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Conference Report

User Interaction Meeting on Accelerator Mass Spectrometry of Radiocarbon, Institute of Physics, Bhubaneswar

August 26-27, 2004

STATUS-REPORT

Introduction

The development of the Accelerated Mass Spectrometry for radio carbon dating in India was initiated jointly by the Institute of Physics (IOP), Bhubaneswar and Physical research Laboratory (PRL), Ahmedabad in the late 1990s. The 3MV pelletron (NEC, USA) accelerator at IOP was augmented as a dedicated system to be used as AMS for routine carbon dating applications. A User Interaction Meeting on AMS Radiocarbon Dating was arranged at the Institute of Physics on Aug 26-27, 2004. Eminent personalities as well as users from a variety of disciplines involving radiocarbon dating attended this meeting. BSIP was represented by B. Sekar and the author of this article. In this brief communication the present status of the system has been reported.

The pelletron accelerator has been augmented to carry out AMS radiocarbon analysis. Various kinds of samples, such as wood, charcoal, sediment, biogenic carbonate, peat etc are processed for AMS measurements. The samples are converted to graphite and pressed into aluminum cathodes. The MC-SNICS negative ion source can hold 40 cathodes. Negative ions of $^{13}C^-$ and $^{14}C^-$ from the ion source are sequentially injected in to the accelerator. The positive ion current from the stable isotope of ^{13}C is measured in an off-axis cup situated after the analyzing magnet whereas ^{14}C ions are counted using a particle detector in the beam line. The ratio of $^{14}C/^{13}C$ of a sample is compared with that of a standard to determine the age of the sample.

The first results with a high $^{12}C^-$ source current of about 25 A were obtained in June 2004. In the June 2004 and July 2004 runs, samples from Birbal Sahni Institute of Paleobotany (BSIP), Lucknow and the University of Arizona AMS facility at Tucson were dated.

Results and Discussion

Table-1 shows the result of the AMS analysis of some reference samples provided to IOP by BSIP and Arizona AMS Laboratory. The BSIP samples were previously dated by liquid scintillation technique. The left over samples (all of them being biogenic carbonates) were sent to IOP. These samples were graphitised at IOP Graphite Laboratory and subsequently analysed by AMS. The Arizona samples however were sent to IOP after graphitisation.

Figure-1 shows the bar diagrams that compare the result given in Table-1. The solid bars represent the reference samples and the gray bars- the IOP measurements. Upper panel samples compare the BSIP data and the lower panel compares the Arizona data. It appears that the IOP samples agree reasonably well with the reference samples. But out of fifteen samples the ages of only four samples agree with 1 sigma uncertainty, five samples agree within 2 sigma uncertainty. And one sample does not agree even with 3 sigma uncertainty. To show the correspondence of the dates a scatter plot has been drawn. Figure 2 shows the plot. A regression line fitted to these points yields the following equation.

$$y = -528 + 1.063\,x \qquad (R^2=0.991, n=10) \qquad \text{Eq-1}$$

Where x is the reference date and y is the IOP date. Ideally the slope and the intercept should be close to unity and zero respectively. But in this case the slope is deviated from unity by 6.3%. In terms of radiocarbon age this is equivalent to 520 year. So the average precision of all measurements within the given age range (0 to 15,000 yr) turned out to be 520 yr. On the other hand the intercept does not give a zero age, rather shows a negative age of 528 year. This probably means that either the machine overestimates the count rates and/or graphitisation process is contaminated by modern carbon (that is atmospheric carbon dioxide). The non-unity slope produces a random error while the negative intercept appears to be a systematic error. However with limited number of sample analysis it is not conclusive that the negative age (i.e -528 yr) will produce a constant offset. Hence if this error is also taken into consideration then the overall uncertainty increases to 740 yr.

