounts over a long

period. We got involved some years ago with soils in Tasmania, where you put it in with the super. In some soils it works and in others it doesn't, and you could do all the conventional things and soils appeared to be the same. Now, what we found out was that there's manganese in the soil and it often occurs – well, it's in very low concentration, but it often occurs as little black nodules or little black coatings – but the manganese avidly fixes the cobalt, so you could virtually predict from the manganese content of the soil whether you should add cobalt in your super, whether it would be any good.

We also did a lot of work on identifying the phosphate minerals in soils, because soils may have – phosphates generally applied to soils in Australia, the phosphorus contents may be quite high but plants can't get it; and we've identified very insoluble minerals that can just hold the phosphorus. So we've been involved, apart from the straight clay minerals, in not only identifying the minerals but seeing what properties these give to the soil. So that would be the sort of work that I got the Prescott Medal for.

Same year, 1977, you became a Fellow of the Australian Academy of Science.

Yes.

Recognition for the same work?

And the spectrography would have come in there. That's on the basis of what you've done in your life. So that would include the spectrography. And I regard that, in *my* mind, as the thing I value most. It's a fairly exclusive club.

Even more so than having a mineral named after you? Norrishite.

Well, it's quite different. And that's nice, but basically the guy that did this, Tony Eggleton, I suppose he just proposes that – I'm not sure if he even asked me; I think he did, and if I agreed he'd submit to the Mineralogical Society and if they accept it that's it. So theoretically you could name it – it was nice to have a mineral named after you; it doesn't mean you've done anything to deserve it.

How often does it happen? How often do people find new minerals?

They still turn up. I've named a couple. When I was doing my MSc I was working on – I did a year's Geology in my first year, then I dropped that subject. When I was doing my MSc, Professor Prider who was Professor of Geology at the time and worked on the rocks from the North-West of Western Australia – these are the ones that are producing diamonds now, from the Kimberleys – and he had noticed that the rutile had a strange morphology – that means the crystal shape was different from what you'd expect – and he gave them to me and by diffraction I showed these, quickly I demonstrated these weren't rutile at all, they were a different mineral. And that took me quite a while in a way, and I ultimately named it 'Preiderite'. Subsequently talking to him he said I'd named it to commemorate his mistake, (laughs) but that wasn't true.

And actually that's interesting, because you know there's a – Ted Ringwood in Canberra, does that mean anything to you? He's a professor there. He proposed a way – – –. You know, to get rid of this long-term radioactive stuff, one technique is to put it into a glass and bury it. Now, the worry is that glasses are not the most stable materials, if they start to weather you wind up with it in your waters, so Ted proposed putting this stuff into very resistant minerals. And one of the main minerals he chose was Piderite, and this is in these kimberlites that come up from deep in the earth and they're weathered to hell now, so they're as old as old, and this mineral, Priderite, is so stable, it just sits out, nothing happens to it. So this technique is based largely on that, its crystal structure has a hole into which these elements can fit and they stay there.

Now, you also got your AO in 1989 – that's for retiring, I presume, in about then?

I have no, I can never go back beyond a couple of years and I'm not sure whether the thing happened two years ago or twenty years ago. But in my recollection, that was for both the work I'd done for the mining industry and for in general the agricultural industry.

Then in 2001 you received a Bailey Distinguished Member Award.

That's the clay. You've done your homework.

Oh, we're meant to do things like this.

And that was a good award, because it's essentially an American thing and it's sort of special to get it.

So it suggests that your big things have been contributions to knowledge of clay.

Yes. Have you got down there the Birks Award?

I've not; see, I've failed in the research.

I can go and consult my office if you want. But that was for the XRF[4] work. Birks Award, people laugh about – – –. (laughs) So there was the two things and I'd rate them about the same. I suppose there might have been a bit more science or academic stuff in the clay work. The fluorescences, I had to develop the theory a lot, but it's been aimed all the time at applying it. And the technique – Mount Isa want to do a thousand assays a day, and that's for thirty elements. Now, they came to me quite a few years ago in a panic. They were expanding their operations and they had no way of analysing the things. They said they'd have to build buildings and employ a whole gang of chemists if they wanted to do this work; it was either that or do it by XRF and with the current techniques they had no way of doing it. And I said, 'Well, I'll have a go', and ultimately gave them successful techniques which they're still using. And so if you just look at it in terms of dollars, it saves them an enormous amount. The same applies to the iron ore people. I had BHP approach me just earlier this year and they wanted – I forget what it was, I think they want to do seven hundred thousand assays a year. Now, whatever it was it works out about one every thirty seconds. Now, that's for a few elements, five or six elements. And you can do it with X-rays, but couldn't do it any other way.

We're starting to review your life, I guess. Are there any people along the line that really helped you? You mightn't have done what you did – – –?

