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ECRC

ENVIRONMENTAL CHANGE RESEARCH CENTRE

University College London

RESEARCH REPORT

No. 54

NERC - GEOPASS Final Project Review: GR3/10529: minutes of Workshop 2

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February 1999

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WC1H 0AP

ECRC Research Report of final NERC-GEOPASS project meeting

29th January - 30th January, 1999

CONTENTS

The final project review meeting took place at the Environmental Change Research Centre, UCL between 29th - 30th January, 1999 inclusive. All but one of the active participants in the project were present:

Prof. Rick Battarbee (RWB): Principal Investigator
Dr. Roger Flower (RJF): Principal Investigator
Dr. David Jewson (DJ): Principal Investigator
Dr. Dave Ryves (DBR): PDRA
Dr. Anson Mackay (AWM): Associated personnel
Dr. Michael Sturm (MS): Senior Visiting Fellow

Apologies: Dr Anna Kuzmina (Senior Visiting Fellow)

1. PROGRESS REPORTS

1.1 Phytoplankton

- DJ showed the rest of the group graphs depicting changes in annual cell nos. between 1994 - 1998, of which 1996-1997 were the trap years. Plotted total cell nos. (log) and mean plotted biovolumes (arithmetic scale) were plotted separately. In terms of productivity, in 1996-1997, the number of diatoms is the same, but the biovolumes are very different. Further, in 1995, *Nitzschia* nos. were very high, but biovolumes remained low. In 1998, both numbers and biovolume are very low. These figures seem to be typical for the southern basin, i.e. are not a localised effect, but results for the northern and middle basins were different.

- Focusing on 1996 and 1997, the two trap years, the crops were dominated by *Synedra*. In the traps both live and dead cells are present. Jewson therefore recalculated his results taking live and dead cells, 0-1400 m. Both traps and water diatoms show very interesting results. DJ first peak is *Synedra*, which gives a different signal from that picked up in the traps.

- *A. baicalensis* exhibits a temperature optimum of about 3-4 °C, but for *Synedra* the optima is closer to 17 °C . *S. acus* will also grow at lower temperatures, although probably gets out-competed. Growth optima for *Cyclotella minuta* is higher than for *A. baicalensis*.

- Light gradient graphs show that *Nitzschia* and *Synedra* have higher growth rates at high light intensities than *Cyclotella* and *Aulacosiera*..

Using our data, we can make an estimate of fluxes, and can therefore estimate how much of a certain species is lost in the water column e.g. *Synedra* and *Nitzschia* because numbers in the deepest trap are less than in the water column. But MS finds clumps of *Synedra* in the traps. Perhaps this only happens when crops are big or dense enough. Loss of *Synedra* could be by dissolution, grazing, or breakage. RJF suggested that it may be possible to use analogue matching on trap samples to correlate with water column samples.

1.1.2 North-South transect - June 1998

- In the south basin in June, large numbers of *Cyclotella* cf. *ornata*, are present, but these decline as one heads north into the middle basin, where instead large numbers of *Aulacoseira* valves dominate. The peak in the middle basin may be partly due to the low numbers of zooplankton in 1997, and so the subsequent spring 'seed' was high.

- Both the middle and south basins have temperature mixing zones down to 150 m. But in the north basin, the mixing zone only reaches 50 m. The middle and south basins are in these terms reasonably similar, although during the 'wipe-out' of diatoms in the south basin, the middle basin may act as a refuge.

- In the south basin, when it is warm, longer valve lengths of A. baicalensis predominate. The short cells disappear from water column very quickly, most likely by dissolution.

- Because of these seasonal changes, it would be good to get a freeze core, and take a tape peel to look for very high resolution changes in diatom communities

1.2 Trap data

- All the trap material has been counted, including spp. assemblages and DDIs. The draft paper currently being written by DBR will focus on the trap site in the southern basin, and aims to use multivariate techniques to describe relationships between phytoplankton, trap contents and surface sediment samples.

- Preliminary analyses have been done using principal components analysis (PCA) and redundancy analysis (RDA). A PCA of the six most common phytoplankton spp. (found in the phytoplankton, the deep traps and the surface traps) shows a seasonality effect, and also shows that there are distinct differences between sequential traps and phytoplankton. In summary, the main gradient is between *C. minuta* and *S. acus*, whilst the second axis is governed by *S. binderanus*. To make the phytoplankton and traps comparable, linear interpolation was used to get similar sampling frequencies. Maybe this isn't surprising, as sedimentary profiles for the deep traps is different from say the upper traps. Also Sturm thinks that there may be some resuspension in lower trap at this time. It may be that one shouldn't compare upper plankton sample with lower water samples.

- RDA was performed, constraining each axis to be a linear combination of environmental analysis, i.e. basically a multiple regression model. In this model, the amount of explanation is significant (over 60%) using the variables: time (day); time (year divided into 3 seasons: summer, winter & autumn); position found in the water column: surface, middle trap, deep lower trap (given as dummy variables); and finally DDI. What RDA shows is the contrast between *Cyclotella* and *Synedra*, which is driven by time. *Stephanodiscus* spp. are found most in deep traps in the summer. In terms of DDI, the surface samples are similar to the middle samples, but that there is significant dissolution in the lower trap. *Synedra* and *Stephanodiscus* are poorly preserved, but the Cyclotellas are better preserved.