As mentioned earlier the two sets of reference samples were treated differently. The BSIP samples were first graphitised followed by AMS analysis, whereas the Arizona samples were obtained in graphite form and so measured directly. This gives an opportunity to analyse the behaviour of the graphitisation process. If a scatter plot is drawn only with the BSIP samples (not shown) and a regression line is fit we get an equation:

$$y = -894 + 1.104\,x \qquad (R^2=0.994, n=4) \qquad \text{Eq-2}$$

Where x and y as described before. The corresponding line for the Arizona samples yields the following equation:

BSIP dates	IOP dates
11383±58	11511±140
5080±100	4610±140
5500±120	5121±120
8230±130	8538±205
ARIZONA dates	IOP dates
14719±77	14684±210
1116±38	599±105
5227±45	5071±165
8734±49	9010±160
9558±55	9263±180
10364±55	11323±160
41000	**47000**

Table-1—Comparison of radiocarbon dates of the IOP AMS analysis and the reference samples from BSIP and Arizona AMS Laboratory. First column represents the reference samples of BSIP and Arizona Lab respectively. The last sample is the age of a marble sample which essentially determines the background

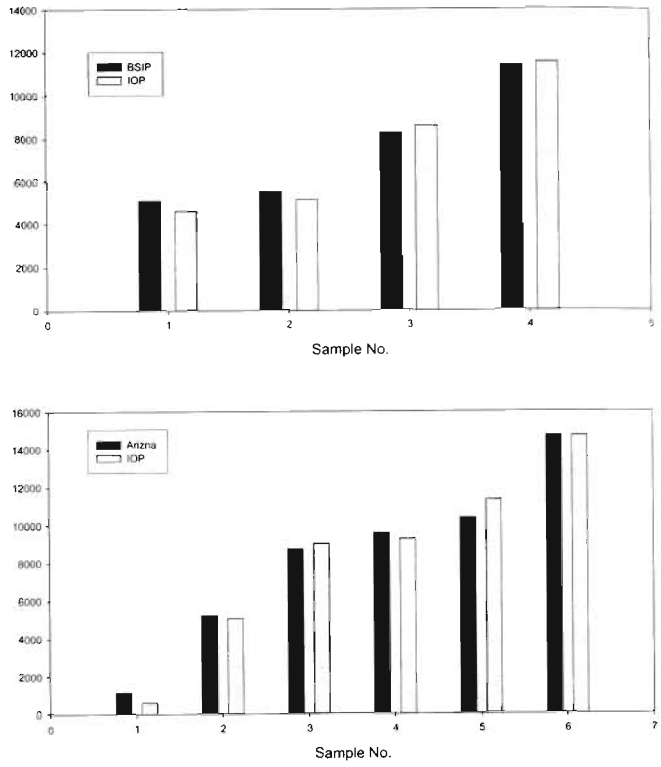

Fig. 1. The bar diagram for the reference samples and the IOP samples. Solid bars represent the reference samples while gray bars the IOP samples.

$y = -397 + 1.05\,x$ (R^2=0.991, n=6) Eq-3

In case of equation (Eq-2) the slope deviates from unity by about 10%, which incorporates an error of more than 800 yr. On the other hand the intercept yields an error about -890 yr. The corresponding errors in case of Eq-3 are 400, and -400 respectively. So it is evident that the graphitisation process itself incorporates significant amount of uncertainty in the age estimation. In this point this is to be mentioned that the graphitisation system was initially built by the author at the Physical Research Laboratory, Ahmedabad. Later it was moved to IOP, Bhubaneswar and modified by Dr. Rajagopalan. In the year 2000 few samples were graphitised at PRL and sent to Arizona AMS Laboratory and VERA Laboratory, Viena for AMS analysis. The Table-2 shows the result of this analysis.

It is seen from this table that one international standard sample (FIRI-I) gave an age that matched very well with the consensus age. The NBS-Ox-II standard was graphitised several times and each of them was separately analysed by Arizona AMS facility and the VERA AMS Laboratory. The average value of fraction modern from all of these measurements gave a value of 1.3218±0.013, which agrees well with the accepted value (viz. 1.3406±0.01, Mann 1983).

