An Interview with Professor Geoff Eglinton

By Professor Vala Ragnarsdottir

As most of you know, Geoffrey Eglinton basically founded the field of molecular organic geochemistry. The scientific community's recognition for his achievements shows in a number of awards he received, such as the NASA Gold Medal for Exceptional Scientific Achievement in 1973. Although he 'retired' from the University of Bristol in England in 1993, he is as busy as ever. In 1993, he received the Royal Society of Chemistry's prestigious Theophilus Redwood Lectureship award. Four years later, he shared the Harold C. Urey Medal (EAG) with Dr. John M. Hayes of WHOI and at the same time received one of The Queen's Medals, as the Royal Medals are popularly called. In 1999, he was a HWK Fellow at the University of Oldenburg in Germany where he investigated aeolian dust in marine sediments. Before that, he worked on similarly intriguing topics, such as sticky smelly oozing stuff, daisy flower compounds that go bang, and fungal pigments.

He is also one of EAOG's past presidents. In 2000, Geoff Eglinton received the V.M. Goldschmidt medal and at that occasion, Professor Vala Ragnarsdottir interviewed him. This article is the result of a joint effort of the three of us.

Angelina Souren
Angie@SmarterScience.com

Vala: How did you first get interested in science?

Geoff: That goes back to school days in Sale, Cheshire, prior to 1945. I used to go to the local library every week and just get all sorts of books off the shelves. One particular book sticks in my mind. It is by a French author called Jean-Henri Fabre, translated into English. It is about his observations of insects, made in the mid-1800's, and is a super book ('Social Life in The Insect World', now available as ISBN 0898757177; see also http://www.e-fabre.net/). Fabre just sat for hours and hours and watched sand wasps. What they did and where they went. Then after they had gone away, he would go and look at what they had been doing. His descriptions seemed to me so beautifully careful and interesting. Natural History at its best! That was one type of science and the sort of thing that I really would have loved to do, but of course at school I was studying just ordinary 'text book' science. I remember what the teachers said, after I took aptitude tests in '44/'45, 'Well, you should be able to work either writing or doing science. So why don't you go into science and write about the science!' So that's actually how I got started.

I also read lots of books on chemistry. I found those exciting because they contained all the usual things that students like, such as how to make explosions and how to make crystal gardens. Of course, I then got myself some bottles and equipment to work with at home and that caused quite a problem in a small house!

Vala: How old were you then?

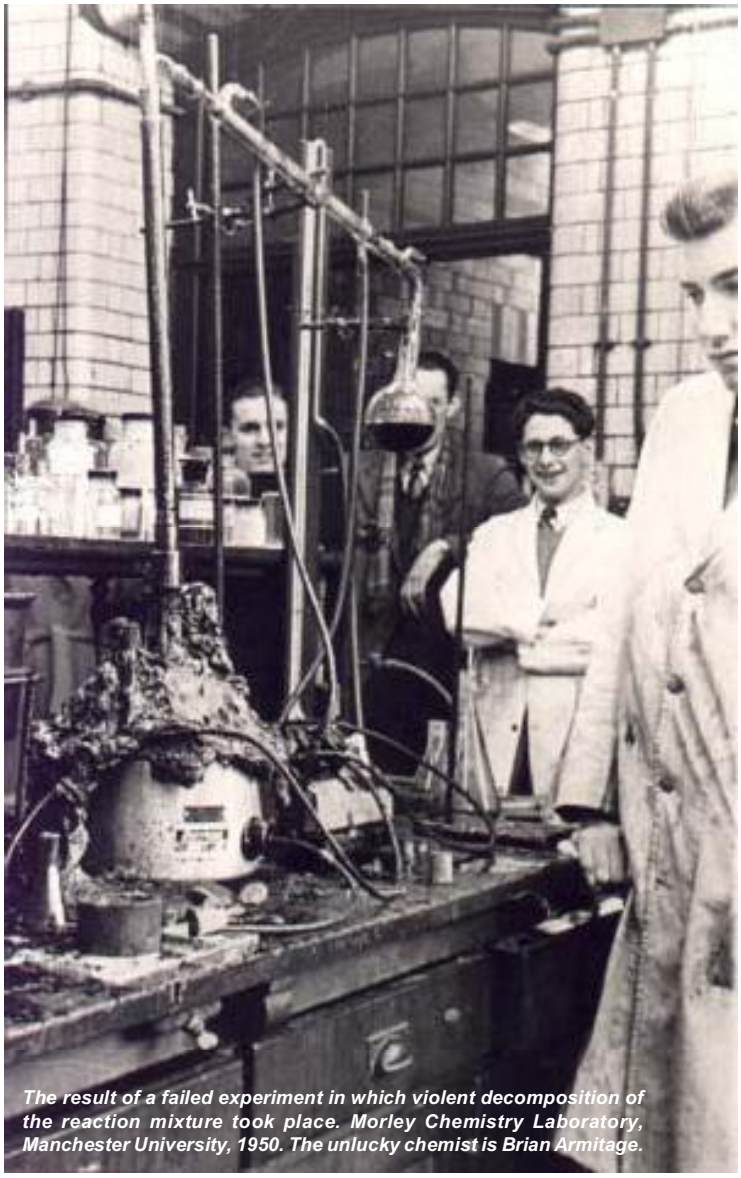
Geoff: I was 15, 16. By that time, I was able to do experiments and mix chemicals and all that sort of stuff, without too much trouble.