Yes. Well, when I did my PhD there was a guy there called Douglas Macewan a Scotsman, who helped me a lot. That's putting it mildly. He is probably the

[4] XRF – X-Ray Fluorescence.

brightest bloke I've ever met. He spoke virtually every European language and I think Chinese as well and he gabbled the languages, but he was very bright. Doing my MSc with Dr Shearer, who was a lecturer in the Physics Department at Perth, he gave me very sound training and I think a very good one. And Tim Marshall when I joined CSIRO, he gave me excellent training, mainly in how to treat staff – I mean, he didn't do overtly, but just my aim would be, when I was head of the section, to treat people the same way, which was not push them around or come in heavy – – –.

So who have been your protégés? Is there anyone taking on your work and developing it?

Almost want written notice of that. A lot of them are scattered – – –.

Yes, there are probably hundreds of people that have been influenced by you, but are there some that you almost father-and-son type relationship?

The guy that rang me up then in Melbourne, Ian Madsen, is in charge of X-ray diffraction in Mineral Chemistry. Bruce Chappell, he's retired now but a professor at the ANU. He obviously can't be a protégé, but in terms of XRFL he probably is. Trying to think. They're notable. There are lots and lots of people out there working in the world who have spent time with me.

Are you the sort of person that's written lots of academic papers? Or has it been primarily reports for – – –?

No. You asked for the *c.v.* and I mightn't have it here. (looks through papers) Well, I've written a lot. I *hate* writing and – – –. (interference with microphone)

Do you want that taken off?

Yes.

I'll just stop this for the moment, then. (break in recording) Okay, Keith, in terms of your written output – – –?

I think it's a hundred and something papers or possibly two hundred in good journals. Then I have lots of what they call technical reports, almost all of this work I did for industry is in that category. Now, compared to some younger people – they churn papers out like – – –. There's a tendency now that –

well, scientists are intelligent people and if you say, 'Your promotion depends on papers', they'll produce papers. And if you just count the papers, they produce a lot. I was on the Queen Elizabeth Scholarship Committee for quite some years, and I remember one – I always got these things to assess over a weekend and then I had to go to Canberra the next week and be part of the committee. And one of these guys, who's under thirty – I think it was the limit, under thirty or thirty-five – I looked at his page of publications and I thought, 'That's not bad.' And then I saw that was List A, and he went down to List Q or something, hundreds of publications. Ultimately, he didn't get a scholarship. One of his referees basically said he was too busy writing papers to think about them. And that's true, I think, a bit. There are lots of journals now and referees aren't always that careful as they should be, and so there's lots of stuff published which shouldn't be published or the world would be no worse if it wasn't published. In fact, CSIRO at the moment, every now and again they get worried because the publication rate has gone down. It's all contracts now, just raising money. So that's more important than publishing. Which is a pity, because I think the quality of the work that's done was different. I mean, they'll encourage people to get money from industry and to work on their specific problems. Now, there's nothing wrong with that and industry may need that help, but it kills the more open-ended research. And traditionally that's what the CSIRO has done. All the management that goes on now in CSIRO to make people produce enough, I don't think there's the slightest bit of evidence that it's any better than when we didn't have that.

Keith, could I just change things fairly radically, dig a bit more into your private life: when did you marry?

'49, I guess, 1949.

How did you get time to court and to marry?

(laughs) Well, at that age you find the time.

A local lass?

Yes, Adelaide. Adelaide family. From a legal family, all brothers and cousins and things, either judges or solicitors. So from my viewpoint a very strange [family], they think differently.

And you have children?

We have a boy and four girls, boy in the middle.

Any of them follow in their father's – or their mother's – footsteps?

My wife, she's not a professional musician but she plays the piano quite well, and all the girls, all our children, the girls all played instruments and the youngest one is a violinist, quite good. My son didn't want to go to university particularly, but he's at the University now as a technician, so it's the nearest to me. He's very useful to have around the house, he's a qualified fitter and turner, I think a qualified refrigeration mechanic, qualified electrician. Every time something goes wrong (laughs) we ring him up. And we have sixteen grandchildren, if it's of interest. Keep us fairly busy.

Was it easy to marry family life and your professional life at CSIRO?

Yes, but my wife's been very tolerant, I think. If you ask her she might give you a different answer. I'm aware of the fact that most times work seemed to take priority. That was the way I wanted it, I guess. My wife still complains about that.

It probably keeps you out of the house when she wants to do something here, anyway.

Yes. I think probably to be a good scientist you've got to be fairly devoted. And that worries me, you don't seem to – I think that's a thing that's been killed in CSIRO. I mentioned earlier that you go up to work in after hours and the only cars you'll see parked are from odd students and, as near as I can see, very few of the staff work more than they have to. And there's a mistrust now, there's no trust. Once – my whole working life up there, I don't think I ever saw a case of seriously cheating on CSIRO by staff or anything like that, but now there's – well, I gather the latest is that they brought in some years ago that a lot of the staff have to sign timesheets, and all the money operations, the whole thing is based on the fact that you'd be cheating them if you can. And I think when this wasn't there, they got much more value. Almost all the research staff worked much longer hours than they were paid for, but they just wanted to do it.

You were honoured by your university there a couple of years ago, with an honorary doctorate.

That was nice. That was good.