- Overall however, the biplots obtained using this method are confusing, as different time integrations are being used, aiming for a full year. The suggestion was made therefore, to put all the plankton data together, all the trap data together, and then determine %age composition over whole year for each.

- Effects of plankton on sediment traps were partitioned out, in an attempt to predict trap material from environmental variables: plankton, DDI and depth. So DBR partialed out the effect of phytoplankton, of which 80% can be explained by time, i.e. season alone. The plankton is therefore a time signal. Factoring out time, or phytoplankton, DDI and depth both became significant, with a certain degree of co-variance being apparent. 6% of variance in the trap data was uniquely attributed to dissolution, whilst depth on its own accounted for 30%, and plankton 30%. There was no interaction between depth and DDI without time.

- Therefore the traps do mirror what is happening in the phytoplankton, but that dissolution is important. 'Memory' or plankton in water before traps opened may be important too. MS suggests a

residual index: so that in the sediment, what is finally able to be stored there, and this residual will give us an indication for palaeo temperature, e.g. ratio of small to longer A. baicalensis.

1.3 Transfer function

- data have mainly been extracted from the Baikal Atlas, + other recent papers and measurements. Data collated are presented in Table 1 below. Data analyses have still to be carried out.

1.4 Core screening

Cores have all been screened for turbidites using visual photography and magentic analyses (e.g. Lees 1996). Many cores suspected of having turbidites have now also been analysed for diatoms - see Figure 1 below). No simple relationship would appear to exist between turbidite occurrence and diatoms. When few or no diatoms are present, the turbidite in question is likely to be perhaps fluvial in origin. However, some turbidites contain fossilised diatoms, e.g. *S. flabellatus*, which would suggest that these are derived from older sediments.

2. WORK COMMITMENTS TO PROJECT

1. **characterise the environmental controls on abundances of key endemic diatom taxa in relation to physical and chemical environmental data**

    - DJ will collate this information for the period 1996 - 1997 using culture work (temperature; light), knowledge of zooplankton effects etc.

Action: DJ to send information to AWM

2. **to understand how diatoms are transported and altered as they sink by (i) analysis of phytoplankton crops at different depths and (i) seston samples from both long-term and interval traps from trap array (sinking rates; dissolution; zooplankton role)**

    - We now have a good understanding of how diatoms are transported and altered as they sink. We also have evidence on sinking rates and dissolution, together with indirect evidence for rapid sinking rates (e.g. DDIs). These results will be collated to form rapid communication paper: see below for details.

Action: DJ to copy to DBR zooplankton data

3. **assess relative roles of taphonomic processes in water column & surface sediments**

    - this has now largely been completed, and data is currently being analysed.

4. **identify locations where high resolution undisturbed cores may be obtained**
    - **systematic coring**
    - **development of combined screening methodology, using magnetics photography & lithostratigraphy and diatoms if necessary**
    - **coring in marginal regions with minimal disturbance**

    - once again this work is now completed: see Figures 1 - 3

Action: MS to send to AWM raw data for BAIK80 ^{210}Pb dates, plus the lithostratigraphic picture. Both will be incorporated into paper submitted to *Geologische Rundschau*.

5. **assess how faithfully sediment diatom assemblages reflect relative live compositions via**
    - **data acquired on dissolution and breakage**
    - **comparison of individual spp. %ages in surface sediments with a similar measure from the water column over an annual cycle**
    - **if necessary, calculation of weighting factors to correct for bias introduced by differential losses**

    - weighting factors, especially e.g. for species such as *Synedra* will be calculated from analysing open trap samples. It is unlikely that we will be able to suggest weighting factors for *Nitzschia acicularis* because it dissolves out almost totally in the water column, and no blooms were detected during the period of study in this project.

6. **develop palaeoclimate reconstruction methods based on relationships between abundances of endemic taxa in water column and corresponding occurrences in surface sediments; explore various calibration techniques**

    - optima for temperature and light has been calculated by DJ, although the spread of data, or standard deviation may also be important
    - ratio of vegetative cells to resting spores may be estimated by valve length calculations
    - relationship between diatom productivity and diatom accumulated rates along N-S axis: need to use dated cores? Perhaps Appleby could run his model on MS's dates on cores 43, 53, 61, 69, 65, 80, 114
    - biomass estimates (maximum values), which should be fed into the transfer function model can be got from the Atlas

Action: MS or RWB to contact Appleby *re.* dating model.

Table 1: Geographical, limnological, climatic, chemical and biological characteristics used as explanatory variables for the distribution of diatoms in surface sediments taken throughout the length of Lake Baikal. Source references for data are also given. Where environmental variables were skewed around the mean, they were log (x+1) transformed.