Vala: I bet your mother wasn't very amused!

Geoff: No, my parents were not too excited about that!

Vala: Then you decided to do A-levels in science. That is, were there A-levels in those days?

Geoff: No, there really weren't the same things, but there were some similar exams for the Higher School Certificate. Because the school was very limited with the staff it had during wartime, I was doing general science at first, but I ended up doing chemistry, physics and English. With that, you could get entry to the local university, which was Manchester. I opted to do chemistry, but I very quickly made friends with students in the Geology Department because it so happened that I joined the mountaineering club. I found that quite a few of its members were in the Geology Department, as you might expect. The great thing about the Manchester University Mountaineering Club was that past students were also members, and active members at that. You could have a really good time out in the hills and



The result of a failed experiment in which violent decomposition of the reaction mixture took place. Morley Chemistry Laboratory, Manchester University, 1950. The unlucky chemist is Brian Armitage.

Box of lunar samples being delivered to the back door of the Lunar Receiving Laboratory, watched by many of the Lunar Sample Preliminary Examination Team and Lunar Sample Analysis Planning Team people. Once inside, the doors were closed and quarantine was declared on Building 37.

mountains of Derbyshire, the Lakes and North Wales, not only with your own age group but also with older people who knew a lot more about mountaineering and were already in careers. Some of them were, for example, lecturers elsewhere and others were doctors, dentists and engineers. What it really boiled down to is that, while I was out on the hills, if there was something curious about the rock formations – as there often was – I could ask somebody about it. What was it and how did it get there? A great way of learning a little bit of geology.

Smelly sticky stuff

Vala: After you finished your Chemistry Degree, what did you decide to do then?

Geoff: Well, that is rather interesting, Vala. Actually, it started already when I was doing my degree in Chemistry. On one of these mountaineering trips in 1948, I remember asking about a curious material, which was oozing out of a cave in Derbyshire, in the limestone area. A great pack of shales, the Mam Tor Shales, dipped across into this limestone area. There's a deep cleft, called The Winnatt's Pass, where out of the shale and associated rocks was oozing a sort of rubbery stuff. Really very weird. It goes by the mineral name of elaterite – not laterite, but elaterite – and elaterite is clearly organic. It smells, it's rubbery, it's sticky and dark and all the rest of it. So I took some back to the lab and showed it to one of the lecturers in Chemistry. He said, 'Yes, that looks very interesting.' And I carried on, 'Do you think one could find out what generated this by examining the organic compounds present? For example, will there be compounds related to chlorophyll if it were from plants?' He looked at me a bit aghast and said something like, 'Well, that's the sort of thing you should think about when you've done your degree. Get that out of the way first.' So I put the idea on one side for quite a number of years, but I still had this stuff on the shelf and kept having a look at it. Finally, early in the 1960s I decided to take the plunge, change my research and look for organic compounds of biological origin in rocks and fossils.

Working on things that go bang

But, going back to1948, I started off on my PhD in a very straightforward manner. The easiest thing to do, after all, for a young student in the UK, was and still is to go on in the same department to do your PhD. The research group at the School of Chemistry at Manchester was really very keen to have me join and was offering studentships. I was then asked to work in the field of synthetic organic chemistry, making – as it happened – acetylene compounds, which are quite explosive. We had a lot of fun then because there was quite a big group of us. We made a whole lot of different compounds. Some of them were very explosive because they would be made at low temperatures and when the equipment warmed up, they would sometimes go off spontaneously.