Explain why you believe that's good.

Well, a DSc is a nice degree to have, and particularly – well, I forget what the term is, the Latin term, but basically you don't submit a thesis, it's just an award. But it's nice from your home university, anyway.

So you still have quite a deep regard for the university that –

Yes.

– let you find your wings.

When I first came to Adelaide – you asked how did I get into clays – I remember I arrived by plane and walking the streets of Adelaide I wondered what this funny stuff they'd made the footpaths were. Well, it was just the clay, it was the soil I realise now. But Perth's all sand, do you know that, and I couldn't figure out what the stuff was. And I remember I came in early by plane and I couldn't get anything to eat till nine or ten o'clock and my view, after a week or so, was if somebody had told me I'd spend the rest of my life working on clays in Adelaide (laughs) I'd have committed suicide. So things [change].

Well, it's pretty important when you think of just the cracking in houses because of our particular soils, that would be well worth, very important research.

Well, this montmorillonite is the thing that swells in soils, this stuff I was working on.

So we're wrapping up now, I guess. But any regrets? Any of the things you haven't achieved that you would have liked to have done? Still a few things out there yet to do?

Yes, there's the odd thing I still want to do. As best I can I'm doing that. I haven't many regrets. The one that I have is that I have a great aversion to writing, and there's a lot of stuff that I should have written up that I haven't. A lot of it I just passed on – various teaching or giving lectures at conferences

– but I could have and should have written more papers. But work-wise, I've no regrets.

Now, I guess one of the reasons for this series of interviews was your AO in 1989. How did you feel when you were approached about that?

Good. (laughs)

But it still doesn't – it's not up there quite with the Fellow of the Australian Academy of Science?

Well, I suppose the distinction is that you get AOs for lots of things. As a scientist, the Academy, as a scientist that gives you a position that you recognise, whereas AOs – I'm not belittling it, but you can get it for – I suppose, I don't know whether they give them for sport, but you can certainly get them for business and all sorts of things. They're both good.

And possibly, by way of reference, do you ever know a Basil Hetzel?

Yes.

Also CSIRO.

Yes.

This is so people can make a cross-reference. I interviewed him for this project years ago.

Basil I knew quite well because he did a lot of work on iodine deficiency in New Guinea and other places, and he wanted to be able to analyse iodine, and he'd get us to do it by XRF of where it's very accurate and quick, good. So I worked with him quite a bit for a while.

Well, I might wrap it up there, Keith. Anything we haven't touched on that you believe we'll be remiss if we don't put it down?

I've mentioned that I feel rather sad about CSIRO, and in *my* view one of the mistakes they've made is to run Divisions *via* managers. Now, in my experience the managers are chosen in mysterious ways. They're not necessarily senior or had experience, they're not necessarily good scientists or had experience in administration. And so I've seen terrible mess-ups, and I think that continues. Some quite young and brash person – and particularly

people who don't see a good future in science because they're not ..... – these people will put their hand up for managers and then they control much better people. There's a lot of damage caused by this. It seems as if, when they nominate a person as a manager, that automatically they give him insights in science and experience at administration, and of course it doesn't happen that way.

Seems a pity to end up on sort of a little downer like that.

Yes.

So CSIRO is not quite as vibrant as it used to be. But is it still doing good work?

Well, I was up there yesterday and I said to someone, 'I hope all Divisions aren't like ours.' And I'm not working there every day so I'm not sure, but certainly prior to my leaving there it wasn't the vibrant place it used to be. I can recall, when you'd go to seminars, people would argue like hell and almost shed blood over differing views. Now, at least there was a passion there, but it seems to me that's all gone. This mistrust that seems to exist between the bureaucrats and the scientists is very damaging, so that I think there's an increasing number of people ticking off the days till they retire, and that's a great pity.

Still, it's good that you have been able to find that little niche to continue.

Yes.

Do you have much run-in with the administration in what you're doing now?

Not run-ins. I don't look for fights, I never have in my life, because it's a very stressful and non-productive way. But while for some years I was an Honorary Research Fellow, which means I could go up to work and it cost CSIRO nothing – well, they provided me with an office or a phone or something – and the whole of that time I was uncomfortable; I felt the managers, or the manager of the group I was in, didn't want me and I think this was because they didn't have me under their control. I mean, I wasn't trying to rebel or do anything, but I think they thought if I didn't like it I could

walk away, which I could have. And there was reasonable hard evidence of that, in various ways. And the only, not exactly brushes, I've had in recent times is these bureaucratic things like you can't go up on a weekend, or you've always got to have someone with you. There's one particular building there that we grind materials finely: now, you're not allowed in there on weekends or at night if you're by yourself. All day, they've got someone grinding up there by themselves. And this is bureaucratic madness, because – – –. So these things frustrate me.

I can't get a nice, positive way to finish so we'll perhaps leave it there anyway, there, Keith.

I'm sure there are good things happening in parts, but – is that still turned on?

That's still going. But I will wrap it up and say thank you, Keith, and –

Yes, okay.

– that'll be terrific.

END OF RECORDING.