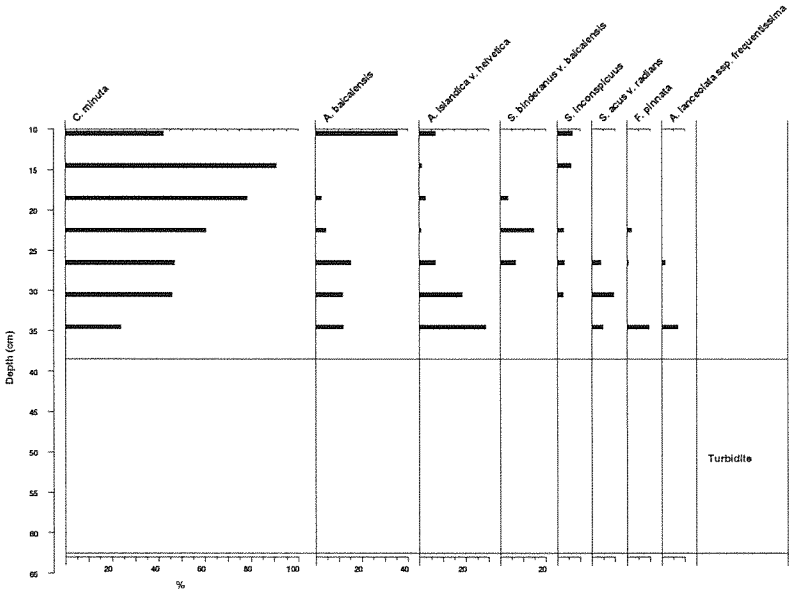
Explanatory Variable	Units	Source	Minimum	Maximum	Mean	STDS	ln (x+1) transformation
Geography							
Latitude	-	1	51.57	55.62	53.32	1.21	-
Longitude	-	1	103.96	109.76	107.39	1.68	-
Distance from North Baikal	-	1	0.16	4.26	2.46	1.21	-
Limnology							
Depth of water	m	1	20.00	1678.00	809.58	480.29	+
Temperature of water surface	°C	3	1.00	13.00	5.92	2.26	+
Transparency in July	m	2	9.00	25.00	21.43	4.57	+
Transparencey in September	m	2	2.00	11.00	6.05	1.95	+
Albedo	%	2	5.00	7.00	5.11	0.45	+
Climate							
Annual solar radiation	mJ m^{-2}	2	4100.00	4700.00	4478.49	187.58	+
Absorbed radiation	Kcal cm^{-2}	2	13.00	15.00	14.23	0.98	-
July heat balance	Kcal cm^{-2}	2	7.00	13.00	10.62	1.52	+
July air temperature	°C	2	9.00	15.00	12.23	1.69	+
Precipitation	mm	2	175.00	550.00	257.26	67.73	+
Snow thickness on lake	cm	2	2.50	12.50	6.17	3.23	+
Depth of ice	cm	3	65.00	100.00	82.87	7.16	+
Length of ice cover	days	3	126.00	168.00	145.33	10.72	+
Chemistry							
$N\text{-}NO^{3-}$	mg m^{-3}	2	15	70	58.17	16.38	+
$P\text{-}PO_4^{3-}$	mg m^{-3}	2	4.00	12.00	7.73	2.67	+
Suspended matter	mg l^{-1}	2	0.75	4.00	2.32	0.64	+
Suspended organic C	mg l^{-1}	2	0.30	1.50	0.38	0.19	+
Organic C	mg l^{-1}	2	1.10	1.70	1.33	0.17	+
Organic N	mg l^{-1}	2	70.00	175.00	118.38	24.24	+
Organic P	mg l^{-1}	2	7.00	16.50	9.96	2.10	+
Biology							
Length of *A. baicalensis* valves	µm	1	20.30	29.44	25.21	1.73	+
Diurnal primary production	g O_2 m^{-2}	4	0.25	2.75	1.05	0.56	+
Phytoplankton biomass	mg m^{-3}	2	50.00	1100.00	150.00	171.95	+
Zoolplankton biomass in September	g m^{-2}	2	5.00	30.00	10.05	8.55	+

1: data from this study
2: Baikal Atlas (1993)
3: Shimaraev *et al.* 1994)
4: Bonderenko *et al.* (1996)