In case of recent (June-July 2004) analysis the graphitisation of the BSIP samples and NBS Oxalic acid standards (both Ox-I and Ox-II) were done at IOP followed by AMS measurements. The Ox-II/Ox-I ratio was determined based on replicate analysis. The mean ratio was 1.31±0.013 which aggred

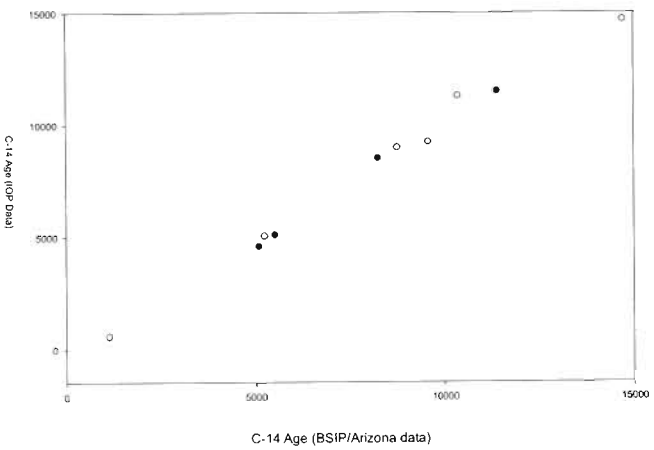

Fig. 2—The scatter plot showing the correspondence between the reference samples and the IOP samples. X-axis represents the age of the reference samples and the Y-axis, the IOP samples. Solid circles are the BSIP samples and the open circles are the Arizona AMS Lab samples.

reasonably well with the accepted value of 1.2736±0.0004 (Mann 1983). However to establish the credibility of the system it is essential that some international standards, such as

Sample	Fraction modern	$\Delta^{14}C$ (‰)	AMS Age(Yr BP)	Consensus age(Yr BP)
FIRI-I	0.5739	-426	4460	4483
NBS Ox-II	1.3197	319.7		
-do-	1.3088	308.8		
-do-	1.3033	303.3		
Blank	0.0036	-996	45,200	
NBS Ox-II	1.3265	326.5		
-do-	1.3257	325.7		
-do-	1.3251	325.1		
-do-	1.344	344		
Average	**1.3218±0.013**			

Table. 2—The graphitisation of samples at the Physical Research Laboratory and their AMS analysis done by Arizona AMS Lab and VERA AMS Lab respectively.

FIRI reference materials whose dates/$\Delta^{14}C$ have been measured by several international laboratories be measured.

Conclusions

The first AMS radiocarbon dating facility developed at IOP seems to be quite promising. Though at present the system has some limitations. The reproducibility of the measurements, limitations in dating relatively older samples (>15,000 yr), and analysis of non-carbonate samples that involve high temperature combustion. Once these limitations are overcome this system will provide a unique facility of radiocarbon dating in the country.

Reference:

Mann WB 1983. An international reference material for radiocarbon dating. Radiocarbon 25 : 519-527.

S. Chakraborty
Birbal Sahni Institute of Palaeobotany,
53 University Road, Lucknow 226 007

18th International Radiocarbon Conference,

September 1-5, 2003, Wellington, New Zealand

18th International Radiocarbon Conference was held in Wellington from 1-5 September,2003. The conference was hosted by the following organizations :

Rafter Radiocarbon Laboratory, Wellington and Institute of Geological and Nuclear Sciences Limited, Wellington. The conference was sponsored by : The International Atomic Energy Agency, Vienna, National Electrostatic Corporation-the world's leader in the manufacture of electrostatic ion beam accelerator system, The Royal Society of New Zealand, Wellington and High Voltage Engineering -Specialized in the development and manufacture of ion beam technology equipment - the largest and most diverse manufacturer of particle accelerator systems for Scientific, Educational and industrial research communities.

In the technical session more than 400 scientists from all over the globe participated and discussed about the present state of art and future strategy for the research in Radiocarbon dating studies. Different aspects of ^{14}C dating research were debated on 13 technical sessions beginning with key note lectures. A total of 437 papers (272 oral and 165 Poster presentations) highlighting several new research developments in the field of ^{14}C dating research..

Some of the topics which were discussed included : Atmospheric and Oceanic Carbon Exchange, AMS sample preparation and Counting techniques, Fresh water, Marine and Ground water dating, Dating of Soils, AMS Dating of Archaeological artifacts, Calibration of dates, Reconstruction of Past Climates, Compound Specific analysis, Data interpretation, Instrumentation, Human/Environmental impact and other cosmogenic dating tools.

