Date electronic copy received at AINSE: 14 August 2007

PROGRESS REPORT FOR AINGRA07114P

PROJECT TITLE	**Eutrophication of Lake Illawarra, NSW, as observed through sediment diatom frustule assemblage changes over time**	
INVESTIGATOR(S)		**Institution and Department**
Chief Investigator	**Professor John Morrison**	Earth and Environmental Sciences, University of Wollongong
Other Investigators	Associate Professor Brian Jones Associate Professor Ron West	
Students	Ms. Dongyan LIU (for PhD)	
ANSTO Investigators	Jenny Harrison	
Specialist Committee	E	

SCIENTIFIC OBJECTIVES

This project will examine the historical development of eutrophication in an urbanised coastal lake by investigating changes in the diatom frustule assemblages in dated sediment cores. Diatom diversity can be related to a water body's environmental conditions. The aim is to determine if long-term changes in the eutrophication status, as indicated by changes in the diatom diversity can be related to specific changes in the catchment, e.g., land use, industrial development and population increase. This aim will be achieved using the Pb-210/Cs-137 dating facilities at ANSTO to accurately date sediment materials in which diatom assemblages will be determined.

PROGRESS REPORT and RESEARCH OUTCOMES

Two sets of 2 sediments cores (pairs from 2 sites) were collected in Lake Illawarra. One core from each site was sub-sampled and samples analysed using ^{210}Pb dating to determine the ages. Sample from one core (LI 2A) showed a satisfactory pattern of change with depth which enabled a good assessment of age of the samples, while the other core (LI 1B) showed evidence that some inhomogeneous sedimentation had occurred (probably a sediment slump) and was unsuitable for dating and further study in this project (apart from the top few cm). This showed the importance of being able to test at least 2 cores. Dating of one set of samples was funded form the AINSE grant while the coast of the second core samples was funded from funds made available by UoW. Analysis of corresponding sediment samples for diatom frustules is nearing completion, after which comparison of the frustule diversity with age of the sediment will be undertaken. This work is expected to be completed by the end of September 2007.

DATA

One set of ^{210}PB dates has been provided by the AINSE award – I will present the more satisfactory set of results (Core LI 2A). Core 2A was sampled every 2 cm, and the samples dried and as much of the shell materials removed as possible. Dried samples were packed into 65 mm petri dishes and sealed with silicone sealant. Na_2CO_3 was added to some samples with low masses in order to fill the standard counting geometry. Samples masses were corrected for shell content. Shell content was determined by furnace ashing each sample at 450°C and then 1000°C. At temperatures >899°C calcium carbonate (the chemical compound in shell) decomposes to CaO and CO_2. The mass lost after the 1000°C ashing was converted to an equivalent $CaCO_3$ weight and subtracted from each total sample mass.
Sample sources were counted according to the following ANSTO method:
ENV-I-044-040 Operation of the Compton Suppression Gamma Spectrometers in B34 using Genie 2000 software.

The ^{137}Cs, ^{210}Pb and ^{226}Ra activities in samples from your core were determined by Compton suppression gamma spectrometry. The Canberra Compton suppression detector system comprises an active NaI(Tl) suppression annulus, a NaI(Tl) plug detector and a reverse electrode germanium (REGe) detector all housed within an inert lead shield.

The ^{210}Pb activity was determined using the 46.5 keV peak and the ^{226}Ra activity was estimated using ^{214}Pb and ^{214}Bi at 351.9 keV and 609.3 keV respectively. Unsupported ^{210}Pb activity was calculated by subtracting ^{226}Ra activity from ^{210}Pb activity. The ^{137}Cs activity of each sample was determined using the 662 keV peak after subtraction of the ^{214}Bi peak interference. Activities quoted are at the date of counting, quoted uncertainties are 1s counting errors and less than (<) values are quoted at the 95% confidence interval. The detector system energy calibration was carried out using a National Institute of Standards and Technology (NIST) traceable $^{154}Eu/^{155}Eu/^{125}Sb$ multi-nuclide standard source and the detector system efficiency calibration was determined using IAEA reference materials including RGU-1, RGTh-1, RGK-1 and Soil-6.