Figure 1: diatom summary profiles for cores screened for turbidites

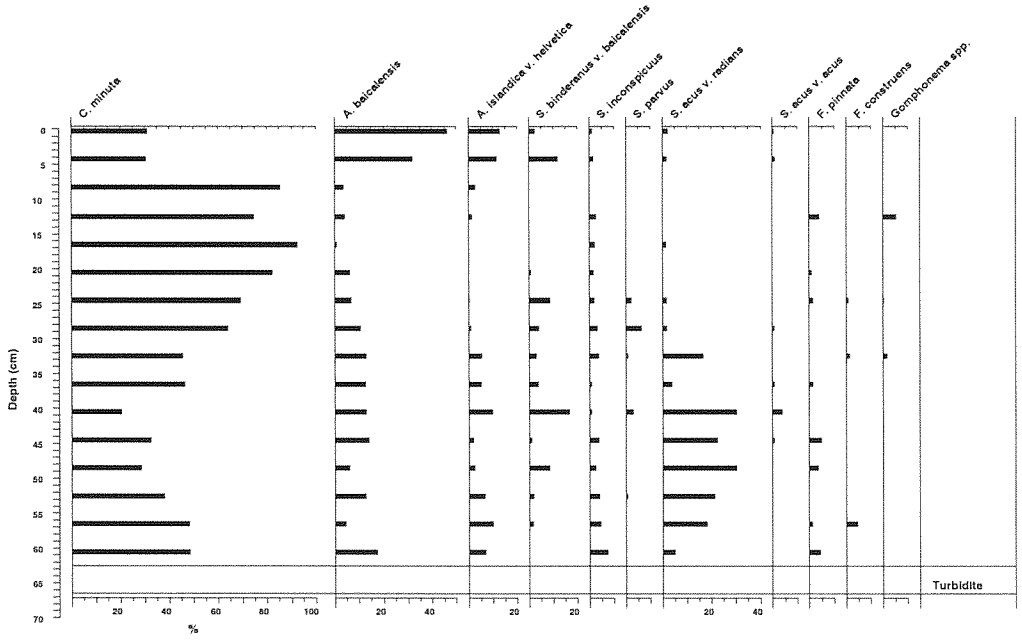
BAIK 113

Angara - Port Baikal transect



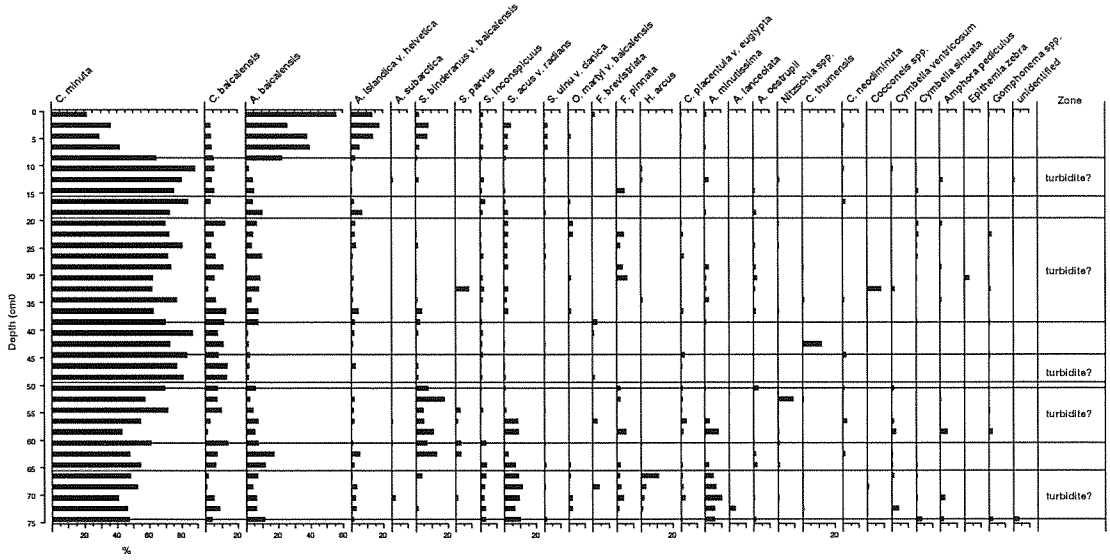
BAIK 114

Angara - Port Baikal transect



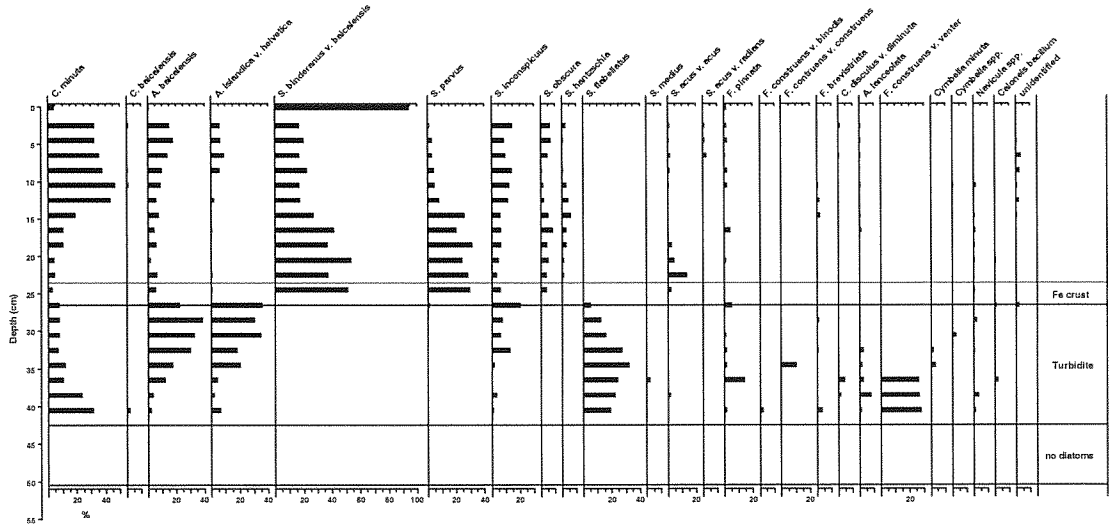
BAIK 43

Angara - Port Baikal transect



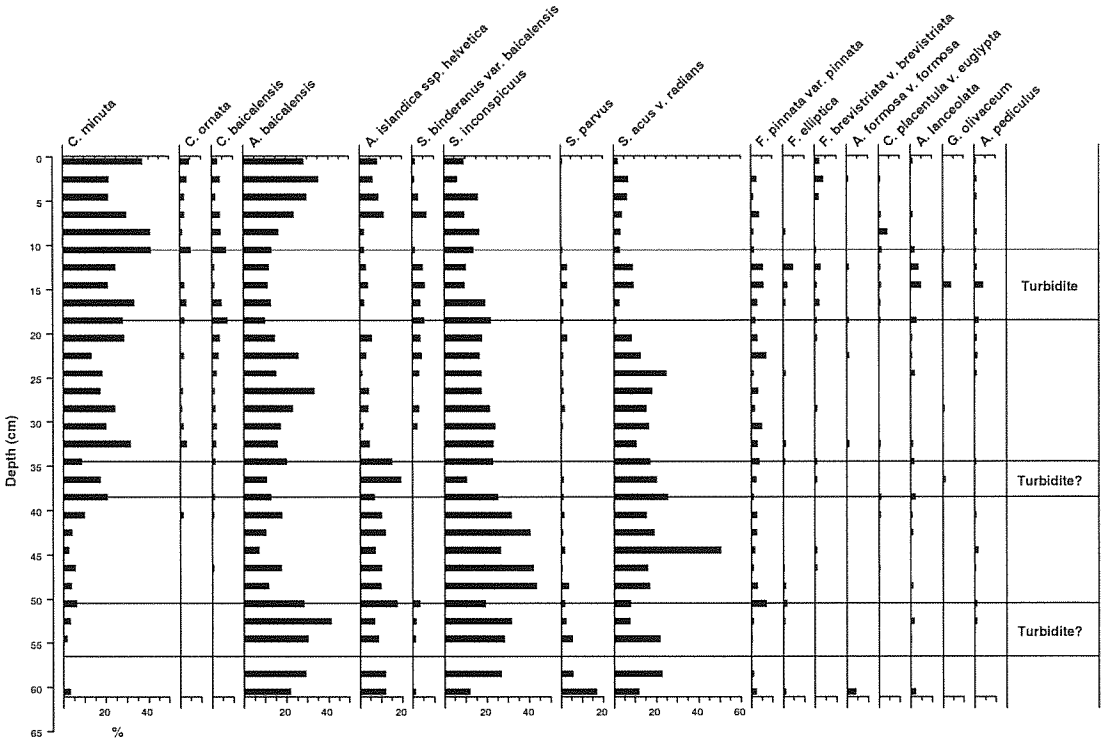
BAIK 56

S-N: Meloe More Sea to north Northern Basin transect



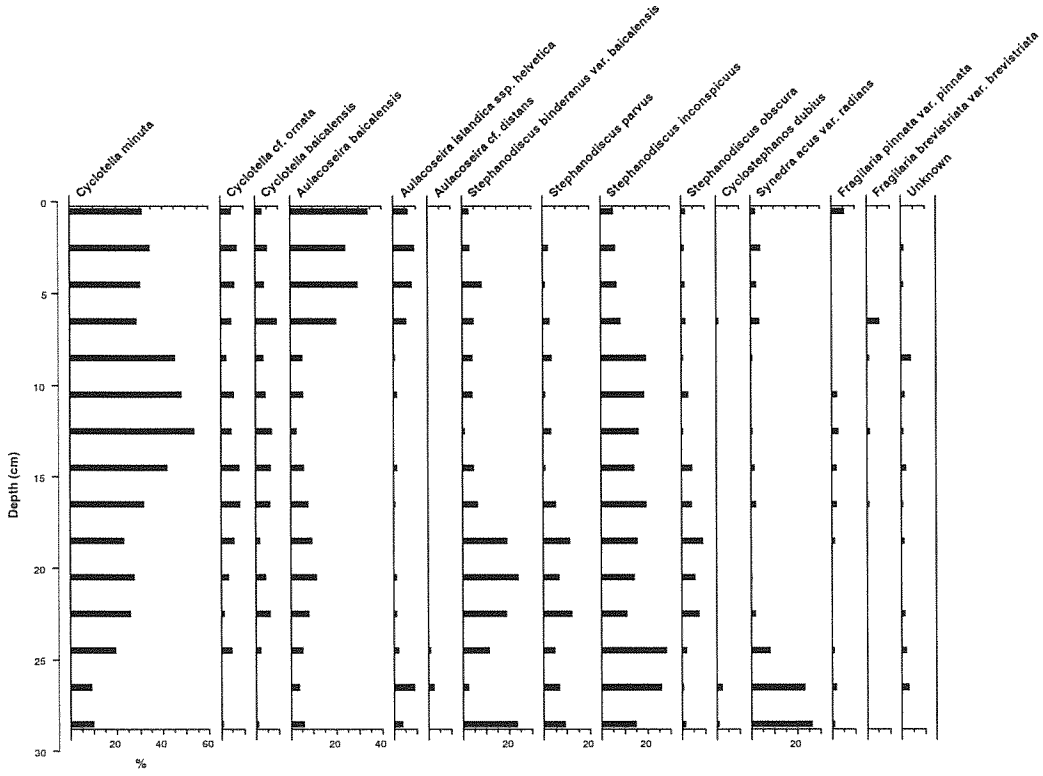
BAIK 78

Zavorotny transect



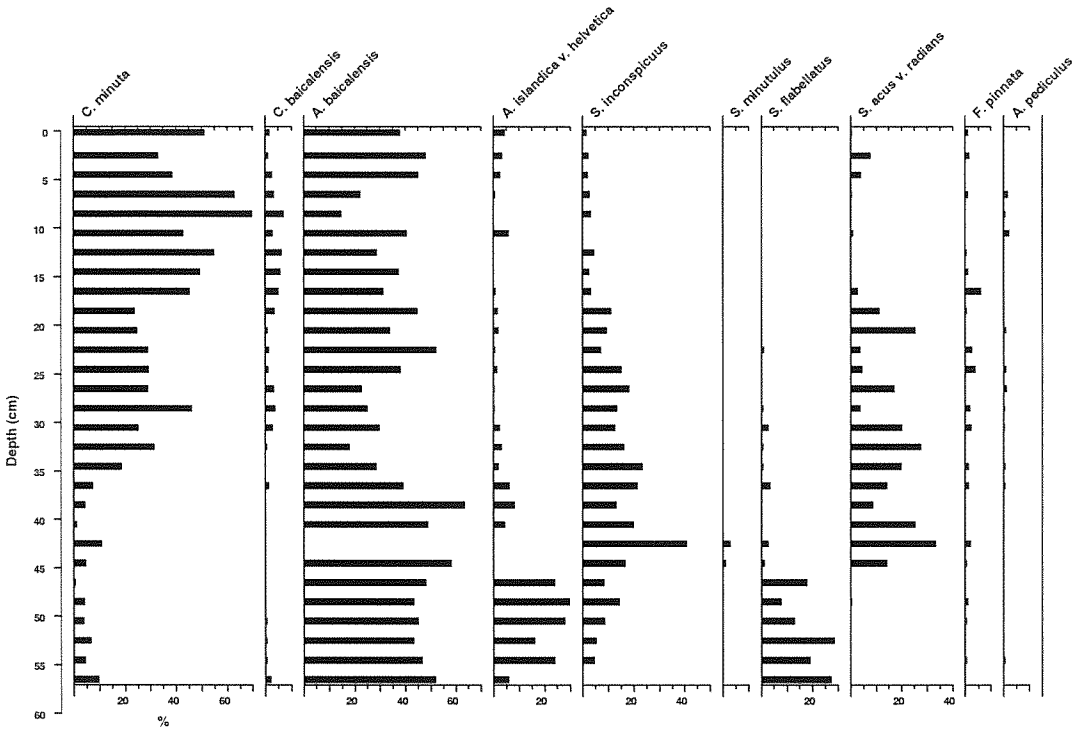
BAIK 69

S-N Maloe More Sea to north Northern Basin transect



BAIK 75

Zavorotny Transect



3. PERFORMANCES AND MEASURES

NERC now require output and performance measures (OPMs) for all funded projects. These are generally split into the following categories given in the table below. A survey round the table revealed that there is a lot of information to collect for this project. The details below represent a start to this collection procedure, which will be updated at the meeting in Lucerne.