Major areas highlighted in the conference include : AMS ^{14}C dating developments, Calibration of dates, Exchange of carbon in marine and atmospheric spheres, reconstruction of Palaeoclimate and dates of new archaeological sites by AMS and other methods. It was announced in the conference that a new calibration program will be ready by the beginning of 2006. There was also voting for deciding the next venue for 19th International Radiocarbon Conference 2006 namely Oxford or Senegal which later decided to have post ballot of members.

B.Sekar
Birbal Sahni Institute of Palaeobotany,
53 University Road, Lucknow 226 007

XI International Palynological Congress

July 4 - 9, 2004

The goal of "International Federation of Palynological Societies" is to advance the knowledge of Palynology and related subjects by promoting International cooperation between palynologists of all countries. In order to fulfill it, the federation invites/selects one of its societies to organize International Palynological Conference (which held every four or five years since 1962) and has entrusted to the Spanish Palynological Association for such eleventh gathering. The "XI International Palynological Congress" was held at Granada, Spain, from 4th to 9th July, 2004. It was jointly organized by the authorities of Spanish Palynological Association, International Federation of Palynological Societies, University of Granada and Zaidin Experimental Research Station (Granada), and sponsored by the Spanish Ministry for innovation, Science and Business; Andalucian Government Ministry for the Environment, Andalucian Government Ministry for Health, Andalucian Government Ministry for Technological Innovation, Andalucian Government Ministry for Education, Spanish Council for Scientific Research, Official College of Pharmacists, IZASA and National Park of Sierra Nevada, besides Zaidin Experimental Research Station and University of Granada. Around 600 participants from different parts of the world (Argentina, Australia, Austria, Belgium, Brazil, Britain, Bulgaria, Canada, China, Colombia, Czech Republic, Denmark, France, Germany, Hungary, India, Iran, Ireland, Israel, Italy, Japan, Malaysia, Mexico, Mongolia, Nepal, Netherlands, Norway, Poland, Portugal, Russia, Saudi Arabia, Slovenia, Spain, Switzerland, Sweden, Taiwan, Togo, Uganda, United Kingdom and United States of America, etc.) were gathered to participate in this remarkable meeting. The venue of Congress was Conference and Exhibition Center, Granada which is a very modern building and has been purpose-built to host conferences, exhibitions, cultural and social events of all kinds. It is equipped with the most outstanding technical means.