Vala: Was there any particular reason for making these compounds?

Geoff: Oh yes! But you don't ask chemists that! It's rather like asking a geologist why should you try and explain what that rock formation is? No, these acetylenic compounds were very interesting as tools to make others. That is, you can use them as reactive units. That's one thing. Another is that while we were working on them, it became increasingly obvious that, surprisingly enough, certain types of these compounds – the polyacetylenes – actually occur in plants. You can isolate explosive compounds from daisy flowers!.

Vala: Really?

Geoff: Yes. This was a field that was developing very rapidly while I was doing my PhD. But I wasn't working on polyacetylenes myself. I was working on the simple acetylenes – with single carbon-carbon triple bonds – and finding ways to make them and also how to use them for making a series of compounds. After three years, I put my PhD in on that and then I went to America to work for a year on synthesizing steroids.

Columbus, Ohio

Vala: And where was that?

Geoff: That was at Ohio State University in Columbus, Ohio. After that, I went to Liverpool University and started to work on determining the structures of the yellow pigments of the ergot fungus, which is a well known parasite of rye. You might say again, why was I doing that? Well, going back to what I had been doing at Columbus, you can imagine that at that point, the making of steroids was getting to be very important, because of medical usage. In the case of the ergot fungus, however, there was no real point in finding out what the bright yellow colour was due to, except out of pure interest because these compounds were clearly structurally peculiar. I didn't solve the colours while I was there, but I made some progress. I was there for almost two years and then I was offered a post in the Chemistry Department at Glasgow. I went up there and set up an analytical laboratory – which they had asked me to do – on infrared spectroscopy. This was to be used for finding out the structures of compounds, particularly those we call natural products, which are the compounds you can extract from plants and animals.

That continued until about 1962, when I decided I would like to start a completely new line of research based on that question I had put at Manchester more than a decade earlier. There were relatively few people working – in the UK anyway – on organic compounds in rocks and fossils, except, of course, in the oil companies about which very little was published. So, I wrote to Melvin Calvin, the Nobel Prize Winner at Berkeley whom I'd heard speak at Glasgow on ***The Origin of Life*** and asked him if I could spend a year's leave of absence with him, starting up this project. I got an enthusiastic 'Yes' and the family set off for California.

Vala: You were in Glasgow then?

Geoff: Yes.

Berkeley, California

Vala: When did you move to Berkeley?

The microbial mats at Laguna Mormona on the West Coast of Baja California provided a good site for low-level ^{14}C biolabelling experiments with in situ mineralization processes involving lipid biomarkers, such as ^{14}C-labelled cholesterol.

Geoff: I went to Berkeley in 1963 for a year, '63/'64,on a sabbatical. Calvin was very interested. He had attracted public attention because of his work on the photosynthetic process, the Calvin Cycle. As a result, he had quite a lot of financial capability and laboratory space. He actually gave me a completely empty laboratory. I mean, that was really something! This laboratory was in the Chemistry building at Berkeley, and had all brand-new benches, taps, electric sockets – the lot. So I decided that I would first of all do a lot of reading! But Calvin was getting more and more impatient and said, 'When are you going to start?' because I arrived in or around September and by November he was pretty restless. He kept on appearing in this empty lab and saying, 'What's going on?' and I replied, 'Well nothing, because I haven't started yet.' But eventually I found a young research student who wanted to come and work on the project. He liked the idea. I said to Calvin, 'We ought to look for certain organic compounds in rocks and fossils.' He wanted to start on the Precambrian right away. In his origin-of-life studies he had worked with people like Preston Cloud and others and they had given him lots of early cherts and similarly unpromising-looking rocks.

Vala: What was the name of this student?

Geoff: This student was called Belsky, Ted Belsky, and he had been working, actually – in the early stages of his PhD – on the reflection spectra from Mars. The connection was infrared spectroscopy. He knew that I was involved with infrared. He turned out to be a very practical character and also, he knew his way round the University, so very quickly we were able to beg, borrow or steal equipment, which he then set up. We bought the first gas chromatograph in the building, got it to work and started to extract rocks. But I refused to start on the Precambrian samples because I thought they were too difficult. I think I was right. We started on the Green River Shale, an organic-rich rock of Eocene age from Wyoming. That came about because I met Bill Fyffe from the Geology Department. We talked and he asked what I was trying to do. A few weeks later he came bouncing back with a set of abstracts from a meeting. I think it was an ACS meeting, a local one, in which somebody from Wyoming reported that he had been extracting these Green River Shales, and had found – or claimed to have found – certain isoprenoid organic compounds in it. And he said, 'This looks interesting.' and I replied that indeed it did! And so we started. We did the Green River Shale compounds and then we went on to the Nonesuch Shale, which was about 1 billion years old, from the Canadian border near Lake Superior. The Nonesuch Shale comes from the copper mines up there and contains small amounts of oil, and it was this we looked at.

