COOPERATION AND THE UQ SEISMOGRAPH STATIONS

[An aural history of the late Dr Jack Webb]

ABSTRACT

A transcript of an aural history project recording the late Dr Jack Webb, Honorary Director of The University of Queensland Seismograph Stations at a Geology & Mineralogy Departmental seminar on 27 August 1982.

C.J. Lynam recorder and transcript

Seminar transcript

34 Quentin Street, Chapel Hill, Q'ld. 4069.
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Dear Colin,

Here are a few thoughts concerning Allen Wilson's connections with the stations which you may care to draw upon if you are called on to speak at next week's function. They're certainly not exhaustive, but they are the highlights as I recollect them on the spur of the moment.

First of all, you could mention that, of the Heads of Department over the fifty-odd years that the University has operated seismographs, Allen had the longest association with the stations. A lot is owed to Professors Richards and Bryan who founded the Brisbane station and guided developments in early years, but the biggest changes took place during Allen's headship.

The two biggest of those changes were, I suppose, the move of the Brisbane station from Saint Lucia to Mount Nebo and the transfer of the Charters Towers station from its original IGY site on the eastern side of Towers Hill to the former RAAF property on the other side of the hill, sites which the stations have occupied ever since, Funds for the construction of the new facilities at the Towers came largely from overseas, but the money to build the new Mount Nebo station was provided by the University only through the efforts of Allen.

It was in the 60's and 70's during Allen's headship that the Department's seismological activities extended to other states and offshore. Starting in 1966 with BUMP in the Bass Strait region, moving to CRUMP in the Cape York/Carpentaria area, and then extending to a series of experiments in Papua New Guinea, we became heavily involved in crust and upper mantle seismology, an involvement which has continued. Some outside funding supported these activities, but the work drew also on the Department's resources, and these were provided readily by Allen.

These items are probably enough, because I don't suppose a long speech will be in order. If you want to say a bit more you could point out that the existence of an observatory function in the Department has always depended on the goodwill of the Head, because it has occasionally needed defending in high places. We are grateful to Allen that he met these needs over many years.

I hope this is of some use to you.

Yours sincerely,

Jack Webb.

Cooperation and The Seismograph Stations of The University of Queensland - **Departmental Seminar**

given by the late Dr Jack Webb (Senior Lecturer Geophysics), Honorary Director of University of Queensland Seismograph Stations, Dept of Geology and Mineralogy, on 27/08/1982.

(Tape and transcript made by C.J. Lynam.)

(words missing from taped record)

and the other one in the more recent sections, matters dealing with the environment, and I'm not really going to depart from those themes and I am going to talk to you about cooperation and it will be largely cooperation on an international scale, but since we will be talking about earthquakes we are going to be concerned with the environment to some extent. They are an environmental hazard, but I am certainly not going to be stressing that aspect, but what I wanted to do really was to talk a little bit about seismology in Queensland and the way it has developed and try to convince you that this Department has a substantial asset in its seismological services.

So, I am going to take a somewhat historical wander through things, so we start off with something with dates on it (OHP), and the point I wanted to make with this (slide) is that this country really has not lagged the rest of the world too much in scientific interest in natural phenomena because the systematic study ,really did not begin until the middle of the 19th century in Europe and whilst (there was) indeed an interest in that sort of thing in this country at that time.

The first observatory of any sort really was set up by Sir Thomas Brisbane at Parramatta. He was something an amateur astronomer. Brisbane was really different to most of the early administrators in that he was something more than an administrator or a military man. He was in fact something of a scientist and he did some useful work. That work was largely concerned with astronomical matters, but I might say he had to set

this all up at his own expense - he did not get any money for it. But by the 1840's we see people trying to put together some sort of systematic accounts of earth tremors, mostly in Tasmania, but there was some effort being made to make some sort of a record of earthquake activity, and of course the versatile Rev. W.B. Clarke, who was something of an amateur geologist got involved in this and made some speculations without too much basis about the causes and phenomena of earthquakes especially in relation to Australia country. (These)were in fact made by an amateur astronomer, Mr. Biggs in Launceston who built his own instrument and in fact operated them for about 3 years and wrote some seismograms. They are pretty primitive, but he did in fact record the odd small earthquake, not very well. The first official interest in observatory seismology was the installation of an instrument in Sydney by the Government Astronomer, Russell.