Scientific programs included Plenary sessions, Opening lecture, 36 Scientific sessions, Society meetings, Scientific excursions and visit to Alhambra. Plenary sessions covered two lectures : one each delivered by Prof. Eugenio Dominguez-Vilches (University of Cordoba, Spain) and Prof. Henery Hooghlemstra (University of Amsterdam, The Netherlands) respectively. Prof. Dominguez spoke about "The use of aerial platforms in aerobiological studies" while Prof. Hooghlemstra dealt with "Ice-ages in the tropics : new records and improved understanding of long Colombian pollen records". Opening lecture was delivered by Prof. P. Mandrioli (CNR-ISAC, Bologna, Italy) on "The first 30 years of the International Association for Aerobiology". Scientific sessions covered around 800 contributions categorized in to 9 groups (i.e. Pollen Biology, Forensic Palynology, Pollen and Spore Morphology, Entomopalynology and Melissopalynology, Aerobiology, Pollen and Allergy, Palaeopalynology and Evolution, Quaternary Palynology, and World Pollen Databases) which convene at 5 places simultaneously. Theme encompasses for presentations were Pollen ontogeny and development, Signalling in pollen development, Stress-induced microspore embryogenesis and pollen germination, Pollen for in-vitro production of haploids; Palynomorph wall chemistry, structure and assembly; Bryophytes and pteridophytes spore morphology; Spermatophytes pollen morphology, evolution, phylogeny and systematics; Pollen morphology and plant systematics; Evolution of angiosperm pollen characters; Basic aerobiology, monitoring, new techniques : pollen, fungal spores; Forecasting pollen, Pollen and fungal spore dispersal and long distance transport, Applied aerobiology : agriculture, cultural heritage, climatic changes; Molecular and cellular analysis of pollen allergens, Clinical aspects of allergenic pollen, Satellite symposium of Olea europaea pollen allergy, Entomopalynology, Melissopalynology, Forensic palynology; Dinoflagellate cysts and dinoflagellate biology, Pre-Cambrian palynology, Palaeozoic palynology, Pre-Jurassic palynology, Mesozoic palynology, Tertiary palynology, Dynamic of ecosystems : palynology and genetics, Timing and nature of vegetation response to abrupt climatic changes, Pleistocene pollen records : patterns and processes of environmental and cultural change, Evolution of landscape and climate in the Mediterranean ecosystem, Tropical paleoecology : sensitive archives of environmental change, Long continental records : the development of ground truth for the marine oxygen isotope chronology, Taphonomy and archaeological palynology; Non-pollen palynomorphs from fresh-water sediments, Peat deposits and archaeological sites; Pollen calibration and quantitative reconstruction of past vegetation cover; Global pollen databases and application of databases. My paper dealt with late Quaternary vegetation in Temperate zone of Kumaun Himalaya - Palynological assay. In recent years, the membership of IFPS societies is decreased but this decrease has not effected the progress of research. Not only high number but high quality of research was presented and use of new technologies and methods have improved the excellence. Society meetings covered two AASP Board Meetings, two IFPS Meetings, AEA Meeting, Phytopal Meeting, besides APLE, CIMP, CPS, GPSBI Assemblies. Currently 20 societies are member of IFPS. The Indian societies may be reshaped to join IFPS.

Pre and Post congress excursions, arranged earlier, were cancelled. However, a Scientific excursions to Sierra Nevada was arranged which was organized by Prof. Joaquin Molero and Prof. Reyes Garcia-Tejero (University of Granada). The Sierra Nevada mountains are most southerly in Europe, includes the highest peak in the Iberian Peninsula, the Mulhacen 3481 metres and shows snow covering even in July

at the higher level. Sierra Nevada massif has clear geographical boundaries : bounded to the east by river Nacimiento in Almeria, to the north-east by valley of Aguas Blancas and Granada depression, to the west by Lecrin valley, to the north by Guadix basin in Marquesado de Zenete, and to the south by Andarax, Adra and Guadalfeo river valleys. Its main axis, forming the watershed between Mediterranean and Atlantic, runs east to west for a length of some 80 km. The breadth varies from 15 km (at its eastern tip) to 40 km (in the centre-west zone). It has a total surface area of around 2000 km2, of which the National park occupies over 860 km2. The gradients of the massif are extremely steep due to its great height. From Nacimiento-Andarax confluence at 300 m to Mulhacen summit, the height point in the Iberian peninsula, at 3482 m, there is a difference of more than 3000 m. Elevation variation results a wide range of temperatures which bring in to play almost every bioclimatic level within the Mediterranean belt, and a large variety of ecosystem. The strategic location also makes Sierra Nevada something of a natural crossroads, where migratory species from Europe, SE Asia and North Africa coincide. Over 2100 plant species inhabit the Park, of which some 80 are exclusive and 250 autochthonous to the Betic mountain range. Holm oak woods feature prominently, intermixed with hawthorn, barberry and Adenocarpus decorticans. Tree life shows thinning at around 2000 m, giving way to a cushioned formation of juniper-broom which overruns the broad schist slopes up to 2700 - 2900 m. Further heights enjoy cold desert where only few species thrive, of which >70% are exclusive to Sierra Nevada. Also arranged guided visit to Alhambra which is Spain's most-visited monumental site, built between 13th and 14th centuries, by the Nazari dynasty. It represents the most exquisite and delicate manifestation of Islamic architecture, almost as if the Arab architects had managed to materialise their own earthly Paradise. Alhambra possesses numerous towers (such as Torre de los Comares, Torre de los Peinador de la Reina and Torre de las Damas), gateways (i.e. Puerta de las Armas, Puerta de la Justicia, la Torre de los Picos and la Torre de Siete Suelos) and can be distinguished in to two main areas - Alcazaba (i.e. military fortress) and Palacio Real. The latter possess clearly defined zone for royal residences and administrative buildings. Among the most outstanding elements of this palace are the main facade and enormous circular courtyard, where important concerts are held. The Palace also houses the Museum of Fine Arts and the Alhambra's Museum.