Vala: What did you find when you started measuring?

Geoff: What did we find? We were looking for hydrocarbons, because especially with the very old rocks, where there isn't that much left except hydrocarbons. With the relatively young Green River Shale, then there are a lot of functionalised compounds present, but we concentrated mainly at that stage on the hydrocarbons. What we found were the usual straight-chain compounds, which largely come from algae and plants. The shorter ones from algae and the longer ones from higher plants. And also the branched compounds, for which there was a lot of interest, the isoprenoids. Pristane, phytane and so on. We – for the first time – showed that these structures were correct and that these compounds were abundant in the shale. At that time, we thought that they were mainly derived from chlorophyll, but it turns out that more of these hydrocarbons are probably formed by microbial activity than directly from plant production.

Vala: You identified all of these compounds by using infrared.

Geoff: No, by using GC and MS. Well, we also used infrared and a few other techniques.

Combining GC and MS

Vala: When was the first combined gas chromatograph-mass spectrometer (GC-MS) built?

Geoff: I have never looked back to find out precisely when that was, but it may have been as early as the late 1940s or early 1950s. It's a very interesting question. The first commercial one, I think, was the LKB made around 1960 in Stockholm for biomedical customers, and that model was the one that we eventually bought for Glasgow. I had written a joint grant application with another colleague at Glasgow, Charles Brooks (these were almost the first days of grant applications). We requested a GC-MS system to be used for the analysis of both biomedical and geological extracts. It came through and we then wondered where to set it up! That was a famous occasion: to give it a room we had to ask permission to demolish a ladies' toilet in the basement of the Chemistry Department. We wrote a justification that there weren't that many women students (at that time anyway, because of course it has changed now) and yet, this was a quite luxurious one, in terms of space but not location. And that's where the Gas Chromatograph-Mass Spectrometer System went. That was somewhere around '65, I think.

Vala: Where did the funding come from?

Geoff: It came from the Science Research Council, which was the forerunner of the Research Council system. In fact, I've still got the application somewhere and a letter approving the GC-MS.

Vala: This was your first grant?

Geoff: Not quite, but it was one of the early Research Council grants. Usually you relied on the department having a little bit of running money and also getting a studentship from the department or something like that. Then, the equipment was generally small and you bought that out of the Department budget. Gradually, the system changed to where now almost everything has to come from grants.

Vala: In Glasgow, you set up a lab to analyse organic compounds?

Geoff: Yes. Well, what I had done when I went to Glasgow in 1954 was to set up the new infrared laboratory as a service for the whole department and also as a research facility. During that time, we also installed our first piece of home-made gas chromatographic equipment. It was about 10 feet

Geoffrey Eglinton and Queen Elizabeth study the display in 1987, at the signing of a formal Collaborative Agreement between The Royal Society and The Academica Sinica. The name of the display was 'Blood from a Stone'. It showed the real-time extraction of bright red porphyrin compounds from shales, including some Chinese examples. Geoffrey: 'We all put on our best behaviour and stood by our exhibits and that's when the picture was taken.' Photograph provided by Royal Society.

tall (as high as one story), heated by boiling solvents and very primitive. Nothing like the bench top instrument we bought when we went to Berkeley in 1963. And then gradually, during this time, the department at Glasgow developed mass spectrometry as a tool for use in organic chemistry. A huge step forward, led by Rowland Reed.

So we had all the bits and pieces: adsorption chromatography, GC, MS, UV and the infrared. But I was still working, or my people were, on acetylene compounds because I hadn't given up yet on those. Still, gradually we tailed off the acetylenes and started in real earnest on the rocks and fossils. So that's how the change happened. By the time I left in '68 and came to Bristol, we had completely stopped working on acetylenes. So we set up the Organic Geochemistry Unit and started getting ready for the arrival of NASA's Apollo samples promised for the autumn of 1969.

Vala: That was the first Organic Geochemistry Unit anywhere?