By 1885, there were a few instruments becoming available. They had been mostly developed in Japan and largely under the influence of John Milne who went to Japan from Britain, in 1876, and become Professor of (must get the order right) Mining, Geology and Seismology in what was then the Imperial College of Engineering in Tokyo. Milne was a quite remarkable man who gathered around him a number of intelligent people of similar interest and there was instrument development going on in Tokyo. At that time these instruments were becoming available, so, Sydney University set up a Ewing and Ellery at {not typable). Melbourne set up a Grayling. They were operational by 1888.

I might say that Milne was a man for whom I have a considerable regard, who, I think, has not been properly appreciated. He was a quite remarkable person, great energy and wide interests. When he got the Post in Tokyo, he set out from England and thought perhaps he should do a little geology on the way and in fact it took him 2 years to get there. So, I guess they were rather glad when the vessel turned up for him to occupy that post. But he was in Tokyo for years and the Japanese had, of course, an existing interest in earthquakes, but I think Milne did quite well to stimulate it. He came back to England in 1895 and went to live in the Isle of Wight at Shide on the outskirts of Newport and in fact set up his own observatory there.

I went down to the Shide last time I was in England, on study leave and I thought it was fairly sad that the only reminder of Milne there was in fact is a little grove of trees and a tablet that had been put there by the Japanese.

O.K. Cooperation started to develop. The Australasian Association for the Advancement of Science set up this Committee on seismological phenomena. It reported regularly to the British Association's Seismological Committee, so there was a nucleus of a sort of data centre developing there. If of course you come to (not heard to type) very quickly when one start looking at earthquakes, one really has to start looking at them on a global basis. The earth is a pretty transparent to seismic waves and fortunately you can see them at a distance and you really need to do that to understand them. So, by 1892 this committee had set up and operated quite successfully. By 1900, Milne had been back at Shide for 5 years and had been working on new instruments and this new generation Milne instrument was available and Milne by then had decided that, with the British Association's encouragement, he must do something about getting some sort of large scale network of instruments operating and this is a map he put out in 1900 in fact, to demonstrate where he had, or would like to have, instruments. You will notice that Sydney and Melbourne are there and places like Cape of Good Hope and Batavia. But, he had quite ambitious objectives.

In 1901 Melbourne puts in a Milne instrument. Pietro Deracci was a fairly energetic Government Astronomer with an interest in geophysics. At the same time as Melbourne had got its Milne, Sydney had received one too, but there was a bit of blasting going on in the roadway down below the observatory, so Russell decided he should not install it then and it was put away in a back room and he did not pull it out until after the 1906 San Francisco earthquake and finally got it operating.

In 1909, another rather remarkable man comes on the scene - Father Piggott who was a Jesuit (priest). He had been previously sent to China

as a missionary. He had only been there a relatively short time when he became very ill. So, he was taken off his missionary duties and he was sent to the observatory at Shanghai which was operated by the Jesuits and where there was, in fact, a substantial interest in recording earthquakes and he got interested in seismology.

He returned to Australia in 1905 and was sent to Riverview to teach Science and decided that he must establish a seismology observatory there and started acquiring instruments. He was a man of great energy one way or another and installed first some of the German and Japanese (seismometers) and prosecuted the development of that observatory with a good deal of initiative and, Riverview in fact grew very rapidly into a very well-respected observatory, certainly one of the best in the Southern Hemisphere, possibly the best! The work was done very carefully, and it rapidly built up an international reputation. Piggott was something of an inventor. He was quite a character, rather unpredictable, quite an inventor. If you go to the Australasian Institution in fact you can have a look at the type of thing. They have an (instrument?) invented by Piggott. At the same time Adelaide started recording with a Milne. All these instruments except Riverview were operated by Government Astronomers.