External funding 31st March - 30 April, 1999:

EAWAG

INTAS-96-1937

- Phytoplankton and mixing in Lake Baikal. Co-ordinator DJ. 60,000ECU (1998/1999)

Royal Society

- Approx £7,500 in 1998 for expenses to Lake Baikal

Russian Academy of Sciences

- unspecified amount for ship time, logistics

University College London

- £3000 for expenses to Lake Baikal in 1998

Publications:

1. **Flower, R.J., Battarbee, R.W., Lees, J., Levina, O., Jewson, Mackay, A.W., D. Ryves, D.B., Sturm, M. & Vologina, V. 1988.** A GEOPASS-NERC project on diatom deposition and sediment accumulation in Lake Baikal, Siberia. *Freshwater Forum*, **11**, 16-29.

2. **Flower, R.J. 1998.** Palaeolimnology and recent environmental change in Lake Baikal: an introduction and overview of inter-related concurrent studies. *Journal of Paleolimnology*, **20**, 107-117

3. **Lees, J.A., Flower, R.J., Ryves, D.B., Vologina, E. & Sturm, M. 1998.** Identifying sedimentation patterns in Lake Baikal using whole core and surface scanning magnetic susceptibility. *Journal of Paleolimnology*, **20**, 187-202.

4. **Kipfer, R., Hohmann,R., Peeters,F., Sturm,M. & Imboden,D. 1998.** Lake Baikal: Basic Research as the Nucleus of Environmental Responsibility?- *EAWAG-News*, **45**, 6-9.

5. **Bangs, M., Battarbee, R.W., Sturm, M., Jewson, D., Ryves, D.B. & Mackay, A.W.** ***in press*** Climate change in Lake Baikal: palaeoindicator evidence in turbidite free zones. *Geologische Rundschau*: Proceedings INTAS Conference Active Tectonic Continental Basins

6. **Flower, R.J., Ryves, D., Battarbee, R.W., Mueller, J. & Sturm, M.** ***in press*** Lake Baikal: some topical aspects of current research. *Journal of Paleolimnology*.

Invited lectures / key-note talks

Battarbee, R.W. 1998. Lakes, climate change and the role of paleolimnology. *1st IGBP PAGES Open Science Meeting*. 20 - 23 April, 1998, London, UK.