Geoff: No, Newcastle was the first one in the UK although a small group had made a start earlier, in the Geology Department in Nottingham. One of my colleagues, Archie Douglas, had gone to Newcastle from Glasgow and joined its geology department, which effectively became an organic geochemistry unit. Newcastle's work was based on microscopy and bulk measurements, especially of coals and kerogens. Less to do with molecules. But gradually it changed to become more like what we were doing, which was entirely molecular from the start. In Glasgow, we had developed this approach and then, when we came to Bristol, we set it up more formally as the main theme of the Organic Geochemistry Unit (OGU). And, you see, James Maxwell was one of my students in Glasgow. He then went to join Calvin separately for a year before he came to Bristol as a lecturer. That way, there was a continuity of expertise.

Vala: Did the funding come from oil companies or NERC?

Geoff: It was a composite of oil companies and NERC (Natural Environment Research Council). I remember, when I was at Glasgow, two BP people coming to see me specifically. They were Gordon Speers and Ted Whitehead. They were pioneers in doing this type of work at BP. I remember it was Gordon Speers saying, 'Now, wouldn't you like to have a contract to do some work?' And I remember I said, 'Well now, hold on, we feel we should be doing the academic stuff.' And he looked quite hurt, you know, and afterwards I thought how daft we were. That was way back, when in fact it was frowned on to have much in the way of industrial support, so I said, 'Well, you know we should be doing the basic stuff.' When we moved down to Bristol, they came to see us again and this time, of course, we replied, 'Well, yes!' Indeed, we were really very pleased to see them. I think they too now wanted to set up an arrangement whereby we were to work on basic things and they on the more applied. We were then to meet with them from time to time to swap results and ideas. In fact, we had some very enjoyable and productive weekend outings with them

What BP did was to approve general areas that they would like us look at and then leave us to get on with them. Then we would have weekend meetings where we would invite most of the group, especially those working on areas that were of interest to them. We would present the work that had been going on, with the BP people there. They would ask questions and make suggestions, and we would for go for walks and have some nice meals. One of these meetings, I remember, was in a small hotel, which can only be described as a second Fawlty Towers. It was really funny to see BP people struggling with the manager – just like we were – who had much in common with Basil Fawlty himself.

This funding from BP went on in various ways for a number of years and certainly helped us greatly. And indeed, it helped them too because some of the results that came out of this were the work of Andrew McKenzie and James Maxwell and others: parameters for assessing the maturity of a rock, or rather the organic material in a rock, or the type of oil and its thermal history. This all came out of the proxies, as we called them, derived from the ratios of one compound to another, where these compounds were being converted, or in some cases eliminated, so that the ratios gave you an indication of where the rocks were on the thermal history plots. That type of subject became really the norm for a lot of work in the oil industry: trying to see which rocks were at which stage of generation and which oil had come from which rock. Although this all came out of the academic work going on at Bristol and elsewhere, we were well aware that there were potential applications in the oil industry, and this approach is now routinely used everywhere.

Vala: How about telling me about how you came to have a NERC-funded service lab here in Bristol?

Geoff: That gradually took place as a result, I think, of us applying for NERC grants over the years. We started off, of course, in Glasgow because NERC was a derivation from the earlier Research Councils structure, which took over responsibility in 1965 for the area that we represented. We had a whole series of NERC grants, in which we were looking