Nothing happened for 28 years. The new initiative came from Professor Bryan. Dr. Bryan as he was then, at this University, who had exceedingly broad interests in earth science and had a long-standing interest in earthquakes. In 1935 there was quite a substantial earthquake felt in the Gayndah area and Bryan and Whitehouse studied the macroseismic effects of that earthquake and got to know a lot of

people in that area. One upshot of that activity was that an anonymous donor offered to buy them a seismograph and it was a later development of the Milne-Shaw seismograph. Shaw was Milne's instrument maker. It was set in operation at the old (UQ) University site in George Street in 1937. It was a horizontal component instrument. A second instrument was acquired a little later. Professor Bryan induced the CSIRO to obtain a second Milne-Shaw, so they had a pair of horizontal component instruments.

The old Milne-Shaw was a tremendously reliable instrument. We still have those two instruments. We used them until the University sub-station moved from St. Lucia here up to Mt. Nebo, and we occasionally think of reinstating one of them. The unfortunate thing about the ones operated at the southern observatories was that they were all oriented to record East-West components and as a result they made rather nice records of a lot of surface waves, not simply because of their orientation part of their characteristics. But they certainly do record the P waves of earthquakes.

Now in those early days Bryan got a tremendous amount of encouragement. There was the nucleus of a sort of regional association starting to develop at that time. The New Zealanders were reasonably well advanced in their seismological activities and the early records of the station in fact contain quite a lot of correspondence between Bryan, and New Zealand seismologists and a few others scattered around the South West Pacific where they are making some attempts to pool their data and determine epicentres.

The Brisbane station in fact did at that time or very soon after, start contributing its data to the organization in the United Kingdom. There was a good deal of interest in the Brisbane station and a lot of the practical interest in fact came from overseas and a lot of the encouragement and notably from Benno Gutenberg, the Director of the Seismological Lab. at Caltech and there was a good deal of personal contact between Bryan and Gutenberg and much practical assistance.

The interest in the area of course came about because by then it was quite obvious that the South West Pacific was an interesting area for earthquakes. This is (OHP) instead of all these nice coloured modern maps, this is a reasonably old one that puts Australia in an awkward place unfortunately. This (OHP) is a summary of the epicentres determined in the United Kingdom between 1913 and 1930 .and it is fairly obvious that this is a very active region. So, if you get a few stations in there you will make some progress. The other thing that had happened of course, was that by then it had been realised largely through the work of Turner at Oxford that some earthquakes had deeper than usual (epicentres) and this is Turner's map of the earthquakes that he had been able to identify up to 1927, (this) concentration here. So, there was much encouragement to persevere with the big Brisbane station.

O.K. we go back here. The next thing that happened to the Brisbane station of course was that the move of the University (of Queensland) to St. Lucia, when we occupied the vault at the back of this (Richards) Building, which was probably a mistake from the beginning. But, it worked all right for a while. But of course, the St. Lucia site got exceedingly noisy (f4om construction) as far as background earth motion is concerned and thought had to be given to moving, but anyway it stayed there for the time being and worked reasonably well.

In 1957, the International Geophysical Year came along, and this university and the University of Adelaide managed to prize some money out of the IGY Committee to buy 2 new instruments and in fact then we were able to put the station at Charters Towers in operation.

It won't have escaped you that in 5 years' time this Department will celebrate an important anniversary of its interest in seismology, so we will have to think of some way of marking that occasion. Charters Towers is just 20 years younger.

O.K. 1963 was the big year. We finally got some money out of the University to enable us to build a new station at Mt. Nebo in February of that year after a lot of site selection and so forth and we put the new station at Mt. Nebo and in operation. By the following month we had moved the Charters Towers station to a new (current) location, equipped it with a lot of new instruments and opened it in March that year. So,

1962-63 were pretty busy times.