Table 1 shows sample descriptions, depths, cumulative dry masses and activity results. Table 2 shows sample depths, cumulative dry masses, bulk densities and CIC and CRS calculated ages and CRS model mass accumulation rates. Total ^{210}Pb activities are plotted against cumulative dry mass (Figure 1) and supported ^{210}Pb (^{226}Ra) activities are plotted against cumulative dry mass (Figure 2). The ^{226}Ra and ^{210}Pb activities were used to calculate unsupported ^{210}Pb which is shown plotted against cumulative dry mass in Figure 3. Ages, calculated using both the CIC and CRS ^{210}Pb dating models, are plotted against cumulative dry mass (Figure 4). Figure 5 shows ^{137}Cs versus cumulative dry mass.

<u>Interpretation</u>

Total ^{210}Pb activities for this core show a decrease in activity with cumulative dry mass (see Figure 1). The supported ^{210}Pb (^{226}Ra) activities are relatively low and close to being constant (see Table 1), suggesting there has been little change in local sediment input.

Unsupported ^{210}Pb activities (Table 1) were calculated by subtracting ^{226}Ra activities from total ^{210}Pb activities. When plotted against cumulative dry mass, unsupported ^{210}Pb activities show a similar trend to total ^{210}Pb (see Figure 3). The unsupported ^{210}Pb activity at 22 ± 1 cm (15.18 g cm^{-2}) is negative, indicating that unsupported ^{210}Pb has decayed to insignificance at this point. Therefore, this data point was not used in any of the age calculations.

Ages for this core were determined using the CRS as well as CIC ^{210}Pb dating models. The CIC model dates were calculated using unsupported ^{210}Pb data between 1 ± 1 cm (0.70 g cm^{-2}) and 19 ± 1 cm (13.23 g cm^{-2}). A single line of best fit was fitted to data points and extrapolated to the top of the core. A single mass accumulation rate was calculated (see below).

<u>Mass Accumulation Rate (CIC Model)</u>

Calculated Sedimentation Rate for LI2A :

0.24 ± 0.06 g/cm^2/y (Correlation Coefficient= 0.7502)

(calculated using unsupported ^{210}Pb data between 1 - 19 cm core depth)

The ages and mass accumulation rates as determined by the CRS model are shown on Table 3. Ages determined by both dating models for each sediment horizon are within statistical error of each other. The first sample interval that contains significant ^{137}Cs activity is the 16 ± 1 cm (11.25 g cm^{-2}) interval (Figure 5). This interval or the depth immediately below contains the 1954 commencement of nuclear testing horizon (1954 or 52 years ago assuming the core was collected in 2006). This first appearance of ^{137}Cs supports the ages determined by both ^{210}Pb dating models.

A broad peak in ^{137}Cs activity is present in this core suggesting the primary pathway of ^{137}Cs to the sediments in this core is via erosion of ^{137}Cs labelled material from the catchment rather than direct atmospheric deposition.

Table 1 – LI2A: Sample numbers, depths, cumulative masses and count dates, total ^{210}Pb, supported ^{210}Pb, unsupported ^{210}Pb and ^{137}Cs activities.

ANSTO ID	Depth (cm)	Cumulative Dry Mass (g/cm^2)	Count Date	Total Pb-210 (mBq/g) or (Bq/kg)	Supported Pb-210 (mBq/g) or (Bq/kg)	Unsupported ^{210}Pb (mBq/g) or (Bq/kg)	^{137}Cs (mBq/g) or (Bq/kg)
J750	1 ± 1	0.70 ± 0.70	02-Mar-07	72.7 ± 8.9	18.4 ± 0.9	54.3 ± 8.9	4.7 ± 0.7
J751	4 ± 1	2.86 ± 0.71	06-Mar-07	44.0 ± 10.1	14.6 ± 1.6	29.4 ± 10.2	4.4 ± 0.9
J752	7 ± 1	5.06 ± 0.72	07-Mar-07	41.2 ± 10.0	18.8 ± 1.5	22.4 ± 10.1	6.1 ± 0.9
J753	10 ± 1	7.18 ± 0.72	08-Mar-07	51.8 ± 9.5	17.8 ± 1.1	34.0 ± 9.6	5.7 ± 0.8
J754	13 ± 1	9.26 ± 0.71	23-Mar-07	39.4 ± 6.6	17.0 ± 0.8	22.5 ± 6.6	4.3 ± 0.6
J755	16 ± 1	11.25 ± 0.70	29-Mar-07	23.7 ± 4.9	15.9 ± 0.7	7.8 ± 5.0	2.3 ± 1.0
J756	19 ± 1	13.23 ± 0.70	26-Mar-07	25.1 ± 7.6	14.5 ± 1.3	10.6 ± 7.7	1.3 ± 0.7
J757	22 ± 1	15.18 ± 0.69	02-Apr-07	11.6 ± 7.0	14.8 ± 1.1	Not Available	1.1 ± 0.6

Table 2 – LI2A: Sample numbers, depths, cumulative masses, dry bulk densities and calculated CIC and CRS ages and CRS mass accumulation rates.