Congress ended with decision that next meeting, XII-IPC will be held in Bonn, Germany in August, 2008. Prof. Ana Teresa Romero, Chairwoman of Congress in question encouraged to all research groups from different corners of the world to continue their efforts, so the next meeting be of an even greater success. The author is grateful to the Organizers of congress for award of IPC-grant, and to authorities of Birbal Sahni Institute of Palaeobotany, Lucknow and funding agencies in New Delhi (Council of Scientific & Industrial Research, Indian National Science Academy and Department of Science & Technology) for providing/sanctioning the partial financial assistance to participate in this International gathering.

Asha Gupta
Birbal Sahni Institute of Palaeobotany,
53 University Road, Lucknow 226 007

Report on Joint AOGS 1st Annual Meeting & 2nd APHW Conference

July 5-9, 2004, International Convention & Exhibition Centre, Suntec, Singapore

Joint Asia Oceania Geosciences Society(AOGS) 1st Annual meeting and 2nd Asia Pacific Hydrology and Water resources(APHW) 2nd conference was held at Suntec Singapore International Convention and Exhibition Centre between 5-9, July, 2004. The conference was organized by Asia Oceania Geosciences Society, Singapore and sponsored by World Scientific Publications, Singapore. There were more than 850 research papers presented in 19 parallel sessions in both the conferences. The main topics covered are the following:-Solid Earth , Oceans and atmospheres, Space Physics, Planetary Science, Bio-Geo-science, Interdisciplinary working groups, Natural Hazards, Nonlinear Physics, Polar Research, General Activities, Hydrological Science, Climatic Change and Disaster, Water resource and Development, Regional Characteristics and Water Problems, Towards the Wise Management, Sound Utilization of Water Resources, Lessons from the Past, Flood water and River Management and Marine Archaeology.

Sessions on Oceans and atmosphere, Bio-Geo-science, Interdisciplinary Working Groups, Climatic change and Disaster and Geochemistry/Geochronometry were quite relevant to the studies going on at BSIP. The papers of above sessions were quite interesting and useful for future research.

The major highlights of the research findings are as follows. B.Sekar discussed the latest information on human settlements along the western coast submerged by sea time to time namely Bet Dwarka and Gulf of Cambay on the basis of ^{14}C and archaeological data in detail. Gratia et al, on the basis of thermoluminescence dating of marine archaeological findings in the Gulf of Cambay, showed that the ancient coastal line in Gujarat was much inside the present sea and how TL dating provided the much needed chronology of one of the earliest civilizations. Gangadharam et al, placed the limitations of the chemical and mineralogical nature of the specimens and