Now the instruments that we acquired in 1962 for Charters Towers and which prompted this move to a new and better site came to us largely as a result of interest in monitoring nuclear testing and I am going to say a few words about this later on. But one of the results of that interest was that the U.S. government was persuaded by their seismologists to divert a substantial sum of money to seismological research and one of the aspects of that programme was the objective of setting up a worldwide network of instruments. 120 of them which would all be exactly the same. Carefully calibrated and which would serve as a sort of primary local network. Charters Towers became a member of that World Wide Standardised System (Network WWSSN) and still is a member of that worldwide standardised network.

(The) next major development again concerns Charters Towers and it was a cooperative project with Columbia University. I might add that (the late Dr) Jack Rynn had a stake in this. Jack was at Columbia at that time, but what had happened was that people's interests had changed somewhat (.... missing script ..). This does sort of average background at a reasonably quiet (....missing script ..).as a function of period. Period scales here in seconds 0.1, 10 0,100,000. So, once you get into this you have got usually noise problems which increase as you go further into it. The characteristics of the WWSSN system (which had two sets of instruments, short-period and long-period), were tailored (....missing script ...) really (.....missing script .....). so that the short-period system was on the high frequency side and this noise factor and the long-period system (.....missing script .....). up here.
This very substantial peak here is associated partly with oceanic type microseisms which at times at least are energetic (.....missing script .....). very effectively but the idea arose (.....missing script .....). which centres around about 30 to 40 seconds because the longer period waves transmit further, they attenuated less rapidly. You will see they are a lot smaller and that was the rationale behind the development of the so-called high gain long period system (HGLP), the development of which in fact was done out at Lamont Doherty Geological Observatory, of Columbia University, and Lamont got money to install a number of these on an experimental basis. Charters Towers was

one of the sites chosen of the six or seven chosen for one of these high gain long period installations. So, that improved our capabilities very substantially.

The most recent development happened in 1975 when this ASRO system was put into service in Charters Towers. Now the ASRO system is really an outgrowth for the SRO system, which is an outgrowth of the high gain long period instrument.

I might say that those high gain long period instruments as well as making conventional analogue records, were also sampled and recorded (digitally). The S.R.O. system tries to look a little further. What we have got here is two zones here; - down here "detection threshold", up here "tripping threshold" at which the instrument output starts distorting because the signals into it are too big, and you will notice these refer only to long period instruments. The World-Wide Seismograph System Network (WWSSN) of long period instruments have a relatively narrow useful dynamic range. The high gain instruments improved that considerably but the SRO instruments you see dive right down into this and they have a fairly high "tripping threshold", so they have a (.....missing script.).

The half of the SRO system in fact is the long period capability but I also have at least one channel vertical component information derived from a short period instrument and that also is recorded digitally. It can't be recorded digitally continuously because it goes through tapes at an alarming rate because you have to sample the short period data pretty fast so in fact the SRO system operates under a small computer and has event detection lodging in it so that in fact only puts on the tape the events of the text. So that is the ASRO system.

So, in 1975 Charters Towers joined what is now known as the Global digital seismograph network (GDSN) and just for your interest here are the stations in the GDSN. There are 30 of them altogether These are SRO stations. The ASRO stations are all stations that were originally High

Gain Long Period stations (HGLP). Now in the HGLP stations the seismometers are, where possible, in sub-surface vaults and they are all sealed from the environment as much as possible.

So, the high gain long period stations that were working well were left as they were, as far as the seismometers were concerned, and just equipped with the rest of the SRO system. The SRO systems themselves having sunk their seismometers down boreholes a hundred metres or so deep and they do this to get away from the long period noise near the ground surface that is generated primarily by air pressure cells. There is no way of getting away from it unless you can seal yourself up in some sort of chamber or get down below ground surface. So, the SRO instruments are all in a bore hole and the ASRO instruments are all essentially surface installations.

The other thing that has subsequently happened is that a number of the standard original worldwide stations have been converted to digital recording and upgraded somewhat. That has all happened in the last two years. Charters Towers you see was one of the first SRO systems to go in. Here is the network as it stands at present. You will notice there is nothing of course in the Soviet Union and some of the installations are (.....missing script .....). I am not sure if there is any data coming out of them. There is I understand a proposal to put one in China. I am not sure that that is going ahead but that will be a step forward. The aim of course is to get as reasonable a global distribution of stations as practicable and I might say that amongst the SRO and ASRO, there is a certain spirit of competitiveness and it is a pleasure to tell you that Charters Towers acquits itself fairly well in that regard.