ANSTO ID	Depth (cm)	Cumulative Dry Mass (g/cm^2)	Combined Calculated CIC Ages (years)	Calculated CRS Ages (years)	Mass Accumulation Rates $g/cm^2/y$
J750	1 ± 1	0.70 ± 0.70	2.9 ± 3.0	3.1 ± 2.1	0.23 ± 0.15
J751	4 ± 1	2.86 ± 0.71	11.8 ± 4.2	11.6 ± 3.6	0.25 ± 0.08
J752	7 ± 1	5.06 ± 0.72	20.9 ± 6.2	18.6 ± 4.1	0.27 ± 0.06
J753	10 ± 1	7.18 ± 0.72	29.7 ± 8.2	28.0 ± 4.4	0.26 ± 0.04
J754	13 ± 1	9.26 ± 0.71	38.3 ± 10.3	41.1 ± 4.8	0.23 ± 0.03
J755	16 ± 1	11.25 ± 0.70	46.4 ± 12.3	49.9 ± 5.3	0.23 ± 0.02
J756	19 ± 1	13.23 ± 0.70	54.6 ± 14.4	57.3 ± 5.4	0.23 ± 0.02
J757	22 ± 1	15.18 ± 0.69	Not Available	Not Available	Not Available

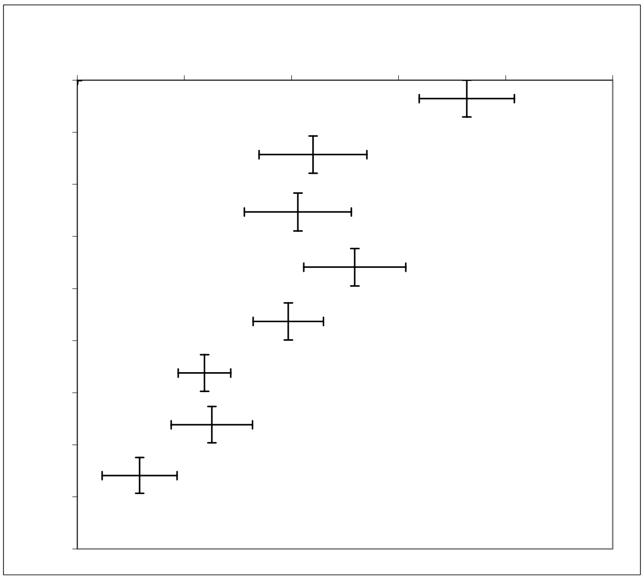

Figure 1 – LI2A: Total ^{210}Pb activity versus cumulative dry mass.

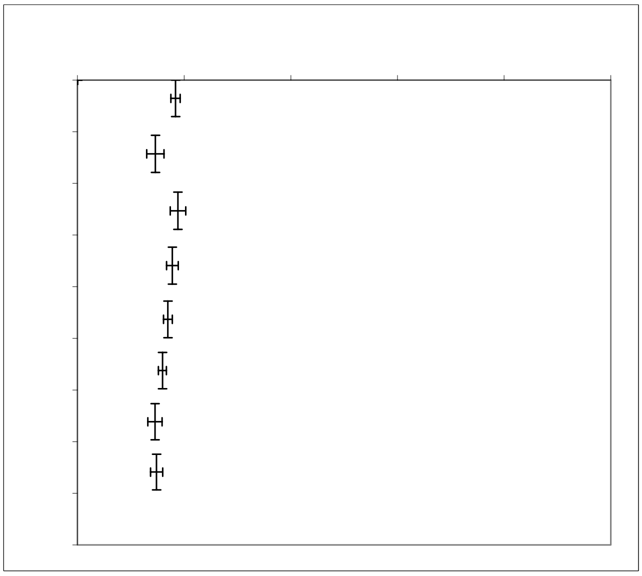

Figure 2 – LI2A: Supported ^{210}Pb (^{226}Ra) activity versus cumulative dry mass.