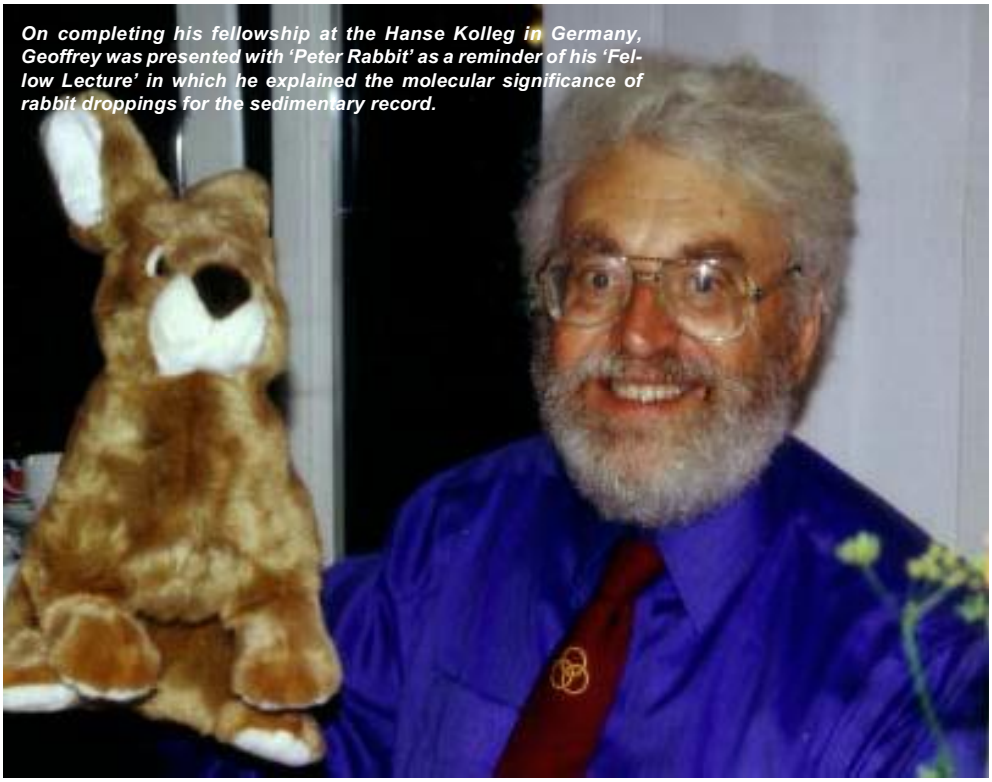
Above: James Maxwell transfers lunar dust (blackish material in test tube) from the special container used to ship it from Houston. All transfer operations were conducted in the Clean Air Facility in the basement of Chemistry, provided for the Apollo work. We managed to keep terrestrial organic contamination by, for example, skin lipids, plasticizers and lubricants to very low levels indeed.

at both lake and ocean environments. We were also looking at the maturity question for oil source rocks of different sorts, and so on. But we were not really concerned directly with industrial applications; we wanted to get at the fundamentals. We constantly sought better equipment. With each grant, we would try to improve the facilities because this was the only way really to be at the front edge of analysing complex mixtures of organic compounds. Just as with isotopic measurements for age determination. Unless you are really pushing the techniques to the limit, you're soon going to fall behind. Something that we worked hard for was computerisation of the mass spectrometers and NERC was very supportive. We got to the point where we had really good equipment run by an expert team of analysts, notably Ann Gowar and Jim Carter. We were able to help other people run their samples

on this instrumentation. Eventually it became a NERC facility and NERC set up a facility committee, which of course included people from outside industry. That, in a way, made life more difficult for us because we had to satisfy them and prepare reports and all the rest of it. But it was a very good discipline for us and it also led to a lot of interest and input from the committee. They would make suggestions and offer help, so the whole facility idea worked extremely well, and we were very glad we went that route.

Vala: When was the NERC facility founded?

Geoff: The first GC-MS analytical lab was set up at Glasgow and stayed there as it really was not sensible to move 'my' half of it. We had to start again from scratch at Bristol. But NERC did come up trumps with the much-needed GC-MS. Indeed, NERC has funded us in one way or another through grant support, right since the time we first came to Bristol.



On completing his fellowship at the Hanse Kolleg in Germany, Geoffrey was presented with 'Peter Rabbit' as a reminder of his 'Fellow Lecture' in which he explained the molecular significance of rabbit droppings for the sedimentary record.

Vala: What about external access?

Geoff: We always made our equipment available to researchers elsewhere, but the official NERC Facility was created some twelve years later, in the early 1980s.

Card games

Vala: Perhaps you would like to tell me a little bit about your role as a teacher. How do you feel you have fitted in with all the other chemists that you have interacted with?

Geoff: I must admit that our area was so different from most of what was going on in the Chemistry Department, that there were problems in trying to satisfy the chemists that we were effectively proper card-carrying chemists! However, we were certainly very much analytically minded, and after all, Bristol has had an analytical side to its Chemistry Department almost since square one. Unfortunately, in recent years the Chemistry Department, in its wisdom, has demolished that, which I think is very sad. We were part of that area and I think the two went extremely well together. That is trying to make improvements in analytical chemistry that were relevant for the field and then applying them in organic geochemistry and in environmental chemistry especially. It was a good marriage for science.