Sturm, M. 1998. Hemipelagic sedimentation and turbidites in the active tectonic basin of Lake Baikal.- *INTAS Conference Active Tectonic Continental Basins*, 30 April - 2 May 1998, Gent-Belgium

Jewson, D. 1998. Life under ice: Lake Baikal's endemic planktonic diatoms. XXVII SIL Congress, University College Dublin 9-15 August 1998

Jewson, D. 1998. What relevance does the study of diatom life cycles have for understanding physical, chemical and biological processes in Baikal? International Conference *Baikal as a World Natural Heritage Site: Results and Prospects of International Cooperation*, 9 - 12 September 1998, Ulan Ude, Sibiria/Russia

Sturm, M. 1998. Short-term signals and long-term memories of sediment archives: application to recent sediments of Lake Baikal.- International Conference *Baikal as a World Natural Heritage Site: Results and Prospects of International Cooperation*, 9 - 12 September 1998, Ulan Ude, Sibiria/Russia

Sturm, M. 1998. Short-term signals and long-term memories: the potential of lacustrine sedimentary archives.- *International Conference Lakes as Indicators for Anthropogenic Processes in the Catchment Area*, 13 - 18 September 1998, Ascona, Switzerland

Jewson, D. 1998. Interdisciplinary studies in Lake Baikal: past present and future. *BICER/ BDP/ DIPWA Joint International Symposium on Lake Baikal*, 5 - 8 November 1998, Yokohama-Hakone/Japan

Sturm, M. 1998. Short-term signals and long-term memories of sediment archives: application to recent sediments of Lake Baikal. *BICER/ BDP/ DIPWA Joint International Symposium on Lake Baikal*, 5 - 8 November 1998, Yokohama-Hakone/Japan

Mackay, A.W. 1999. *Pollution an Climate Change in Lake Baikal.* Department of Animal and Plant Sciences, University of Sheffield, 1st March 1999.

Mackay. A.W. 1999. *Pollution an Climate Change in Lake Baikal* Department of Geography, University of Durham.

Conferences (^{T} = talk; ^{P} = poster)

^{T}**Sturm, M., Vologina, V., Lovina, O., Flower, R.J., Ryves, D.B. & Lees, J.A. 1998.** Hemipelagic sedimentation and turbidites in the active tectonic basin of Lake Baikal. *Active Tectonic Basins: interaction between structural and sedimentary processes.* 30 April - 2 May, 1998, Gent, Belgium.

^{T}**Bangs, M. 1998.** Climate change in Lake Baikal: diatom evidence in turbidite free zones. *British Diatomists Meeting* Slapton 23-25 October 1998.

^{T}**Mackay, A.W., Bangs, M., Battarbee, R.W., Flower, R.J., Jewson, D., Kuzmina, A.E., Lees, J.A., Ryves, D.B. & Sturm, M. 1998.** Deposition and Accumulation of Endemic Planktonic Diatoms in the Sediments of Lake Baikal: Their Potential Role in Climate Reconstruction During the Holocene. American Geophysical Union Fall Conference. 6 - 11th December, 1998, San Francisco, USA.

Ryves, D.B., Flower, R.J., Mackay, A.W., Lees, J., Vologina, D., Battarbee, R.W., Jewson, D. & Sturm, M. 1998. Diatom deposition and sediment accumulation in Lake Baikal, Siberia: an introduction to on-going interrelated studies. *Active Tectonic Basins: interaction between structural and sedimentary processes.* 30 April - 2 May, 1998, Gent, Belgium.

3.1 Publications to be written

Collation of results for papers outlined at the last meeting are in hand, but are updated here. A time-table is set out, so that as many papers as possible may be submitted as soon as possible. We have identified 3 rapid communication papers for completion by September, 1999 (see below).

Fast-track papers

Jewson + Battarbee, Mackay, Ryves, Sturm + Bangs + Granin

Aulacoseira baicalensis valve morphology as a climate indicator (*Nature / Science*)

DJ will count more valve lengths from BAIK80 and BAIK38, and add spatial differences to his paper. Colour plates already prepared and valve diameters will be dropped from the paper.

- **Needs slides from AWM for B38 & B80**
- **Needs trap slides – DBR to give AWM details, and AWM to give slides to DJ**

Sturm + Ryves, Jewson, Matta, Vologina, Granin

Dramatic particle fluxes in Lake Baikal: initial results of high-resolution particle analysis of traps and surface sediments (*Nature / Science*)

- **Needs DDI data and benthic data for surface samples from '96 & '97 near the trap from AWM**
- **MS will give RWB composite diagram for inclusion in the report**

Battarbee + Jewson, Sturm, Ryves, Mackay, Flower, Kuzmina

Differential dissolution of Lake Baikal diatoms: correction factors and implications for palaeoclimatic reconstruction (*Nature / Science*)

- **Will centre on 2 diagrams and 3-4 tables. To be discussed with DBR.**
- **Still needs annual valve count flux to the bottom traps (from DBR)**
- **AWM to check accumulation rates in the sediments from Leverhulme**
- **MS to give AWM new core samples to count**

Jewson + Granin + others to be determined

Culturing endemic Baikal endemic diatoms in different temperature and light regimes (*L&O; Proceedings of the Royal Society*)

Sturm

Sedimentation processes and sedimentation Baikal (*Eos*)

Longer papers

Ryves + Jewson, Sturm, Battarbee, Flower, Mackay, Kuzmina, Lees

Taphonomy and the transformation of living planktonic communities to surface sediment assemblages in Lake Baikal, Siberia

- **DBR will finish report composite diagram after 14th July**

Jewson + others to de determined

Six species paper (*J. Ecol.*)

Mackay, Ryves, Kuzmina, Battarbee, Jewson, Sturm, Flower

Inferred climate change in Lake from a surface sediment, diatom calibration data-set. (*JOPL*)