All of these SRO and ASRO station operations are coordinated to some extent by the US Geological Survey who provide the back up for them and they have a little newsletter which they send around occasionally which talks about station performance and one of the things they do is - see this little chart which indicates the times at which the stations went on operating. The Americans in their quaint way call it "outage".

Here is the operational time for the network in 1980. As you can see Charters Towers is not by any means the best It got 4. However, by 1981

we were second. Mind you there were two ahead of us. So, we are working on it. No. 1 here is another Australian station. This is the station operated by the BMR at Narrogen in Western Australia and the other one is Matsushiro in Japan. Matsushiro is an ASRO station Narrogen is an SRO, Narrogen had a fearful amount of trouble in their early days with their borehole but they seem to have overcome that.

Now I must not dwell too long on the instruments, but this stable network has opened up a lot of new areas for seismological research and although we have not done a lot with the digital records, I might say that we send these tapes instantly to the U.S.A. where they are all put together in network day tapes and one can buy these, but before we do our tapes are copied by the BMR in Canberra so in fact there are copies of all the Australian data available here, although I must say we have never, had any trouble getting them fairly quickly from the U.S.A..But, just as an example - a trivial example of the usefulness of these digital records, this is actually short period data, but this is actually a conventional photographic seismogram and it is a local earthquake. A tiny little one south of Charter's Towers. Very close to the station. You can't really see the trace movement there because it is moving so fast. That is the problem. It just doesn't register very well, but it is about that amplitude. But use the same thing on digital printout and you can scale from the tape and you can pullout the time scale. So just as a picture to look at it is a vast improvement and of course the data you can have immediate access to all sorts of processing procedures.

Well here is in fact the chain that links up the global digital seismic station network. The station tapes go the U.S. GSC U.S. Geological Seismology Laboratory they make an archive network data tapes and then they go to several regional data centres in the United States and primarily into the National Geophysical Solid Data Centre at Boulde, where anyone can get the data. You can buy a whole network day tape, or they will if you ask, extract certain things from a network day tapes, and there are facilities for users to go to those sectors and work.

Now I want to say a few words about seismological data centres, partly because I went to one sometime during my study leave and Colin Lynam has been on my back ever since I came back to say something about my

study leave because they are another aspect about this cooperative side of seismology and there are three centres that I want to talk about briefly and the first one of course is the one that was started by John Milne. This is the International Seismological Centre. It is located at Newbury Park and its antecedents go back to John Milne's return to England and the British Association started publishing his list of epicentres at the at Shive on Milne's death.

Before Milne's death in fact, H.H. Turner who was Professor of Astronomy at Oxford had become fairly interested in this work and encouraged Milne a good deal. In 1913 after Milne's death, Turner took over the continuation of that work when he transferred it to Oxford in 1919 (under) the sponsorship of the British Association. May be too, there was a fairly substantial change in the setup of this activity and the International Union of Geology and Geophysics, (which) in fact decided to sponsor an International Data Service and it was given the name of International Seismological Service, ISS and continued under Turner's direction. Turner in fact devoted a large part of 17 years of his life to that work and he did some valuable seismological work as well as providing a valuable service at the same time. I went and had a look at (.....missing script .....). Jeffries became Director and he continued Turner's job. Some of the people who worked under Jeffries were still around and I have spoken to one or two of them and they tell some stories about Jeffries.

In 1946 the ISS moved to Kew where it was looked after by the Meteorological Office and then, that was immediately after the war. The work languished during the war and there was a backlog of the data. So, in the meantime in Edinburgh this International Seismological Research Centre was set up with Willmore as Director and they devoted some of their energies in fact to try to catch up on some of this backlog on ISS data and in 1968 the ISS moved to Edinburgh & was merged with ISRC and Willmore became Director of this organization.