Other than that we were of course supposed to be part of the Chemistry Department. For example some of us, such as James Maxwell and myself and some of the postdocs, would teach straight organic chemistry or analytical chemistry. We took full part in the tutorial system and I enjoyed that very much. I found it extremely stimulating, fun even, because the tutorial system in the Chemistry Department operated with first-year students. Of course, you only saw a small fraction of the total number of students, but you got to know those quite well. It was satisfying to get them interested in chemistry. Sometimes we did this by playing card games! We devised a type of chemical card game, which was based on something one of the lecturers in Glasgow had started. It's a bit like Scrabble, and it's a bit like Dominoes, but essentially you have to specify the chemical reactions that will take you from one card to another. You can, for instance, test each other by asking which reaction you are using and why.

Vala: I bet that was very popular!

Geoff: Oh, it was! It made an interesting diversion from the usual rather formal questions that were set. The other thing we did was to go over to Earth Sciences, or Geology as it then was, and teach an optional Organic Geochemistry course for geologists. That involved trying to explain some basic organic chemistry as a start to the course and then take it on into geochemistry. That was also very worthwhile.

Vala: What about the joint degree in Chemistry and Geology?

Geoff: Yes, Chemistry and Geology was actually one of the reasons I was invited to Bristol from Glasgow: to start that course. Eventually, it became difficult to carry on because Geology was running part and we were running the other part and we had some practical problems in interfacing the two parts.

Vala: It's a pity that it fizzled out.

Geoff: Well, yes, it really was a popular little course. It turned out some very good people, such as Simon Brassell who is now on the staff at Indiana. But after a number of years, apart from the internal issues such as trying to get agreement about marking systems, another problem had surfaced, which was national in scope and more serious. When we started in '68 or thereabouts, we were virtually the only place in the UK offering something involving Joint Chemistry and Geology as an honours degree. By the time we had gone on for a number of years, 30 or 40 universities were offering some variant of this. They had diluted the pool of interest very greatly. The intake numbers were becoming so variable and low, that we decided that it wasn't really worth all the effort, which was a shame.

Vala: Tell me a little bit about your PhD students. How many have you had and how many are now eminent organic geochemists around the world?

Geoff: We have to remember that what we used to call the OGU, *i.e.* the Organic Geochemistry Unit, consisted really of myself and James Maxwell as teaching staff. We shared activities and tasks with some of the postdoctoral people, visitors and also those on research grants. But the

two of us were then jointly responsible for a considerable number of PhD students going through. Since then, Richard Evershed has replaced me and he has also had a number of PhD students. I gather from talking to Sue Trott, our secretary, who is just retiring, that something close to about 90 PhDs went through the OGU from 1968 to now (2000).

Vala: You have also had a large number of postdocs and visitors?

Geoff: Oh yes, lots! We were very fortunate that so many people wanted to come to the OGU. It's nice to have something as a label and the Organic Geochemistry Unit was indeed a useful label. The OGU attracted people from all over. For example, when we were doing the lunar sample work back in 1968/70, John Hayes came over from the United States, also Paul Abell from Rhode Island. He was one of the people who worked on the Olduvai fossils but he was really a physical chemist. So there were two Americans at that time working in the lab on the Apollo 11 lunar samples. We have had numerous academic visitors – especially Americans, Australians, Brazilians and Chinese. It's really been a very enjoyable time with this international aspect as well as our own students.

Vala: Most children want to do something completely different from their parents, but you have a son in organic geochemistry. How come he didn't get put off from the research that you were doing?

Geoff: We have two sons, David and Timothy. Both of them did PhDs in chemistry, but the elder one – that's David – joined Exxon as a trainee on the management side. He left research in chemistry as soon as he joined the company. He's been with them ever since and is now involved in the distribution of natural gas and oil, whereas Timothy seemed to want to work in organic geochemistry. I think that possibly came about because we have a number of 'geochemical' friends in other places, like Archie Douglas at Newcastle. Timothy did his PhD jointly with Archie Douglas and with Charles Curtis at Manchester. But I've encountered other cases like ours, for example, Kate Freeman at Penn State, whose father is an organic chemist. But I must admit there is a much closer parallel for Timothy and I because we're both doing some form of organic geochemistry. In fact, I'm an Adjunct at WHOI and he's employed by WHOI, so that comes even closer. It's fun for me because we talk about things that he's done. He's the really active one!.

Vala: Did you ever collaborate?

Geoff: Yes, we did a long time ago, but it was never written up because Tim got so active doing other things. But recently we had a little paper on some hydrocarbons from Serbian plants, which was done jointly with some Serbs.