their possible mode of origin by comprehensive physical examination and chemical analysis of selected artifacts from off-shore marine archaeological site, Gulf of Khambhat. Rajavelu traced the maritime contacts of eastern coast (the coromandal coast) from Ist century A.D. onwards with Southeast Asian countries on the basis of ports, archaeological findings in the form of potsherds, coins and epigraphical sources. Kathiroli et al indicated that on the basis of trace and rare earth element geochemistry of the bed sediments and archaeological samples of gulf of Cambay, west coast of India that the artifacts are insitu and they are not transported and are made from the nearby seafloor sediments. S.P.Gupta threw fresh light on the east-west contacts in the early historical periods ranging between 300 B.C and 1300 A.D. Rajan Karaigowder brought out the role of technology in the backdrop of recent archaeological investigations in the area of traditional gem stone industry, pearl industry and indigenous irrigation technology. Harsh Gupta connected the maritime archaeological discoveries in Cambay and the Bhuj earthquakes of Jan 2001, Gujarat, pointing out that a combination of sea level rise and violent earth quakes between Pleistocene and Holocene period appears to be responsible for submergence of Cambay. Bhattacharyya et al have found orbital forcing could be the major cause for synchronization of climatic changes covering vast area of Mediterranean region, Tibetan Plateau and Western part of Himalayan region for regulating the climatic dynamics of the regional climatology . Sharma Chhaya has found that spider-webs were better substrates for airborne palynomorphs as compared to the soil samples as relative frequency of both arboreal and non-arboreal taxa is more in spider-webs on the basis of pollen rain studies at Keoladeo National Park wetland, Bharatpur, Rajasthan. Mukund Kajale stressed the significance of marine archeobotanical investigations from the Gulf of Khambhat(Cambay) region for understanding history of submergence of archaeological sites, phases of sea level changes, geomorphology, neo-tectonics and probable human adaptations to palaeoenvironmental and palaeoclimatic conditions during the Holocene period. R.P.Singh et al explained the use of surface latent heat flux peaks as a potential precursor for earth quakes occurring in near the coastal regions. The migration of the SLHF may provide the probable location of the epicenter of the earth quake. The monitoring of the SLHF globally is possible due to availability of optical and microwave sensors onboard satellites, which may provide early information about impending coastal earth quake. Short term prediction of earth quakes on the basis of FM radio waves and its worthiness was well documented by Atsumi Kumanoto et al. The reinforcement of existing structures and enhancement of short term prediction research was concluded as two keys for seismic hazard mitigation by Toshiyasu Nagao et al.. For proper understanding of sea level changes, remote sensing tools namely a number of space geodetic measurements of sea surface topography, ice mass, time variable gravity and ground motions are recommended by Benjamin Chao. For estimation of mean sea level changes interatively re-weighted least squares method from tide gauge data has been found to be more accurate than the use of ordinary least square by Baki Iz et al. In giving global picture of long term sea level change measurements sea level time series has been able to make a significant contribution was reported by John Hanaah. The temporal variation of submarine grou nd water discharge and associated chemical substances appears to cause significant environment and ecological changes in the coastal ocean was explained by Kim et al. Wang et al have recommended further study as light oxygen isotope signals along with ^{14}C and Tritium data of coastal waters in both summer and winter periods provide encouraging evidences of submarine groundwater discharge from the aquifers of the Pingtung Plain. Ozawa et al have proposed that dynamic regulation of global climatic system and fluid turbulence is at states of maximum entropy production. Dewar R.C. illustrated the relevance of maximum entropy production to biological feedback processes namely stomatal regulation of leaf gas exchange and how it maximizes the entropy production of the CO_2 -fixing dark reactions located in leaf chloroplasts. Axel Kleidon discussed the potential applicability of maximum entropy production and its limits as well as its potential use in describing an adaptive biosphere under global climatic change. Yoichi Facuda reviewed the satellite missions and precise gravimetry and discussed how both the techniques should be combined for investigation of active Geosphere. Ken Satake discussed common features in tsunamigenic ocean floors of subduction zone earth quakes from ocean bottom to coastal deposits. Wang Bin found that the seasonal march of the background monsoon flows control the nature of monsoon-ocean feedback and remarkably modify the atmospheric response to remote forcing on the basis of study of impacts of the monsoon-warm ocean interaction on the variability of the Asian-Australian monsoon system. I could interact with number of Indian and foreign scientists relevant to my discipline. Future collaborative/consultancy programs were also discussed with the following scientists namely Dr. Chang-Sik Cheong ,Geochronology Team leader, Korea Basic Science Institute, Daejeon, Korea, Dr.Karl-Heinz Wyrwoll, School of Earth and Geographical Sciences, University of Western Australia, Crawley WA,Dr.Mark M Baskaran, Wayne State University, Dept of Geology, Detroit, USA, Dr.R.V.Krishnamurthy, Isotope Lab, Michican University, USA and Dr.Kaji Dairaku, Atmospheric Environment Division, University of Tsukuba, Japan. On the whole the conferences were quite useful and informative for international/national collaboration and research.

B.Sekar & A.Bhattacharya
Birbal Sahni Institute of Palaeobotany,
53 University Road, Lucknow 226 007