In 1970 it was reconstituted in essentially its present form and they got a new Director who was Ed Arnold who came from the sister institution of America who really did a very good job in setting up the new ISC. In 1975 the ISC moved to Newbury in large measure to get

access to suitable and not too expensive computing facilities. And the ISC has as its aim to produce you see, a monthly earthquake catalogue of about 1400 epicentres published 24 months after the event They are looking at analyzing just on a million observations a year. 18 months after the events. We are working on February 1981 at the moment for a consolidated tape for all the Australian stations as prepared by the BMR.

The other centre with which we have long standing relationships is the National Earthquake Information Service at Golden Colorado. It is the responsibility now of the U.S. Geological Survey. It formerly came under various other organisations, The National Oceanic and Atmospheric Administration, Environmental Science Service, and U.S. Coast Centre. NElS has somewhat different objectives to the ISC. They don't hope to do the best possible job but they analyse everything that they can with the aim at providing a fairly rapid service for the determination of earthquakes and obviously concentrate on the more important and easy to determine ones and they turn out about 500 epicentres per month. They publish things called the Preliminary Determination or that should be PDE Preliminary Determination of Epicentres, Earthquake Data Reports and also a monthly catalogue.

The other data centre we have regular relations with of course is the national one whose responsibility is to maintain the national earthquake data file which lists all the determinable earthquakes in Australia and its territories and they also prepare a consolidated listing of earthquake observations for Australian stations and they also prepare the data tapes that go overseas. So, we are a sort of symbiotic setup because they depend on us and we depend on them.

Now I just want to say a few words about ISC because I have found it an interesting experience to spend a while there. The ISC is, well as it says there, an international non-governmental scientific organisation

and its objectives are listed there and its main tasks. It is directed by governing council, well, directed in matters of policy, directed in matters of administration by an executive committee. But that governing council is made up of a member from each nation that contributes to the upkeep of the ISC. It is supported wholly by contributions in the range of from member countries and their budget is somewhere in the range of $2SU,000 to $300,000 a year and that is all provided by member countries. Australia has been a contributor for a long, long time. There are all sorts of arguments of course about whether ·different countries are pulling their weight. The biggest contributors are the United States.

Just to keep Colin happy I just want to rush through the setup of Newbury. We won't dwell on this at all. They use the large computer bureau at the Science Research Council Rutherford Laboratory at Chiltern which is 20 miles north of Newbury and they have data links to Rutherford and all their computing is done there. They just have (.....missing script .....). equipment. Their data comes in in various ways. They are encouraging people to send more and more on magnetic tape and the larger countries do, including the U.S.S.R. when I was there in fact the Russian tapes stopped coming and we started getting all their readings coded by hand on sheets and if you have ever tried to decipher thousands of lines of coding on sheets done by various Russians in a hurry .. (laughter!)

But anyway, all that is put into the system at Newbury, other people's files can go straight in on tape and card so it all goes in in a batch job at Rutherford into this data collection file. So, the data collection file is being updated continuously and the steps in the production of their connotations are these. These go on all the time. Once a month they extract a month of data and put it into a bulletin for publication and then they go through this location procedure and it operates under a package called GRIP. GRIP stands for Group Revise Identify Program, so it is very substantial program that goes through the (.....missing script .....). locations, associates readings with events, all that sort of thing and prints out one listings, and these come back to Newbury and goes through the editing procedures. Now all the editing is done by seismologists and it is a lengthy involved procedure and it may take up to eight classes of the data before the seismologists are satisfied with it. That is all done under the control

of a programme that has the delightful name of 'euphoria', but at the end of it hopefully you are euphoric and you say yes go ahead and publish that. The Bulletin is computer typeset. This programme (.....missing script .....).

They have some imagination and it is produced in film form and the Bulletin is printed in Bangkok, because they found it is much faster and much cheaper to do it there. So, it is printed in Bangkok and eventually distributed hopefully just two years after the event. Here is a page from it. It lists earthquakes and their parameters and then station readings. And that book comes out every month. Every six months they produce a reprint catalogue and they produce it continually bulletin file which grows each year of course.