Vala: I saw a photograph in your office at home of you with the Queen at The Royal Society. Could you tell me about that event?

Geoff: This was in 1987 at the signing of a formal Collaborative Agreement between The Royal Society and The Academica Sinica. We had a display of some of our work, which we had entitled 'Blood from a Stone'. It showed the real-time extraction of bright red porphyrin compounds from shales, including some Chinese examples. The chemistry told us that these biomarkers had come from the original green chlorophyll pigments of the abundant algae that had contributed debris to the shales during deposition. Ann Gowar, Simon Brassell, I and a grad student, Bin Zheng who was funded by the Chinese Academy, manned the exhibit. The Queen was due to come round with Prince Phillip that evening. We all put on our best behaviour and stood by our exhibits and that's when the picture was taken.

A Few Hundred Biomarkers

Vala: There is one term that is very much used in biogeochemistry and that's the term 'biomarker'. Can you tell me how that term came about?

Geoff: This usage developed mainly as a result of the ever growing popularity of what Calvin and I had first called 'chemical fossils'. The term chemical fossil never really caught on for some reason. I think it was the connotation that maybe it was the chemists that were the fossils! However, 'molecular biomarker' did. I do not know who actually put these terms together first. But 'molecular biomarker' got shortened. I think it was an organic geochemist called Wolfgang Seifert, who was working for Chevron who telescoped it to just 'biomarker'. So instead of 'biological marker compound', which is clear but not very easily used, or 'molecular biomarker' with is easier, you could just have 'biomarker'. For a long time, we thought that the term 'biomarker' belonged exclusively to us organic geochemists, and then we found out that the DNA people were using it as well. But it is very convenient. It's short and it tells you immediately that it's something with a biological origin and that it's some sort of indicator.

Vala: How many biomarkers do you think that you have discovered, or found, in your career?

Geoff: With all the people passing through the OGU, many of them contributed new compounds, or recognised compounds for the first time. Certainly, Bristol must be responsible for, I would say, a few hundred compounds, which in some way are sufficiently distinct that they can be recognised as individual biomarkers. Often, it's only a question of stereochemistry, but that's still highly important to have. Of course, the number of potentially fully identifiable, distinct compounds in nature must be in the millions. But certain molecules stick out as being readily recognisable, information-rich and also useful because they are often preserved to some extent. The whole biomarker game is trying to guess which compounds are going to be important because of the information they carry. That's partly the fun of the hunt for new ones. It's like finding new minerals. Some minerals may not differ much from others but they may still contain key new information. Likewise, small differences in biomarker structure or isotopic content can be very significant.

'Retired' is Not in His Dictionary

Vala: Since you retired from Bristol, you have been travelling round the world as a 'troubadour', as you referred to yourself in your acceptance speech when you got the Goldschmidt Award. Where have you been and who were you working with?

Geoff: I have been lucky to be invited to places, partly by my ex-colleagues. People like Paul Philp, Michael Sarnthein and Jurgen Rullkotter with whom I have worked in the past. I've been at Norman, Oklahoma, which is one of the great homes of oil exploration. I've been at Woods Hole, of course, a lot. That, I feel, is a really great place because of its basis in marine organic geochemistry and also because it's very well known for its connection to oil, through John Hunt. It also happens to be where my son Timothy is! And then I have taught at Kiel and been a Fellow at the Hanse Advanced Study Institute at Delmenhorst in North Germany and that's been very enjoyable. And then finally a place my wife Pam and I have been to several times is Dartmouth College in New Hampshire where one of my other ex-colleagues, Meixun Zhao, is on the staff. I've taught a postgraduate course there and really enjoyed doing that. It's also a very good place to go because of the snow. It gives a complete contrast to Bristol in the winter. Both Pam and I really like experiencing the crisp snow and the blue skies, when you get that combination, which you often do in the New Hampshire winter

Vala: Where are you going next?

Geoff: Next month, November (2000), I'm going back to Germany and going to the Hanse Institute to attend a conference and to write up some of the work and then on to Leipzig. And then after that we get ready to go to Dartmouth College for January, February and March.

Vala: Most of the winter you will be away?

Geoff: Yes, we are often on the move. However, I keep meaning to stay at home and write up a whole lot of stuff that I have ready for a book, but it's just such a monumental business trying to do that. I really need a highly energetic, young, computer-wise colleague to join me. If anyone wants to volunteer?