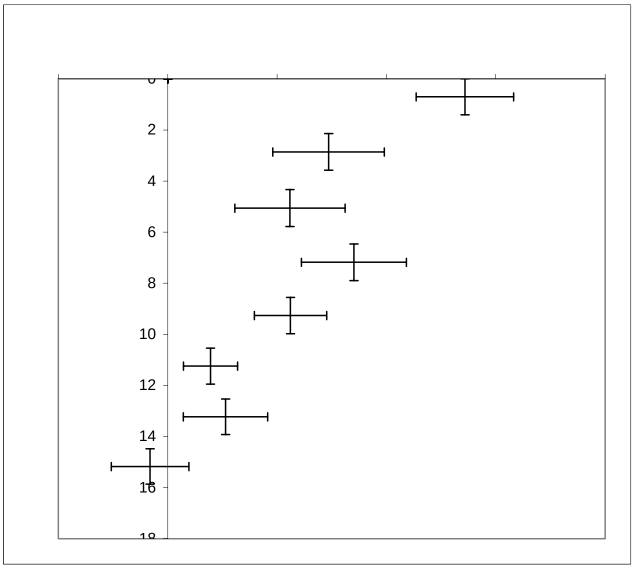

Figure 3 – LI2A: Unsupported ^{210}Pb activity versus cumulative dry mass.

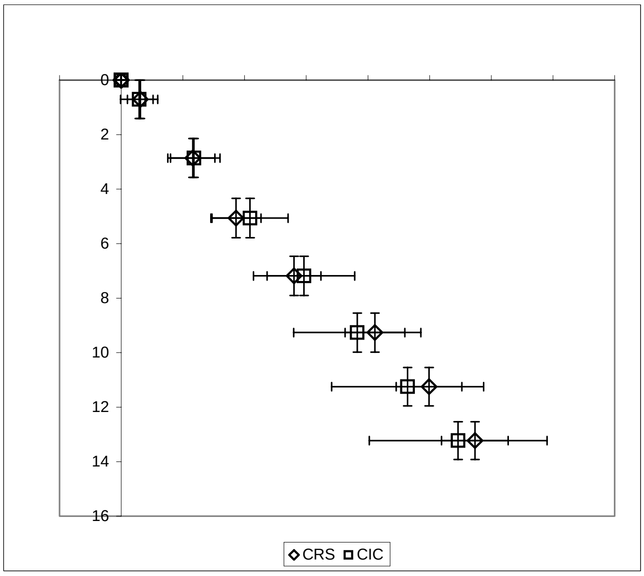

Figure 4 – LI2A: Age versus cumulative dry mass using CIC and CRS models.

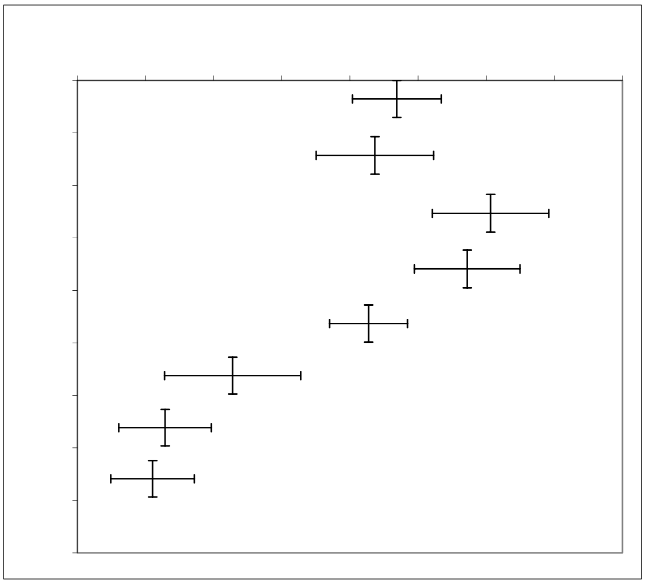

Figure 5 - LI2A: ^{137}Cs versus cumulative dry mass

Signature of Investigator preparing the report for After signing this report please fax this page with your signature for our files	Proj: AINGRA07114P Date:

PUBLICATIONS / REPORTS arising as a result of your work.

No publications have been produced to date as this work is not yet completed

PhD STUDENTS

Liu Dongyan – PhD student – expected to submit thesis in Jan/Feb2008, with completion by mid-2008