O.K., I haven't got a lot of time left. The other thing I wanted to say a few words about has to do with nuclear tests. And they are an unpleasant fact of life, but seismologists are inevitably involved in the surveillance of nuclear tests. Just to remind you, and we needn't worry too much about this.

It all started in 1958, the scientific aspect of detecting nuclear tests, the ones that are above the ground are no great problem, but the ones underground present a lot of identification problems and the early optimism was really unfounded and the fact that they generally agree in theory in identifying underground tests has been developed. It is at least the excuse, it may well not be the reason, but it is an excuse for not going ahead with negotiating comprehensive test bans. The test bans have been signed and a partial test ban treaty which prohibits and the non-proliferation treaty. The 1976 threshold test ban treaty which limits underground tests to yields below 150 kilotons and to designated test sites but there has been no real progress made on treaty bans and as you see they still go on at 30 per year at least and the only way of detecting them of policing a ban is by seismic methods and so the implications and the possibilities of that continue to be investigated and that is left to what has been called forensic seismology and every few months this group of scientific experts of the Committee of the Conference of Disarmament meets in Geneva and talks about seismic detection problems.

The Russians really do not want to try any of these out. They say there has been pressure to try the various techniques in fact there have been some exercises run the last of which we participated in a couple of years back. The Russians say they don't want to participate in any of these things until the test ban treaty is solved.

Just a little reminder the earthquake seems a little different to detect these things because of the core there is a shallow zone in seismic events in which (.....missing script .....).are very weak and close to the event there is zone up to about 25 degrees where the seismic signals are complicated by the structure of the crust and the upper mantle that there is a rather clear source window from about 25 degrees up to about 102 degrees where the things are not too (.....missing script .....). where these (.....missing script ..). still affected by the structure of the earth but less than otherwise and I put here a few tests I have received just to show that Charters Towers is a useful vantage for a number of those sites, so it would be a useful station if there was ever an agreed system for monitoring underground tests. I will say that you can see these just as an example of some of the things you see - Mururoa tests 5.6 magnitude. This has (.....missing script .....).10 or 11 years ago. I just put it on because it is a nice big shot. It was up in an Island *in* the Aleutians. Here I have the North South component the others are all simply because it is hard to read on the records. It should have been bigger than that. The cavity produced by the shot which was about 1800 metres deep as all these cavities do eventually collapses when the gas has cooled down and collapsed and collapse was *big* enough to produce a 4.9 magnitude event and you can just see *it* there.

Most of the Soviet tests at present are *in* (.....missing script. *)* the part of Tomsk and (.....missing script.). There have been shots in Western Siberia and they are getting out near the(.....missing script and they are getting very small. These are probably not weapon tests, probably instruction ranges.

I really don't have time to say anything about our own stations in Queensland. That would be time for another lecture. I do want to tell you the fact that cooperation has brought in substantial amounts of money to this department. We have an instrument from C.S.I.R.O. and

some operating expenses. This is the IGY equipment and payment for services. We have one station in Queensland a signal instrument station and the BMR have supported us with a substantial amount of money for our regular operating costs. This $260,000 represents, the value of equipment and buildings provided for us by the various agencies and for some years we received some operating support too.

Other benefactors, the late Archbishop Duhig, presented a number of instruments to this department, which are still in use and there have been other smaller ones. So, all in all we have raised about $467,000 for the system and we still get recorder supplies & such things too from the American sources so that is really all I have time for and I hope that is has been enough to make the point that we do indeed have a valuable and useful asset which would be missed internationally if we didn't keep it up. There are arguments, of course whether the University should be paying towards these activities and I am in sympathy with them and we are certainly trying to get other Government support. It should be a government activity, but it is nevertheless a valuable asset and it would be a pity to see it die.

That is really all I have time for. I am sorry I have gone on a little overtime. I would like to have said a little bit more about our feature transfer to the stations

Thank you

I think we have time for two brief questions. Don't give me too many because there are no mathematics at all.

[Marks on the original transcript by C. Lynam]