Mackay et al. same authors

Take preferred core, using all info, add correction factors diagram, and then apply all temp. Reconstruction techniques, such as valve length, productivity signals. Multi-method paper: evaluate methods of reconstruction correspond to each other. (*JOPL*)

Sturm, Bezrukova, Granina, Kuzmina, Vologina, Levina, Ryves, Mackay, Bangs, Lees + others from EAWAG, maybe Grachev

Spatial patterns of recent sedimentation rates in Lake Baikal (*JOPL, Marine Geology; The Holocene*)

- **AWM to give to MS info. on which cores have been analysed by who**
- **Longer-term – AWM to compose web-site for Baikal data and papers**

4. FUTURE WORK

DYVES (Dynamics of vertical particle fluxes and recent sedimentation)

Neutrino trap detector array: when neutrinos penetrate the water column of Baikal, especially during July and August, the amounts of hits were higher. An hypothesis is that pico plankton or secondary products are affecting the results.

When the neutrino detectors are next changed, DJ & MS will deploy sediment traps. DJ will take water samples. MS will put in a sediment trap with 15 open traps and 2 interval-sequential traps. New project has been formulated: DYVES (dynamics of vertical particle fluxes and recent sedimentation), where MS will leave trap in south basin as long as possible, e.g. at least 5 years. In Russia, the project is called ABS-99 (autonomous submerged buoy station). Because this is supposed to be a long term site, MS wants to go take from the ice, a transect of narrow, well defined cores. There is always the discussion about the paper mill in Baikalsk, so use this place as a base. We can then use this place to detect any 'memory' effects for years to come.

This project is being carried out together with a nuclear research team in Moscow, and the physics research team in Irkutsk. The project will be truly interdisciplinary, even including the Japanese (Watanabe), LIN, EAWAG, Ulster, DESY (Germany) and Austria.

The suggestion was made that the ECRC could apply to NERC for a small grant to take lots of surface diatom samples from this region, linking to the neutrino + other work in time for next spring.

GEOPASS - NERC II - Holocene climate variability

GEOPASS/NERC are interested in last 10 to 15 K years, covering the ice maximum and younger Dryas
GFZ cores: 15 m cores, to detect interglacial back to 250 K years
BDP core: 100 ms, going back millions of years

The ECRC are interested in 15K year cores, and in the Eemian record contained within 15 m cores. Between these 2 interglacials, we have the issue as to what happens to the diatoms. The glacial isotope period between the Holocene and Eemian is very complicated, with several isotope stages (2 - 5d). (**Action:** AWM to get samples from Johannes Muller). Germany's plan now is to do a thorough survey of a longer core, from the very surface layers, down 15m in detail. About 110K years ago, there was a magnet reversal / excursion which is about the only definite thing that one can date at that scale.

A large multidisciplinary project should go the EU (**Action:** need to appoint a co-ordinator for a large multidisciplinary project, and this will probably be Heidi). Need a good dating chronology, by maybe employing a post-doc / PhD. As far as NERC are concerned we should still apply for Holocene funding, and to take 10 - 20 longer cores, 2 - 5 m, screening for turbidites first of all etc. We should apply for Intas funding too to help with Russian funding.

Action: RWB to inform gtroup on 5th framework program and approriate sections for a Baikal-proposal, including proposal deadlines.

Biodiversity of Environmental Change.

Next to Olkhon lake, Haringary Bay is an extremely good site, being 34 m deep, but is protected from the rest of the Maloe More straight by a 20 m underwater crest. The bay also experiences very low rainfall levels, and there are no inflows from the surrounding landscape. The site is close to Skvortzov's original 1916 site, and the area is rich in benthic taxa (with the potential for preserved *Nitzschia* species).

It is suggested that a core, possibly of Holocene length, be obtained in 1999, and funds from a NERC small grant applied for, as the site should be turbidite free, although it may be affected to a degree by resuspension from strong winds.

Biodiversity of satellite lakes

This project will form a proposal to EU preserving ecosystems, bringing together Flower, Williams, Riedler and Koen Martins .

A further extension to this could be an investigation into where 3 biogeographic areas meet: Pacific basin, Arctic basin and Angara basin (not actual names). Several lakes have already been looked at here, which contain endemics, some of them from Baikal. In some of the mountain lakes, we have some living fossil diatom spp. - need to know extent. Climate change record sharper than in Baikal itself.

Pollution and eutrophication in the Selenga Delta region

There is still a lot of interest in this region by scientists and environmentalists alike, principally because of the Selengisk paper and pulp mill and because the Selenga provides *c.* 33% of the water flowing into Baikal. In this region, PCBs are high, although there is little change in metals. P loadings are increasing in Selenga region, and there have been diatom collections since 1970s in the shallow ponds within Selenga regions.

The ECRC would like to collect cores from this region to detect any changes in the plankton record, linked to eutrophication, and to analyses for PCBs etc. An initial survey in 1993 does how a link between the sediment and monitoring record.

Action: AWM to contact Kodzher re work they are doing in this region.

GIS survey

The ECRC would like to see a comprehensive survey undertaken, mapping out all spatial data, including diatoms and sediment analyses, and then to create a relationship database in *Access*, or even a WWW based system. This kind of work should be built into larger projects e.g. as part of a submission to EU FP5.

Action: MS to send to RJF an http address for a Baikal map already on the web.